# THE GLOBAL REFERENCE ATMOSPHERIC MODEL - MOD 2
# (WITH TWO SCALE PERTURBATION MODEL)

by

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INTERIM TECHNICAL REPORT

for

NASA George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

Contract NAS8-30657

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# Abstract

This report describes recent improvements in the Global Reference Atmospheric Model (NASA-TMX-64871 and 64872), originally developed as a global scale (all latitudes and longitudes) model from surface to orbital altitudes. The basic model includes monthly mean values of pressure, density, temperature, and geostrophic winds, as well as quasi-biennial and random perturbations. The newer version reported here incorporates a revised two scale random perturbation model using perturbation magnitudes which are adjusted to conform to constraints imposed by the perfect gas law and the hydrostatic condition. The two scale perturbation model produces appropriately correlated (horizontally and vertically) small scale and large scale perturbations. These stochastically simulated perturbations are representative of the magnitudes and wavelengths of perturbations produced by tides and planetary scale waves (large scale) and turbulence and gravity waves (small scale). Other new features of the model are: 1) a second order geostrophic wind relation for use at low latitudes, and which does not "blow up" at low latitudes as the ordinary geostrophic relation does, 2) revised quasi-biennial amplitudes and phases and revised stationary perturbations, based on data through 1972. The new model is better than the original version, especially in producing more realistic simulations of vertical profiles of atmospheric parameters.

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# 1. INTRODUCTION

In response to needs for empirical model atmospheres of wider scope and application Georgia Tech recently developed, under NASA sponsorship, a Global Reference Atmosphere Model (GRAM) with latitude, longitude, and monthly variations over a height range from 0 to 700 km (Justus, et al., 1974 a, b, 1975, 1976).

## 1.1 Description of the Basic Model

The Georgia Tech Global Reference Atmospheric Model (GRAM), is an amalgamation of two previously existing empirical atmospheric models for the low (< 25 km) and high (> 90 km) atmosphere, with a newly developed latitude-longitude dependent model for the middle atmosphere. The high atmospheric region above 115 km is simulated entirely by the Jacchia (1970) model. The Jacchia program sections are in separate subroutines so that later Jacchia models (Jacchia, 1971) or other thermospheric-exospheric models could easily be adapted and substituted into the program if required for special applications. The atmospheric region between 25 km and 115 km is simulated by a newly developed latitude-longitude dependent empirical model modification of the latitude dependent empirical model developed by Groves (1971), which is described more fully in this report. Between 90 km and 115 km a smooth transition between the modified Groves values and the Jacchia values is accomplished by a fairing technique. Below 25 km the atmospheric parameters are computed by a 4-D world-wide atmospheric model developed for NASA by Allied Research Associates (Spiegler and Fowler, 1972). Between 25 and 30 km an interpolation scheme is used between the 4-D results and the modified Groves values. Figure 1.1 presents a schematic summary of the Global Reference Atmospheric Model program atmospheric regions and how they are modeled.

The modifications to Groves model to produce longitude as well as latitude variations in the monthly mean were accomplished in two steps. For the original version, upper air summary map data for monthly means at the 10 mb level for 1966 and 1967 (NOAA, 1969b) and the 2 and 0.4 mb levels for 1966, 1967, and 1968 (NOAA, 1969a, 1970, 1971) were read and converted to values for the 30, 40, and 52 km levels. These upper air map values at the 2 and 0.4 mb levels were extended around the entire northern hemisphere by subjective extrapolation. For the Mod 2 version, additional 10 mb data for 1964 and 1965 (NOAA, 1967a) and 2 and 0.4 mb data for 1964 and 1965 (NOAA, 1967 b, c) and 1972 (NOAA, 1975) were also read and added to the earlier data. The 1972 2 and 0.4 mb data extended into the eastern hemisphere, so no extrapolation of it was necessary. Next the 30, 40, and 52 km latitude-longitude dependent values were extrapolated to 90 km by an extrapolation scheme developed by Graves, (1973). All of the map generated and extrapolated data were converted to percent deviation from the longitudinal mean and these are applied as deviations (called stationary perturbations) to the Groves model values, which are taken as the latitude dependent longitudinal means.

The seasonal variations in the middle atmosphere (25-115 km) are assumed to be the same in northern and southern hemispheres with a six months phase lag. That is, the southern hemisphere July is the same as the northern hemisphere January. In the 4-D region ($\leq$ 25 km)separate global coverage data values are available for each of the twelve months. A set of annual reference period data are also available for the 4-D and modified Groves regions. If the annual reference period is selected, the Jacchia section sets the exospheric temperature to 1000° K to represent annual mean conditions.

The monthly mean geostrophic winds are computed from horizontal pressure gradients, estimated by finite differences. Near the equator, a newly devised

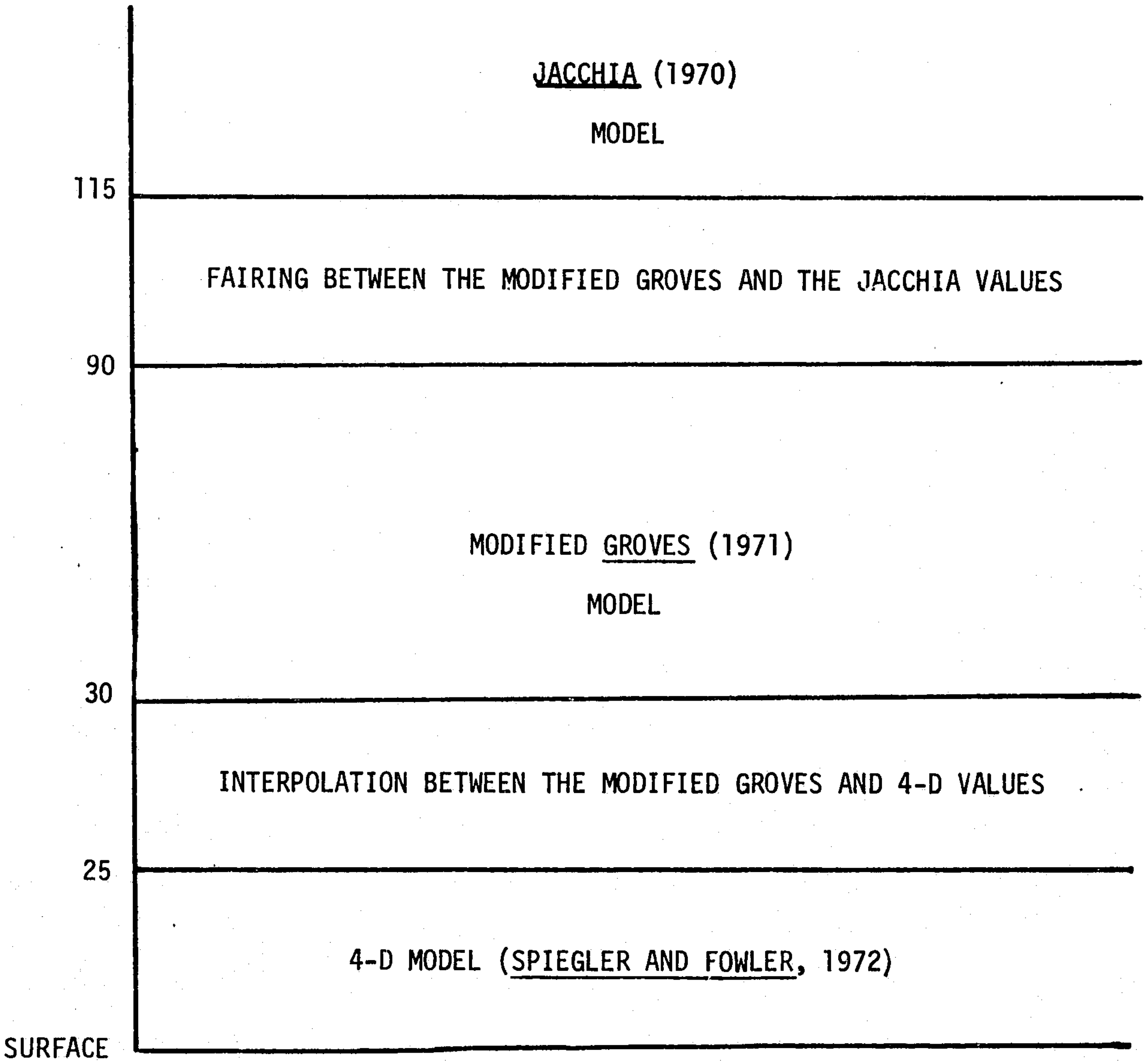


Figure 1.1 Schematic summary of the atmospheric regions in the Global Reference Atmospheric Model (GRAM) program and the simulation methods used for mean monthly values in each region

second order geostrophic wind, which remains finite as f (the Coriolis parameter) approaches zero, is used instead of the usual geostrophic relation (which approaches infinite values as f approaches zero). Mean vertical winds, of the order of a cm/sec, are also evaluated from the slopes of isentropic surfaces and the horizontal advective winds. Wind shear in the monthly mean horizontal wind is estimated from horizontal temperature gradients. These parameters serve as a consistency check on the pressure and temperature fields of the empirical model.

In addition to the monthly mean values of pressure, density and temperature, two types of perturbations are evaluated: quasi-biennial (QBO) and random. The QBO oscillations in pressure, density, temperature, and winds, empirically determined to be represented by an 870 day period sinusoidal variation, have amplitudes and phases which vary with height and latitude. The QBO amplitudes are primarily significant at low altitudes ($\approx$ 20 - 40 km) at equatorial latitudes and at higher altitudes (50 - 60 km) at higher latitudes. For the Mod 2 version, the QBO amplitudes and phases were newly evaluated from a larger data set, which included MRN data through 1972.

For realistic simulation of actual atmospheric parameter values as they would likely be at any given time, random perturbations are also computed and applied as perturbations to the monthly mean values. The random perturbations are evaluated by a simulation technique which uses empirical values of variation magnitudes and scales to generate random perturbations which have realistic space and time correlations.

Originally the perturbation model was characterized by a single vertical scale and horizontal scale, and no attempt was made to insure compliance with constraints on the perturbation magnitudes, required by the perfect gas law (Buell, 1970) and hydrostatic equation (Buell, 1972b). In an earlier report (Justus and Woodrum, 1975), the revisions were described which improved the data base of the perturbation magnitudes, and adjusted the magnitude profiles to insure compliance with the Buell constraints. For the Mod 2 version reported here, the use of a two scale perturbation model has been implemented. This model simulates separately the perturbations of small scale (e.g. turbulence and gravity waves) and large scale (e.g. tides and planetary waves) effects. These perturbations are still treated stochastically, however - no deterministic model of these physical processes is used.

In short, the major revisions in the Mod 2 version reported here are:

- revised stationary perturbations (now based on 1964 - 1972 upper air charts),
- revised quasi-biennial amplitudes and phases (now based on 1961 - 1972 MRN data),
- new second order geostrophic wind equations for use at low latitudes, and mean vertical winds based on slope of isentropic surfaces, and
- a two-scale random perturbation model to better simulate the effects of both small scale and large scale perturbations from monthly mean conditions.

The following sections give a technical description of the Global Reference Atmospheric Model - Mod 2 with emphasis on the new additions, and new users manual descriptions of the program aspects of the revised model.

## 2. TECHNICAL DESCRIPTION OF THE MODEL

### 2.1 The Jacchia Section

The Jacchia (1970) model for the thermosphere and exosphere was originally implemented to compute atmospheric density at satellite altitudes. The Jacchia model accounts for temperature and density variations due to solar and geomagnetic activity, diurnal and semi-annual variations, and seasonal and latitudinal variations. The Jacchia model assumes a uniformly mixed composition from sea level to 105 km, with diffusive equilibrium among the constituents (nitrogen, oxygen, argon, helium, and hydrogen) above 105 km. Fixed boundary values for temperature and density are assumed at 90 km. Alterations, described in Justus et al (1974 a), were made to allow atmospheric pressure to be computed from the density and temperature. Geostrophic winds (first order only) are evaluated in the Jacchia section by computing horizontal pressure gradients with successive evaluations of the Jacchia model at different latitudes and longitudes.

### 2.2 The 4-D Section (below 25 km)

The 4-D atmospheric model, developed by Allied Research Associates (Spiegler and Fowler, 1972) was designed to extract from data tapes and interpolate on latitude and longitude, mean monthly and daily variance profiles of pressure, density, temperature, at 1 km intervals from the surface to a height of 25 km for any location on the globe. The data tapes contain empirically determined atmospheric parameter profiles at a large array of locations. The northern hemisphere grid array is equivalent to the NMC grid network. Grids spaced at 5 degree intervals of latitude and longitude are used in the equatorial and southern hemisphere regions.

Technical changes made in the 4-D program were: a modified latitude-longitude interpolation method, previously described in Justus et al (1974 a), an adjustment routine to modify the variance to comply with the Buell constraints, and a check routine to determine vertical and horizontal consistency of the 4-D data.

The method of application of the 4-D model in the PROFILE program is as follows: at the first time that atmospheric parameters at a location below 30 km are required, a set of atmospheric profiles of monthly mean and daily variances of pressure, density, and temperature are generated at a 16 point grid of locations spaced at 5 degree latitude and longitude intervals (a slightly different grid is used near the poles). This grid of profiles, covering 15° x 15° of latitude-longitude is then stored in the computer and all further atmospheric parameter values in the 0-25 km range are found by interpolation between locations within this grid. If the trajectory goes outside this grid while the height remains below 25 km, the program attempts an estimate of the atmospheric parameters by an additional call on the routine which sets up the 4-D data grid.

The location of the grid points to be evaluated is determined dynamically based on the position and direction of travel along the trajectory when the 4-D grid is first required by a procedure described in Justus et al (1974 a). The 4-D data tapes normally contain data for the surface to 25 km in 1 km steps. At locations where the surface is at more than 1 km above sea level the surface value will be followed by one or more zero records, and the first non-zero record above the surface value will be at the lowest integer km higher than the surface. For example, if the surface is at 700 m then there will be data at surface, 1 km, 2 km, etc., but if the surface is at 1.3 km the data will contain the surface, one zero record, 2 km, 3 km etc. In the Mod-2 version an interpolation routine (based on the hydrostatic relation and constant lapse rate altitude segments) is used to fill in data between sea level and the first non-zero data above the surface. Interpolation is also used to fill in any missing data immediately below the 25 km height. The basic interpolation equations were described in Justus et al (1974 a).

## 2.3 The Modified Groves Section (25 - 90 km)

The starting point for the middle atmosphere (25 - 110 km) is the latitude dependent model of Groves (1971). This empirical model combines many observations from a wide range of longitudes. Observational results over approximately six years were used to compute longitudinal averages, which are presented versus latitude and month. Latitude coverage of the Groves model is from the equator to 70° or in some cases 80°. Southern hemisphere data were utilized in developing the Groves model as northern hemisphere data with a 6-month change of date. Tabulations of the Groves model are at intervals of 5 km in height, 10° in latitude (northern hemisphere), and one month in time (southern hemisphere displaced six months). If the Groves values of an atmospheric parameter y were known up to 80° latitude, then the 90° latitude Groves value was computed from

$$y_{90} = (4y_{80} - y_{70})/3 \tag{2.1}$$

If Groves values of the atmospheric parameter y were known only up to 70° latitude, then the 80° and 90° latitude Groves values was computed from

$$y_{90} = (9y_{70} - 4y_{60})/5 \tag{2.2}$$

$$y_{80} = (8y_{70} - 3y_{60})/5 \tag{2.3}$$

The Groves model data has only height and latitude variation for each month. For longitude variation, the Groves model data is modified by longitude, latitude, and height dependent stationary perturbations. These stationary perturbations are derived, by methods described more fully in Justus et al (1974 a) from 10, 2, and 0.4 mb map data and extrapolation up to 90 km. The stationary perturbations were evaluated at longitudes 10°, 40°, 70°, ... 340° for latitudes 10°, 30°, 50°, 70°, and 90°.

Originally, only the 1966 and 1967 10 mb monthly mean values (NOAA, 1969 b) were read and averaged. The 2 mb and 0.4 mb weekly mean maps for 1966, 1967, and 1968 (NOAA, 1969 a), 1970, 1971) were read for the first week of each month, and averaged over the three years. For the Mod 2 version, additional 10 mb data for 1964 and 1965 (NOAA, 1967 a) and 2 and 0.4 mb data for 1964 and 1965 (NOAA, 1967 b, c) and 1972 (NOAA, 1975) were also read and added to the earlier data. The 1972 2 and 0.4 mb data extended into the eastern hemisphere, so no extrapolation into this hemisphere was required, as was done with the earlier data.

After the upper air chart data were averaged, the next step was to convert the readings to constant heights of 30, 40, and 52 km. This was done by assuming that the temperature followed a constant lapse rate between each chart level and the nearest interpolation altitude with lapse rates based on the Groves model.

In order to introduce longitude variability at heights above 52 km, the extrapolation technique of Graves et al. (1973) was used to project the 52 km interpolated chart data up to 90 km. The 5 extrapolation height levels are 60, 68, 76, 84, and 90 km.

After the chart data were interpolated to 30, 40, and 52 km and extrapolated to 60, 68, 76, 84, and 90 km, the stationary perturbations (relative deviations to be added to the Groves values) were calculated. At each altitude and latitude the stationary perturbation $s_y$ for a parameter y (which can represent pressure, density, or temperature) was computed by the relation

$$s_y = (y - \langle y \rangle)/\langle y \rangle \tag{2.4}$$

where $\langle y \rangle$ represents the longitude averaged value of y (i.e. averaged around a circle of fixed latitude). Note that the definition of $s_y$ makes it be identically zero at the pole. The stationary perturbation $s_y$ for parameter y is added to the Groves value $G_y$ to produce the longitude variable modified Groves value $G'_y$, according to the relation

$$G'_y = G_y(1 + s_y) \tag{2.5}$$

The modified Groves values, determined by relation (2.5) are used as the monthly mean values for the altitude range 30 to 90 km.

## 2.4 Interpolation and Fairing

The 4-D data are available on the data tapes at one km height intervals and at 5° x 5° latitude-longitude grids in the southern and equatorial areas and at the NMC grid locations in the northern hemisphere. NMC grid profiles are always converted (by interpolation) to 5° x 5° grids before interpolation to the trajectory locations. The general interpolation requirements for the 4-D section are height interpolation over 1 km and latitude-longitude interpolation over a 5° x 5° square grid.

The Groves data are tabulated at 5 km height intervals and 10° latitude intervals. Interpolation is required between these tabulated locations. The stationary perturbations are evaluated at 20° latitude and 30° longitude intervals and at 30, 40, 52, 60, 68, 76, 84, and 90 km altitudes. Interpolation between these tabulated locations is also required. For values between 25 km and 30 km interpolation between the 4-D data and Groves-plus-stationary-perturbation data are required. The interpolations are always carried out in the program by doing the latitude (Groves) or latitude-longitude (4-D) interpolation first, and then doing the height interpolation.

The Jacchia model can be evaluated at any height above 90 km and at any latitude and longitude, so no interpolation is required. However, between 90 and 115 km there is overlap between the Groves data and the Jacchia model, so a fairing procedure is used to effect a smooth transition between the Groves data at 90 km and the Jacchia values at 115 km.

The method used to interpolate pressure, density, and temperature over a height interval between heights $z_1$ and $z_2$ is to assume linear variation of the temperature and of the logarithm of the density. The latitude interpolation for the Groves data is done by assuming linear variation between the latitudes $\phi_1$ and $\phi_2$ (which are at $\Delta\phi = 10°$ apart). Two dimensional latitude-longitude interpolation between a square or rectangular array of positions at latitudes $\phi_1$ and $\phi_2$ and west longitudes $\lambda_1$ and $\lambda_2$, is done by the relation

$$F(\phi , \lambda) = F_o + (F_1 - F_o)\delta\phi + (F_2 - F_o)\delta\phi + (F_3 - F_1 - F_2 + F_o)\delta\phi \ \delta\lambda$$

where $\delta\phi$ is $(\phi - \phi_1)/(\phi_2 - \phi_1)$ and $\delta\lambda$ is $(\lambda - \lambda_1)/(\lambda_2 - \lambda_1)$.

To accomplish smooth transition between the Groves values at 90 km and the Jacchia values at 115 km a fairing technique is used. This fairing technique was described in Justus et al (1974 a). The fairing is done only at the altitudes 95, 100, 105, 110, i.e. heights for which there are Groves values. Linear interpolation is then used to fill in the remaining heights, as discussed in the height interpolation section above.

A new feature of the Mod-2 version is that interpolation of the random perturbation magnitudes is done linearly on the variance ($\sigma^2$) rather than linearly on the magnitude ($\sigma$). This is because the Buell adjustment equations (see later sections) are nearly linear in the variances. Thus once variances have been Buell adjusted, their adjustment would tend to be preserved by linear interpolation on variances, not magnitudes.

## 2.5 Geostrophic Winds

The eastward (i.e. blowing toward the east) wind component u and northward component v can be evaluated from the geostrophic wind equations

$$u = -(1/\rho f)\ \partial p/\partial y \tag{2.6}$$

$$v = (1/\rho f)\ \partial p/\partial x \tag{2.7}$$

where $\rho$ is the density, f is the Coriolis parameter ($2\ \Omega \sin \phi$) and $\partial p/\partial x$ and $\partial p/\partial y$ are the eastward and northward components of the horizontal pressure gradient. For evaluation in the model, the pressure gradient terms must be approximated by finite differences.

Geostrophic wind values are also computed in the Jacchia height range by evaluating the Jacchia model at 5 degree increments of latitude and longitude and taking finite differences of the resulting pressure. This technique probably over extends the capabilities of the Jacchia model, however, and the computed winds in this height range should not be considered precise.

## 2.6 Thermal Wind Shear

The wind shear components $\partial u/\partial z$ and $\partial v/\partial z$ are evaluated by the thermal wind equations

$$\partial u/\partial z = -(g/fT)\ \partial T/\partial y \tag{2.8}$$

$$\partial v/\partial z = (g/fT)\ \partial T/\partial x \tag{2.9}$$

which is the usual form, leaving off a correction term in $\partial T/\partial z$, which is normally small. The horizontal temperature gradient terms are estimated by finite differences in a similar manner to the pressure gradient components in equations (2.6) and (2.7).

Thermal wind shears are also computed in the Jacchia height range in a manner similar to that described for the wind calculations. Again, however, for the reasons already discussed, these values should not be taken as precise.

## 2.7 Second Order Geostrophic Winds

Since the ordinary geostrophic winds are inversely proportional to the coriolis parameter f (which goes to zero at the equator), these relations give unrealistically large winds at low latitudes. To overcome this problem, second order geostrophic relations

$$u = (g/D)[a\, \partial p/\partial x + (b - f)\, \partial p/\partial y] \tag{2.10}$$

$$v = (g/D)[-a\, \partial p/\partial z + (c + f)\, \partial p/\partial x] \tag{2.11}$$

are used at low latitudes, where D is given by

$$D = ad - (b - f)(c + f) \tag{2.12}$$

and the coefficients a, b, c, and d (related to second order pressure derivatives) are evaluated by the method described in Appendix A.

## 2.8 Mean Vertical Winds

The Mod 2 version also evaluates mean vertical winds from the slope of isentropic surfaces. On such surfaces, the entropy function $\psi$ is constant, where $\psi$ is

$$\psi = C_p\, T + gz + (u^2 + v^2)/2 = \text{const.} \tag{2.13}$$

Therefore, on isentropic surfaces

$$\partial\psi/\partial t + u\partial\psi/\partial x + v\partial\psi/\partial y + w\partial\psi/\partial z = 0 \tag{2.14}$$

and, if $\partial\psi/\partial t$ is assumed zero, the vertical wind w can be solved for as

$$w = -[u\partial\psi/\partial x + v\partial\psi/\partial y]/(\partial\psi/\partial z) \tag{2.15}$$

By differentiation of (2.13), with the assumption that u and v are the geostrophic winds $u_g$ and $v_g$, and that $\partial u/\partial z$ and $\partial v/\partial z$ are given by the thermal wind relations, (2.15) becomes

$$w = -C_p\,[u_g(\partial T/\partial x) + v_g(\partial T/\partial y)]/$$

$$\{g + C_p(\partial T/\partial z) + (g/fT)[v_g(\partial T/\partial x) - u_g(\partial T/\partial y)]\} \qquad (2.16)$$

Mean vertical winds evaluated by (2.16) are generally less than a cm/sec, and hence are realistic values for the large scale mean vertical winds affecting mean meridional circulation.

## 2.9 The Quasi-Biennial Perturbations

In the Mod-0 Global Reference Atmospheric Model, MRN data from 1964-1969 were used to evaluate quasi-biennial amplitudes and phases in the height range 25-65 km. The quasi-biennial period which produce minimum variance, when simultaneously evaluating the annual, semi-annual, and quasi-biennial variation, was found to be 870 days. For the Mod 2 version, the harmonic analysis was done the same way with MRN data for 1970-1972 added to the original data base. Again the 870 day period was found to produce minimum variance for the QBO winds, while a 900 day period did slightly better for the thermodynamic variables. In order to retain a single period, the original 870 day period was chosen as still the preferable value overall. The revised quasi-biennial magnitudes and phases are listed in the "SCIDAT" data tape listing at the end of this report (Appendix B).

## 2.10 The Random Perturbation Model (Two Scale)

The original single scale perturbation model in the Global Reference Atmosphere Model (Justus et al, 1974 a) was evaluated by the following method: first the density perturbation $\rho_2'$ at the new location was computed from $\rho_1'$ the density perturbation at the previous location by the relation

$$(\rho_2'/\bar{\rho}_2) = A(\rho_1'/\bar{\rho}_1) + Br_1 \qquad (2.17)$$

where $\bar{\rho}_1$ and $\bar{\rho}_2$ are the known mean densities at the previous and new positions, A and B are determined from the required conditions, and $r_1$ is a random number selected from a Gaussian distribution with mean zero and unit standard deviation. The required conditions to be used in determining A and B are

$$<\rho_2' \rho_1'> = R \sigma_{\rho 1} \sigma_{\rho 2} \qquad (2.18)$$

$$<\rho_2'^2> = \sigma_{\rho_2}^{2} \qquad (2.19)$$

where $\sigma_{\rho 1}$ and $\sigma_{\rho 2}$ are the known standard deviations in density at the previous and new location, and R is the known autocorrelation in density perturbations between the previous and new locations. Next (with analogous notation as in (2.17) through (2.19), the new temperature perturbation was computed by

$$(T_2'/\bar{T}_2) = C(T_1'/\bar{T}_1) + D(\rho_2'/\bar{\rho}_2) + Er_2 \qquad (2.20)$$

In addition to the autocorrelation R (assumed the same for T' and $\rho'$ in the original one-scale model) the cross correlation $(R_{\rho T})_2$ was also maintained (through the coefficient D in equation (2.20)). The correlation $(R_{\rho T})_2$ was determined from the known standard deviations and means by the Buell (1970) relation

$$(R_{\rho T})_2 = \frac{[(\sigma_p)_2/\bar{p}_2]^2 - [(\sigma_\rho)_2/\bar{\rho}_2]^2 - [(\sigma_T)_2/\bar{T}_2]^2}{2[(\sigma_\rho)_2/\bar{\rho}_2]\,[(\sigma_T)_2/\bar{T}_2]} \qquad (2.21)$$

Once the density and temperature perturbations were evaluated, the pressure perturbation was determined via

$$(p_2'/p_2) = (\rho_2'/\bar{\rho}_2) + (T_2'/\bar{T}_2) \qquad (2.22)$$

which is a first order perturbation equation from the perfect gas law. In the original single scale perturbation model, wind perturbation components u' v' were assumed to be uncorrelated with each other and with the thermodynamic variables, and hence were computed by relations analagous to equation (2.17).

In the original one-scale model, only the total perturbations are considered (e.g. $\rho = \bar{\rho} + \rho'$) while in the new two scale model the perturbations are assumed to be made up of a large scale and small scale component (e.g. $\rho = \bar{\rho} + \rho_L + \rho_S$). To first order in the perturbations the state of the mean atmosphere is described by

$$\bar{p} = \bar{\rho} R \bar{T} \tag{2.23}$$

and the mean plus large scale perturbations by

$$(\bar{p} + p_L) = (\bar{\rho} + \rho_L) R(\bar{T} + T_L) \tag{2.24}$$

and the actual atmospheric parameters p, $\rho$, and T by

$$p = \rho R T \tag{2.25}$$

Division of equations (2.24) and (2.25) by $\bar{p}$ on the left and by $\bar{\rho} R \bar{T}$ on the right yields, to first order in the perturbations

$$p_L/\bar{p} = (\rho_L/\bar{\rho}) + (T_L/T) \tag{2.26}$$

$$p_S/\bar{p} = (\rho_S/\bar{\rho}) + (T_S/\bar{T}) \tag{2.27}$$

These results mean that the small scale and large scale perturbations each separately must obey the Buell triangle relationships for their magnitudes. Thus, analogous to equation (2.21), the correlations $R_{\rho_L T_L}$ for large scale perturbations and $R_{\rho_S T_S}$ for small scale perturbations are given in terms of their respective magnitudes by

$$R_{\rho_L T_L} = \frac{(\sigma_{p_L}/\bar{p})^2 - (\sigma_{\rho_L}/\bar{\rho})^2 - (\sigma_{T_L}/\bar{T})^2}{2(\sigma_{\rho_L}/\bar{\rho})(\sigma_{T_L}/\bar{T})} \tag{2.28}$$

$$R_{\rho_s T_s} = \frac{(\sigma_{p_s}/\bar{p})^2 - (\sigma_{\rho_s}/\bar{\rho})^2 - (\sigma_{T_s}/\bar{T})^2}{2(\sigma_{\rho_s}/\bar{\rho})(\sigma_{T_s}/\bar{T})} \tag{2.29}$$

The large and small scale components are assumed to be independent so correlations such as $R_{\rho_s T_L}$, $R_{\rho_L T_s}$ etc. are taken to be zero.

The density perturbations $\rho_{L_2}$ and $\rho_{s_2}$ at the new position are thus computed from the known perturbations $\rho_{L_1}$ and $\rho_{s_1}$ at the previous position by relations analogous to equation (2.17)

$$(\rho_{L_2}/\bar{\rho}) = A_L(\rho_{L_1}/\bar{\rho}_1) + B_L r_{L_1} \tag{2.30}$$

$$(\rho_{s_2}/\bar{\rho}) = A_s(\rho_{s_1}/\bar{\rho}_1) + B_s r_{s_1} \tag{2.31}$$

where $A_L$, $B_L$, $A_s$ and $B_s$ can each be determined (as before) from the conditions

$$\langle \rho_{L_2}\, \rho_{L_1} \rangle = R_L\,(\rho)\, \sigma_{\rho L_2}\, \sigma_{\rho L_1} \tag{2.32}$$

$$\langle \rho_{L_2}^{\,2} \rangle = \sigma_{\rho L_2}^{2} \tag{2.33}$$

$$\langle \rho_{s_2}\, \rho_{s_1} \rangle = R_s\,(\rho)\, \sigma_{\rho s_2}\, \sigma_{\rho s_1} \tag{2.34}$$

$$\langle \rho_{s_2}^{\,2} \rangle = \sigma_{\rho s_2}^{2} \tag{2.35}$$

where the density autocorrelations $R_L\,(\rho)$ and $R_s\,(\rho)$ are determined from the known horizontal and vertical scale of the large scale and small scale perturbations (see the following section on scales). Similarly, the temperature perturbations are computed (analogous to equation (2.20) by

$$(T_{L_2}/\bar{T}_2) = C_L(T_{L_1}/\bar{T}_1) + D_L(\rho_{L_2}/\bar{\rho}_2) + E_L r_{L_2} \tag{2.36}$$

$$(T_{s_2}/\bar{T}_2) = C_s(T_{s_1}/\bar{T}_1) + D_s(\rho_{s_2}/\bar{\rho}_2) + E_s r_{s_2} \tag{2.37}$$

where again $D_L$ and $D_s$ are determined by the required cross correlations $R_{\rho_s T_s}$ and $R_{\rho_L T_L}$ at the new position, as computed from equations (2.28) and (2.29). Once the density and temperature perturbations are computed, the pressure perturbations are evaluated from equations (2.26) and (2.27).

A further addition to the new model has been brought about by empirically evaluated correlations $R_{u_L v_L}$, $R_{u_s v_s}$, $R_{u_L \rho_L}$, and $R_{u_s \rho_s}$. The new method of evaluating the velocity perturbation components is somewhat analogous to that employed for the temperature component. The equations used are

$$u_{L_2} = F_L u_{L_1} + G_L \rho_{L_2} + H_L r_{u_L} \tag{2.38}$$

$$u_{s_2} = F_s u_{s_1} + G_s \rho_{s_2} + H_s r_{u_s} \tag{2.39}$$

and

$$v_{L_2} = I_L v_{L_1} + J_L u_{L_2} + K_L r_{v_L} \tag{2.40}$$

$$v_{s_2} = I_s v_{s_1} + J_s u_{s_2} + K_s r_{v_s} \tag{2.41}$$

where the coefficients $G_L$ and $G_s$ are determined from the newly evaluated correlations $R_{u_L \rho_L}$ and $R_{u_s \rho_s}$, and the coefficients $J_L$ and $J_s$ are evaluated from the correlations $R_{u_L v_L}$ and $R_{u_s v_s}$.

For evaluation of the coefficients C, D, and E in (2.36) and (2.37), and the coefficients F through K in (2.38) through (2.41), these equations are successively multiplyed through by the perturbation quantities on the right hand side (see Appendix B in Justus et al, (1974 a)). The relations thus established for the coefficients A through K (with analogous equations for both large scale $A_L - K_L$ and small scale $A_s - K_s$) are

$$A = R(\rho)\ \sigma_{\rho_2}/\sigma_{\rho_1} \tag{2.42}$$

$$B = \sigma_{\rho_2}[1 - R^2(\rho)]^{1/2} \tag{2.43}$$

$$C = [R(T)\ \sigma_{T_2}/\sigma_{T_1}]\ \{[1 - R_{T_2\rho_2}\ R_{T_1\rho_1}]/$$

$$[1 - R^2(T)\ R^2_{T_1\rho_1}]\} \tag{2.44}$$

$$D = [R(T)\ \sigma_{T_2}\sigma_{T_1} - C\sigma^2_{T_1}]/(A\ R_{T_1\rho_1}\ \sigma_{T_1}) \tag{2.45}$$

$$E = [\sigma^2_{T_2} - C^2\ \sigma_{T_1}^{\ 2} - D^2\sigma_{\rho_2}^{\ 2} -$$

$$2\ C\ D\ R(T)\ R_{T_1\rho_1}\ \sigma_{T_1}\ \sigma_{\rho_2}]^{1/2} \tag{2.46}$$

$$F = (\sigma_{u_2}/\sigma_{u_1})\ \{[R(u) - R(\rho)\ R_{u_2\rho_2}\ R_{u_1\rho_1}]/$$

$$[1 - R^2(\rho)\ R^2_{u_1\rho_1}]\} \tag{2.47}$$

$$G = (R(u)\ \sigma_{u_2} - F\ \sigma_{u_1}]/[R(\rho)\ R_{u_1\rho_1}\ \sigma_{\rho_2}] \tag{2.48}$$

$$H = [\sigma_{u_2}^{\ 2} - F^2\ \sigma_{u_1}^{\ 2} - G^2\ \sigma_{\rho_2}^{\ 2} -$$

$$2\ F\ G\ R\ (\rho)R_{u_1\rho_1}\ \sigma_{\rho_2}\ \sigma_{u_1}]^{1/2} \tag{2.49}$$

$$I = (\sigma_{v_2}/\sigma_{v_1})\ \{[R(v) - R(\rho)\ R^2_{v_2\rho_2}\ R_{v_1\rho_1}]/$$

$$[1 - R^2\ (\rho)\ R_{v_1\rho_1}]\} \tag{2.50}$$

$$J = [R(v)\ \sigma_{v_2} - I\ \sigma_{v_1}]/[R(\rho)\ R_{v_1\rho_1}\ \sigma_{\rho_2}] \tag{2.51}$$

$$K = [\sigma_{v_2}^{\ 2} - I^2\ \sigma_{v_1}^{\ 2} - J^2\ \sigma_{\rho_2}^{\ 2} -$$

$$2\ I\ J\ R\ (\rho)\ R_{v_{1\rho_1}}\ s_{\rho_2}\ \sigma_{v_1}]^{1/2} \tag{2.52}$$

where the autocorrelations of density R ($\rho$), temperature R(T) and wind R(u) (R(u) and R(v) are assumed equal), are determined from the horizontal and vertical scales $L_{Z_\rho}$, $L_{H_\rho}$, $L_{Z_T}$, $L_{H_T}$, $L_{Z_u}$ and $L_{H_u}$ by the relations

$$R(\rho) = \exp \{ - [(\Delta x^2 + \Delta y^2)/L^2_{H_\rho} + \Delta z^2/L^2_{Z_\rho} ]^{1/2}\} \tag{2.53}$$

$$R(T) - \exp \{ - [(\Delta x^2 + \Delta y^2)/L^2_{H_T} + \Delta z^2/L^2_{Z_T} ]^{1/2}\} \tag{2.54}$$

$$R(u) = \exp \{ - [(\Delta x^2 + \Delta y^2)/L^2_{H_u} + \Delta z^2/L^2_{Z_u} ]^{1/2}\} \tag{2.55}$$

The following two sections describe how the total perturbation magnitudes (Buell adjusted, and obtained as described in Justus and Woodrum, 1975) are subdivided into large and small scale magnitudes, and how the horizontal and vertical scales for equation (2.53) through (2.55) were evaluated by vertical structure function analysis.

## 2.11 Daily Difference Analysis for the Two Scale Perturbation Magnitudes

Consider the density $\rho$, and the zonal and meridional wind components u and v to be made up of the following components: mean (subscript o), seasonal variation (subscript s), planetary wave component (subscript p), tidal component (subscript t), gravity wave component (subscript g), and error and/or small scale turbulence (subscript e). Thus, the parameters $\rho$, u, and v can be written

$$\rho = \rho_o + \rho_s + \rho_p + \rho_t + \rho_g + \rho_e \tag{2.56}$$

$$u = u_o + u_s + u_p + u_t + u_g + u_e \tag{2.57}$$

$$v = v_o + v_s + v_p + v_t + v_g + v_e \tag{2.58}$$

By daily difference analysis (Justus and Woodrum, 1973) the mean square differences over one 24 hour day ($< \Delta\rho_1^2> = <[\rho(t + 1 \text{ day}) - \rho(t)]^2>$, etc.) are given by

$$<\Delta\rho_1^2> \;=\; 2<\rho_g^2> + 2<\rho_e^2> \tag{2.59}$$

and similar relations for u and v and daily differences over n = 7 to 15 days ($<\Delta\rho_n^2> = <[\rho(t + n \text{ days}) - \rho(t)]^2>$, etc.) are given by

$$<\Delta\rho_n^2> \;=\; 2<\rho_p^2> + 2<\rho_g^2> + 2<\rho_e^2> \tag{2.60}$$

and similar relations for u and v. The monthly means $\bar{\rho}$, $\bar{u}$, and $\bar{v}$, are:

$$\bar{\rho} \;=\; \rho_o + \rho_s \tag{2.61}$$

$$\bar{u} \;=\; u_o + u_s$$

$$\bar{v} \;=\; v_o + v_s \tag{2.63}$$

and so mean square differences of deviations from the monthly means ($<\Delta\rho_o^2> = <[\rho - \bar{\rho}]^2>$, etc. are given by

$$<\rho_g^2> \;=\; <\rho_p^2> + <\rho_t^2> + <\rho_g^2> + <\rho_e^2> \tag{2.64}$$

and similar relations for u and v. Combination of the above equations allows the following solutions for the desired component magnitudes in terms of the measurable rms differences:

$$<\rho_g^2> + <\rho_e^2> \;=\; 1/2\ <\Delta\rho_1^2> \tag{2.65}$$

$$<\rho_p^2> \;=\; 1/2\ <\Delta\rho_n^2> - 1/2\ <\Delta\rho_1^2> \tag{2.66}$$

$$<\rho_t^2> \;=\; <\Delta\rho_o^2> - 1/2\ <\Delta\rho_n^2> \tag{2.67}$$

All of the quantities on the right of (2.65) through (2.67) are directly measurable from data profiles.

For the two-scale perturbation model, the small scale component would be represented by the gravity wave component

$$\sigma_s^2 = \langle \rho_g^2 \rangle + \langle \rho_e^2 \rangle = 1/2 \langle \Delta\rho_1^2 \rangle \qquad (2.68)$$

where only the true turbulence contribution of $\langle \rho_e^2 \rangle$ is to be taken (the error component can be estimated from time series analysis (Justus and Woodrum, 1973) and the turbulence component can be estimated from turbulence studies). The large scale component is represented by the sum of the planetary wave and tidal components

$$\sigma_L^2 = \langle \rho_p^2 \rangle + \langle \rho_t^2 \rangle = \langle \Delta\rho_o^2 \rangle - 1/2 \langle \Delta\rho_1^2 \rangle \qquad (2.69)$$

A similar analysis can be performed to determine the u - v cross correlations and the u - $\rho$ cross correlations. The analysis is done in terms of mean product daily differences ($\langle \Delta u_1 \, \Delta v_1 \rangle = \langle [u(t + 1 \text{ day}) - u(t)] \, [v(t + 1 \text{ day}) - v(t)] \rangle$, etc). Application of the same daily difference techniques yields the following:

$$\langle \Delta u_1 \, \Delta v_1 \rangle = 2\langle u_g \, v_g \rangle + 2\langle u_e \, v_e \rangle \qquad (2.70)$$

$$\langle \Delta u_1 \, \Delta\rho_1 \rangle = 2\langle u_g \, \rho_g \rangle + 2\langle u_e \, \rho_e \rangle \qquad (2.71)$$

$$\langle \Delta u_n \, \Delta v_n \rangle = 2\langle u_p \, v_p \rangle + 2\langle u_g \, v_g \rangle + 2\langle u_e \, v_e \rangle \qquad (2.72)$$

$$\langle \Delta u_n \, \Delta\rho_n \rangle = 2\langle u_p \, \rho_p \rangle + 2\langle u_g \, \rho_g \rangle + 2\langle u_2 \, \rho_e \rangle \qquad (2.73)$$

$$\langle \Delta u_o \, \Delta v_o \rangle = \langle u_p \, v_p \rangle + \langle u_t \, v_t \rangle + \langle u_g \, v_g \rangle + \langle u_e \, v_e \rangle \qquad (2.74)$$

$$\langle \Delta u_o \, \Delta\rho_o \rangle = \langle u_p \, \rho_p \rangle + \langle u_t \, \rho_t \rangle + \langle u_g \, \rho_g \rangle + \langle u_e \, \rho_e \rangle \qquad (2.75)$$

Rearrangement to solve for the component cross products yields:

$$\langle u_g\ v_g\rangle + \langle u_e\ v_e\rangle = 1/2\ \langle \Delta u_1\ \Delta v_1\rangle \qquad (2.76)$$

$$\langle u_g\ \rho_g\rangle + \langle u_e\ \rho_e\rangle = 1/2\ \langle \Delta u_1\ \Delta \rho_1\rangle \qquad (2.77)$$

$$\langle u_p\ v_p\rangle = 1/2\ \langle \Delta u_n\ \Delta v_n\rangle - 1/2\ \langle \Delta u_1\ \Delta v_1\rangle \qquad (2.78)$$

$$\langle u_p\ \rho_p\rangle = 1/2\ \langle \Delta u_n\ \Delta \rho_n - 1/2\ \langle \Delta u_1\ \Delta \rho_1\rangle \qquad (2.79)$$

$$\langle u_t\ v_t\rangle = \langle \Delta u_o\ \Delta v_o\rangle - 1/2\ \langle \Delta u_n\ \Delta v_n\rangle \qquad (2.80)$$

$$\langle u_t\ \rho_t\rangle = \langle \Delta u_o\ \Delta \rho_o\rangle - 1/2\ \langle \Delta u_n\ \Delta \rho_n\rangle \qquad (2.81)$$

Again all the terms on the right are directly measurable from the MRN and upper level profiles. The correlations $(r_{u\rho})_s$ and $(r_{uv})_s$ for the small scale perturbations would be given by

$$(r_{u\rho})_s = \frac{\langle u_g\ \rho_g\rangle + \langle u_e\ \rho_e\rangle}{(\sigma_u)_s\ (\sigma_\rho)_s} \qquad (2.82)$$

$$(r_{uv})_s = \frac{\langle u_g\ v_g\rangle + \langle u_e\ v_e\rangle}{(\sigma_u)_s\ (\sigma_v)_s} \qquad (2.83)$$

where the major contribution to $\langle u_e\ \rho_e\rangle$ and $\langle u_e\ v_e\rangle$ will come from the turbulence (the error component assumed to be uncorrelated). The correlations $(r_{u\rho})_L$ and $(r_{uv})_L$ for the large scale perturbations would be given by

$$(r_{u\rho})_L = \frac{\langle u_p\ \rho_p\rangle + \langle u_t\ \rho_t\rangle}{(\sigma_u)_L\ (\sigma_\rho)_L} \qquad (2.84)$$

$$(r_{uv})_L = \frac{\langle u_p\ v_p\rangle + \langle u_t\ v_t\rangle}{(\sigma_u)_L\ (\sigma_v)_L} \qquad (2.85)$$

Application of the above daily difference analysis to MRN data for 1964-1972 has yielded magnitudes of the large and small scale components, and values for the density - velocity correlations. Since large scale magnitudes $\sigma_L$ and small scale magnitudes $\sigma_s$ must add as the sum of the squares to give the total perturbation magnitude $\sigma_T$ (because large and small scale perturbations are considered independent), then

$$\sigma_T^2 = \sigma_L^2 + \sigma_s^2 \tag{2.86}$$

and the values of $\sigma_L$ and $\sigma_s$ can be described in terms of the previously evaluated total perturbations magnitudes (Justus and Woodrum, 1975) and the fraction $f_L$ of the total variance contained in the large scale variance, i.e.

$$f_L = \sigma_L^2/\sigma_T^2 \tag{2.87}$$

Thus, $\sigma_L$ and $\sigma_s$ are given in terms of $\sigma_T$ and $f_L$ by

$$\sigma_L = \sqrt{f_L}\,\sigma_T \tag{2.88}$$

$$\sigma_s = \sqrt{1 - f_L}\,\sigma_T \tag{2.89}$$

Total magnitudes for pressure, density and temperature perturbations are listed as the code "R" data on the "SCIDAT" data tape (Appendix B), the total magnitudes for the wind components are the code "RW" data, and the fractional variances in the large scale are the code "P" and "PW" data.

The wind - density correlations, determined from daily difference analysis relations (2.82) through (2.85) are given in the SCIDAT data tape code "CS" and "CL" data.

## 2.12 Vertical Structure Function Analysis for Perturbation Vertical Scales

Vertical structure functions may be used to determine vertical scales of the gravity waves, planetary waves, and tides. The vertical structure function of the one day differences (for example, in $\rho$) is

$$\begin{aligned} D_{\Delta\rho_1}(\zeta) &= \langle[\Delta\rho_1(z+\zeta) - \Delta\rho_1(z)]^2\rangle \\ &= 2\langle[\rho_g(z+\zeta) - \rho_g(z)]^2\rangle + 4\langle\rho_e{}^2\rangle \\ &= 2D_{\rho_g}(\zeta) + 4\langle\rho_e{}^2\rangle \end{aligned} \tag{2.90}$$

and the vertical structure function of the 7 - 15 day difference is

$$\begin{aligned} D_{\Delta\rho_n}(\zeta) &= \langle[\Delta\rho_n(z+\zeta) - \Delta\rho_n(z)]^2\rangle \\ &= 2\langle[\rho_p(z+\zeta) - \rho_p(z)]^2\rangle \\ &\quad + 2\langle[\rho_g(z+\zeta) - \rho_g(z)]^2\rangle + 4\langle\rho_e{}^2\rangle \\ &= 2\,D_{\rho_p}(\zeta) + 2D_{\rho_g}(\zeta) + 4\langle\rho_e{}^2\rangle \end{aligned} \tag{2.91}$$

Therefore the structure function for the planetary waves $D_{\rho_p}$ is formed from

$$D_{\rho_p}(\zeta) = [D_{\Delta\rho_n}(\zeta) - D_{\Delta\rho_1}(\zeta)]/2 \tag{2.92}$$

The vertical structure function for $\Delta\rho_o$ is

$$\begin{aligned} D_{\Delta\rho_o}(\zeta) &= \langle[\Delta\rho_o(z+\zeta) - \Delta\rho_o(z)]^2\rangle \\ &= \langle[\rho(z+\zeta) + \bar{\rho}(z+\zeta) - \rho(z) + \bar{\rho}(z)]^2\rangle \\ &= \langle[\rho_p(z+\zeta) - \rho_p(z)]^2\rangle + \langle[\rho_t(z+\zeta) - \rho_t(z)]^2\rangle \\ &\quad + \langle[\rho_g(z+\zeta) - \rho_g(z)]^2\rangle + 2\langle\rho_e{}^2\rangle \\ &= D_{\rho_p}(\zeta) + D_{\rho_t}(\zeta) + D_{\rho_y}(\zeta) + 2\langle\rho_e{}^2\rangle . \end{aligned} \tag{2.93}$$

Thus the structure function of the tides $D_{\rho_t}(\zeta)$ can be computed from

$$D_{\rho_t}(\zeta) = D_{\Delta\rho_o}(\zeta) - 1/2\, D_{\Delta\rho_n}(\zeta) \tag{2.94}$$

Vertical structure function analysis was performed on 1964-1972 MRN data and the vertical structure functions of large scale and small scale components were determined. Vertical scales were determined from subjective intersection of the vertical structure function curves and $2\sigma^2$ values (the small scale vertical structure function should level off at $2\sigma_s^2$ and the large scale at $2\sigma_L^2$). Since the MRN data cover 25 - 65 km, the vertical scales thus determined are taken as applying to an average height of 45 km. A set of vertical scales, thus determined, for the large scale and small scale wind perturbations is shown in Figure 2.1. Considerable variation with latitude is seen for the large scale, hence a latitude varying function was selected to fit to all of the MRN determined vertical scales. The latitude function is of the general form

$$L_V = a + b\,(90 - \phi)^2 \tag{2.95}$$

where $L_V$ is the vertical scale, a and b are the empirical coefficients required to fit the observed data, and $\phi$ is the latitude in degrees. These functions, thus fit through the data points, for the large scale and small scale components are shown as the solid and dashed curves in Figure 2.1.

Earlier (Justus and Woodrum, 1975), the Buell depth of pressure scale D, given by the relation

$$D = H_p(\sigma_p/\bar{p})/[(\sigma_T/\bar{T})(1 - R^2_{\rho T})^{1/2}] \tag{2.96}$$

where $H_p$ is the pressure scale height, was suggested as the vertical scale to use in the single scale perturbation model. The current vertical structure function analysis has shown that this cannot be applied as the vertical scale (either large or small scale) for all of the parameters, because the vertical scales for temperature tend to be smaller than for density or pressure, for

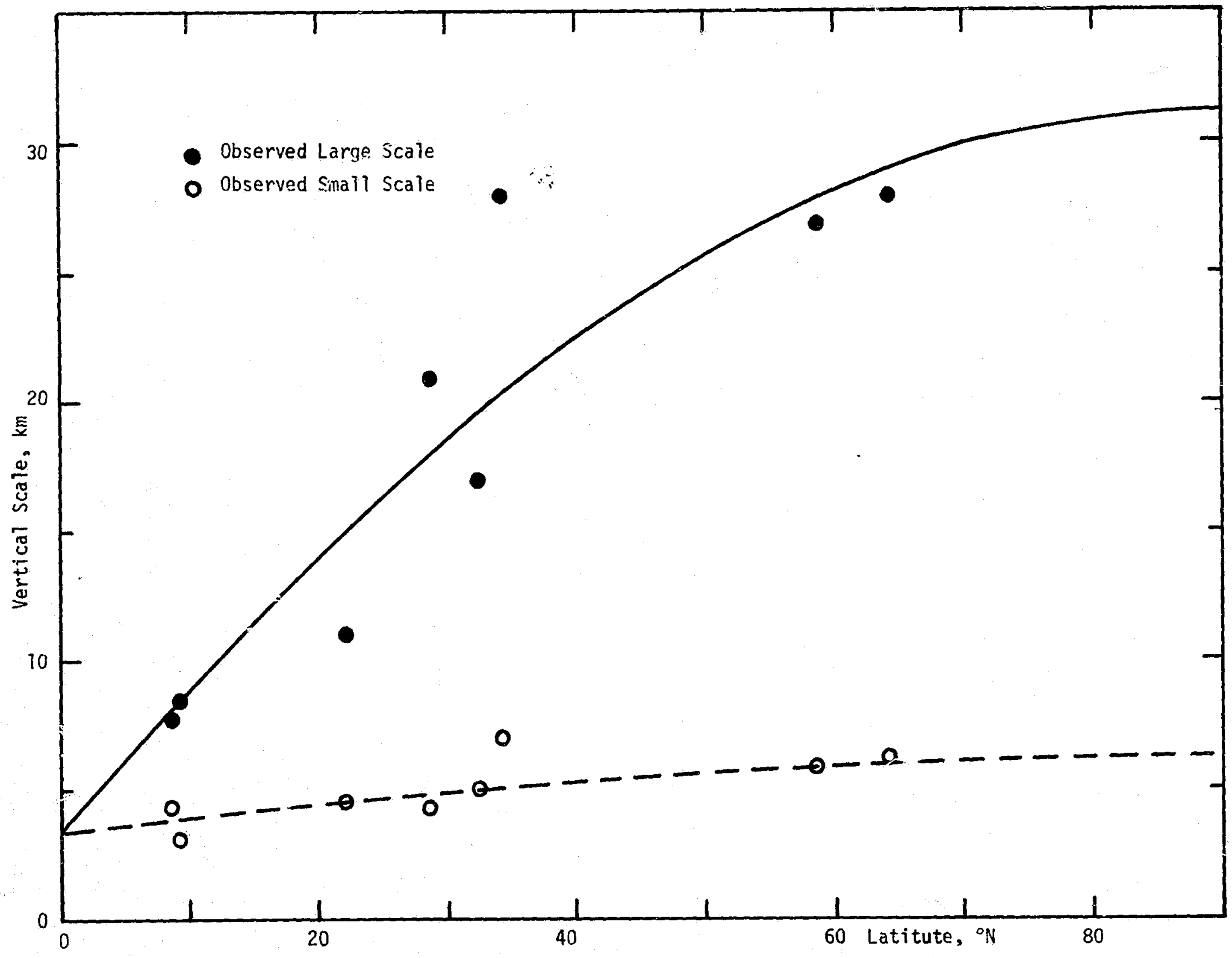


Figure 2.1 - Structure Function Vertical Scales for Large and Small Scale Wind Perturbations

example. Nevertheless, the Buell depth of pressure scale variation with height as evaluated in Figure 4.3 of Justus and Woodrum (1975) has been taken as describing the form of the vertical variation of the vertical scale with height from the surface to near 60 km. The variations of vertical scale with height, previously presented as Table 8 in Justus and Woodrum, (1972) were taken to represent height variation of the vertical scales up to about 150 km altitude. From these two sources of height variation of scale, a height function f(z) has been empirically evaluated which adjusts the 45 km vertical scale, determined from (2.95), to any height z. This function, normalized to one at 45 km, is given by

$$f(z) = 0.22 + 0.00258\ z^{1.5} \qquad (2.97)$$

and the vertical scale at any height z, is thus given, by combination of (2.95) and (2.97) by

$$L_v\ (z) = [a + b\ (90 - \phi)^2][0.22 + 0.00258z^{1.5}] \qquad (2.98)$$

Figure 2.2 shows the data, normalized to one at 45 km, on which relation (2.97) was based. The solid dots are the relative height variation of the Buell depth of pressure scale up to 55 km (from Figure 4.3 of Justus and Woodrum, 1975). The open circles are the relative height variations of gravity wave wind scales, from Table 8 of Justus and Woodrum, (1972), and the triangles are the relative height variations of gravity wave pressure, density, and temperature scales from Table 8 of the same source. The solid curve in Figure 2.2 is a plot of equation (2.97).

## 2.13 Horizontal Scales

The previous horizontal scales used in the single scale perturbation model, varying linearly from 900 km at the surface to 1500 km at an altitude

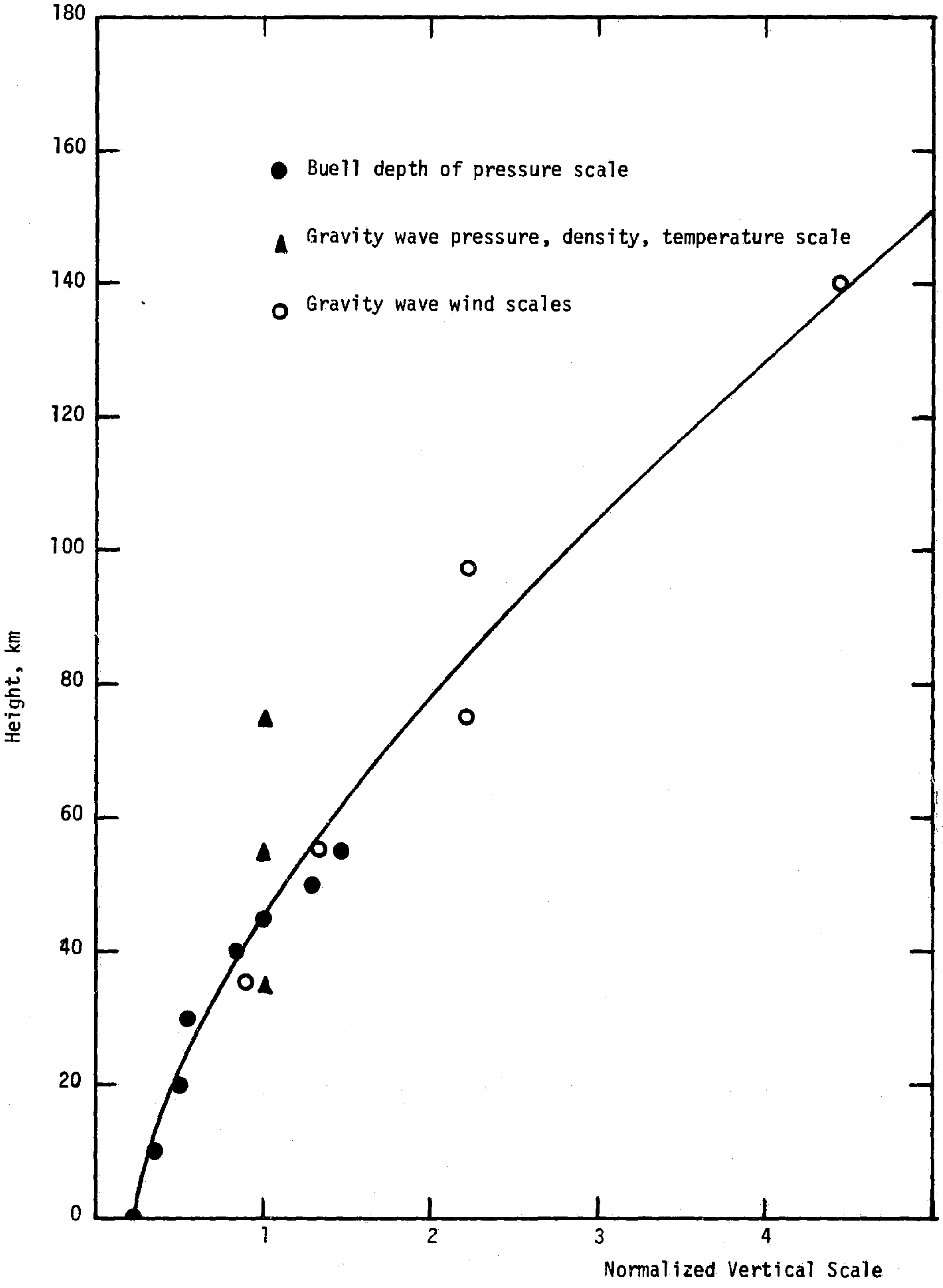


Figure 2.2 - Height Variation of Vertical Scales

of 100 km, have been retained as the horizontal scale of the large scale perturbation components. Horizontal scales for the small scale component, obtained from a subjective fit of data presented in Table 8 of Justus and Woodrum (1972), are given by

$$L_H = 20 + 0.0125\ z^2 \tag{2.99}$$

This function goes from 20 km at the surface ($z = 0$) to 145 km at a height of 100 km and adequately fits the observed gravity wave horizontal scale from Table 8 of Justus and Woodrum (1972).

## 2.14 The Adjustment Technique for the Statistical Parameters

There are certain constraints which are placed on the thermodynamic variation statistics as a result of the perfect gas law (Buell, 1970) and the equation of hydrostatic equilibrium (Buell, 1972). As Buell has shown, these relations can be conveniently expressed in terms of the coefficients of variation ($V_p = \sigma_p/\bar{p}$, $V_\rho = \sigma_\rho/\bar{\rho}$, $V_T = \sigma_T/\bar{T}$) and the correlation coefficients ($r_{pT}$, $r_{\rho T}$, $r_{p\rho}$). The Buell equations for the perfect gas law constraint are:

$$r_{pT} = (V_p^2 - V_\rho^2 + V_T^2)/(2V_pV_T) \tag{2.100}$$

$$r_{\rho T} = (V_p^2 - V_\rho^2 - V_T^2)/(2V_\rho V_T) \tag{2.101}$$

$$r_{p\rho} = (V_p^2 + V_\rho^2 - V_T^2)/(2V_pV_\rho) \tag{2.102}$$

which express the law of cosines for a triangle whose sides are $V_p$, $V_\rho$, and $V_T$ and whose interior angles are arc cosines of the correlation coefficients. The Buell equation for the hydrostatic equilibrium constraint is

$$H_p\ \partial V_p{}^2/\partial z = V_p{}^2 - V_\rho{}^2 + V_T{}^2 \tag{2.103}$$

where $H_p$ is the pressure scale height $H_p = R\bar{T}/g$. Buell (1972b) described a method for numerically integrating equation (2.103) to obtain adjusted values of $V_p$, $V_\rho$, and $V_T$ which satisfy the constraint relationship from a set of original coefficients of variation which do not satisfy this constraint.

For the Mod 2 program, total perturbation magnitudes for heights above 25 km were obtained from MRN "SUMS" tape data and from rocket grenade and other high altitude data sources (Theon et al, 1972), and were Buell adjusted, as described in Justus and Woodrum, (1975). A new subroutine ADJUST was added to the program to do the Buell adjustment for the data profiles obtained from the 4-D data tapes (0 - 25 km).

## 3. SAMPLE RESULTS

Figure 3.1 shows a sample vertical profile of mean temperature (given as percent deviation from the 1962 U.S. Standard Atmosphere) produced by the Mod 2 Global Reference Atmospheric Model. This profile is for Kennedy Space Flight Center in January. The dashed curve in Figure 3.1 shows, for comparison, the range reference atmosphere temperature profile for Kennedy Space Flight Center. Figures 3.2 through 3.4 show similar comparisons between Global Reference Atmospheric Model profiles and Kennedy range reference atmosphere profiles for density, zonal (east-west) wind and meridional (north-south) wind components. These figures show good agreement between the model and the range reference atmosphere values, with only minor changes from the mean atmospheric values produced by the original Mod 0 version (c.f. Figures 10.9 - 10.11 in Justus et al, 1974a).

Figure 3.5 shows an example vertical profile of mean values and mean plus perturbation values from the original single scale perturbation model. This figure shows zonal winds at Kennedy in January, compared to an observed MRN profile measured on January 19, 1972. The single scale perturbation model is seen to put too much perturbation variance into small vertical scales. This problem is overcome with the new two scale perturbation model, as shown in Figure 3.6 for January zonal wind at Kennedy. In this figure a significant portion of the perturbation variance is in relatively large vertical scales and a smaller amount of the variance is in the small vertical wave lengths. Correspondence of the model generated mean plus perturbation with the sample MRN observed data is considerably better with the two scale perturbation model.

Further examples of two scale perturbation model results are shown in

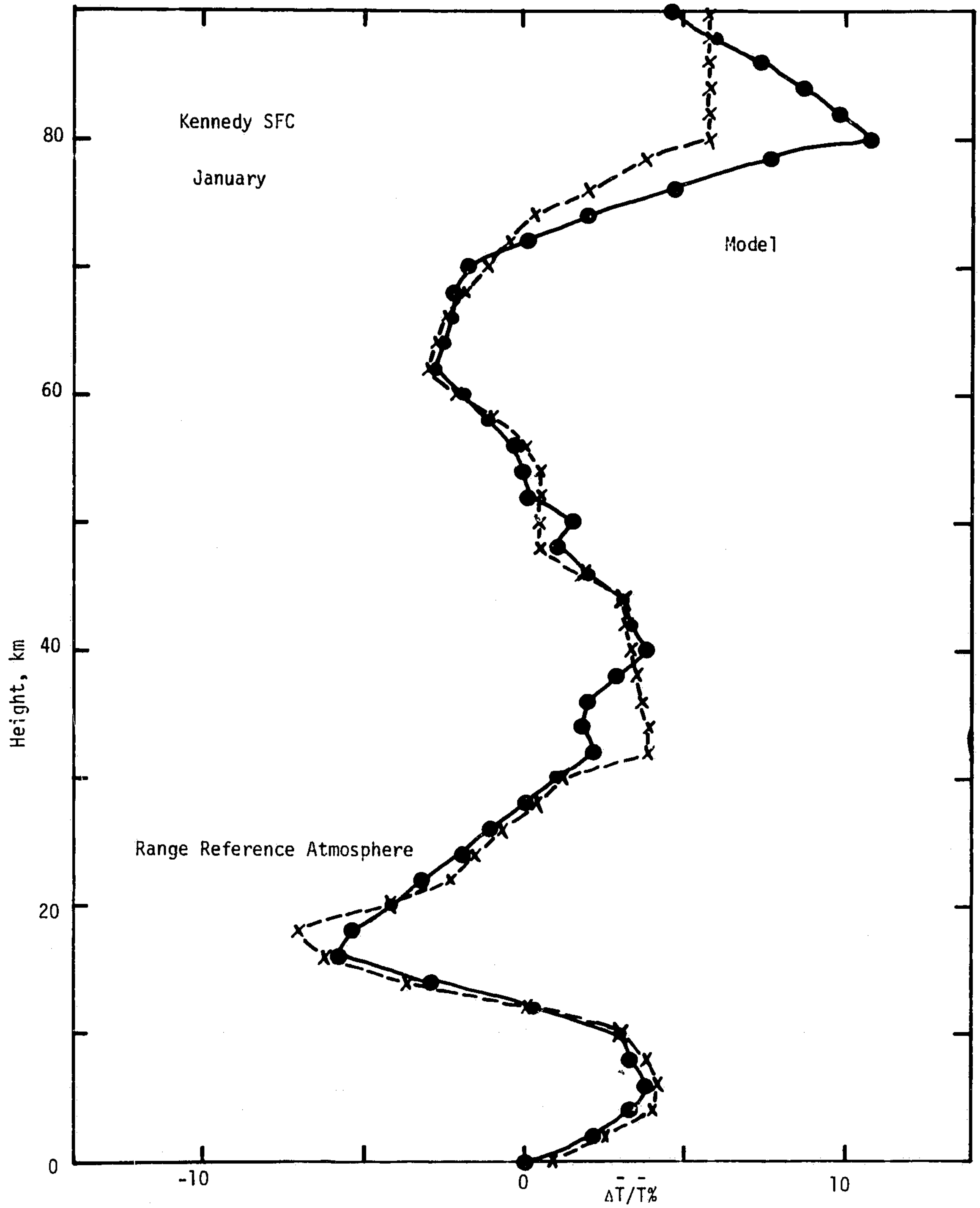


Figure 3.1 - GRAM2 generated monthly mean temperature for Kennedy SFC in January, compared to the Kennedy January Range Reference Atmosphere. Percent deviations are with respect to the 1962 U.S. Standard Atmosphere.

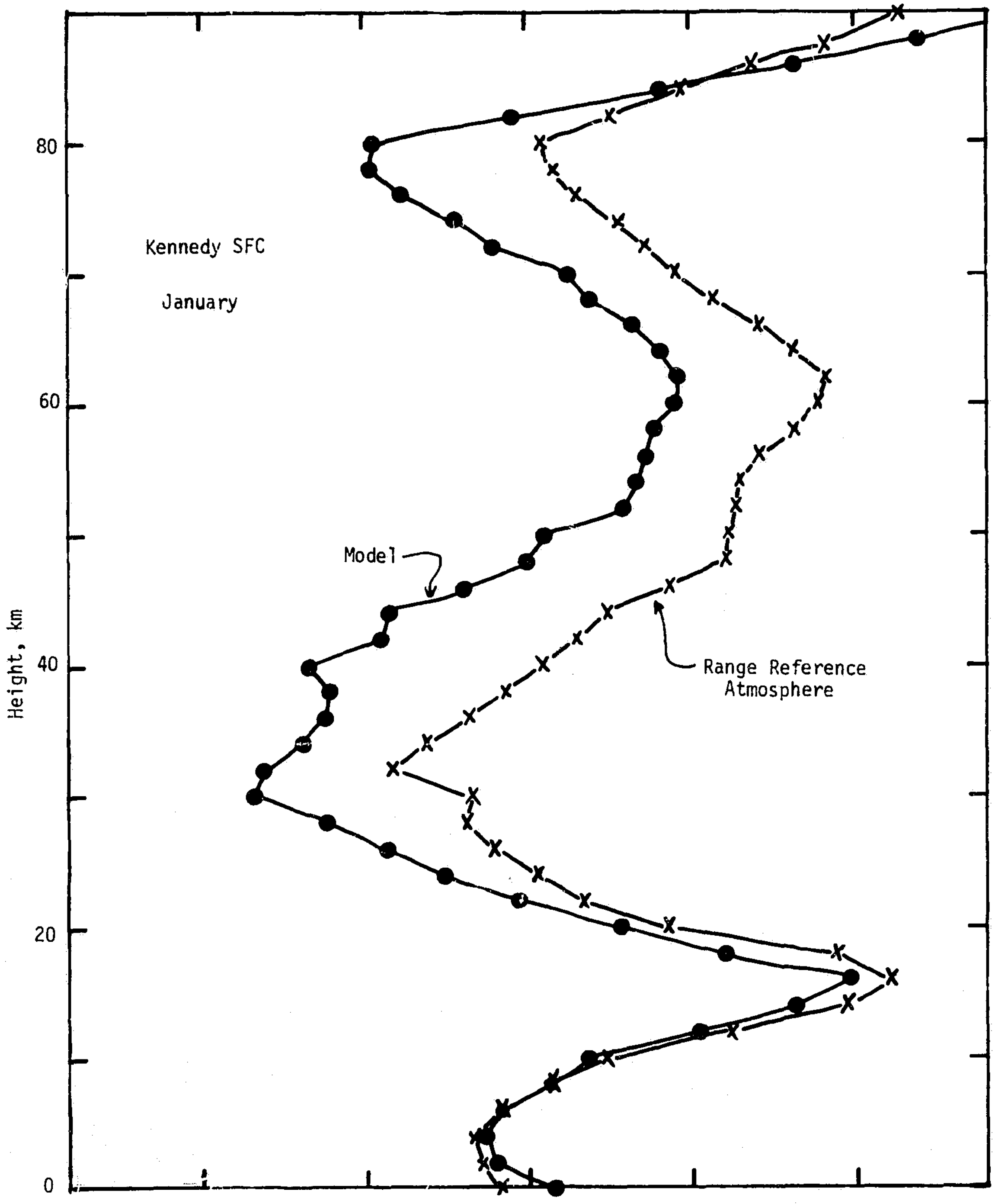


Figure 3.2 - As in Figure 3.1 for Density.

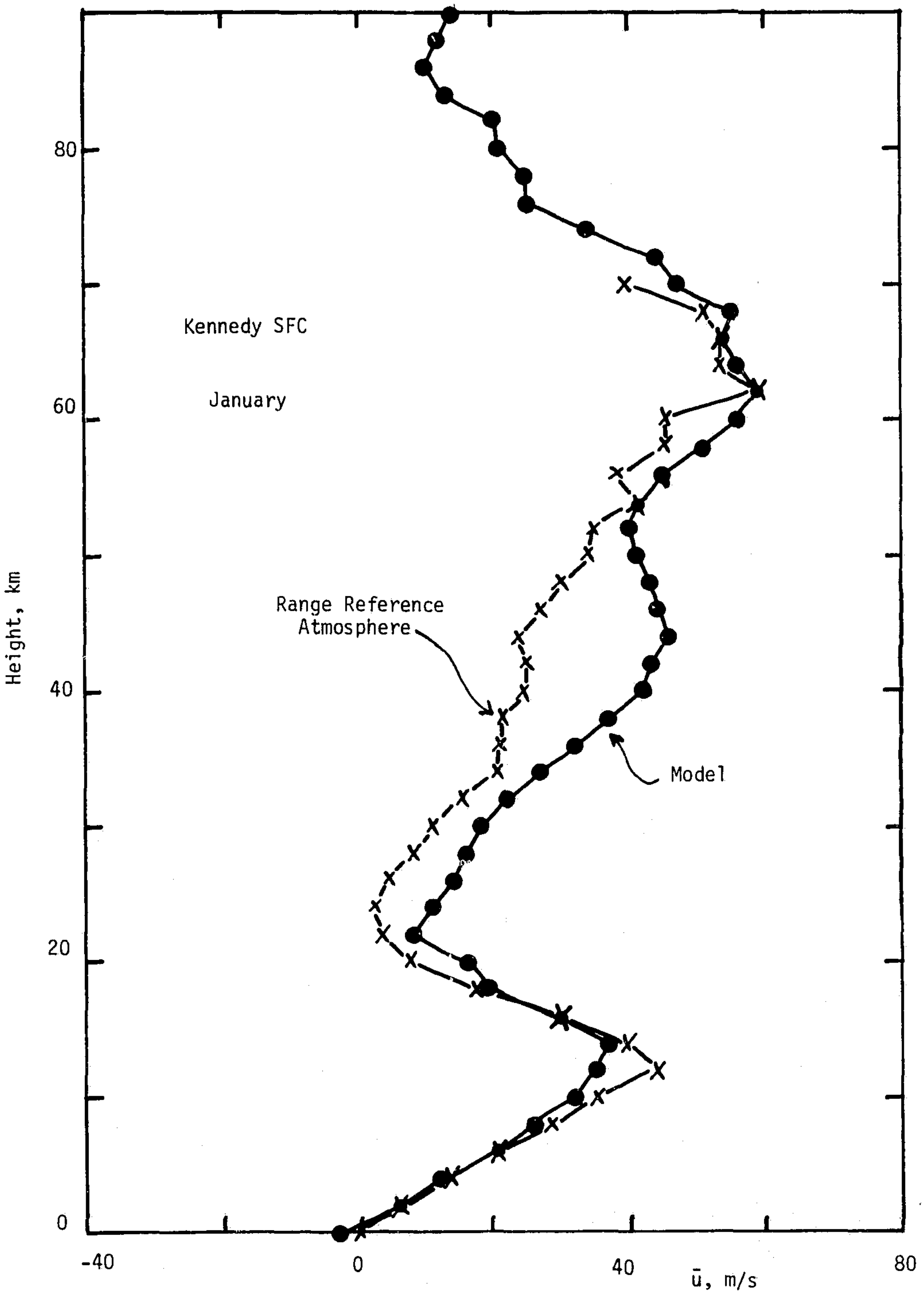


Figure 3.3 - As in Figure 3.1 for Zonal Wind.

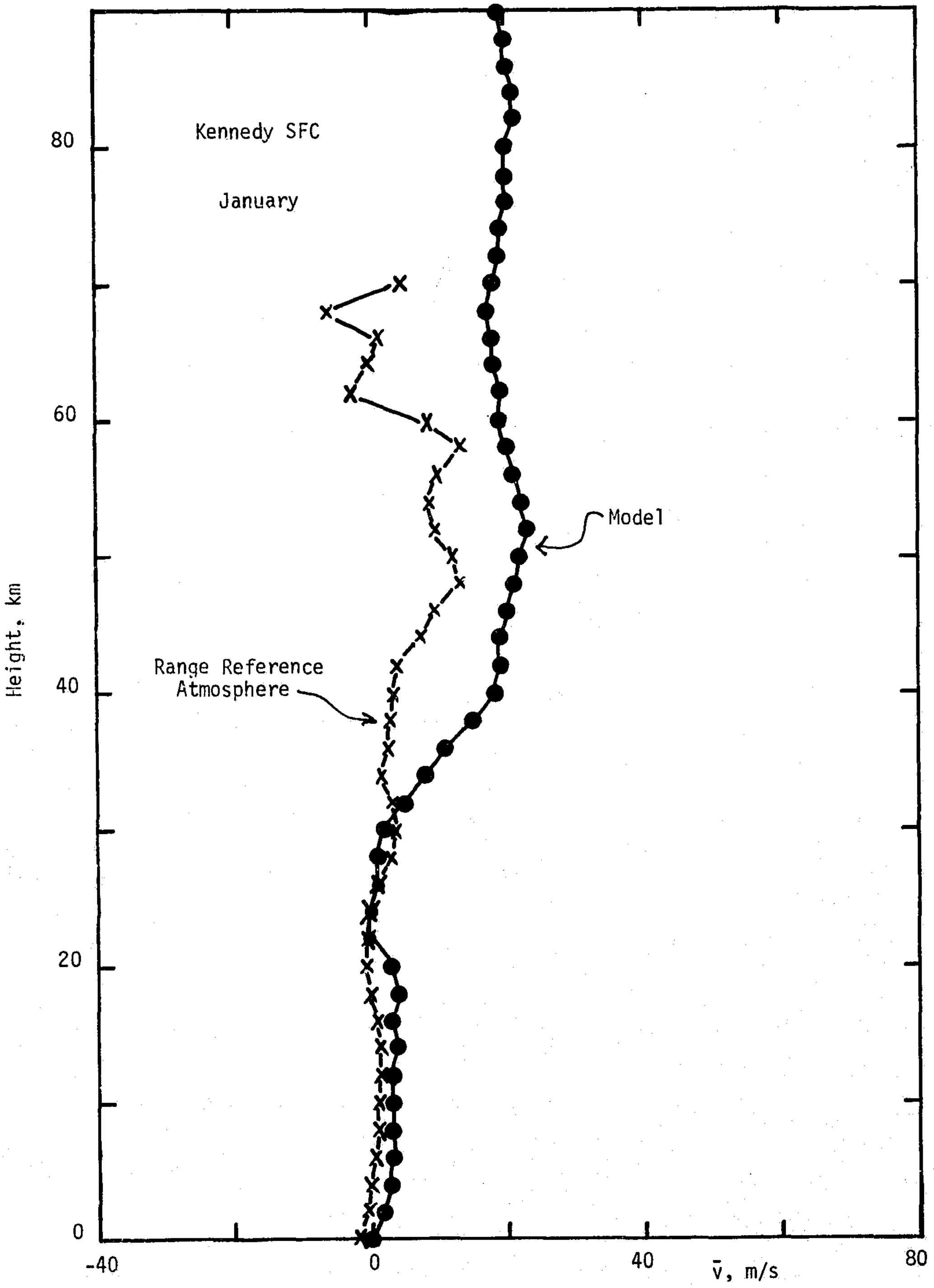


Figure 3.4 - As in Figure 3.1 for Meridional Wind.

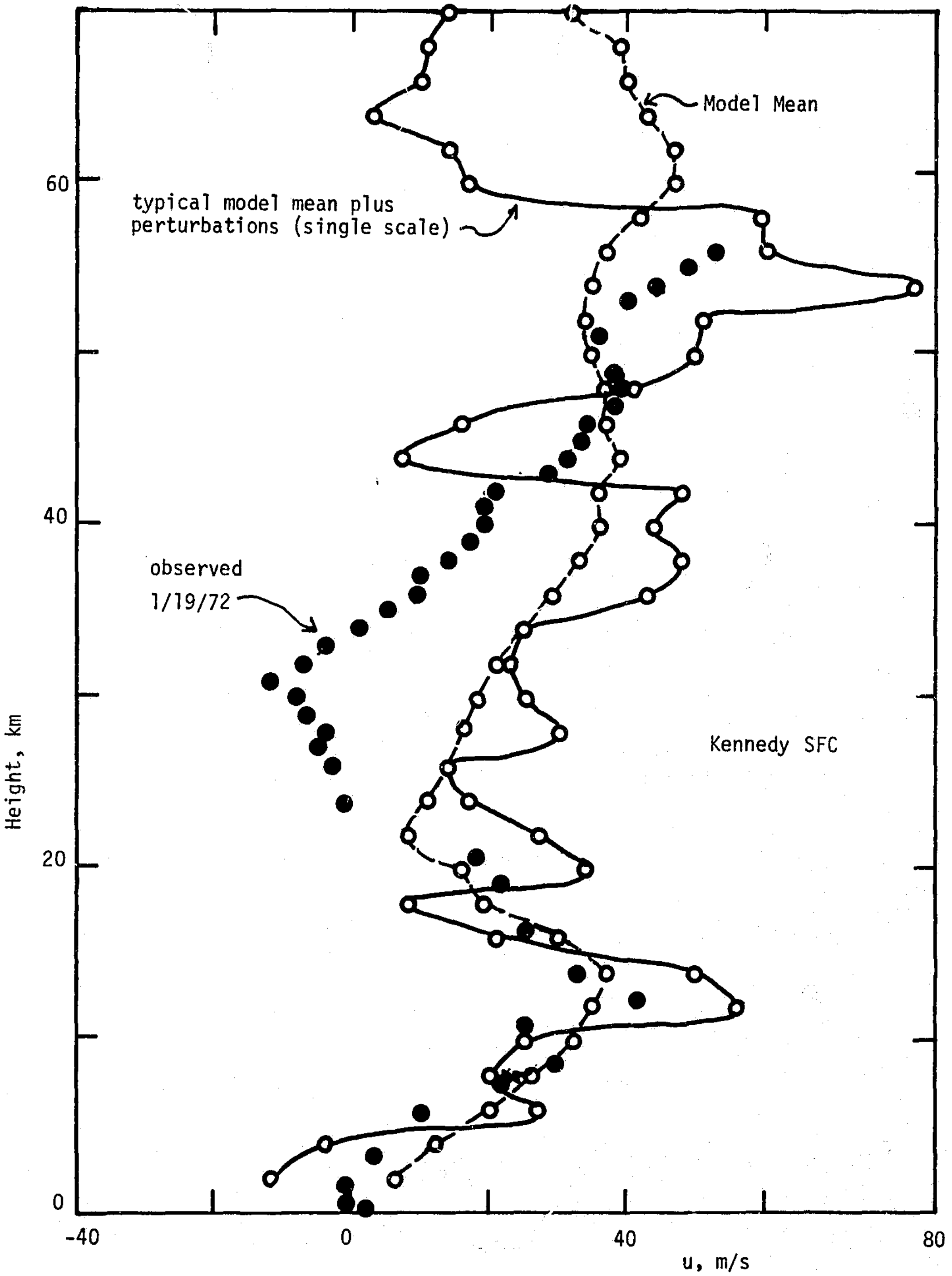


Figure 3.5 - Single scale model zonal wind monthly mean and mean plus perturbation for Kennedy SFC in January compared to an observed MRN profile of January 19, 1972.

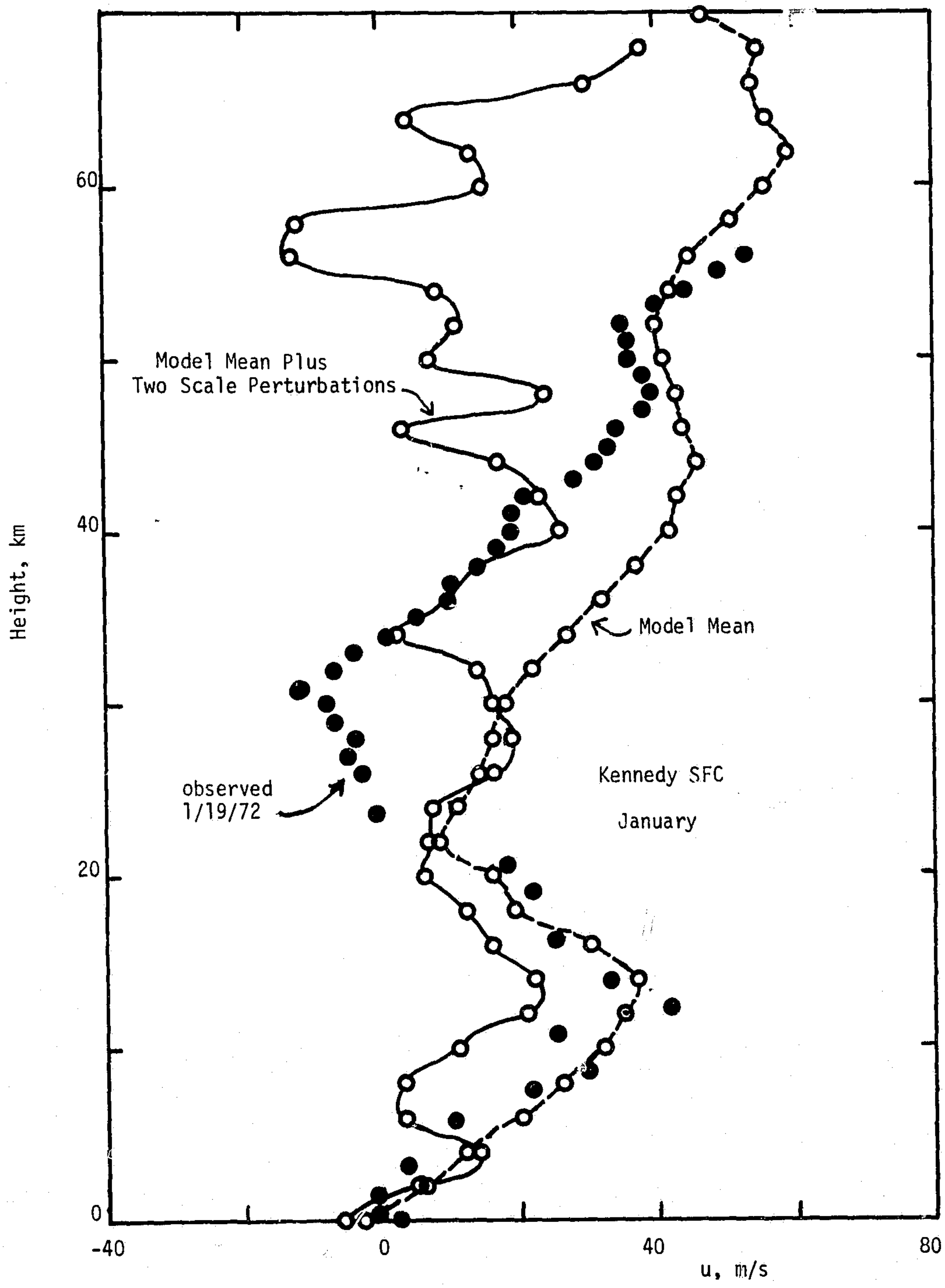


Figure 3.6 - Two-Scale model zonal wind monthly mean and mean plus perturbation for Kennedy SFC in January compared to an observed MRN profile of January 19, 1972.

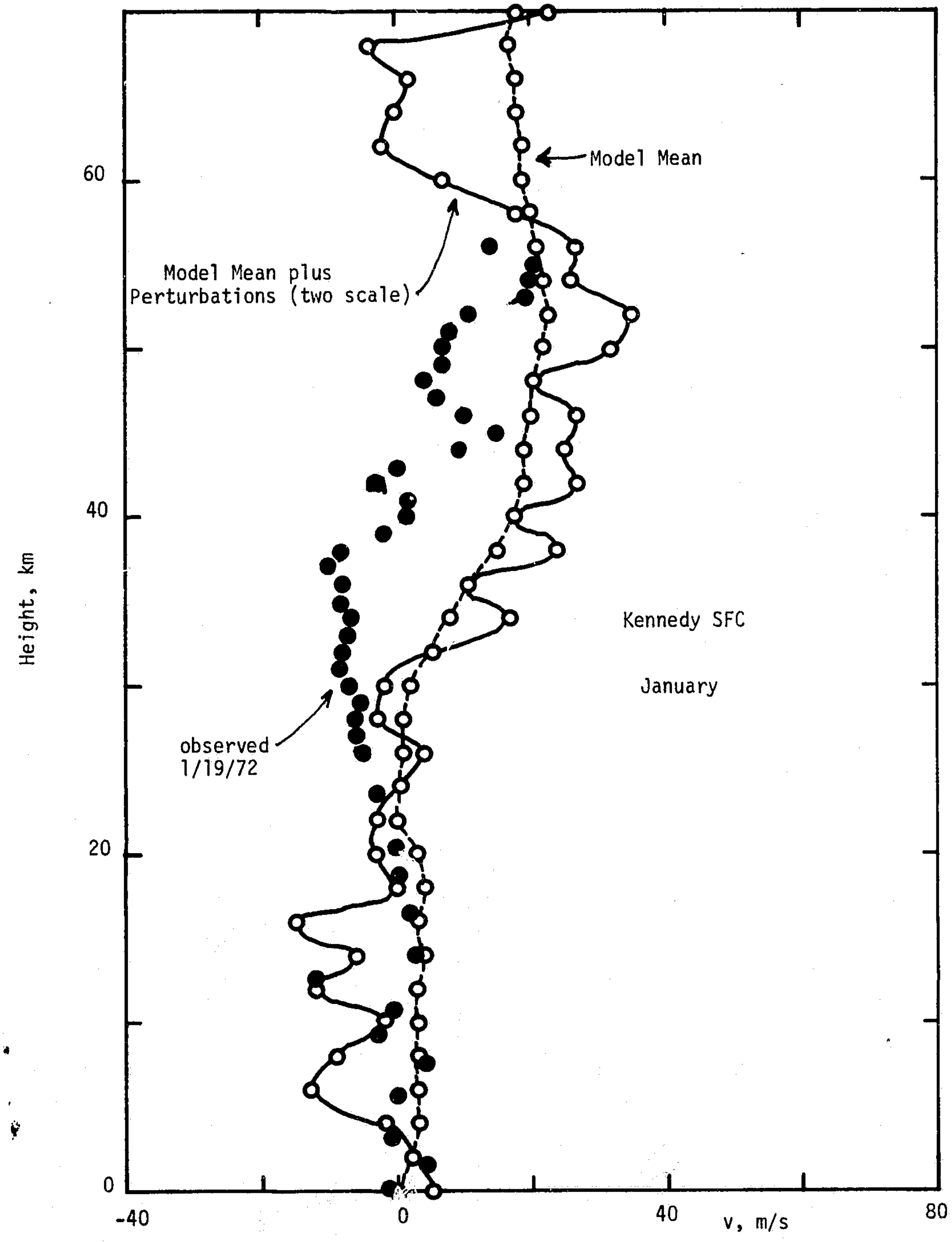


Figure 3.7 - As in Figure 3.6 for Meridional Wind.

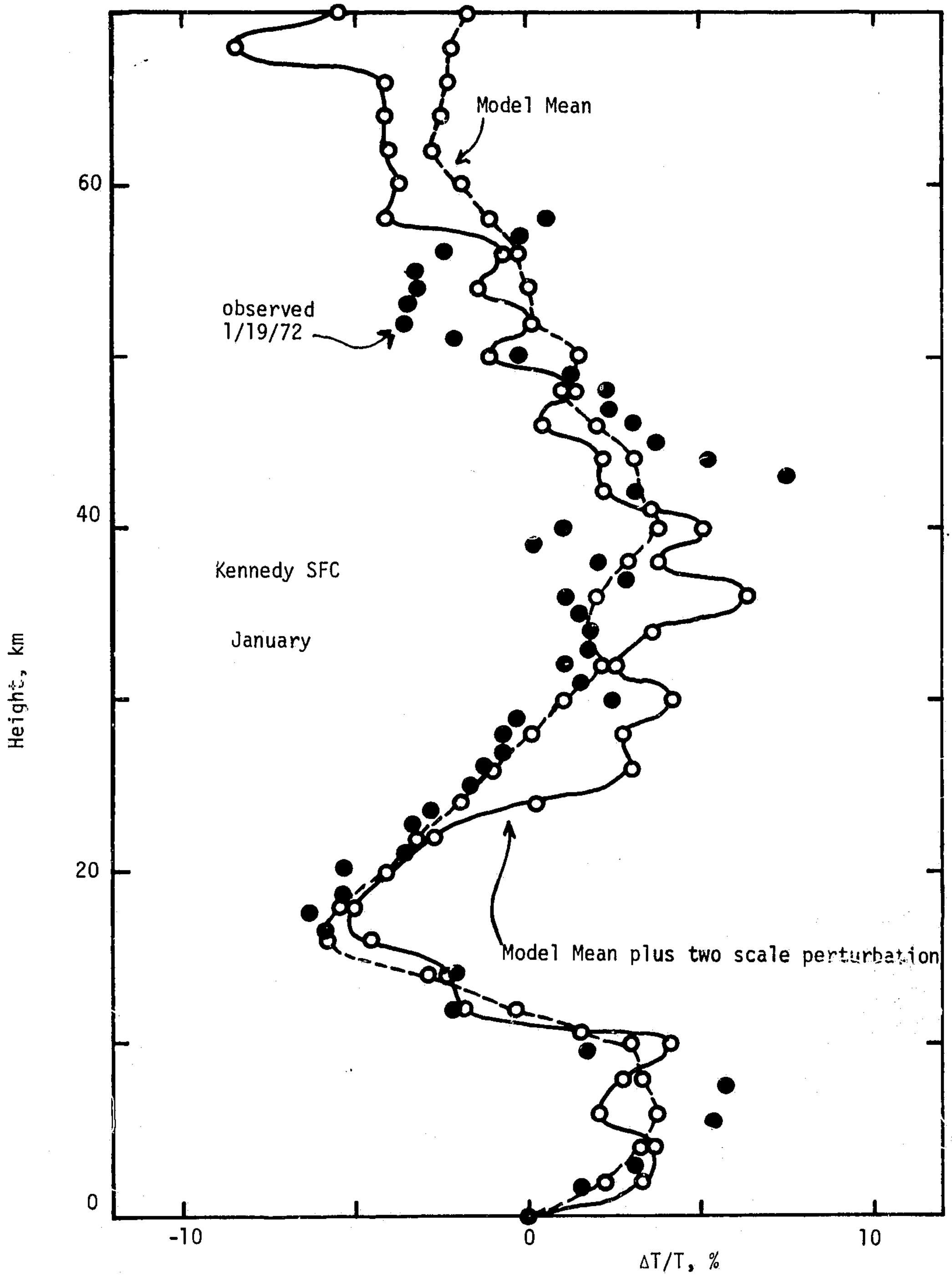


Figure 3.8 - As in Figure 3.6 for Temperature. Percent Deviations are with respect to the U. S. 1962 Standard Atmosphere.

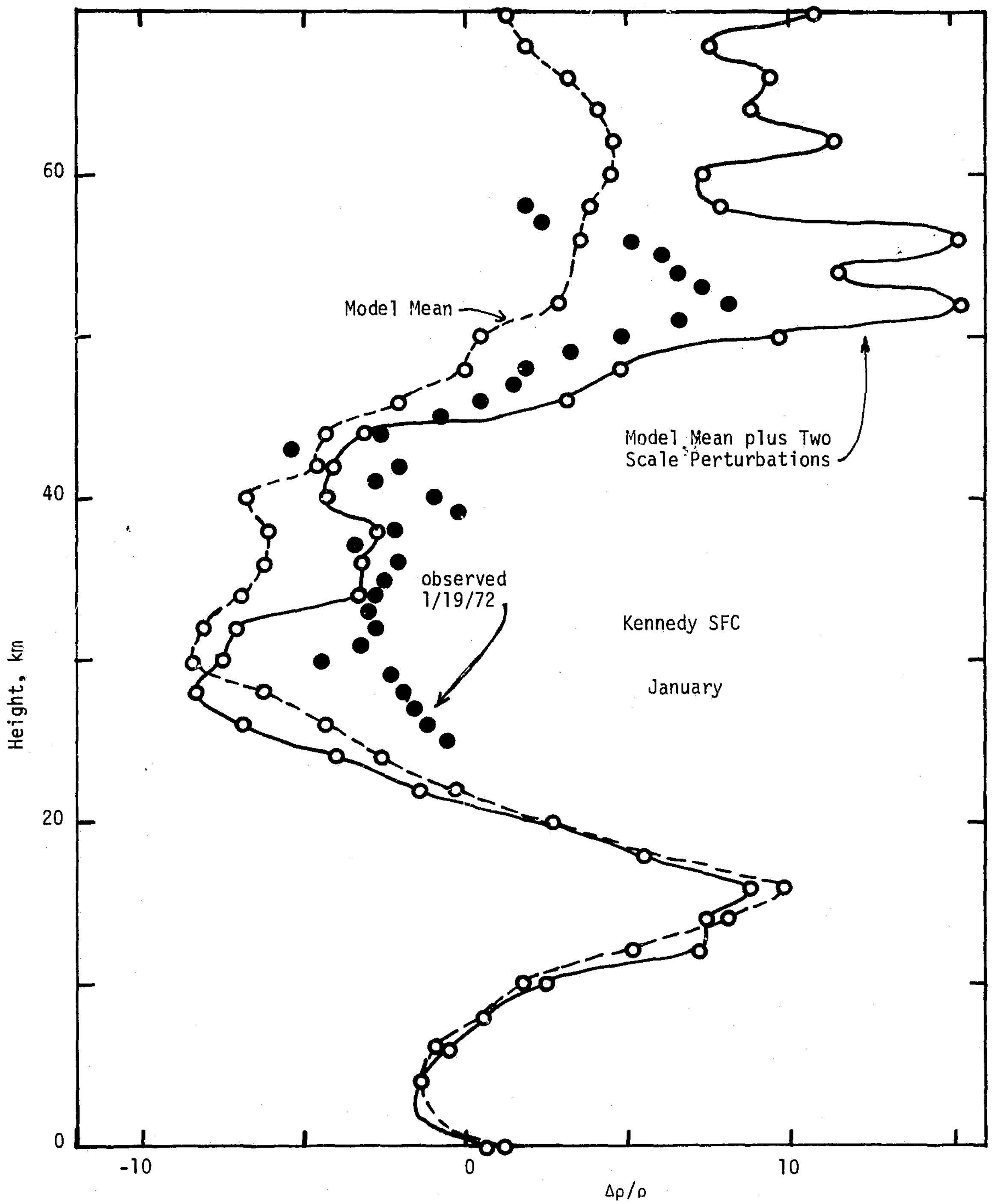


Figure 3.9 - As in Figure 3.6 for Density. Percent deviations are with respect to the 1962 U. S. Standard Atmosphere.

Figures 3.7 through 3.9, for meridional wind, temperature, and density, respectively. Good correspondence is seen in all of these between the relative amounts of perturbation variance in large and small scales, and the vertical structure of the measured (January 19, 1972) profiles.

# 4. USERS MANUAL

The Global Reference Atmospheric Model (GRAM) program is designed to produce atmospheric parameter values either along a linear path (to be called a profile) with automatically stepped constant height, latitude, and longitude increments, or along any set of connected positions (to be called a trajectory) which must be input individually into the program.

There are three general types of input to the GRAM program: (1) A set of three cards, called the initial data, which contain the values of the program options, the initial position, the profile increments, and other information required before the calculations are begun, (2) A data tape (SCIDAT) containing parameter values for the Groves (1971) model, the stationary perturbations (deviations from the Groves model, to produce longitude varying monthly means), and random and quasi-biennial perturbation parameter values, and (3) The data tapes with one data file for each month, containing profiles of monthly mean pressure, density, temperature, and their variances from the surface to 25 km, for the entire globe. If it is desired to compute atmospheric parameters along a trajectory instead of a linear profile, then a fourth type of data - the trajectory times and positions - must be input.

In terms of program function, the major elements of the GRAM program are the main segment (GRAM), the subroutine SCIMOD, which is a driver for all of the atmospheric evaluation subroutines, and SETUP, a subroutine used to read the SCIDAT data tape, and load the necessary starting conditions for execution. Figure 4.1 shows a simplified schematic of the main segment and illustrates the function of the SETUP and SCIMOD subroutines.

Output of the GRAM program consists of monthly mean pressure, density, temperature, wind and wind shear, total (mean plus perturbation) values of

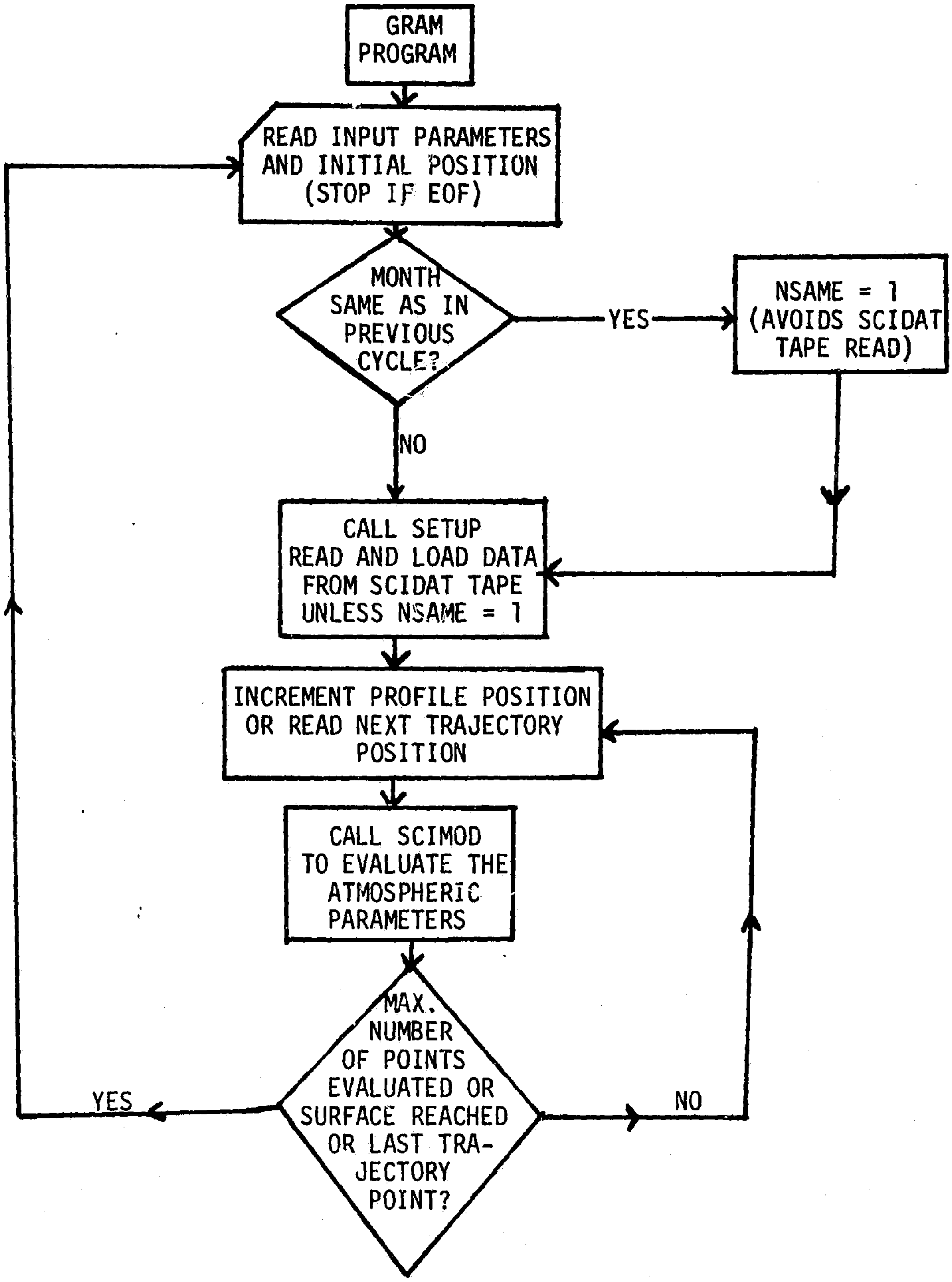


Figure 4.1: Simplified flow chart of the GRAM program.

pressure, density, temperature, winds, perturbation values, and magnitudes.

Complete discussion of the input, output, and program operation characteristics for the GRAM program are given in the following sections of the users manual.

## 4.1 The 4-D Data Tapes (0-25 km)

The description contained in this section was paraphrased from the 4-D program users manual (Fowler and Willard, 1972). For more information on the 4-D section of GRAM, consult that document and Spiegler and Fowler (1972).

The world-wide meteorological data set developed for the 4-D model by Allied Research Associates is stored on three 7-track, 800 bpi binary tapes labelled WW1A-WW3A. Each tape contains four files of data where one file represents one month; WW1A contains months 1-4, WW2A contains months 5-8, and WW3A contains months 9-12. A 13th month containing the annual reference period has been added as a fourth tape.

Within each file are 3490 records representing the values at individual grid points. These points are grouped into three grids: 288 points on the northern hemisphere equatorial (EQN) grid; 1977 points on the northern hemisphere (National Meteorological Center) grid; and 1225 points on the southern hemisphere (SH) grid. On the NMC grid, the data were computed at NMC points and stored in the order given by the NMC grid table shown in the SCIDAT data tape listing in Appendix B. On the other two grids, the data was given at $5^{\circ}$ latitude-longitude intersections westward from the Greenwich Meridian to $5^{\circ}$ east. The EQN grid covers the latitudes from $0^{\circ}$ to $15^{\circ}$ north with points occurring in the following order: 1-4 = Lon. 0, Lat. 0, 5, 10, 15; 5-8 = lon. 5W, Lat. 0, 5, 10, 15; ... 285-288 - Lon. $5^{\circ}$ E, Lat. 0, 5, 10, 15. The SH grid contains all data from $5^{\circ}$ south to the south pole as follows: 1 = South Pole, 2-18 = Lon. 0, Lat. -5 to -85; 19-35 = Lon. $5^{o}$ W, Lat. -5 to -85; ... 1209 - 1225 = Lon. $5^{o}$ E, Lat. -5 to -85. It should be noted that the south pole is given only once, as the first point of the SH data set.

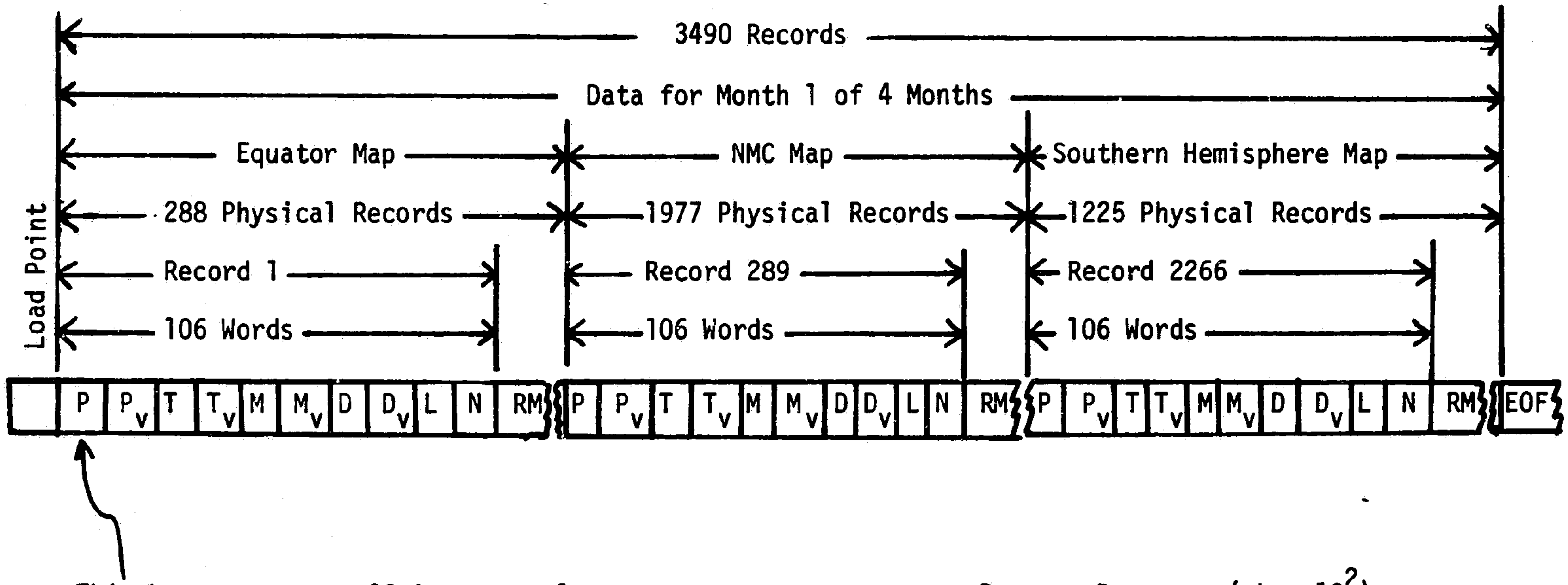
Each record consists of 106 36-bit words where the first 104 words contain the computed data for a point and the last two are identifiers. All data values are multiplied by 100 and converted to integer; they are then packed with two 18-bit values to a word. The data is arranged by level for each parameter; thus, the first 13 words contain the pressure means from the surface to 25 km and the next 13 words contain the pressure variances for the same levels. This pattern continues for the 26 levels of temperature means and variances, moisture means and variances, and density means and variances.

Word 105 contains the latitude and longitude of the point in question. There are integer values that have been multiplied by 10; each occupies 18 bits of the word. The latitude is always positive (since the southern hemisphere is identified by grid), and the longitude is always west.

The last word contains three 12 bit integer values. The left-most group of bits is the homogeneous moisture region in which the point lies, the center group is the point number, and the right-most group of bits is the month. It should be noted that the points are numbered within the grid that contains them, and not by their location on tape. Thus the point numbers run from 1-288, 1-1977, and 1-1225, not from 1-3490. Figure 4.2 shows the tape structure for one month.

## 4.2 The SCIDAT Data Tape

This section describes in detail the data contained on the SCIDAT data tape. A listing of this tape, and a synopsis of the data contained on



This box represents 26 integer values of pressure in millibars x $10^2$. Each value is packed sequentially as an 18 bit byte, starting with the surface and ending with the 25 km value

Variances are the square of the standard deviations.

RM denotes end of record mark.

EOF Denotes end of file mark.

$P$ - Pressure (mb x $10^2$)

$P_v$ - Pressure Variance (mb$^2$ x $10^2$)

$T$ - Temperature ($^oK$ x $10^2$)

$T_v$ - Temperature Variance ($^oK^2$ x $10^2$)

$M$ - Moisture (g/m$^3$ x $10^2$)

$M_v$ - Moisture Variance (g$^2$/m$^6$ x $10^2$)

$D$ - Density (g/m$^3$ x $10^2$)

$D_v$ - Density Variance (g$^2$/m$^6$ x $10^2$)

$L$ - Word 105 Containing Latitude and Longitude

$N$ - Word 106 Containing Homogeneous Region Number, MSF Point Number, and Month Number

Figure 4.2: Record Structure on the 4-D Data Tapes

it are given in Appendix B.

<u>NMC Grid Data</u>. This data set gives the 4-D northern hemisphere point number and the dual index for the corresponding NMC location. The NMC grid locations form an octagonal array, centered on the North Pole. The points are at square grid locations on the polar projection used for the NMC grid. A conversion between the latitude and longitude (treated as polar coordinates on the flat NMC grid plane) and the NMC grid indices (treated as Cartesian coordinates on the projection plane) is accomplished by a polar to Cartesian coordinate transformation, via equations programmed into the 4-D model. The NMC grid data on the SCIDAT tape merely establishes the equivalence between the sequential 4-D NMC point number and the two-dimensional x-y NMC grid point location. The NMC grid data constitute the first file on the SCIDAT tape. An end of file marker appears on the tape at the end of the NMC grid data. The NMC grid data file contains 396 NTRAN readable records (36 bit binary words) with 15 integers (one per word) in each record.

<u>Groves Data</u>. The <u>Groves</u> (1971) data for monthly mean pressure, density, and temperature are tabulated at 10 degree latitude intervals from 0 to $90^0$ for each month. The yearly average Groves data is coded as month 13. The southern hemisphere data is the same as the northern hemisphere data displaced by 6 months. Annual mean (month 13) data is the same for both northern and southern hemispheres.

The format of the Groves data is the same as in <u>Groves</u> (1971) original report, except that a prefix code P, D, or T has been added at the front of each record. Each record contains the code, the month, the height in km and the 0, 10, 20, ...,$90^0$ latitude values of the parameter expressed as a three digit integer, with a exponent common to all of the values on the record appearing at the end of the record. Thus a value of 276 with an exponent at the end of the record of -6, would be the same as $276 \times 10^{-6} = 2.76 \times 10^{-4}$. Pressure data are in units of $N/m^2$, density values are in $kg/m^3$, and temperatures are in $^oK$. The Groves data set contains 702 NTRAN readable (36 bit binary word) records with 14 integer values (one per word) in each record (including the code word P, D, or T).

Stationary Perturbations. The stationary perturbations are latitude-longitude dependent relative perturbations to be applied to the Groves values, considered to be the longitudinal mean value. Data for each of 12 months and for the annual reference period (month 13) are given for the northern hemisphere latitudes. Southern hemisphere data are the same as the northern hemisphere values displaced by 6 months.

Each record contains the code S, the month, the height in km, the west longitude, in degrees, and then 15 values of stationary perturbations in per mill (%/10). The first five of the values are for pressure perturbations at latitudes 10, 30, 50, 70, and 90. The next five values are for density, and the last five values are for temperature. The monthly mean value $y_m$ for parameter y at any latitude and longitude can be computed from the Groves value $G_y$ at the latitude and the stationary perturbation $s_y$ (in per mill) at the latitude and longitude by the relation

$$y_m = G_y (1 + s_y/1000) \tag{4.1}$$

Note that the stationary perturbation values at $90^0$ latitude are always zero. However, there is a place for $90^0$ values on the data tape, so that if a systematic departure from Groves values is desired at the poles, a set of stationary perturbation data reflecting this condition could be developed and put on the tape. The stationary perturbations listed on the Mod-2 SCIDAT tape have been revised, as described in Section 2, by the addition of data read from 1964, 1965, and 1972 upper air charts.

The Groves data and stationary perturbation data constitute the second file on the SCIDAT tape. An end of file marker appears at the end of the stationary perturbation data. The stationary perturbation code S data consists of 1248 NTRAN readable (36 bit binary word) records, with 19 integer values (one per word) in each record (including the code word S).

The Random Perturbation Data. Random perturbation magnitudes (standard deviations) are latitude dependent only. Each code R record has the code, the month (1-13) and the height in km, followed by 15 values of random perturbation magnitude, five for pressure (in per mill, at latitudes 10, 30, 50, 70, and 90), five for density, and five for temperature. These data give the relative standard deviations $\sigma_p/p$, $\sigma_\rho/\rho$, and $\sigma_T/T$, for use in the random perturbation model.

The code RW data are similar, except that only ten wind values appear in each record (after the code, month, and height): five for eastward wind magnitude (in m/s at latitudes 10, 30, 50, 70, and 90) and five for northward wind magnitude.

The code R and RW total perturbation magnitudes have been revised by the incorporation of new data sources, as described in Justus and Woodrum, (1975). The code R data have also been subjected to Buell (1970, 1972) adjustment, also described in Justus and Woodrum (1975).

The code R and RW data constitute the third file on the SCIDAT tape. An end-of-file mark appears on the tape at the end of the code RW data. The code R data consist of 260 NTRAN readable (36 bit binary word) records with 18 integer words (one value per word) in each record (including the code word R). For the code RW data, there are 325 records with 13 36 bit binary integer words (one value per word) in each record (including the code word

RW).

Large Scale Fraction Data. From daily difference analysis described in Section 2, the fraction of the total variance ($\sigma^2$ from code R and RW data) contained in the large scale perturbations has been determined as a fraction of height and latitude. Separate evaluations by month were also made, but were not found to be significantly different from the annual averages. Therefore the SCIDAT tape contains only the annual average fraction (expressed as per mill) of total variance contained in the large scale. Large scale and small scale magnitudes $\sigma_L$ and $\sigma_S$ are computed from the fractional data $f_L$ (code P) in per mill, by the relations

$$\sigma_L = \sqrt{f_L/1000}\ \sigma_T \qquad (4.2)$$

$$\sigma_S = \sqrt{1 - f_L/1000}\ \sigma_T \qquad (4.3)$$

where $\sigma_T$ is the total perturbation magnitude (code R or code RW data). The code P data set contains 25 NTRAN readable (36 bit binary word) records, with 18 words (one integer value per word) on each record (including the code word P).

Density-Velocity Correlations. Daily difference analysis described in Section 2 was also used to evaluate the cross correlations $R_{u\rho}$ and $R_{v\rho}$ for use in the velocity perturbation model (equations (2.38) - (2.41) and (2.44) - (2.50)). Both large scale and small scale values of the density-velocity correlations were evaluated, and are given on the SCIDAT data tape (codes CL and CS) in per mill (i.e. divide by 1000 to get correlations in the range -1 to +1).

The code P large scale fraction data and the code CS and CL density-velocity correlation data constitute the fourth file on the SCIDAT tape. An end-of-file mark appears on the tape at the end of the code CL data. The code CS and CL data consist of 50 NTRAN readable (36 bit binary word) records, with 13 integer values (one per word) in each record (including the code word either CS or CL).

The Quasi-Biennial Oscillation (QBO) Data. The QBO data consists of height and latitude dependent amplitudes and phases for quasi-biennial variations in pressure (QP), density (QD), temperature (QT), and eastward and northward wind components (QU and QV, respectively). The amplitude of the QBO thermodynamic parameters are in per mill (%/10). The amplitudes of the QBO wind components are in decimeters per second (0.1 m/s). The phases of all of the QBO parameters are measured in days after January 0, 1966 for the occurrence of the first maximum value. Since the period of the QBO variations is taken to be 870 days, the phases could vary from 0 to 870.

Each QBO data record contains the code, the height in km, the amplitude and phase for $10^{o}$ latitude, the amplitude and phase for $30^{o}$ latitude, etc. out to the amplitude and phase for $90^{o}$ latitude. There are 80 NTRAN readable (36 bit binary word) records in the QBO data set. Each record contains 12 integer values (one per word), including the code word QP, QD, QT, QU, or QV.

A final end of file mark appears at the end of the code QV data. Appendix B gives a brief summary of the data on the SCIDAT tape and a complete listing of all the values appearing in the tape records.

### 4.3 The Initial Input Data

The initial input data consists of two free field (no set format with commas after each number) cards containing initial position data, program options, and other information required to begin computation, plus an optional third free field card to give initial random perturbation data if random perturbations are to be computed, plus an optional set of trajectory position data cards (followed by a backup card), if trajectory positions are to be read in rather than a linear profile generated automatically in the program. Appendix C gives a brief summary of the input characteristics, a summary of the data deck setup, and some sample input and output for the program. The following gives a more detailed description of each program input card.

Input Card Number 1. The first input card, read in by the main program segment PROFILE in free field format contains the following information. Designation R indicates real quantities, I denotes integer quantities.

1. Initial Height (R): The initial height in km for the beginning point of the profile or trajectory. This can be any non-negative real number. Atmospheric parameters are never evaluated at the first position, which is used only to establish the initial conditions.

2. Initial Latitude (R): The latitude of the initial position in degrees, with southern latitudes negative. If the initial latitude, or any subsequent latitude is greater than $90^o$ in absolute magnitude, then a transformation

$$\text{lat} = (180° - |\text{lat}|)(\text{lat}/|\text{lat}|) \tag{4.4}$$

$$\text{lon} = \text{lon} + 180^o \tag{4.5}$$

is made.

3. Initial West Longitude (R): The west longitude of the initial position in degrees. East longitude can be put in as negative or converted to 0 - $360^o$ west longitude. If negative (east) longitudes are input they are converted to the 0 - $360^o$ scale before being used by the program. At any time during the run if a longitude gets outside the 0 - $360^o$ range it is put back into that range by adding or subtracting $360^o$, as necessary.

4. F10.7 (R): The solar 10.7 cm radio noise flux in units of $10^{-22}$

watts/$m^2$ (the normal units for this parameter) at the time for which the atmospheric values are to be computed. This factor is used only in the Jacchia section, so a value of zero can be used on input if the height never goes above 90 km. A value of 230 for both design steady state conditions and for maximum conditions may be used, or consult the Aerospace Environment Division (AED) of Marshall Space Flight Center (MSFC) for monthly predictions.

5. Mean F10.7 (R): The 81 day mean solar 10.7 cm radio flux. This parameter is used in the Jacchia section to compute the nighttime minimum global exospheric temperature (equation (14) in Jacchia, 1970). Use zero if the height does not go above 90 km. A value of 230 may be used for both design steady state or maximum conditions, or consult the AED or MSFC for monthly predictions.

6. AP (R): The geomagnetic index $a_p$, used to compute a geomagnetic correlation to the exospheric temperature, in equation (22) of Jacchia, (1970). Use zero if the height does not go above 90 km. A design steady state value of 20.3 and a maximum condition value of 400 may be used for $a_p$, or consult the AED at MSFC for monthly predictions.

7-9. Date (I): The date, for the starting time of the trajectory or profile evaluation in month/day/two digit year form, as three integer input values. The day of the month and the year have no direct effect on the program calculations, except in the case of the quasi-biennial oscillation terms. For the annual reference period, use month 13. The quasi-biennial terms are automatically set to zero if month 13 is used. The month is used to establish which Groves data, stationary perturbation data, and random data (including large scale fractions and velocity-density correlations) to load from the SCIDAT data tape into the working arrays. The program will work more efficiently if multiple trajectories or profiles are evaluated during one run operation and the months are the same. (This avoids repeated look-up of the Groves, stationary perturbation, and random data from the SCIDAT tape.)

10-12. Greenwich Time (I): The Greenwich mean time for the starting position in hours, minutes, and seconds as three integer values. Only the Jacchia section is directly affected by the time of day, so unless the height goes above 90 km, the starting time would serve merely as a reference parameter for the particular run being done. Greenwich time corresponding to a local time of 0900 hours should be used for design steady state Jacchia section conditions, and for maximum conditions the local time should be taken as 1400 hours.

13. Latitude Increment (R): If a linear profile is to be generated automatically this is the latitude increment (in degrees) between successive profile positions. The new latitude would be the old latitude plus the latitude increment. For a profile with decreasing latitude (going southward) the increment must be negative. Use zero if separate trajectory position input is to be read in. If a vertical profile (i.e. changing only height) is to be evaluated, then use zero latitude increment.

14. West Longitude Increment (R): If a linear profile is to be generated automatically this is the west longitude increment (in degrees) between successive profile positions. The new longitude will be the old longitude plus the longitude increment. For a profile progressing eastward use a negative increment. Use zero if separate trajectory position input is to be read in. If a vertical profile is to be evaluated, then use zero increment.

15. Height Increment (R): The height decrease in km between suc-

cessive positions, for an automatically generated linear profile. The profiles normally are generated downward (descending height). (New height = old height minus the height increment). If an upward generated profile is desired the height increment should be negative. Downward generated profiles will be evaluated until the height is incremented to a negative value or until the maximum number of positions (item 16, 1st card) is exceeded.

16. Maximum Number of Positions (I): The maximum number of profile positions to be generated automatically. This does not include the initial position, for which no atmospheric parameters are evaluated. Use zero if trajectory positions are to be read in.

17. Time Increment (I): The time displacement (seconds) between successive automatically generated profile positions. This would normally be set to zero, but could be used as a counter to be printed out in the time position with the output. For trajectories the time for each position is read in with the position data (see trajectory input section below). The hours, minutes, and seconds parameters (read in as items 10-12, 1st card) are updated according to the new time generated by the time increment. However, only the elapsed time in seconds is printed out on the present output.

18. Trajectory Option (I): This option tells the program whether a trajectory or a linear profile is to be evaluated. A value of 0 means a linear profile is to be generated automatically from the parameters read on the first card. A value greater than zero means that trajectory position data must be read in to determine the positions at which atmospheric parameters are to be evaluated. The unit from which the trajectory data are to be read is specified by the (non-zero) trajectory option. Thus, if trajectory data are to be read in from cards, use a trajectory option of 5 (the

card input unit).

19. Output Option (I): This option tells the program whether or not to produce non-print output of the atmospheric parameters (see the output description section). Non-print (i.e. disk or cards) output is convenient to use as input to plotter programs. A value of 0 means no non-print output. A value greater than 0 means to output the data on the unit number equal to the output option value.

20. Minimum Geostrophic Latitude (R): Below this latitude (in absolute magnitude) the second order geostrophic relations are used. Above this latitude, or above 90 km, only the usual geostrophic relations are used.

With normal numbers of decimal places and no unnecessary blank spaces, the above 20 items should fit onto one card. However, if they occupy more than the 80 columns allowed on one card, they may be spread out onto two cards if the following rules of free field input are observed on the first of the two cards: (1) Do not put a comma after the last number appearing on the first card. (2) If the last number on the first card is an integer, it should be right justified to column 80. For input on other computers, consult your operations manual for characteristics of free field input.

Input Card Number 2. The second input card is read in by the subroutine SETUP and contains various unit numbers to be used and options controlling the random and quasi-biennial calculations. The unit numbers are the parameters used in read statements in the FORTRAN program to control which file is being read from. The unit numbers are required in the input in order to give maximum flexibility in choice of I/O devices for the program. All input items on card number 2 are integers.

1. Groves Input Unit: This is the unit number of the SCIDAT tape file. If the SCIDAT tape has been assigned by the UNIVAC control statements -

```
@ ASG, T     SCIDAT,   T,   U1961 N
@ USE     3, SCIDAT
```

where U1961 is the reel number for tape SCIDAT, then the Groves input unit number should be 3 on this input card. The Groves and stationary perturbation data must be read from the SCIDAT tape. Later options on this card allow the NMC grid data, the random perturbation data, and the quasi-biennial data each to be read from other files.

2. Random Input Unit: This is the unit number for the random perturbation standard deviations (and the large scale fraction data and density-velocity correlations). If this unit number is the same as the Groves input unit number, then all of the random perturbation data are read from the SCIDAT data tape. Otherwise all of the random perturbation data are read from the file for whatever the unit number is set to. For card input, the unit number should be set to 5. The SCIDAT tape is read with NTRAN, but if alternate random data are read in from a different file, the file must be FORTRAN readable with format

```
1X, A1, I2, I4, 3(1X, 5I4)
```

for the random pressure, density, and temperature data (see Appendix B and Section 4.3 for which values must go in each record). For the random wind data the FORTRAN readable format for the alternate data is

```
1X, A2, I2, I4, 2(1X, 5I4)
```

If the random data input unit is different from the Groves input unit, then the code P and PW large scale fraction data and code CS and CL density-velocity correlation data must follow (after an end-of-file) the code RW data on the random input unit. The FORTRAN readable format for the large scale fraction (code P) data is

1X, A1, I2, I4, 3(1X, 5I4)

The format for the code PW data is

1X, A2, I2, I4, 2(1X, 5I4)

The format for the CS and CL data is

1X, A2, I2, I4, 2(1X, 5I5)

See Appendix B and Section 4.3 for description of the values which must go in each of these records.

All of the random perturbation data, random pressure, density, and temperature data, random wind data, large scale fraction data, and density-velocity correlation data must be read in from the same file, either all from SCIDAT, or all from the alternate FORTRAN readable file.

3. QBO Input Unit: If the QBO data parameters are to be read in from the SCIDAT data tape, this unit number is set the same as the Groves input unit. If alternate QBO parameters are to be read in the QBO unit number can be any FORTRAN readable file. Use Unit 5 for card input. The format for all of the alternate QBO input is

1X, A2, I3, 5(I4, I5)

(See Appendix B and Section 4.3 for which data values must go into each record). All of the QBO pressure, density, temperature, and wind data must be read from the same file, either all from SCIDAT or all from the alternate QBO input file.

4. 4-D Input Unit: This is the unit number for the 4-D data tape. Any available unit number can be used. If the 4-D tape WW1A, containing the January data, has been assigned by the control statements

```
@ ASG,   T   WW1A,   T,  U 2400 N
@ USE   4,   WW1A
```

then the 4-D input unit number is 4.

5. Random Option: This option tells the program whether or not to compute random perturbations. If the value is 1 random perturbations are computed. If the value is 2 then random perturbations are not computed. If any values other than 1 or 2 are input the run is terminated with a message "ERR0R IN SETUP INPUT" and a dump of the parameters most recently read in.

6. QBO Option: This option tells the program whether or not to compute QBO perturbations. If the value is 1 QBO perturbations are computed. For 2 no QBO perturbations are computed, and for any other values the "ERR0R IN SETUP INPUT" and dump of most recent parameters read in is given.

7. First Random Number: This number is required as a starting parameter for the random number generating subroutine RAND. Any odd positive integer can be used. Use a value of 1 for a standard design application run. Provided all other input is the same, a given value for the starting random number will always produce the same random perturbation output. Therefore, to get a set of different perturbations along a given single trajectory, a set of different starting random numbers should be used. Note, however, that if any other parameters are changed (different spacing along the trajectory, different starting position, etc.) then the same starting random number will produce a different set of random perturbations.

8. NMC Read Option: This option tells the program whether to read the NMC grid data from the SCIDAT data tape (value 0 for the option) or from an input card file (any non-zero value for the option).

9. 4-D Scratch Unit: In order to save array space the 4-D profiles

required to interpolate to the 5° x 5° grid locations are read from the tapes to this scratch file rather than being put into arrays. The unit number for this scratch file can be any available unit. Normally the file is a temporary drum file, and, if so, does not (on the UNIVAC) have to be assigned (@ ASG) before execution of the program.

10. NMC Grid Point Scratch Unit: Also in order to save computer storage, the NMC grid point array read in from the SCIDAT tape (or from cards) is stored in a temporary scratch file (usually on drum). If the drum scratch file is used, it does not have to be assigned (on the UNIVAC) before execution of the program.

Input Card Number 3. This card is read by the SETUP subroutine and contains starting values for the random perturbation parameters at the initial position. If random perturbations are not to be computed (Random Option = 2), then this card should not be put in. All values of this free field format card are real. For a normal design application the values on this card should all be zero, unless the run is to be a continuation of a previously run trajectory or profile segment, in which case the output random parameters of the last output position are input, and the last output position becomes the initial position of the new run.

1-6. Initial PL, PS, DL, DS, TL, TS: These are initial values of random relative pressure ($p'/\bar{p}$), density ($\rho'/\bar{\rho}$), and temperature ($T'/\bar{T}$) in percent for the large scale (L) and small scale (S) components. These are starting values for the initial position. Use zero for standard design applications.

7-10. Initial UL, US, VL, VS: Initial values of the random eastward (U) and northward (V) random wind components in m/s for the large scale (L) and small scale (S) components. Use zeros for standard design applications.

Trajectory Input. The free field trajectory position input and backup record are put in only if a trajectory is to be evaluated, rather than a linear profile, generated automatically in the program from information on the first input card. There is no limit to the number of trajectory position records which can be put in. The program continues evaluating the atmospheric parameters and looping back to read a new trajectory position until a position below the surface is reached, or until the trajectory backup record is reached. Each free field trajectory record has the time (integer seconds), the height (kilometers), the latitude (degrees, southern latitude negative), and the west longitude (degrees, 0-360° or east longitudes negative). Any east longitudes read in as negative values are converted to the 0-360° system before being used by the program. The trajectory backup record has the same free field form as a regular trajectory record, except any negative value for height is used. The negative height terminates the loop which evaluates atmospheric parameters and reads a new trajectory record. If a trajectory height goes negative, then any remaining trajectory input cards are read and ignored. The trajectory input can either be input from cards (trajectory option = 5) or form any other unit (with trajectory option = unit number). The trajectory option is item 18 on card #1.

### 4.4 Output of the Program

The first few lines of print output are primarily a listing of the input parameters. Following a heading which describes each output value for the trajectory or profile evaluations, the position, time monthly mean and total pressure, density, tem erature, and winds are listed for each position. The thermal wind shear for the monthly mean winds, the percent deviation from the standard atmosphere ($p$, $\rho$, and $t$), the mean vertical wind and the perturbation data are also given for each position. The perturbation data consist of the stationary perturbations, the quasi-biennial values at the position and time, the quasi-biennial magnitudes, the random perturbation values, and the random perturbation standard deviations. Optional non-print (e.g. disk or punch) output for values at each position is also available to be used for input to plotter programs, or for other purposes.

Heading Information. Primarily the heading information contains a listing of the input data values. However, there are some changes from the values input. If an east longitude is put in as a negative value, $-180° < \text{lat} < 0°$, then it is converted to a west longitude in the 0-360 range before the heading is listed. The program evaluates the initial random pressure, density, temperature and wind standard deviations and the initial density velocity correlation from data on the SCIDAT data tape, and lists the computed values on the heading. The Julian date is computed by the program from the input date and is also listed with the heading information. The Julian date is required by the Jacchia and QBO sections of the program. If month 13 (annual reference period) is input, then the Julian date is set to zero. (The Jacchia section takes the exospheric temperature to be 1000° K and the QBO section is bypassed if month 13 is input).

Position and Time Output. Positions and times as generated by the automatic linear profile features or as input by the trajectory input cards are listed on the output. The time is given in seconds. Within the program, the input time in hours, minutes, and seconds are updated in that form also. However, only a continuously increasing time in seconds is printed out. If time in hours, minutes, and seconds were desired, these variables could easily be printed out by adding them to the output list. All output west longitudes are converted to the 0-360 range before being printed out. If a latitude greater than 90° in absolute magnitude is generated (or input) then a transformation

$$\text{lat} = (180° - |\text{lat}|)(\text{lat}/|\text{lat}|) \tag{4.6}$$

$$\text{lon} = \text{lon} + 180° \tag{4.7}$$

is made.

Monthly Mean Data. The monthly mean values of pressure, density, and temperatures, consist of either: (1) values from the 4-D data tapes if the height is below 25 km, (2) the sum of Groves plus stationary perturbation values if the height is between 30 and 90 km, (3) an interpolation between 4-D at 25 km and Groves plus stationary perturbations at 30 km if the height is between 25 and 30 km, (4) Jacchia model values if the height is above 115 km, or (5) faired values between Groves and Jacchia if the height is between 90 and 115 km.

The percent deviations from the U.S. 1962 Standard Atmosphere are evaluated by using standard atmosphere values computed by the subroutine STDATM. The percent deviations are evaluated by the relations $100(T - T_s)/T_s$, $100(\rho - \rho_s)/\rho_s$, and $100(p - p_s)/p_s$, where the subscript s refers to the standard atmosphere values. This subroutine accurately reproduces the tabulated U.S. Standard Atmosphere 1962 values to within an accuracy of better than 0.2% above 90 km. The STDATM values are based on a model of parabolic segments for the height variation of the molecular weight above 90 km. The subroutine reproduces the tabular values even more accurately in the height region below 90 km, where the molecular weight is constant. Since the U.S. 1962 Standard Atmosphere is not defined above 700 km, the percent deviations printed out for heights above 700 km are zero.

The thermal wind shear values are values of $\partial u/\partial z$ and $\partial v/\partial z$ for the monthly mean geostrophic wind (see Section 2). The wind values, computed from the usual geostrophic wind equation or the second order geostrophic relation if the latitude is less than the input value of minimum geostrophic latitude, are determined by horizontal gradients of the monthly mean pressure. The thermal wind shear components, computed by the thermal wind equations, are determined by the horizontal gradients of the monthly mean temperature. Thus, a comparison of numerically differentiated geostrophic mean winds and the thermal wind shear serve as a check of the mean pressure and temperature fields. The mean vertical wind is evaluated, as described in Section 2, by combinations of horizontal and vertical temperature gradients and the geostrophic winds.

The Total (Mean Plus Perturbation) Data. The parameter values listed under the heading of "Mean Plus Perturbations" are the monthly mean values, as defined above, plus the random perturbations, plus (if the height is between 10 and 90 km) the quasi-biennial perturbations. These mean-plus-perturbation values represent values which would be typical "instantaneous" values of the pressure, density, temperature or winds. The percent deviations from the U.S. Standard atmosphere are computed in the same way as for the percent deviations of the monthly mean values from the standard atmosphere.

Perturbation Values. The data under the "Perturbation Values" heading are the various perturbation values, magnitudes, and amplitudes. The stationary perturbations (denoted SP on the printout) are defined only if the height is between 30 and 90 km. The monthly mean $y_m$ of parameter y should be the Groves value $G_y$, evaluated from the SCIDAT data tape, modified by the given stationary perturbation value $s_y$, in percent, by the relation

$$y_m = G_y (1 + s_y/100) \tag{4.8}$$

The data labeled "QBO" are the values of the QBO oscillation at the output time and position. The data labeled "MAG" gives the magnitude of the QBO oscillations at the output position and time. The QBO perturbation values should always be less than or equal to the magnitude values in absolute value. The data labeled "RANL", "RANS","RANT" are the large scale, small scale and total random perturbations evaluated at the output time and place. The data labeled "SIGL", "SIGS", and "SIGT" are the standard deviations of the large scale, small scale, and total random components at the output time and positions. According to the Gaussian distribution, on which the random perturbations are based, the perturbation values should be within the range $\pm\sigma$ 68% of the time and outside the range $\pm\sigma$ 32% of the time. Similarly, the perturbation values should be within the range $\pm 2\sigma$ 95% of the time, and outside the range $\pm 2\sigma$ 5% of the time. The evaluation of the QBO and random perturbation output can be suppressed by the QBO and random options, if desired.

Non-Print Output. The non-print output is available as an option, controlled by the input value of the output option parameter. If non-print output is desired, it comes out in the form of records with format F5.1, F6.2, F7.2, 2F5.1, 3F5.0, 5F5.1, 2E10.3, I5, I3 containing the following information: (1) the height in km, (2) the latitude in degrees, (3) the west longitude in degrees 0-360, (4-5) the percentage deviation of the mean monthly values of pressure and density from the 1962 U.S. Standard Atmosphere, (6) the monthly mean temperature, (7-8) the eastward and northward components of the monthly mean (geostrophic) wind, (9-13) the magnitudes of the total random perturbations in pressure, density, temperature (per cent, and eastward and northward wind (m/s), (14-15) the monthly mean pressure ($N/m^2$) and density ($kg/m^3$), (16) the time, in seconds, and (17) the month (with 13 indicating annual mean).

4.5 Program Diagnostics. There are several possible reasons which can cause the printing of diagnostic messages and termination of the run during the SETUP phase. If, during the setup procedure, the NMC grid point number data table does not contain the required 1977 values, a message Diagnostic 1: "N RECØRDS WRITTEN BY SETNMC IN SCRATCH FILE M" is printed, and EXECUTION IS TERMINATED. This situation should only arise if the NMC grid point table is being read from cards, rather than the SCIDAT data tape. If during the reading of the SCIDAT data tape, any record is read which does not have the expected code character or characters (P, D, T, S, R, RW, QP, QD, QT, QU, or QV; see Appendix B), then the message results Diagnostic 2: "ERROR IN SETUP INPUT" followed by a listing of the latest data values read in. This message is also produced if the random option and the quasi-biennial option do not have a value of either 1 or 2. Any condition which results in this error message terminates the execution.

There are also general conditions which could result in diagnostic messages in the 4-D section: If during the reading of the 4-D data tape on the first access of the region below 30 km, a parity error is encountered, a message

Diagnostic 3: "INPUT UNIT NØ. M IN ERRØR (-3) FØR RECØRD NØ N" is printed - execution continues. Such an error will only be of consequence if the particular record read is required for interpolation. If an end of file is read, a message is written

Diagnostic 4: "***** UNIT NØ. JT IN ERRØR IRC RECØRDS READ
IREAD(IRN, 3) + XXXX MP = XX MØNTH = XX IP = XXXX IPT(I, J) = XXXX IRN = XX
M STATUS L"

Where

JT = Unit on which 4-D data tape is mounted

IRC = Total number of records read thus far from 4-D tape

IREAD(IRN, 3) = Sequential point number selected by SELEC4

MP = Month word in last record read

M0NTH = Run month

IP = Point number word in last record read

IPT(I, J) = Point number required for profile J to be interpolated to Ith requested profile

IRN = Sequential point number required

M = Unit status (READ)

L = NTRAN status (-2 for end of file, -3 for parity, etc.)

and EXECUTION IS TERMINATED

If IRC > IREAD(IRN, 3), the diagnostic message 4 is written - L should be 106, and IRC and IREAD values should indicate this condition. EXECUTI0N IS TERMINATED.

If MP ≠ M0NTH, or IP ≠ IP(I, J) the diagnostic message 4 is printed, again with L = 106, and MP/MONTH or IP/IP(I, J) indicating error. EXECUTI0N IS TERMINATED.

The writing of scratch file SCRCH1 with data for subsequent unpacking and interpolation is also checked. If there is a write error, the diagnostic 4 is printed, with JT the scratch file unit number, M as WRITE and L as -3 or -4. EXECUTI0N IS TERMINATED.

These diagnostics can arise if a bad or wrong 4-D data tape is being accessed, or if there is a malfunction of the tape drive. In some cases a tape will, for example, indicate parity errors when being read from one tape drive, but not another.

If, during the course of evaluation of position in the 4-D height range, it is found that the position is outside the previously established 4-D grid, then a new grid is generated by calling GEN4D. If this occurs again, the message results

Diagnostic 5: "UNABLE TO GENERATE 4-D GRID" and EXECUTI0N IS TERMINATED.

A new feature, the wind diagnostic symbol (asterisk), has also been added to the program. Presence of the asterisk between the E-W and N-S wind components on the print output indicates a diagnostic condition yielding questionnable wind values. Conditions which can produce this are: 1) a negative value computed for $\zeta^2$ (equation A-14 when attempting to evaluate second order geostrophic winds (in this case $\zeta^2$ is set to zero and calculation proceeds), 2) second order geostrophic wind speed greater than normal geostrophic wind speed when the latitude is in the second order geostrophic range (in this case the normal geostrophic wind components are output instead of the second order geostrophic winds), 3) a 4-D data consistency check violation (i.e. unrealistic scale heights or unrealistic horizontal pressure gradients) within the 4 x 4 grid of 4-D data profiles.

# 5. PROGRAMMERS MANUAL

## 5.1: Description of Subroutines

The following is a brief description of each of the PROFILE program subroutines, in alphabetical order:

| | |
|---|---|
| ADJUST: | Adjusts the 4-D profiles of pressure, density, and temperature variance (read from the 4-D tapes) to satisfy the Buell constraints imposed by the perfect gas law and hydrostatic equation |
| CHECK: | A consistency check routine for the 4-D 16 profile grid data produced by GEN4D. CHECK is called for each height to be evaluated, and tests for reasonable values of scale height immediately above and below that height. It also tests for reasonable horizontal pressure gradients. Failure of either test produces the diagnostic asterisk between the output values of wind components. |
| CORLAT: | Evaluates the horizontal and vertical scales for large and small scale density, temperature, and wind components, computes the autocorrelations and cross correlations for the two scale perturbation model, and evaluates new perturbation values having appropriate correlations with the perturbations at the previous position. |
| DIAGEQ: | A matrix diagonalizing procedure used by the ADJUST subroutine. |
| FAIR: | Fairs between the Groves and Jacchia values in the 90 to 115 km height range. |
| GEN4D: | Generates the polar (\|latitude\| > 75°) or non-polar (16 5° x 5° points) grid of pressure, density, temperature and variance profiles. See Figure 5.1 for a flow chart of this subroutine. |
| GETNMC: | Reads the NMC grid point values from the SCIDAT data tape or from cards and loads them onto a scratch file. This subroutine is essentially unchanged from the subroutine of the same name in the original 4-D program. |
| GRAM: | The main segment of the Global Reference Atmospheric Model program. The main segment serves as a driver for the SETUP and SCIMOD subroutines. |

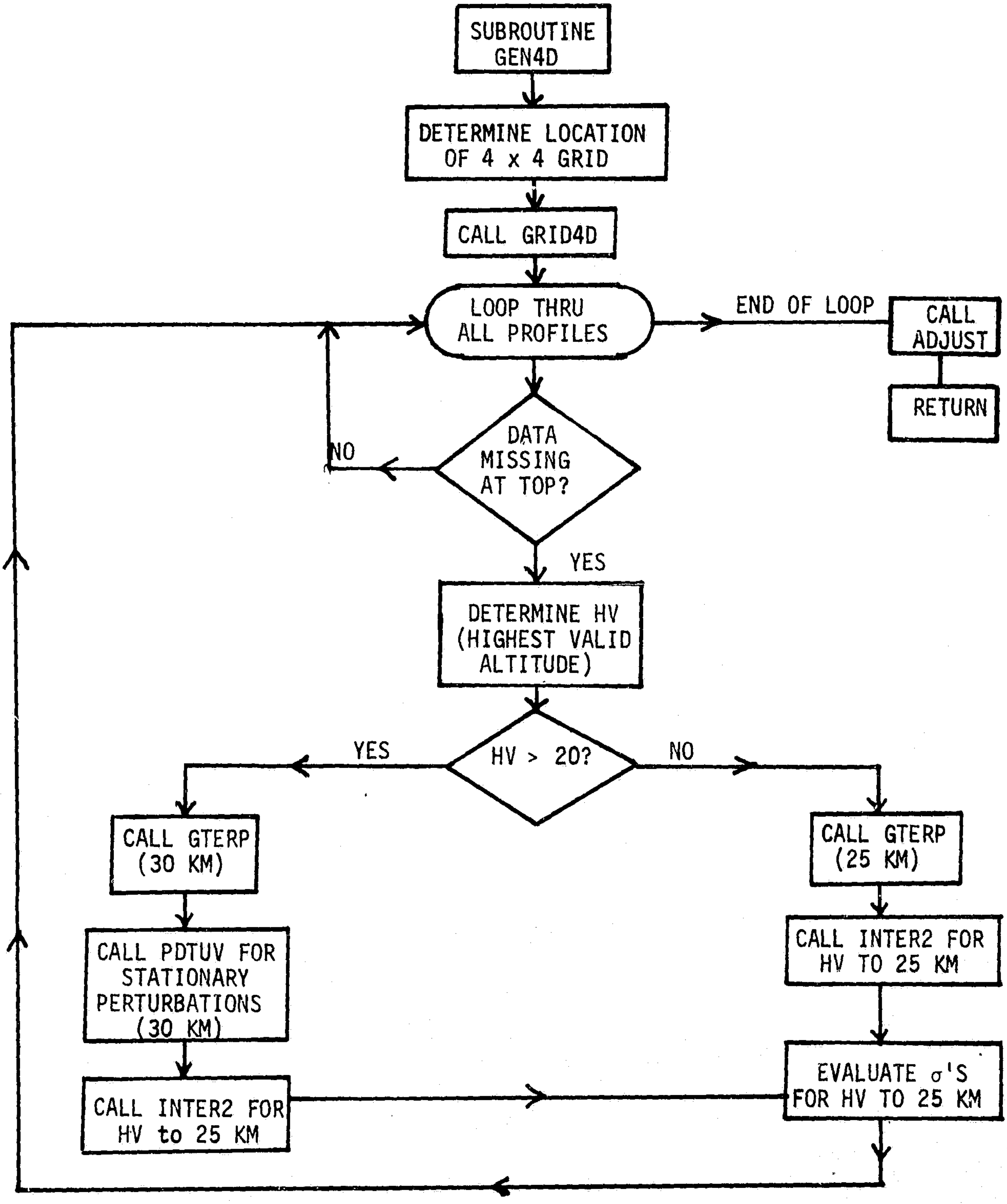


Figure 5.1: Simplified flow chart of the GEN4D subroutine.

| | |
|---|---|
| GRID4D: | After array of 4-D grid lat-lons has been evaluated, this subroutine looks up the data from the 4-D data tapes and interpolates to determine profiles of pressure density, temperature, and variance at the 4-D grid locations. Profiles to be interpolated to 4-D grid locations are loaded onto a scratch file from the tapes before the interpolation is done. |
| GR0UP | A subroutine, called by CHECK, which groups the 16 4-D pressure data at the given height into one or more groups which have consistent and reasonable horizontal pressure gradients within each group. If the subsequent geostrophic wind calculations in WIND use horizontal pressure gradients evaluated from differences across inconsistent groups of 4-D data, the diagnostic asterisk is printed between the output values of wind components. |
| GTERP: | Uses linear latitude interpolation and linear temperature and linear logarithm of density interpolation on height to evaluate Groves data to a given latitude and height. See Section 5 of *Justus et al* (1974a). |
| INTERW: | Two variable linear interpolation between known value U1 and V1 at Z1 and U2 and V2 at Z2 to determine U and V at Z, where Z is between Z1 and Z2. |
| INTERZ: | Three variable interpolation, linear on temperature, and gas constant ($R = p/\rho T$), and linear on the logarithm of pressure, with pressure computed from perfect gas law and interpolated temperature and density, and gas constant. |
| INTER2: | Three variable interpolation, linear on all three variables. |
| INTER4: | Interpolates between the pressure, density, and temperature profiles at the 4-D grid locations. This subroutine calls subroutine INTLL to do the latitude interpolation. |
| INTLL: | One variable interpolation between values in an array of latitude and longitude locations by equation (5.6) of *Justus et al* (1974a). |

| | |
|---|---|
| INTRP4: | The subroutine for the latitude-longitude interpolation of values from the 4-D data tapes into the 4-D grid array. This is a modification of the INTERP subroutine of the original 4-D program. |
| INTRUV: | Evaluates the standard deviations of the random wind components at given height and latitude by calling INTERW subroutine. |
| JAC: | Calculates the molecular weight, density, and temperature for the Jacchia model. |
| JACCH: | Main subroutine of the Jacchia section, serves as a driver for JAC and other Jacchia section subroutines. JACCHIA also evaluates the seasonal and latitudinal variations in the lower thermosphere. |
| NORMAL: | Computes two independent random numbers selected from a Gaussian distribution with mean zero and unit standard deviation. |
| PDTUV: | Interpolates the stationary perturbations on latitude and longitude at a given height. Ths subroutine is similar to INTLL. |
| PERTRB: | Evaluates the pressure, density, temperature and wind component random perturbations by the correlated random perturbation model discussed in Section 8 of the technical description section of the report. |
| PHASE: | A linear height-latitude interpolation routine for the quasi-biennial phase. The interpolation properly accounts for the phase discontinuity between 0 and 870 days (the quasi-biennial period). |
| QBOGEN: | Computes the QBO perturbation values and their amplitudes and phases. The amplitudes and phases of the QBO pressure, density, temperature, and wind perturbations are interpolated from the amplitude and phase data from the SCIDAT data tape, by calling the INTERZ and INTERW subroutines. |
| RAND: | Produces a random number selected from a uniform distribution between 0 and 1. This is required as input to the subroutine NORMAL. |
| RIG: | Computes the acceleration of gravity and the radius from the center of the Earth for a position at a given latitude and height. |
| RTERP: | Computes the standard deviations of the random pressure, density, and temperature perturbations by calling subroutine INTERZ. |

RTRAN: This subroutine contains several NTRAN read sections with multiple entry points coming from subroutine SETUP. The NTRAN read statements are for reading the SCIDAT data tape.

SCIMOD: The heart of the GRAM program. This subroutine branches on height to evaluate the atmospheric parameters by the Jacchia, the modified Groves, or the 4-D methods. The QBO and random perturbations are also evaluated and the output is printed (and optionally also punched) by the SCIMOD subroutine. See Figure 5.2 for a flow chart of the SCIMOD subroutine and Figure 4.1, for a flow chart showing how SCIMOD fits into the overall GRAM program.

SELEC4: Selects the 4-D data needed for interpolation. This subroutine is a modification of the INPUT subroutine of the original 4-D program.

SETUP: This subroutine reads in the NMC grid points with the GETNMC subroutine and reads and loads the data from the required month on the SCIDAT data tapes into arrays. See Figure 5.3 for a flow chart of the SETUP subroutine, and Figure 4.1 for a flow chart showing how SETUP fits into the overall GRAM program.

SORT4: Sorts the 4-D locations for sequential tape reading from the 4-D data tapes. This subroutine is a modification of the SORT subroutine from the original 4-D program.

STDATM: Evaluates the 1962 U.S. Standard Atmosphere values of pressure, density, and temperature, at any given height up to 700 km.

TINF: This subroutine computes the exospheric temperature for the Jacchia model.

TME: This subroutine calculates the variables necessary for input into the subroutine TINF in the Jacchia model.

WIND: This subroutine evaluates the first order (usual) geostrophic winds from input values of horizontal pressure gradient. If the latitude is below the minimum geostrophic latitude, it evaluates the second order geostrophic wind, and uses that wind (if it is smaller in magnitude than the first order geostrophic wind). If a negative

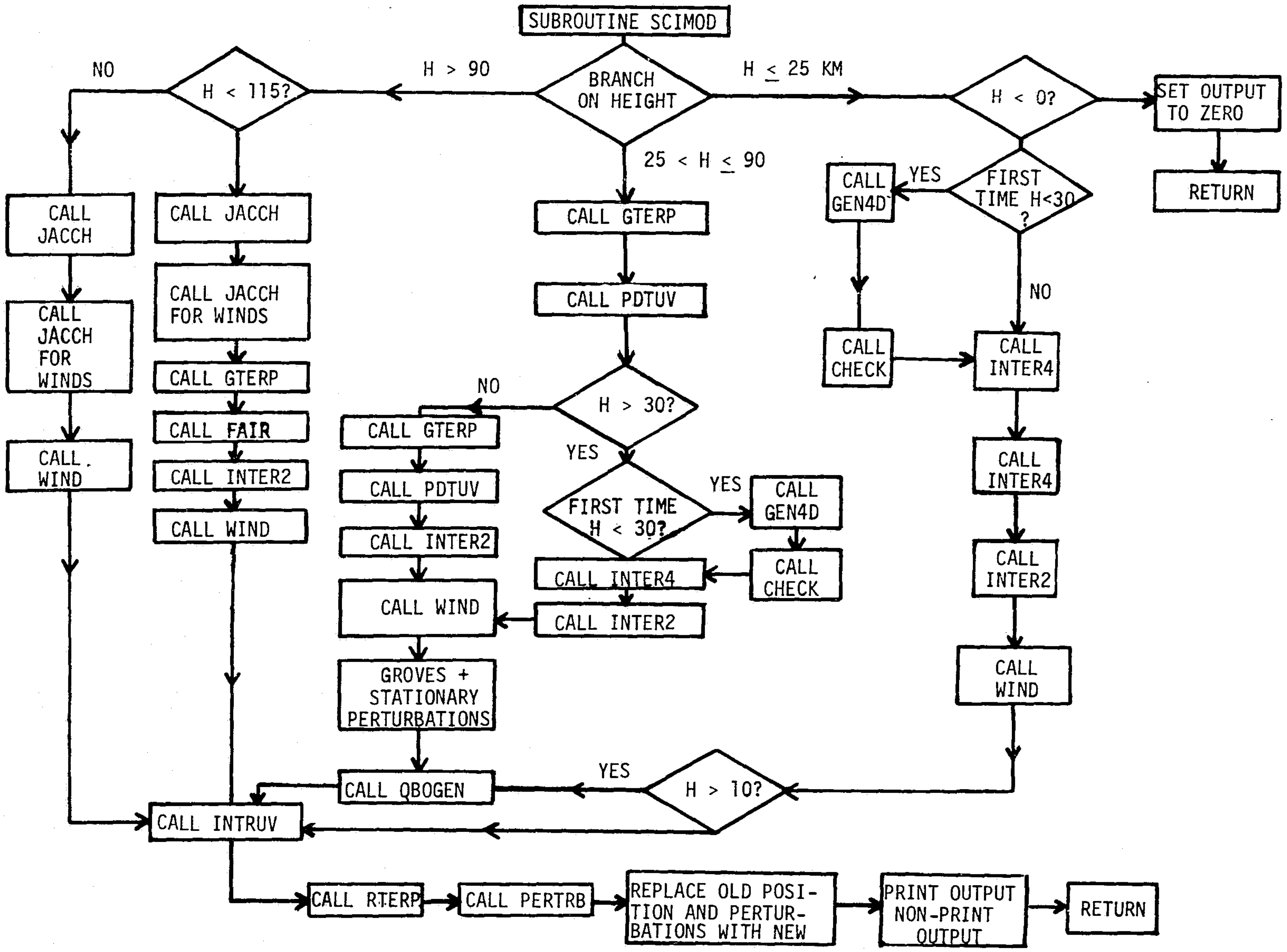


Figure 5.2: An abbreviated flow chart of the SCIMOD subroutine.

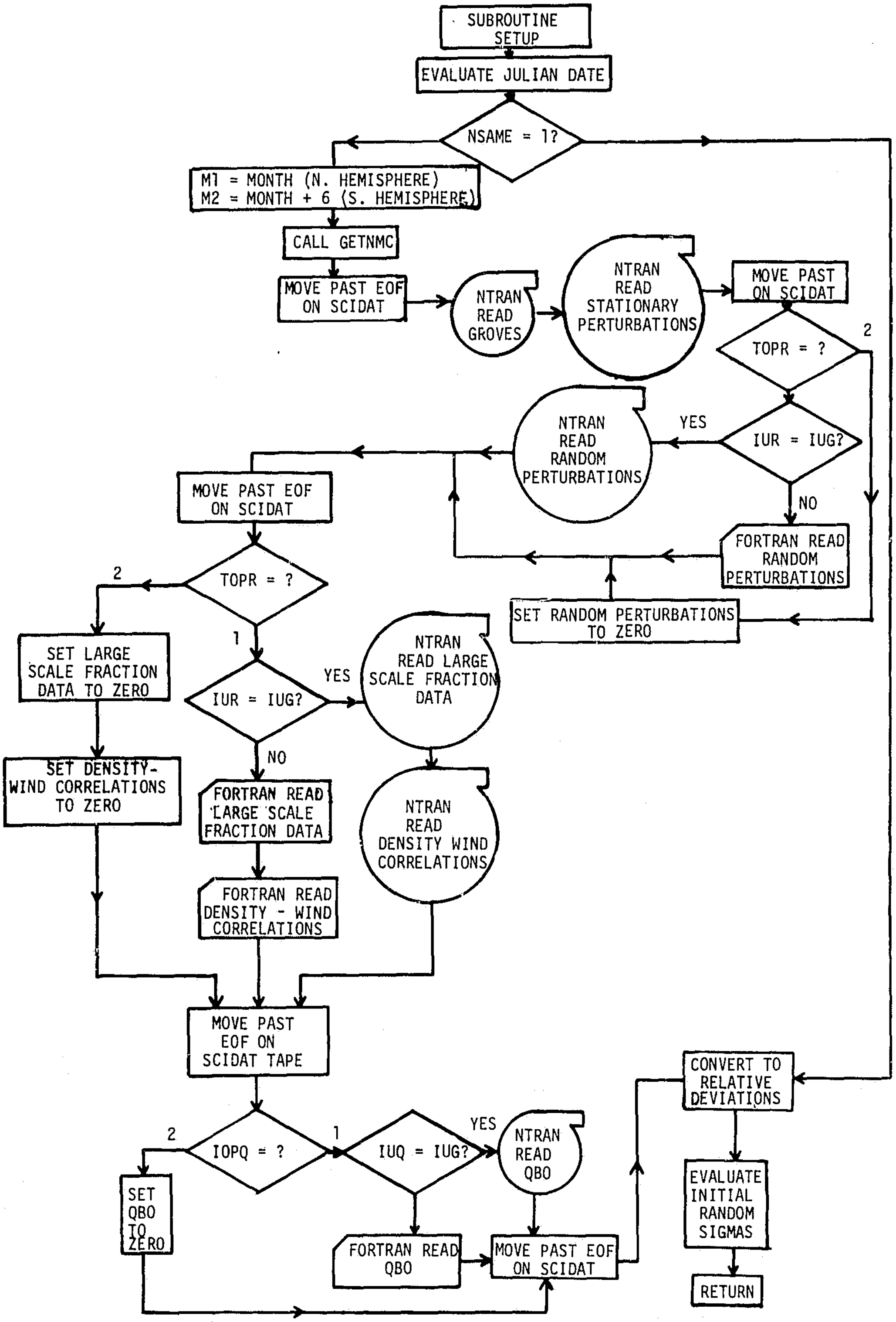


Figure 5.3: Abbreviated flow chart of the SETUP subroutine.

value of $\zeta^2$ is computed or if the low latitude second order geostrophic wind is larger than the first order geostrophic wind, a diagnostic asterisk will be output between the wind component values printed out.

The UNIVAC tape reading library routine NTRAN is not available on all computers. However, a similar function (reading 36 bit binary integer arrays in tape records) can be performed easily by alternate program techniques. For example, on Georgia Tech's CDC Cyber 74 system, this function is done by BUFFER IN statements. These routines are used to read the SCIDAT and 4-D data tapes. Also the FLD function, a UNIVAC library routine used to divide the 36 bit 4-D tape words onto 2 18 bit integers, must also be programmed by alternate methods on non-UNIVAC machines. On Georgia Tech's CDC machine, this is done by specially written subroutines (WRDCHG, RFLD, and FLD) which utilize the SHIFT and MASK bit manipulating CDC library routines.

If the GRAM program is mapped without segmenting the program, it requires approximately 39 K decimal words core storage. In order to take up less core storage (e.g. be accomodated into smaller core partitions), the program can be mapped in segmented form. An efficient segmentation of the program can be accomplished by subdividing the program into a primary segment, a setup segment, a Jacchia segment, and a 4-D segment. The primary segment should contain CORLAT, GRAM, GTERP, INTERW, INTERZ, INTER2, INTRUV, NORMAL, PDTUV, PERTRB, PHASE, QBOGEN, RAND, RIG, RTERP, SCIMOD, STDATM, and WIND. The setup segment should contain: GETNMC, RTRAN, and SETUP. The Jacchia segment should contain: FAIR, JAC, JACCH, TINF, and TME. The 4-D segment should contain: ADJUST, CHECK, DIAGEQ, GEN4D, GRID4D, GROUP, INTER4, INTLL, INTRP4, SELEC4, and SORT4. The following MAP statement for file GRAM to create absolute element ABS will accomplish the mapping of the program with these segments setup as described:

```
@MAP, IS , GRAM. ABS
   IN GRAM. CORLAT,  .  GRAM,
   IN GRAM. INTER2,  .  INTRUV,  .  NORMAL,  .  PDTUV,  .  PERTRB,  .  PHASE
   IN GRAM. QBOGEN,  .  RAND,  .  RIG,  .  RTERP
   IN GRAM. SCIMOD,  .  STDATM,  .  WIND
   NOT TPF$
   SEG SETUP*
   IN GRAM.  GETNMC,  .  RTRAN,  .  SETUP
   NOT TPF$
   SEG JACCH*,  SETUP
   IN GRAM.  FAIR,  .  JAC,  .  JACCH,  .  TINF,  .  TME
   NOT TPF$
   SEG SEG4D*,  SETUP
   IN GRAM.  ADJUST,  .  CHECK,  .  DIAGEQ
   IN GRAM.  GEN4D,  .  GRID4D,  .  INTER4,  .  INTLL,  .. INTRP4
   IN GRAM.  SELEC4,  .  SORT4,  .  GROUP
   NOT TPF$
   END
```

This segmented map saves approximately 4 K (decimal) in core storage, but does not significantly affect run time, since the segments being overlayed (the setup, Jacchia, and 4-D segments) only have to be loaded in once during any given trajectory or profile evaluation. If further reduction in size is desired the 4-D segment can be subdivided into two parts, one containing only CHECK, GROUP, INTER4, and INTLL and another segment containing ADJUST, DIAGEQ, GEN4D, GRID4D, INTRP4, SELEC4 and SORT4. This saves another 1 K in storage, approximately.

Some characteristics of some of the subroutines in each of these segments are described more fully in the following sections.

## 5.2: The Primary Section

This section consists of the main program segment GRAM, the SCIMOD subroutine, the subroutines for evaluating Groves values, the stationary perturbations, the QBO and random perturbations, and general interpolation subroutines. With the exception of GRAM and SCIMOD the parts of this section were adequately described in the previous section.

Many of the subroutines transfer their input and output via COMMON statements. This procedure saves much in core storage space. The discussion in this and subsequent sections describes the input and output of some of the subroutines, both by argument lists and via COMMON statements.

Main Segment GRAM. This program serves as a driver for the SETUP and SCIMOD subroutines (see Figure 4.1). It reads one card, the first input card, in free field format. This card contains:

| | | |
|---|---|---|
| 1. | The initial height | H1 |
| 2. | The initial latitude (degrees) | PHI1 |
| 3. | The initial west longitude (degrees) | THET1 |
| 4. | The F10.7 solar flux | F10 |
| 5. | The 81 day mean F10.7 solar flux | F10B |
| 6. | The $a_p$ geomagnetic index | AP |
| 7-9. | The date month/date/2 digit year | MN/IDA/IYR |
| 10-12. | The Greenwich time hours: minutes: seconds | IMRO; MINO; ISECO |
| 13-15. | The latitude, longitude, and height increments | DPHI, DTHET, DH |
| 16. | The maximum number of profile positions | NMAX |
| 17. | The time increment between profile positions | INCT |
| 18. | The trajectory option | IOPT |
| 19 | The output option | IOPP |
| 20. | The minimum geostrophic latitude | GLAT |

The trajectory input records (if used) are also read by GRAM, after control has returned from SETUP, which reads the second and third initial data input cards. See Section 4.4 and Appendix C for further description of the card input.

The COMMON "IOTEMP" transfers data from the card input in GRAM to the other subroutines called by GRAM (SETUP, SCIMOD, and RIG).

Subroutine SCIMOD. This program is the primary subroutine of the GRAM program. It serves as a driver for all of the various sections of the atmospheric evaluation. See Figure 5.2 for a flow chart of this subroutine.

The input to SCIMOD, transferred by COMMON statements IOTEMP and PDTCOM, is:

| | | |
|---|---|---|
| 1. | Acceleration of gravity (m/sec$^2$) | G |
| 2. | Earth radius to height H (km) | RI |
| 3. | Height (km) | H |
| 4. | Latitude (radians) | PHIR |
| 5. | Longitude (radians) | THETR |
| 6. | F10.7 solar flux | F10 |
| 7. | Mean F10.7 solar flux | F10B |
| 8. | Geomagnetic index $a_p$ | AP |
| 9-11. | Date | MN/IDA/IYR |
| 12-14. | Time | IHR: MIN: ISEC |
| 15. | Previous height (km) | H1 |
| 16. | Previous latitude (radians) | PHI1R |
| 17. | Previous longitude (radians) | THET1R |
| 18-20. | Previous random pressure, density, and temperature perturbations (%), large scale (L) and small scale (S) | RP1L, RD1L, RT1L, RP1S, RD1S, RT1S |
| 21-23. | Previous random pressure, density, and temperature standard deviations (5), large scale (L) and small scale (S) | SP1L, SD1L, ST1L, SP1S, SD1S, ST1S |
| 24-25. | Previous random winds (m/s), large scale (L) and small scale (S) | RU1L, RV1L, RU1S, RV1S |
| 26-27. | Previous standard deviation of random winds (m/s), large scale (L) and small scale (S) | SU1L, SV1L, SU1S, SV1S |

The COMMON "PDTCOM" contains data transferred into SCIMOD from SETUP. The COMMON "IOTEMP" transfers data in from GRAM. The COMMON "C4" transfers data out to the 4-D section of the program. The COMMON "COMPER" transfers data out to the random perturbation subroutines.

The SCIMOD subroutine prints and (optionally) punches on a non-print output file, the output described in Section 4 and Appendix C. It also transfers output to other subroutines via the above-mentioned COMMON lists. The SCIMOD subroutine updates the profile or trajectory positions by setting the current position equal to the previous position before exit. The previous position information then stays in the COMMON list unit the next call to SCIMOD. The previous random perturbations are handled in similar fashion

## 5.3 The Setup Section

The function of the setup section of the program is to load the initial data and the data from the SCIDAT tape. See Figure 4.1 for a flow chart illustrating how the SETUP subroutine fits into the overall program and Figure 5.2 for a flow chart of the SETUP subroutine.

The SETUP subroutine reads the second and third cards of input. The second cards contains:

| | | |
|---|---|---|
| 1. | Groves input unit | IUG |
| 2. | Random input unit | IUR |
| 3. | QBO input unit | IUQ |
| 4. | 4-D input unit | IU4 |
| 5. | Random option | IOPR |
| 6. | QBO option | IOPQ |
| 7. | First random number | NR1 |
| 8. | NMC read option | NMCOP |
| 9. | 4-D scratch unit | IOTEM1 |
| 10. | NMC grid point scratch unit | IOTEM2 |

The third card (optional, read only if IOPR = 1) contains:

| | | |
|---|---|---|
| 1-6. | Initial random perturbations in pressure, density, and temperature (%), large scale (L) and small scale (S) | RP1L, RD1L, RT1L<br>RP1S, RD1S, RT1S |
| 7-10. | Initial random wind perturbation (m/s), large scale (L) and small scale (S) | RU1L, RV1L, RU1S, RV1S |

The COMMON list "PDTCOM" transfers the arrays, loaded with the appropriate data from the SCIDAT data tape, to the other subroutines. This COMMON list contains the following arrays:

| | | |
|---|---|---|
| 1-3. | Groves pressure, density, and temperature | PG, DG, TG |
| 4-6. | Stationary perturbations in pressure, density, and temperature | PSP, DSP, TSP |
| 7-11. | Amplitudes of QBO pressure, density, and temperature, and winds | PAQ, DAQ, TAQ, UAQ, VAQ |
| 12-16. | Phases of QBO pressure, density, and temperature, and winds | PDQ, DDQ, TDQ, UDQ, VDQ |
| 17-21. | Standard deviations for the random pressure, density, temperature and winds | PR, DR, TR, UR, VR |

The COMMON list "COTRAN" is used to transfer data to setup from the NTRAN read subroutine RTRAN, which has multiple entry points for various different types of data from the SCIDAT data tape.

## 5.4 The Jacchia Section

The subroutine JACCH calculates the pressure, density, and temperature at a point in space for heights above 90 km for a particular time.

| | | |
|---|---|---|
| 1. | Height in km | H |
| 2. | Latitude in radians | PHIR |
| 3. | West longitude in degrees (0 to 360 degrees) | THET |
| 4. | Solar radio noise flux F10.7 ($10^{-22}$ watts/$m^2$) | F10 |
| 5. | 81 - day average solar flux F10.7 | F10B |
| 6. | Geomagnetic index $a_p$ | AP |

| | | |
|---|---|---|
| 7. | Month | MN |
| 8. | Day of month | IDA |
| 9. | Year | IYR |
| 10. | Hour of day in universal time | IHR |
| 11. | Minute of hour in universal time | MIN |
| 12. | Mean Julian day | XMJD |

The outputs are:

| | | |
|---|---|---|
| 1. | Pressure in units of $nt/m^2$ | PH |
| 2. | Density in units of $kg/m^3$ | DH |
| 3. | Temperature in Kelvin degrees | TH |

The theory and methods used in JACCH for calculating the pressure, density, and temperature are given in Jacchia, (1970). A brief explanation will be given below.

The subroutine JACCH consists of four sections: the main routine and three imbedded subroutines. All sections have numerous comments to explain each part of the program.

**Main Routine (JACCH).** The main routine acts as the calling routine, and also, calculates the seasonal - latitudinal variations in the lower thermosphere.

The seasonal - latitudinal density variations are given by equation (2.1) of Justus et al (1974 a).

The equations for the molecular weight and the relative temperature were given as equations (2.2) and (2.3) of Justus et al (1974 a). After the density, temperature, and molecular weight are calculated, the pressure is calculated from the ideal gas law:

$$P = \frac{\rho RT}{M}$$

where $\rho$ is the density, $R$ is the universal gas constant, $T$ is the temperature, and M is the molecular weight.

An option is included in the main routine whereby the yearly mean values of the density, pressure, and temperature may be calculated directly. If the value of the month input variable is thirteen, (MN = 13), the exosphere temperature is immediately set equal to 1000° K (which is the recommended design value for annual mean conditions) and the yearly mean density, pressure, and temperature values are calculated. Note that the 1962 U.S. Standard Atmosphere has an exospheric temperature of approximately 1500° K and is thus considerably different from the 1000° K results of the annual mean in the PROFILE program.

<u>Subroutine TME</u>. This subroutine calculates variables necessary for input into the subroutine TINF. The input variables are:

| | | |
|---|---|---|
| 1. | month (month = 13 denotes annual mean and bypasses this subroutine) | MN |
| 2. | day of month | IDA |
| 3. | year | IYR |
| 4. | hour of day in universal time | IHR |
| 5. | minute of day in universal time | MIN |
| 6. | mean Julian day | XMJD |
| 7. | latitude in radians | XLAT |
| 8. | longitude in degrees (input: 0 to 360 degrees turning westward; output: -180 to + 180 degrees) | XLONG |

The output variables are:

| | | |
|---|---|---|
| 1. | solar declination angle in radians | SDA |
| 2. | solar hour angle in radians | SHA |
| 3. | day number from January 1 | DD |
| 4. | day number divided by tropical year (365.2422 days) | DY |

Subroutine TINF. This subroutine calculates the exospheric temperature. The input variables are:

| | | |
|---|---|---|
| 1. | solar radio noise flux ($10^{-22}$ watts/$m^2$) | F10 |
| 2. | 81 - day average F10 | F10B |
| 3. | geomagnetic latitude in radians | XLAT |
| 4. | solar declination angle | SDA |
| 5. | solar hour angle | SHA |
| 6. | day number divided by tropical year | DY |
| 7. | diurnal factor equal to 0.31 | R |

The output is the exospheric temperature, TE. Factors included in the calculation of the exospheric temperature are solar activity variations, diurnal variations, variations with the geomagnetic activity, and semi-annual variations.

Subroutine JAC. This subroutine calculates the molecular weight, density, and temperature without the seasonal - latitudinal variations. The input variables are:

| | | |
|---|---|---|
| 1. | height in km | Z |
| 2. | exospheric temperature | T |

The output variables are:

| | | |
|---|---|---|
| 1. | temperature | TZ |
| 2. | molecular weight | EM |
| 3. | density | DENS |

### 5.5 The 4-D Section

GRID4D and subroutines S0RT4, INTRP4 and SELEC4 are basically the MAIN PR0GRAM, S0RT, INTERP and INPUT as documented in the 4-D users reference manual and subsequent updates.

Some changes have been made.

Statement numbers have been ordered in GRID4D and SØRT4.

In GRID4D, NTRAN MØVE statements are used to select the appropriate file for a given month on the 4-D data tape mounted on UNIT IT in the UNIVAC version. In Georgia Tech's CDC version, and on other machines, separate reads for each record must be used until and end of file is reached, and reading continues until the proper file is found. If a parity error is encountered in reading IT, a message

"INPUT UNIT NO. IT IN ERRØR FØR RECØRD NØ IRC"

is printed - execution continues. Such an error will only be of consequence if the particular record read in error is required for interpolation.

Grid point profiles for subsequent interpolation are tagged and filed on a dynamically assigned scratch UNIT SCRCH1 (IØTEM1 in calling program), instead of occupying core as in the 4-D model.

Any error in the handling of the 4-D data tape or UNIT SCRCH(IØTEM1 in calling program) by TRID4D which results in a transfer to

STATEMENT NO. 30

is fatal, and results in the printing of an error message and termination of execution (see Section 4.5).

Slight changes have been made to the logic of SØRT4 in the interests of efficiency.

SELEC4 is concerned only with the selection of the record numbers of the appropriate interpolation profiles.

GETNMC has been added to file the NMC grid point data, read either from cards of the SCIDAT data tape on UNIT IUG, on a dynamically assigned scratch file SCRCH2 (IOTEN2 in calling program), instead of occupying 1977 words of core as in the 4-D model. If other than 1977 records are filed, an error message

"N REC0RDS WRITTEN BY GETNMC ON SCRATCH FILE M"

is printed and execution terminated.

INTRP4 uses a modified latitude - longitude interpolation scheme in the mixed NMC - equatorial, equatorial and southern hemisphere regions.

The dimensions of some variables have been altered in keeping with the maximum number of profiles to be used in interpolation (16 instead of 25 as in the 4-D model), and to provide the index word for each record of SCRCH1 (IN (107) instead of (106)).

All references to, and subroutines associated with, the determination of the coefficients of the best fit polynomials to the selected profiles, as performed in the original 4-D model, have been deleted. All vertical interpolations required are performed by SCIM0D.

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# APPENDIX A

# THE SECOND ORDER GEOSTROPHIC WIND RELATIONS

The atmospheric equations of motion in $\beta$ plane representation on constant pressure surfaces, as derived in any of the standard meteorological references (e.g. Hess, 1959), can be written as

$$u_t + u(u_x) + v(u_y - f) = -g\ z_x \tag{A-1}$$

$$v_t + u(v_x + f) + v(v_y) = -g\ z_y \tag{A-2}$$

where u and v are respectively the eastward and northward wind components, f is the Coriolis parameter ($2\ \Omega \sin \phi$), g is the acceleration of gravity, z is the height of the constant pressure surface, and subscripts denote partial differentiation with respect to the subscript variable. For the geostrophic approximation the local and convective derivatives are assumed negligible so that balance results between the Coriolis force and the pressure gradient force.

$$\bar{v} = g\ z_x/f \tag{A-3}$$

$$\bar{u} = -g\ z_y/f \tag{A-4}$$

where $\bar{u}$ and $\bar{v}$ are the geostrophic wind components. The geostrophic wind equations suffer from the well known problem that they produce unreasonably large velocity estimates as f becomes small (i.e. at equatorial latitudes), because f appears in the denominator. This Appendix describes a wind equation which is only slightly more generalized than the geostrophic equation, but does not suffer this anomaly at low latitudes. The new equation is also based on the assumption of stationary flow ($u_t = v_t = 0$), but the spatial derivatives ($u_x$, $u_y$, etc) are assumed to be constants, rather than zero as in the geostrophic analysis. Thus, the new equations are referred to as second order geostrophic relations.

If the assumptions $u_t = v_t = 0$ and $u_x = a$, $u_y = b$, $v_x = c$, $v_y = d$ (where a, b, c and d are constants) are substituted into equations (A-1) and (A-2), and the resultant equations are differentiated alternately with respect to x and y, the following four equations result:

$$a^2 + (b - f)c = -g\, z_{xx} \qquad \text{(A-5)}$$

$$ab + (b - f)d = -g\, z_{xy} \qquad \text{(A-6)}$$

$$a(c + f) + cd = -g\, z_{xy} \qquad \text{(A-7)}$$

$$b(c + f) + d^2 = -g\, z_{yy} \qquad \text{(A-8)}$$

The continuity condition on constant pressure surfaces is (see, e.g. Hess, 1959; page 262)

$$u_x + v_y + \omega_p = 0 \qquad \text{(A-9)}$$

where $\omega$ is the vertical velocity ($\omega = dp/dt$) in constant pressure coordinates. This relation is exact in that the density gradient terms do not appear in the constant pressure surface analysis. If the vertical term in (A-9) is neglected then the continuity condition becomes

$$u_x + v_y = a + d = 0 \qquad \text{(A-10)}$$

from which it follows, by (A-6) and (A-7), that

$$a = -d = -g\, z_{xy}/f \qquad \text{(A-11)}$$

Subtraction of (A-5) from (A-8) yields the following equation for the strain $\gamma$($\gamma = c + b$)

$$\gamma = g(z_{xx} - z_{yy})/f \qquad \text{(A-12)}$$

and addition of (A-5) and (A-8) yields a relation for the vorticity $\zeta$ ($\zeta = c - b$)

$$\zeta^2/2 + f\zeta - g(z_{xx} + z_{yy}) - 2a^2 - \gamma^2/2 = 0 \tag{A-13}$$

which has as a solution

$$\zeta = -f \pm [f^2 + \gamma^2 + 4a^2 + 4g(z_{xx} + z_{yy})]^{1/2} \tag{A-14}$$

where the positive sign is for northern hemisphere and the negative sign for southern hemisphere. Relations (A-12) and (A-14) can be used to evaluate the constants b and c by the relations

$$b = (\gamma - \zeta)/2 \tag{A-15}$$

$$c = (\gamma + \zeta)/2 \tag{A-16}$$

With values for the constants a, b, c, and d, the solutions to (A-1) and (A-2) (now easily found as the algebraic solution of these two simultaneous equations, linear in u and v) are given by

$$u = (g/D)\,[az_x + (b - f)z_y] \tag{A-17}$$

$$v = (g/D)\,[-az_y + (c + f)z_x] \tag{A-18}$$

where D is the determinant of the system given by

$$D = ad - (b - f)(c + f) \tag{A-19}$$

Although the geostrophic wind is $O(f^{-1})$ as f approaches zero, the generalized gradient wind solutions (A-17) and (A-18) are $O(f)$ as f approaches zero. This follows from the fact that although the wind derivatives a, b, c, and d are $O(f^{-1})$ the determinant D is $O(f^{-2})$, hence u and v become $O(f)$. This overcomes the geostrophic dilemma of large velocities at equatorial latitudes. The generalized gradient wind does become exactly zero at $f = 0$, an obvious simplification from what really occurs, but not a gross error, since the true winds at the equator are generally light.

For a constant geometric height representation, in which pressure gradients must be used instead of the gradients of the pressure contour heights, the substitutions

$$z_x = (\alpha/g)\ p_x \tag{A-20}$$

$$z_y = (\alpha/g)\ p_y \tag{A-21}$$

$$z_{xx} = (\alpha/g)\ p_{xx} + 2(\alpha_x/g)\ p_x \tag{A-22}$$

$$z_{yy} = (\alpha/g)\ p_{yy} + 2(\alpha_y/g)\ p_y \tag{A-23}$$

$$z_{xy} = (\alpha/g)\ p_{xy} + (\alpha_x/g)\ p_y + (\alpha_y/g)\ p_x \tag{A-24}$$

must be made into equations (A-11) through (A-19). The equations (A-20) through (A-24) come from the general pressure-height transformation equations

$$(fx)_p = (fx)_z + (\alpha/g)\ p_x\ f_z \tag{A-26}$$

$$(fy)_p = (fy)_z + (\alpha/g)\ p_y\ f_z \tag{A-27}$$

where the subscripts x, y and z denote partial differentiation, and the notation $(\ )_p$ and $(\ )_z$ denotes differentiation on a constant pressure surfaces or a constant height surface, respectively. In equations (A-20) through (A-27) $\alpha$ specific volume $(1/\rho)$ and the derivatives $\alpha_x$ and $\alpha_y$ are evaluated from the perfect gas law by

$$\alpha_x = \alpha(T_x/T - p_x/p) \tag{A-28}$$

$$\alpha_y = \alpha(T_y/T - p_y/p) \tag{A-29}$$

# APPENDIX B

## LISTING OF THE REVISED TAPE "SCIDAT-MOD-2" FOR THE GRAM PROGRAM

The tape contains the following data, identified by code characters at the beginning of each record. Month 13 refers to annual mean values. For code P, D, T, S, R and RW data, southern latitudes are given by northern hemisphere data displaced six months. Annual mean data and the QBO parameters are the same for both southern and northern hemispheres. For a more complete discussion of the input data, see Section 4.2.

| Code | Data | Description |
|---|---|---|
| None | NMC Grid Data | Same as NMC Grid Required by NASA version 4-D program. Data consists of sequential point number followed by the two corresponding NMC grid indices. There are five points per record on the tape. |
| P | Groves Pressure ($\text{nt/m}^2$) | Month, height, values at latitudes 0, 10, 20, ... 90 exponent. Same format as in Groves report. |
| D | Groves Density ($\text{kg/m}^3$) | |
| T | Groves Temperature (°K) | |
| S | Stationary Perturbations in monthly means (per mill) | Month, height, longitude, $\Delta p$ at north latitude, 10, 30, 50, 70, 90, $\Delta p$ same, $\Delta T$ same. |
| R | Random pressure, density and temperature perturbation magnitudes (per mill) | Month, height, $\Delta p$ at north latitude 10, 30, 50, 70, 90, $\Delta \rho$ same, $\Delta T$ same |
| RW | Random magnitudes wind perturbation (m/s) | Month, height, $\Delta u$ at north latitude 10, 30, 50, 70, 90, $\Delta v$ same |
| P | Fractional variance in large scale thermodynamic variables | 13 (Annual), height, fractional variance in large scale per mill for pressure, density and temperature, each at latitude 10°, 30°, 50°, 70°, 90° |
| PW | Fractional variance in large scale winds | 13 (Annual), height, fractional variance in u at 10°, 30°, 50°, 70°, 90° latitude, same for v |

| Code | Data | Description |
|---|---|---|
| CS | Small scale density-velocity correlations | 13 (Annual), height, $\langle \rho u \rangle_S$ at 10°, 30°, 50°, 70°, 90° latitude, same for $\langle \rho v \rangle$ |
| CL | Large scale density-velocity correlations | 13 (Annual), height, $\langle \rho u \rangle_2$ at 10°, 30°, 50°, 70°, 90° latitude, same for $\langle \rho v \rangle_L$ |
| QP | QBO pressure parameters-amplitude (per mill) and phase (days after Jan. 0, 1966 when 1st maximum occurs) | |
| QD | QBO density parameters (as in QP) | |
| QT | QBO temperature parameters | Height, amplitude and phase at 10° latitude, amplitude and phase at 30° ... , amplitude and phase at 90° |
| QU | QBO eastward wind parameters-amplitude (0.1 m/s) and phase (days after Jan. 0, 1966) | |
| QV | QBO northward wind parameters - (as in QU) | |

The tape consists of five NTRAN readable (36 bit binary integer word record) files with an end of file marker after each file. The first file contains the NMC grid data, the second contains the Groves and stationary perturbation data, the third contains the random perturbation data, the fourth contains the fractional large scale variances and the density-velocity correlations, and the fifth contains the QBO data. The number of words per NTRAN record is 15 for the NMC grid data. Each record contains NMC grid x-y coordinates for 5 points. The total number of NMC grid points is 1977. The NMC grid data file contains a total of 396 records, with the last record containing points 1976 and 1977 and zeros in the remaining words. There are 14 words per record for the Groves data (including the code word), 19 for the stationary perturbations, 18 for the code R data, 13 for the code RW data, 18 for the large scale fractional variances in thermodynamic variables, 13 for large scale fractional wind variances, 13 for the density-velocity correlations (small scale and large scale), and 12 for the quasi-biennial data. The Groves data contains 702 records, the stationary perturbation data contains 1248 records, the code R random data contains 260 records, the code RW random winds data contain 325 records, the code P large scale fractional variances contain 25 records, the code PW large scale fractional wind variances contain 25 records, and code CS and CL density-velocity correlation data contain 25 records each, and the QBO data contain 80 records.

Following is a listing of the data contained on the SCIDAT tape.

```
***NMC GRID DATA***
     1    15     1     2    16     1     3    17     1     4    18     1     5    19     1
     6    20     1     7    21     1     8    22     1     9    23     1    10    24     1
    11    25     1    12    26     1    13    27     1    14    28     1    15    29     1
    16    30     1    17    31     1    18    32     1    19    33     1    20    14     2
    21    15     2    22    16     2    23    17     2    24    18     2    25    19     2
    26    20     2    27    21     2    28    22     2    29    23     2    30    24     2
    31    25     2    32    26     2    33    27     2    34    28     2    35    29     2
    36    30     2    37    31     2    38    32     2    39    33     2    40    34     2
    41    13     3    42    14     3    43    15     3    44    16     3    45    17     3
    46    18     3    47    19     3    48    20     3    49    21     3    50    22     3
    51    23     3    52    24     3    53    25     3    54    26     3    55    27     3
    56    28     3    57    29     3    58    30     3    59    31     3    60    32     3
    61    33     3    62    34     3    63    35     3    64    12     4    65    13     4
    66    14     4    67    15     4    68    16     4    69    17     4    70    18     4
    71    19     4    72    20     4    73    21     4    74    22     4    75    23     4
    76    24     4    77    25     4    78    26     4    79    27     4    80    28     4
    81    29     4    82    30     4    83    31     4    84    32     4    85    33     4
    86    34     4    87    35     4    88    36     4    89    11     5    90    12     5
    91    13     5    92    14     5    93    15     5    94    16     5    95    17     5
    96    18     5    97    19     5    98    20     5    99    21     5   100    22     5
   101    23     5   102    24     5   103    25     5   104    26     5   105    27     5
   105    28     5   107    29     5   108    30     5   109    31     5   110    32     5
   111    33     5   112    34     5   113    35     5   114    36     5   115    37     5
   116    10     6   117    11     6   118    12     6   119    13     6   120    14     6
   121    15     6   122    16     6   123    17     6   124    18     6   125    19     6
   126    20     6   127    21     6   128    22     6   129    23     6   130    24     6
   131    25     6   132    26     6   133    27     6   134    28     6   135    29     6
   136    30     6   137    31     6   138    32     6   139    33     6   140    34     6
   141    35     6   142    36     6   143    37     6   144    38     6   145     9     7
   146    10     7   147    11     7   148    12     7   149    13     7   150    14     7
   151    15     7   152    16     7   153    17     7   154    18     7   155    19     7
   156    20     7   157    21     7   158    22     7   159    23     7   160    24     7
   161    25     7   162    26     7   163    27     7   164    28     7   165    29     7
   166    30     7   167    31     7   168    32     7   169    33     7   170    34     7
   171    35     7   172    36     7   173    37     7   174    38     7   175    39     7
   176     8     8   177     9     8   178    10     8   179    11     8   180    12     8
   181    13     8   182    14     8   183    15     8   184    16     8   185    17     8
   185    18     8   187    19     8   188    20     8   189    21     8   190    22     8
   191    23     8   192    24     8   193    25     8   194    26     8   195    27     8
   196    28     8   197    29     8   198    30     8   199    31     8   200    32     8
   201    33     8   202    34     8   203    35     8   204    36     8   205    37     8
   206    38     8   207    39     8   208    40     8   209     7     9   210     8     9
   211     9     9   212    10     9   213    11     9   214    12     9   215    13     9
   216    14     9   217    15     9   218    16     9   219    17     9   220    18     9
   221    19     9   222    20     9   223    21     9   224    22     9   225    23     9
   226    24     9   227    25     9   228    26     9   229    27     9   230    28     9
   231    29     9   232    30     9   233    31     9   234    32     9   235    33     9
   236    34     9   237    35     9   238    36     9   239    37     9   240    38     9
   241    39     9   242    40     9   243    41     9   244     6    10   245     7    10
   246     8    10   247     9    10   248    10    10   249    11    10   250    12    10
   251    13    10   252    14    10   253    15    10   254    16    10   255    17    10
   256    18    10   257    19    10   258    20    10   259    21    10   260    22    10
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| 1566 | 38 | 38 | 1567 | 39 | 38 | 1568 | 40 | 38 | 1569 | 41 | 38 | 1570 | 42 | 38 |
| 1571 | 43 | 38 | 1572 | 44 | 38 | 1573 | 45 | 38 | 1574 | 46 | 38 | 1575 | 3 | 39 |
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| 1601 | 29 | 39 | 1602 | 30 | 39 | 1603 | 31 | 39 | 1604 | 32 | 39 | 1605 | 33 | 39 |
| 1606 | 34 | 39 | 1607 | 35 | 39 | 1608 | 36 | 39 | 1609 | 37 | 39 | 1610 | 38 | 39 |
| 1611 | 39 | 39 | 1612 | 40 | 39 | 1613 | 41 | 39 | 1614 | 42 | 39 | 1615 | 43 | 39 |
| 1616 | 44 | 39 | 1617 | 45 | 39 | 1618 | 4 | 40 | 1619 | 5 | 40 | 1620 | 6 | 40 |
| 1621 | 7 | 40 | 1622 | 8 | 40 | 1623 | 9 | 40 | 1624 | 10 | 40 | 1625 | 11 | 40 |
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| 1636 | 22 | 40 | 1637 | 23 | 40 | 1638 | 24 | 40 | 1639 | 25 | 40 | 1640 | 26 | 40 |
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| 1646 | 32 | 40 | 1647 | 33 | 40 | 1648 | 34 | 40 | 1649 | 35 | 40 | 1650 | 36 | 40 |
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| 1666 | 12 | 41 | 1667 | 13 | 41 | 1668 | 14 | 41 | 1669 | 15 | 41 | 1670 | 16 | 41 |
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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1801 | 39 | 44 | 1802 | 40 | 44 | 1803 | 9 | 45 | 1804 | 10 | 45 | 1805 | 11 | 45 |
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| 1826 | 32 | 45 | 1827 | 33 | 45 | 1828 | 34 | 45 | 1829 | 35 | 45 | 1830 | 36 | 45 |
| 1831 | 37 | 45 | 1832 | 38 | 45 | 1833 | 39 | 45 | 1834 | 10 | 46 | 1835 | 11 | 46 |
| 1836 | 12 | 46 | 1837 | 13 | 46 | 1838 | 14 | 46 | 1839 | 15 | 46 | 1840 | 16 | 46 |
| 1841 | 17 | 46 | 1842 | 18 | 46 | 1843 | 19 | 46 | 1844 | 20 | 46 | 1845 | 21 | 46 |
| 1846 | 22 | 46 | 1847 | 23 | 46 | 1848 | 24 | 46 | 1849 | 25 | 46 | 1850 | 26 | 46 |
| 1851 | 27 | 46 | 1852 | 28 | 46 | 1853 | 29 | 46 | 1854 | 30 | 46 | 1855 | 31 | 46 |
| 1856 | 32 | 46 | 1857 | 33 | 46 | 1858 | 34 | 46 | 1859 | 35 | 46 | 1860 | 36 | 46 |
| 1861 | 37 | 46 | 1862 | 38 | 46 | 1863 | 11 | 47 | 1864 | 12 | 47 | 1865 | 13 | 47 |
| 1866 | 14 | 47 | 1867 | 15 | 47 | 1868 | 16 | 47 | 1869 | 17 | 47 | 1870 | 18 | 47 |
| 1871 | 19 | 47 | 1872 | 20 | 47 | 1873 | 21 | 47 | 1874 | 22 | 47 | 1875 | 23 | 47 |
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| 1881 | 29 | 47 | 1882 | 30 | 47 | 1883 | 31 | 47 | 1884 | 32 | 47 | 1885 | 33 | 47 |
| 1886 | 34 | 47 | 1887 | 35 | 47 | 1888 | 36 | 47 | 1889 | 37 | 47 | 1890 | 12 | 48 |
| 1891 | 13 | 48 | 1892 | 14 | 48 | 1893 | 15 | 48 | 1894 | 16 | 48 | 1895 | 17 | 48 |
| 1895 | 18 | 48 | 1897 | 19 | 48 | 1898 | 20 | 48 | 1899 | 21 | 48 | 1900 | 22 | 48 |
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| 1906 | 28 | 48 | 1907 | 29 | 48 | 1908 | 30 | 48 | 1909 | 31 | 48 | 1910 | 32 | 48 |
| 1911 | 33 | 48 | 1912 | 34 | 48 | 1913 | 35 | 48 | 1914 | 36 | 48 | 1915 | 13 | 49 |
| 1916 | 14 | 49 | 1917 | 15 | 49 | 1918 | 16 | 49 | 1919 | 17 | 49 | 1920 | 18 | 49 |
| 1921 | 19 | 49 | 1922 | 20 | 49 | 1923 | 21 | 49 | 1924 | 22 | 49 | 1925 | 23 | 49 |
| 1926 | 24 | 49 | 1927 | 25 | 49 | 1928 | 26 | 49 | 1929 | 27 | 49 | 1930 | 28 | 49 |
| 1931 | 29 | 49 | 1932 | 30 | 49 | 1933 | 31 | 49 | 1934 | 32 | 49 | 1935 | 33 | 49 |
| 1936 | 34 | 49 | 1937 | 35 | 49 | 1938 | 14 | 50 | 1939 | 15 | 50 | 1940 | 16 | 50 |
| 1941 | 17 | 50 | 1942 | 18 | 50 | 1943 | 19 | 50 | 1944 | 20 | 50 | 1945 | 21 | 50 |
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1961    17    51 1962    18    51 1963    19    51 1964    20    51 1965    21    51
1966    22    51 1967    23    51 1968    24    51 1969    25    51 1970    26    51
1971    27    51 1972    28    51 1973    29    51 1974    30    51 1975    31    51
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P  8  75   256  268  261  251  250  268  295  316  329  333   -2
P  8  80   111  116  116  109  104  106  115  125  131  133   -2
P  8  85   469  506  501  459  408  390  397  430  450  456   -3
P  8  90   200  214  214  189  158  140  134  138  140  141   -3
P  8  95   855  931  902  796  660  567  504  489  480  477   -4
P  8 100   395  421  412  359  301  255  216  199  189  185   -4
P  8 105   199  213  199  171  145  122  102   91   84   82   -4
P  8 110   113  117  109   90   75   63   52   45   41   39   -4
P  9  25   251  253  254  257  259  260  260  262  263  264    1
P  9  30   118  120  121  122  124  124  124  124  124  124    1
P  9  35   582  589  596  597  607  613  610  599  592  590    0
P  9  40   299  301  303  302  307  313  310  301  296  294    0
P  9  45   159  159  160  158  162  165  163  157  153  152    0
P  9  50   860  858  858  845  865  883  875  840  819  812   -1
P  9  55   465  464  461  451  461  471  467  450  440  436   -1
P  9  60   244  245  242  234  235  241  243  237  233  232   -1
P  9  65   121  124  125  118  115  117  121  120  119  119   -1
P  9  70   569  600  606  560  528  537  573  582  587  589   -2
P  9  75   255  275  283  255  233  234  252  262  268  270   -2
P  9  80   110  122  126  112   98   96  103  110  114  116   -2
P  9  85   476  527  550  477  405  378  399  430  449  455   -3
P  9  90   206  230  236  200  166  150  153  164  171  173   -3
P  9  95    90  101  104   87   72   63   62   64   65   66   -3
P  9 100   419  480  487  404  328  280  265  261  259  258   -4
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | 9 | 105 | 213 | 246 | 247 | 199 | 158 | 131 | 119 | 110 | 105 | 103 | -4 |
| P | 9 | 110 | 122 | 141 | 138 | 107 | 82 | 66 | 56 | 48 | 43 | 42 | -4 |
| P | 10 | 25 | 251 | 250 | 251 | 253 | 254 | 254 | 250 | 243 | 239 | 237 | 1 |
| P | 10 | 30 | 119 | 119 | 119 | 120 | 119 | 118 | 116 | 113 | 111 | 111 | 1 |
| P | 10 | 35 | 590 | 588 | 585 | 583 | 578 | 564 | 556 | 539 | 529 | 525 | 0 |
| P | 10 | 40 | 305 | 302 | 298 | 295 | 289 | 281 | 274 | 264 | 258 | 256 | 0 |
| P | 10 | 45 | 163 | 161 | 157 | 153 | 150 | 145 | 140 | 135 | 132 | 131 | 0 |
| P | 10 | 50 | 886 | 869 | 850 | 824 | 801 | 767 | 740 | 708 | 689 | 682 | -1 |
| P | 10 | 55 | 478 | 468 | 457 | 439 | 426 | 403 | 389 | 374 | 365 | 362 | -1 |
| P | 10 | 60 | 250 | 246 | 240 | 228 | 217 | 204 | 199 | 191 | 186 | 185 | -1 |
| P | 10 | 65 | 123 | 123 | 122 | 113 | 106 | 99 | 99 | 95 | 93 | 92 | -1 |
| P | 10 | 70 | 575 | 586 | 594 | 549 | 487 | 454 | 466 | 452 | 444 | 441 | -2 |
| P | 10 | 75 | 253 | 265 | 274 | 248 | 217 | 202 | 213 | 207 | 203 | 202 | -2 |
| P | 10 | 80 | 110 | 117 | 122 | 110 | 94 | 87 | 93 | 92 | 91 | 91 | -2 |
| P | 10 | 85 | 479 | 515 | 533 | 471 | 402 | 371 | 398 | 400 | 401 | 402 | -3 |
| P | 10 | 90 | 212 | 228 | 233 | 202 | 172 | 158 | 169 | 170 | 171 | 171 | -3 |
| P | 10 | 95 | 92 | 99 | 102 | 88 | 75 | 69 | 74 | 74 | 74 | 74 | -3 |
| P | 10 | 100 | 416 | 462 | 480 | 413 | 343 | 310 | 325 | 316 | 311 | 309 | -4 |
| P | 10 | 105 | 202 | 230 | 242 | 207 | 172 | 151 | 150 | 139 | 132 | 130 | -4 |
| P | 10 | 110 | 112 | 130 | 137 | 116 | 93 | 78 | 72 | 61 | 54 | 52 | -4 |
| P | 11 | 25 | 251 | 250 | 248 | 247 | 246 | 245 | 244 | 239 | 236 | 235 | 1 |
| P | 11 | 30 | 120 | 119 | 118 | 116 | 115 | 113 | 111 | 109 | 108 | 107 | 1 |
| P | 11 | 35 | 595 | 589 | 578 | 562 | 546 | 529 | 518 | 511 | 507 | 505 | 0 |
| P | 11 | 40 | 309 | 303 | 294 | 283 | 270 | 255 | 247 | 244 | 242 | 242 | 0 |
| P | 11 | 45 | 164 | 161 | 155 | 148 | 139 | 129 | 123 | 122 | 121 | 121 | 0 |
| P | 11 | 50 | 889 | 869 | 838 | 792 | 736 | 666 | 633 | 632 | 631 | 631 | -1 |
| P | 11 | 55 | 480 | 470 | 452 | 425 | 388 | 346 | 330 | 333 | 335 | 335 | -1 |
| P | 11 | 60 | 253 | 248 | 239 | 221 | 200 | 177 | 168 | 169 | 170 | 170 | -1 |
| P | 11 | 65 | 126 | 124 | 120 | 110 | 98 | 67 | 84 | 84 | 84 | 84 | -1 |
| P | 11 | 70 | 582 | 576 | 571 | 525 | 464 | 413 | 404 | 396 | 391 | 390 | -2 |
| P | 11 | 75 | 254 | 255 | 256 | 237 | 210 | 191 | 190 | 184 | 180 | 179 | -2 |
| P | 11 | 80 | 111 | 112 | 113 | 104 | 93 | 86 | 87 | 84 | 82 | 82 | -2 |
| P | 11 | 85 | 489 | 495 | 492 | 448 | 402 | 381 | 393 | 387 | 383 | 382 | -3 |
| P | 11 | 90 | 213 | 216 | 212 | 192 | 175 | 169 | 178 | 176 | 175 | 174 | -3 |
| P | 11 | 95 | 887 | 899 | 888 | 826 | 774 | 772 | 819 | 811 | 806 | 805 | -4 |
| P | 11 | 100 | 379 | 395 | 405 | 384 | 365 | 364 | 386 | 372 | 364 | 361 | -4 |
| P | 11 | 105 | 172 | 184 | 195 | 192 | 183 | 180 | 184 | 174 | 168 | 166 | -4 |
| P | 11 | 110 | 91 | 100 | 109 | 106 | 99 | 93 | 91 | 81 | 75 | 73 | -4 |
| P | 12 | 25 | 251 | 247 | 245 | 241 | 239 | 241 | 242 | 240 | 239 | 238 | 1 |
| P | 12 | 30 | 119 | 118 | 116 | 113 | 111 | 112 | 110 | 107 | 105 | 105 | 1 |
| P | 12 | 35 | 592 | 584 | 565 | 552 | 530 | 524 | 506 | 486 | 474 | 470 | 0 |
| P | 12 | 40 | 306 | 301 | 289 | 279 | 263 | 252 | 237 | 227 | 221 | 219 | 0 |
| P | 12 | 45 | 161 | 159 | 152 | 147 | 136 | 125 | 116 | 110 | 106 | 105 | 0 |
| P | 12 | 50 | 869 | 854 | 827 | 788 | 723 | 645 | 586 | 563 | 549 | 545 | -1 |
| P | 12 | 55 | 468 | 460 | 442 | 422 | 382 | 336 | 303 | 294 | 289 | 287 | -1 |
| P | 12 | 60 | 248 | 243 | 234 | 221 | 198 | 172 | 154 | 150 | 148 | 147 | -1 |
| P | 12 | 65 | 125 | 122 | 117 | 111 | 99 | 86 | 78 | 75 | 73 | 73 | -1 |
| P | 12 | 70 | 585 | 568 | 556 | 533 | 477 | 420 | 381 | 357 | 343 | 338 | -2 |
| P | 12 | 75 | 255 | 250 | 245 | 239 | 220 | 199 | 183 | 167 | 157 | 154 | -2 |
| P | 12 | 80 | 112 | 109 | 108 | 105 | 99 | 91 | 85 | 77 | 72 | 71 | -2 |
| P | 12 | 65 | 486 | 477 | 459 | 449 | 433 | 411 | 388 | 353 | 332 | 325 | -3 |
| P | 12 | 90 | 208 | 204 | 199 | 194 | 191 | 185 | 179 | 162 | 152 | 148 | -3 |
| P | 12 | 95 | 853 | 833 | 807 | 822 | 849 | 867 | 841 | 764 | 718 | 702 | -4 |
| P | 12 | 100 | 360 | 353 | 353 | 368 | 393 | 412 | 405 | 361 | 335 | 326 | -4 |
| P | 12 | 105 | 162 | 161 | 161 | 173 | 188 | 201 | 195 | 172 | 158 | 154 | -4 |
| P | 12 | 110 | 840 | 850 | 872 | 912 | 962 | 992 | 947 | 816 | 737 | 711 | -5 |

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P 13  25   251  250  249  248  249  250  251  249  248  248     1
P 13  30   119  119  118  118  117  118  118  116  115  115     1
P 13  35   588  588  583  576  570  570  567  555  550  549     0
P 13  40   303  302  298  292  288  286  282  273  271  271     0
P 13  45   161  160  157  154  151  149  145  139  138  138     0
P 13  50   865  861  848  824  808  792  769  734  730  729    -1
P 13  55   466  464  456  440  430  420  408  389  388  389    -1
P 13  60   246  244  239  229  223  218  212  202  201  201    -1
P 13  65   123  122  120  115  111  109  106  102  100   99    -1
P 13  70   576  576  570  545  525  518  513  489  462  453    -2
P 13  75   256  258  258  247  237  236  236  224  202  195    -2
P 13  80   111  112  113  108  103  102  103   98   88   85    -2
P 13  85   482  486  488  460  433  425  428  405  375  365    -3
P 13  90   206  208  207  193  178  173  174  164  152  147    -3
P 13  95   877  882  877  814  752  724  723  678  626  608    -4
P 13 100   384  386  385  359  334  322  321  303  276  268    -4
P 13 105   182  182  181  169  158  153  154  143  132  128    -4
P 13 110   960  959  943  873  811  792  801  748  690  669    -5
D  1  25   400  393  392  381  377  382  395  403  408  409    -4
D  1  30   178  175  173  171  171  176  179  176  174  174    -4
D  1  35   820  815  805  800  791  812  813  772  747  739    -5
D  1  40   404  400  386  374  367  371  361  338  324  320    -5
D  1  45   207  203  196  189  180  177  168  153  144  141    -5
D  1  50   108  107  104  100   94   89   81   72   67   65    -5
D  1  55   585  581  575  554  511  467  420  367  335  325    -6
D  1  60   327  325  320  302  277  248  218  192  176  171    -6
D  1  65   182  179  174  164  146  131  115  100   91   88    -6
D  1  70   952  926  906  837  755  661  581  497  447  430    -7
D  1  75   444  431  421  403  365  330  289  241  212  203    -7
D  1  80   195  190  187  180  171  157  137  110   94   88    -7
D  1  85   850  832  809  791  760  722  634  503  424  398    -8
D  1  90   370  365  349  339  333  320  283  225  190  179    -8
D  1  95   148  146  139  138  141  143  131  103   86   81    -8
D  1 100   580  574  560  571  622  645  593  474  403  379    -9
D  1 105   242  236  234  244  271  294  278  224  192  181    -9
D  1 110   108  106  104  107  119  128  124  101   87   83    -9
D  2  25   400  393  386  379  382  391  387  377  371  369    -4
D  2  30   178  174  172  171  173  178  175  168  164  162    -4
D  2  35   823  813  799  791  790  799  804  765  742  734    -5
D  2  40   403  393  386  375  368  366  366  348  337  334    -5
D  2  45   205  201  195  187  181  176  173  162  155  153    -5
D  2  50   108  106  104   99   95   90   85   77   72   71    -5
D  2  55   591  592  580  545  521  483  446  390  356  345    -6
D  2  60   334  332  325  303  284  261  235  203  184  177    -6
D  2  65   182  181  174  161  149  136  122  105   95   91    -6
D  2  70   943  914  873  809  760  694  612  516  458  439    -7
D  2  75   444  425  408  382  364  338  300  243  209  197    -7
D  2  80   198  189  185  177  171  160  141  111   93   87    -7
D  2  85   845  812  817  795  766  738  654  494  398  366    -8
D  2  90   360  343  347  342  341  331  295  222  178  164    -8
D  2  95   147  140  139  137  142  145  133   99   79   72    -8
D  2 100   610  571  574  574  598  619  578  439  356  328    -9
D  2 105   264  246  249  247  257  266  254  195  160  148    -9
D  2 110   125  114  114  113  116  118  114   89   74   69    -9
D  3  25   399  387  388  380  381  390  381  354  338  332    -4
D  3  30   178  175  174  172  174  177  173  162  155  153    -4
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D  3   35   827  811  805  802  787  795  785  755  737  731   -5
D  3   40   400  397  390  382  371  368  365  356  351  349   -5
D  3   45   204  202  198  191  183  180  177  170  166  164   -5
D  3   50   109  109  106  101   96   94   90   84   80   79   -5
D  3   55   605  604  591  555  524  509  479  439  415  407   -6
D  3   60   340  343  331  305  288  276  258  233  218  213   -6
D  3   65   185  182  174  161  150  145  134  121  113  111   -6
D  3   70   931  912  863  800  760  735  668  594  550  535   -7
D  3   75   440  417  400  384  368  358  325  282  256  248   -7
D  3   80   195  186  183  177  174  172  155  129  113  108   -7
D  3   85   841  793  803  796  778  776  724  589  508  481   -8
D  3   90   361  345  350  345  340  346  323  255  214  201   -8
D  3   95   153  140  142  139  138  141  136  108   91   86   -8
D  3  100   644  591  583  574  578  589  559  451  386  365   -9
D  3  105   279  249  247  248  247  251  241  200  175  167   -9
D  3  110   131  117  114  110  110  112  111   94   84   80   -9
D  4   25   398  394  386  383  379  378  375  376  377  377   -4
D  4   30   178  178  174  174  173  173  173  174  175  175   -4
D  4   35   829  823  822  814  798  793  802  793  788  786   -5
D  4   40   406  406  402  396  384  381  377  364  356  354   -5
D  4   45   208  208  205  198  192  192  187  175  168  165   -5
D  4   50   112  112  110  106  103  103   98   89   84   82   -5
D  4   55   623  622  610  582  563  565  541  485  451  440   -6
D  4   60   352  350  340  323  311  314  294  264  246  240   -6
D  4   65   189  186  179  168  164  165  155  139  129  126   -6
D  4   70   958  942  903  864  838  846  788  697  642  624   -7
D  4   75   440  435  435  416  409  412  389  341  312  303   -7
D  4   80   193  190  196  196  195  200  186  162  148  143   -7
D  4   85   826  821  864  872  871  889  853  730  656  632   -8
D  4   90   368  364  382  388  373  374  353  301  270  259   -8
D  4   95   159  157  163  159  147  139  135  115  103   99   -8
D  4  100   673  648  669  654  603  560  522  445  399  383   -9
D  4  105   282  265  269  265  253  234  223  192  173  167   -9
D  4  110   126  116  115  114  108  107  106   95   88   86   -9
D  5   25   396  400  391  389  384  381  385  398  406  408   -4
D  5   30   178  180  177  177  177  176  178  181  183  183   -4
D  5   35   829  832  835  830  816  811  823  857  877  884   -5
D  5   40   411  414  411  402  396  395  399  399  399  399   -5
D  5   45   212  212  209  204  202  201  201  200  199  199   -5
D  5   50   113  114  112  109  109  110  109  104  101  100   -5
D  5   55   621  628  624  608  605  616  606  586  574  570   -6
D  5   60   350  351  344  334  338  344  341  324  314  310   -6
D  5   65   193  191  184  180  179  184  183  178  175  174   -6
D  5   70   984  985  958  930  935  957  945  906  883  875   -7
D  5   75   444  458  465  457  456  469  466  467  468  468   -7
D  5   80   191  200  208  207  211  221  225  224  223  223   -7
D  5   85   838  872  897  894  903  941  978  990  997 1000   -8
D  5   90   384  383  390  375  366  365  372  365  361  359   -8
D  5   95   163  166  166  151  131  119  119  122  124  124   -8
D  5  100   663  670  665  602  510  439  424  422  421  420   -9
D  5  105   262  266  270  246  210  178  173  178  181  182   -9
D  5  110   111  112  115  107   94   85   85   88   90   90   -9
D  6   25   397  400  395  392  396  399  397  403  407  408   -4
D  6   30   177  178  180  181  182  183  183  187  189  190   -4
D  6   35   828  835  845  848  848  851  870  897  913  919   -5
D  6   40   411  413  412  414  413  416  426  436  442  444   -5
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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | 6 | 45 | 210 | 211 | 209 | 209 | 210 | 215 | 219 | 223 | 225 | 226 | -5 |
| D | 6 | 50 | 111 | 112 | 111 | 112 | 114 | 117 | 119 | 120 | 121 | 121 | -5 |
| D | 6 | 55 | 606 | 617 | 619 | 622 | 631 | 649 | 669 | 673 | 675 | 676 | -6 |
| D | 6 | 60 | 339 | 341 | 343 | 347 | 356 | 368 | 379 | 380 | 381 | 381 | -6 |
| D | 6 | 65 | 187 | 189 | 188 | 188 | 193 | 202 | 209 | 213 | 215 | 216 | -6 |
| D | 6 | 70 | 98 | 99 | 97 | 97 | 100 | 106 | 110 | 113 | 115 | 115 | -6 |
| D | 6 | 75 | 447 | 463 | 458 | 461 | 474 | 511 | 547 | 580 | 600 | 606 | -7 |
| D | 6 | 80 | 193 | 202 | 204 | 204 | 211 | 232 | 257 | 275 | 286 | 289 | -7 |
| D | 6 | 85 | 85 | 87 | 87 | 86 | 87 | 94 | 104 | 113 | 118 | 120 | -7 |
| D | 6 | 90 | 384 | 380 | 372 | 355 | 335 | 333 | 350 | 365 | 374 | 377 | -8 |
| D | 6 | 95 | 160 | 159 | 152 | 134 | 109 | 96 | 99 | 105 | 109 | 110 | -8 |
| D | 6 | 100 | 636 | 633 | 616 | 535 | 412 | 330 | 328 | 345 | 355 | 359 | -9 |
| D | 6 | 105 | 252 | 256 | 252 | 224 | 171 | 136 | 132 | 140 | 145 | 146 | -9 |
| D | 6 | 110 | 106 | 109 | 113 | 104 | 83 | 67 | 66 | 69 | 71 | 71 | -9 |
| D | 7 | 25 | 400 | 399 | 401 | 402 | 408 | 407 | 407 | 413 | 417 | 418 | -4 |
| D | 7 | 30 | 178 | 179 | 182 | 185 | 186 | 187 | 190 | 194 | 196 | 197 | -4 |
| D | 7 | 35 | 820 | 840 | 856 | 863 | 881 | 891 | 903 | 919 | 929 | 932 | -5 |
| D | 7 | 40 | 404 | 410 | 415 | 419 | 428 | 437 | 444 | 452 | 457 | 458 | -5 |
| D | 7 | 45 | 207 | 208 | 209 | 211 | 217 | 226 | 230 | 231 | 232 | 232 | -5 |
| D | 7 | 50 | 108 | 109 | 111 | 112 | 116 | 121 | 125 | 125 | 125 | 125 | -5 |
| D | 7 | 55 | 585 | 591 | 609 | 615 | 641 | 672 | 695 | 700 | 703 | 704 | -6 |
| D | 7 | 60 | 327 | 328 | 338 | 343 | 357 | 374 | 393 | 400 | 404 | 406 | -6 |
| D | 7 | 65 | 182 | 183 | 186 | 188 | 195 | 207 | 219 | 225 | 229 | 230 | -6 |
| D | 7 | 70 | 95 | 95 | 95 | 95 | 100 | 108 | 117 | 122 | 125 | 126 | -6 |
| D | 7 | 75 | 444 | 446 | 440 | 434 | 468 | 524 | 587 | 625 | 648 | 655 | -7 |
| D | 7 | 80 | 195 | 195 | 195 | 191 | 203 | 231 | 265 | 291 | 307 | 312 | -7 |
| D | 7 | 85 | 85 | 85 | 84 | 80 | 82 | 89 | 103 | 113 | 119 | 121 | -7 |
| D | 7 | 90 | 370 | 370 | 358 | 329 | 302 | 297 | 314 | 332 | 343 | 346 | -8 |
| D | 7 | 95 | 148 | 148 | 142 | 122 | 102 | 90 | 91 | 94 | 96 | 96 | -8 |
| D | 7 | 100 | 580 | 591 | 581 | 500 | 399 | 333 | 310 | 305 | 302 | 301 | -9 |
| D | 7 | 105 | 242 | 247 | 245 | 215 | 173 | 143 | 130 | 125 | 122 | 121 | -9 |
| D | 7 | 110 | 108 | 112 | 113 | 103 | 86 | 70 | 62 | 58 | 56 | 55 | -9 |
| D | 8 | 25 | 400 | 403 | 406 | 406 | 408 | 403 | 411 | 423 | 430 | 433 | -4 |
| D | 8 | 30 | 178 | 179 | 184 | 185 | 188 | 188 | 192 | 196 | 198 | 199 | -4 |
| D | 8 | 35 | 823 | 845 | 853 | 872 | 882 | 895 | 907 | 924 | 934 | 938 | -5 |
| D | 8 | 40 | 403 | 410 | 417 | 420 | 429 | 440 | 445 | 445 | 445 | 445 | -5 |
| D | 8 | 45 | 205 | 208 | 206 | 210 | 219 | 225 | 227 | 225 | 224 | 223 | -5 |
| D | 8 | 50 | 108 | 108 | 110 | 111 | 117 | 120 | 122 | 120 | 119 | 118 | -5 |
| D | 8 | 55 | 591 | 593 | 594 | 609 | 642 | 666 | 673 | 665 | 660 | 659 | -6 |
| D | 8 | 60 | 334 | 326 | 330 | 336 | 353 | 370 | 379 | 373 | 369 | 368 | -6 |
| D | 8 | 65 | 182 | 182 | 179 | 182 | 192 | 201 | 208 | 207 | 206 | 206 | -6 |
| D | 8 | 70 | 94 | 93 | 93 | 92 | 96 | 102 | 110 | 112 | 113 | 114 | -6 |
| D | 8 | 75 | 444 | 455 | 440 | 431 | 445 | 488 | 542 | 568 | 584 | 589 | -7 |
| D | 8 | 80 | 198 | 203 | 202 | 194 | 197 | 216 | 244 | 261 | 271 | 275 | -7 |
| D | 8 | 85 | 85 | 90 | 89 | 85 | 82 | 84 | 91 | 101 | 107 | 109 | -7 |
| D | 8 | 90 | 360 | 384 | 390 | 351 | 305 | 287 | 293 | 321 | 338 | 343 | -8 |
| D | 8 | 95 | 147 | 161 | 158 | 139 | 114 | 101 | 96 | 99 | 101 | 101 | -8 |
| D | 8 | 100 | 610 | 658 | 659 | 583 | 479 | 408 | 360 | 349 | 342 | 340 | -9 |
| D | 8 | 105 | 264 | 287 | 281 | 252 | 214 | 182 | 154 | 142 | 135 | 132 | -9 |
| D | 8 | 110 | 125 | 133 | 129 | 112 | 96 | 81 | 68 | 62 | 58 | 57 | -9 |
| D | 9 | 25 | 399 | 400 | 399 | 400 | 401 | 403 | 401 | 407 | 411 | 412 | -4 |
| D | 9 | 30 | 178 | 180 | 181 | 185 | 185 | 185 | 186 | 188 | 189 | 190 | -4 |
| D | 9 | 35 | 827 | 841 | 854 | 863 | 873 | 872 | 871 | 873 | 874 | 875 | -5 |
| D | 9 | 40 | 400 | 406 | 412 | 415 | 418 | 424 | 422 | 416 | 412 | 411 | -5 |
| D | 9 | 45 | 204 | 206 | 208 | 208 | 211 | 214 | 212 | 205 | 201 | 199 | -5 |
| D | 9 | 50 | 109 | 109 | 110 | 109 | 112 | 114 | 113 | 108 | 105 | 104 | -5 |

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D  9   55   605  600  606  600  620  631  616  587  570  564   -6
D  9   60   340  336  328  326  340  347  339  323  313  310   -6
D  9   65   185  181  179  175  178  183  182  175  171  169   -6
D  9   70   931  945  939  895  880  903  932  922  916  914   -7
D  9   75   440  460  468  432  409  419  451  454  456  456   -7
D  9   80   195  212  217  196  180  184  200  209  214  216   -7
D  9   85   941  922  967  865  762  744  809  865  899  910   -8
D  9   90   361  403  417  361  302  282  300  329  346  352   -8
D  9   95   153  169  174  147  122  111  113  123  129  131   -8
D  9  100   644  721  741  633  526  464  459  479  491  495   -9
D  9  105   279  318  332  280  233  202  196  197  198  198   -9
D  9  110   131  151  154  127  104   88   83   80   78   78   -9
D 10   25   398  394  391  395  400  402  395  382  374  372   -4
D 10   30   178  178  179  181  182  184  180  175  172  171   -4
D 10   35   829  832  839  843  845  836  827  810  800  796   -5
D 10   40   406  405  404  408  402  393  390  378  371  368   -5
D 10   45   208  206  204  202  199  193  189  183  179  178   -5
D 10   50   112  110  108  106  104  101   97   93   91   90   -5
D 10   55   623  611  598  584  574  550  529  505  491  486   -6
D 10   60   352  341  329  321  313  297  282  271  264  262   -6
D 10   65   189  184  177  167  164  155  149  142  138  136   -6
D 10   70   958  945  928  873  808  754  745  719  703  698   -7
D 10   75   440  448  455  418  372  349  358  345  337  335   -7
D 10   80   193  202  211  192  167  155  164  157  153  151   -7
D 10   85   826  883  928  842  722  669  714  706  701  700   -8
D 10   90   368  396  409  361  303  277  298  302  304  305   -8
D 10   95   159  159  170  147  128  119  128  130  131  132   -8
D 10  100   673  719  731  631  534  502  546  553  557  559   -9
D 10  105   282  310  322  276  237  220  239  241  242  243   -9
D 10  110   126  142  150  132  110  100  104  101   99   99   -9
D 11   25   396  394  389  391  391  392  393  387  383  382   -4
D 11   30   178  177  177  178  178  179  178  173  170  169   -4
D 11   35   829  831  828  823  816  815  805  792  784  782   -5
D 11   40   411  406  399  389  382  372  367  361  357  356   -5
D 11   45   212  203  201  194  185  178  173  169  167  166   -5
D 11   50   113  111  107  102   96   90   85   84   83   83   -5
D 11   55   621  609  585  560  522  473  451  453  454  455   -6
D 11   60   350  343  329  309  286  253  239  241  242  243   -6
D 11   65   193  188  179  165  149  132  124  127  129  129   -6
D 11   70   984  960  926  846  749  654  625  627  628  629   -7
D 11   75   444  439  436  401  354  313  303  299  297  296   -7
D 11   80   191  192  197  183  160  144  144  137  133  131   -7
D 11   85   838  843  861  796  703  654  655  633  620  615   -8
D 11   90   384  390  386  345  304  283  294  288  284  283   -8
D 11   95   163  162  156  141  128  124  131  132  133  133   -8
D 11  100   663  668  651  593  555  559  606  602  600  599   -9
D 11  105   262  270  272  260  252  259  282  281  280  280   -9
D 11  110   111  116  125  123  119  121  129  125  123  122   -9
D 12   25   397  390  385  384  384  380  390  399  404  406   -4
D 12   30   177  175  177  172  172  177  173  176  175  174   -4
D 12   35   828  821  809  801  789  811  805  776  759  753   -5
D 12   40   411  405  392  381  369  372  362  348  340  337   -5
D 12   45   210  207  196  191  180  176  166  158  153  152   -5
D 12   50   111  109  105  101   95   87   80   76   74   73   -5
D 12   55   606  598  576  555  510  458  418  400  389  386   -6
D 12   60   339  332  321  305  279  242  218  214  212  211   -6
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D 12  65   187  185  175  164  146  126  113  111  110  109    -6
D 12  70   380  951  918  859  749  642  575  555  543  539    -7
D 12  75   447  435  422  409  361  318  287  269  258  255    -7
D 12  80   193  133  189  184  169  150  139  125  117  115    -7
D 12  85   851  831  808  794  749  691  634  574  538  526    -8
D 12  90   384  375  356  347  327  302  286  260  244  239    -8
D 12  95   160  155  149  145  141  136  131  120  113  111    -8
D 12 100   636  617  605  609  627  633  619  563  529  518    -9
D 12 105   252  244  239  256  281  305  302  272  254  248    -9
D 12 110   106  103  106  114  126  137  137  124  116  114    -9
D 13  25   398  396  392  390  391  392  393  394  396  397    -4
D 13  30   178  175  178  178  179  180  181  180  179  178    -4
D 13  35   828  830  831  831  829  834  838  831  820  816    -5
D 13  40   406  406  403  399  395  396  396  389  387  386    -5
D 13  45   209  207  203  200  197  197  194  188  187  187    -5
D 13  50   110  110  108  106  104  100  100   96   94   94    -5
D 13  55   604  603  597  581  571  559  541  515  514  514    -6
D 13  60   339  336  331  320  314  305  294  281  283  284    -6
D 13  65   186  184  179  172  167  162  157  150  151  151    -6
D 13  70   956  946  921  878  846  824  803  768  775  779    -7
D 13  75   446  445  439  420  404  399  395  377  357  350    -7
D 13  80   195  197  198  191  185  184  185  175  150  142    -7
D 13  85   848  858  868  835  802  802  810  767  711  693    -8
D 13  90   373  377  378  356  333  326  329  311  288  281    -8
D 13  95   158  159  157  145  133  128  129  122  113  110    -8
D 13 100   649  652  648  600  551  528  523  491  453  440    -9
D 13 105   269  271  272  256  239  229  227  210  193  187    -9
D 13 110   118  119  120  114  107  103  103   96   89   86    -9
T  1  25   218  219  217  219  219  220  215  207  204  203     0
T  1  30   231  232  230  229  225  222  216  208  205  204     0
T  1  35   247  245  243  238  233  226  219  213  209  208     0
T  1  40   258  257  258  256  248  238  229  222  214  211     0
T  1  45   265  266  269  268  263  251  242  236  223  219     0
T  1  50   271  272  274  272  268  259  254  250  249  249     0
T  1  55   270  269  268  264  261  257  254  252  254  255     0
T  1  60   257  254  252  251  249  249  248  244  244  244     0
T  1  65   234  232  233  234  237  238  239  232  228  227     0
T  1  70   211  211  211  216  222  229  229  222  200  190     0
T  1  75   200  201  201  204  212  219  220  214  194  197     0
T  1  80   197  198  196  198  204  211  213  211  211  211     0
T  1  85   193  194  192  194  200  207  211  211  211  211     0
T  1  90   185  185  186  189  199  208  214  214  214  214     0
T  1  95   187  187  190  195  203  210  214  216  217  218     0
T  1 100   204  203  204  204  206  210  214  215  216  216     0
T  1 105   231  232  228  222  217  215  217  215  214  213     0
T  1 110   273  276  271  259  248  240  235  229  225  224     0
T  2  25   218  218  218  219  218  217  217  214  200  195     0
T  2  30   231  232  231  228  224  219  220  217  200  194     0
T  2  35   246  245  244  239  234  228  224  221  199  192     0
T  2  40   258  259  258  254  250  243  234  227  205  198     0
T  2  45   268  270  271  268  265  257  247  237  219  213     0
T  2  50   273  275  275  271  269  263  256  247  250  251     0
T  2  55   270  263  266  264  261  259  254  249  248  248     0
T  2  60   253  250  247  247  247  247  245  240  234  232     0
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T  2  70   213  210  213  217  221  226  226  217  195  188     0
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T  2   75    201  201  205  209  213  217  218  211  193  187    0
T  2   80    195  195  199  201  205  211  213  207  210  211    0
T  2   85    193  192  192  195  200  205  209  208  207  207    0
T  2   90    193  191  189  190  195  202  207  203  209  209    0
T  2   95    200  197  197  197  197  200  206  209  211  211    0
T  2  100    219  215  213  210  207  206  210  214  216  217    0
T  2  105    251  246  237  230  225  225  228  230  231  232    0
T  2  110    296  290  278  266  258  259  261  261  261  261    0
T  3   25    219  221  219  220  219  217  218  221  198  190    0
T  3   30    231  232  231  230  224  221  222  226  210  205    0
T  3   35    245  247  245  240  236  232  231  231  226  224    0
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T  3   45    271  272  271  266  264  262  255  247  254  256    0
T  3   50    275  274  273  269  268  267  261  255  269  274    0
T  3   55    268  266  263  261  261  260  257  253  254  254    0
T  3   60    250  245  243  245  246  248  245  241  232  229    0
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T  3   85    197  195  195  195  196  199  202  200  199  198    0
T  3   90    198  193  190  189  191  192  196  199  201  201    0
T  3   95    204  199  195  195  196  197  199  205  209  210    0
T  3  100    220  214  210  208  207  209  215  223  228  229    0
T  3  105    255  245  236  227  226  231  245  256  263  265    0
T  3  110    306  291  275  265  263  274  291  303  310  313    0
T  4   25    220  221  222  222  222  222  223  221  211  208    0
T  4   30    233  233  235  232  229  229  228  222  222  222    0
T  4   35    248  249  247  244  242  243  237  229  239  242    0
T  4   40    262  262  260  256  256  258  252  243  255  259    0
T  4   45    273  272  271  269  269  270  266  259  275  280    0
T  4   50    275  274  273  271  272  272  271  267  281  286    0
T  4   55    267  265  264  263  263  265  262  261  264  265    0
T  4   60    248  246  246  247  249  249  249  247  244  243    0
T  4   65    227  227  231  235  236  237  237  234  227  225    0
T  4   70    209  210  218  222  224  225  226  224  209  204    0
T  4   75    200  200  206  212  213  214  215  213  202  198    0
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T  4   85    202  200  199  197  191  186  187  187  187  187    0
T  4   90    200  197  194  190  185  179  181  183  184  185    0
T  4   95    199  193  190  189  191  191  193  197  199  200    0
T  4  100    209  201  195  196  201  210  221  232  239  241    0
T  4  105    239  229  220  216  218  237  263  285  298  303    0
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T  5   25    221  221  223  223  224  225  225  223  238  243    0
T  5   30    234  233  235  233  231  232  232  231  248  254    0
T  5   35    250  250  248  245  246  248  246  238  254  259    0
T  5   40    262  262  260  259  262  264  261  255  264  267    0
T  5   45    270  271  271  271  273  277  275  270  270  270    0
T  5   50    274  274  275  275  276  278  279  278  279  279    0
T  5   55    269  267  265  265  267  268  270  271  273  274    0
T  5   60    252  252  251  252  251  253  254  257  262  264    0
T  5   65    227  231  236  237  237  237  238  241  242  242    0
T  5   70    206  211  218  220  220  221  224  229  223  221    0
T  5   75    199  200  203  204  204  205  209  211  207  206    0
T  5   80    202  199  197  194  190  186  188  188  196  199    0
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T  5  85    203  193  196  189  179  170  168  168  168  168     0
T  5  90    193  194  192  195  172  161  159  162  164  164     0
T  5  95    187  187  187  187  184  180  180  184  186  187     0
T  5 100    193  191  194  197  204  212  223  234  241  243     0
T  5 105    219  215  216  220  230  253  279  302  316  320     0
T  5 110    269  259  255  259  274  304  343  373  391  397     0
T  6  25    220  220  223  225  225  225  228  229  239  242     0
T  6  30    234  234  234  234  233  234  238  239  246  248     0
T  6  35    249  249  246  246  247  250  251  249  258  261     0
T  6  40    259  260  259  259  262  266  266  264  269  271     0
T  6  45    268  269  270  272  275  277  279  278  281  282     0
T  6  50    272  273  275  275  276  279  282  283  286  287     0
T  6  55    269  268  267  267  269  273  275  278  280  281     0
T  6  60    255  256  253  252  252  256  259  264  267  268     0
T  6  65    232  234  233  232  232  236  240  245  247  248     0
T  6  70    208  211  213  213  212  214  220  225  220  218     0
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T  6  80    201  196  194  190  181  175  173  173  185  189     0
T  6  85    199  195  192  184  170  156  151  149  148  147     0
T  6  90    189  189  188  179  162  147  144  145  146  146     0
T  6  95    184  186  189  189  182  173  171  173  174  175     0
T  6 100    191  193  198  206  213  219  222  226  228  229     0
T  6 105    215  214  221  232  247  265  282  295  303  305     0
T  6 110    261  253  253  264  285  313  343  366  380  384     0
T  7  25    218  220  222  224  224  227  230  231  239  242     0
T  7  30    231  233  233  232  235  238  239  238  248  251     0
T  7  35    247  245  244  244  246  250  252  251  259  262     0
T  7  40    258  256  256  257  259  264  267  266  269  270     0
T  7  45    265  265  268  268  271  274  278  279  283  284     0
T  7  50    271  271  273  272  274  276  281  285  293  296     0
T  7  55    270  269  267  266  267  270  276  281  283  284     0
T  7  60    257  257  253  250  251  256  262  267  267  267     0
T  7  65    234  234  230  226  229  234  241  246  244  243     0
T  7  70    211  211  209  207  207  211  217  222  214  211     0
T  7  75    200  200  200  197  191  189  191  194  196  197     0
T  7  80    197  195  195  189  178  168  165  164  182  188     0
T  7  85    193  194  191  183  167  153  144  140  138  137     0
T  7  90    185  185  186  179  167  153  145  141  139  138     0
T  7  95    187  189  193  195  192  184  174  168  164  163     0
T  7 100    204  204  206  214  222  221  216  212  210  209     0
T  7 105    231  229  229  237  246  255  258  260  261  262     0
T  7 110    273  265  260  265  276  293  306  314  319  320     0
T  8  25    218  219  221  223  225  229  229  227  239  243     0
T  8  30    231  233  230  232  234  238  237  234  247  251     0
T  8  35    246  244  243  242  246  249  249  245  259  264     0
T  8  40    258  255  253  254  259  261  262  260  270  273     0
T  8  45    268  265  267  267  269  271  274  274  285  289     0
T  8  50    273  272  271  271  271  274  277  279  289  292     0
T  8  55    270  268  266  264  263  266  272  275  276  276     0
T  8  60    253  257  254  250  248  250  257  263  260  259     0
T  8  65    233  236  235  230  225  229  237  245  240  238     0
T  8  70    213  218  217  212  208  210  215  221  212  209     0
T  8  75    201  205  207  203  196  191  190  194  197  198     0
T  8  80    195  199  201  196  183  172  165  167  192  200     0
T  8  85    193  196  196  188  174  161  151  148  146  146     0
T  8  90    193  194  191  187  180  170  159  150  145  143     0
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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T | 8 | 95 | 200 | 199 | 197 | 197 | 199 | 194 | 181 | 170 | 163 | 161 | 0 |
| T | 8 | 100 | 219 | 216 | 211 | 208 | 212 | 211 | 203 | 193 | 187 | 185 | 0 |
| T | 8 | 105 | 251 | 247 | 236 | 226 | 225 | 224 | 220 | 213 | 209 | 207 | 0 |
| T | 8 | 110 | 296 | 291 | 276 | 263 | 256 | 254 | 250 | 241 | 236 | 234 | 0 |
| T | 9 | 25 | 219 | 220 | 222 | 224 | 225 | 225 | 226 | 224 | 229 | 231 | 0 |
| T | 9 | 30 | 231 | 232 | 233 | 231 | 233 | 234 | 233 | 229 | 237 | 240 | 0 |
| T | 9 | 35 | 245 | 244 | 243 | 241 | 242 | 245 | 244 | 239 | 248 | 251 | 0 |
| T | 9 | 40 | 260 | 258 | 256 | 254 | 256 | 257 | 256 | 252 | 260 | 263 | 0 |
| T | 9 | 45 | 271 | 269 | 268 | 265 | 267 | 268 | 268 | 266 | 272 | 274 | 0 |
| T | 9 | 50 | 275 | 273 | 272 | 270 | 270 | 271 | 271 | 272 | 278 | 280 | 0 |
| T | 9 | 55 | 268 | 269 | 265 | 262 | 259 | 260 | 264 | 267 | 263 | 262 | 0 |
| T | 9 | 60 | 250 | 254 | 257 | 250 | 241 | 242 | 250 | 256 | 245 | 241 | 0 |
| T | 9 | 65 | 229 | 238 | 242 | 234 | 224 | 223 | 232 | 240 | 229 | 225 | 0 |
| T | 9 | 70 | 213 | 221 | 225 | 218 | 209 | 207 | 214 | 220 | 204 | 199 | 0 |
| T | 9 | 75 | 202 | 203 | 211 | 206 | 198 | 194 | 195 | 201 | 191 | 188 | 0 |
| T | 9 | 80 | 197 | 200 | 202 | 198 | 190 | 182 | 180 | 184 | 211 | 220 | 0 |
| T | 9 | 85 | 197 | 199 | 198 | 192 | 185 | 177 | 172 | 173 | 174 | 174 | 0 |
| T | 9 | 90 | 198 | 199 | 197 | 193 | 191 | 185 | 177 | 173 | 171 | 170 | 0 |
| T | 9 | 95 | 204 | 207 | 206 | 205 | 203 | 196 | 188 | 179 | 174 | 172 | 0 |
| T | 9 | 100 | 220 | 225 | 222 | 216 | 211 | 204 | 195 | 184 | 177 | 175 | 0 |
| T | 9 | 105 | 255 | 257 | 248 | 236 | 226 | 216 | 202 | 187 | 178 | 175 | 0 |
| T | 9 | 110 | 306 | 307 | 294 | 278 | 261 | 244 | 223 | 198 | 183 | 178 | 0 |
| T | 10 | 25 | 220 | 221 | 223 | 223 | 221 | 220 | 220 | 221 | 213 | 210 | 0 |
| T | 10 | 30 | 233 | 233 | 232 | 230 | 228 | 224 | 225 | 225 | 216 | 213 | 0 |
| T | 10 | 35 | 248 | 246 | 243 | 241 | 238 | 235 | 234 | 232 | 225 | 223 | 0 |
| T | 10 | 40 | 262 | 260 | 257 | 252 | 251 | 249 | 245 | 244 | 237 | 235 | 0 |
| T | 10 | 45 | 273 | 271 | 269 | 265 | 263 | 261 | 259 | 257 | 253 | 252 | 0 |
| T | 10 | 50 | 275 | 274 | 273 | 271 | 269 | 265 | 265 | 265 | 261 | 260 | 0 |
| T | 10 | 55 | 267 | 267 | 266 | 262 | 258 | 255 | 256 | 258 | 250 | 247 | 0 |
| T | 10 | 60 | 248 | 251 | 254 | 247 | 241 | 240 | 246 | 246 | 231 | 226 | 0 |
| T | 10 | 65 | 227 | 233 | 240 | 236 | 224 | 222 | 231 | 233 | 214 | 208 | 0 |
| T | 10 | 70 | 209 | 216 | 223 | 219 | 210 | 210 | 218 | 219 | 198 | 191 | 0 |
| T | 10 | 75 | 200 | 206 | 210 | 207 | 203 | 202 | 207 | 209 | 200 | 197 | 0 |
| T | 10 | 80 | 199 | 202 | 202 | 200 | 197 | 196 | 198 | 203 | 223 | 230 | 0 |
| T | 10 | 85 | 202 | 203 | 200 | 195 | 194 | 193 | 194 | 197 | 199 | 199 | 0 |
| T | 10 | 90 | 200 | 200 | 198 | 195 | 197 | 198 | 197 | 196 | 195 | 195 | 0 |
| T | 10 | 95 | 199 | 200 | 206 | 205 | 202 | 201 | 199 | 195 | 190 | 192 | 0 |
| T | 10 | 100 | 209 | 217 | 222 | 221 | 217 | 209 | 210 | 193 | 183 | 179 | 0 |
| T | 10 | 105 | 239 | 247 | 250 | 249 | 241 | 228 | 209 | 192 | 182 | 178 | 0 |
| T | 10 | 110 | 293 | 301 | 299 | 290 | 276 | 256 | 227 | 199 | 182 | 177 | 0 |
| T | 11 | 25 | 221 | 221 | 222 | 220 | 219 | 210 | 216 | 215 | 201 | 196 | 0 |
| T | 11 | 30 | 234 | 234 | 232 | 220 | 220 | 220 | 210 | 220 | 207 | 200 | 0 |
| T | 11 | 35 | 250 | 247 | 243 | 238 | 233 | 226 | 224 | 225 | 215 | 212 | 0 |
| T | 11 | 40 | 262 | 260 | 257 | 253 | 246 | 209 | 205 | 205 | 224 | 220 | 0 |
| T | 11 | 45 | 270 | 270 | 269 | 266 | 261 | 252 | 248 | 251 | 209 | 205 | 0 |
| T | 11 | 50 | 274 | 274 | 273 | 271 | 266 | 258 | 250 | 260 | 250 | 250 | 0 |
| T | 11 | 55 | 269 | 269 | 269 | 264 | 259 | 255 | 255 | 256 | 255 | 255 | 0 |
| T | 11 | 60 | 252 | 252 | 253 | 249 | 244 | 240 | 245 | 244 | 206 | 200 | 0 |
| T | 11 | 65 | 227 | 229 | 234 | 233 | 229 | 230 | 235 | 231 | 226 | 224 | 0 |
| T | 11 | 70 | 206 | 209 | 215 | 216 | 216 | 220 | 225 | 220 | 210 | 207 | 0 |
| T | 11 | 75 | 199 | 202 | 205 | 206 | 206 | 212 | 218 | 215 | 196 | 190 | 0 |
| T | 11 | 80 | 202 | 203 | 201 | 199 | 201 | 207 | 211 | 214 | 222 | 225 | 0 |
| T | 11 | 85 | 203 | 203 | 199 | 196 | 199 | 203 | 209 | 213 | 215 | 216 | 0 |
| T | 11 | 90 | 193 | 192 | 191 | 194 | 200 | 207 | 211 | 212 | 213 | 210 | 0 |
| T | 11 | 95 | 187 | 191 | 196 | 202 | 208 | 214 | 215 | 212 | 210 | 210 | 0 |
| T | 11 | 100 | 193 | 200 | 210 | 219 | 222 | 220 | 215 | 209 | 205 | 204 | 0 |

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T 11 105     219  227  239  245  241  231  217  206  199  197      0
T 11 110     269  282  286  284  272  253  231  212  201  197      0
T 12  25     220  221  222  219  217  221  216  210  206  205      0
T 12  30     234  234  229  229  224  221  216  211  208  207      0
T 12  35     249  248  243  240  234  225  219  218  215  214      0
T 12  40     259  259  257  255  243  236  228  227  220  218      0
T 12  45     268  267  270  268  263  249  242  243  234  231      0
T 12  50     272  272  273  271  266  257  254  258  255  254      0
T 12  55     269  268  267  265  261  255  253  256  258  259      0
T 12  60     255  255  254  252  248  247  247  245  247  248      0
T 12  65     232  230  233  236  235  238  240  233  238  240      0
T 12  70     208  209  211  216  222  228  201  224  206  200      0
T 12  75     199  200  202  204  212  218  222  217  198  192      0
T 12  80     201  201  198  198  204  211  214  214  219  221      0
T 12  85     199  200  198  197  201  207  213  214  215  215      0
T 12  90     189  185  169  194  203  213  217  217  217  217      0
T 12  95     184  184  187  196  207  219  222  219  217  217      0
T 12 100     191  193  197  204  212  220  221  217  215  214      0
T 12 105     215  220  225  225  222  219  215  211  209  208      0
T 12 110     261  270  271  263  250  238  227  216  209  207      0
T 13  25     219  220  221  222  221  222  222  220  218  217      0
T 13  30     232  233  232  231  229  228  227  225  224  224      0
T 13  35     247  247  244  241  240  238  236  233  234  234      0
T 13  40     260  259  257  255  254  252  248  244  244  244      0
T 13  45     269  269  269  268  267  264  261  258  257  257      0
T 13  50     273  273  273  272  270  268  267  267  270  271      0
T 13  55     269  268  266  264  262  262  262  263  263  263      0
T 13  60     252  252  251  249  247  248  251  251  247  246      0
T 13  65     230  231  233  233  231  233  237  236  230  228      0
T 13  70     210  212  215  216  216  219  223  222  207  203      0
T 13  75     200  202  205  205  205  206  203  208  198  194      0
T 13  80     198  199  199  197  195  194  194  194  206  210      0
T 13  85     198  197  196  192  188  185  184  184  184  184      0
T 13  90     193  192  191  189  187  185  184  183  183  183      0
T 13  95     193  193  194  196  197  197  195  194  193  193      0
T 13 100     206  206  207  209  211  213  214  213  212  212      0
T 13 105     235  234  232  230  230  233  236  238  239  239      0
T 13 110     283  280  273  268  265  268  271  271  271  271      0

***STATIONARY PERTURBATIONS, CODE S***
S 1 30   10  -1  -6 -48 -93    0          2   0 -21 -33    0        -1  -7 -24 -59    0
S 1 30   40  -1  -6 -57-104    0         -3  -6 -15 -46    0        -1  -3 -42 -59    0
S 1 30   70 -10 -15 -66 -82    0        -25 -17 -26 -46    0        20   2 -38 -36    0
S 1 30  100 -10 -23  -3   5    0         -9 -11  14   7    0         3 -11 -20  -2    0
S 1 30  130  -1  11  51 104    0          2  17  48  73    0        -6  -3   3  36    0
S 1 30  160  -1  11  96 191    0          8  11  72 126    0       -10  -3  21  59    0
S 1 30  190  15  28  87 169    0         19  22  43  86    0        -1   6  43  78    0
S 1 30  220   7. 19  69  93    0          8  17  14  33    0        -6   2  52  64    0
S 1 30  250 -10  -6   6   5    0         -9 -11 -26 -20    0         3  11  38  26    0
S 1 30  280  15  11 -39 -82    0          2   0 -38 -66    0         7   6   3 -12    0
S 1 30  310  -1  -6 -48-104    0          2 -11 -38 -66    0        -1   2 -11 -40    0
S 1 30  340  -1 -15 -48-104    0          2 -11 -26 -46    0        -6  -3 -24 -55    0
S 1 40   10  14  18 -43 -88    0          9  -1 -63 -66    0         5  23  20 -23    0
S 1 40   40  28  29 -35 -84    0         22   7 -57 -69    0         5  19  20 -15    0
S 1 40   70  21  25 -70 -93    0         17   4-102 -96    0         5  19  32   2    0
S 1 40  100   3 -28 -98 -74    0          9 -35-110 -82    0        -7   7  12  10    0
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S 1 40   130 -21 -43 -31   8    0     -20 -27  -5  -6    0       1 -16 -29  15    0
S 1 40   160 -18  -3 102 125    0      -7  33 138 125    0     -11 -36 -33   2    0
S 1 40   190 -32  19 173 202    0     -22  48 207 195    0      -7 -28 -29   6    0
S 1 40   220 -21  11 130 168    0     -15  25 124 138    0      -7 -12   4  27    0
S 1 40   250 -11 -21  43  62    0     -15 -22  23  34    0       1  -1  20  27    0
S 1 40   280   0  -3 -11 -35    0      -9   1 -11 -32    0       8  -5   0  -2    0
S 1 40   310  24   0 -70 -88    0      25  -7 -52 -66    0       1   7 -21 -23    0
S 1 40   340  14  -3 -90-103    0       6 -25 -93 -76    0       8  23   4 -27    0
S 1 52    10  22  40 -29-102    0      13  38 -18 -97    0       9   0 -11  -5    0
S 1 52    40  30  63  13 -80    0      20  50   9 -99    0       9   7   5  19    0
S 1 52    70  27  69  21 -52    0      17  62 -14 -86    0       9   7  36  35    0
S 1 52   100  15   4 -31 -32    0      17  -3 -60 -55    0      -2   7  32  23    0
S 1 52   130 -14 -39 -19  26    0      -5 -41 -26  19    0      -9   0   9   7    0
S 1 52   160 -24 -29  74 125    0     -15 -30  80 138    0      -9   3  -7 -12    0
S 1 52   190 -22 -13  96 183    0     -16 -13 104 195    0      -6   0  -7  -9    0
S 1 52   220 -27 -35  90 165    0     -20 -37  85 166    0      -6   3   5  -1    0
S 1 52   250 -24 -33  54  62    0     -18 -31  52  70    0      -6   0   1  -9    0
S 1 52   280  -9 -13 -13 -52    0      -6 -10   3 -42    0      -2  -8 -15 -12    0
S 1 52   310   7 -16-105-115    0       5  -4 -82 -99    0       2 -12 -26 -16    0
S 1 52   340  19   1-151-128    0       9   8-133-110    0       9  -8 -22 -20    0
S 1 60    10  28  26 -59-120    0      25  53 -14 -91    0       6 -22 -41 -27    0
S 1 60    40  37  65  -6 -75    0      32  77  36 -65    0       6 -10 -37 -10    0
S 1 60    70  42  70  35 -29    0      22  77  48 -35    0      18  -6 -12  11    0
S 1 60   100  19  12  -6 -14    0      12   5 -22 -24    0       6   6  12  15    0
S 1 60   130 -27 -32   6  39    0     -12 -44 -30  22    0     -14  10  37  19    0
S 1 60   160 -32 -13  76 130    0     -25 -40  60 104    0     -10  30  21  28    0
S 1 60   190 -27   2 106 206    0     -25 -27  81 155    0      -2  26  21  41    0
S 1 60   220 -32 -27 118 176    0     -28 -40  68 155    0      -6  14  49  24    0
S 1 60   250 -27 -27  65  47    0     -25 -37  48  63    0      -5  10  16 -15    0
S 1 60   280 -13 -27 -29 -67    0      -8 -20 -18 -50    0      -2  -6  -8 -19    0
S 1 60   310  10 -32-124-135    0       8 -16-112-112    0       2 -18 -16 -27    0
S 1 60   340  23 -17-182-158    0      25  12-145-122    0      -2 -30 -41 -40    0
S 1 68    10  34   7 -94-159    0      32  18 -66-116    0       0  -8 -24 -44    0
S 1 68    40  42  58 -49-103    0      41  57 -17 -68    0       0  -4 -33 -35    0
S 1 68    70  65  67  13 -35    0      41  66  31 -21    0      19   1 -20 -13    0
S 1 68   100  24  10  -5  -4    0      23  18   7  -5    0       5  -8  -7   5    0
S 1 68   130 -40 -26  30  66    0     -32 -30  19  42    0      -9   1  10  27    0
S 1 68   160 -44   8 100 172    0     -32   9  83 137    0      -9   5  19  40    0
S 1 68   190 -28  22 137 264    0     -23   9 104 200    0      -4  10  36  53    0
S 1 68   220 -38 -14 171 218    0     -32 -20 128 168    0      -4   5  40  44    0
S 1 68   250 -31 -20  88  44    0     -32 -30  56  42    0       0  10  27  14    0
S 1 68   280 -12 -29 -34 -91    0     -14 -30 -29 -68    0       5   1  -3 -13    0
S 1 68   310   8 -43-143-171    0       5 -39-126-147    0       0  -4 -16 -35    0
S 1 68   340  21 -40-214-202    0      23 -30-187-163    0      -4  -8 -29 -44    0
S 1 76    10  41  11-105-191    0      31  -6-115-176    0      10  20   9 -18    0
S 1 76    40  46  70 -58-128    0      40  49 -74-120    0      10  20  18  -4    0
S 1 76    70  82  81  24 -41    0      76  59 -14 -49    0      10  20  36  13    0
S 1 76   100  21  11   0   6    0      28   3 -17  -8    0      -5  10  23  18    0
S 1 76   130 -46 -37  24  84    0     -43 -22  43  74    0      -5 -15 -18  13    0
S 1 76   160 -56  -5  95 194    0     -46  25 121 197    0     -15 -30 -27  -4    0
S 1 76   190 -36  11 142 297    0     -25  37 170 299    0     -10 -25 -23   0    0
S 1 76   220 -46 -16 201 257    0     -40  -9 196 238    0     -10 -10   5  18    0
S 1 76   250 -36 -15 112  61    0     -31 -15  95  43    0       0   0  14  18    0
S 1 76   280  -5 -32 -41-104    0     -13 -25 -36-100    0       5  -5  -5  -4    0
S 1 76   310  10 -42-164-198    0       8 -46-141-182    0       0   0 -27 -22    0
S 1 76   340  26 -37-229-238    0      14 -49-227-217    0      10  15  -5 -27    0
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S 1 84   10  53  26-105-236     0       41  26 -92-200     0       13   0 -13  -5     0
S 1 84   40  63  90 -46-119     0       50  30 -51-137     0       13  10   6  23     0
S 1 94   70  99 100  72  -7     0       85  91  28 -45     0       13  10  45  41     0
S 1 84  100  14  24  40  30     0       18  14   2   2     0       -3  10  40  27     0
S 1 84  130 -59 -44  19 101     0      -46 -44   9  91     0      -13   0  11   9     0
S 1 84  160 -75 -24  68 178     0      -63 -28  78 196     0      -13   5  -8 -15     0
S 1 84  190 -46  -5 117 292     0      -35  -5 128 305     0       -8   0  -8 -10     0
S 1 84  220 -57 -20 209 270     0      -56 -25 204 272     0       -8   5   6  -1     0
S 1 84  250 -40 -16 123  61     0      -32 -16 123  72     0       -8   0   1 -10     0
S 1 84  280  -4 -44 -56-116     0       -1 -33 -37-104     0       -3 -11 -18 -15     0
S 1 84  310  10 -55-195-222     0        8 -39-166-207     0        3 -16 -32 -19     0
S 1 84  340  43 -32-246-262     0       30 -22-225-244     0       13 -11 -28 -24     0
S 1 90   10  66  15-132-217     0       58  38 -91-195     0        7 -26 -42 -25     0
S 1 90   40  77  91 -62-108     0       64 101 -25-105     0        7 -10 -32  -1     0
S 1 90   70 123 103  95  21     0       94 108  95   5     0       23  -4   2  18     0
S 1 90  100  14  32  68  48     0       10  25  48  34     0        7   6  22  18     0
S 1 90  130 -77 -33  41 116     0      -56 -51   3  95     0      -21  12  37  23     0
S 1 90  160 -88  -3  68 178     0      -77 -35  57 160     0      -10  33  12  18     0
S 1 90  190 -54   9 122 300     0      -50 -19 104 267     0       -4  28  17  32     0
S 1 90  220 -66  -9 235 280     0      -59 -26 186 258     0       -4  17  42  18     0
S 1 90  250 -48 -15 133  48     0      -41 -19 117  66     0       -4   6  17 -11     0
S 1 90  280  -9 -56 -72-136     0       -2 -45 -57-113     0       -4 -10 -12 -20     0
S 1 90  310  14 -74-218-244     0       10 -54-199-216     0        1 -20 -22 -30     0
S 1 90  340  48 -56-277-285     0       49 -22-240-256     0        1 -31 -42 -40     0
S 2 30   10   4  -9 -37-100     0       -6  -6 -17 -36     0        8  -2 -24 -62     0
S 2 30   40   4  -1 -37 -90     0        0   3  -5 -36     0        4  -7 -28 -53     0
S 2 30   70  -4  -1 -28 -50     0      -22  -8 -11 -36     0       12   2 -20 -12     0
S 2 30  100  -4  -9   7  19     0       -6 -13  12   8     0        4   2  -6  15     0
S 2 30  130   4  -1  43 108     0       11   9  46  78     0       -5  -7  -2  28     0
S 2 30  160  -4   8  69 157     0        6   9  58 110     0       -9   2  11  37     0
S 2 30  190  -4   8  60 138     0       -6  -2  40  78     0       -1   7  20  55     0
S 2 30  220  -4   8  52  88     0        0  14  23  40     0       -5  -2  29  55     0
S 2 30  250  -4  -1   7  19     0       -6   3 -22 -11     0       -1  -2  34  28     0
S 2 30  280  13   8 -28 -70     0       17   3 -40 -61     0        4   7  16  -3     0
S 2 30  310  -4  -1 -54-110     0       11   3 -51 -74     0       -9  -2  -6 -35     0
S 2 30  340   4  -3 -54-110     0        0 -13 -34 -61     0       -1   2 -24 -53     0
S 2 40   10  -6   9 -33-168     0      -13 -11 -38-124     0        7  21   9 -46     0
S 2 40   40   1  13 -60-158     0       -6  -9 -68-124     0        7  21   5 -38     0
S 2 40   70  11  20 -84-134     0       10   7 -87-114     0        3  13   1 -17     0
S 2 40  100   1  -8 -56 -44     0       -3  -3 -21 -35     0        3  -3 -36  -5     0
S 2 40  130  -3 -15  30  94     0        0  15  72  91     0       -1 -30 -40   3     0
S 2 40  160   1  -1 108 213     0        5  12 135 200     0       -5 -14 -24  16     0
S 2 40  190 -10   6 124 270     0      -11  15 116 230     0       -1  -7   9  37     0
S 2 40  220 -10   6 128 222     0       -8   9  94 170     0       -5  -3  29  49     0
S 2 40  250  -6   2  49  75     0        0  -3   6  31     0       -5   5  42  45     0
S 2 40  280   4 -23 -56 -54     0        7 -14 -76 -64     0       -5 -11  21  16     0
S 2 40  310  11 -19-100-149     0       18 -14 -87-131     0       -5  -7 -12 -17     0
S 2 40  340   4   9 -49-168     0        2  -3 -46-131     0        3  13  -3 -42     0
S 2 52   10  45  67  -8-171     0       37  51 -14-162     0        8  14   4 -10     0
S 2 52   40  35  70   4-159     0       28  55   7-153     0        8  14  -4  -6     0
S 2 52   70  29  64 -28-107     0       17  60 -26-112     0       12   3  -4   2     0
S 2 52  100   0  13 -50  -3     0       -2  20 -62 -22     0        1  -1  12  18     0
S 2 52  130  -3 -44 -14 117     0       -4 -36 -11 106     0        1  -8  -4  10     0
S 2 52  160  -8 -21  89 211     0       -7 -12 107 220     0       -3  -8 -16  -6     0
S 2 52  190  -3   0 114 231     0       -5   3 122 245     0        1  -4  -8 -10     0
S 2 52  220 -22 -21  98 196     0      -19 -16  98 196     0       -3  -4   0   2     0
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S 2 52  250 -38 -60  15  58    0     -28 -50   1  48    0     -10  -8  16  10    0
S 2 52  280 -36 -60 -69 -55    0     -28 -51 -68 -56    0     -10  -8   0  -2    0
S 2 52  310 -14 -36 -89-144    0      -8 -34 -89-141    0      -6  -1   0  -2    0
S 2 52  340  19  22 -62-174    0      17  12 -66-169    0       1  11   4  -6    0
S 2 60   10  55  75 -17-175    0      45  75   3-178    0       8  -1 -23   4    0
S 2 60   40  42  75 -11-153    0      36  82  16-168    0       8  -5 -31  12    0
S 2 60   70  42  65 -34-109    0      26  68 -26-107    0      16  -5  -6   0    0
S 2 60  100   1  21 -28  23    0       0  14 -60  -5    0       0   7  34  25    0
S 2 60  130  -3 -42  -5 132    0      -3 -54 -26 111    0       0  15  26  21    0
S 2 60  160 -12 -27  66 205    0      -6 -23  95 208    0      -4  -5 -27   0    0
S 2 60  190  -3  -3 107 220    0      -3  -3 112 228    0       0   3  -2  -8    0
S 2 60  220 -25 -22 107 198    0     -22 -23  91 203    0      -4  -1  14  -4    0
S 2 60  250 -49 -71  36  59    0     -38 -57  11  71    0     -12 -13  26 -12    0
S 2 60  280 -48 -66 -64 -72    0     -38 -64 -72 -46    0      -8  -1  10 -25    0
S 2 60  310 -21 -37 -93-153    0     -16 -37 -85-137    0      -8   3 -14 -21    0
S 2 60  340  19  31 -64-175    0      20  24 -60-178    0       0   3  -6   8    0
S 2 68   10  62  75 -40-194    0      50  69 -24-146    0       9   0 -17 -46    0
S 2 68   40  51  72 -44-171    0      50  79 -24-131    0       5   0 -25 -38    0
S 2 68   70  61  63 -46-113    0      50  59 -24-101    0      14   0 -17  -7    0
S 2 68  100   4  26  -6  43    0       6  20 -12  34    0       5   4   5  20    0
S 2 68  130  -5 -37  12 162    0      -3 -28  12 139    0      -5  -5   5  24    0
S 2 68  160 -20 -31  53 222    0     -12 -28  48 199    0      -9   0   5  24    0
S 2 68  190  -4   1 112 236    0      -3   1  96 199    0       0   4  13  33    0
S 2 68  220 -32 -26 125 213    0     -29 -28 108 169    0      -5  -5  17  38    0
S 2 68  250 -58 -80  67  57    0     -55 -77  36  34    0      -5  -5  26  20    0
S 2 68  280 -52 -64 -55 -88    0     -55 -67 -60 -86    0       0   4   9  -7    0
S 2 68  310 -29 -34-103-180    0     -20 -28 -96-161    0      -9   0  -4 -24    0
S 2 68  340  21  35 -76-187    0      23  30 -60-146    0       0   4 -17 -38    0
S 2 76   10  77  90 -48-236    0      66  65 -55-206    0       9  22   9 -36    0
S 2 76   40  62  85 -60-206    0      51  62 -59-182    0       9  22   0 -31    0
S 2 76   70  77  69 -54-130    0      69  58 -55-115    0       9  12   0 -13    0
S 2 76  100  10  26 -18  52    0       4  27   7  50    0       4  -2 -23   5    0
S 2 76  130 -10 -54  -6 180    0      -8 -27  25 176    0      -1 -27 -33   5    0
S 2 76  160 -31 -38  41 241    0     -22 -24  65 234    0      -6 -17 -23   9    0
S 2 76  190  -5  -1 124 271    0      -5   8 120 248    0      -1  -7   5  23    0
S 2 76  220 -36 -33 153 264    0     -34 -27 127 219    0      -6  -2  23  36    0
S 2 76  250 -67 -81 106  90    0     -57 -84  65  55    0      -6   2  37  36    0
S 2 76  280 -56 -70 -42 -92    0     -49 -59 -55 -95    0      -6 -12  14   9    0
S 2 76  310 -41 -38-113-206    0     -34 -30-102-187    0      -6  -7  -9 -13    0
S 2 76  340  21  47 -83-228    0      19  33 -84-197    0       4  17   0 -31    0
S 2 84   10  90 121 -39-262    0      79 100 -43-254    0      12  20   5 -12    0
S 2 84   40  76 115 -60-228    0      63  94 -54-222    0      12  20  -5  -7    0
S 2 84   70  96  80 -60-133    0      78  77 -56-135    0      17   4  -5   2    0
S 2 84  100  11  22 -24  65    0       9  23 -37  42    0       1  -1  15  21    0
S 2 84  130  -9 -81 -30 188    0      -9 -71 -25 175    0       1 -11  -5  12    0
S 2 84  160 -35 -57  10 240    0     -30 -46  31 248    0      -4 -11 -20  -7    0
S 2 84  190  -3 -10 119 276    0      -5  -3 130 293    0       1  -6 -10 -12    0
S 2 84  220 -45 -39 168 286    0     -40 -32 168 285    0      -4  -6   0   2    0
S 2 84  250 -81 -89 147 116    0     -67 -78 125 104    0     -14 -11  20  12    0
S 2 84  280 -73 -85 -32 -87    0     -59 -74 -32 -84    0     -14 -11   0  -2    0
S 2 84  310 -51 -43-115-213    0     -42 -41-116-211    0      -9  -1   0  -2    0
S 2 84  340  25  66 -83-246    0      24  52 -89-240    0       1  15   5  -7    0
S 2 90   10 105 136 -47-269    0      92 130 -28-270    0      11   4 -21   4    0
S 2 90   40  88 125 -76-229    0      76 124 -48-234    0      11   4 -31   9    0
S 2 90   70 116  79 -65-131    0      95  84 -58-134    0      21  -2  -6   0    0
S 2 90  100   9  22  -1  87    0       9  19 -34  61    0       0   4  34  28    0
```

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S 2 90   130   -7 -82 -24 205     0       -7 -92 -41 181     0        0   9  24  19     0
S 2 90   160  -41 -65 -13 232     0      -34 -58  15 237     0       -5  -7 -31   2     0
S 2 90   190   -2 -13 108 265     0       -4 -15 115 277     0        0  -2  -6 -10     0
S 2 90   220  -52 -42 176 294     0      -44 -40 162 289     0       -5  -2  14  -5     0
S 2 90   250  -97-105 176 120     0      -80 -89 142 129     0      -15 -12  29 -10     0
S 2 90   280  -26 -93 -30 -96     0      -74 -89 -34 -78     0      -10  -7   9 -24     0
S 2 90   310  -58 -42-122-223     0      -53 -46-111-206     0      -10   4 -11 -19     0
S 2 90   340   26  79 -82-243     0       24  72 -81-250     0        0   9  -6   9     0
S 3 30    10   -1  -5 -13 -36     0       -2  -7  -7 -19     0        3   2 -11 -23     0
S 3 30    40   -1  -5 -22 -45     0        3  -1  -7 -25     0       -6  -2 -16 -23     0
S 3 30    70   -1  -5 -22 -35     0       -2  -1 -13 -31     0        3   2  -7  -9     0
S 3 30   100   -1  -5 -13 -17     0       -2  -7 -19 -13     0        3   2   2   0     0
S 3 30   130   -1  -5  -4  20     0       -8  -7  -2  17     0        3   2   2   9     0
S 3 30   160   -1   4  13  48     0       -8  -1  21  39     0        3   2  -2  13     0
S 3 30   190   -1   4  22  58     0       -2   4  15  35     0        3  -2   7  17     0
S 3 30   220   -1   4  22  39     0       -2   4   9  17     0        3  -2  16  22     0
S 3 30   250   -1   4  13  11     0        3   4  -2   5     0       -2  -2  16  13     0
S 3 30   280    9  12   4   2     0        9  10   4  -7     0        3   2   2   9     0
S 3 30   310   -1   4   4 -17     0        3   4   4  -7     0       -6  -2  -2  -9     0
S 3 30   340   -1  -5  -4 -27     0        9  -1  -2  -7     0       -6  -2  -7 -18     0
S 3 40    10   -1  -1 -35 -99     0       -7 -11 -30 -91     0        5  12  -3 -13     0
S 3 40    40    3  20 -23 -74     0       -2  10 -33 -76     0        5   8   9   4     0
S 3 40    70   17  24 -12 -23     0       14  23 -25 -34     0        5   1  13  12     0
S 3 40   100    3   9  -4  24     0        1  21   0  20     0        1 -11  -7   4     0
S 3 40   130    3  -1  34  92     0        3   5  58 101     0       -3  -7 -23  -8     0
S 3 40   160    3   9  77 130     0        9  31 110 143     0       -6 -19 -31 -13     0
S 3 40   190  -11   2  77 126     0       -5  18  96 140     0       -6 -15 -19 -13     0
S 3 40   220  -15  -1  46  45     0      -10   8  72  44     0       -6 -11 -27   0     0
S 3 40   250   -8 -12 -23 -36     0       14  -8 -36 -49     0      -22  -7  13  12     0
S 3 40   280    3 -15 -35 -48     0        3 -24 -66 -67     0        1   8  29  20     0
S 3 40   310    3 -15 -54 -65     0      -10 -39 -85 -67     0       13  24  33   4     0
S 3 40   340    3 -19 -47 -70     0      -10 -34 -61 -61     0       13  16  13  -8     0
S 3 52    10   18  41  -8 -97     0       10  32  -2 -85     0        9   9  -6 -15     0
S 3 52    40   29  55  -4 -53     0       19  46  -6 -44     0        9   9   1  -7     0
S 3 52    70   27  45   4 -10     0       26  40   1 -10     0        2   5   1   1     0
S 3 52   100   18  15 -21  40     0       17  19 -22  31     0        2  -2   1   8     0
S 3 52   130    5  -2   8  72     0       10   7  16  67     0       -5 -10 -10   5     0
S 3 52   160    5  -7  36  95     0       16   5  53  98     0      -12 -14 -14  -3     0
S 3 52   190    1  -5  55  87     0       11   4  63  86     0      -12 -10  -6   1     0
S 3 52   220  -17 -22  32  42     0      -11 -19  28  42     0       -5  -2   5   1     0
S 3 52   250  -29 -32  -6   7     0      -32 -32 -16   0     0        2   1   9   8     0
S 3 52   280  -32 -43 -34 -38     0      -34 -47 -47 -44     0        2   5  13   8     0
S 3 52   310  -18 -35 -41 -55     0      -21 -40 -50 -58     0        2   5   9   5     0
S 3 52   340   -6 -10 -21 -91     0      -13 -15 -18 -83     0        6   5  -3 -11     0
S 3 60    10   24  43  -9-117     0       23  46  -9 -93     0        0   1   0 -25     0
S 3 60    40   37  57  -9 -73     0       33  59   2 -42     0        0   1 -12 -29     0
S 3 60    70   28  57   2 -17     0       29  39  10  -3     0        0  17  -8 -16     0
S 3 60   100   15  15 -19  46     0       20   9 -21  44     0       -4   5   0   5     0
S 3 60   130    2  -9  -9  84     0        5  -4  10  65     0       -4  -3 -16  18     0
S 3 60   160   -7 -13  35 102     0        2 -14  21  86     0       -8   1  16  18     0
S 3 60   190  -11  -9  46 102     0       -2 -11  56  73     0       -8   1 -12  26     0
S 3 60   220  -20 -18  56  52     0      -20 -27  14  35     0        0   5  45  18     0
S 3 60   250  -20 -28   8  15     0      -36 -34  -9   5     0       16   9  16   9     0
S 3 60   280  -33 -42 -30 -35     0      -29 -40 -25 -33     0       -4  -3  -4   1     0
S 3 60   310  -16 -42 -41 -54     0      -20 -24 -32 -50     0        4 -20 -12  -4     0
S 3 60   340    2 -13 -30-104     0       -5  -1 -17 -68     0        4 -12 -12 -20     0
```

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S 3 68    10   28   47 -18-142    0       20   46  -5-125    0        3   3  -9 -21    0
S 3 68    40   34   59 -22 -99    0       37   55  -5 -74    0       -1   3 -13 -21    0
S 3 68    70   28   69  -8 -34    0       29   65  -5 -23    0        3   3  -4  -8    0
S 3 68   100   16   21 -20  51    0       11   17 -27  55    0        3   3   4   2    0
S 3 68   130   -1  -14 -15 101    0        3  -11 -16  93    0       -1  -2   0  11    0
S 3 68   160  -12  -14  43 119    0       -6  -11  51 106    0       -1  -2  -4  11    0
S 3 68   190  -16  -13  40 126    0      -14  -11  29 106    0       -1  -2   4  15    0
S 3 68   220  -19  -17  95  73    0      -23  -21  73  55    0       -1  -2  17  20    0
S 3 68   250   -8  -20  23  26    0      -14  -21   6  16    0        3  -2  13  11    0
S 3 68   280  -34  -42 -28 -32    0      -40  -40 -27 -35    0        3   3   4   6    0
S 3 68   310  -16  -54 -51 -63    0       -6  -49 -49 -61    0       -6  -2  -4  -8    0
S 3 68   340    0  -21 -38-126    0        3  -21 -27-113    0       -6  -2  -9 -17    0
S 3 76    10   37   57 -29-162    0       28   44 -23-149    0        7  15  -6 -17    0
S 3 76    40   37   62 -24-114    0       28   53 -34-111    0        7  10   8   1    0
S 3 76    70   32   73  -7 -38    0       28   71 -17 -46    0        7   1  12  10    0
S 3 76   100   17   17 -18  58    0       16   28 -17  48    0        2  -9  -6   6    0
S 3 76   130   -3  -19 -29 106    0        2  -12  -6 108    0       -2  -9 -20  -3    0
S 3 76   160  -18  -29  26 120    0      -10   -6  55 130    0      -12 -23 -30 -13    0
S 3 76   190  -23  -24  31 127    0      -12   -9  51 139    0      -12 -18 -16  -8    0
S 3 76   220  -23  -24  97  85    0      -15  -15 116  83    0       -7  -9 -20   1    0
S 3 76   250  -18  -24  42  44    0       -1  -18  24  31    0      -17  -4  12  10    0
S 3 76   280  -33  -34 -13 -18    0      -33  -43 -37 -33    0        2  10  26  20    0
S 3 76   310  -13  -44 -35 -66    0      -24  -64 -64 -68    0       12  20  31   6    0
S 3 76   340    7  -13 -40-141    0       -7  -30 -47-132    0       12  15   8 -13    0
S 3 84    10   51   75 -35-180    0       38   59 -27-167    0       13  12  -8 -19    0
S 3 84    40   53   81 -19-117    0       38   70 -16-110    0       13  12   2  -9    0
S 3 84    70   38   79   3 -30    0       38   70  -4 -24    0        3   7   2   1    0
S 3 84   100   23    8 -23  67    0       20   11 -24  57    0        3  -3   2  11    0
S 3 84   130  -12  -36 -49 104    0       -4  -21 -36  98    0       -7 -13 -13   6    0
S 3 84   160  -39  -55  -9 109    0      -22  -34  10 113    0      -17 -18 -19  -4    0
S 3 84   190  -42  -43  15 123    0      -26  -29  24 123    0      -17 -13  -8   1    0
S 3 84   220  -33  -32  86  84    0      -26  -29  79  84    0       -7  -3   7   1    0
S 3 84   250  -27  -27  58  55    0      -30  -28  45  45    0        3   2  12  11    0
S 3 84   280  -27  -25  17  -1    0      -31  -31   2 -11    0        3   7  17  11    0
S 3 84   310   -3  -27 -11 -59    0       -6  -32 -23 -64    0        3   7  12   6    0
S 3 84   340   19   -1 -35-156    0       12   -7 -31-143    0        8   7  -3 -14    0
S 3 90    10   59   83 -42-202    0       56   79 -38-177    0        3   1  -3 -25    0
S 3 90    40   64   89 -25-136    0       56   85 -14-110    0        3   1  -8 -25    0
S 3 90    70   39   94  -2 -38    0       42   73   8 -21    0       -2  17  -8 -15    0
S 3 90   100   23    6 -19  73    0       24    3 -20  68    0       -2   6  -3  10    0
S 3 90   130  -18  -46 -64 119    0      -13  -39 -48  98    0       -7 -10 -18  20    0
S 3 90   160  -54  -66 -14 112    0      -42  -59 -23  98    0      -12  -4   8  15    0
S 3 90   190  -59  -51   3 132    0      -45  -48  17 112    0      -12  -4 -13  20    0
S 3 90   220  -39  -30 116  93    0      -36  -36  67  75    0       -2   6  45  15    0
S 3 90   250  -18  -20  71  67    0      -34  -31  54  57    0       19  11  18  10    0
S 3 90   280  -28  -25  26   8    0      -25  -22  26   5    0       -2   1   3   0    0
S 3 90   310    3  -30  -9 -58    0       -5  -14  -1 -54    0        3 -15  -8  -5    0
S 3 90   340   28   -4 -42-169    0       21    9 -29-151    0        8 -10 -13 -20    0
S 4 30    10    1   -1   1   6    0       -1    4   1  12    0       -3  -3   0  -9    0
S 4 30    40   -7   -1   1   6    0       -1   -1   7  17    0       -3  -3  -4 -13    0
S 4 30    70    1    7   1   6    0       -1    4   1   6    0        2   6   0  -5    0
S 4 30   100   18    7   1  14    0       20   -7  12  17    0        2  10  -8  -5    0
S 4 30   130   -7  -10  -7  14    0       -1  -18   1  17    0       -3  10  -8  -5    0
S 4 30   160   -7   -1   1  14    0      -12   -7   7  23    0        2   1  -4   0    0
S 4 30   190    1   -1  10  23    0       -7   -1   7   6    0        6   1   0  13    0
S 4 30   220    1   -1  10   6    0        4    4   1 -11    0       -3  -3  14  17    0
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S 4 30  250   1   7   1 -11   0      4   4 -15 -28   0     -3  -3  18  13   0
S 4 30  280  10   7  -7 -29   0      4  10 -15 -33   0      2  -3   5   8   0
S 4 30  310  -7  -1  -7 -29   0     -1  10  -4 -28   0     -3  -7  -4   0   0
S 4 30  340  -7 -10  -7 -20   0     -7  -1  -4   0   0      2  -7  -8 -13   0
S 4 40   10  -8   7   3  -7   0    -14  -4  -6  -3   0      7  12  10   0   0
S 4 40   40   2  -3   0 -18   0      4  -7  -4 -11   0     -1   4   2  -8   0
S 4 40   70   6   3 -11 -22   0     16   1  -1  -5   0     -9   0  -9 -16   0
S 4 40  100  12   0 -15 -14   0     16   1  -1   5   0     -5   0  -9 -20   0
S 4 40  130   6   0 -11 -14   0     11   1  -4  -5   0     -5  -4  -9  -8   0
S 4 40  160   2   3  -8 -10   0      1   8   4  -5   0     -1  -4 -13  -4   0
S 4 40  190 -11   3   3   8   0    -21  13  12   5   0     10 -11  -9   0   0
S 4 40  220  -8   3  21  24   0     -6   8  36  24   0     -1  -7 -13   0   0
S 4 40  250 -11   0  18  35   0    -11   6  18  24   0     -1  -4  -2   8   0
S 4 40  280  -1  -7   3   8   0      1  -4 -11 -13   0     -1   0  14  20   0
S 4 40  310   9  -7   3   8   0      6 -12 -14 -13   0      3   4  18  20   0
S 4 40  340   2  -3  -8   1   0     -1  -9 -30  -3   0      3   8  22   4   0
S 4 52   10  16  27  17  -1   0     19  32  19  -3   0     -1  -5  -1   1   0
S 4 52   40  12  23   2 -21   0      6  18   0 -23   0      6   2   3   1   0
S 4 52   70   7  13  -8 -44   0     -1  10 -13 -41   0     10   2   3  -3   0
S 4 52  100   3   7 -16 -23   0      2  12 -21 -20   0     -1  -5   3  -3   0
S 4 52  130   4  -5 -23 -14   0      6  -8 -30 -10   0     -5   2   7  -3   0
S 4 52  160  -8  -2 -16  -5   0     -4  -1 -17  -2   0     -5  -1  -1  -3   0
S 4 52  190   4  -7  -8  13   0      4  -9  -5  15   0      2   2  -4  -3   0
S 4 52  220  -6 -16   0  33   0     -5 -18  -1  35   0     -1   2   3   1   0
S 4 52  250 -12 -16  11  33   0    -12 -19   5  26   0     -1   2   7   8   0
S 4 52  280 -18 -16  -3  10   0    -17 -18   0   5   0     -1   2  -4   5   0
S 4 52  310  -5 -20  24  12   0     -1 -18  34   9   0     -5  -1  -8   1   0
S 4 52  340   4  13  21   6   0      3  18  30   8   0      2  -5  -8  -3   0
S 4 60   10  10  14  14  -4   0     21  35  23   1   0    -12 -19  -9  -2   0
S 4 60   40  18  23   0 -19   0     12  26   6 -21   0      8  -6  -5  -2   0
S 4 60   70  14  13   0 -39   0      9  13 -11 -51   0      4   6  11  10   0
S 4 60  100   5   5 -10 -19   0      0   4 -18 -29   0      4   2   7  10   0
S 4 60  130   1   5 -14 -14   0      0 -12 -25 -17   0      0  14  11   2   0
S 4 60  160 -12  -4 -14  -9   0     -6  -3 -22  -6   0     -8   2   7  -2   0
S 4 60  190   1   0 -10  11   0      9  -9 -11  12   0     -4  10   3  -2   0
S 4 60  220  -3  -9  14  37   0     -9 -21 -11  34   0      4  10  23   2   0
S 4 60  250 -12  -9  24  42   0    -15 -21   2  34   0      4  14  23  10   0
S 4 60  280 -16 -17 -10  11   0    -21 -15   2  12   0      4  -2 -13  -2   0
S 4 60  310 -16 -26   5   6   0      0 -15  33  19   0    -12 -11 -25 -14   0
S 4 60  340  10   0   0  -4   0      6  19  33  12   0      8 -19 -33 -14   0
S 4 68   10  -2   0   7  -8   0      1   4   4   1   0     -2  -6  -1  -7   0
S 4 68   40  24  18  -3 -25   0     27  22  -6 -20   0     -2  -1  -1 -11   0
S 4 68   70  20  23   7 -39   0     10  22   4 -40   0      7   7   3  -2   0
S 4 68  100   5   8 -12 -13   0      1   4  -6  -9   0      3   7  -1  -2   0
S 4 68  130   1  18 -10 -14   0      1   4  -6  -9   0     -2   7  -1  -2   0
S 4 68  160 -18   0  -9 -10   0    -15  -5  -6  -9   0     -2   3  -1  -2   0
S 4 68  190   2   7  -6  18   0      1   4  -6  11   0      3   3  -1  10   0
S 4 68  220  -3  -2  37  44   0      1  -5  23  32   0     -2  -1  16  15   0
S 4 68  250  -9   0  49  55   0     -7   4  33  42   0     -2  -1  16  10   0
S 4 68  280 -13 -17 -19  13   0    -15 -14 -15  11   0      3  -1  -1   6   0
S 4 68  310 -25 -37 -15  -4   0    -24 -32  -6   1   0     -7  -6 -10  -2   0
S 4 68  340  17 -16 -27 -16   0     18  -5 -15  -9   0      3 -10 -15 -11   0
S 4 76   10   1   2  12 -13   0     -5  -7   4 -12   0      4   6   8  -1   0
S 4 76   40  26  21  -3 -33   0     23  16  -5 -28   0      4   6   4  -5   0
S 4 76   70  21  26   7 -48   0     26  27  13 -34   0     -1   2  -6 -15   0
S 4 76  100   6  12 -19 -23   0      9  13 -11  -6   0     -6  -3  -6 -15   0
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S 4 76  130  -4  21 -13 -23   0     0  24 -11 -15   0    -6  -3  -6  -5   0
S 4 76  160 -19  -2 -19 -13   0   -17   1  -5  -9   0    -1  -3 -11  -5   0
S 4 76  190  11   2 -13  23   0     0  13  -2  22   0     9  -8 -11  -1   0
S 4 76  220  -4  -7  42  53   0    -3  -2  49  51   0    -1  -3 -11  -1   0
S 4 76  250 -14  -2  62  58   0   -11   1  58  57   0    -1  -3   4   8   0
S 4 76  280 -14 -17 -13  28   0   -11 -19 -23  10   0    -1   2   8  18   0
S 4 76  310 -29 -40 -13   3   0   -28 -42 -23 -12   0    -1   2  13  18   0
S 4 76  340  21 -17 -29 -23   0    17 -25 -42 -24   0     4   6  13   4   0
S 4 84   10   2   2  16 -10   0     3   4  19 -14   0    -2  -7  -1   1   0
S 4 84   40  32  24   3 -38   0    24  24  -2 -35   0     8   3   4   1   0
S 4 84   70  30  31   5 -58   0    14  24  -2 -56   0    13   3   4  -4   0
S 4 84  100   0   5 -19 -38   0     3  14 -23 -35   0    -2  -7   4  -4   0
S 4 84  130 -15  22 -13 -28   0    -8  24 -23 -24   0    -7   3  10  -4   0
S 4 84  160 -28  -5 -25 -17   0   -19  -6 -23 -14   0    -7  -2  -1  -4   0
S 4 84  190  21   0 -23  18   0    14  -6 -13  28   0     3   3  -6  -4   0
S 4 84  220  -7  -7  36  53   0    -8  -6  29  46   0    -2   3   4   1   0
S 4 84  250 -13   0  69  83   0    -8  -6  61  69   0    -2   3  10  12   0
S 4 84  280 -15 -14 -11  42   0   -12 -17  -4  37   0    -2   3  -6   6   0
S 4 84  310 -32 -38 -13  16   0   -25 -37  -2  15   0    -7  -2 -12   1   0
S 4 84  340  24 -13 -25 -25   0    23 -13 -14 -19   0     3  -7 -12  -4   0
S 4 90   10  -6 -14  12  -9   0     9   8  21  -8   0   -12 -22  -7  -2   0
S 4 90   40  40  25   0 -36   0    32  29   6 -37   0     8  -1  -7  -2   0
S 4 90   70  40  35  12 -57   0    34  29   0 -65   0     8   4  15   8   0
S 4 90  100  -1   0 -11 -36   0    -3   3 -21 -45   0     3  -1   4   8   0
S 4 90  130 -16  35   0 -30   0   -17  18 -12 -31   0    -2  15   9   3   0
S 4 90  160 -37  -4 -23 -20   0   -26  -8 -30 -17   0    -7  -1   9  -2   0
S 4 90  190  20   5 -23  17   0    23  -3 -27  18   0    -2  10   4  -2   0
S 4 90  220  -6   0  53  54   0   -11 -11  27  52   0     3  15  26   3   0
S 4 90  250 -11  10  88  96   0   -17  -5  63  83   0     3  15  26  14   0
S 4 90  280 -11 -14 -23  43   0   -17 -13  -6  46   0     3  -1 -13  -2   0
S 4 90  310 -42 -44 -34  12   0   -29 -34  -6  23   0   -12 -12 -30 -13   0
S 4 90  340  30 -34 -52 -36   0    23 -13 -15 -19   0     8 -22 -36 -13   0
S 5 30   10  -2  -7  -3   1   0    -1  -8   0   9   0     0   3   1  -9   0
S 5 30   40  -2   1  -3  -7   0    -1  -8  -6  -1   0     0   3   1  -9   0
S 5 30   70   6   1  -3  -7   0    -1  -3  -6  -7   0     0   3   1   0   0
S 5 30  100  -2   1 -11  -7   0    -1  -3  -6  -7   0     4   3  -3   0   0
S 5 30  130  -2   1 -11  -7   0    -1  -3 -11  -7   0     0   3   1   0   0
S 5 30  160  -2  -7 -11  -7   0    -1  -8 -16  -7   0     4   3   6   0   0
S 5 30  190   6   1  -3   1   0     4  -3   0  -1   0     0   3   1   4   0
S 5 30  220  -2   1  13   9   0    -1   3  16   4   0     0  -2  -7   4   0
S 5 30  250  -2   9  13   9   0    -7   8   5  -1   0     4  -2   6   8   0
S 5 30  280   6   9  13   9   0    10  19  10   4   0    -4  -6  -3   4   0
S 5 30  310  -2   1   5   9   0    -1   8  10   4   0    -4  -6  -3   4   0
S 5 30  340  -2  -7   5   1   0     4  -3   5   9   0    -4  -2  -3  -5   0
S 5 40   10  12   1  -9  -5   0     8  -4 -13  -5   0     2   6   5   1   0
S 5 40   40  -1   4 -12 -12   0    -6   1 -16 -12   0     5   2   5   1   0
S 5 40   70 -24  -9  -9 -15   0   -26 -16 -16 -14   0     5   6   9   1   0
S 5 40  100  -4 -12  -6 -18   0    -6 -14 -13 -17   0     2   2   5   1   0
S 5 40  130 -11  -2 -12 -18   0   -14  -2 -13 -17   0     2  -2   2  -3   0
S 5 40  160 -11  -6 -15 -21   0   -14  -4 -11 -17   0     2  -2  -2  -7   0
S 5 40  190 -11  -2 -15 -12   0    -9   3 -11  -9   0    -2  -6  -6  -3   0
S 5 40  220  19   1   1   4   0    23   3   4   5   0    -2  -2  -6  -3   0
S 5 40  250  -1   7  30  20   0     1  10  33  19   0    -2  -2  -2   1   0
S 5 40  280   9  14  33  39   0    11  15  35  36   0    -2  -2  -2   5   0
S 5 40  310  16   7  14  27   0    23  13  21  22   0    -6  -6  -6   5   0
S 5 40  340   6  -2   1  11   0     8  -4   1   7   0    -2   2  -2   1   0
```

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 5 | 52 | 10 | 1 | -7 | 1 | 9 | 0 | -3 | -6 | -4 | 4 | 0 | 3 | -1 | 5 | 6 | 0 |
| S | 5 | 52 | 40 | 11 | -1 | 4 | 2 | 0 | 11 | -1 | 0 | -2 | 0 | -1 | -1 | 5 | 3 | 0 |
| S | 5 | 52 | 70 | 8 | 7 | 10 | -4 | 0 | 13 | 5 | 4 | -8 | 0 | -4 | 3 | 5 | 3 | 0 |
| S | 5 | 52 | 100 | 1 | 5 | 11 | -4 | 0 | 5 | 4 | 7 | -8 | 0 | -4 | 3 | 5 | 3 | 0 |
| S | 5 | 52 | 130 | -2 | -1 | 4 | -3 | 0 | -1 | 0 | -1 | -2 | 0 | -1 | -1 | 5 | -1 | 0 |
| S | 5 | 52 | 160 | -2 | -2 | -12 | -13 | 0 | -2 | -3 | -13 | -9 | 0 | -1 | -1 | 1 | -4 | 0 |
| S | 5 | 52 | 190 | -5 | -8 | -18 | -13 | 0 | -9 | -8 | -14 | -8 | 0 | 3 | -1 | -6 | -4 | 0 |
| S | 5 | 52 | 220 | -4 | -7 | -12 | -6 | 0 | -6 | -7 | -8 | -1 | 0 | 3 | -1 | -3 | -4 | 0 |
| S | 5 | 52 | 250 | 1 | -1 | -4 | 2 | 0 | 2 | 3 | 3 | 5 | 0 | -1 | -4 | -6 | -4 | 0 |
| S | 5 | 52 | 280 | -1 | -1 | 1 | 5 | 0 | 0 | 3 | 8 | 9 | 0 | -1 | -4 | -6 | -4 | 0 |
| S | 5 | 52 | 310 | -4 | -2 | 8 | 9 | 0 | -3 | -3 | 10 | 7 | 0 | -1 | -1 | -3 | 3 | 0 |
| S | 5 | 52 | 340 | -4 | 17 | 10 | 16 | 0 | -7 | 12 | 8 | 11 | 0 | 3 | 7 | 1 | 6 | 0 |
| S | 5 | 60 | 10 | 2 | -10 | 4 | 12 | 0 | 2 | -6 | 2 | 11 | 0 | 3 | -4 | 3 | 1 | 0 |
| S | 5 | 60 | 40 | 15 | -1 | 8 | 0 | 0 | 8 | 0 | 5 | 6 | 0 | 3 | 0 | 3 | -3 | 0 |
| S | 5 | 60 | 70 | 6 | 7 | 8 | 0 | 0 | 5 | 9 | 14 | -3 | 0 | 3 | 0 | -9 | 1 | 0 |
| S | 5 | 60 | 100 | -2 | 7 | 8 | 0 | 0 | -1 | 3 | 17 | -3 | 0 | -1 | 4 | -9 | 1 | 0 |
| S | 5 | 60 | 130 | -2 | -1 | 8 | -4 | 0 | -4 | -3 | 2 | -3 | 0 | -1 | 4 | 7 | 1 | 0 |
| S | 5 | 60 | 160 | -2 | -1 | -8 | -16 | 0 | -4 | -3 | -15 | -15 | 0 | -1 | 4 | 7 | 1 | 0 |
| S | 5 | 60 | 190 | -2 | -6 | -20 | -16 | 0 | -4 | -12 | -21 | -15 | 0 | -1 | 4 | -1 | 1 | 0 |
| S | 5 | 60 | 220 | -2 | -6 | -16 | -8 | 0 | -1 | -6 | -12 | -9 | 0 | -1 | 0 | -1 | 1 | 0 |
| S | 5 | 60 | 250 | -2 | -6 | -8 | 0 | 0 | 2 | 0 | -6 | 0 | 0 | -1 | -4 | -1 | 1 | 0 |
| S | 5 | 60 | 280 | -2 | -6 | -4 | 0 | 0 | -1 | 0 | 0 | 6 | 0 | -1 | -8 | -5 | -7 | 0 |
| S | 5 | 60 | 310 | -6 | -1 | 8 | 12 | 0 | -1 | -3 | 5 | 9 | 0 | -5 | 0 | 3 | 1 | 0 |
| S | 5 | 60 | 340 | -2 | 23 | 12 | 20 | 0 | -1 | 18 | 8 | 17 | 0 | -1 | 4 | 3 | 5 | 0 |
| S | 5 | 68 | 10 | 5 | -11 | 8 | 9 | 0 | 6 | -9 | 3 | 12 | 0 | 0 | -1 | 2 | -6 | 0 |
| S | 5 | 68 | 40 | 14 | -1 | 10 | -5 | 0 | 14 | -1 | 11 | 4 | 0 | 0 | 3 | 2 | -6 | 0 |
| S | 5 | 68 | 70 | 6 | 9 | 4 | 0 | 0 | 14 | 8 | 3 | -4 | 0 | -4 | 3 | 2 | 2 | 0 |
| S | 5 | 68 | 100 | -1 | 12 | 2 | 0 | 0 | -3 | 8 | 3 | -4 | 0 | 0 | 3 | -2 | 2 | 0 |
| S | 5 | 68 | 130 | -2 | 3 | 14 | -2 | 0 | -3 | -1 | 11 | -4 | 0 | 0 | 3 | 2 | -2 | 0 |
| S | 5 | 68 | 160 | 1 | 2 | 0 | -15 | 0 | -3 | -1 | -5 | -12 | 0 | 5 | 3 | 7 | -2 | 0 |
| S | 5 | 68 | 190 | -3 | -1 | -21 | -14 | 0 | -3 | -1 | -21 | -12 | 0 | 0 | 3 | -2 | 2 | 0 |
| S | 5 | 68 | 220 | -2 | -8 | -19 | -7 | 0 | -3 | -9 | -13 | -4 | 0 | 0 | -1 | -7 | 2 | 0 |
| S | 5 | 68 | 250 | 1 | -10 | -5 | 2 | 0 | -3 | -9 | -5 | -4 | 0 | 5 | -1 | 2 | 6 | 0 |
| S | 5 | 68 | 280 | -5 | -15 | -11 | -4 | 0 | -3 | -9 | -5 | -4 | 0 | -4 | -6 | -2 | 2 | 0 |
| S | 5 | 68 | 310 | -11 | -6 | 6 | 14 | 0 | -11 | -1 | 11 | 12 | 0 | -4 | -6 | -2 | 2 | 0 |
| S | 5 | 68 | 340 | -3 | 25 | 11 | 21 | 0 | -3 | 24 | 11 | 20 | 0 | 0 | -1 | -2 | -2 | 0 |
| S | 5 | 76 | 10 | 7 | -7 | 13 | 7 | 0 | 6 | -13 | 6 | 4 | 0 | 1 | 7 | 7 | 3 | 0 |
| S | 5 | 76 | 40 | 17 | 2 | 17 | -8 | 0 | 12 | 0 | 8 | -10 | 0 | 6 | 2 | 7 | 3 | 0 |
| S | 5 | 76 | 70 | 7 | 15 | 13 | 3 | 0 | 3 | 7 | 3 | 0 | 0 | 1 | 7 | 12 | 3 | 0 |
| S | 5 | 76 | 100 | 2 | 15 | 4 | 3 | 0 | 1 | 13 | -2 | 0 | 0 | 1 | 2 | 7 | 3 | 0 |
| S | 5 | 76 | 130 | -3 | 2 | 17 | -5 | 0 | -2 | 5 | 16 | 0 | 0 | 1 | -3 | 2 | -2 | 0 |
| S | 5 | 76 | 160 | 2 | 2 | 4 | -20 | 0 | 1 | 2 | 3 | -12 | 0 | 1 | -3 | -3 | -6 | 0 |
| S | 5 | 76 | 190 | -3 | -3 | -26 | -16 | 0 | -2 | 2 | -19 | -10 | 0 | 1 | -3 | -8 | -6 | 0 |
| S | 5 | 76 | 220 | 2 | -12 | -26 | -6 | 0 | 1 | -8 | -19 | -3 | 0 | 1 | -3 | -8 | -6 | 0 |
| S | 5 | 76 | 250 | 2 | -12 | -5 | 3 | 0 | 3 | -10 | -2 | 4 | 0 | -4 | -3 | -3 | -2 | 0 |
| S | 5 | 76 | 280 | -8 | -20 | -18 | -1 | 0 | -8 | -18 | -12 | -5 | 0 | -4 | -3 | -3 | 3 | 0 |
| S | 5 | 76 | 310 | -18 | -12 | 0 | 19 | 0 | -10 | -5 | 8 | 14 | 0 | -4 | -3 | -8 | 3 | 0 |
| S | 5 | 76 | 340 | -3 | 29 | 8 | 23 | 0 | -5 | 25 | 11 | 18 | 0 | 1 | 7 | -3 | 3 | 0 |
| S | 5 | 84 | 10 | 13 | -4 | 22 | 18 | 0 | 7 | -4 | 17 | 10 | 0 | 4 | -1 | 7 | 10 | 0 |
| S | 5 | 84 | 40 | 18 | 1 | 26 | -2 | 0 | 18 | 6 | 17 | -6 | 0 | -1 | -1 | 7 | 4 | 0 |
| S | 5 | 84 | 70 | 5 | 24 | 24 | 5 | 0 | 7 | 15 | 17 | 2 | 0 | -6 | 4 | 7 | 4 | 0 |
| S | 5 | 84 | 100 | -5 | 22 | 15 | 5 | 0 | 7 | 15 | 8 | 2 | 0 | -6 | 4 | 7 | 4 | 0 |
| S | 5 | 84 | 130 | -1 | 1 | 26 | -7 | 0 | -4 | 6 | 17 | -6 | 0 | -1 | -1 | 7 | -1 | 0 |
| S | 5 | 84 | 160 | 3 | -1 | 2 | -31 | 0 | 7 | -4 | -1 | -22 | 0 | -1 | -1 | 1 | -7 | 0 |
| S | 5 | 84 | 190 | 1 | -6 | -39 | -23 | 0 | -4 | -4 | -28 | -14 | 0 | 4 | -1 | -10 | -7 | 0 |
| S | 5 | 84 | 220 | 3 | -13 | -34 | -16 | 0 | -4 | -13 | -28 | -6 | 0 | 4 | -1 | -4 | -7 | 0 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 5 | 84 | 250 | -1 | -20 | -18 | -1 | 0 | -4 | -13 | -10 | 2 | 0 | -1 | -6 | -10 | -7 | 0 |
| S | 5 | 84 | 280 | -11 | -27 | -27 | -6 | 0 | -14 | -23 | -19 | 2 | 0 | -1 | -6 | -10 | -7 | 0 |
| S | 5 | 84 | 310 | -21 | -16 | -7 | 26 | 0 | -14 | -13 | -1 | 19 | 0 | -1 | -1 | -4 | 4 | 0 |
| S | 5 | 84 | 340 | -3 | 33 | 10 | 32 | 0 | -4 | 34 | 8 | 16 | 0 | 4 | 10 | 1 | 10 | 0 |
| S | 5 | 90 | 10 | 15 | -5 | 29 | 26 | 0 | 14 | -4 | 24 | 23 | 0 | 2 | -5 | 4 | 4 | 0 |
| S | 5 | 90 | 40 | 21 | 0 | 34 | -4 | 0 | 17 | 1 | 27 | 2 | 0 | 2 | 0 | 4 | -3 | 0 |
| S | 5 | 90 | 70 | -1 | 25 | 23 | 11 | 0 | 2 | 26 | 32 | 7 | 0 | 2 | 0 | -8 | 4 | 0 |
| S | 5 | 90 | 100 | -7 | 25 | 11 | 11 | 0 | -8 | 20 | 24 | 7 | 0 | -4 | 6 | -8 | 4 | 0 |
| S | 5 | 90 | 130 | -1 | 0 | 34 | -9 | 0 | -2 | -1 | 27 | -8 | 0 | 2 | 0 | 10 | 4 | 0 |
| S | 5 | 90 | 160 | 4 | 0 | 11 | -35 | 0 | 2 | -1 | -1 | -34 | 0 | 2 | 0 | 10 | -3 | 0 |
| S | 5 | 90 | 190 | 4 | -5 | -48 | -30 | 0 | 2 | -9 | -45 | -27 | 0 | 2 | 6 | -2 | -3 | 0 |
| S | 5 | 90 | 220 | 4 | -15 | -36 | -19 | 0 | 5 | -12 | -37 | -20 | 0 | 2 | 0 | -2 | -3 | 0 |
| S | 5 | 90 | 250 | -1 | -25 | -25 | -9 | 0 | 2 | -20 | -23 | -5 | 0 | -4 | -5 | -2 | -3 | 0 |
| S | 5 | 90 | 280 | -13 | -36 | -36 | -14 | 0 | -11 | -26 | -29 | -5 | 0 | -4 | -10 | -8 | -9 | 0 |
| S | 5 | 90 | 310 | -24 | -15 | -7 | 31 | 0 | -20 | -15 | -9 | 26 | 0 | -4 | 0 | -2 | 4 | 0 |
| S | 5 | 90 | 340 | -1 | 51 | 11 | 41 | 0 | -2 | 42 | 10 | 35 | 0 | 2 | 6 | 4 | 4 | 0 |
| S | 6 | 30 | 10 | -5 | -3 | -5 | 3 | 0 | 0 | -13 | 1 | 8 | 0 | -4 | 6 | -3 | -5 | 0 |
| S | 6 | 30 | 40 | -5 | -3 | -5 | -4 | 0 | -5 | -8 | -4 | 3 | 0 | 0 | 1 | 2 | -5 | 0 |
| S | 6 | 30 | 70 | 3 | -3 | -5 | -4 | 0 | -5 | -2 | -9 | -12 | 0 | 5 | 1 | 6 | 3 | 0 |
| S | 6 | 30 | 100 | 3 | -3 | -5 | -4 | 0 | 6 | -2 | -9 | -12 | 0 | 0 | 1 | 2 | 3 | 0 |
| S | 6 | 30 | 130 | -5 | -3 | -13 | -4 | 0 | -10 | -2 | -14 | -7 | 0 | 5 | 1 | 6 | 3 | 0 |
| S | 6 | 30 | 160 | 3 | -3 | -5 | -4 | 0 | 0 | -2 | -14 | -7 | 0 | 5 | 1 | 6 | 3 | 0 |
| S | 6 | 30 | 190 | 3 | -3 | -5 | 3 | 0 | 0 | -2 | -4 | -2 | 0 | 5 | 1 | 2 | 3 | 0 |
| S | 6 | 30 | 220 | 3 | 5 | 10 | 11 | 0 | 0 | 3 | 6 | 8 | 0 | 0 | -3 | -3 | 3 | 0 |
| S | 6 | 30 | 250 | -5 | 5 | 10 | 11 | 0 | 0 | 8 | 12 | 8 | 0 | -4 | -3 | -3 | 3 | 0 |
| S | 6 | 30 | 280 | 12 | 13 | 10 | -19 | 0 | 11 | 14 | 17 | -17 | 0 | 0 | 1 | -7 | -1 | 0 |
| S | 6 | 30 | 310 | -5 | 5 | 10 | 11 | 0 | 6 | 8 | 17 | 13 | 0 | -8 | -7 | -7 | -1 | 0 |
| S | 6 | 30 | 340 | -5 | -3 | 3 | 3 | 0 | -5 | -2 | 1 | 18 | 0 | -4 | -3 | -3 | -10 | 0 |
| S | 6 | 40 | 10 | -2 | -2 | 2 | 13 | 0 | -7 | -3 | 2 | 18 | 0 | 4 | 0 | -2 | -3 | 0 |
| S | 6 | 40 | 40 | 2 | -2 | 2 | 13 | 0 | 0 | -3 | 2 | 18 | 0 | 0 | 0 | -2 | -3 | 0 |
| S | 6 | 40 | 70 | -5 | -2 | -2 | 13 | 0 | -5 | -1 | -3 | 15 | 0 | 0 | 0 | 2 | -3 | 0 |
| S | 6 | 40 | 100 | -2 | 1 | -2 | 10 | 0 | -2 | 6 | 2 | 15 | 0 | 0 | -4 | -2 | -3 | 0 |
| S | 6 | 40 | 130 | -2 | -2 | -2 | 10 | 0 | 3 | -1 | -5 | 8 | 0 | -4 | 0 | 2 | 1 | 0 |
| S | 6 | 40 | 160 | -2 | -2 | -5 | 7 | 0 | 3 | 1 | -5 | 2 | 0 | -4 | -4 | 2 | 4 | 0 |
| S | 6 | 40 | 190 | -5 | -5 | -5 | -79 | 0 | -2 | -1 | -8 | -86 | 0 | -4 | -4 | 2 | 8 | 0 |
| S | 6 | 40 | 220 | -5 | -5 | -2 | -58 | 0 | -5 | -6 | -3 | -64 | 0 | 0 | 0 | 2 | 8 | 0 |
| S | 6 | 40 | 250 | 2 | 1 | 2 | 16 | 0 | 3 | -1 | -1 | 15 | 0 | 0 | 4 | 2 | 1 | 0 |
| S | 6 | 40 | 280 | 12 | 3 | 5 | 19 | 0 | 7 | 4 | 6 | 22 | 0 | 4 | 4 | -2 | -3 | 0 |
| S | 6 | 40 | 310 | 8 | 3 | 5 | 16 | 0 | 5 | 4 | 9 | 20 | 0 | 4 | 4 | -2 | -3 | 0 |
| S | 6 | 40 | 340 | -2 | 1 | 2 | 16 | 0 | 0 | 1 | 4 | 18 | 0 | 0 | 0 | -2 | -3 | 0 |
| S | 6 | 52 | 10 | 2 | 6 | 4 | 1 | 0 | 2 | 8 | 5 | -2 | 0 | -1 | -2 | -2 | 3 | 0 |
| S | 6 | 52 | 40 | 1 | 3 | 4 | 0 | 0 | 5 | 3 | 5 | 1 | 0 | -4 | -2 | -2 | -1 | 0 |
| S | 6 | 52 | 70 | 1 | -1 | 0 | -2 | 0 | 4 | 0 | 2 | -2 | 0 | -4 | -2 | -2 | -1 | 0 |
| S | 6 | 52 | 100 | -8 | -9 | -2 | -6 | 0 | -7 | -6 | 4 | -6 | 0 | -1 | -2 | -5 | -1 | 0 |
| S | 6 | 52 | 130 | -10 | -10 | -4 | -8 | 0 | -8 | -7 | 1 | -7 | 0 | -1 | -2 | -5 | -1 | 0 |
| S | 6 | 52 | 160 | -10 | -9 | -10 | -9 | 0 | -8 | -6 | -7 | -8 | 0 | -1 | -2 | -2 | -1 | 0 |
| S | 6 | 52 | 190 | -10 | -10 | -8 | -9 | 0 | -8 | -11 | -7 | -8 | 0 | -1 | 1 | -2 | -1 | 0 |
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| S | 6 | 52 | 250 | -5 | 0 | -2 | 4 | 0 | -8 | -1 | -4 | 1 | 0 | 3 | 1 | 2 | 3 | 0 |
| S | 6 | 52 | 280 | 5 | 7 | 5 | 13 | 0 | 2 | 2 | -1 | 12 | 0 | 3 | 5 | 6 | -1 | 0 |
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| S | 6 | 52 | 340 | 26 | 14 | 11 | 8 | 0 | 22 | 13 | 8 | 8 | 0 | 3 | 1 | 2 | -1 | 0 |
| S | 6 | 60 | 10 | -3 | 4 | 0 | 4 | 0 | 7 | 2 | 6 | 2 | 0 | -11 | 1 | -5 | 2 | 0 |
| S | 6 | 60 | 40 | 1 | -4 | 3 | -3 | 0 | -5 | -1 | 3 | 0 | 0 | 5 | -3 | -1 | -2 | 0 |
| S | 6 | 60 | 70 | 1 | -4 | 0 | 1 | 0 | -5 | -1 | -2 | -5 | 0 | 5 | -3 | 3 | 2 | 0 |
| S | 6 | 60 | 100 | -8 | -8 | -4 | -6 | 0 | -11 | -10 | -5 | -8 | 0 | 5 | 1 | -1 | 2 | 0 |

```
S 6 60 130  -8 -12  -8  -6   0   -11 -10  -8  -8   0     5  -3   3   2   0
S 6 60 160  -8  -9  -8 -10   0   -11 -10 -13  -9   0     5   1   3  -2   0
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S 6 60 220  -3  -4  -8  -6   0   -11  -4  -5   0   0     5   1  -1  -5   0
S 6 60 250  -8   0   0   8   0    -2   2   1   2   0    -3  -3  -1   6   0
S 6 60 280   5  13  11  15   0     7   6   6  13   0    -3   5   3   2   0
S 6 60 310  10  17  15  11   0    23  22  12  10   0   -11  -3   3   2   0
S 6 60 340  27  13  11   4   0    29  16  12  10   0    -3   1  -1  -5   0
S 6 68  10 -14   3  -7   0   0    -8   7  -1   3   0    -6   2  -3  -4   0
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S 6 68 130   0 -10  -7   0   0    -8 -17  -9 -10   0     4   2   1   4   0
S 6 68 160   0 -10  -7 -10   0    -8  -9  -9 -10   0     4   2   6   0   0
S 6 68 190   0   3  -7 -10   0    -8  -1 -16 -17   0     4   2   1   0   0
S 6 68 220   0 -10  -7 -10   0     1  -9  -9 -10   0    -1  -3  -3   0   0
S 6 68 250 -14 -10  -7  10   0    -8  -1  -1  10   0    -1  -3  -3   4   0
S 6 68 280   0  16   5  10   0     1  16  14  17   0     4   2  -3   0   0
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S 6 76 130  -5 -13  -1  -3   0     0 -13  -1  -4   0    -4   0   1  -3   0
S 6 76 160  -5 -13  -1  -7   0     0  -5  -4 -10   0    -4  -6   1   3   0
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S 6 76 340  21  11  12  -7   0    20  11  11  -6   0     1   0   1  -3   0
S 6 84  10 -12   7 -10   3   0    -6   6 -10  -4   0    -1  -4  -3   5   0
S 6 84  40  -5  -7   0 -13   0     6  -4  -1 -11   0    -6  -4  -3  -1   0
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S 6 84 280  14  31  16   8   0     6  27   8  11   0     5   7  10  -1   0
S 6 84 310  10  23  22   5   0     6  16  18   4   0     5   7  10  -1   0
S 6 84 340  27  13  12 -13   0    17  16   8 -11   0     5   2   4  -1   0
S 6 90  10 -16   7 -16  11   0    -6   4 -10   7   0   -14   0  -8   6   0
S 6 90  40 -10 -11  -1 -16   0    -9  -9  -3 -12   0     3   0  -1  -1   0
S 6 90  70  -4 -11   7   4   0    -6  -9   3  -4   0     3   0   6   6   0
S 6 90 100  -4 -17 -24  -3   0    -6 -18 -23  -6   0     8   0  -1   6   0
S 6 90 130  -4 -23 -16  -3   0    -9 -18 -16  -6   0     3   0  -1  -1   0
S 6 90 160  -4 -17  -1 -10   0    -9 -18  -7  -4   0     3   0   6  -1   0
S 6 90 190  -4   1 -16 -10   0    -9  -6 -13  -4   0     3   5  -8  -8   0
S 6 90 220   3  -5  -8  -3   0    -6  -6  -3   5   0     8   0  -1  -8   0
S 6 90 250  -4   1  -1  31   0    -2   4   6  24   0    -3  -6  -1   6   0
S 6 90 280  15  37  30  11   0    17  31  22   7   0    -3   5   6  -1   0
S 6 90 310   3  25  30   4   0    14  28  28   5   0    -8   0   6  -1   0
S 6 90 340  28  13  15 -16   0    30  16  16 -12   0    -3   0  -1  -8   0
```

```
S 7 30  10    4   1   7  -1   0     5   0   3  10   0    -4   2   1  -6   0
S 7 30  40    4  -7  -8  -8   0     5 -10  -7  -5   0     0   6   1  -2   0
S 7 30  70    4  -7  -8 -15   0     0 -10 -12 -20   0     0   6   5   7   0
S 7 30 100    4  -7  -8  -8   0     5 -10 -12 -20   0     0   2   5   7   0
S 7 30 130   -4   1  -8  -8   0    -5  -5 -12 -20   0     5   2   5   7   0
S 7 30 160    4  -7  -8   7   0    11  -5 -12   5   0     0   2   5   2   0
S 7 30 190    4  -7  -8  -1   0     0 -10  -7  -5   0     5   2   1   7   0
S 7 30 220  -29   1   7   7   0   -33   5   9  10   0     0  -7   1  -2   0
S 7 30 250    4   9   7  14   0     5   5   9  10   0    -4  -3  -4  -2   0
S 7 30 280   12  16  15   7   0     5  21  19  15   0     5  -3  -8  -6   0
S 7 30 310   -4   1   7   7   0     0  10   9  10   0    -4  -7  -4  -2   0
S 7 30 340   -4   3   7  -1   0     0  10  14  15   0    -4  -3  -8 -10   0
S 7 40  10    0  -4  -4   1   0    -5  -9  -6   2   0     3   3   4   1   0
S 7 40  40    4  -4   2   4   0     0  -6  -4   2   0     3   3   4   1   0
S 7 40  70   -3  -4   2   1   0    -2  -6   1   0   0    -1  -1   0   1   0
S 7 40 100   -3  -3  -1  -1   0     2  -2   3   2   0    -5  -5  -3  -3   0
S 7 40 130   -3  -1   2   1   0     2   3   5   4   0    -5  -5  -3  -3   0
S 7 40 160    0   2   5   1   0     5   3   8   8   0    -5  -1  -3  -6   0
S 7 40 190    0  -1   2  -1   0     5   3   5   0   0    -5  -5  -3  -3   0
S 7 40 220    4   2  -4  -1   0     7   8  -4  -5   0    -5  -5   0   1   0
S 7 40 250  -10   2  -1   1   0   -10  -4  -2   4   0     3   7   0  -3   0
S 7 40 280    7   8  -1  -1   0     0   5   1  -7   0     7   3   0   5   0
S 7 40 310    4   8  -1  -4   0    -2   5  -6  -9   0     7   3   4   5   0
S 7 40 340    0   2  -1  -1   0    -2  -2  -2   0   0     3   3   0   1   0
S 7 52  10    1  -3  -4   6   0     0  -9  -3   4   0     0   3   3  -2   0
S 7 52  40   -5  -8   1  12   0     0  -9  -3  14   0     0   3  -1  -2   0
S 7 52  70  -11 -12   1  15   0   -12  -9   7  14   0    -4  -1  -5  -2   0
S 7 52 100  -14 -11  -1   6   0   -12   2   7   4   0    -4  -8  -8  -2   0
S 7 52 130   -8  -9  -8  -2   0     0   2  -3   4   0    -4  -8  -5  -2   0
S 7 52 160   -7  -5  -8  -8   0   -12   2  -3  -6   0     0  -5  -1  -2   0
S 7 52 190   -2  -5  -8  -8   0     0   2 -14  -6   0     0  -5   3  -2   0
S 7 52 220   -1   4   3  -4   0     0   2  -3   4   0     0  -1   3  -2   0
S 7 52 250    2  10   4  -2   0     0   2  -3  -6   0     0   3   3   2   0
S 7 52 280    5  17   7 -17   0     2  13   3 -21   0     4   7   3   5   0
S 7 52 310   15  14  16  -1   0    11   2  18  -6   0     4  10   3   5   0
S 7 52 340   25   7  -1   2   0    23   2  -3   4   0     0   3   3   2   0
S 7 60  10   -5  -1   0   1   0     6  -3  -5   8   0   -11   2   7  -9   0
S 7 60  40  -10  -5  -7   8   0    -3  -9   6  13   0    -7   2 -12  -5   0
S 7 60  70  -19  -9  -7  14   0    -9 -14   3  13   0    -7   6  -8   2   0
S 7 60 100  -10 -13 -11   8   0   -22 -14   0   3   0    13   2  -8   6   0
S 7 60 130   -5 -13 -11   1   0   -15 -14 -11  -5   0    13   2  -1   6   0
S 7 60 160   -1  -9  -7  -6   0   -12  -6  -8 -12   0    13  -6  -1   6   0
S 7 60 190    3  -5  -7  -6   0    -9  -9  -8 -12   0    13   2   3   6   0
S 7 60 220    8  -1   8  -6   0    -6   6   3  -2   0    13  -2   3  -5   0
S 7 60 250   -1   8   8   1   0     6  15   3  -2   0   -11  -6   3   2   0
S 7 60 280    8  20  11 -16   0    10  21   6 -12   0    -3   2   3  -2   0
S 7 60 310   12  20  22   1   0    22  18  14   3   0   -11   2   7  -2   0
S 7 60 340   21   8   0   1   0    31   9  -2   5   0   -11  -2   3  -5   0
S 7 68  10   -9   0  10  -1   0   -10   1   2   2   0    -3   3  -1  -4   0
S 7 68  40   -9   0 -13   9   0   -10  -7 -12   8   0     1   7  -1  -4   0
S 7 68  70  -23   0 -13  19   0   -19  -7 -12  15   0    -3   7   4   5   0
S 7 68 100   -9 -13 -13   9   0    -1 -15 -19   8   0     1  -2  -1   5   0
S 7 68 130    5 -13 -13   9   0    -1 -15 -12   2   0     1  -2   4   5   0
S 7 68 160    5 -13  -2  -1   0     7 -15 -12  -5   0     1  -2   4   1   0
S 7 68 190   19   0  -2  -1   0     7  -7  -5  -5   0     6   3   4   5   0
S 7 68 220   19   0  10 -11   0    16   1  10 -12   0     1  -7  -1  -4   0
```

```
S 7 68  250   -9    0   10   -1   0      -10    1   10    2   0      -3   -2   -1    1   0
S 7 68  280    5   26   10  -21   0       -1   26   17  -18   0       6   -2   -5   -4   0
S 7 68  310    5   13   21   -1   0        7   26   24    2   0      -3   -2   -1    1   0
S 7 68  340    5    0   -2  -11   0       16    9   10    2   0      -3   -2   -5   -8   0
S 7 76   10  -14    5   11   -9   0      -17   -1    5  -10   0       2    6    5   -2   0
S 7 76   40   -9    5  -11    6   0      -14    5  -14    4   0       2    6    5   -2   0
S 7 76   70  -25    0  -11   24   0      -23    2   -7   23   0      -3    0    0   -2   0
S 7 76  100   -9  -19  -19   13   0       -3  -12  -11   17   0      -3  -10   -5   -2   0
S 7 76  130    1  -19  -11    6   0        9  -12   -7   10   0      -3  -10   -5   -2   0
S 7 76  160    6  -14   -6   -6   0       11  -12   -2    2   0      -3   -5   -5   -7   0
S 7 76  190   17   -9   -2    2   0       20   -1   -2    4   0      -3   -5    0   -2   0
S 7 76  220   12   -9   11  -13   0       17   -6    9  -12   0      -3   -5    0   -2   0
S 7 76  250  -14    5    7    2   0      -14   -1    7    2   0       2    6    0   -2   0
S 7 76  280   17   25    7  -17   0        6   21    5  -24   0       7    6    0    9   0
S 7 76  310    6   25   24    6   0        0   15   19    0   0       7    5    5    9   0
S 7 76  340   12    5   -2  -13   0        9    2   -2  -14   0       2    6    0    4   0
S 7 84   10  -12   10   17  -13   0       -8    8   15  -10   0       0    4    5   -4   0
S 7 84   40  -10   14   -8    1   0       -8    8   -4    5   0       0    4   -2   -4   0
S 7 84   70  -29   -3  -18   20   0      -31   -3  -13   21   0      -5   -1   -8   -4   0
S 7 84  100  -16  -35  -37    8   0       -8  -24  -23   13   0      -5  -12  -14   -4   0
S 7 84  130   -5  -33  -22    1   0        3  -24  -13    5   0      -5  -12   -8   -4   0
S 7 84  160    3  -21  -10  -13   0        3  -13   -4  -10   0       0   -7   -2   -4   0
S 7 84  190   14  -19   -1   -5   0       14  -13   -4   -3   0       0   -7    5   -4   0
S 7 84  220    9  -15   17  -15   0        3  -13   15  -10   0       0   -1    5   -4   0
S 7 84  250  -10   14   13    3   0       -8    8    5   -3   0       0    4    5    4   0
S 7 84  280   24   36   11   -1   0       14   29    5  -10   0       6   10    5   11   0
S 7 84  310   18   40   34   22   0       14   29   24   13   0       6   15    5   11   0
S 7 84  340   14   12    3   -7   0       14    8   -4  -10   0       0    4    5    4   0
S 7 90   10  -19   10   27  -22   0       -6   11   17  -10   0      -9    2    8  -14   0
S 7 90   40  -13   16  -19   -6   0       -6   14   -3   -1   0      -9    2  -18   -7   0
S 7 90   70  -38    4  -34   19   0      -28   -4  -17   18   0      -9    8  -11    1   0
S 7 90  100  -13  -45  -57   11   0      -22  -42  -40    6   0       8   -3  -18    8   0
S 7 90  130    0  -39  -27    3   0      -12  -39  -27   -4   0       8   -3   -5    8   0
S 7 90  160   13  -27  -11  -14   0       -2  -23  -10  -17   0      14   -9    2    8   0
S 7 90  190   19  -21    4   -6   0        7  -23    0  -10   0      14    2    2    8   0
S 7 90  220   19  -21   27  -22   0        4  -14   17  -14   0      14   -3    8   -7   0
S 7 90  250  -13   16   19   11   0       -6   20   13    2   0      -9   -3    8    1   0
S 7 90  280   25   45   19    3   0       30   39   13    6   0      -3    2    8    1   0
S 7 90  310   13   53   42   36   0       23   45   33   28   0      -9    8    8    1   0
S 7 90  340    6   10   11  -14   0       17   14    3   -4   0      -9   -3    8   -7   0
S 8 30   10    4   -3    0    1   0        6   -3   -3    4   0      -3    3    1   -7   0
S 8 30   40    4   -3    0   -7   0        1   -3   -3   -6   0       1   -2    1    1   0
S 8 30   70    4   -3   -8   -7   0        0   -3   -8  -11   0      -3   -2    1    1   0
S 8 30  100    4   -3   -8   -7   0        1   -3   -3   -6   0       1   -2   -4   -3   0
S 8 30  130    4   -3   -8   -7   0        1   -3   -8  -11   0       1    3    1    1   0
S 8 30  160   -4   -3   -8   -7   0       -4   -9   -8   -1   0       1    3    1   -3   0
S 8 30  190    4   -3    0    1   0        1   -3   -3   -1   0       1   -2    1    1   0
S 8 30  220  -12   -3    8    8   0      -10    2    7    9   0      -3   -2    1    1   0
S 8 30  250   -4    5    8    8   0      -10    7    7    4   0       1   -2    1    6   0
S 8 30  280   12   13    8    8   0       17   17    7    9   0       1    3    1    1   0
S 8 30  310  -12    5    8    8   0       -4   12   12    9   0      -3   -2   -4   -3   0
S 8 30  340   -4   -3    0    1   0       -4   -9    2   -1   0       1    3    1    1   0
S 8 40   10    2   -2   -3   -8   0        4   -1   -3   -6   0      -2   -1    0   -1   0
S 8 40   40   -4   -5    3    1   0       -6  -13   -1   -2   0       2    7    4    3   0
S 8 40   70   -4   -2    3    1   0       -4   -1   -1   -2   0      -2   -1    4    3   0
S 8 40  100   -1   -5    3   -2   0       -1   -8    2    1   0      -2    3    0   -1   0
```

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 8 | 40 | 130 | -4 | -2 | 3 | -2 | 0 | -6 | -3 | 4 | 1 | 0 | 2 | -1 | 0 | -1 | 0 |
| S | 8 | 40 | 160 | -4 | -5 | 0 | -5 | 0 | -6 | -3 | 2 | -4 | 0 | 2 | -1 | 0 | -1 | 0 |
| S | 8 | 40 | 190 | -4 | -5 | -3 | -8 | 0 | -6 | -3 | -3 | -8 | 0 | 2 | -1 | 0 | -1 | 0 |
| S | 8 | 40 | 220 | 2 | -2 | 0 | -8 | 0 | -1 | 1 | -5 | -10 | 0 | 2 | -1 | 4 | 3 | 0 |
| S | 8 | 40 | 250 | 2 | 5 | 9 | 7 | 0 | 1 | 1 | 4 | 5 | 0 | 2 | 3 | 4 | 3 | 0 |
| S | 8 | 40 | 280 | 6 | 11 | -9 | 16 | 0 | 4 | 13 | -10 | 20 | 0 | 2 | -1 | 4 | -1 | 0 |
| S | 8 | 40 | 310 | 6 | 8 | -3 | 10 | 0 | 11 | 13 | 6 | 11 | 0 | -6 | -5 | -8 | -1 | 0 |
| S | 8 | 40 | 340 | 6 | 2 | 0 | -5 | 0 | 11 | 6 | 6 | -6 | 0 | -6 | -5 | -8 | -1 | 0 |
| S | 8 | 52 | 10 | 2 | 0 | 0 | 12 | 0 | 3 | 0 | -1 | 10 | 0 | -2 | 0 | 2 | 4 | 0 |
| S | 8 | 52 | 40 | 6 | 6 | 7 | 14 | 0 | 4 | 5 | 8 | 16 | 0 | 2 | 0 | -2 | 0 | 0 |
| S | 8 | 52 | 70 | 0 | 7 | 6 | 4 | 0 | -6 | 11 | 7 | 10 | 0 | 5 | -4 | -2 | -7 | 0 |
| S | 8 | 52 | 100 | 2 | 7 | 4 | 0 | 0 | 0 | 11 | 6 | 6 | 0 | 2 | -4 | -2 | -7 | 0 |
| S | 8 | 52 | 130 | 0 | 4 | 7 | 0 | 0 | 2 | 8 | 13 | 6 | 0 | -2 | -4 | -6 | -7 | 0 |
| S | 8 | 52 | 160 | -1 | -3 | 3 | -8 | 0 | 1 | -3 | 5 | -4 | 0 | -2 | 0 | -2 | -4 | 0 |
| S | 8 | 52 | 190 | 0 | -5 | -8 | -14 | 0 | 2 | -5 | -9 | -14 | 0 | -2 | 0 | 2 | 0 | 0 |
| S | 8 | 52 | 220 | 2 | -3 | -1 | -14 | 0 | 3 | -2 | -3 | -18 | 0 | -2 | 0 | 2 | 4 | 0 |
| S | 8 | 52 | 250 | 2 | 1 | 3 | -5 | 0 | 4 | -3 | -3 | -10 | 0 | -2 | 4 | 5 | 4 | 0 |
| S | 8 | 52 | 280 | -1 | 1 | 3 | 7 | 0 | -7 | -2 | -3 | 1 | 0 | 5 | 4 | 5 | 7 | 0 |
| S | 8 | 52 | 310 | -6 | -9 | -11 | 3 | 0 | -7 | -13 | -12 | -3 | 0 | 2 | 4 | 2 | 7 | 0 |
| S | 8 | 52 | 340 | -4 | -8 | -12 | 0 | 0 | -1 | -8 | -9 | -1 | 0 | -2 | 0 | -2 | 0 | 0 |
| S | 8 | 60 | 10 | 0 | 4 | 2 | 13 | 0 | 4 | -2 | 0 | 14 | 0 | -6 | 6 | 0 | -1 | 0 |
| S | 8 | 60 | 40 | 4 | 0 | 0 | 13 | 0 | 8 | 10 | 6 | 14 | 0 | -2 | -10 | 0 | -1 | 0 |
| S | 8 | 60 | 70 | 4 | 0 | 6 | -5 | 0 | 1 | 7 | 3 | 4 | 0 | 2 | -6 | 0 | -9 | 0 |
| S | 8 | 60 | 100 | 8 | 0 | 2 | -8 | 0 | -5 | 10 | 3 | 1 | 0 | 14 | -10 | 0 | -9 | 0 |
| S | 8 | 60 | 130 | -5 | 4 | 2 | -5 | 0 | 1 | 1 | 6 | -1 | 0 | -6 | 6 | -4 | -5 | 0 |
| S | 8 | 60 | 160 | -5 | 0 | 2 | -12 | 0 | 1 | -5 | 3 | -7 | 0 | -6 | 6 | 0 | -5 | 0 |
| S | 8 | 60 | 190 | -5 | -5 | -5 | -12 | 0 | 1 | -5 | -8 | -14 | 0 | -6 | -2 | 0 | 3 | 0 |
| S | 8 | 60 | 220 | -5 | -5 | 2 | -12 | 0 | 4 | -2 | -2 | -14 | 0 | -10 | -2 | 4 | 3 | 0 |
| S | 8 | 60 | 250 | 0 | 4 | 6 | -1 | 0 | 4 | 4 | 3 | -7 | 0 | -6 | -2 | 4 | 6 | 0 |
| S | 8 | 60 | 280 | 4 | 8 | 6 | 16 | 0 | 1 | 1 | 3 | 7 | 0 | 2 | 6 | 4 | 10 | 0 |
| S | 8 | 60 | 310 | 0 | -5 | -13 | 9 | 0 | -11 | -8 | -8 | 4 | 0 | 10 | 6 | -4 | 6 | 0 |
| S | 8 | 60 | 340 | 0 | -5 | -17 | 2 | 0 | -11 | -8 | -11 | -1 | 0 | 10 | 2 | -8 | 3 | 0 |
| S | 8 | 68 | 10 | -9 | 7 | 2 | 11 | 0 | -7 | 9 | 1 | 15 | 0 | -2 | 2 | 0 | -3 | 0 |
| S | 8 | 68 | 40 | 5 | -6 | 7 | 14 | 0 | 1 | 1 | 9 | 15 | 0 | 3 | -2 | 0 | 1 | 0 |
| S | 8 | 68 | 70 | 5 | -3 | 6 | -10 | 0 | 1 | 1 | 9 | -6 | 0 | -2 | -2 | 0 | -3 | 0 |
| S | 8 | 68 | 100 | 20 | -7 | 0 | -16 | 0 | 19 | -8 | 1 | -13 | 0 | 3 | -2 | -5 | -3 | 0 |
| S | 8 | 68 | 130 | -8 | 7 | 1 | -10 | 0 | -7 | 9 | 1 | -6 | 0 | -2 | 2 | 0 | -3 | 0 |
| S | 8 | 68 | 160 | -9 | 5 | 1 | -17 | 0 | -7 | 1 | 1 | -13 | 0 | -2 | 2 | 0 | -3 | 0 |
| S | 8 | 68 | 190 | -8 | -9 | -7 | -11 | 0 | -7 | -8 | -6 | -13 | 0 | -2 | -2 | 0 | 1 | 0 |
| S | 8 | 68 | 220 | -12 | -6 | 3 | -8 | 0 | -7 | -8 | 1 | -13 | 0 | -2 | -2 | 0 | 1 | 0 |
| S | 8 | 68 | 250 | -6 | 1 | 12 | 7 | 0 | -7 | 1 | 9 | 1 | 0 | -2 | -2 | 4 | 5 | 0 |
| S | 8 | 68 | 280 | 5 | 14 | 12 | 23 | 0 | 1 | 9 | 9 | 15 | 0 | 3 | 2 | 4 | 5 | 0 |
| S | 8 | 68 | 310 | 8 | -1 | -16 | 14 | 0 | 10 | 1 | -14 | 15 | 0 | -2 | 2 | 0 | 1 | 0 |
| S | 8 | 68 | 340 | 8 | -2 | -20 | 3 | 0 | 10 | -8 | -21 | 1 | 0 | 3 | 2 | 0 | 1 | 0 |
| S | 8 | 76 | 10 | -12 | 9 | 3 | 10 | 0 | -9 | 10 | 3 | 7 | 0 | -4 | 1 | -1 | 0 | 0 |
| S | 8 | 76 | 40 | 8 | -6 | 7 | 14 | 0 | 5 | -10 | 5 | 13 | 0 | 1 | 6 | 4 | 0 | 0 |
| S | 8 | 76 | 70 | 8 | -6 | 7 | -13 | 0 | 5 | -4 | 5 | -12 | 0 | 1 | -4 | 4 | 0 | 0 |
| S | 8 | 76 | 100 | 23 | -11 | -2 | -21 | 0 | 22 | -10 | -2 | -18 | 0 | 1 | 1 | -1 | -5 | 0 |
| S | 8 | 76 | 130 | -7 | 9 | -2 | -13 | 0 | -9 | 10 | 0 | -9 | 0 | 1 | -4 | -1 | -5 | 0 |
| S | 8 | 76 | 160 | -7 | 4 | -2 | -21 | 0 | -9 | 7 | 0 | -18 | 0 | 1 | 1 | -1 | -5 | 0 |
| S | 8 | 76 | 190 | -7 | -11 | -7 | -13 | 0 | -9 | -10 | -5 | -9 | 0 | 1 | 1 | -1 | 0 | 0 |
| S | 8 | 76 | 220 | -12 | -11 | 7 | -5 | 0 | -15 | -7 | 3 | -7 | 0 | 1 | 1 | 4 | 6 | 0 |
| S | 8 | 76 | 250 | -7 | 4 | 17 | 14 | 0 | -6 | -2 | 10 | 9 | 0 | 1 | 6 | 4 | 6 | 0 |
| S | 8 | 76 | 280 | 8 | 13 | 17 | 29 | 0 | 5 | 15 | 10 | 26 | 0 | 6 | 1 | 4 | 0 | 0 |
| S | 8 | 76 | 310 | 3 | -1 | -21 | 17 | 0 | 8 | 1 | -15 | 13 | 0 | -4 | -4 | -7 | 0 | 0 |
| S | 8 | 76 | 340 | 3 | -1 | -25 | 2 | 0 | 11 | 1 | -15 | 5 | 0 | -4 | -4 | -7 | 0 | 0 |

```
S 8 84  10 -15   5   5  15  0   -13  13   2   9  0   -3   0   3   7  0
S 8 84  40  11   0   7  17  0     8   3  12  17  0    2   0  -4   0  0
S 8 84  70  11 -12   5 -24  0     8  -8  12  -7  0    8  -5  -4 -13  0
S 8 84 100  23 -12  -3 -35  0    19  -8  -3 -23  0    2  -5  -4 -13  0
S 8 84 130  -9   2 -12 -28  0    -3  13  -8 -15  0   -3  -5 -10 -13  0
S 8 84 160 -11   5  -6 -28  0    -3   3   2 -23  0   -3   0  -4  -7  0
S 8 84 190  -9 -10  -3 -11  0    -3  -8  -8 -15  0   -3   0   3   0  0
S 8 84 220 -15  -8  12   4  0   -13  -8  12   1  0   -3   0   3   7  0
S 8 84 250  -7  10  29  21  0    -3   3  22  17  0   -3   5   9   7  0
S 8 84 280  19  21  29  39  0     8  13  22  25  0    8   5   9  13  0
S 8 84 310   3   0 -25  28  0    -3  -8 -29  17  0    2   5   3  13  0
S 8 84 340  -3  -6 -33   2  0    -3  -8 -29   1  0   -3   0  -4   0  0
S 8 90  10 -20  13   7  24  0   -15   5   5  18  0   -6   4   2   4  0
S 8 90  40   9  -4   7  17  0    13   5   5  18  0   -1  -7   2  -3  0
S 8 90  70  15 -21   7 -40  0    13 -10   2 -28  0    5  -7   2 -16  0
S 8 90 100  33 -21  -7 -55  0    16 -10  -8 -40  0   15 -12  -4 -16  0
S 8 90 130 -14   1 -21 -40  0    -5  -1 -15 -34  0   -6   4  -4 -10  0
S 8 90 160 -14   7  -7 -40  0    -9   2  -5 -31  0   -6   4  -4 -10  0
S 8 90 190 -14 -10   0 -12  0    -5  -7  -1 -13  0   -6  -1   2   4  0
S 8 90 220 -20 -10  14   9  0   -12  -7  12   6  0  -12  -1   2   4  0
S 8 90 250 -14  13  35  31  0    -5  14  30  24  0   -6  -1   8  11  0
S 8 90 280  27  30  35  59  0    19  20  30  45  0    5  10   8  18  0
S 8 90 310   9   7 -28  45  0    -2  -1 -22  33  0   10   4  -4  11  0
S 8 90 340   3  -4 -42   2  0    -9  -7 -32   3  0   10   4 -10   4  0
S 9 30  10   8  -3  -4   6  0     7  -6   0   6  0   -1   1  -3  -3  0
S 9 30  40   0  -3  -4  -3  0     1  -6  -5   0  0   -1   1   1  -3  0
S 9 30  70  -8  -3  -4 -11  0    -9  -6  -5 -10  0    3   1   1  -3  0
S 9 30 100   0 -11 -12 -11  0     1 -11 -11 -10  0   -1   1   1  -3  0
S 9 30 130   0  -3  -4 -11  0    -4  -1   0  -5  0    3   1  -7  -7  0
S 9 30 160   0  -3  -4 -11  0     1  -1   5   0  0   -1  -3 -12  -7  0
S 9 30 190   0  -3   4   6  0     1   4   5  -5  0   -1  -3  -3   6  0
S 9 30 220  -8   5  12  14  0    -9  -1  11   6  0   -1   1   1   6  0
S 9 30 250  -8   5  12  14  0    -9  10   0   6  0    3  -3  10   6  0
S 9 30 280  16  13   4   6  0    18  20   0   6  0   -1  -3   6  10  0
S 9 30 310   0   5   4   6  0    -4   4   0   6  0   -1   1   6   1  0
S 9 30 340   0  -3  -4  -3  0     7  -6   0   6  0   -1   1  -3  -3  0
S 9 40  10  -3   0   3   6  0    -1  -2  -1   2  0   -2   3   3   2  0
S 9 40  40  -3   3   6   3  0    -3   5   3   2  0   -2  -1   3   2  0
S 9 40  70   0   7   6   3  0     4  12  -1   4  0   -2  -5   3  -2  0
S 9 40 100   0   3  -4  -4  0    -1   9  -8  -8  0    2  -5   7   2  0
S 9 40 130 -10  -3 -10 -10  0   -13   0 -13 -13  0    2  -1   3   2  0
S 9 40 160  -7  -3  -7 -10  0    -8  -5  -4  -5  0    2   3  -1  -6  0
S 9 40 190  -3  -3  -4  -7  0    -6  -5   3  -5  0    2   3  -5  -2  0
S 9 40 220   0   0   6  -1  0    -3  -5   8   2  0    2   3  -1  -2  0
S 9 40 250  13  -3   3   3  0    11  -7   8   4  0    2   3  -5  -2  0
S 9 40 280  13  -3  -1   6  0    14  -2   6   9  0    2  -1  -5  -2  0
S 9 40 310  -3   0   3   6  0    -3   2   3   4  0    2  -1  -1   2  0
S 9 40 340   3   0  -1   6  0     9  -2  -4   4  0   -6   3   3   2  0
S 9 52  10   3   9   7   8  0     1   2   0   9  0    2   7   6  -1  0
S 9 52  40  11  13   8  15  0    13  10  17  16  0   -2   4  -1  -1  0
S 9 52  70   6   7  22  15  0    11  14  30  15  0   -6  -4  -9  -1  0
S 9 52 100  -1   0  12  12  0     1   6  21  13  0   -2  -7  -9  -1  0
S 9 52 130  -3  -3   4   2  0    -3   1   9  -3  0   -6 -11  -5   3  0
S 9 52 160  -3  -6   1  -5  0    -5   0   2  -8  0    2  -7  -1   3  0
S 9 52 190   3   3   1  -6  0     2  -4  -1  -9  0    2   7   2   3  0
S 9 52 220  -1   3  -8 -12  0    -6  -4 -12 -15  0    6   7   6   3  0
```

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 9 | 52 | 250 | -4 | -5 | -21 | -17 | 0 | -3 | -3 | -23 | -11 | 0 | -2 | -4 | 2 | -5 | 0 |
| S | 9 | 52 | 280 | -2 | -4 | -19 | -12 | 0 | -6 | -11 | -17 | -11 | 0 | -2 | 0 | -1 | -1 | 0 |
| S | 9 | 52 | 310 | -4 | -5 | -11 | -5 | 0 | -6 | -6 | -9 | -3 | 0 | 2 | 0 | -1 | -1 | 0 |
| S | 9 | 52 | 340 | 0 | 0 | -9 | 5 | 0 | -6 | -6 | -18 | 6 | 0 | 6 | 7 | 10 | -1 | 0 |
| S | 9 | 60 | 10 | 4 | 15 | 12 | 6 | 0 | 5 | 11 | 8 | 9 | 0 | -2 | 3 | 3 | -6 | 0 |
| S | 9 | 60 | 40 | 9 | 19 | 17 | 11 | 0 | 11 | 11 | 17 | 18 | 0 | -2 | 7 | -1 | -6 | 0 |
| S | 9 | 60 | 70 | 0 | 6 | 17 | 15 | 0 | 5 | 5 | 20 | 15 | 0 | -6 | 3 | -5 | -2 | 0 |
| S | 9 | 60 | 100 | -4 | -6 | 8 | 11 | 0 | -2 | -4 | 8 | 15 | 0 | -2 | -1 | -1 | -6 | 0 |
| S | 9 | 60 | 130 | -9 | -19 | 0 | 2 | 0 | -5 | -10 | 2 | 6 | 0 | -2 | -9 | -1 | -6 | 0 |
| S | 9 | 60 | 160 | 0 | -15 | 0 | -2 | 0 | -2 | -4 | 2 | -4 | 0 | 2 | -9 | -5 | 2 | 0 |
| S | 9 | 60 | 190 | 4 | 6 | 0 | -2 | 0 | 5 | 5 | 5 | -10 | 0 | 2 | 3 | -5 | 10 | 0 |
| S | 9 | 60 | 220 | 4 | 6 | -5 | -6 | 0 | 2 | 5 | -3 | -16 | 0 | 2 | 3 | -1 | 10 | 0 |
| S | 9 | 60 | 250 | -4 | -6 | -9 | -19 | 0 | -5 | -7 | -30 | -19 | 0 | -2 | -1 | 20 | 2 | 0 |
| S | 9 | 60 | 280 | -9 | -11 | -22 | -11 | 0 | -8 | -7 | -15 | -16 | 0 | -2 | -1 | -5 | 6 | 0 |
| S | 9 | 60 | 310 | -4 | -2 | -13 | -6 | 0 | -5 | -7 | -9 | -4 | 0 | 2 | 3 | -5 | -2 | 0 |
| S | 9 | 60 | 340 | 9 | 6 | -5 | 2 | 0 | -2 | 2 | -6 | 6 | 0 | 14 | 3 | 3 | -6 | 0 |
| S | 9 | 68 | 10 | 2 | 17 | 13 | 0 | 0 | 3 | 14 | 8 | 1 | 0 | 0 | 5 | -1 | -4 | 0 |
| S | 9 | 68 | 40 | 5 | 25 | 17 | 8 | 0 | 3 | 23 | 17 | 9 | 0 | 0 | 0 | -1 | -4 | 0 |
| S | 9 | 68 | 70 | -2 | 3 | 13 | 12 | 0 | -6 | 6 | 17 | 18 | 0 | 0 | 0 | -1 | -4 | 0 |
| S | 9 | 68 | 100 | -4 | -6 | 4 | 5 | 0 | -6 | -3 | 8 | 9 | 0 | 0 | 0 | -1 | -4 | 0 |
| S | 9 | 68 | 130 | -8 | -26 | -5 | -4 | 0 | -6 | -20 | 0 | 1 | 0 | 0 | -4 | -11 | -4 | 0 |
| S | 9 | 68 | 160 | -2 | -26 | -10 | -3 | 0 | 3 | -2 | 0 | 1 | 0 | 0 | -4 | -11 | -4 | 0 |
| S | 9 | 68 | 190 | 5 | 10 | -3 | 8 | 0 | 3 | 6 | 0 | 1 | 0 | 0 | 0 | -1 | 5 | 0 |
| S | 9 | 68 | 220 | 4 | 12 | -3 | 2 | 0 | 3 | 6 | -8 | -8 | 0 | 0 | 5 | 4 | 5 | 0 |
| S | 9 | 68 | 250 | -6 | -10 | 6 | -16 | 0 | -6 | -3 | 0 | -16 | 0 | 0 | -4 | 13 | 5 | 0 |
| S | 9 | 68 | 280 | -12 | -13 | -22 | 0 | 0 | -6 | -11 | -25 | -8 | 0 | 0 | -4 | 4 | 10 | 0 |
| S | 9 | 68 | 310 | -3 | -1 | -12 | -7 | 0 | -6 | -3 | -17 | -8 | 0 | 0 | 0 | 4 | 1 | 0 |
| S | 9 | 68 | 340 | 20 | 9 | 0 | -3 | 0 | 20 | 6 | 0 | 1 | 0 | 4 | 5 | 4 | -4 | 0 |
| S | 9 | 76 | 10 | 2 | 25 | 15 | -2 | 0 | 3 | 19 | 11 | -2 | 0 | -3 | 4 | 3 | -3 | 0 |
| S | 9 | 76 | 40 | 2 | 25 | 20 | 7 | 0 | 6 | 27 | 17 | 6 | 0 | -3 | 0 | 3 | 3 | 0 |
| S | 9 | 76 | 70 | -3 | 3 | 9 | 7 | 0 | 0 | 11 | 11 | 11 | 0 | -3 | -5 | -2 | -3 | 0 |
| S | 9 | 76 | 100 | -7 | -14 | 4 | 3 | 0 | -5 | -5 | 2 | 3 | 0 | 2 | -5 | 3 | 3 | 0 |
| S | 9 | 76 | 130 | -7 | -33 | -11 | -7 | 0 | -8 | -26 | -12 | -8 | 0 | -3 | -5 | -2 | 3 | 0 |
| S | 9 | 76 | 160 | -3 | -29 | -16 | -7 | 0 | -2 | -29 | -15 | -5 | 0 | 2 | 0 | -2 | -3 | 0 |
| S | 9 | 76 | 190 | 7 | 12 | -6 | 12 | 0 | 3 | 9 | -3 | 11 | 0 | 2 | 4 | -2 | -3 | 0 |
| S | 9 | 76 | 220 | 7 | 17 | -1 | 7 | 0 | 3 | 11 | 0 | 6 | 0 | 2 | 4 | 3 | -3 | 0 |
| S | 9 | 76 | 250 | -3 | -11 | 15 | -16 | 0 | -5 | -13 | 17 | -13 | 0 | 2 | 0 | -2 | -3 | 0 |
| S | 9 | 76 | 280 | -12 | -15 | -22 | 3 | 0 | -13 | -15 | -18 | 6 | 0 | 2 | 0 | -7 | -3 | 0 |
| S | 9 | 76 | 310 | -3 | -2 | -11 | -7 | 0 | -2 | 1 | -9 | -8 | 0 | 2 | 0 | -2 | 3 | 0 |
| S | 9 | 76 | 340 | 21 | 17 | 4 | -2 | 0 | 22 | 9 | 0 | -5 | 0 | -3 | 4 | 8 | 3 | 0 |
| S | 9 | 84 | 10 | 3 | 35 | 26 | -1 | 0 | 1 | 21 | 12 | -1 | 0 | 3 | 10 | 9 | -1 | 0 |
| S | 9 | 84 | 40 | -1 | 32 | 17 | 6 | 0 | 1 | 30 | 23 | 9 | 0 | -3 | 5 | -2 | -1 | 0 |
| S | 9 | 84 | 70 | -11 | -3 | -2 | 6 | 0 | -9 | 2 | 12 | 9 | 0 | -8 | -5 | -13 | -1 | 0 |
| S | 9 | 84 | 100 | -6 | -23 | -4 | 4 | 0 | -9 | -18 | 12 | 9 | 0 | -3 | -10 | -13 | -1 | 0 |
| S | 9 | 84 | 130 | -15 | -46 | -17 | 0 | 0 | -9 | -27 | -13 | -1 | 0 | -8 | -15 | -7 | 4 | 0 |
| S | 9 | 84 | 160 | 3 | -37 | -19 | -7 | 0 | 1 | -27 | -22 | -11 | 0 | 3 | -10 | -2 | 4 | 0 |
| S | 9 | 84 | 190 | 8 | 23 | -6 | 14 | 0 | 11 | 11 | -10 | 9 | 0 | 3 | 10 | 4 | 4 | 0 |
| S | 9 | 84 | 220 | 16 | 28 | 9 | 8 | 0 | 11 | 21 | 1 | -1 | 0 | 8 | 10 | 9 | 4 | 0 |
| S | 9 | 84 | 250 | -6 | -16 | 13 | -25 | 0 | 1 | -8 | 12 | -20 | 0 | -3 | -5 | 4 | -7 | 0 |
| S | 9 | 84 | 280 | -15 | -16 | -27 | 2 | 0 | -9 | -18 | -22 | -1 | 0 | -3 | 0 | -2 | -1 | 0 |
| S | 9 | 84 | 310 | 1 | -1 | -12 | -5 | 0 | 1 | 2 | -10 | -1 | 0 | 3 | 0 | -2 | -1 | 0 |
| S | 9 | 84 | 340 | 23 | 25 | 22 | -3 | 0 | 11 | 11 | 1 | -1 | 0 | 8 | 10 | 14 | -1 | 0 |
| S | 9 | 90 | 10 | 4 | 41 | 34 | -3 | 0 | 3 | 37 | 28 | 3 | 0 | 0 | 7 | 3 | -7 | 0 |
| S | 9 | 90 | 40 | -6 | 41 | 15 | 4 | 0 | 0 | 29 | 18 | 9 | 0 | -6 | 7 | -3 | -7 | 0 |
| S | 9 | 90 | 70 | -21 | -2 | -9 | 4 | 0 | -14 | -6 | -5 | 6 | 0 | -6 | 2 | -8 | -1 | 0 |
| S | 9 | 90 | 100 | -6 | -31 | -15 | -3 | 0 | -8 | -27 | -8 | 6 | 0 | 0 | -3 | -3 | -7 | 0 |

```
S 9  90  130  -21  -60  -22    4    0     -16  -49  -16    3    0     -6  -14   -3   -1    0
S 9  90  160    4  -50  -22   -3    0       3  -35  -18   -7    0      0  -14   -3    4    0
S 9  90  190    9   31   -9   22    0       9   26   -2   12    0      0    7   -3   10    0
S 9  90  220   19   30   15   16    0      17   31   12    6    0      5    7    3   10    0
S 9  90  250   -6  -21   28  -27    0      -5  -17    5  -28    0      0   -3   19   -1    0
S 9  90  280  -16  -17  -34    4    0     -14  -14  -25   -4    0      0   -3   -8   10    0
S 9  90  310    4    2  -15   -9    0       3   -3  -12   -4    0      0    2   -3   -1    0
S 9  90  340   34   31   34   -9    0      20   29   25   -1    0     15    7    8   -7    0
S10  30   10    2   -8  -12    5    0       3  -10   -6   12    0     -1    2   -5   -9    0
S10  30   40    2   -3   -4    5    0      -2   -4    0   12    0      3    2   -5   -9    0
S10  30   70    2    0   -4   -4    0       3    6   -6    0    0     -6   -7   -5   -4    0
S10  30  100    2   -8   -4    5    0       9    1    0    6    0     -6   -7   -5   -4    0
S10  30  130    2    0    5   43    0       9    1   11   35    0     -6   -2   -5    0    0
S10  30  160   -6    0   13   15    0      -8    1   16    6    0      3    2    4    5    0
S10  30  190    2    8   13    5    0      -2   -4   11  -12    0      3    7    9   14    0
S10  30  220   -6    0   22   -4    0     -13   -4   11  -12    0      7    7    9   14    0
S10  30  250   -6    3    5  -22    0      -8   12  -11  -23    0      3   -2   13    5    0
S10  30  280   10   16  -12  -22    0       9   12  -11  -23    0      3    2    0    0    0
S10  30  310   -6    0  -12  -22    0      -2    1  -11  -12    0     -1   -2    0   -4    0
S10  30  340    2   -8  -12   -4    0       3  -10    0   12    0     -1   -2   -9   -9    0
S10  40   10    5   12   14    0    0       5   11    8   -4    0      0   -1    5    4    0
S10  40   40   -1    8   22   12    0      -7    4   21    4    0      4    3    1    8    0
S10  40   70   -4   -2   18   12    0      -5   -6   16    9    0      0    3    1    4    0
S10  40  100   -8    5   11   12    0     -10    1   11   12    0      0    3    1    0    0
S10  40  130   -8   -2    4    8    0     -10   -1    3    9    0      0   -1   -3    0    0
S10  40  160    5    1    0    4    0      10   -1    3    1    0     -4    3   -3    4    0
S10  40  190   12    5    0    4    0      12    6   -2    9    0      0   -1    1   -5    0
S10  40  220   -1   -2   -7    0    0      -2   -1   -7    4    0      0   -1   -3   -5    0
S10  40  250   -1  -12  -18   -8    0      -2  -11  -14    1    0      0   -1   -3   -9    0
S10  40  280   -1  -12  -22  -16    0       5   -6  -17  -15    0     -4   -5   -3   -5    0
S10  40  310   -1   -5  -18  -16    0       0   -4  -17  -18    0      0   -1    1    0    0
S10  40  340    2    5   -4   -8    0       5    9   -7  -12    0      0   -5    1    4    0
S10  52   10    0    7   19    9    0       1    7   13   -1    0     -2    1    7   11    0
S10  52   40    6   15   31   17    0       7   20   27   11    0     -2   -2    3    7    0
S10  52   70    3   20   27   21    0       4   28   29   20    0     -2   -6   -1    3    0
S10  52  100   -3    7   22   29    0      -4    2   23   34    0      2    5   -1   -5    0
S10  52  130   -4    8   10   19    0     -10    4   17   25    0      6    5   -5   -5    0
S10  52  160  -10    4    3    7    0     -15    4   14   17    0      6    1   -8   -9    0
S10  52  190   -3    2   -6   -6    0      -1    2    0    5    0     -2    1   -8  -12    0
S10  52  220    2   -3  -24  -18    0       4   -8  -24  -10    0     -2   -2   -1   -9    0
S10  52  250    5  -16  -27  -16    0       6  -18  -30  -19    0     -2    1    3   -1    0
S10  52  280    3  -11  -26  -22    0       1  -14  -32  -25    0      2    1    7    3    0
S10  52  310    0   -6  -15  -20    0       3   -6  -20  -31    0     -2   -2    3   11    0
S10  52  340   -1  -22  -13  -18    0       4  -20  -17  -25    0     -5   -2    3    7    0
S10  60   10   -1    9   23   17    0       0    7   22   14    0     -2   -1    1    3    0
S10  60   40    3   14   33   23    0       6   14   32   18    0     -2   -1   -3    3    0
S10  60   70   -1    9   23   23    0       6   23   29   23    0     -6  -17   -7   -1    0
S10  60  100   -1    9   18   23    0       0    7   25   31    0     -2    3   -7   -5    0
S10  60  130   -1   14    3   11    0      -3   10   11   18    0      2   -1   -7   -5    0
S10  60  160   -1    5   -3   -6    0     -12    4    0    6    0     10    3   -3   -9    0
S10  60  190   -1    5  -13  -12    0      -3    1   -7  -14    0     -2    7   -3   -1    0
S10  60  220    3   -9  -23  -18    0       0  -12  -29  -23    0      2    3    9    3    0
S10  60  250    3  -13  -18  -12    0       3  -15  -32  -23    0     -2   -1   13    7    0
S10  60  280    7   -9  -18  -18    0       0  -12  -25  -23    0      6    7    9    7    0
S10  60  310   -1   -9  -13  -18    0       0   -6  -14  -14    0     -2   -1    1   -1    0
S10  60  340   -6  -27  -13  -12    0       0  -22  -11  -14    0     -6   -5   -3   -1    0
```

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S10 | 68 | 10 | -4 | 8 | 21 | 14 | 0 | 0 | 5 | 20 | 22 | 0 | 0 | 3 | -3 | -4 | 0 |
| S10 | 68 | 40 | 3 | 16 | 29 | 21 | 0 | 0 | 14 | 30 | 22 | 0 | 0 | -1 | -3 | -4 | 0 |
| S10 | 68 | 70 | -7 | -5 | 18 | 19 | 0 | 0 | 5 | 20 | 22 | 0 | -4 | -10 | -3 | -4 | 0 |
| S10 | 68 | 100 | -6 | 11 | 13 | 16 | 0 | 0 | 14 | 20 | 22 | 0 | -4 | -6 | -3 | -4 | 0 |
| S10 | 68 | 130 | -1 | 12 | -3 | 8 | 0 | 0 | 14 | 0 | 10 | 0 | -4 | -1 | -7 | -4 | 0 |
| S10 | 68 | 160 | 7 | 8 | -6 | -9 | 0 | 0 | 5 | -10 | -2 | 0 | 5 | 3 | 2 | 1 | 0 |
| S10 | 68 | 190 | -2 | 12 | -13 | -9 | 0 | 0 | 5 | -20 | -14 | 0 | 0 | 3 | 2 | 5 | 0 |
| S10 | 68 | 220 | 7 | -6 | -13 | -13 | 0 | 0 | -14 | -20 | -26 | 0 | 5 | 3 | 7 | 10 | 0 |
| S10 | 68 | 250 | 5 | -16 | -3 | -5 | 0 | 0 | -14 | -10 | -14 | 0 | 0 | -1 | 11 | 5 | 0 |
| S10 | 68 | 280 | 15 | -2 | -11 | -13 | 0 | 8 | -5 | -10 | -14 | 0 | 5 | 3 | 2 | 1 | 0 |
| S10 | 68 | 310 | -4 | -10 | -11 | -14 | 0 | 0 | -5 | -10 | -14 | 0 | 0 | -1 | 2 | 1 | 0 |
| S10 | 68 | 340 | -13 | -30 | -21 | -16 | 0 | -8 | -23 | -10 | -14 | 0 | -4 | -1 | -7 | -4 | 0 |
| S10 | 76 | 10 | -7 | 8 | 21 | 15 | 0 | -6 | 9 | 17 | 8 | 0 | -1 | -1 | 6 | 6 | 0 |
| S10 | 76 | 40 | 6 | 17 | 27 | 22 | 0 | 2 | 15 | 27 | 12 | 0 | 4 | 4 | 1 | 11 | 0 |
| S10 | 76 | 70 | -12 | -12 | 15 | 22 | 0 | -11 | -11 | 14 | 16 | 0 | -1 | -1 | 1 | 6 | 0 |
| S10 | 76 | 100 | -7 | 12 | 10 | 8 | 0 | -9 | 6 | 10 | 12 | 0 | -1 | 4 | 1 | -4 | 0 |
| S10 | 76 | 130 | 2 | 12 | -6 | 8 | 0 | -4 | 12 | -6 | 8 | 0 | 4 | 4 | -4 | -4 | 0 |
| S10 | 76 | 160 | 11 | 12 | -8 | -5 | 0 | 12 | 6 | -3 | -7 | 0 | -1 | 4 | -4 | 1 | 0 |
| S10 | 76 | 190 | -3 | 17 | -13 | -12 | 0 | -1 | 18 | -9 | 0 | 0 | -1 | -1 | -4 | -9 | 0 |
| S10 | 76 | 220 | 11 | -2 | -8 | -12 | 0 | 12 | -2 | -6 | -4 | 0 | -1 | -1 | -4 | -9 | 0 |
| S10 | 76 | 250 | 6 | -16 | 4 | -5 | 0 | 7 | -16 | 4 | 0 | 0 | -1 | -1 | 1 | -9 | 0 |
| S10 | 76 | 280 | 15 | -2 | -8 | -12 | 0 | 18 | 1 | -9 | -7 | 0 | -1 | -1 | 1 | -4 | 0 |
| S10 | 76 | 310 | -7 | -12 | -8 | -12 | 0 | -6 | -11 | -13 | -15 | 0 | -1 | -1 | 1 | 6 | 0 |
| S10 | 76 | 340 | -16 | -36 | -25 | -18 | 0 | -14 | -28 | -26 | -23 | 0 | -1 | -6 | 1 | 6 | 0 |
| S10 | 84 | 10 | -8 | 10 | 34 | 32 | 0 | -8 | 4 | 27 | 17 | 0 | -2 | 2 | 9 | 14 | 0 |
| S10 | 84 | 40 | 7 | 15 | 34 | 34 | 0 | 11 | 25 | 27 | 31 | 0 | -2 | -3 | 4 | 9 | 0 |
| S10 | 84 | 70 | -12 | -15 | 16 | 27 | 0 | -8 | -6 | 15 | 17 | 0 | -2 | -8 | -1 | 4 | 0 |
| S10 | 84 | 100 | -5 | 19 | 10 | 4 | 0 | -8 | 15 | 15 | 17 | 0 | 3 | 7 | -1 | -6 | 0 |
| S10 | 84 | 130 | 7 | 19 | -17 | -1 | 0 | 2 | 15 | -10 | 2 | 0 | 8 | 7 | -6 | -6 | 0 |
| S10 | 84 | 160 | 15 | 14 | -21 | -17 | 0 | 11 | 15 | -10 | -12 | 0 | 8 | 2 | -11 | -11 | 0 |
| S10 | 84 | 190 | -3 | 17 | -21 | -27 | 0 | 2 | 15 | -10 | -12 | 0 | -2 | 2 | -11 | -17 | 0 |
| S10 | 84 | 220 | 10 | -6 | -13 | -24 | 0 | 11 | -6 | -10 | -12 | 0 | -2 | -3 | -1 | -11 | 0 |
| S10 | 84 | 250 | 5 | -15 | 5 | -11 | 0 | 2 | -16 | 2 | -12 | 0 | -2 | 2 | 4 | -1 | 0 |
| S10 | 84 | 280 | 16 | -3 | -1 | -11 | 0 | 11 | -6 | -10 | -12 | 0 | -3 | 2 | 9 | 4 | 0 |
| S10 | 84 | 310 | -8 | -17 | -6 | 1 | 0 | -8 | -16 | -10 | -12 | 0 | -2 | -3 | 4 | 14 | 0 |
| S10 | 84 | 340 | -22 | -39 | -19 | -6 | 0 | -18 | -37 | -23 | -12 | 0 | -7 | -3 | 4 | 9 | 0 |
| S10 | 90 | 10 | -13 | 14 | 42 | 42 | 0 | -8 | 12 | 37 | 36 | 0 | -5 | -2 | 0 | 3 | 0 |
| S10 | 90 | 40 | 5 | 14 | 36 | 42 | 0 | 7 | 15 | 33 | 36 | 0 | -5 | -2 | 0 | 3 | 0 |
| S10 | 90 | 70 | -17 | -26 | 12 | 28 | 0 | -11 | -10 | 16 | 29 | 0 | -5 | -17 | -4 | -2 | 0 |
| S10 | 90 | 100 | -4 | 23 | 6 | -1 | 0 | -3 | 20 | 12 | 5 | 0 | 0 | 3 | -4 | -7 | 0 |
| S10 | 90 | 130 | 10 | 23 | -24 | -8 | 0 | 7 | 20 | -16 | 1 | 0 | 5 | 3 | -9 | -7 | 0 |
| S10 | 90 | 160 | 27 | 14 | -30 | -29 | 0 | 12 | 15 | -23 | -19 | 0 | 14 | 3 | -4 | -12 | 0 |
| S10 | 90 | 190 | -4 | 23 | -30 | -36 | 0 | -3 | 15 | -23 | -31 | 0 | 0 | 8 | -4 | -2 | 0 |
| S10 | 90 | 220 | 10 | -6 | -12 | -29 | 0 | 7 | -10 | -16 | -31 | 0 | 5 | 3 | 5 | 3 | 0 |
| S10 | 90 | 250 | 5 | -16 | 12 | -8 | 0 | 5 | -16 | 2 | -19 | 0 | 0 | -2 | 15 | 8 | 0 |
| S10 | 90 | 280 | 23 | -1 | 6 | -8 | 0 | 15 | -5 | -2 | -11 | 0 | 9 | 8 | 10 | 8 | 0 |
| S10 | 90 | 310 | -13 | -21 | 0 | 6 | 0 | -8 | -16 | -5 | 5 | 0 | -5 | -2 | 0 | 3 | 0 |
| S10 | 90 | 340 | -30 | -41 | -18 | -1 | 0 | -21 | -38 | -16 | -3 | 0 | -10 | -7 | -4 | 3 | 0 |
| S11 | 30 | 10 | -6 | -8 | -41 | -58 | 0 | 0 | -5 | -21 | -26 | 0 | 0 | -3 | -20 | -29 | 0 |
| S11 | 30 | 40 | 3 | 1 | -32 | -58 | 0 | 0 | 6 | -10 | -26 | 0 | 0 | -3 | -24 | -25 | 0 |
| S11 | 30 | 70 | 3 | 1 | -32 | -38 | 0 | -5 | 0 | -16 | -20 | 0 | 4 | 1 | -20 | -20 | 0 |
| S11 | 30 | 100 | 3 | -8 | -14 | 13 | 0 | 0 | -11 | -10 | 11 | 0 | 4 | -3 | -6 | 4 | 0 |
| S11 | 30 | 130 | -6 | -8 | 31 | 93 | 0 | 0 | 0 | 30 | 72 | 0 | -4 | -7 | 3 | 18 | 0 |
| S11 | 30 | 160 | -6 | 1 | 75 | 123 | 0 | -5 | 0 | 58 | 85 | 0 | -4 | 1 | 17 | 36 | 0 |
| S11 | 30 | 190 | 3 | 9 | 75 | 113 | 0 | 6 | 6 | 47 | 60 | 0 | -4 | 6 | 26 | 46 | 0 |
| S11 | 30 | 220 | 3 | 9 | 49 | 53 | 0 | 0 | 6 | 18 | 11 | 0 | 0 | 1 | 35 | 41 | 0 |

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S11 30  250  -6   1    4  -28   0      0    0  -27  -39   0      -4    1   26    8   0
S11 30  280   3   3  -41  -68   0      0    0  -33  -57   0       4    6   -2  -15   0
S11 30  310   3   1  -32  -78   0      0    0  -21  -45   0       0    1  -11  -29   0
S11 30  340   3  -3  -41  -68   0      0   -5  -16  -26   0       4   -3  -24  -34   0
S11 40   10   6   8  -35  -77   0      5    2  -26  -55   0       1    6   -9  -24   0
S11 40   40  13  15  -27  -66   0     10    7  -15  -52   0       1   10   -9  -20   0
S11 40   70  10  15  -23  -24   0      5    4  -15    1   0       5   10   -9  -24   0
S11 40  100   0 -10  -16    7   0     -3  -11   -2   13   0       5   -2  -13   -7   0
S11 40  130  -4  -6   27   78   0     -8   -3   33   73   0       5   -6   -5    6   0
S11 40  160  -7   4   65  123   0     -8    9   60  103   0       1   -6    3   19   0
S11 40  190  -4  13   96  127   0      0   17   81  103   0      -3    2   11   23   0
S11 40  220  -7  13   77   78   0     -5   22   57   58   0      -3   -2   20   23   0
S11 40  250  -4  -3   23   -1   0      2    4   11  -16   0      -7   -6   11   15   0
S11 40  280   0 -13  -35  -64   0      2   -3  -37  -64   0      -3  -10    3    2   0
S11 40  310  -4 -27  -78  -90   0      0  -23  -74  -88   0      -3   -2   -1   -2   0
S11 40  340   0 -20  -74  -90   0      0  -23  -72  -76   0       1    2   -1  -11   0
S11 52   10  14  35   11  -79   0     14   35   14  -74   0      -1    1   -5   -4   0
S11 52   40  29  55  -16  -60   0     26   54  -12  -54   0       2    1   -5   -8   0
S11 52   70  19  49  -18  -42   0     13   44  -11  -26   0       6    5   -9  -12   0
S11 52  100  13  12  -16    2   0      9   12   -5   23   0       2    1  -12  -20   0
S11 52  130   3 -23   13   56   0      5  -21    5   62   0      -1   -3    7   -4   0
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S11 52  250 -29 -11    7    9   0    -30  -10   19    6   0       2   -3  -12    4   0
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S11 52  310 -24 -45  -67  -79   0    -19  -45  -80  -86   0      -5    1   14    8   0
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S11 68  130 -10 -32   27   62   0     -4  -30   21   48   0      -5   -8    4   13   0
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S11 68  190  -6  24  101  192   0     -4   18   78  148   0      -5    6   21   36   0
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S11 68  250 -23  -3    8   11   0    -21  -10   -2    5   0       0    2   13    4   0
S11 68  280  -3 -39  -39  -66   0    -13  -39  -36  -53   0       9    6   -1  -10   0
S11 68  310 -31 -36  -60-100   0    -30  -39  -59  -81   0       0    2   -1  -19   0
S11 68  340  -5 -39  -65-112   0     -4  -39  -47  -81   0       0   -3  -14  -23   0
S11 76   10  10  27  -29-123   0     10   24  -20-110   0       2    5   -7  -17   0
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```

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S11 76  130 -11 -37  29  67     0       -14 -32  31  69     0         2  -5  -2   2     0
S11 76  160 -16   5 106 202     0       -17  11  99 180     0        -3  -5   7  16     0
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S11 84   40  38  54 -68-130     0        35  52 -61-120     0         3   1  -6 -10     0
S11 84   70  52  70 -75-116     0        42  62 -65-102     0         8   6 -11 -15     0
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S11 84  130 -10 -46  34  67     0        -8 -42  26  71     0        -2  -4   8  -5     0
S11 84  160 -24   5 121 219     0       -17   4 107 208     0        -7   1  13   9     0
S11 84  190 -14  36 136 258     0       -12  30 125 241     0        -2   6   8  14     0
S11 84  220  -8 -13 102 193     0        -8  -9 109 179     0        -2  -4  -6  14     0
S11 84  250 -28 -20  11  30     0       -31 -16  26  24     0         3  -4 -16   4     0
S11 84  280   7 -50 -39 -71     0        -1 -46 -38 -73     0         8  -4  -1   4     0
S11 84  310 -41 -36 -45-108     0       -35 -37 -63-115     0        -7   1  18   9     0
S11 84  340 -10 -44 -64-133     0        -3 -39 -75-136     0        -7  -4  13   4     0
S11 90   10   6  33 -47-147     0        11  37 -35-139     0        -4  -3 -11  -8     0
S11 90   40  44  50 -74-139     0        40  59 -64-126     0         2  -9 -11 -13     0
S11 90   70  61  73 -85-132     0        51  75 -74-117     0         7   2 -11 -13     0
S11 90  100  33  10 -90 -87     0        31  11 -74 -69     0         2   2 -16 -18     0
S11 90  130 -16 -48  44  61     0        -7 -46  34  61     0        -9  -3   7   2     0
S11 90  160 -32   4 136 232     0       -21   5 119 213     0        -9   2  17  21     0
S11 90  190 -16  44 147 284     0       -13  33 132 248     0        -4  12  12  26     0
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S12 30   70   3  -4 -24 -17     0        -6  -7  -3  -5     0         8   4 -19 -14     0
S12 30  100  -5 -21  -5  24     0         0  -7   8  27     0        -5 -14 -15  -5     0
S12 30  130   3  -4  31  66     0         5   4  43  59     0        -5  -9 -10   9     0
S12 30  160  -5   5  68 108     0         0   9  72  84     0        -5  -1  -1  24     0
S12 30  190   3  13  86 118     0         0  15  60  65     0        -1  -1  26  47     0
S12 30  220   3   5  59  35     0         0  -7   2   2     0         8  17  58  33     0
S12 30  250  -5   5 -24 -49     0        -6  -2 -55 -43     0        -1   4  31   0     0
S12 30  280   3  13 -42 -80     0        -6   4 -44 -68     0         8   8  -1  -9     0
S12 30  310  -5   5 -24 -80     0        -6   4 -21 -55     0         3   4  -1 -24     0
S12 30  340   3  -4 -51 -59     0         5  -7 -38 -36     0        -1  -1 -15 -24     0
S12 40   10   0  13 -25 -47     0        -2   4 -31 -37     0         1  10   6  -6     0
S12 40   40  -4  24 -12 -28     0        -9  12 -14 -21     0         5  10   1  -6     0
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S12 40  100  -4   2  -4  32     0         3  -4   9  51     0        -6   2 -11 -19     0
S12 40  130  -4  -5  12  71     0        -7  -1  29  83     0         1  -2 -15 -15     0
S12 40  160  -4  -5  53 101     0        -7  -6  60  86     0         1   2  -7  12     0
S12 40  190  -7  -5  82 101     0        -7   4  85  83     0         1  -6  -3  20     0
S12 40  220   0  -1  58  51     0        -4   7  60  15     0         5  -6  -3  38     0
S12 40  250   6 -12  -4 -23     0         8 -11  -5 -24     0         1   2   1  -1     0
S12 40  280  -4 -23 -62 -87     0        -4 -22 -68 -83     0         1  -2   6  -6     0
S12 40  310   3 -15 -66 -97     0        11  -4 -76 -92     0        -6 -10  14  -6     0
S12 40  340  10   6 -33 -72     0        11   9 -48 -70     0        -3  -6  14  -1     0
```

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S12 | 52 | 10 | 12 | 24 | 17 | -45 | 0 | 19 | 26 | 10 | -38 | 0 | -7 | -1 | 7 | -7 | 0 |
| S12 | 52 | 40 | 17 | 41 | 15 | -35 | 0 | 7 | 37 | 15 | -19 | 0 | 4 | 3 | -1 | -15 | 0 |
| S12 | 52 | 70 | 12 | 50 | 21 | -19 | 0 | 3 | 46 | 25 | -4 | 0 | 8 | 3 | -5 | -15 | 0 |
| S12 | 52 | 100 | 2 | 35 | 0 | 42 | 0 | -5 | 26 | -3 | 52 | 0 | 8 | 7 | 3 | -11 | 0 |
| S12 | 52 | 130 | 15 | 24 | 19 | 60 | 0 | 13 | 22 | 11 | 64 | 0 | 4 | 3 | 7 | -3 | 0 |
| S12 | 52 | 160 | 9 | 14 | 36 | 84 | 0 | 4 | 15 | 44 | 79 | 0 | 4 | -1 | -9 | 5 | 0 |
| S12 | 52 | 190 | -8 | -20 | 34 | 91 | 0 | -9 | -18 | 47 | 66 | 0 | 0 | -1 | -13 | 13 | 0 |
| S12 | 52 | 220 | -5 | -29 | -6 | 23 | 0 | -1 | -22 | 19 | 13 | 0 | -3 | -8 | -24 | 9 | 0 |
| S12 | 52 | 250 | -5 | -63 | -42 | -48 | 0 | -1 | -59 | -29 | -51 | 0 | -3 | -4 | -13 | 5 | 0 |
| S12 | 52 | 280 | -15 | -22 | -53 | -53 | 0 | -11 | -20 | -59 | -64 | 0 | -3 | -1 | 7 | 13 | 0 |
| S12 | 52 | 310 | -18 | -44 | -38 | -58 | 0 | -15 | -44 | -62 | -64 | 0 | -3 | -1 | 26 | 9 | 0 |
| S12 | 52 | 340 | -8 | -12 | -4 | -32 | 0 | -1 | -9 | -18 | -32 | 0 | -7 | -1 | 14 | 1 | 0 |
| S12 | 60 | 10 | -3 | 19 | 9 | -60 | 0 | 17 | 28 | 30 | -37 | 0 | -16 | -11 | -20 | -24 | 0 |
| S12 | 60 | 40 | 15 | 38 | 3 | -60 | 0 | 11 | 45 | 26 | -32 | 0 | 4 | -7 | -28 | -24 | 0 |
| S12 | 60 | 70 | 24 | 53 | 9 | -36 | 0 | 8 | 52 | 30 | -15 | 0 | 16 | 1 | -20 | -24 | 0 |
| S12 | 60 | 100 | 11 | 38 | 9 | 44 | 0 | 1 | 38 | -4 | 28 | 0 | 8 | -3 | 12 | 14 | 0 |
| S12 | 60 | 130 | 15 | 28 | 27 | 68 | 0 | 17 | 25 | 17 | 50 | 0 | 0 | 1 | 8 | 22 | 0 |
| S12 | 60 | 160 | 11 | 14 | 27 | 92 | 0 | 11 | 14 | 35 | 82 | 0 | 0 | -3 | -8 | 10 | 0 |
| S12 | 60 | 190 | -7 | -20 | 33 | 116 | 0 | -8 | -20 | 22 | 66 | 0 | 0 | 1 | 12 | 48 | 0 |
| S12 | 60 | 220 | -7 | -35 | -16 | 28 | 0 | -5 | -31 | -22 | 28 | 0 | -4 | -3 | 8 | 1 | 0 |
| S12 | 60 | 250 | -12 | -64 | -40 | -44 | 0 | -5 | -65 | -56 | -48 | 0 | -4 | 5 | 12 | 1 | 0 |
| S12 | 60 | 280 | -16 | -20 | -52 | -44 | 0 | -18 | -24 | -48 | -48 | 0 | 0 | 1 | -4 | 5 | 0 |
| S12 | 60 | 310 | -16 | -40 | -4 | -60 | 0 | -21 | -48 | -39 | -53 | 0 | 4 | 13 | 37 | -7 | 0 |
| S12 | 60 | 340 | -16 | -11 | -4 | -44 | 0 | -8 | -14 | 9 | -21 | 0 | -8 | 1 | -12 | -20 | 0 |
| S12 | 68 | 10 | -17 | 8 | -9 | -87 | 0 | -6 | 16 | 9 | -63 | 0 | -13 | -6 | -16 | -21 | 0 |
| S12 | 68 | 40 | 17 | 33 | -28 | -82 | 0 | 12 | 35 | -3 | -63 | 0 | 5 | -6 | -20 | -17 | 0 |
| S12 | 68 | 70 | 40 | 54 | -13 | -62 | 0 | 29 | 55 | -3 | -47 | 0 | 10 | 3 | -16 | -17 | 0 |
| S12 | 68 | 100 | 17 | 31 | 10 | 48 | 0 | 21 | 45 | 22 | 52 | 0 | 1 | -10 | -8 | -3 | 0 |
| S12 | 68 | 130 | 14 | 22 | 32 | 86 | 0 | 20 | 26 | 34 | 85 | 0 | -4 | -6 | -3 | 10 | 0 |
| S12 | 68 | 160 | 9 | 13 | 19 | 106 | 0 | 12 | 16 | 22 | 85 | 0 | -4 | -1 | -3 | 19 | 0 |
| S12 | 68 | 190 | -10 | -19 | 49 | 170 | 0 | -15 | -23 | 34 | 134 | 0 | 1 | -1 | 14 | 37 | 0 |
| S12 | 68 | 220 | -7 | -23 | 8 | 40 | 0 | -15 | -42 | -28 | 19 | 0 | 5 | 12 | 36 | 23 | 0 |
| S12 | 68 | 250 | -14 | -60 | -24 | -44 | 0 | -15 | -61 | -40 | -47 | 0 | -4 | 3 | 18 | 1 | 0 |
| S12 | 68 | 280 | -13 | -14 | -50 | -41 | 0 | -15 | -23 | -53 | -47 | 0 | 5 | 8 | 1 | -3 | 0 |
| S12 | 68 | 310 | -14 | -29 | 17 | -69 | 0 | -15 | -32 | 9 | -63 | 0 | 1 | 3 | 5 | -12 | 0 |
| S12 | 68 | 340 | -21 | -11 | -11 | -64 | 0 | -15 | -13 | -3 | -47 | 0 | -4 | -1 | -8 | -17 | 0 |
| S12 | 76 | 10 | -27 | 8 | -14 | -105 | 0 | -24 | 4 | -21 | -95 | 0 | -3 | 5 | 6 | -7 | 0 |
| S12 | 76 | 40 | 25 | 34 | -33 | -97 | 0 | 18 | 25 | -41 | -89 | 0 | 7 | 10 | 2 | -12 | 0 |
| S12 | 76 | 70 | 46 | 61 | -26 | -80 | 0 | 45 | 53 | -21 | -68 | 0 | 2 | 10 | -5 | -12 | 0 |
| S12 | 76 | 100 | 15 | 29 | -2 | 32 | 0 | 18 | 22 | 6 | 49 | 0 | -3 | 5 | -8 | -17 | 0 |
| S12 | 76 | 130 | 15 | 13 | 23 | 84 | 0 | 12 | 19 | 33 | 97 | 0 | 2 | 0 | -8 | -12 | 0 |
| S12 | 76 | 160 | 10 | 13 | 11 | 127 | 0 | 3 | 10 | 21 | 113 | 0 | 2 | 0 | -8 | 11 | 0 |
| S12 | 76 | 190 | -11 | -25 | 54 | 213 | 0 | -12 | -18 | 60 | 188 | 0 | 2 | -5 | -8 | 20 | 0 |
| S12 | 76 | 220 | -1 | -25 | 23 | 75 | 0 | -6 | -18 | 33 | 39 | 0 | 2 | -10 | -12 | 30 | 0 |
| S12 | 76 | 250 | -16 | -57 | -14 | -45 | 0 | -18 | -58 | -10 | -41 | 0 | 2 | 0 | -3 | 2 | 0 |
| S12 | 76 | 280 | -11 | -14 | -44 | -45 | 0 | -9 | -8 | -52 | -41 | 0 | 2 | -5 | 6 | 2 | 0 |
| S12 | 76 | 310 | -16 | -30 | 35 | -80 | 0 | -9 | -24 | 14 | -79 | 0 | -8 | -10 | 20 | -3 | 0 |
| S12 | 76 | 340 | -27 | -14 | -6 | -80 | 0 | -21 | -8 | -21 | -73 | 0 | -3 | -5 | 15 | -3 | 0 |
| S12 | 84 | 10 | -34 | 14 | -5 | -114 | 0 | -24 | 16 | -14 | -105 | 0 | -10 | -1 | 8 | -9 | 0 |
| S12 | 84 | 40 | 32 | 45 | -41 | -114 | 0 | 26 | 41 | -38 | -96 | 0 | 6 | 4 | -1 | -19 | 0 |
| S12 | 84 | 70 | 56 | 70 | -31 | -99 | 0 | 45 | 66 | -26 | -81 | 0 | 11 | 4 | -6 | -19 | 0 |
| S12 | 84 | 100 | 22 | 37 | -1 | 11 | 0 | 11 | 27 | -5 | 26 | 0 | 11 | 9 | 4 | -14 | 0 |
| S12 | 84 | 130 | 20 | 21 | 24 | 72 | 0 | 14 | 17 | 18 | 77 | 0 | 6 | 4 | 8 | -4 | 0 |
| S12 | 84 | 160 | 14 | 12 | 1 | 136 | 0 | 6 | 13 | 11 | 129 | 0 | 6 | -1 | -11 | 6 | 0 |
| S12 | 84 | 190 | -10 | -27 | 39 | 234 | 0 | -10 | -26 | 56 | 216 | 0 | 0 | -1 | -15 | 15 | 0 |
| S12 | 84 | 220 | -4 | -40 | -3 | 100 | 0 | 0 | -29 | 27 | 87 | 0 | -5 | -11 | -30 | 10 | 0 |

```
S12 84  250 -20 -62 -26 -41     0      -15 -57 -12 -45     0       -5  -6 -15   6     0
S12 84  280 -14 -15 -37 -35     0       -9 -13 -46 -48     0       -5  -1   8  15     0
S12 84  310 -24 -37  67 -75     0      -20 -37  33 -85     0       -5  -1  32  10     0
S12 84  340 -38 -19  14 -75     0      -28 -18  -4 -76     0      -10  -1  18   1     0
S12 90   10 -49  10  -9-129     0      -31  19   6-107     0      -21  -9 -12 -24     0
S12 90   40  37  45 -52-137     0       32  51 -27-107     0        6  -4 -22 -28     0
S12 90   70  72  74 -41-121     0       53  73 -24 -92     0       18   1 -22 -24     0
S12 90  100  32  39   8   7     0       20  42  -4  -1     0       12   1  11  10     0
S12 90  130  26  22  35  79     0       23  22  22  61     0        1   1  11  15     0
S12 90  160  14  10  -9 142     0       17  13   2 133     0        1  -4 -12  10     0
S12 90  190  -9 -25  35 270     0      -10 -29  29 215     0        1   1   6  43     0
S12 90  220  -9 -43 -19 103     0       -4 -45 -17 104     0       -5  -4  -3   0     0
S12 90  250 -26 -66 -30 -33     0      -19 -67 -37 -40     0       -5   1   6   5     0
S12 90  280 -14 -13 -36 -25     0      -16 -16 -34 -30     0        1   1   2  10     0
S12 90  310 -26 -31 100 -73     0      -28 -45  59 -68     0        1  12  39  -4     0
S12 90  340 -49 -19  19 -81     0      -40 -19  26 -68     0      -10   1  -3 -14     0
S13 30   10   1  -4 -15 -24     0        2  -4  -7  -5     0        0   0  -8 -19     0
S13 30   40   0  -2 -16 -28     0        0  -2  -4  -9     0        0   0 -11 -17     0
S13 30   70   0  -2 -16 -21     0       -5  -3  -9 -15     0        4   2  -7  -7     0
S13 30  100   1  -7  -5   2     0        2  -6  -1   1     0        1   0  -4   1     0
S13 30  130   0  -1   9  34     0        0   0  11  25     0        0   0   0   8     0
S13 30  160  -1   0  25  53     0        0   0  22  38     0        0   1   4  14     0
S13 30  190   3   5  28  53     0        1   2  18  25     0        1   2  11  24     0
S13 30  220  -3   4  28  30     0       -4   4  11  10     0        0   1  17  22     0
S13 30  250  -3   4   5  -1     0       -3   4  -9 -10     0        0   0  16  10     0
S13 30  280  10  12  -9 -27     0        8  11  -9 -24     0        3   2   1   0     0
S13 30  310  -3   2 -11 -32     0        0   4  -7 -19     0       -2  -1  -3 -11     0
S13 30  340   0  -5 -16 -32     0        1  -4  -7  -9     0       -1  -1 -10 -18     0
S13 40   10   2   5 -13 -39     0       -1  -1 -16 -30     0        3   3   4  -8     0
S13 40   40   3   9 -10 -33     0        0   1 -15 -27     0        3   7   4  -5     0
S13 40   70   3   3 -14 -23     0        3   3 -19 -18     0        1   5   4  -3     0
S13 40  100   0  -3 -15  -5     0        0  -2 -10  -1     0        0   0  -4  -2     0
S13 40  130  -4  -6   4  27     0       -4   0  14  27     0        0  -5  -9   0     0
S13 40  160  -3   0  31  55     0        0   7  42  53     0       -1  -6  -8   2     0
S13 40  190  -6   3  44  61     0       -5  10  48  55     0        0  -6  -3   6     0
S13 40  220  -3   3  38  44     0       -1   7  36  32     0       -1  -3   1  12     0
S13 40  250  -1  -3  11  13     0        0  -3   4   4     0       -1   0   7   8     0
S13 40  280   4  -4 -15 -17     0        3  -2 -20 -21     0        1  -1   5   4     0
S13 40  310   6  -4 -29 -36     0        7  -5 -30 -35     0        0   1   2   0     0
S13 40  340   4  -1 -24 -39     0        3  -5 -28 -33     0        1   5   3  -6     0
S13 52   10  11  21   2 -37     0       10  18   2 -35     0        1   2   1  -1     0
S13 52   40  15  28   7 -28     0       12  25   6 -27     0        3   3   0   0     0
S13 52   70  11  27   5 -18     0        7  26   3 -18     0        3   1   1   0     0
S13 52  100   2   8  -6   5     0        2   9  -8   4     0        0   0   2   0     0
S13 52  130   0  -8   0  27     0        1  -5   0  28     0       -1  -2   0   0     0
S13 52  160  -4  -4  21  50     0       -2  -1  26  53     0       -1  -2  -3  -1     0
S13 52  190  -3  -4  26  56     0       -1  -4  29  57     0        0   0  -2   0     0
S13 52  220  -7 -12  18  40     0       -5 -11  19  40     0        0   0   0   1     0
S13 52  250 -10 -18   0   7     0       -9 -17  -1   5     0       -1   0   1   2     0
S13 52  280 -10 -15 -19 -21     0      -10 -15 -20 -23     0        0   0   1   2     0
S13 52  310  -4 -15 -26 -36     0       -3 -16 -27 -38     0        0   1   2   2     0
S13 52  340   6   0 -24 -40     0        5  -1 -25 -38     0        1   1   1  -1     0
S13 60   10  10  19  -1 -42     0       14  24   7 -34     0       -3  -3  -7  -7     0
S13 60   40  17  28   1 -32     0       15  31  12 -26     0        2  -3 -10  -6     0
S13 60   70  14  27   3 -19     0       10  27   8 -17     0        4   0  -5  -2     0
S13 60  100   4   8  -4   8     0        1   6  -7   4     0        4   1   2   4     0
```

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S13 | 60 | 130 | -3 | -3 | 2 | 30 | 0 | -1 | -11 | -2 | 24 | 0 | 0 | 3 | 6 | 6 | 0 |
| S13 | 60 | 160 | -5 | -4 | 20 | 50 | 0 | -4 | -7 | 18 | 46 | 0 | 0 | 2 | 2 | 6 | 0 |
| S13 | 60 | 190 | -4 | -2 | 25 | 62 | 0 | -3 | -7 | 24 | 49 | 0 | 0 | 6 | 2 | 12 | 0 |
| S13 | 60 | 220 | -6 | -11 | 25 | 45 | 0 | -7 | -13 | 12 | 39 | 0 | 0 | 3 | 13 | 6 | 0 |
| S13 | 60 | 250 | -12 | -13 | 6 | 9 | 0 | -11 | -18 | -4 | 7 | 0 | -1 | 1 | 11 | 1 | 0 |
| S13 | 60 | 280 | -10 | -16 | -19 | -22 | 0 | -10 | -15 | -17 | -19 | 0 | 0 | 0 | 0 | -2 | 0 |
| S13 | 60 | 310 | -5 | -16 | -25 | -38 | 0 | -3 | -13 | -24 | -32 | 0 | -2 | -1 | -1 | -6 | 0 |
| S13 | 60 | 340 | 7 | -1 | -23 | -46 | 0 | 6 | 2 | -20 | -37 | 0 | 0 | -4 | -8 | -8 | 0 |
| S13 | 68 | 10 | 7 | 16 | -9 | -54 | 0 | 8 | 17 | -3 | -39 | 0 | 0 | 0 | -6 | -14 | 0 |
| S13 | 68 | 40 | 18 | 27 | -10 | -43 | 0 | 17 | 27 | -1 | -29 | 0 | 1 | 0 | -8 | -13 | 0 |
| S13 | 68 | 70 | 19 | 27 | -4 | -25 | 0 | 15 | 27 | 1 | -19 | 0 | 4 | 1 | -4 | -5 | 0 |
| S13 | 68 | 100 | 7 | 3 | -5 | 9 | 0 | 7 | 9 | -3 | 10 | 0 | 2 | 0 | -1 | 1 | 0 |
| S13 | 68 | 130 | -4 | -7 | 5 | 39 | 0 | -2 | -7 | 5 | 33 | 0 | -1 | 0 | 0 | 7 | 0 |
| S13 | 68 | 160 | -7 | -3 | 23 | 60 | 0 | -4 | -3 | 20 | 51 | 0 | 0 | 1 | 3 | 9 | 0 |
| S13 | 68 | 190 | -3 | 3 | 32 | 81 | 0 | -5 | 0 | 22 | 62 | 0 | 0 | 3 | 8 | 17 | 0 |
| S13 | 68 | 220 | -6 | -8 | 40 | 56 | 0 | -7 | -12 | 27 | 40 | 0 | 0 | 1 | 12 | 16 | 0 |
| S13 | 68 | 250 | -13 | -19 | 19 | 12 | 0 | -14 | -17 | 8 | 6 | 0 | 0 | 0 | 12 | 7 | 0 |
| S13 | 68 | 280 | -9 | -14 | -19 | -25 | 0 | -12 | -15 | -17 | -23 | 0 | 3 | 1 | 1 | 0 | 0 |
| S13 | 68 | 310 | -8 | -18 | -28 | -47 | 0 | -6 | -14 | -25 | -40 | 0 | -2 | -1 | -2 | -7 | 0 |
| S13 | 68 | 340 | 7 | -5 | -36 | -56 | 0 | 9 | -4 | -27 | -45 | 0 | 0 | -1 | -7 | -14 | 0 |
| S13 | 76 | 10 | 9 | 21 | -12 | -66 | 0 | 6 | 13 | -15 | -61 | 0 | 2 | 8 | 3 | -6 | 0 |
| S13 | 76 | 40 | 21 | 30 | -14 | -54 | 0 | 17 | 23 | -17 | -50 | 0 | 4 | 8 | 3 | -4 | 0 |
| S13 | 76 | 70 | 23 | 31 | -6 | -31 | 0 | 21 | 26 | -9 | -27 | 0 | 2 | 4 | 4 | -2 | 0 |
| S13 | 76 | 100 | 8 | 7 | -9 | 7 | 0 | 8 | 8 | -5 | 10 | 0 | 0 | 0 | -2 | -1 | 0 |
| S13 | 76 | 130 | -6 | -12 | 1 | 40 | 0 | -4 | -5 | 9 | 42 | 0 | 0 | -5 | -7 | 0 | 0 |
| S13 | 76 | 160 | -10 | -7 | 19 | 67 | 0 | -7 | 0 | 28 | 66 | 0 | -2 | -5 | -8 | 0 | 0 |
| S13 | 76 | 190 | -5 | 0 | 33 | 94 | 0 | -3 | 6 | 38 | 90 | 0 | -1 | -4 | -4 | 4 | 0 |
| S13 | 76 | 220 | -7 | -11 | 49 | 73 | 0 | -6 | -7 | 48 | 62 | 0 | -1 | -2 | 0 | 8 | 0 |
| S13 | 76 | 250 | -16 | -18 | 30 | 21 | 0 | -13 | -18 | 23 | 14 | 0 | -1 | 0 | 6 | 7 | 0 |
| S13 | 76 | 280 | -6 | -14 | -17 | -23 | 0 | -8 | -13 | -21 | -26 | 0 | 2 | 0 | 4 | 4 | 0 |
| S13 | 76 | 310 | -11 | -17 | -28 | -52 | 0 | -10 | -18 | -30 | -51 | 0 | 0 | 1 | 2 | 1 | 0 |
| S13 | 76 | 340 | 7 | -3 | -40 | -70 | 0 | 5 | -7 | -42 | -65 | 0 | 2 | 5 | 3 | -4 | 0 |
| S13 | 84 | 10 | 12 | 28 | -8 | -71 | 0 | 10 | 24 | -9 | -70 | 0 | 2 | 3 | 1 | -1 | 0 |
| S13 | 84 | 40 | 26 | 39 | -12 | -58 | 0 | 23 | 36 | -11 | -55 | 0 | 4 | 4 | 0 | 0 | 0 |
| S13 | 84 | 70 | 28 | 34 | -4 | -33 | 0 | 23 | 32 | -5 | -32 | 0 | 4 | 1 | 1 | 0 | 0 |
| S13 | 84 | 100 | 7 | 5 | -11 | 4 | 0 | 7 | 5 | -12 | 5 | 0 | 0 | 0 | 1 | 0 | 0 |
| S13 | 84 | 130 | -9 | -13 | -5 | 39 | 0 | -6 | -13 | -4 | 39 | 0 | -2 | -3 | 0 | 0 | 0 |
| S13 | 84 | 160 | -14 | -14 | 9 | 64 | 0 | -10 | -11 | 15 | 67 | 0 | -2 | -3 | -5 | -2 | 0 |
| S13 | 84 | 190 | -7 | -3 | 27 | 95 | 0 | -4 | -3 | 32 | 97 | 0 | -1 | 0 | -3 | -1 | 0 |
| S13 | 84 | 220 | -10 | -13 | 49 | 79 | 0 | -10 | -12 | 50 | 78 | 0 | -1 | 0 | 0 | 1 | 0 |
| S13 | 84 | 250 | -18 | -19 | 36 | 26 | 0 | -16 | -18 | 33 | 23 | 0 | -1 | 0 | 2 | 3 | 0 |
| S13 | 84 | 280 | -6 | -15 | -12 | -19 | 0 | -7 | -15 | -13 | -21 | 0 | 0 | 0 | 2 | 3 | 0 |
| S13 | 84 | 310 | -11 | -16 | -25 | -48 | 0 | -9 | -17 | -28 | -51 | 0 | 0 | 1 | 3 | 4 | 0 |
| S13 | 84 | 340 | 9 | 0 | -36 | -73 | 0 | 6 | -1 | -39 | -72 | 0 | 1 | 2 | 1 | -1 | 0 |
| S13 | 90 | 10 | 11 | 29 | -11 | -74 | 0 | 15 | 31 | -4 | -67 | 0 | -3 | -3 | -6 | -6 | 0 |
| S13 | 90 | 40 | 30 | 40 | -17 | -61 | 0 | 27 | 42 | -7 | -55 | 0 | 2 | -1 | -10 | -6 | 0 |
| S13 | 90 | 70 | 32 | 35 | -6 | -35 | 0 | 27 | 36 | -1 | -32 | 0 | 5 | 0 | -3 | -2 | 0 |
| S13 | 90 | 100 | 9 | 4 | -10 | 4 | 0 | 5 | 4 | -11 | 2 | 0 | 4 | 1 | 1 | 4 | 0 |
| S13 | 90 | 130 | -11 | -20 | -3 | 41 | 0 | -9 | -22 | -8 | 35 | 0 | -2 | 1 | 5 | 6 | 0 |
| S13 | 90 | 160 | -16 | -15 | 7 | 62 | 0 | -15 | -16 | 6 | 59 | 0 | 0 | 0 | 1 | 4 | 0 |
| S13 | 90 | 190 | -8 | 0 | 24 | 100 | 0 | -7 | -6 | 24 | 89 | 0 | 0 | 6 | 1 | 10 | 0 |
| S13 | 90 | 220 | -11 | -13 | 55 | 82 | 0 | -11 | -15 | 42 | 76 | 0 | 1 | 3 | 12 | 5 | 0 |
| S13 | 90 | 250 | -20 | -20 | 42 | 30 | 0 | -18 | -20 | 31 | 27 | 0 | 0 | 0 | 12 | 3 | 0 |
| S13 | 90 | 280 | -5 | -15 | -12 | -18 | 0 | -5 | -15 | -10 | -15 | 0 | 0 | 0 | 0 | 0 | 0 |
| S13 | 90 | 310 | -13 | -16 | -24 | -48 | 0 | -11 | -15 | -23 | -43 | 0 | -2 | 0 | -1 | -4 | 0 |
| S13 | 90 | 340 | 9 | -1 | -39 | -78 | 0 | 8 | 3 | -32 | -70 | 0 | 1 | -4 | -7 | -7 | 0 |

```
-----END OF FILE WRITTEN-----

***RANDOM PERTURBATIONS, CODE R***
R 1   25     11  21  40  77  85     14  18  40  53  55     13  18  28  46  51
R 1   30     18  28  47  98 110     14  29  49  91 101     19  23  32  41  44
R 1   35     28  36  56 112 125     24  34  55 103 117     20  27  42  57  61
R 1   40     33  46  77 134 149     31  39  61 114 128     18  29  61  64  65
R 1   45     36  54 103 161 177     38  51  84 136 151     20  26  55  58  59
R 1   50     40  60 119 183 201     40  57 108 164 181     21  23  42  47  47
R 1   55     44  65 125 189 207     42  61 133 200 219     18  29  43  46  46
R 1   60     48  72 123 179 194     46  72 130 198 217     23  34  39  51  54
R 1   65     55  74 115 166 180     51  86 134 191 205     34  39  44  52  54
R 1   70     67  75 106 150 162     66  89 131 185 199     44  46  50  55  57
R 1   75     74  74  95 123 131     86  93 123 171 177     52  69  76  73  72
R 1   80     92  93 102  99  99     81  92 117 150 160     52  60  76  96 101
R 1   85    110 114 115  93  84    102  95 112 131 137     65  70  69  83  86
R 1   90    146 134 119  83  62    130 167 162 116  96    106 108 110 104 101
R 1  100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R 1  120    183 183 133 183 183     79  79  79  79  79    211 211 211 211 211
R 1  140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R 1  160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R 1  180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R 1  200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69
R 2   25     13  19  35  37  35     18  21  26  28  27     14  16  35  41  42
R 2   30     19  24  52  64  67     12  23  40  59  64     17  22  33  58  62
R 2   35     29  32  68  81  82     24  31  53  83  92     22  26  36  58  62
R 2   40     35  41  84  99 101     33  36  70  85  91     21  28  39  62  66
R 2   45     40  50  98 122 127     39  42  89 106 110     21  27  40  58  63
R 2   50     44  59 106 138 144     42  52 100 136 146     20  24  35  71  80
R 2   55     48  67 112 152 159     47  60 113 164 176     16  30  42  95 109
R 2   60     51  75 117 166 177     49  73 113 171 183     23  34  35 102 120
R 2   65     57  79 117 170 184     53  86 128 182 194     32  37  45  53  56
R 2   70     69  79 112 161 176     68  93 133 188 202     44  45  49  54  55
R 2   75     75  78 103 141 152     86  97 130 181 195     52  67  73  70  69
R 2   80     93  93 106 118 122     81  95 123 166 178     52  61  75  92  97
R 2   85    110 111 114 104 100    103  96 118 147 156     65  70  70  84  88
R 2   90    146 133 118  88  72    130 163 159 127 114    106 111 114 107 105
R 2  100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R 2  120    193 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R 2  140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R 2  160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R 2  180     71  71  71  71  71     58  58  53  58  58     81  81  81  81  81
R 2  200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69
R 3   25     22  27  32  74  82     26  27  44  67  72     14  16  33  38  39
R 3   30     27  34  42  84  94     20  28  36  82  93     16  19  35  44  46
R 3   35     38  42  58  95 105     25  37  46  87  96     22  22  32  47  50
R 3   40     50  50  70 112 124     32  39  66  97 105     25  24  34  46  50
R 3   45     64  64  78 130 145     41  43  66 105 115     34  27  35  43  45
R 3   50     86  79  91 150 165     66  58  77 127 140     27  28  32  38  40
R 3   55     96  93 103 163 177     93  76  88 152 167     20  29  36  37  38
R 3   60     95 101 115 175 189    104 106  99 161 176     25  31  35  43  46
R 3   65     70  94 128 187 203     79 104 126 182 196     24  32  40  46  48
R 3   70     75  92 128 190 207     77 105 141 199 215     39  41  44  48  49
R 3   75     78  89 122 181 198     91 109 146 208 225     49  62  64  61  60
R 3   80     92  92 114 158 170     83 104 139 204 221     52  63  71  81  83
R 3   85    109 105 111 130 135    103  99 130 194 198     66  71  72  85  90
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R 3  90   145 129 112  97  91   129 151 153 153 153   108 121 122 116 114
R 3 100   132 132 132 132 132   154 154 154 154 154    75  75  75  75  75
R 3 120   183 183 183 183 183    79  79  79  79  79   211 211 211 211 211
R 3 140   125 125 125 125 125    72  72  72  72  72   146 146 146 146 146
R 3 160    90  90  90  90  90    65  65  65  65  65   105 105 105 105 105
R 3 180    71  71  71  71  71    58  58  58  58  58    81  81  81  81  81
R 3 200    61  61  61  61  61    52  52  52  52  52    69  69  69  69  69
R 4  25    17  20  20  29  32    22  17  16  27  29    14  13  15  23  25
R 4  30    22  26  30  42  47    15  22  18  28  30    15  16  20  26  29
R 4  35    30  33  43  58  64    25  28  23  37  40    18  20  28  27  31
R 4  40    35  40  59  78  85    32  32  40  49  53    17  20  34  37  42
R 4  45    38  48  77 103 113    39  38  52  67  70    19  20  33  46  53
R 4  50    41  57  94 127 138    38  43  71 100 108    19  21  32  40  44
R 4  55    47  68 109 143 155    41  51  88 126 136    16  23  31  30  31
R 4  60    54  81 125 157 161    48  53 105 137 152    24  26  32  34  35
R 4  65    62  96 140 176 190    56  83 126 143 155    30  28  31  48  51
R 4  70    73 101 146 201 219    72 109 150 177 196    43  38  36  44  45
R 4  75    79 100 143 216 233    91 120 164 225 245    49  56  50  48  46
R 4  80    92  90 124 198 215    85 115 157 235 251    53  66  66  63  59
R 4  85   108  94 104 162 178   103 103 146 227 243    66  72  75  86  88
R 4  90   144 122 102 110 118   125 134 143 183 196   110 133 132 126 123
R 4 100   132 132 132 132 132   154 154 154 154 154    75  75  75  75  75
R 4 120   183 183 183 183 183    79  79  79  79  79   211 211 211 211 211
R 4 140   125 125 125 125 125    72  72  72  72  72   146 146 146 146 146
R 4 160    90  90  90  90  90    65  65  65  65  65   105 105 105 105 105
R 4 180    71  71  71  71  71    58  58  58  58  58    81  81  81  81  81
R 4 200    61  61  61  61  61    52  52  52  52  52    69  69  69  69  69
R 5  25    12  15  21  20  21    16  18  17  22  23    15  13  12  20  22
R 5  30    20  21  29  29  30    10  17  19  23  23    17  17  17  24  26
R 5  35    33  30  38  41  43    17  23  29  27  26    22  19  19  24  27
R 5  40    46  38  48  56  59    26  26  35  38  38    24  18  24  30  32
R 5  45    62  48  60  72  77    48  34  42  48  50    26  20  23  31  35
R 5  50    70  59  72  90  97    65  45  55  67  71    28  22  24  31  34
R 5  55    76  68  83 102 110    74  59  67  87  95    26  23  24  24  25
R 5  60    76  77  97 109 120    86  66  79 102 107    25  27  28  24  23
R 5  65    66  87 111 127 134    70  81 101  98 105    26  31  31  39  41
R 5  70    74  90 116 148 155    74  99 120 128 135    40  40  35  36  36
R 5  75    78  91 116 162 172    90 107 131 164 170    48  54  50  41  36
R 5  80    92  92 109 152 163    82  99 126 177 189    52  62  62  53  48
R 5  85   109 105 108 128 134   105 115 133 171 181    65  70  70  73  74
R 5  90   145 128 108  92  87   124 129 140 159 165   107 113 112 108 107
R 5 100   132 132 132 132 132   154 154 154 154 154    75  75  75  75  75
R 5 120   183 183 183 183 183    79  79  79  79  79   211 211 211 211 211
R 5 140   125 125 125 125 125    72  72  72  72  72   146 146 146 146 146
R 5 160    90  90  90  90  90    65  65  65  65  65   105 105 105 105 105
R 5 180    71  71  71  71  71    58  58  58  58  58    81  81  81  81  81
R 5 200    61  61  61  61  61    52  52  52  52  52    69  69  69  69  69
R 6  25    17  20  15  20  22    20  20  14  17  18    14  11  12  12  12
R 6  30    22  24  20  24  26    16  16  14  21  23    16  14  12  18  19
R 6  35    31  30  28  35  37    27  25  17  25  27    20  16  17  22  24
R 6  40    36  36  37  42  45    34  32  29  37  40    18  17  19  22  23
R 6  45    39  41  46  53  56    39  35  34  35  37    18  18  20  22  24
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R 6  55    47  55  66  68  70    45  50  54  63  67    19  24  24  15  12
R 6  60    51  63  75  71  71    50  55  66  67  70    26  30  32  17  14
R 6  65    57  75  85  81  81    52  70  82  59  60    31  34  31  29  29
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| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| R | 6 | 70 | 69 | 79 | 87 | 96 | 95 | 67 | 87 | 93 | 84 | 81 | 43 | 42 | 34 | 27 | 24 |
| R | 6 | 75 | 76 | 84 | 90 | 104 | 106 | 87 | 96 | 103 | 104 | 101 | 49 | 54 | 48 | 33 | 24 |
| R | 6 | 80 | 94 | 94 | 96 | 104 | 105 | 79 | 86 | 97 | 113 | 117 | 52 | 59 | 58 | 42 | 35 |
| R | 6 | 85 | 110 | 113 | 110 | 99 | 95 | 106 | 122 | 124 | 119 | 118 | 65 | 68 | 66 | 58 | 56 |
| R | 6 | 90 | 146 | 131 | 113 | 80 | 68 | 124 | 126 | 138 | 139 | 140 | 104 | 96 | 96 | 93 | 91 |
| R | 6 | 100 | 132 | 132 | 132 | 132 | 132 | 154 | 154 | 154 | 154 | 154 | 75 | 75 | 75 | 75 | 75 |
| R | 6 | 120 | 183 | 183 | 183 | 183 | 183 | 79 | 79 | 79 | 79 | 79 | 211 | 211 | 211 | 211 | 211 |
| R | 6 | 140 | 125 | 125 | 125 | 125 | 125 | 72 | 72 | 72 | 72 | 72 | 146 | 146 | 146 | 146 | 146 |
| R | 6 | 160 | 90 | 90 | 90 | 90 | 90 | 65 | 65 | 65 | 65 | 65 | 105 | 105 | 105 | 105 | 105 |
| R | 6 | 180 | 71 | 71 | 71 | 71 | 71 | 58 | 58 | 58 | 58 | 58 | 81 | 81 | 81 | 81 | 81 |
| R | 6 | 200 | 61 | 61 | 61 | 61 | 61 | 52 | 52 | 52 | 52 | 52 | 69 | 69 | 69 | 69 | 69 |
| R | 7 | 25 | 13 | 23 | 14 | 17 | 17 | 15 | 19 | 12 | 16 | 16 | 12 | 13 | 10 | 14 | 15 |
| R | 7 | 30 | 18 | 26 | 18 | 20 | 21 | 17 | 23 | 12 | 20 | 22 | 17 | 15 | 11 | 17 | 18 |
| R | 7 | 35 | 26 | 32 | 26 | 27 | 28 | 22 | 27 | 16 | 23 | 25 | 21 | 18 | 16 | 17 | 18 |
| R | 7 | 40 | 33 | 39 | 34 | 35 | 36 | 29 | 33 | 27 | 30 | 31 | 19 | 18 | 18 | 21 | 22 |
| R | 7 | 45 | 39 | 46 | 41 | 43 | 43 | 34 | 38 | 33 | 34 | 35 | 19 | 20 | 18 | 20 | 21 |
| R | 7 | 50 | 47 | 54 | 50 | 49 | 49 | 36 | 45 | 37 | 46 | 49 | 25 | 21 | 22 | 16 | 14 |
| R | 7 | 55 | 59 | 61 | 58 | 51 | 48 | 41 | 56 | 51 | 47 | 47 | 25 | 24 | 23 | 13 | 9 |
| R | 7 | 60 | 69 | 68 | 65 | 53 | 48 | 77 | 63 | 53 | 53 | 52 | 33 | 35 | 30 | 18 | 13 |
| R | 7 | 65 | 59 | 76 | 73 | 58 | 53 | 63 | 77 | 73 | 52 | 41 | 32 | 33 | 31 | 21 | 17 |
| R | 7 | 70 | 69 | 77 | 74 | 65 | 62 | 68 | 86 | 81 | 60 | 53 | 42 | 41 | 33 | 21 | 15 |
| R | 7 | 75 | 76 | 81 | 79 | 72 | 68 | 87 | 93 | 85 | 70 | 60 | 49 | 53 | 48 | 28 | 17 |
| R | 7 | 80 | 92 | 95 | 91 | 78 | 73 | 79 | 81 | 84 | 78 | 74 | 51 | 58 | 56 | 37 | 28 |
| R | 7 | 85 | 110 | 116 | 111 | 85 | 74 | 106 | 125 | 120 | 94 | 84 | 65 | 67 | 64 | 51 | 46 |
| R | 7 | 90 | 146 | 133 | 114 | 76 | 62 | 124 | 125 | 137 | 132 | 126 | 103 | 89 | 89 | 86 | 87 |
| R | 7 | 100 | 132 | 132 | 132 | 132 | 132 | 154 | 154 | 154 | 154 | 154 | 75 | 75 | 75 | 75 | 75 |
| R | 7 | 120 | 183 | 183 | 183 | 183 | 183 | 79 | 79 | 79 | 79 | 79 | 211 | 211 | 211 | 211 | 211 |
| R | 7 | 140 | 125 | 125 | 125 | 125 | 125 | 72 | 72 | 72 | 72 | 72 | 146 | 146 | 146 | 146 | 146 |
| R | 7 | 160 | 90 | 90 | 90 | 90 | 90 | 65 | 65 | 65 | 65 | 65 | 105 | 105 | 105 | 105 | 105 |
| R | 7 | 180 | 71 | 71 | 71 | 71 | 71 | 58 | 58 | 58 | 58 | 58 | 81 | 81 | 81 | 81 | 81 |
| R | 7 | 200 | 61 | 61 | 61 | 61 | 61 | 52 | 52 | 52 | 52 | 52 | 69 | 69 | 69 | 69 | 69 |
| R | 8 | 25 | 15 | 23 | 16 | 43 | 47 | 19 | 20 | 16 | 16 | 15 | 15 | 15 | 11 | 32 | 38 |
| R | 8 | 30 | 19 | 30 | 20 | 56 | 63 | 16 | 21 | 16 | 55 | 61 | 16 | 16 | 13 | 30 | 34 |
| R | 8 | 35 | 28 | 41 | 27 | 62 | 70 | 24 | 24 | 18 | 61 | 68 | 19 | 23 | 17 | 31 | 35 |
| R | 8 | 40 | 33 | 60 | 36 | 69 | 78 | 31 | 28 | 27 | 62 | 69 | 18 | 37 | 19 | 28 | 31 |
| R | 8 | 45 | 37 | 69 | 44 | 77 | 87 | 36 | 50 | 33 | 67 | 76 | 19 | 32 | 20 | 21 | 21 |
| R | 8 | 50 | 42 | 106 | 54 | 83 | 91 | 40 | 91 | 40 | 77 | 86 | 19 | 32 | 22 | 15 | 13 |
| R | 8 | 55 | 45 | 124 | 63 | 88 | 95 | 43 | 112 | 53 | 82 | 89 | 18 | 30 | 22 | 16 | 15 |
| R | 8 | 60 | 50 | 126 | 73 | 94 | 100 | 48 | 136 | 62 | 87 | 96 | 26 | 31 | 29 | 21 | 19 |
| R | 8 | 65 | 58 | 98 | 84 | 97 | 109 | 53 | 110 | 73 | 93 | 96 | 32 | 22 | 31 | 23 | 21 |
| R | 8 | 70 | 69 | 89 | 87 | 103 | 107 | 67 | 103 | 93 | 99 | 100 | 43 | 34 | 34 | 23 | 19 |
| R | 8 | 75 | 77 | 87 | 90 | 107 | 112 | 87 | 101 | 108 | 110 | 113 | 49 | 51 | 48 | 31 | 22 |
| R | 8 | 80 | 94 | 95 | 96 | 105 | 107 | 79 | 87 | 97 | 115 | 120 | 52 | 58 | 58 | 42 | 34 |
| R | 8 | 85 | 110 | 113 | 110 | 99 | 95 | 106 | 123 | 124 | 120 | 118 | 65 | 68 | 66 | 58 | 55 |
| R | 8 | 90 | 145 | 131 | 113 | 81 | 68 | 124 | 126 | 138 | 139 | 140 | 104 | 96 | 96 | 93 | 91 |
| R | 8 | 100 | 132 | 132 | 132 | 132 | 132 | 154 | 154 | 154 | 154 | 154 | 75 | 75 | 75 | 75 | 75 |
| R | 8 | 120 | 183 | 183 | 183 | 183 | 183 | 79 | 79 | 79 | 79 | 79 | 211 | 211 | 211 | 211 | 211 |
| R | 8 | 140 | 125 | 125 | 125 | 125 | 125 | 72 | 72 | 72 | 72 | 72 | 146 | 146 | 146 | 146 | 146 |
| R | 8 | 160 | 90 | 90 | 90 | 90 | 90 | 65 | 65 | 65 | 65 | 65 | 105 | 105 | 105 | 105 | 105 |
| R | 8 | 180 | 71 | 71 | 71 | 71 | 71 | 58 | 58 | 58 | 58 | 58 | 81 | 81 | 81 | 81 | 81 |
| R | 8 | 200 | 61 | 61 | 61 | 61 | 61 | 52 | 52 | 52 | 52 | 52 | 69 | 69 | 69 | 69 | 69 |
| R | 9 | 25 | 21 | 19 | 17 | 25 | 27 | 23 | 20 | 17 | 22 | 24 | 14 | 15 | 13 | 15 | 16 |
| R | 9 | 30 | 24 | 24 | 23 | 32 | 35 | 23 | 19 | 15 | 25 | 26 | 15 | 17 | 15 | 17 | 17 |
| R | 9 | 35 | 28 | 34 | 34 | 40 | 43 | 28 | 25 | 20 | 35 | 37 | 16 | 21 | 21 | 24 | 26 |
| R | 9 | 40 | 31 | 43 | 46 | 52 | 55 | 32 | 33 | 31 | 37 | 39 | 19 | 19 | 26 | 32 | 34 |
| R | 9 | 45 | 34 | 52 | 60 | 66 | 71 | 35 | 39 | 40 | 46 | 48 | 19 | 20 | 25 | 29 | 31 |

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R 9  65     60  88 113 124 137     53  85 104 104 107     31  33  31  40  41
R 9  70     71  90 117 151 160     69  99 122 129 141     43  40  35  35  34
R 9  75     77  91 116 163 174     88 107 131 167 177     49  54  49  40  35
R 9  80     92  92 109 152 163     82  99 126 178 188     52  62  62  52  47
R 9  85    109 106 108 128 135    105 115 133 171 184     66  70  70  73  73
R 9  90    144 127 108  93  89    124 129 140 159 165    107 113 112 108 107
R 9 100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R 9 120    183 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R 9 140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R 9 160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R 9 180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R 9 200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69
R10  25     15  28  32  39  41     17  27  23  46  51     14  17  17  20  21
R10  30     19  33  42  43  43     18  29  30  36  37     15  20  21  21  21
R10  35     26  42  55  56  56     21  33  40  36  34     16  21  26  30  35
R10  40     31  52  69  76  81     28  39  53  50  52     18  24  31  40  44
R10  45     35  65  84 100 107     35  47  63  66  70     18  29  34  43  47
R10  50     39  83 100 123 133     36  53  80  92  99     19  38  30  41  45
R10  55     44 104 114 143 155     41  76  95 117 129     19  36  30  38  38
R10  60     50 120 128 165 178     44 129 111 132 147     25  39  34  45  45
R10  65     61 110 144 188 204     53 119 133 160 175     32  27  31  46  49
R10  70     72 106 148 209 228     71 120 153 189 209     43  35  35  42  42
R10  75     79 102 144 218 233     90 123 165 233 255     50  54  50  47  45
R10  80     92  90 124 198 213     84 116 157 238 246     53  65  66  62  58
R10  85    108  94 104 162 181    103 104 146 224 243     66  72  75  86  86
R10  90    143 122 102 113 124    125 133 143 184 197    110 133 132 126 123
R10 100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R10 120    183 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R10 140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R10 160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R10 180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R10 200     61  61  51  61  61     52  52  52  52  52     69  69  69  69  69
R11  25     15  36  24  54  60     17  16  19  43  49     15  26  18  28  30
R11  30     20  55  34  65  71     19  34  25  56  64     16  28  19  30  33
R11  35     28  75  44  77  84     24  45  38  66  73     18  38  26  40  42
R11  40     33  97  53  98 107     30  72  45  75  83     18  41  31  52  56
R11  45     37 122  66 123 134     36 109  54  97 108     19  33  35  52  56
R11  50     40 124  80 146 160     39 129  65 117 129     20  24  31  48  52
R11  55     46 117  93 166 181     40 118  77 146 161     19  20  35  41  41
R11  60     52 104 108 179 194     48 116  86 164 178     24  23  37  43  44
R11  65     58  98 125 189 205     55 108 120 188 203     32  27  41  46  48
R11  70     70  94 127 190 209     69 108 139 200 215     43  39  45  47  49
R11  75     77  89 121 181 200     88 110 145 209 222     51  61  65  61  60
R11  80     92  92 114 158 169     82 104 139 204 221     52  63  71  80  83
R11  85    109 105 111 130 134    102 100 130 185 199     66  71  72  85  90
R11  90    145 129 112  98  92    128 151 153 153 154    108 121 122 115 113
R11 100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R11 120    183 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R11 140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R11 160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R11 180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R11 200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69
R12  25     21  18  45  34  30     21  22  31  31  32     16  17  22  33  35
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R12  30     24  24  57  55  53     24  21  51  40  36     18  21  24  39  42
R12  35     31  33  62  71  73     29  29  64  60  61     19  24  29  52  58
R12  40     36  43  67  99 105     35  40  65  64  65     19  29  38  58  63
R12  45     39  52  79 129 138     39  49  73  98 104     20  29  41  52  54
R12  50     42  61  89 153 165     41  49  82 127 137     21  24  35  46  48
R12  55     47  69  97 168 182     44  64  92 161 173     18  27  38  48  49
R12  60     51  76 107 175 189     50  73  94 175 188     23  36  39  50  53
R12  65     57  80 114 171 186     53  90 121 187 203     31  39  47  51  54
R12  70     69  79 111 161 176     68  93 131 189 203     44  45  49  53  55
R12  75     76  78 103 141 152     86  97 129 182 195     52  67  73  70  69
R12  80     94  93 106 118 121     80  95 123 167 179     52  61  75  92  97
R12  85    110 112 114 104 100    102  96 117 147 156     65  70  70  84  87
R12  90    146 133 118  88  72    130 163 159 127 114    106 111 114 107 105
R12 100    132 132 132 132 132    154 154 154 154 154     75  75  75  75  75
R12 120    183 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R12 140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R12 160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R12 180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R12 200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69
R13  25     20  38  46  77  95     22  30  35  58  77     15  19  30  43  98
R13  30     24  46  63 104 126     21  39  40  74  92     17  24  38  53 104
R13  35     33  56  90 136 159     28  45  57  92 113     21  26  49  62 110
R13  40     40  67 118 177 202     34  57  82 120 139     21  28  71  85 114
R13  45     46  76 145 220 250     41  67 111 161 183     23  27  50  70 122
R13  50     54  88 167 255 289     49  78 138 209 236     22  26  41  60  75
R13  55     59  96 184 282 321     56  86 162 244 277     20  28  39  56  63
R13  60     63 104 199 309 353     66 102 183 272 306     29  33  39  58  92
R13  65     65 104 209 331 336     61 108 208 334 342     35  35  44  50  77
R13  70     77 102 203 349 416     74 116 226 342 391     46  44  54  44  67
R13  75     86 100 132 341 422     94 120 227 377 441     52  62  80  65  59
R13  80    102 102 152 290 377     90 111 212 385 469     54  65 106 116  94
R13  85    121 116 135 195 281    112 118 181 332 423     68  74 128 164 171
R13  90    158 140 173 134 194    135 149 180 219 298    109 117 165 185 189
R13 100    192 192 192 192 192    224 224 224 224 224     97  97  97  97  97
R13 120    183 183 183 183 183     79  79  79  79  79    211 211 211 211 211
R13 140    125 125 125 125 125     72  72  72  72  72    146 146 146 146 146
R13 160     90  90  90  90  90     65  65  65  65  65    105 105 105 105 105
R13 180     71  71  71  71  71     58  58  58  58  58     81  81  81  81  81
R13 200     61  61  61  61  61     52  52  52  52  52     69  69  69  69  69

***RANDOM WINGS, CODE RW***
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RW 1  15     9  11  11  10  10      7  10  10  11  11
RW 1  20    10   8  11  12  13      5   5   9  13  14
RW 1  25    12   9  20  21  21      2   4  11  17  18
RW 1  30    15  13  25  27  27      4   6  15  20  21
RW 1  35    17  18  29  29  28      7  10  17  27  29
RW 1  40    18  22  36  30  27      6  11  20  33  37
RW 1  45    24  27  46  33  27     11  14  22  40  45
RW 1  50    23  29  50  36  29     13  16  28  45  50
RW 1  55    21  29  44  38  35     16  16  25  42  46
RW 1  60    21  29  37  38  38     16  19  26  39  43
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RW 1  70    30  42  44  34  30     17  22  32  47  50
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REPRODUCIBILITY
ORIGINAL PAGE IS

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RW 1  75    35  38  45  51  52     32  43  46  42  40
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RW 1  85    41  33  46  73  80     56  61  76  81  82
RW 1  90    76  54  63  81  87     79 118 121 115 112
RW 1 100    74  59  53  53  53     75 132  87  53  53
RW 1 120    72  64  52  52  52     72  85  52  52  52
RW 1 140    69  69  69  69  69     69  69  69  69  69
RW 1 160    87  87  87  87  87     87  87  87  87  87
RW 1 180    87  87  87  87  87     87  87  87  87  87
RW 1 200    87  87  87  87  87     87  87  87  87  87
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RW 2  85    41  35  46  57  60     56  61  74  60  61
RW 2  90    76  54  62  55  57     78 113 113  57  56
RW 2 100    63  44  57  53  53     63  44  57  53  53
RW 2 120    50  57  52  52  52     50  57  52  52  52
RW 2 140    69  69  69  69  69     69  69  69  69  69
RW 2 160    87  87  87  87  87     87  87  87  87  87
RW 2 180    87  87  87  87  87     87  87  87  87  87
RW 2 200    87  87  87  87  87     87  87  87  87  87
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RW 3 120    71  65  52  52  52     71  79  52  52  52
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REPRODUCIBILI
ORIGINAL PAGE

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| RW | 3 | 160 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| RW | 3 | 180 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
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| RW | 4 | 70 | 28 | 35 | 35 | 30 | 28 | 17 | 19 | 24 | 26 | 26 |
| RW | 4 | 75 | 36 | 40 | 41 | 35 | 33 | 31 | 31 | 36 | 42 | 44 |
| RW | 4 | 80 | 31 | 34 | 38 | 41 | 42 | 37 | 47 | 54 | 56 | 57 |
| RW | 4 | 85 | 43 | 45 | 46 | 45 | 46 | 56 | 62 | 65 | 55 | 56 |
| RW | 4 | 90 | 77 | 59 | 48 | 49 | 49 | 72 | 77 | 95 | 54 | 54 |
| RW | 4 | 100 | 74 | 65 | 50 | 53 | 53 | 71 | 74 | 74 | 53 | 53 |
| RW | 4 | 120 | 72 | 71 | 52 | 52 | 52 | 70 | 71 | 52 | 52 | 52 |
| RW | 4 | 140 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 | 69 |
| RW | 4 | 160 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| RW | 4 | 180 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| RW | 4 | 200 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
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| RW | 5 | 80 | 31 | 38 | 43 | 43 | 43 | 37 | 48 | 52 | 49 | 48 |
| RW | 5 | 85 | 44 | 52 | 55 | 46 | 46 | 56 | 61 | 61 | 50 | 50 |
| RW | 5 | 90 | 79 | 82 | 72 | 50 | 50 | 73 | 86 | 98 | 52 | 51 |
| RW | 5 | 100 | 76 | 78 | 62 | 53 | 53 | 72 | 80 | 75 | 53 | 53 |
| RW | 5 | 120 | 72 | 73 | 52 | 52 | 52 | 70 | 75 | 52 | 52 | 52 |
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| RW | 5 | 160 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| RW | 5 | 180 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| RW | 5 | 200 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
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| RW | 6 | 5 | 5 | 8 | 11 | 11 | 11 | 3 | 6 | 9 | 9 | 9 |

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RW 6 100   77  86  69  53  53    73  85  76  53  53
RW 6 120   73  77  52  52  52    71  79  52  52  52
RW 6 140   69  69  69  69  69    69  69  69  69  69
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RW 6 180   87  87  87  87  87    87  87  87  87  87
RW 6 200   87  87  87  87  87    87  87  87  87  87
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RW 7 180   87  87  87  87  87    87  87  87  87  87
RW 7 200   87  87  87  87  87    87  87  87  87  87
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RW 9  140    69   69   69   69   69    69   69   69   69   69
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RW 9  180    97   87   87   87   87    87   87   87   87   87
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RW10   65    20   34   35   29   27    20   19   20   21   21
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RW10  140     69   69   69   69   69     69   69   69   69   69
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RW10  180     87   87   87   87   87     87   87   87   87   87
RW10  200     87   87   87   87   87     87   87   87   87   87
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RW12 200    87  87  87  87  87    87  87  87  87  87
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RW13 200    87  87  87  87  87    87  87  87  87  87
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P13  15   679 633 608 592 587   586 557 538 527 522   447 496 749 824 849
P13  20   652 644 645 644 645   570 575 579 582 582   434 497 745 822 848
P13  25   621 643 663 673 677   616 613 611 611 610   445 519 732 803 827
P13  30   607 672 719 747 757   500 591 656 695 707   390 454 740 828 857
P13  35   571 696 784 838 856   459 613 722 788 810   362 520 752 850 883
P13  40   531 692 808 877 900   509 654 758 821 841   412 588 714 790 815
P13  45   523 690 802 869 892   534 670 766 824 844   440 551 630 678 693
P13  50   495 667 789 863 887   491 649 762 830 853   418 493 545 577 588
P13  55   471 646 770 846 871   483 636 746 812 834   430 472 502 520 526
P13  60   517 655 753 813 832   587 673 734 771 784   544 570 588 600 604
P13  65   550 642 707 747 760   681 710 730 742 747   677 703 722 733 737
P13  70   583 629 662 682 688   648 663 673 679 681   574 597 597 602 604
P13  75   616 616 616 616 616   615 615 615 615 615   471 471 471 471 471
P13  80   637 637 637 637 637   571 571 571 571 571   455 455 455 455 455
P13  85   657 657 657 657 657   526 526 526 526 526   439 439 439 439 439
P13  90   678 678 678 678 678   482 482 482 482 482   422 422 422 422 422
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P13 120   599 599 599 599 599   328 328 328 328 328   325 325 325 325 325
P13 140   479 479 479 479 479   262 262 262 262 262   260 260 260 260 260
P13 160   360 360 360 360 360   197 197 197 197 197   195 195 195 195 195
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P13 200   120 120 120 120 120    66  66  66  66  66    65  65  65  65  65

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PW13   15   903 890 876 867 864   324 583 835 775 810
PW13   20   884 883 880 877 876   327 575 805 803 836
PW13   25   864 878 887 892 894   344 575 739 839 872
PW13   30   854 872 885 892 895   324 552 751 832 859
PW13   35   821 858 885 901 906   304 545 786 890 918
PW13   40   794 854 896 921 930   328 550 706 944 974
PW13   45   798 853 899 927 937   349 537 618 920 943
PW13   50   768 831 876 903 912   339 489 650 856 889
PW13   55   734 761 781 793 797   366 450 649 771 811
PW13   60   721 686 662 647 642   469 550 674 749 773
PW13   65   743 720 704 694 690   601 713 794 842 858
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PW13   90   707 707 707 707 707   707 707 707 707 707
PW13  100   654 654 654 654 654   654 654 654 654 654
PW13  120   615 615 615 615 615   615 615 615 615 615
PW13  140   575 575 575 575 575   575 575 575 575 575
PW13  160   536 536 536 536 536   536 536 536 536 536
PW13  180   496 496 496 496 496   496 496 496 496 496
PW13  200   457 457 457 457 457   457 457 457 457 457

*** SMALL AND LARGE SCALE U-D AND V-D ANNUAL CORRELATIONS, CODE CS,CL***
CS13    0    -55  -17  -47  -65  -70   108  -27 -122 -181 -201
CS13    5    -61  -22  -42  -54  -58    82  -29 -107 -156 -173
CS13   10    -67  -26  -38  -44  -46    56  -32  -93 -131 -144
CS13   15    -74  -31  -33  -34  -34    30  -34  -78 -106 -116
CS13   20    -80  -36  -28  -24  -22     4  -36  -64  -82  -88
CS13   25    -86  -71  -60  -54  -52     1  -73 -125 -157 -168
CS13   30   -122  -67  -28   -4    4   -56  -75  -88  -97 -100
CS13   35   -113  -46    2   30   40   -75  -25   11   32   39
CS13   40    -72   -8   37   65   75  -101   15   98  147  163
CS13   45    -51   -9   22   40   46  -152   -8   95  157  177
CS13   50   -107  -52  -12   10   18  -169  -38   55  111  129
CS13   55   -213  -39    0   52   70  -183  -72    8   56   72
CS13   60   -102 -108  -15   41   60  -173  -93  -37   -2    9
CS13   65   -137  -77   15   68   87  -231  -56   68  143  168
CS13   70   -143  -82   19   79   99  -256  -58   82  168  196
CS13   75   -149  -86   24   89  112  -283  -61   97  193  225
CS13   80   -155  -91   29   99  124  -309  -63  112  218  253
CS13   85   -162  -96   34  110  136  -335  -65  126  243  281
CS13   90   -168 -100   38  120  148  -361  -67  141  268  310
CS13  100   -181 -109   48  140  172  -413  -72  170  318  366
CS13  120   -181 -109   48  140  172  -413  -72  170  318  366
CS13  140   -181 -109   48  140  172  -413  -72  170  318  366
CS13  160   -181 -109   48  140  172  -413  -72  170  318  366
CS13  180   -181 -109   48  140  172  -413  -72  170  318  366
CS13  200   -181 -109   48  140  172  -413  -72  170  318  366
```

```
CL13   0    309 -207 -576 -796 -869     23  145  235  289  309
CL13   5    289 -232 -553 -763 -832     23  136  218  268  287
CL13  10    270 -197 -530 -729 -795     23  126  202  248  265
CL13  15    251 -191 -507 -696 -759     24  117  185  227  242
CL13  20    232 -136 -484 -663 -722     24  107  169  207  220
CL13  25    283 -150 -459 -644 -705    -18   69  131  169  182
CL13  30    223 -159 -432 -595 -650     74  116  147  165  172
CL13  35     56 -202 -385 -495 -532     30  107  163  196  207
CL13  40     96 -183 -382 -502 -542     -4   40   71   90   96
CL13  45    163 -170 -407 -549 -596     34  -30  -76 -102 -111
CL13  50    137 -180 -405 -540 -586     50  -47 -116 -157 -171
CL13  55    126 -144 -335 -450 -489     36  -50 -110 -146 -159
CL13  60     79 -108 -240 -320 -347     -2  -84 -143 -178 -190
CL13  65     60 -133 -277 -361 -390     26  -94 -160 -200 -214
CL13  70     41 -133 -254 -328 -353     26 -111 -180 -222 -237
CL13  75     22 -127 -231 -294 -316     27 -127 -199 -243 -259
CL13  80      3 -122 -208 -261 -280     27 -144 -219 -265 -282
CL13  85    -16 -117 -185 -227 -243     27 -160 -238 -287 -304
CL13  90    -36 -111 -162 -194 -206     27 -177 -258 -309 -327
CL13 100    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
CL13 120    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
CL13 140    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
CL13 160    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
CL13 180    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
CL13 200    -74 -101 -116 -127 -132     28 -210 -297 -352 -372
-----END OF FILE WRITTEN-----

***QUASI-BIENNIAL OSCILLATIONS,CODE QP,QD,QT,QU, OR QV***
QP 15    1  291    1  807    1  554    1  404    1  353
QP 20    2  248    2  778    2  537    2  392    2  344
QP 25    3  369    3  811    3  506    3  323    3  262
QP 30    6   63    8  675   10  491   11  381   12  344
QP 35    8   49   15  669   20  491   23  385   24  349
QP 40    9   39   22  665   31  491   37  387   39  352
QP 45    8   27   26  645   39  465   47  357   49  321
QP 50    9  839   27  595   40  422   48  317   50  282
QP 55   11  825   26  574   37  395   43  288   45  251
QP 60   16  837   31  580   42  396   49  285   51  249
QP 65   13  732   26  525   35  378   41  289   43  259
QP 70   11  669   21  497   28  360   33  277   34  250
QP 75    8  646   16  469   21  342   25  266   26  240
QP 80    5  603   10  441   14  325   16  254   17  231
QP 85    3  560    5  413    7  307    8  243    9  222
QP 90    0  517    0  384    0  289    0  231    0  212
QD 15    5  428    2  151    1  823    0  704    0  665
QD 20   10  368    5   95    1  770    1  653    1  614
QD 25   15  410    7  188    2   30    1  805    1  773
QD 30    6  287    5  807    4  557    4  407    3  357
QD 35    6   76    9  699   11  523   12  417   13  382
QD 40    8   66   15  695   20  522   23  419   24  384
QD 45    9   40   24  668   35  496   42  393   44  358
QD 50    8  869   28  625   43  450   52  346   55  311
QD 55    8  842   26  589   38  403   46  299   48  263
QD 60   15  829   19  584   22  409   24  304   24  269
QD 65   13  704   16  466   18  296   20  194   20  160
QD 70   10  645   13  411   15  243   16  143   16  110
```

```
QD 75    8   585   10   355   11   191   12    92   12    59
QD 80    5   526    6   300    7   138    8    41    8     9
QD 85    3   466    3   244    4    85    4   860    4   828
QD 90    0   407    0   189    0    33    0   809    0   778
QT 15    4    10    3   695    2   563    2   483    2   457
QT 20    6     4    6   673    4   529    4   443    4   414
QT 25   11    18    9   626    7   439    6   327    6   290
QT 30    9     9   10   636   10   462   11   357   11   322
QT 35    3   853    9   631   14   473   17   378   18   346
QT 40    1   810    9   603   16   455   19   367   21   337
QT 45    4     3    8   580   10   370   12   245   12   203
QT 50    1   784    2   492    3   283    4   157    4   115
QT 55    2   811    4   514    4   302    5   175    5   132
QT 60    6    18    6   513    5   245    5    85    5    31
QT 65    5   822    5   476    4   228    4    80    4    29
QT 70    4   817    4   454    3   194    3    40    3   856
QT 75    3   811    3   432    3   161    3   869    3   814
QT 80    2   805    2   410    2   126    2   829    2   771
QT 85    1   799    1   388    1    94    1   788    1   728
QT 90    0   794    0   366    0    61    0   748    0   685
QU 15   42   655   25   586   14   537    6   507    4   497
QU 20   84   504   51   505   27   505   13   506    8   505
QU 25  126   325   76   390   41   436   19   463   12   472
QU 30  158   205   99   355   57   462   31   526   23   547
QU 35  146    79   93   280   56   424   33   511   25   539
QU 40   56   843   47   221   40   398   37   505   35   540
QU 45   21   591   24   102   26   374   27   537   28   591
QU 50   49   289   43   793   39   282   36   498   35   570
QU 55   61   421   55   845   51   278   48   463   47   520
QU 60   52   159   47   721   44   253   41   494   40   574
QU 65   44     7   39   640   36   221   34   493   34   583
QU 70   35   725   31   558   29   190   27   492   27   592
QU 75   26   573   24   476   22   158   21   490   20   600
QU 80   17   421   16   395   15   127   14   489   13   609
QU 85    9   269    8   313    7    95    7   483    7   618
QU 90    0   118    0   231    0    63    0   486    0   626
QV 15    1   226    3    91    5   866    7   809    7   790
QV 20    1   264    6   140   11    53   13     0   14   853
QV 25    1   438    9   246   16   109   20    27   21     0
QV 30    1   404    9   270   15   175   19   117   20    98
QV 35    8   274   13   245   17   225   20   213   20   209
QV 40    6   174   16   238   22   284   26   312   28   321
QV 45    7   441   11   363   14   308   16   275   16   264
QV 50    1   544   19   453   31   389   39   350   41   337
QV 55    5   647   11   543   15   469   17   424   18   409
QV 60    4   571    9   533   13   507   15   491   15   485
QV 65    4   609    8   582   11   564   12   552   13   548
QV 70    3   648    6   632    9   621   10   614   10   611
QV 75    2   686    5   681    6   678    7   675    8   674
QV 80    1   724    3   730    4   734    5   737    5   737
QV 85    1   763    2   779    2   791    2   793    3   800
QV 90    0   801    0   828    0   848    0   859    0   863
-----END OF FILE WRITTEN-----
```

# APPENDIX C

## SAMPLE INPUT AND OUTPUT FOR THE PROFILE PROGRAM

Input to PROFILE is as follows:

(All input data cards are in free field format.)

CARD 1

INITIAL HEIGHT - Height of starting position, km

INITIAL LATITUDE - Latitude of starting position (degrees, southern latitudes negative)

INITIAL WEST LONGITUDE - West longitude of starting position (degrees, 0 to 360 degrees, or east longitudes negative)

F10.7 - Solar 10.7 cm radio noise flux ($10^{-22}$ watts/m$^2$) at time of calculations. Use zero if height does not go over 90 km. Use 230 for design applications or consult Aerospace Environment Division (AED) of Marshall Space Flight Center (MSFC) for monthly predictions.

MEAN F10.7 - 81 day mean solar 10.7 cm flux. Use zero if height does not go over 90 km. Use 230 for design applications or consult AED, MSFC for monthly predictions.

AP - Geomagnetic index $a_p$. Use zero if height does not go over 90 km. Use 20.3 for design steady state conditions, or 400 for maximum conditions, or consult AED, MSFC.

DATE - Date for starting time of calculations (month, date, two digit year). Use month 13 for annual reference period.

GREENWICH TIME - Time for starting position (hours, minutes, seconds). Use time corresponding to local time - 0900 for design steady state, or 1400 maximum conditions.

LAT INCREMENT - Latitude displacement (degrees) between successive positions (new lat = old lat + lat increment). Use zero if trajectory positions are to be read in.

WEST LON INCREMENT - West longitude displacement (degrees) between successive positions (new long = old lon + lon increment). Use zero if trajectory positions are to be read in.

HEIGHT INCREMENT - Height decrease (km) between successive positions (new height = old height - height increment). Normal profiles are generated downward. If an upward generated profile id desired set height increment negative.

| | | |
|---|---|---|
| CARD 1 | MAXIMUM NUMBER OF POSITIONS | Number of positions to be computed, <u>not</u> including initial position. Use zero if trajectory positions are to be read in. |
| | TIME INCREMENT | Time displacement (seconds) between successive positions for automatically generated profiles (new time = old time + time increment) |
| | TRAJECTORY OPTION | 0 for linear profile generated automatically internal to the program, or value equal to unit number (e.g. 5 for card input) for a trajectory with each position to read in. |
| | OUTPUT OPTION | 0 for no non-print output of atmospheric parameter values, or value equal to unit number to get non-print output. |
| | MIN. GEOSTROPH. LAT. | Lowest latitude (magnitude) for which only ordinary (first order) geostrophic winds are to be considered. Below this latitude second order geostrophic wind will be evaluated. |
| CARD 2 | GROVES INPUT UNIT | Unit number for tape containing Groves and stationary perturbations (SCIDAT tape in Appendix A). Use any available unit number. |
| | RANDOM INPUT UNIT | Unit number of file from which random perturbation data are to be read. If same as Groves input unit, these are read from SCIDAT tape. If card input, use 5. |
| | QBO INPUT UNIT | Unit number of file from which QBO parameters are to be read. If same as Groves input unit, these are read from SCIDAT tape. If card input, use 5. |
| | 4-D INPUT UNIT | Unit number for 4-D input data tape. Use any available unit number. |
| | RANDOM OPTION | 1 means compute random perturbation output, 2 means do not compute random perturbation output. |
| | QBO OPTION | 1 means compute QBO output, 2 means do not compute QBO output. |
| | FIRST RANDOM NUMBER | Initial number for random number generator used to compute random perturbations (can be any odd positive integer). Use 1 for standard design applications. |
| | NMC READ OPTION | 0 means read NMC grid data from SCIDAT tape, otherwise these data are read from cards. |
| | 4-D, P, D, T, SCRATCH UNIT | Unit number for scratch file for 4-D grid profiles required in computations. Use any available unit number. This normally is a temporary drum file. |

| | | |
|---|---|---|
| CARD 2 (cont'd.) | NMC GRID POINTS SCRATCH UNIT - | Unit number for scratch file to store NMC grid point data. Use any available unit number. This normally is a temporary drum file. |
| CARD 3 (OPTIONAL)* | INITIAL PL, DL, TL, PS, DS, TS - | Initial values of large scale and small scale random relative pressure, density, and temperature perturbations, percent. Use zeros for standard design applications. |
| | INITIAL UL, VL, US, VS - | Initial values of large scale and small scale random wind components, m/s. Use zeros for standard design applications. |

* - Include card 3 only if random option = 1.

| | |
|---|---|
| TRAJECTORY INPUT - | Use only if linear profile is not to be generated automatically. Each record has time (seconds), height (km), latitude (degrees), and west longitude (degrees). |
| TRAJECTORY BACKUP RECORD - | Only if trajectory input is used. Same form as a trajectory position but with any negative height value. |

The trajectory input records are optional, in free field format. If included, use as many records (e.g. cards), as necessary.

Input for the following sample output listing is as follows:

CARD1: 92.9, 28.45, 80.53, .0, .0, .0, 1, 1, 75, 0, 0, 0, .0, .0, 2., 47, 0, 0, 0, 20,

CARD2: 3, 3, 3, 4, 1, 1, 1, 0, 12, 13

CARD3: 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,

## A SUMMARY OF THE ORGANIZATION OF AN INPUT DATA DECK IS AS FOLLOWS

Initial Data

Card 1, as described at the beginning of this Appendix

Card 2, as described at the beginning of this Appendix

Card 3, optional, included only if random option = 1

## NMC Grid Data

Optional. Include as card input only if this is not to be read from the SCIDAT data tape.

## Random Perturbation Data

Optional. Include as card input only if the random input unit is 5 and these data are not to be read from the SCIDAT data tape or some other input file. Do not include if random option = 2.

## QBO Parameters

Optional. Include as card input only if the QBO input unit is 5 and these data are not to be read from the SCIDAT data tape or some other file. Do not include if QBO option = 2.

## Trajectory Position Data and Backup Card

Optional. Include if trajectory, rather than linear profile generated by the program is to be evaluated, and if trajectory option is 5. Trajectory data is on other file if trajectory unit is not 0 or 5.

## More Data of the Same Kind (Starting with Initial Data, Card 1)

If additional trajectories or profiles are to be evaluated, the data may be input one set immediately after the other. The program is actually more efficient for such multiple runs if the month remains the same. This is because as long as the month remains the same the SCIDAT data tape read can be avoided for each subsequent data set.

## OUTPUT OF PROFILE IS AS FOLLOWS

| | | |
|---|---|---|
| JULIAN DATE | - | Computed from input date, set equal to zero for month 13 (annual average) |
| INITIAL STANDARD DEVIATIONS IN P, D, T, U, V FOR LARGE SCALE AND SMALL SCALE | - | Computed for initial position on input data |

| | |
|---|---|
| HEIGHT, LAT, LON, TIME | Position and time where atmospheric parameters are evaluated |
| UNPERTURBED PRESSURE DENSITY, TEMPERATURE AND GEOSTROPHIC WIND (monthly mean values) | Computed from Jacchia, 4-D, or Groves - plus - stationary perturbations, depending on height. |
| TOTAL PRESSURE, DENSITY, TEMPERATURE, AND WIND | Monthly means plus random perturbations and QBO perturbations |
| THERMAL WIND SHEAR | From thermal wind equations using finite differences of Jacchia, 4-D, or Groves - plus - stationary perturbations, depending on height. |
| MEAN VERTICAL WIND | From mean isentropic surface slopes |
| PERTURBATION VALUES | Stationary perturbations, QBO perturbations and amplitudes, and random perturbations and magnitudes for the small scale (S), large scale (L), and total (T) perturbations. Perturbations are those which are added to monthly means to produce total results output. |

Following is a listing of sample output from the GRAM program. Initial lines of output are merely listings of the input data for easy reference. These listings are provided to indicate formats and kinds of input and output data. For a listing of the input cards for these sample outputs, see earlier in the Appendix.

```
****** GLOBAL REFERENCE ATMOSPHERE - MOD 2 ******

INITIAL HEIGHT =   92.00 KM             INITIAL LAT =  28.45 DEG                 INITIAL WEST LON =  80.53 DEG
F10.7 =     0.00                        MEAN F10.7 =    0.00                     AP =     0.00
DATE =  1/ 1/75                         GREENWICH TIME =  0: 0: 0
LAT INCREMENT =   0.00 DEG              WEST LON INCREMENT =   0.00 DEG          HEIGHT INCREMENT =    2.00 KM
MAXIMUM NUMBER OF POSITIONS =   47      TIME INCREMENT =    0 SEC
TRAJECTORY OPTION =    0                OUTPUT OPTION =  0                       MIN GEOSTROPH LAT =  20.0

GROVES INPUT UNIT =  3                  RANDOM INPUT UNIT =  3                   QBO INPUT UNIT =  3
4-D INPUT UNIT =  4                     RANDOM OPTION =  1                       QBO OPTION =  1
FIRST RANDOM NUMBER =      1
NMC READ OPTION =  0                    4-D P.D.T DATA SCRATCH UNIT = 12
NMC GRID POINTS SCRATCH UNIT = 13       JULIAN DATE = 2442414.0

INITIAL P.D.T =   0.00 %     0.00 %     0.00 %           SIGMA P.D.T =  11.13 %    11.06 %    6.58 %
INITIAL U.V =    0.00 M/S      0.00 M/S                  SIGMA U.V =   47.48 M/S     93.93 M/S            LARGE SCALE

INITIAL P.D.T =   0.00 %     0.00 %     0.00 %           SIGMA P.D.T =   7.53 %    11.89 %    7.81 %
INITIAL U.V =    0.00 M/S      0.00 M/S                  SIGMA U.V =   31.35 M/S     62.02 M/S            SMALL SCALE

INITIAL UDL,VDL = -10.39 % -16.73 %                      INITIAL UDS,VDS = -10.71 %  -9.15 %

**  PERCENT DEVIATIONS FROM 1962 US STANDARD ATMOSPHERE APPEAR BELOW PRESSURE, DENSITY AND TEMPERATURE VALUES  **


                          UNPERTURBED (MONTHLY MEAN)            MEAN PLUS PERTURBATIONS         THERMAL
                      -----------------------------------  ----------------------------------     WIND      PERTURBATION VALUES
HEIGHT   LAT    WEST   PRES.    DENS.   TEMP  GEOSTROPH.    PRES.    DENS.   TEMP     TOTAL      SHEAR
 (KM)           LON    (NT/     (KG/    (DEG  WIND (M/S)    (NT/     (KG/    (DEG  WIND (M/S)  (M/S/KM) ----------------------------
TIME    (DEG)  (DEG)   M**2)    M**3)   KEL-  ----------    M**2)    M**3)   KEL-  ----------  --------  P    D    T    U    V   W
(SEC)                                   VIN)   E-W   N-S                     VIN)  E-W    N-S  E-W  N-S (%)  (%)  (%)  M/S  M/S CM/S

 90.00  28.45  80.53 .199E+00 .367E-05  189.    14.    19. .229E+00 .386E-05  207.  -16.    82.  -.8  -.4                      -.19
     0                  21.0%    15.8%  4.5%                  39.3%    21.8% 14.8%                     7.9  7.8   .1           SP
                                                                                                       0.0  0.0  0.0   0.   0. QBO
                                                                                                       0.0  0.0  0.0   0.   0. MAG
                                                                                                       9.6  2.6  7.0  -4.   7. RANS
                                                                                                       7.7 11.8  8.2  30.  62. SIGS
                                                                                                       5.4  2.6  2.9 -26.  55. RANL
                                                                                                      11.1 11.4  7.0  47.  97. SIGL
                                                                                                      15.1  5.2  9.9 -30.  62. RANT
                                                                                                      13.5 16.4 10.8  56. 115. SIGT

 88.00  28.45  80.53 .281E+00 .513E-05  191.    12.    20. .324E+00 .543E-05  209.   19.    74. -1.0  -.2                      -.29
     0                  18.5%    12.0%  5.9%                  36.6%    18.5% 15.8%                     7.7  7.3   .4           SP
                                                                                                       -.1  -.1  -.0  -0.   0. QBO
                                                                                                        .2   .1   .0   0.   0. MAG
                                                                                                       7.7  -.5  8.2  14.  25. RANS
                                                                                                       7.3 10.0  7.1  26.  52. SIGS
                                                                                                       7.6  6.5  1.1  -7.  30. RANL
                                                                                                      10.4 10.0  6.2  41.  82. SIGL
                                                                                                      15.3  6.0  9.3   7.  54. RANT
                                                                                                      12.7 14.1  9.4  48.  97. SIGT

 86.00  28.45  80.53 .398E+00 .716E-05  194.    10.    20. .448E+00 .736E-05  213.   19.    18. -1.1  -.1                      -.39
     0                  16.0%     8.2%  7.4%                  30.6%    11.2% 17.7%                     7.5  6.8   .7           SP
                                                                                                       -.1  -.2  -.0  -1.   0. QBO
                                                                                                        .4   .2   .1   1.   0. MAG
                                                                                                       3.4 -2.0  5.5  22. -13. RANS
                                                                                                       6.9  7.8  5.9  20.  39. SIGS
                                                                                                       9.2  5.0  4.2 -12.  11. RANL
                                                                                                       9.6  8.1  5.2  33.  64. SIGL
```

```
                                                                                                          12.7  3.8  9.6  18.  -3. RANT
                                                                                                          11.8 11.3  7.9  39.  75. SIGT

84.00  28.45  80.53 .560E+00 .996E-05  196.   13.    21. .632E+00 .103E-04  213.    2.   17. -1.4  .1                          -.52
   0                   12.9%     4.1%   8.7%                 27.4%     8.2%  18.1%                     7.3  6.4  1.0              SP
                                                                                                        -.1  -.4  -.0  -1.   0. QBO
                                                                                                         .6   .4   .1   1.   0. MAG
                                                                                                         6.2  1.1  5.1  28.  -1. RANS
                                                                                                         6.5  6.5  5.1  17.  30. SIGS
                                                                                                         6.8  3.2  3.6 -39.  -3. RANL
                                                                                                         8.9  6.9  4.5  29.  50. SIGL
                                                                                                        13.0  4.3  8.7 -11.  -4. RANT
                                                                                                        11.0  9.5  6.8  34.  58. SIGT

82.00  28.45  80.53 .782E+00 .138E-04  198.   20.    21. .867E+00 .146E-04  207.   -2.    4. -1.5  .2                          -.60
   0                    9.1%     -.4%   9.8%                 28.9%     5.5%  14.8%                     6.9  5.8  1.1              SP
                                                                                                        -.1  -.4  -.0  -1.   0. QBO
                                                                                                         .8   .5   .2   1.   0. MAG
                                                                                                        10.4  4.7  5.7  19.   0. RANS
                                                                                                         6.1  6.2  4.7  17.  26. SIGS
                                                                                                          .6  1.6 -1.0 -48. -17. RANL
                                                                                                         8.2  6.9  4.3  29.  45. SIGL
                                                                                                        11.8  6.4  4.6 -21. -17. RANT
                                                                                                        10.2  9.3  6.4  33.  53. SIGT

80.00  28.45  80.53 .109E+01 .191E-04  200.   21.    20. .119E+01 .205E-04  202.  -13.   12. -1.7  .3                          -.68
   0                    5.3%    -4.7%  10.8%                 14.8%     2.8%  11.7%                     6.5  5.2  1.3              SP
                                                                                                        -.0  -.5  -.0  -1.   0. QBO
                                                                                                         1.0   .6   .2   2.   0. MAG
                                                                                                         6.6  4.5  2.1   3.   3. RANS
                                                                                                         5.6  6.0  4.4  16.  23. SIGS
                                                                                                         2.5  3.9 -1.3 -37. -12. RANL
                                                                                                         7.4  6.9  4.0  29.  40. SIGL
                                                                                                         9.1  8.3   .8 -34.  -9. RANT
                                                                                                         9.3  9.1  5.9  33.  46. SIGT

78.00  28.45  80.53 .152E+01 .262E-04  203.   25.    20. .163E+01 .279E-04  203.    0.  -11. -2.1  .4                          -.92
   0                    2.2%    -4.8%   7.7%                  9.6%     1.3%   7.7%                     6.1  4.7  1.4              SP
                                                                                                          .0  -.6  -.0  -0.   0. QBO
                                                                                                         1.2   .7   .2   2.   0. MAG
                                                                                                         3.0  4.1 -1.1   1.  -1. RANS
                                                                                                         5.2  5.9  4.6  17.  21. SIGS
                                                                                                         4.1  3.0  1.2 -25. -30. RANL
                                                                                                         6.8  7.0  4.3  31.  39. SIGL
                                                                                                         7.2  7.1   .1 -24. -32. RANT
                                                                                                         8.6  9.2  6.3  35.  45. SIGT

76.00  28.45  80.53 .212E+01 .359E-04  206.   25.    20. .224E+01 .379E-04  204.    3.  -24. -2.4  .5                         -1.11
   0                     .7%    -3.8%   4.7%                  6.3%     1.4%   4.1%                     5.7  4.1  1.6              SP
                                                                                                          .2  -.6  -.0   0.   0. QBO
                                                                                                         1.4   .9   .3   2.   0. MAG
                                                                                                        -2.6   .5 -3.1   2.  -3. RANS
                                                                                                         4.8  5.8  4.8  17.  20. SIGS
                                                                                                         8.1  5.5  2.5 -24. -41. RANL
                                                                                                         6.2  7.2  4.5  33.  38. SIGL
                                                                                                         5.4  6.0  -.6 -22. -44. RANT
                                                                                                         7.8  9.2  6.6  37.  43. SIGT

74.00  28.45  80.53 .293E+01 .490E-04  208.   34.    19. .287E+01 .524E-04  188.   -6.   -8. -2.3  .5                         -1.16
   0                    -.3%    -2.2%   2.0%                 -2.3%     4.4%  -8.0%                     5.4  4.3  1.1              SP
                                                                                                          .3  -.5   .0   1.   0. QBO
                                                                                                         1.6  1.0   .3   3.   0. MAG
                                                                                                        -7.7  1.6 -9.3  -6.   4. RANS
                                                                                                         4.6  5.6  4.6  18.  18. SIGS
```

```
                                                                                                                   5.3  5.8  -.5 -34. -24. RANL
                                                                                                                   5.8  7.2  4.5  34.  34. SIGL
                                                                                                                  -2.4  7.4 -9.8 -40. -28. RANT
                                                                                                                   7.4  9.1  6.4  38.  39. SIGT

 72.00  28.45  80.53 .401E+01 .659E-04  212.    44.    19. .435E+01 .748E-04  200.    6.    34. -2.3   .5                           -1.24
   0                   -.9%    -1.0%     .1%                    7.5%    12.3%  -5.8%                       5.2  4.4   .7            SP
                                                                                                            .5  -.4   .0   1.   1. QBO
                                                                                                           1.8  1.2   .4   3.   1. MAG
                                                                                                          -2.0  4.2 -6.2  -8.  15. RANS
                                                                                                           4.6  5.3  3.8  19.  15. SIGS
                                                                                                           9.9  9.7   .2 -31.  -0. RANL
                                                                                                           5.9  7.2  4.1  35.  28. SIGL
                                                                                                           7.9 13.9 -6.0 -39.  15. RANT
                                                                                                           7.4  8.9  5.6  40.  32. SIGT

 70.00  28.45  80.53 .550E+01 .687E-04  216.    47.    18. .586E+01 .970E-04  208.   -7.    23. -2.3   .4                           -1.23
   0                   -.4%     1.3%   -1.7%                    6.1%    10.8%  -5.5%                       5.0  4.6   .3            SP
                                                                                                            .7  -.3   .1   2.   1. QBO
                                                                                                           2.0  1.3   .4   3.   1. MAG
                                                                                                           -.9  1.9 -2.8 -16.   4. RANS
                                                                                                           4.6  5.1  3.0  20.  11. SIGS
                                                                                                           6.6  7.8 -1.2 -41.   0. RANL
                                                                                                           5.9  7.1  3.5  36.  19. SIGL
                                                                                                           5.8  9.7 -3.9 -57.   4. RANT
                                                                                                           7.4  8.7  4.6  41.  22. SIGT

 68.00  28.45  80.53 .742E+01 .116E-03  222.    55.    17. .743E+01 .123E-03  208.   38.    -4.  -.9   .4                            -.96
   0                   -.4%     1.9%   -2.2%                    -.2%     7.6%  -8.5%                       4.7  4.8  -.1            SP
                                                                                                           1.0  -.1   .1   3.   1. QBO
                                                                                                           2.2  1.4   .4   3.   1. MAG
                                                                                                          -4.7  -.8 -3.9  -7.   1. RANS
                                                                                                           4.5  4.9  2.6  20.  12. SIGS
                                                                                                           4.0  6.6 -2.6 -12. -24. RANL
                                                                                                           5.8  7.1  3.4  34.  20. SIGL
                                                                                                           -.8  5.7 -6.5 -20. -22. RANT
                                                                                                           7.4  8.6  4.3  40.  23. SIGT

 66.00  28.45  80.53 .100E+02 .152E-03  230.    54.    18. .105E+02 .161E-03  226.   30.     2.   .0   .2                            -.31
   0                    .8%     3.2%   -2.3%                    6.0%     9.4%  -4.1%                       4.8  4.8  -.1            SP
                                                                                                           1.2   .1   .1   4.   1. QBO
                                                                                                           2.4  1.5   .5   4.   1. MAG
                                                                                                          -4.6 -3.4 -1.2  -3.   8. RANS
                                                                                                           4.4  4.6  2.3  20.  13. SIGS
                                                                                                           8.4  9.3  -.8 -25. -25. RANL
                                                                                                           5.8  7.1  3.3  32.  20. SIGL
                                                                                                           3.9  5.8 -2.0 -28. -16. RANT
                                                                                                           7.3  8.5  4.0  38.  24. SIGT

 64.00  28.45  80.53 .133E+02 .196E-03  237.    56.    18. .138E+02 .205E-03  233.    4.    -8.   .7  -.8                             .37
   0                    1.5%    4.1%   -2.5%                    5.3%     8.8%  -4.1%                       4.8  4.9  -.1            SP
                                                                                                           1.6   .6   .2   4.   1. QBO
                                                                                                           2.6  1.6   .5   4.   1. MAG
                                                                                                          -2.3 -2.1  -.2 -26.  14. RANS
                                                                                                           4.4  4.5  2.1  19.  14. SIGS
                                                                                                           4.5  6.1 -1.6 -31. -33. RANL
                                                                                                           5.8  6.8  3.1  30.  19. SIGL
                                                                                                           2.1  3.9 -1.8 -57. -19. RANT
                                                                                                           7.2  8.1  3.8  35.  24. SIGT

 62.00  28.45  80.53 .175E+02 .250E-03  244.    59.    19. .186E+02 .267E-03  241.   13.    -2.  1.1  -.2                            1.00
   0                    1.6%    4.6%   -2.8%                    7.7%    11.4%  -4.0%                       4.8  4.9  -.1            SP
                                                                                                           2.1  1.1   .3   4.   1. QBO
                                                                                                           2.8  1.8   .6   4.   1. MAG
```

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                                                                                                      -1.6 -1.2  -.4 -27.  13. RANS
                                                                                                       4.3  4.3  2.2  18.  13. SIGS
                                                                                                       5.4  6.5 -1.0 -23. -34. RANL
                                                                                                       5.7  6.3  2.8  27.  17. SIGL
                                                                                                       3.8  5.3 -1.5 -50. -21. RANT
                                                                                                       7.1  7.6  3.6  32.  21. SIGT

60.00  28.45  80.53 .230E+02 .320E-03  251.   56.   19. .233E+02 .328E-03  246.   15.    7.  1.5  -.5                          1.62
   0                    2.4%     4.5%  -1.9%                 3.7%     7.3%  -3.7%                        4.8  4.9  -.1            SP
                                                                                                       2.5  1.6   .3   4.   0. QBO
                                                                                                       3.0  1.9   .6   5.   1. MAG
                                                                                                      -6.0 -3.6 -2.4 -17.   9. RANS
                                                                                                       4.2  4.1  2.2  16.  13. SIGS
                                                                                                       4.8  4.6   .2 -29. -22. RANL
                                                                                                       5.7  5.7  2.5  24.  14. SIGL
                                                                                                      -1.2  1.0 -2.2 -46. -13. RANT
                                                                                                       7.0  7.0  3.3  28.  19. SIGT

58.00  28.45  80.53 .299E+02 .406E-03  257.   51.   20. .302E+02 .422E-03  249.  -12.   18.  1.8  -.3                          1.51
   0                    2.6%     3.9%  -1.1%                 3.6%     7.9%  -4.1%                        4.7  4.6   .1            SP
                                                                                                       2.3  1.8   .3   4.   1. QBO
                                                                                                       2.8  2.1   .5   5.   1. MAG
                                                                                                      -5.3 -3.1 -2.2 -25.  16. RANS
                                                                                                       4.1  3.9  2.2  15.  12. SIGS
                                                                                                       4.0  5.1 -1.2 -41. -19. RANL
                                                                                                       5.4  5.3  2.3  24.  13. SIGL
                                                                                                      -1.3  2.0 -3.3 -67.  -3. RANT
                                                                                                       6.8  6.6  3.1  28.  18. SIGT

56.00  28.45  80.53 .388E+02 .515E-03  263.   45.   21. .431E+02 .573E-03  262.  -13.   27.  2.0  -.2                          1.54
   0                    3.2%     3.6%   -.3%                14.3%    15.2%   -.6%                        4.6  4.3   .3            SP
                                                                                                       2.1  2.0   .2   3.   1. QBO
                                                                                                       2.6  2.3   .4   5.   1. MAG
                                                                                                       -.9   .4 -1.4 -15.  29. RANS
                                                                                                       3.9  3.8  2.1  14.  12. SIGS
                                                                                                       9.5  8.6   .9 -46. -25. RANL
                                                                                                       5.2  4.9  2.1  25.  11. SIGL
                                                                                                       8.5  9.0  -.4 -61.   5. RANT
                                                                                                       6.5  6.2  2.9  28.  17. SIGT

54.00  28.45  80.53 .501E+02 .652E-03  267.   42.   22. .531E+02 .704E-03  264.    8.   26.  1.8  -.1                          1.11
   0                    3.2%     3.3%   -.0%                 9.5%    11.5%  -1.4%                        4.5  4.0   .5            SP
                                                                                                       2.1  2.2   .2   3.   1. QBO
                                                                                                       2.5  2.5   .3   5.   1. MAG
                                                                                                      -2.7  -.3 -2.4  -9.  19. RANS
                                                                                                       3.8  3.6  2.0  14.  12. SIGS
                                                                                                       6.6  5.7   .8 -27. -16. RANL
                                                                                                       5.0  4.7  1.9  25.  11. SIGL
                                                                                                       3.9  5.5 -1.6 -36.   3. RANT
                                                                                                       6.3  5.9  2.7  28.  16. SIGT

52.00  28.45  80.53 .640E+02 .824E-03  271.   40.   23. .715E+02 .924E-03  271.   11.   35.  1.2   .8                           .65
   0                    2.8%     2.9%    .2%                14.8%    15.3%    .1%                        4.4  3.7   .7            SP
                                                                                                       2.2  2.4   .1   3.   0. QBO
                                                                                                       2.5  2.6   .3   5.   1. MAG
                                                                                                      -1.1  1.8 -2.8  -8.  20. RANS
                                                                                                       3.6  3.5  1.8  13.  12. SIGS
                                                                                                      10.3  7.7  2.6 -24.  -8. RANL
                                                                                                       4.9  4.6  1.7  26.  11. SIGL
                                                                                                       9.3  9.5  -.2 -32.  12. RANT
                                                                                                       6.1  5.7  2.5  29.  16. SIGT

50.00  28.45  80.53 .811E+02 .103E-02  275.   41.   22. .861E+02 .113E-02  268.    7.   32.   .6   .2                           .17
   0                    1.7%      .5%   1.5%                 8.0%     9.7%  -1.1%                        3.5  2.6   .9            SP
```

```
                                                                                                                  2.3  2.6   .1    2.   -0. QBO
                                                                                                                  2.6  2.6   .2    4.    2. MAG
                                                                                                                 -4.5   .9 -5.4  -23.   15. RANS
                                                                                                                  3.5  3.4  1.6   12.   11. SIGS
                                                                                                                  8.2  5.5  2.8  -13.   -6. RANL
                                                                                                                  4.7  4.5  1.6   26.   11. SIGL
                                                                                                                  3.8  6.4 -2.6  -36.    9. RANT
                                                                                                                  5.9  5.6  2.3   29.   16. SIGT

48.00  28.45  80.53 .103E+03  132E-02   273.    43.     21. .108E+03 .138E-02   274.    24.     20.    .2    .3                             -.15
    0                  1.1%      .0%   1.0%                    5.8%     4.8%   1.3%                                  2.6  1.5  1.0              SP
                                                                                                                  2.4  2.5   .3    1.   -0. QBO
                                                                                                                  2.5  2.5   .4    4.    1. MAG
                                                                                                                 -4.5 -1.3 -3.3   -8.    6. RANS
                                                                                                                  3.3  3.2  1.7   11.   11. SIGS
                                                                                                                  6.8  3.5  3.3  -12.   -7. RANL
                                                                                                                  4.6  4.3  1.7   25.   11. SIGL
                                                                                                                  2.3  2.2   .1  -20.   -1. RANT
                                                                                                                  5.6  5.4  2.4   28.   15. SIGT

46.00  28.45  80.53 .132E+03 .168E-02   272.    44.     20. .136E+03 .177E-02   268.     3.     27.   -.1    .4                             -.42
    0                   .3%    -2.0%   2.0%                    3.6%     3.2%    .4%                                  1.6   .3  1.2              SP
                                                                                                                  2.4  2.4   .5   -0.   -1. QBO
                                                                                                                  2.5  2.4   .7    3.    1. MAG
                                                                                                                 -3.2  -.5 -2.7   -3.   17. RANS
                                                                                                                  3.1  3.0  1.7   11.   10. SIGS
                                                                                                                  4.1  3.4   .7  -38.   -9. RANL
                                                                                                                  4.4  4.2  1.8   25.   10. SIGL
                                                                                                                   .9  2.9 -2.0  -41.    7. RANT
                                                                                                                  5.4  5.1  2.5   27.   14. SIGT

44.00  28.45  80.53 .168E+03 .216E-02   269.    46.     19. .168E+03 .219E-02   267.    17.     25.   -.3    .6                             -.53
    0                  -.9%    -4.3%   3.1%                    -.9%    -3.1%   2.2%                                   .7  -.8  1.4              SP
                                                                                                                  2.4  2.1   .7   -1.   -1. QBO
                                                                                                                  2.4  2.1   .8    3.    1. MAG
                                                                                                                 -4.5 -2.4 -2.2   -3.   16. RANS
                                                                                                                  2.9  2.8  1.8   10.    9. SIGS
                                                                                                                  2.2  1.5   .7  -24.  -10. RANL
                                                                                                                  4.2  3.9  1.9   24.   10. SIGL
                                                                                                                 -2.3  -.8 -1.5  -28.    6. RANT
                                                                                                                  5.1  4.8  2.6   26.   13. SIGT

42.00  28.45  80.53 .218E+03 .286E-02   264.    43.     19. .216E+03 .287E-02   262.    23.     27.    .0    .5                             -.33
    0                 -1.0%    -4.5%   3.3%                   -1.9%    -4.1%   2.2%                                  1.3  -.0  1.3              SP
                                                                                                                  2.2  1.8   .7   -3.   -1. QBO
                                                                                                                  2.2  1.8   .8    4.    1. MAG
                                                                                                                 -8.1 -3.3 -4.8   -4.   11. RANS
                                                                                                                  2.7  2.6  1.8    9.    8. SIGS
                                                                                                                  5.1  2.0  3.0  -13.   -2. RANL
                                                                                                                  4.0  3.5  2.0   22.    9. SIGL
                                                                                                                 -3.0 -1.3 -1.7  -17.    9. RANT
                                                                                                                  4.8  4.3  2.7   24.   12. SIGT

40.00  28.45  80.53 .279E+03 .373E-02   260.    42.     18. .289E+03 .382E-02   263.    26.     17.    .1    .6                             -.35
    0                 -3.0%    -6.7%   3.8%                     .6%    -4.3%   5.1%                                   .7  -.8  1.4              SP
                                                                                                                  2.1  1.4   .8   -5.   -2. QBO
                                                                                                                  2.1  1.4   .8    5.    2. MAG
                                                                                                                 -2.1 -1.5  -.6    4.    6. RANS
                                                                                                                  2.6  2.3  1.8    8.    7. SIGS
                                                                                                                  3.6  2.6  1.1  -16.   -5. RANL
                                                                                                                  3.7  3.1  2.1   20.    8. SIGL
                                                                                                                  1.6  1.1   .5  -12.    1. RANT
                                                                                                                  4.5  3.8  2.8   22.   11. SIGT
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38.00  28.45  80.53 .365E+03 .504E-02  252.   37.   15. .381E+03 .522E-02  254.   14.   24.  1.1   .6
   0                   -3.3%    -6.1%  2.9%                 1.0%    -2.7%  3.8%                              -.07
                                                                                                .2  -.9  1.1             SP
                                                                                               1.8  1.2   .8   -7.   -1. QBO
                                                                                               1.8  1.2   .8    7.    1. MAG
                                                                                              -1.5 -1.5  -.0   -0.   10. RANS
                                                                                               2.3  2.2  1.9    8.    7. SIGS
                                                                                               4.0  3.9   .1  -16.    1. RANL
                                                                                               3.4  2.9  2.0   19.    8. SIGL
                                                                                               2.5  2.4   .1  -16.   11. RANT
                                                                                               4.2  3.6  2.8   20.   10. SIGT

36.00  28.45  80.53 .477E+03 .681E-02  244.   32.   11. .512E+03 .702E-02  255.   10.   10.  2.2   .6
   0                   -4.3%    -6.2%  2.0%                 2.7%    -3.2%  6.4%                               .07
                                                                                               -.3 -1.1   .8             SP
                                                                                               1.6  1.0   .8   -9.   -1. QBO
                                                                                               1.6  1.0   .9    9.    1. MAG
                                                                                                .7 -1.8  2.5    2.    0. RANS
                                                                                               2.1  2.2  1.9    7.    7. SIGS
                                                                                               4.9  4.0   .9  -15.   -0. RANL
                                                                                               3.1  2.7  1.9   17.    7. SIGL
                                                                                               5.6  2.2  3.4  -13.   -0. RANT
                                                                                               3.8  3.4  2.7   19.   10. SIGT

34.00  28.45  80.53 .628E+03 .921E-02  238.   27.    8. .662E+03 .956E-02  242.    2.   17.  2.5   .6
   0                   -5.3%    -6.9%  1.8%                 -.2%    -3.3%  3.6%                               .06
                                                                                               -.8 -1.2   .5             SP
                                                                                               1.3   .7   .9   -9.   -1. QBO
                                                                                               1.3   .8   .9   10.    1. MAG
                                                                                                .3  -.1   .4    6.    9. RANS
                                                                                               1.9  2.1  1.8    6.    6. SIGS
                                                                                               3.7  3.2   .5  -21.    2. RANL
                                                                                               2.8  2.5  1.8   16.    7. SIGL
                                                                                               4.0  3.0   .9  -15.   10. RANT
                                                                                               3.4  3.2  2.6   17.    9. SIGT

32.00  28.45  80.53 .833E+03 .125E-01  233.   22.    5. .841E+03 .126E-01  234.   14.    6.  2.8   .6
   0                   -6.3%    -8.1%  2.2%                -5.4%    -7.1%  2.5%                              -.04
                                                                                              -1.2 -1.4   .2             SP
                                                                                               1.0   .5   .9   -9.   -1. QBO
                                                                                               1.0   .7   .9   10.    1. MAG
                                                                                              -2.0  -.9 -1.1   10.    3. RANS
                                                                                               1.8  1.9  1.8    6.    5. SIGS
                                                                                               2.0  1.5   .5   -9.   -1. RANL
                                                                                               2.5  2.3  1.7   14.    6. SIGL
                                                                                               -.0   .6  -.6    1.    2. RANT
                                                                                               3.1  3.0  2.4   15.    8. SIGT

30.00  28.45  80.53 .110E+04 .169E-01  229.   18.    2. .114E+04 .170E-01  236.   16.   -2.  1.6   .6
   0                   -7.8%    -8.4%  1.0%                -4.5%    -7.5%  4.2%                              -.10
                                                                                              -1.7 -1.5  -.1             SP
                                                                                                .8   .2  1.0   -8.   -1. QBO
                                                                                                .9   .5  1.0   10.    1. MAG
                                                                                               -.1 -1.2  1.0   10.   -3. RANS
                                                                                               1.6  1.8  1.7    5.    4. SIGS
                                                                                               2.9  1.9  1.0   -4.   -1. RANL
                                                                                               2.2  2.1  1.5   12.    4. SIGL
                                                                                               2.8   .7  2.1    5.   -3. RANT
                                                                                               2.7  2.8  2.3   13.    6. SIGT

28.00  28.45  80.53 .151E+04 .235E-01  225.   16.    1. .151E+04 .230E-01  231.   19.   -3.  1.4   .5
   0                   -6.4%    -6.2%   .1%                -6.3%    -8.3%  2.7%                              -.08
                                                                                               0.0  0.0  0.0             SP
                                                                                                .5  -.2   .9   -6.   -1. QBO
                                                                                                .6   .6  1.0    9.    1. MAG
                                                                                              -1.1 -2.7  1.7    3.   -3. RANS
                                                                                               1.5  1.6  1.5    4.    3. SIGS
                                                                                                .7   .7  -.0    6.   -0. RANL
                                                                                               2.0  1.9  1.4   11.    4. SIGL
                                                                                               -.4 -2.0  1.7    9.   -3. RANT
```

```
                                                                                                           2.5  2.4  2.1  12.    5. SIGT

26.00  28.45  80.53 .207E+04 .328E-01  220.    14.     1. .210E+04 .319E-01  229.    16.     4.  1.3   .3                           -.05
    0                  -5.3%    -4.3% -1.0%                  -4.2%    -6.9%  3.0%                          0.0  0.0  0.0            SP
                                                                                                            .2  -.6   .9  -5.   -1. QBO
                                                                                                            .4   .7   .9   8.    1. MAG
                                                                                                            .7 -1.5  2.3   7.    2. RANS
                                                                                                           1.3  1.3  1.3   4.    3. SIGS
                                                                                                            .2  -.6   .8  -1.    2. RANL
                                                                                                           1.8  1.6  1.3  10.    3. SIGL
                                                                                                            .9 -2.1  3.0   7.    4. RANT
                                                                                                           2.2  2.0  1.9  10.    4. SIGT

24.00  28.45  80.53 .284E+04 .457E-01  216.    11.     0. .285E+04 .450E-01  221.     7.     1.  1.1   .3                           -.03
    0                  -4.6%    -2.6% -1.9%                  -4.0%    -4.0%   .2%                          0.0  0.0  0.0            SP
                                                                                                            .1  -.7   .8  -3.   -1. QBO
                                                                                                            .3   .7   .9   7.    1. MAG
                                                                                                            .2  -.2   .3   0.    2. RANS
                                                                                                            .5   .6   .6   3.    3. SIGS
                                                                                                            .3  -.7  1.0  -1.   -1. RANL
                                                                                                            .6   .7   .6   8.    3. SIGL
                                                                                                            .5  -.9  1.3  -1.    1. RANT
                                                                                                            .8   .9   .8   9.    4. SIGT

22.00  28.45  80.53 .391E+04 .643E-01  212.     8.     0. .388E+04 .636E-01  213.     7.    -3.  -.1  -.0                            .00
    0                  -3.5%     -.3% -3.2%                  -4.1%    -1.4% -2.7%                          0.0  0.0  0.0            SP
                                                                                                            .1  -.5   .7  -0.   -1. QBO
                                                                                                            .2   .6   .7   6.    1. MAG
                                                                                                            .0  -.2   .2   3.    1. RANS
                                                                                                            .4   .6   .5   3.    3. SIGS
                                                                                                           -.8  -.4  -.5  -4.   -4. RANL
                                                                                                            .6   .7   .5   8.    3. SIGL
                                                                                                           -.8  -.5  -.2  -1.   -3. RANT
                                                                                                            .7  1.0   .8   9.    5. SIGT

20.00  28.45  80.53 .545E+04 .914E-01  207.    16.     3. .543E+04 .912E-01  208.     6.    -3. -1.6  -.3                           -.00
    0                  -1.5%     2.8% -4.2%                  -1.7%     2.6% -4.1%                          0.0  0.0  0.0            SP
                                                                                                            .1  -.3   .6   2.   -0. QBO
                                                                                                            .2   .5   .6   5.    1. MAG
                                                                                                           -.9  -.6  -.3   0.    1. RANS
                                                                                                            .4   .7   .5   3.    3. SIGS
                                                                                                            .6   .7  -.2 -12.   -6. RANL
                                                                                                            .6   .9   .5   8.    4. SIGL
                                                                                                           -.3   .1  -.5 -11.   -5. RANT
                                                                                                            .7  1.1   .8   8.    5. SIGT

18.00  28.45  80.53 .759E+04 .129E+00  205.    19.     4. .758E+04 .128E+00  206.    12.    -8. -3.3  -.4                           -.07
    0                    .3%     6.0% -5.4%                    .2%     5.6% -5.1%                          0.0  0.0  0.0            SP
                                                                                                            .1  -.3   .5   2.   -0. QBO
                                                                                                            .2   .4   .5   4.    0. MAG
                                                                                                           -.3  -.5   .2   2.    3. RANS
                                                                                                            .5   .9   .6   3.    5. SIGS
                                                                                                            .1   .4  -.3 -11.   -8. RANL
                                                                                                            .6  1.0   .6   9.    5. SIGL
                                                                                                           -.2  -.1  -.1  -9.   -4. RANT
                                                                                                            .8  1.3   .8   9.    7. SIGT

16.00  28.45  80.53 .107E+05 .183E+00  204.    30.     3. .108E+05 .181E+00  207.    16.   -15. -4.1  -.3                           -.09
    0                   3.5%     9.8% -5.8%                   3.9%     8.8% -4.5%                          0.0  0.0  0.0            SP
                                                                                                            .1  -.2   .4   2.   -0. QBO
                                                                                                            .1   .3   .4   3.    0. MAG
                                                                                                           -.5 -1.2   .7   2.   -8. RANS
                                                                                                            .6  1.1   .7   3.    6. SIGS
                                                                                                            .9   .6   .3 -18.  -10. RANL
```

```
                                                                                                      .7  1.2   .6  18.   7. SIGL
                                                                                                      .4  -.7  1.0 -16. -18. RANT
                                                                                                      .9  1.6   .9  12.   9. SIGT
 14.00  28.45  80.53 .149E+05 .246E+00  210.   37.    4. .149E+05 .245E+00  212.   22.   -6. -1.1  -.1                          -.04
   0                     5.8%     8.1% -2.9%                 4.8%     7.4% -2.3%                   0.0  0.0  0.0            SP
                                                                                                      .0  -.2   .2   2.  -8. QBO
                                                                                                      .1   .2   .2   2.   0. MAG
                                                                                                    -1.0 -1.2   .2  -6.   1. RANS
                                                                                                      .7  1.1   .7   4.   7. SIGS
                                                                                                      .8   .6   .2 -11. -10. RANL
                                                                                                      .9  1.3   .7  11.   8. SIGL
                                                                                                     -.3  -.6   .3 -17.  -9. RANT
                                                                                                     1.1  1.7  1.0  12.  11. SIGT
 12.00  28.45  80.53 .205E+05 .328E+00  217.   35.    3. .204E+05 .335E+00  213.   21.  -12.  2.8   .1                          .07
   0                     5.5%     5.2%   .3%                 5.3%     7.2% -1.9%                   0.0  0.0  0.0            SP
                                                                                                      .0  -.1   .1   1.  -0. QBO
                                                                                                      .0   .1   .1   1.   0. MAG
                                                                                                     -.5   .6 -1.0   4.  -8. RANS
                                                                                                      .7  1.0   .8   4.   8. SIGS
                                                                                                      .2  1.4 -1.2 -20.  -6. RANL
                                                                                                      .9  1.1   .7  13.   9. SIGL
                                                                                                     -.3  2.0 -2.3 -16. -15. RANT
                                                                                                     1.1  1.5  1.1  13.  12. SIGT
 10.00  28.45  80.53 .278E+05 .421E+00  230.   32.    3. .283E+05 .424E+00  233.   11.   -2.  3.5   .2                          .16
   0                     4.8%     1.8%  3.0%                 6.8%     2.5%  4.2%                   0.0  0.0  0.0            SP
                                                                                                     0.0  0.0  0.0   0.   0. QBO
                                                                                                     0.0  0.0  0.0   0.   0. MAG
                                                                                                     -.2  -.7   .5  -5.  -4. RANS
                                                                                                      .7   .9   .8   5.   9. SIGS
                                                                                                     2.0  1.4   .6 -16.  -0. RANL
                                                                                                      .9  1.0   .8  14.  10. SIGL
                                                                                                     1.8   .7  1.1 -21.  -4. RANT
                                                                                                     1.1  1.3  1.1  15.  14. SIGT
  8.00  28.45  80.53 .370E+05 .529E+00  244.   26.    3. .369E+05 .528E+00  243.    3.   -9.  3.9   .2                          .46
   0                     3.9%      .6%  3.3%                 3.4%      .5%  2.8%                   0.0  0.0  0.0            SP
                                                                                                     0.0  0.0  0.0   0.   0. QBO
                                                                                                     0.0  0.0  0.0   0.   0. MAG
                                                                                                     -.4  -.0  -.3  -4.  -2. RANS
                                                                                                      .6   .8   .8   4.   8. SIGS
                                                                                                     -.1   .0  -.1 -19. -10. RANL
                                                                                                      .8   .8   .8  12.   9. SIGL
                                                                                                     -.5  -.0  -.5 -23. -12. RANT
                                                                                                     1.0  1.1  1.1  13.  12. SIGT
  6.00  28.45  80.53 .436E+05 .654E+00  259.   20.    3. .479E+05 .656E+00  254.    3.  -13.  3.6   .3                          .27
   0                     2.9%     -.9%  3.8%                 1.4%     -.6%  2.0%                   0.0  0.0  0.0            SP
                                                                                                     0.0  0.0  0.0   0.   0. QBO
                                                                                                     0.0  0.0  0.0   0.   0. MAG
                                                                                                     -.8   .5 -1.3   0.  -9. RANS
                                                                                                      .5   .7   .7   3.   6. SIGS
                                                                                                     -.6  -.2  -.4 -17.  -8. RANL
                                                                                                      .7   .7   .7  10.   8. SIGL
                                                                                                    -1.4   .3 -1.7 -16. -16. RANT
                                                                                                      .9  1.0  1.0  11.  10. SIGT
  4.00  28.45  80.53 .628E+05 .808E+00  271.   12.    3. .629E+05 .807E+00  272.   14.   -2.  3.5   .3                          .27
   0                     1.9%    -1.4%  3.3%                 2.1%    -1.5%  3.6%                   0.0  0.0  0.0            SP
                                                                                                     0.0  0.0  0.0   0.   0. QBO
                                                                                                     0.0  0.0  0.0   0.   0. MAG
                                                                                                     -.0  -.3   .3  -1.  -6. RANS
```

```
                                                                                                          .5    .6    .7   3.    5. SIGS
                                                                                                          .2    .2    .0   3.    1. RANL
                                                                                                          .6    .7    .7   9.    6. SIGL
                                                                                                          .2   -.1    .3   2.   -5. RANT
                                                                                                          .7    .9   1.0   9.    8. SIGT

2.00  28.45  80.53 .804E+05 .996E+00  281.     6.     2. .808E+05 .990E+00  284.     5.     2.  3.5  1.0                            -.00
   0                  1.1%    -1.1%   2.2%                  1.6%    -1.6%   3.3%                         0.0   0.0   0.0            SP
                                                                                                         0.0   0.0   0.0   0.    0. QBO
                                                                                                         0.0   0.0   0.0   0.    0. MAG
                                                                                                          .2   -.6    .8  -3.   -3. RANS
                                                                                                          .4    .8    .8   2.    4. SIGS
                                                                                                          .3   -.0    .3   2.    3. RANL
                                                                                                          .5    .8    .8   7.    5. SIGL
                                                                                                          .5   -.6   1.1  -1.    0. RANT
                                                                                                          .6   1.1   1.2   7.    7. SIGT

0.00  28.45  80.53 .102E+06 .123E+01  288.    -3.     0. .102E+06 .124E+01  288.    -6.     5.  5.6  1.4                             .14
   0                   .8%      .7%    .1%                  1.1%     1.2%   -.1%                         0.0   0.0   0.0            SF
                                                                                                         0.0   0.0   0.0   0.    0. QBO
                                                                                                         0.0   0.0   0.0   0.    0. MAG
                                                                                                         -.6   -.0   -.5   0.    1. RANS
                                                                                                          .3   1.4   1.4   1.    3. SIGS
                                                                                                          .9    .5    .3  -3.    4. RANL
                                                                                                          .4   1.4   1.4   5.    4. SIGL
                                                                                                          .3    .5   -.2  -3.    5. RANT
                                                                                                          .5   1.9   2.0   5.    5. SIGT
```

# APPENDIX D - PROFILE PROGRAM LISTING

Following is a listing of the Global Reference Atmospheric Model (GRAM) - Mod 2. Sequence numbers containing a three character subroutine code and a five digit number appear on the right of the printout.

```
      SUBROUTINE ADJUST                                                 ADJ00100
      COMMON/C4/DUM1(32),NG,P(16,26),D(16,26),T(16,26),SP(16,26)        ADJ00200
     $,SD(16,26),ST(16,26),DU1,DU2,HS                                   ADJ00300
      COMMON/ADJCOM/A(26,3), B(26), X(26), KOUNT                        ADJ00400
      DIMENSION PQ(26), QQ(26), UC(26), VC(26), WC(26), U(26), V(26),   ADJ00500
     $ W(26)                                                            ADJ00600
C     ASSUMPTIONS                                                       ADJ00700
C       HS IS THE SURFACE LEVEL                                         ADJ00800
C       ALL DATA VALUES ABOVE SURFACE LEVEL ARE IN 1 KM INCREMENTS      ADJ00900
      E1=0.075                                                          ADJ01000
      E2=0.150                                                          ADJ01100
      MAXIT=3                                                           ADJ01200
      KSMAX=10                                                          ADJ01300
      HSJ = HS                                                          ADJ01400
      IF (HS.LT.0.) HSJ = 0.                                            ADJ01500
      JJ=INT(HSJ+2.)                                                    ADJ01600
      STEST=0.05                                                        ADJ01700
      ISS=1                                                             ADJ01800
      CONST=28703./980.665                                              ADJ01900
      N=26                                                              ADJ02000
      ITER=0                                                            ADJ02100
      UC(1)=SQRT(SP(KOUNT,1))                                           ADJ02200
      VC(1)=SQRT(SD(KOUNT,1))                                           ADJ02300
      WC(1)=SQRT(ST(KOUNT,1))                                           ADJ02400
      DO 5 I=JJ,N                                                       ADJ02500
      UC(I)=SQRT(SP(KOUNT,I))                                           ADJ02600
      VC(I)=SQRT(SD(KOUNT,I))                                           ADJ02700
    5 WC(I)=SQRT(ST(KOUNT,I))                                           ADJ02800
      NM=N-1                                                            ADJ02900
      NP=N+1                                                            ADJ03000
C.....SETS UP QUADRATURE FACTORS                                        ADJ03100
      PQ(1)=500.*(FLOAT(INT(HSJ+1.))-HS)/(CONST*T(KOUNT,1))             ADJ03200
      QQ(1)=500.*(FLOAT(INT(HSJ+1.))-HS)/(CONST*T(KOUNT,JJ))            ADJ03300
      DO 15 I=JJ,NM                                                     ADJ03400
      IP=I+1                                                            ADJ03500
      PQ(I)=500./(CONST*T(KOUNT,I))                                     ADJ03600
   15 QQ(I)=500./(CONST*T(KOUNT,IP))                                    ADJ03700
      GO TO 58                                                          ADJ03800
   12 NM=N-1                                                            ADJ03900
      NP=N+1                                                            ADJ04000
      DO 14 I=1,26                                                      ADJ04100
      U(I)=UC(I)*UC(I)                                                  ADJ04200
      V(I)=VC(I)*VC(I)                                                  ADJ04300
      W(I)=WC(I)*WC(I)                                                  ADJ04400
   14 CONTINUE                                                          ADJ04500
C.....INITIALIZE A(I,J)                                                 ADJ04600
      DO 20 I=1,26                                                      ADJ04700
      DO 20 J=1,3                                                       ADJ04800
   20 A(I,J)=0.                                                         ADJ04900
C.....SETS UP COEFFICIENTS                                              ADJ05000
      I2=0                                                              ADJ05100
      DO 35 I=1,NM                                                      ADJ05200
      IF(I.GT.1.AND.I.LT.JJ) GO TO 35                                   ADJ05300
      AW=1./SP(KOUNT,I)                                                 ADJ05400
      BW=1./SD(KOUNT,I)                                                 ADJ05500
      CW=1./ST(KOUNT,I)                                                 ADJ05600
```

```
      IM=I-1                                                                    ADJ05700
      IF(I.EQ.JJ) IM=1                                                          ADJ05800
      IP=I+1                                                                    ADJ05900
      IF (I.EQ.1) IP=JJ                                                         ADJ06000
      I2=I2+1                                                                   ADJ06100
      AW1=1./SP(KOUNT,IP)                                                       ADJ06200
      BW1=1./SQ(KOUNT,IP)                                                       ADJ06300
      CW1=1./ST(KOUNT,IP)                                                       ADJ06400
      IF(I.EQ.1) GO TO 25                                                       ADJ06500
      A(I2,1)=-(1.-QQ(IM))*(1.+PQ(I))/AW+(1./BW+1./CW)*PQ(I)*QQ(IM)             ADJ06600
   25 A(I2,2)=((1.-QQ(I))**2)/AW1+((1.+PQ(I))**2)/AW+(1./BW+1./CW)              ADJ06700
     $ *(PQ(I)**2)+(1./BW1+1./CW1)*QQ(I)**2                                     ADJ06800
      IF(I.EQ.NM) GO TO 30                                                      ADJ06900
      A(I2.3)=-(1.-QQ(I))*(1.+PQ(IP))/AW1+(1./BW1+1./CW1)*                      ADJ07000
     $ PQ(IP)*QQ(IP)                                                            ADJ07100
   30 B(I2)=U(IP)-U(I)-(U(I)-V(I)+W(I))*PQ(I)-(U(IP)-V(IP)+W(IP))*QQ(I)         ADJ07200
   35 CONTINUE                                                                  ADJ07300
      CALL DIAGEQ(I2)                                                           ADJ07400
C.....FINDS CORRECTIONS                                                          ADJ07500
      AW=1./SP(KOUNT,1)                                                         ADJ07600
      BW=1./SQ(KOUNT,1)                                                         ADJ07700
      CW=1./ST(KOUNT,1)                                                         ADJ07800
      UC(1)=SQRT(U(1)+X(1)*(1.+PQ(1))/AW)                                       ADJ07900
      VC(1)=SQRT(V(1)-X(1)*PQ(1)/BW)                                            ADJ08000
      WC(1)=SQRT(W(1)+X(1)*PQ(1)/CW)                                            ADJ08100
      AW=1./SP(KOUNT,N)                                                         ADJ08200
      BW=1./SQ(KOUNT,N)                                                         ADJ08300
      CW=1./ST(KOUNT,N)                                                         ADJ08400
      UC(N)=SQRT(U(N)-X(I2)*(1.-QQ(NM))/AW)                                     ADJ08500
      VC(N)=SQRT(V(N)-X(I2)*QQ(NM)/BW)                                          ADJ08600
      WC(N)=SQRT(W(N)+X(I2)*QQ(NM)/CW)                                          ADJ08700
      I2=1                                                                      ADJ08800
      DO 40 I=JJ,NM                                                             ADJ08900
      I2=I2+1                                                                   ADJ09000
      I2M=I2-1                                                                  ADJ09100
      AW=1./SP(KOUNT,I)                                                         ADJ09200
      BW=1./SQ(KOUNT,I)                                                         ADJ09300
      CW=1./ST(KOUNT,I)                                                         ADJ09400
      IM=I-1                                                                    ADJ09500
      IF(I.EQ.JJ)IM=1                                                           ADJ09600
      UC(I)=ABS(U(I)          +(-X(I2M)*(1.-QQ(IM))+X(I2)*(1.+PQ(I)))/AW)       ADJ09700
      UC(I)=SQRT(UC(I))                                                         ADJ09800
      VC(I)=ABS(V(I)          -(X(I2M)*QQ(IM)+X(I2)*PQ(I))/BW)                  ADJ09900
      VC(I)=SQRT(VC(I))                                                         ADJ10000
      WC(I)=ABS(W(I)          +(X(I2M)*QQ(IM)+X(I2)*PQ(I))/CW)                  ADJ10100
   40 WC(I)=SQRT(WC(I))                                                         ADJ10200
C.....GETS ADJUSTED VALUES                                                       ADJ10300
C.....    ADJUSTS ON TRIANGLE INEQUALITIES                                      ADJ10400
   56 K=0                                                                       ADJ10500
      DO 68 I=1.N                                                               ADJ10600
      IF(I.GT.1.AND.I.LT.JJ) GO TO 68                                           ADJ10700
      AU=UC(I)                                                                  ADJ10800
      AV=VC(I)                                                                  ADJ10900
      AM=WC(I)                                                                  ADJ11000
      AMAX=AMAX1(AU,AV,AM)                                                      ADJ11100
      EE=E1*AMAX                                                                ADJ11200
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REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

```
      EF=EE*AMAX                                                        ADJ11300
      AW=SF(KOUNT,I)                                                    ADJ11400
      BW=SC(KOUNT,I)                                                    ADJ11500
      CW=ST(KOUNT,I)                                                    ADJ11600
      COR=AU+AV-AM-EE                                                   ADJ11700
      DIV=AW+BW+CW                                                      ADJ11800
      IF(COR.GT.0.) GO TO 60                                            ADJ11900
      COR=(AU+AV-AM-EF)/DIV                                             ADJ12000
      AU=AU-COR*AW                                                      ADJ12100
      AV=AV-COR*BW                                                      ADJ12200
      AM=AM+COR*CW                                                      ADJ12300
      GO TO 64                                                          ADJ12400
   60 COR=AU-AV+AM-EE                                                   ADJ12500
      IF(COR.GT.0.) GO TO 62                                            ADJ12600
      COR=(AU-AV+AM-EF)/DIV                                             ADJ12700
      AU=AU-COR*AW                                                      ADJ12800
      AV=AV+COR*BW                                                      ADJ12900
      AM=AM-COR*CW                                                      ADJ13000
      GO TO 64                                                          ADJ13100
   62 COR=-AU+AV+AM-EE                                                  ADJ13200
      IF(COR.GT.0.) GO TO 66                                            ADJ13300
      COR=(-AU+AV+AM-EF)/DIV                                            ADJ13400
      AU=AU+COR*AW                                                      ADJ13500
      AV=AV-COR*BW                                                      ADJ13600
      AM=AM-COR*CW                                                      ADJ13700
   64 K=K+1                                                             ADJ13800
   66 UC(I)=AU                                                          ADJ13900
      VC(I)=AV                                                          ADJ14000
      WC(I)=AM                                                          ADJ14100
   68 CONTINUE                                                          ADJ14200
      KMAX=K                                                            ADJ14300
  100 IF((ITER.EQ.0).OR.(KMAX.NE.0)) GO TO 110                          ADJ14400
      GO TO 112                                                         ADJ14500
  110 ITER=ITER+1                                                       ADJ14600
      IF(ITER.LE.MAXIT) GO TO 12                                        ADJ14700
  112 IF (ISS.NE.1) GO TO 999                                           ADJ14800
  114 ITER=1                                                            ADJ14900
      ISS=2                                                             ADJ15000
      VTA=VC(1)                                                         ADJ15100
      WTA=WC(1)                                                         ADJ15200
      DO 120 I=JJ,NM                                                    ADJ15300
      IM=I-1                                                            ADJ15400
      IF(I.EQ.JJ)IM=1                                                   ADJ15500
      VTB=VC(I)                                                         ADJ15600
      WTB=WC(I)                                                         ADJ15700
      VC(I)=(VC(I+1)+2.*VTB+VTA)*0.25                                   ADJ15800
      WC(I)=(WC(I+1)+2.*WTB+WTA)*0.25                                   ADJ15900
      VTA=VTB                                                           ADJ16000
      WTA=WTB                                                           ADJ16100
  120 CONTINUE                                                          ADJ16200
      GO TO 12                                                          ADJ16300
C.....CALCULATE THE CORRECTED VARIANCES                                  ADJ16400
  999 DO 1010 I=1,N                                                     ADJ16500
      IF(I.GT.1.AND.I.LT.JJ) GO TO 1010                                 ADJ16600
      SF(KOUNT,I)=UC(I)**2                                              ADJ16700
      SC(KOUNT,I)=VC(I)**2                                              ADJ16800
```

```
      ST(KOUNT,I)=WC(I)**2                                                ADJ16900
 1713 CONTINUE                                                            ADJ17000
      RETURN                                                              ADJ17100
      END                                                                 ADJ17200
```

```
      SUBROUTINE CHECK                                                  CHK00100
      COMMON/CHK/P(4,4,3),RHO(4,4,3),NO(2)                              CHK00200
      COMMON/WINCOM/DGH,FCORY,DX5,DY5                                   CHK00300
      COMMON/CHIC/LA(16),NB(2),IWSYM                                    CHK00400
      NB(1) = 0                                                         CHK00500
      NB(2) = 0                                                         CHK00600
      CALL GROUP                                                        CHK00700
      NS=0                                                              CHK00800
      NR=1                                                              CHK00900
      IF(NO(1).EQ.0.AND.NO(2).EQ.0) GO TO 1000                          CHK01000
      DO 640 KL=1,2                                                     CHK01100
      IF (NO(KL).EQ.0) GO TO 640                                        CHK01200
  450 CONTINUE                                                          CHK01300
      NNR=4*NR                                                          CHK01400
      IF(NO(KL).LE.NNR) GO TO 500                                       CHK01500
      NR=NR+1                                                           CHK01600
      GO TO 450                                                         CHK01700
  500 CONTINUE                                                          CHK01800
      I1=NR                                                             CHK01900
      J1=NO(KL)-(NR-1)*4                                                CHK02000
      SH1 = 6.                                                          CHK02100
      SH2 = 6.                                                          CHK02200
      DP = P(I1,J1,2) - P(I1,J1,1)                                      CHK02300
      IF (DP) 510,520,510                                               CHK02400
 510  SH1 = ABS(P(I1,J1,2)/DP)                                          CHK02500
 520  DP = P(I1,J1,2) - P(I1,J1,3)                                      CHK02600
      IF (DP) 530,540,530                                               CHK02700
 530  SH2 = ABS(P(I1,J1,2)/DP)                                          CHK02800
 540  IF(SH1.LT.4.0.OR.SH2.LT.4.0) GO TO 640                            CHK02900
      IF(SH1.GT.9.0.OR.SH2.GT.9.0) GO TO 640                            CHK03000
      NR=1                                                              CHK03100
      NS=NS+1                                                           CHK03200
  640 CONTINUE                                                          CHK03300
      RETURN                                                            CHK03400
 1000 IWSYM = "*"                                                       CHK03500
      RETURN                                                            CHK03600
      END                                                               CHK03700
```

```
      SUBROUTINE CORLAT(A,B,C,D,E,F,G,H,AI,AJ,AK,SP1,SP2,SD1,SD2,ST1,   COR00100
     1 ST2,SU1,SU2,SV1,SV2,UD1,UD2,VD1,VD2,RD,RT,RV)                    COR00200
      IF(SD1*ST1*SD2*ST2.GT.0.) GO TO 5                                 COR00300
C.....DEFAULT VALUES AVOID DIVISION BY ZERO                             COR00400
      IF(SD1.LE.0.) SD1=0.001                                           COR00500
      IF(ST1.LE.0.) ST1=0.001                                           COR00600
      IF(SD2.LE.0.) SD2=0.001                                           COR00700
      IF(ST2.LE.0.) ST2=0.001                                           COR00800
 5    CONTINUE                                                          COR00900
      IF(ABS(TD1).LE.0.) TD1 = 0.001                                    COR01000
      IF (ABS(UD1).LE.0.) UD1 = 0.001                                   COR01100
      IF (ABS(VD1).LE.0.) VD1 = 0.001                                   COR01200
      IF (ABS(SU1).LE.0.) SU1 = 0.001                                   COR01300
      IF (ABS(SV1).LE.0.) SV1 = 0.001                                   COR01400
      IF (ABS(UD1).GE.1.) UD1 = 0.99*UD1/ABS(UD1)                       COR01500
      IF (ABS(VD1).GE.1.) VD1 = 0.99*VD1/ABS(VD1)                       COR01600
      A=RD*SD2/SD1                                                      COR01700
      B=SD2*SQRT(1-RD*RD)                                               COR01800
      TD2=(SP2*SP2-SD2*SD2-ST2*ST2)/(2*SD2*ST2)                         COR01900
      TD1=(SP1*SP1-SD1*SD1-ST1*ST1)/(2*SD1*ST1)                         COR02000
      IF(ABS(TD2).GE.1.0) TD2=0.99*TD2/ABS(TD2)                         COR02100
      IF(ABS(TD1).GE.1.0) TD1=0.99*TD1/ABS(TD1)                         COR02200
      C=(ST2/ST1)*RT*(1-TD2*TD1)/(1-TD1*TD1*RT*RT)                      COR02300
      D=(RT*ST2*ST1-C*ST1*ST1)/(A*TD1*SD1*ST1)                          COR02400
      E=      ST2*ST2-C*C*ST1*ST1-D*D*SD2*SD2-2*C*D*RT*TD1*ST1*SD2      COR02500
      IF(E.GE.0.) GO TO 10                                              COR02600
      E=0.                                                              COR02700
   10 E=SQRT(E)                                                         COR02800
      F=(SU2/SU1)*(RV-RD*UD2*UD1)/(1-RD*RD*UD1*UD1)                     COR02900
      G=(RV*SU2-F*SU1)/(RD*UD1*SD2)                                     COR03000
      H=      SU2*SU2-F*F*SU1*SU1-G*G*SD2*SD2-2*F*G*RD*UD1*SD2*SU1      COR03100
      IF(H.GE.0.) GO TO 15                                              COR03200
      H=0.                                                              COR03300
   15 H=SQRT(H)                                                         COR03400
      AI=(SV2/SV1)*(RV-RD*VD2*VD1)/(1-RD*RD*VD1*VD1)                    COR03500
      AJ=(RV*SV2-AI*SV1)/(RD*VD1*SD2)                                   COR03600
      AK=       SV2*SV2-AI*AI*SV1*SV1-AJ*AJ*SD2*SD2-2*AI*AJ*RD*VD1*SD2*SV1COR03700
      IF(AK.GE.0.) GO TO 25                                             COR03800
      AK=0.                                                             COR03900
   25 AK=SQRT(AK)                                                       COR04000
      RETURN                                                            COR04100
      END                                                               COR04200
```

```
      SUBROUTINE DIAGEQ(N)                                              DIA00100
C     A(I,J)=DIAG. TERMS, I=ROW NO., J=DIAG. NO.                        DIA00200
C     B(I)=RIGHT SIDE TERMS                                             DIA00300
C     N=NO. OF ROWS                                                     DIA00400
C     K=NO. OF BORDER DIAGONALS, M=K+1=INDES OF PRIN. DIAG              DIA00500
C              2KH=TOTAL NO. OF DIAGS.                                  DIA00600
C     X(I)=SOLUTION                                                     DIA00700
      COMMON/ADJCOM/A(26,3), B(26), X(26)                               DIA00800
      K = 1                                                             DIA00900
      M=K+1                                                             DIA01000
      DO 30 L=1,N                                                       DIA01100
      ALM=A(L,M)                                                        DIA01200
      A(L,M)=1.                                                         DIA01300
      IF(L.EQ.N) GO TO 15                                               DIA01400
      I2=MIN0(K,N-L)                                                    DIA01500
      DO 10 I=1,I2                                                      DIA01600
      MPI=M+I                                                           DIA01700
   10 A(L,MPI)=A(L,MPI)/ALM                                             DIA01800
   15 B(L)=B(L)/ALM                                                     DIA01900
      IF(L.EQ.N) GO TO 30                                               DIA02000
      DO 25 I=1,I2                                                      DIA02100
      LPI=L+I                                                           DIA02200
      FACT=A(LPI,M-I)                                                   DIA02300
      DO 20 J=1,I2                                                      DIA02400
      MJI=M+J-I                                                         DIA02500
   20 A(LPI,MJI)=A(LPI,MJI)-A(L,M+J)*FACT                               DIA02600
   25 B(LPI)=B(LPI)-B(L)*FACT                                           DIA02700
   30 CONTINUE                                                          DIA02800
      X(N)=B(N)                                                         DIA02900
      NM1=N-1                                                           DIA03000
      DO 50 L=1,NM1                                                     DIA03100
      NML=N-L                                                           DIA03200
      SUM=0.                                                            DIA03300
      I2=MIN0(K,L)                                                      DIA03400
      DO 40 I=1,I2                                                      DIA03500
   40 SUM=SUM+A(NML,M+I)*X(NML+I)                                       DIA03600
   50 X(NML)=B(NML)-SUM                                                 DIA03700
      RETURN                                                            DIA03800
      END                                                               DIA03900
```

```
      SUBROUTINE FAIR (PG, DG, TG, PJ, DJ, TJ, IH, P, D, T,                 FAI00100
     1 DPYG, DPXJ, DPYJ, DPX, DPY,         DTYG, DTXJ, DTYJ, DTX, DTY)      FAI00200
C.....FAIRS BETWEEN GROVES AND JACCHIA VALUES 90 LE HEIGHT LE 115 KM         FAI00300
      DIMENSION CZ(6)                                                       FAI00400
C.....FAIRING VALUES                                                        FAI00500
      DATA CZ /1.0,0.9045085,0.6545085,0.3454915,0.0954915,0.0/             FAI00600
C     HEIGHT INDEX                                                          FAI00700
      I =(IH - 85)/5                                                        FAI00800
C     GROVES FAIRING COEFFICIENT                                            FAI00900
      CZI = CZ(I)                                                           FAI01000
C     JACCHIA FAIRING COEFFICIENT                                           FAI01100
      SZI = 1.0 - CZI                                                       FAI01200
C     FAIRED TEMPERATURE                                                    FAI01300
      T = TG*CZI + TJ*SZI                                                   FAI01400
C     FAIRED PRESSURE                                                       FAI01500
      P = EXP(ALOG(PG)*CZI + ALOG(PJ)*SZI)                                  FAI01600
C     FAIRED DENSITY                                                        FAI01700
      D = EXP(ALOG(DG)*CZI + ALOG(DJ)*SZI)                                  FAI01800
      DPX = DPXJ                                                            FAI01900
C     DP/DY FOR GEOSTROPHIC WINDS                                           FAI02000
      DPY=DPYG*CZI+DPYJ*SZI                                                 FAI02100
      DTX = DTXJ                                                            FAI02200
C      DT/DY FOR THERMAL WINDS                                              FAI02300
      DTY = DTYG * CZI + DTYJ * SZI                                         FAI02400
      RETURN                                                                FAI02500
      END                                                                   FAI02600
```

```
      SUBROUTINE GEN4D
C.....GENERATES NG = 9 OR 16 4D PROFILES P,D,T AND SIGMAS SP,SD,ST AT
C         GRID OF LATITUDES AND LONGITUDES GLAT,GLON. CURRENT LATITUDE,
C         LONGITUDE=CLAT,CLON. PREVIOUS LATITUDE,LONGITUDE=PLAT,PLON.
      COMMON/C4/GLAT(16),GLON(16),NG,P(16,26),D(16,26),T(16,26),
     $ SP(16,26),SD(16,26),ST(16,26),PLON,CLON,HS
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,CD,XMJD,PLAT,CLAT,
     $ NSAME,RP1,RD1,RT1,SP1,SD1,ST1,RU1,RV1,SU1,SV1,
     $ MN,IDA,IYR,H1,PHI1R,THET1R,G,RI,Z,PHIR,THETR,F10,F10B,AP,
     $ IHR,MIN,NMORE,DX,HL,VL,DZ,E,EPS,IOPP,LOOK,DUMMY(20)
      COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19),
     1        PSP(8,10,12),DSP(8,10,12),TSP(8,10,12)
     2,PAQ(17,5),DAQ(17,5),TAQ(17,5),
     3PDQ(17,5),DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),
     4UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10),
     5PQ,DQ,TQ,UQ,VQ,PQA,DQA,TQA,UA,VA,IOPQ
     * ,PLP(25,10),DLP(25,10),TLP(25,10),ULP(25,10),VLP(25,10),UDL(25,
     * 10),VDL(25,10),UDS(25,10),VDS(25,10)
      COMMON/ADJCOM/DUM(130),KOUNT
      LOOK=0
      F = 0.017453293
      NG = 16
      DX = PLON - CLON
C.....LONGITUDE DISPLACEMENT FROM PREVIOUS TO CURRENT POSITION
      DY = CLAT - PLAT
C.....LATITUDE DISPLACEMENT FROM PREVIOUS TO CURRENT POSITION
      IF (DY) 20,10,20
 10   IF (DX) 15,12,15
 12   K = 0
      GO TO 40
   15 THETA = 180. + SIGN(90.,DX)
      GO TO 30
   20 THETA = ATAN(DX/DY)/F
      IF (DY.GT.0.) THETA = THETA + 180.
      IF (THETA.LT.0.) THETA = THETA + 360.
C.....THETA = AZIMUTH ANGLE OF TRAJECTORY. USED TO ORIENT LAT-LON GRID
   30 K = INT((THETA + 67.5)/45.)
C     INDEX USED IN COMPUTED GO TO FOR 110 THRU 180
      IF (K.GT.8) K=K-8
C     NORTH POLAR GRID
      IF (CLAT.GT.75.0.AND.K.GE.3.AND.K.LE.7)GO TO 200
C     SOUTH POLAR GRID
      IF (CLAT.LT.-75.0.AND.(K.GE.7.OR.K.LE.3))GO TO 200
C.....INITIAL ESTIMATE OF REFERNCE LATITUDE (LOWER LEFT GRID POINT)
 40   LATO = 5*INT(CLAT/5.)
      IF (CLAT.LT.0.) LATO = LATO - 5
C.....INITIAL ESTIMATE OF REFERENCE LONGITUDE (LOWER LEFT GRID POINT)
      LONO=5*INT(CLON/5.)
C.....ADJUSTS LATO,LONO ACCORDING TO DIRECTION OF TRAJECTORY AZIMUTH
      IF (K.GT.0) GO TO 100
      LATO = LATO - 5
      LONO= LONO + 10
      GO TO 190
 100  GO TO (110,120,130,140,150,160,170,180),K
  110 LATO = LATO-10
      LONO = LONO + 10
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      GO TO 190                                                         GEN05700
  120 LAT0 = LAT0-10                                                    GEN05800
      LON0 = LON0+15                                                    GEN05900
      GO TO 190                                                         GEN06000
  130 LAT0 = LAT0-5                                                     GEN06100
      LON0 = LON0+15                                                    GEN06200
      GO TO 190                                                         GEN06300
  140 LON0 = LON0+15                                                    GEN06400
      GO TO 190                                                         GEN06500
  150 LON0 = LON0+10                                                    GEN06600
      GO TO 190                                                         GEN06700
  160 LON0 = LON0+5                                                     GEN06800
      GO TO 190                                                         GEN06900
  170 LAT0 = LAT0-5                                                     GEN07000
      LON0 = LON0+5                                                     GEN07100
      GO TO 190                                                         GEN07200
  180 LAT0 = LAT0-10                                                    GEN07300
      LON0 = LON0+5                                                     GEN07400
  190 IF (LON0.GT.360) LON0 = LON0 - 360                                GEN07500
      DO 195 I=1,4                                                      GEN07600
      I12 = I+12                                                        GEN07700
      DO 195 J=I,I12,4                                                  GEN07800
      GLAT(J) = LAT0 + 1.25*(J-I)                                       GEN07900
C.....LATITUDE, LONGITUDE GRID AT 5 DEGREE INTERVALS                    GEN08000
  195 GLON(J) = LON0 - 5. * (I - 1)                                     GEN08100
      GO TO 400                                                         GEN08200
C     POLAR GRID                                                        GEN08300
  200 NG = 9                                                            GEN08400
      DO 210 J=1,8                                                      GEN08500
C.....POLAR GRID LATITUDES 1-8 = +75 (N) OR -75 (N)                     GEN08600
      GLAT(J) = SIGN(75.,CLAT)                                          GEN08700
C.....POLAR GRID LONGITUDES 1-8 AT 45 DEG INTERVALS                     GEN08800
  210 GLON(J) = 45.*(J-1)                                               GEN08900
C.....POLAR GRID LATITUDE 9 = POLE +90 OR -90                           GEN09000
      GLAT(9) = SIGN(90.,CLAT)                                          GEN09100
C.....POLAR GRID LONGITUDE 9 = 0                                        GEN09200
      GLON(9) = 0.                                                      GEN09300
C.....GENERATES 16 PROFILES (OR 9 PROFILES FOR POLAR GRID)              GEN09400
  400 CALL GRID4D                                                       GEN09500
      DO 600 I=1,NG                                                     GEN09600
      CHECK=P(I,26)*D(I,26)*T(I,26)*SP(I,26)*SD(I,26)*ST(I,26)          GEN09700
C     CHECK FOR ZERO DATA AT HEIGHT 25                                  GEN09800
      IHV=26                                                            GEN09900
      SPR=SP(I,26)                                                      GEN10000
      SDR=SD(I,26)                                                      GEN10100
      STR=ST(I,26)                                                      GEN10200
      IF (CHECK.GT.0.) GO TO 491                                        GEN10300
      DO 420 J1=1,25,1                                                  GEN10400
      J=26-J1                                                           GEN10500
      CHECK = P(I,J) * D(I,J) * T(I,J) * SP(I,J) * SD(I,J) * ST(I,J)    GEN10600
C      FINDS INDEX IHV OF HIGHEST HEIGHT WITH NON-ZERO DATA             GEN10700
      IHV = J                                                           GEN10800
      IF (CHECK.GT.0.) GO TO 440                                        GEN10900
  420 CONTINUE                                                          GEN11000
C     HEIGHT = HEIGHT INDEX - 1                                         GEN11100
  440 Z1 = IHV -1.                                                      GEN11200
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```
C     SPR,SDR,STR=SIGMAS AT HEIGHT Z1
      SPR = SP(I,IHV)
      SDR=SD(I,IHV)
      STR=ST(I,IHV)
C.....IF HEIGHT Z1 GEQ 20 KM, USE GROVES AT 30 KM FOR INTERPOLATION,
C         OTHERWISE USE GROVES AT 25 KM
      IF (IHV.GE.21) GO TO 480
C.....EVALUATES GROVES AT 25 KM FOR INTERPOLATION AND
C         FILL IN OF ZERO DATA
      CALL GTERP(25,GLAT(I),P2,D2,T2,PG,DG,TG,DPY,DTY,DP2Y)
      IHP = IHV + 1
      DO 450 K=IHP,26
C.....AVOIDS INTERPOLATION OF P,D,T IF ONLY SIGMAS ARE ZERO
      IF ((P(I,K)*D(I,K)*T(I,K)).GT.0.) GO TO 445
      H=K-1
C.....INTERPOLATES BETWEEN 4D AT HEIGHT Z1 AND GROVES AT 25 TO FILL
C         IN MISSING DATA
      CALL INTER2(P(I,IHV),D(I,IHV),T(I,IHV),Z1,P2,D2,T2,25.,PH,DH,TH,H)
      P(I,K)=PH
      D(I,K)=DH
      T(I,K)=TH
  445 SP(I,K) = SPR
      SD(I,K)=SDR
C.....SETS MISSING SIGMAS EQUAL TO SIGMAS AT HEIGHT Z1
  450 ST(I,K)=STR
      GO TO 500
C.....EVALUATES GROVES AT 30 KM FOR INTERPOLATION AND FILL IN OF
C         ZERO DATA
  480 CALL GTERP(30,GLAT(I),P2,D2,T2,PG,DG,TG,DPY,DTY,DP2Y)
      CALL PDTUV(PSP,DSP,TSP,GLAT(I),GLON(I),30,DP,DD,DT,DPX,DPY,DTX,DTY
C     COMPUTE PERTURBATIONS TO GROVES MODEL
     $ ,DP2X,DP2Y,DPXY)
C.....ADD STATIONARY PERTURBATIONS TO GROVES MODEL
      P2 = P2*(1. + DP)
      D2 = D2*(1. + DD)
      T2 = T2*(1. + DT)
      IHP = IHV + 1
      DO 490 K=IHP,25
C.....AVOIDS INTERPOLATING P,D,T IF ONLY SIGMAS ARE ZERO
      IF ((P(I,K)*D(I,K)*T(I,K)).GT.0.) GO TO 485
      H=K-1
C.....INTERPOLATES BETWEEN 4D AT HEIGHT Z1 AND GROVES AT 30 KM TO
C         FILL IN MISSING DATA
      CALL INTER2(P(I,IHV),D(I,IHV),T(I,IHV),Z1,P2,D2,T2,30.,PH,DH,TH,H)
      P(I,K)=PH
      D(I,K)=DH
      T(I,K)=TH
  485 SP(I,K) = SPR
      SD(I,K)=SDR
C     SET MISSING SIGMAS AT HEIGHT 1
  490 ST(I,K) = STR
  491 CONTINUE
      IHP = IHV - 1
      DO 492 K=2,9
      IF (SP(I,K) .LE . 0.) SP(I,K) = SP(I,1)
      IF (SD(I,K) .LE. 0.) SD(I,K)= SD(I,1)
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  492 IF (ST(I,K) .LE. 0.) ST(I,K) = ST(I,1)                            GEN16900
      DO 495 K=10,IHP                                                   GEN17000
C......SETS ALL ZERO SIGMAS TO SIGMA AT HEIGHT Z1                       GEN17100
      IF (SP(I,K).LE.0.0.AND.P(I,K).GT.0.) SP(I,K) = SPR                GEN17200
      IF (SD(I,K).LE.0.0.AND.D(I,K).GT.0.) SD(I,K) = SDR                GEN17300
  495 IF (ST(I,K).LE.0.0.AND.T(I,K).GT.0.) ST(I,K) = STR                GEN17400
  500 PA = P(I,1)                                                       GEN17500
      TA = T(I,1)                                                       GEN17600
      R =287.05                                                         GEN17700
      K = 2                                                             GEN17800
  510 PB = P(I,K)                                                       GEN17900
      TB = T(I,K)                                                       GEN18000
      IF ((PB*TB) .GT. 0.) GO TO 520                                    GEN18100
      K = K + 1                                                         GEN18200
      GO TO 510                                                         GEN18300
  520 IF (TA-TB) 560, 570, 560                                          GEN18400
  560 TZ = (TA-TB) / ALOG(TA/TB)                                        GEN18500
      GO TO 575                                                         GEN18600
  570 TZ = TA                                                           GEN18700
  575 HS = K-1.+0.001*R*TZ*ALOG(PB/PA)/G                                GEN18800
      KM=K-2                                                            GEN18900
      IF(HS.LT.KM) HS=KM                                                GEN19000
      IF(ABS(K-1-HS).GT.0.1) GO TO 578                                  GEN19100
      GAM=TB-T(I,K+1)                                                   GEN19200
      IF(GAM) 582,590,582                                               GEN19300
  578 IF(TA-TB) 580,590,580                                             GEN19400
  580 GAM=(TA-TB)/(K-1-HS)                                              GEN19500
  582 KM1=KM+1                                                          GEN19600
      DO 585 JD=1,KM1,1                                                 GEN19700
      J=JD-1                                                            GEN19800
      TJ=TA-GAM*(J-HS)                                                  GEN19900
      PJ=PA*(TJ/TA)**(G/(R*GAM*0.001))                                  GEN20000
      DJ=PJ/(R*TJ)                                                      GEN20100
      P(I,J+1)=PJ                                                       GEN20200
      D(I,J+1)=DJ                                                       GEN20300
  585 T(I,J+1)=TJ                                                       GEN20400
      GO TO 599                                                         GEN20500
  590 KM1=KM+1                                                          GEN20600
      DO 595 JD=1,KM1,1                                                 GEN20700
      J=JD-1                                                            GEN20800
      TJ=TA                                                             GEN20900
      PJ=PA*EXP(-G*(J-HS)/(R*0.001*TJ))                                 GEN21000
      DJ=PJ/(R*TJ)                                                      GEN21100
      P(I,J+1)=PJ                                                       GEN21200
      D(I,J+1)=DJ                                                       GEN21300
  595 T(I,J+1)=TJ                                                       GEN21400
  599 HS=0.                                                             GEN21500
      KOUNT = I                                                         GEN21600
      CALL ADJUST                                                       GEN21700
  600 CONTINUE                                                          GEN21800
      RETURN                                                            GEN21900
      END                                                               GEN22000
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      SUBROUTINE GETNMC
C
C     READS "SETUP" DATA TAPE, OR NMC GRID DATA CARDS.
C     AND WRITES SCRATCH FILE FOR USE BY SELEC4.
C
      DIMENSION IP(15),BUFFER(64)
C
      COMMON /ICTEMP/ SCRCH1,SCRCH2,IUG,NMCOP
C
      INTEGER SCRCH2
C
      NREC=0
      IF(NMCOP.NE.0) GO TO 2
C
 1    CALL NTRAN(IUG,2,15,IP,L,2)
      IF(L.NE.15) GO TO 6
      GO TO 3
    2 READ(5,100) (IP(I),I=1,15)
  100 FORMAT(15I5)
    3 DO 4 I=1,15,3
      M=IP(I)
      IF(M.LT.1) GO TO 5
      IJ=IP(I+1)*1000+IP(I+2)
      CALL NTRAN(SCRCH2,1,1,IJ,L,22)
      NREC=NREC+1
    4 CONTINUE
      IF(NMCOP.NE.0) GO TO 2
      GO TO 1
    5 IF(NREC.NE.1977) GO TO 6
C     MOVES PAST FIRST EOF ON UNIT IUG
      CALL NTRAN(IUG,8,1,22)
      RETURN
    6 WRITE(6,200) NREC,SCRCH2
  200 FORMAT(1H1/1X,I6," RECORDS WRITTEN BY GETNMC IN SCRATCH FILE",I3)
      STOP
      END
```

```
      SUBROUTINE GRID4D
      REAL LAT,LON
      COMMON/C4/LAT(16),LON(16),NP,P(16,26),R(16,26),T(16,26),SP(16,26),
     $ SR(16,26),ST(16,26)
      COMMON /PLTCOM/ IT,MONTH
C
C     SUBROUTINE TO SELECT PRESSURE, TEMPERATURE, AND DENSITY PROFILES (
C     TOGETHER WITH THE NORMALIZED VARIANCES IN EACH, AT UP TO 16 "GRID
C     AT LAT/LONS SELECTED BY CALLING PROGRAM.
C
C     USES NASA HUNTSVILLE MSFC 4-D DATA TAPES
C
      DIMENSION IN(107),BUFFER(64)
C
      COMMON /ICTEMP/ SCRCH1,SCRCH2
      COMMON /PCINT/ IPT(16,5),LL(16),DXY(16,2)
      COMMON /ORDER/ IPTN(16,5),IREAD(65,3)
      COMMON /INT/ D(203,5),IG(5),DYX(2),DLA(4),DLO(4)
C
      INTEGER SCRCH1,READ,WRITE
C
C
C     INITIALIZE
C
      ZERO=0.0
      ONE=1.0
      TEN=10.0
      HUNDR=100.0
      THOU=1000.0
      READ=6H READ
      WRITE=6H WRITE
C
      N=MONTH-1-((2*MONTH)/9)*4
      IF(MONTH.EQ.13) N=0
      NUMEOF = 0
      CALL NTRAN(IT,10,22)
      IF (N.EQ.0) GO TO 20
      CALL NTRAN(IT,8,N,22)
C
C     APPROPRIATE 4-D INPUT TAPE NOW POSITIONED - FILE NEEDED PROFILES
C
C
   20 CALL SELEC4
C
      IRC=0
      IRN=1
      IF(IREAD(IRN,3).EQ.0) GO TO 39
   21 JT=IT
      M=READ
 22   CALL NTRAN(IT,2,106,IN,L,22)
      IRC =IRC +1
      IF (L.EQ.-2) GO TO 39
      IF (L.LT.0) WRITE(6,23) IT,L,IRC
   23 FORMAT(" INPUT UNIT NO.",I3," IN ERROR (",I2,") FOR RECORD NO.",I5
     1)
      IF(IRC.LT.IREAD(IRN,3)) GO TO 22
```

```
      IF(IRC.GT.IREAD(IRN,3)) GO TO 39                                  GRI05100
   24 I=IREAD(IRN,1)                                                    GRI05200
      J=IREAD(IRN,2)                                                    GRI05300
      IF(IRN.EQ.1) GO TO 25                                             GRI05400
      IF(IREAD(IRN,3).EQ.IREAD(IRN-1,3)) GO TO 27                       GRI05500
   25 IP=FLD(12,12,IN(106))                                             GRI05600
      MP=FLD(24,12,IN(106))                                             GRI05700
      IF((MP.NE.MONTH).OR.(IP.NE.IPT(I,J))) GO TO 39                    GRI05800
      DO 26 IK=1,106,1                                                  GRI05900
      K=107-IK                                                          GRI06000
      IN(K+1)=IN(K)                                                     GRI06100
   26 CONTINUE                                                          GRI06200
  27  FLD(0,18,IN(1)) = I                                               GRI06300
      FLD(18,18,IN(1)) = J                                              GRI06400
      JT=SCRCH1                                                         GRI06500
      M=WRITE                                                           GRI06600
      CALL NTRAN(SCRCH1,1,107,IN,L,22)                                  GRI06700
      IRN=IRN+1                                                         GRI06800
      IF(L.NE.107)  GO TO 39                                            GRI06900
      IF(IREAD(IRN,3).EQ.IRC) GO TO 24                                  GRI07000
      IF(IREAD(IRN,3).EQ.0) GO TO 28                                    GRI07100
      GO TO 21                                                          GRI07200
C                                                                       GRI07300
C     INTERPOLATE TO GIVEN LAT/LON FROM GRID DATA                       GRI07400
C                                                                       GRI07500
   28 M=READ                                                            GRI07600
      DO 38 II=1,NP                                                     GRI07700
      DO 29 I=1,208                                                     GRI07800
      DO 29 J=1,5                                                       GRI07900
      D(I,J)=1.0                                                        GRI08000
   29 CONTINUE                                                          GRI08100
      DO 32 J=1,4                                                       GRI08200
      IF(IPT(II,J).EQ.0) GO TO 32                                       GRI08300
      FLD(0,18,INDEX) = II                                              GRI08400
      FLD(18,18,INDEX) = J                                              GRI08500
      CALL NTRAN(SCRCH1,10,22)                                          GRI08600
  30  CALL NTRAN(SCRCH1,2,107,IN,L,22)                                  GRI08700
      IF(L.EQ.-2) GO TO 39                                              GRI08800
      IF(IN(1).NE.INDEX) GO TO 30                                       GRI08900
      DO 31 I=2,105                                                     GRI09000
      J2=2*I-2                                                          GRI09100
      J1=J2-1                                                           GRI09200
      D(J1,J)=FLD(0,18,IN(I))/HUNDR                                     GRI09300
      D(J2,J)=FLD(18,18,IN(I))/HUNDR                                    GRI09400
   31 CONTINUE                                                          GRI09500
      DLA(J)=FLD(0,18,IN(106))/TEN                                      GRI09600
      DLO(J)=FLD(18,18,IN(105))/TEN                                     GRI09700
   32 CONTINUE                                                          GRI09800
C                                                                       GRI09900
C     IF NECESSARY, INTERPOLATE                                         GRI10000
C                                                                       GRI10100
      LALC=LL(II)                                                       GRI10200
      DO 33 I=1,5                                                       GRI10300
      IG(I)=IPT(II,I)                                                   GRI10400
   33 CONTINUE                                                          GRI10500
      IF(IG(2).NE.0) GO TO 35                                           GRI10600
```

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      DO 34 I=1,208                                                     GRI10700
      D(I,5)=D(I,1)                                                     GRI10800
   34 CONTINUE                                                          GRI10900
      GO TO 37                                                          GRI11000
   35 IF(IG(5).NE.2) GO TO 36                                           GRI11100
      DYX(1)=DXY(II,1)                                                  GRI11200
      DYX(2)=DXY(II,2)                                                  GRI11300
C                                                                       GRI11400
   36 CALL INTRP4 (LALO)                                                GRI11500
C                                                                       GRI11600
   37 DO 38 I=1,26                                                      GRI11700
      P(II,I)=D(1,5)*HUNDR                                              GRI11800
      R(II,I)=D(I+156,5)/THOU                                           GRI11900
      T(II,I) =D(I+52,5)                                                GRI12000
      DIVIDE=ONE                                                        GRI12100
      IF(P(II,I).GT.ZERO) DIVIDE=(P(II,I)/HUNDR)**2                     GRI12200
      SP(II,I)=D(I+26,5)/DIVIDE                                         GRI12300
      DIVIDE=ONE                                                        GRI12400
      IF(P(II,I).GT.ZERO) DIVIDE=(THOU*R(II,I))**2                      GRI12500
      SR(II,I)=D(I+182,5)/DIVIDE                                        GRI12600
      DIVIDE=ONE                                                        GRI12700
      IF(T(II,I).GT.ZERO) DIVIDE=T(II,I)**2                             GRI12800
      ST(II,I)=D(I+78,5)/DIVIDE                                         GRI12900
   38 CONTINUE                                                          GRI13000
      RETURN                                                            GRI13100
   39 WRITE(6,40) JT,IRC,IREAD(IRN,3),MP,MONTH,IP,I,J,IPT(I,J),IRN,M,L  GRI13200
   40 FORMAT(" ***** UNIT NO.",I3," IN ERROR",I7," RECORDS READ"/       GRI13300
     1" IREAD(IRN,3) =",I5," MP =",I3," MONTH =",I3,                    GRI13400
     2" IP =",I5," IPT(",I2,",",I1,") =",I5," IRN =",I3/A6," STATUS",I5)GRI13500
      STOP                                                              GRI13600
      END                                                               GRI13700
```

```
C      FIRST DATA CARD READS INITIAL HEIGHT (KM), INITIAL LATITUDE (DEG) GRM00400
C         INITIAL LONGITUDE (DEG), F10.7, MEAN F10.7, AP, MONTH, DAY,   GRM00500
C         YEAR (TOTAL YEAR - 1900), GREENWICH HOUR, MINUTES, SECONDS,   GRM00600
C         LATITUDE INCREMENT (DEG), LONGITUDE INCREMENT (DEG),          GRM00700
C         HEIGHT DECREASE (KM), MAXIMUM NUMBER OF POSITIONS (EXCLUDING  GRM00800
C         INITIAL POSITION) TO BE COMPUTED, TIME INCREMENT BETWEEN      GRM00900
C         POSITIONS, TRAJECTORY OPTION, OUTPUT OPTION,MINIMUM GEOSTROPHICGRM01000
C          LATITUDE                                                     GRM01100
       COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOF,DD,XMJD,PHI1,PHI,          GRM01200
     .            NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,GRM01300
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,    GRM01400
     .    IHR,MIN,NMORE,DX,HL,VL,DZ,B,EPS,IOFP,LOOK,IET,GLAT,           GRM01500
     1RP1S,RD1S,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,                GRM01600
     2UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2                           GRM01700
        COMMON/CHIC/LA(4,4),N3(2),IWSYM                                 GRM01800
 9090  FORMAT("1 ****** GLOBAL REFERENCE ATMOSPHERE - MOD 2 ******"/)   GRM01900
       PI=3.1415927                                                     GRM02000
       FAC=0.017453293                                                  GRM02100
       LOOK=0                                                           GRM02200
       MONTH = 0                                                        GRM02300
       IOPT=0                                                           GRM02400
     5 IF(IOPT.EQ.0.OR.(IOPT.GT.0.AND.H.LT.0.)) GO TO 6                 GRM02500
       READ(IOPT,10)IET,H,PHI,THET                                      GRM02600
       GO TO 5                                                          GRM02700
    6  MN = MONTH                                                       GRM02800
       NSAME = 0                                                        GRM02900
       READ(5,10,END=90) H1,PHI1,THET1,F10,F10B,AP,MN,IDA ,IYR,IHRO,MINO,GRM03000
     1  ISECO,DPHI,DTHET,DH,NMAX,INCT,IOPT,IOPP,GLAT                    GRM03100
 10     FORMAT( )                                                       GRM03200
       WRITE(6,9090)                                                    GRM03300
       IF(ABS(PHI1).LE.90.)GO TO 7                                      GRM03400
       PHI1=SIGN(180.-ABS(PHI1),PHI1)                                   GRM03500
       THET1=THET1+180.                                                 GRM03600
       IF(THET1.GT.360.)THET1=THET1-360.                                GRM03700
     7 IF(THET1.LT.0.)  THET1=THET1+360                                 GRM03800
       GLAT = ABS(GLAT)                                                 GRM03900
       IF (GLAT.LT. 5.) GLAT =  5.                                      GRM04000
       IF (GLAT.GT.70.) GLAT = 70.                                      GRM04100
       WRITE(6,9015) H1,PHI1,THET1,F10,F10B,AP,MN,IDA ,IYR,IHRO,MINO,   GRM04200
     $  ISECO,DPHI,DTHET,DH,NMAX,INCT,IOPT,IOPP,GLAT                    GRM04300
C       SET NSAME TO AVOID SETUP                                        GRM04400
   15 IF (MN.EQ.MONTH) NSAME = 1                                        GRM04500
C      LOOKUP ON MULTIPLE PASSES                                        GRM04600
       MONTH = MN                                                       GRM04700
C       CONVERT LATITUDE TO RADIANS                                     GRM04800
       PHI1R=PHI1*FAC                                                   GRM04900
C      CONVERT LONGITUDE TO RADIANS                                     GRM05000
       THET1R=THET1*FAC                                                 GRM05100
C      CONVERT LATITUDE INCREMENT TO RADIANS                            GRM05200
       DPHIR=DPHI*FAC                                                   GRM05300
C      CONVERT LONGITUDE INCREMENT TO RADIANS                           GRM05400
       DTHETR=DTHET*FAC                                                 GRM05500
C      READ DATA TAPE TO INITIALIZE ARRAYS                              GRM05600
       CALL SETUP                                                       GRM05700
       NT = 1                                                           GRM05800
       IF(IOPT.EQ.0) GO TO 18                                           GRM05900
```

```
      READ(IOPT,10)IET,H,PHI,THET
      IF(THET.LT.0.)THET=THET+360.
      PHIR=PHI*FAC
      THETR=THET*FAC
      GO TO 19
   18 H = H1 - DH
C.....DISPLACES POSITION BEFORE EVALUATION OF ATMOSPHERIC PARAMETERS
      IET = INCT
      PHIR=PHI1R+DPHIR
      THETR=THET1R+DTHETR
C      A=EQUATORIAL EARTH RADIUS, B = POLAR EARTH RADIUS
C      EPS= EARTH ECCENTRICITY
   19 A = 6378.160
      B = 6356.7747
      EPS=(1.-(B*B)/(A*A))
C.....COMPUTES RADIUS TO HEIGHT H, AND GRAVITY AT HEIGHT AND
C           LATITUDE PHIR
      CALL RIG
      ISEC=ISECO+IET
      ISEC=MOD(ISEC,60)
      MIN = MINO + IET/60
      IHR = IHRO + MIN / 60
      MIN = MOD(MIN,60)
C.....COMPUTES P,D,T,U,V AT FIRST POSITION AFTER INITILL POSITION
      IF(H1.LE.30.) LOOK=1
      CALL SCIMOD
   20 NT = NT + 1
      IF (IOPT.EQ.0) GO TO 22
      READ(IOPT,10)IET,H,PHI,THET
      IF(H.LT.0.)GO TO 5
      IF(ABS(PHI).LE.90.)GO TO 21
      PHI=SIGN(180.-ABS(PHI),PHI)
      THET=THET+180.
   21 IF(THET.LT.0.)THET=THET+360.
      IF(THET.GE.360.)THET=THET-360.
      PHIR=PHI*FAC
      THETR=THET*FAC
      GO TO 25
C     INCREMENT THE HEIGHT
 22   H = H1 - DH
      IF (H .LT. 0.0) GO TO 5
C     INCREMENT THE LATITUDE
      PHIR=PHIR+DPHIR
C     INCREMENT THE LONGITUDE
      THETR=THETR+DTHETR
C..... CHANGES LONGITUDE BY 180 DEGREES AND IF ABS(LAT) GTR 90 DEG
C..... MAKES LAT=SIGN(LAT)*(180.-ABS(LAT))
      IF (ABS(PHIR).LE.PI/2) GO TO 23
      PHIR=SIGN(PI-ABS(PHIR),PHIR)
      THETR=THETR+PI
   23 IF (THETR.GE.2.*PI) THETR = THETR - 2. * PI
      IF (THETR.LT.0.) THETR = THETR + 2. * PI
C      INCREMENT THE TIME
      IET=IET+INCT
   25 MIN=MINO+IET/60
      ISEC=ISECO+IET
```

```
      ISEC=MOD(ISEC,60)                                                 GRM11600
      IHR=IHRC+MIN/60                                                   GRM11700
      MIN=MOD(MIN,60)                                                   GRM11800
C     COMPUTE RADIUS AND GRAVITY AT NEW POSITION                        GRM11900
      CALL RIG                                                          GRM12000
C     COMPUTE P.D,T,U,V, AT NEW POSITION                                GRM12100
      CALL SCIMOD                                                       GRM12200
                                                                        GRM12300
C.....READS NEW INPUT IF NMORE = 0 OR MAX POINTS COMPUTED               GRM12400
      IF(NMORE.EQ.0.OR.(IOPT.EQ.0.AND.NT.GE.NMAX)) GO TO 5              GRM12500
C     CYCLE TO NEW POSITION                                             GRM12600
      GO TO 20                                                          GRM12700
   90 STOP                                                              GRM12800
 9010 FORMAT("  INITIAL HEIGHT = ",F7.2," KM",T43,"INITIAL LAT = ",     GRM12900
     1F6.2," DEG",T83,"INITIAL WEST LON = ",F6.2," DEG",/,"  F10.7 = ",FGRM13000
     $8.2,                                                              GRM13100
     2T43,"MEAN F10.7 = ",F7.2,T83,"AP = ",F8.2,/,"  DATE = ",I2,"/",I2,GRM13200
     3"/",I2,T43,"GREENWICH TIME = ",I2," ,I2," ,I2/,"  LAT INCREMENT GRM13300
     4= ",F6.2," DEG",T43,"WEST LON INCREMENT = ",F6.2," DEG",T83,"HEI",GRM13400
     $"GHT INCR",                                                       GRM13500
     5"EMENT = ",F7.2," KM",/,"  MAXIMUM NUMBER OF POSITIONS = ",I4,T43,GRM13600
     6"TIME INCREMENT = ",I4," SEC",/2X,"TRAJECTORY OPTION = ",I4,      GRM13700
     7T43,"OUTPUT OPTION = ",I2,T83,"MIN GEOSTROPH LAT = ",F5.1,/)      GRM13800
      END                                                               GRM13900
```

```
      SUBROUTINE GROUP
      DIMENSION KOU(2)
      COMMON /CHIC/LA(4,4),NB(2),IWSYM
      COMMON /CHK/P(4,4,3),DEN(4,4,3),NO(2)
      COMMON /WINCOM/DGH,FCORY,DX5,DY5
      FCORX = FCORY*DX5/DY5
      KK=1
      DO 100 I=1,4
      DO 100 J=1,4
      LA(I,J)=4*(I-1)+J
  100 CONTINUE
  200 CONTINUE
      DO 250 M=1,4
      DO 250 N=1,4
      IF (KK.EQ.1) GO TO 210
      I=5-M
      J=5-N
      NN=-1
      N4=-1
      GO TO 220
  210 CONTINUE
      I=M
      J=N
      NN=1
      N4=1
  220 CONTINUE
      IF (N.EQ.4) GO TO 225
      DINX=FCORX* (DEN(I,J+NN,2)+DEN(I,J,2))/2
      VY=(P(I,J+NN,2)-P(I,J,2))/DINX
      IF(ABS(VY).GT.100) GO TO 225
      LA(I,J)=MIN0(LA(I,J),LA(I,J+NN))
      LA(I,J+NN)=LA(I,J)
  225 CONTINUE
      IF(M.EQ.4) GO TO 250
      DINY=FCORY* (DEN(I+N4,J,2)+DEN(I,J,2))/2
      VX=(P(I+N4,J,2)-P(I,J,2))/DINY
      IF(ABS(VX).GT.100) GO TO 250
      LA(I,J)=MIN0(LA(I,J),LA(I+N4,J))
      LA(I+N4,J)=LA(I,J)
  250 CONTINUE
      KK=KK+1
      IF(KK.EQ.2) GO TO 200
      NO(1)=0
      NO(2)=0
      II=1
      DO 400 LL=1,11
      KOU(II)=1
      DO 300 I=1,4
      DO 300 J=1,4
      IF(LA(I,J).EQ.LL) KOU(II)=KOU(II)+1
  300 CONTINUE
      IF (KOU(II).GE.7) NO(II)=LL
      IF (KOU(II).GE.7) II=2
  400 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GTERP(IH,PHI,P,D,T,PG,DG,TG,DPY,DTY,DP2Y)
C.....INTERPOLATES GROVES DATA TO HEIGHT IH AND LATITUDE PHI
      DIMENSION PG(18,19),TG(18,19),DG(18,19)
C     HEIGHT INDEX
      I =(IH - 20)/5
C     LOWER LATITUDE INDEX
      J = INT((PHI + 100.)/10.)
      IF (J.LT.1) J = 1
      IF (J.GT.18) J = 18
C     UPPER LATITUDE INDEX
      JP = J + 1
C.....CHECK FOR DENSITY OF TEMPERATURE LEQ 0
      CHK = DG(I,J) * TG(I,J) * DG(I,JP) * TG(I,JP)
      IF (CHK) 10,10,20
 10   P = PG(I,J)
      D = DG(I,J)
      T = TG(I,J)
      GO TO 30
C.....LATITUDE DEVIATION FROM GROVES ARRAY POSITION
 20   PHIF = (PHI + 100. - 10.*J)/10.
      TL= TG(I,J) + (TG(I,JP ) - TG(I,J))*PHIF
C      LATITUDE INTERPOLATION
      DL= DG(I,J) + (DG(I,JP ) - DG(I,J)) *PHIF
      R1 = PG(I,J)/(DG(I,J)*TG(I,J))
      R2 = PG(I,JP)/(DG(I,JP)*TG(I,JP))
C     INTERPOLATED GAS CONSTANT
      R = R1 + (R2 - R1)*PHIF
C     PRESSURE COMPUTED FROM INTERPOLATED GAS CONSTANT
      P =DL*R*TL
      D = DL
      T = TL
C     DP/DY FOR GEOSTOPHIC WINDS
 30   DPY = (PG(I,JP) - PG(I,J)) * 0.5
C     DT/DY FOR THERMAL WINDS
      DTY = (TG(I,JP) - TG(I,J)) * 0.5
      JM = J - 1
      IF (JM.LT.1) JM = JP
      DP2Y = (PG(I,JP) - PG(I,JM ))*0.5
      IF (ABS(PHI)-90.) 50,40,40
40    DPY = 0.
      DTY = 0.
      DP2Y = 0.
50    CONTINUE
      RETURN
      END
```

C-3

```
      SUBROUTINE INTERW(U1,V1,Z1,U2,V2,Z2,U,V,Z)                        INW00100
      IF ( Z1 - Z2 ) 20,10,20                                           INW00200
   10 U = U1                                                            INW00300
C     SETS U,V = U1,V1 IF Z1 = Z2                                       INW00400
      V = V1                                                            INW00500
      RETURN                                                            INW00600
   20 A = (Z-Z1)/(Z2-Z1)                                                INW00700
      U = U1 + (U2-U1) * A                                              INW00800
      V = V1 + (V2-V1) * A                                              INW00900
C.....LINEAR INTERPOLATION BETWEEN U1,V1 AT HEIGHT Z1 AND U2,V2 AT      INW01000
C         HEIGHT Z2.  OUTPUT IS U,V AT HEIGHT Z                         INW01100
      RETURN                                                            INW01200
      END                                                               INW01300
```

```
      SUBROUTINE INTERZ(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,Z)                 INZ00100
    5 IF (Z1 - Z2)  20,10,20                                             INZ00200
 10   P = P1                                                             INZ00300
      D = D1                                                             INZ00400
C     SETS P, D, T = P1,D1,T1, IF Z1 = Z2                                INZ00500
      T =T1                                                              INZ00600
      RETURN                                                             INZ00700
 20   A = (Z - Z1)/ (Z2 - Z1)                                            INZ00800
      T = T1 + (T2 - T1)*A                                               INZ00900
      D = D1 + (D2 - D1)*A                                               INZ01000
      P = P1 + (P2 - P1) * A                                             INZ01100
C.....LINEAR INTERPOLATION BETWEEN P1,D1,T1 AT HEIGHT Z1 AND P2,D2,T2     INZ01200
C          AT HEIGHT Z2 TO OUTPUT VALUES OF P,D,T AT HEIGHT Z            INZ01300
      RETURN                                                             INZ01400
      END                                                                INZ01500
```

```
      SUBROUTINE INTER2(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,Z)                IN200100
C.....INTERPOLATES BETWEEN P1,D1,T1 AT HEIGHT Z1 AND P2,D2,T2 AT        IN200200
C         HEIGHT Z2 TO OUTPUT VALUES OF P,D,T AT HEIGHT Z               IN200300
C.....CHECKS FOR T1,D1,T2,D2 PRODUCT = 0, FOR GAS CONSTANT INTERPOLATIONIN200400
      CHK=T1*D1*T2*D2                                                   IN200500
      IF (CHK) 10,10,5                                                  IN200600
    5 IF (Z1 - Z2)  20,10,20                                            IN200700
 10   P = P1                                                            IN200800
      D = D1                                                            IN200900
C       SETS P,D,T = P1,D1,T1 IF Z1=Z2                                  IN201000
      T = T1                                                            IN201100
      RETURN                                                            IN201200
   20 IF(P1*D1*T1*P2*D2*T2.LE.0.)GO TO 30                               IN201300
      A=ALOG(D2/D1)/(Z2-Z1)                                             IN201400
C      LINEAR INTERPOLATION ON LOG D                                    IN201500
      DZ= D1*EXP(A*(Z - Z1))                                            IN201600
      A=(Z-Z1)/(Z2-Z1)                                                  IN201700
C      LINEAR INTERPOLATION ON T                                        IN201800
      TZ= T1 + A*(T2-T1)                                                IN201900
      R1=P1/(D1*T1)                                                     IN202000
      R2=P2/(D2*T2)                                                     IN202100
C      LINEAR INTERPOLATION ON GAS CONSTANT R                           IN202200
      R=(R2-R1)*A+R1                                                    IN202300
C       PRESSURE FROM PERFECT GAS LAW                                   IN202400
      P = DZ * R * TZ                                                   IN202500
      D = DZ                                                            IN202600
      T = TZ                                                            IN202700
      RETURN                                                            IN202800
   30 P=0.                                                              IN202900
      D=0.                                                              IN203000
      T=0.                                                              IN203100
      RETURN                                                            IN203200
      END                                                               IN203300
```

```
      SUBROUTINE INTER4 (                 CLAT, CLON, IZ,      P, D, T,        IN400100
     $ P4, D4, T4, DPX, DPY, DTX, DTY,DPXX,DPYY,DPXY)                          IN400200
C.....INTERPOLATES BETWEEN 4D ARRAYS P(I,IH),D(I,IH),T(I,IH) AT GRID           IN400300
C          LOCATIONS LATITUDE GLAT(I) LONGITUDE GLON(I).                       IN400400
C          CLAT,CLON = CURRENT LATITUDE,LONGITUDE                              IN400500
C          IZ = HEIGHT                       NG = NUMBER OF 4D GRID POSITIONS  IN400600
C          OUTPUT = P4,D4,T4, AND DERIVATIVES DPX,DPY,DTX,DTY                  IN400700
      COMMON /C4/ GLAT(16),GLON(16),NG                                         IN400800
      COMMON/CHIC/LA(4,4),NB(2),IWSYM                                          IN400900
      DIMENSION                         P(16,26),D(16,26),T(16,26),LAX(16)     IN401000
      IWSYM = " "                                                              IN401100
      ICHK = 0                                                                 IN401200
C     HEIGHT INDEX = HEIGHT + 1                                                IN401300
    5 IH = IZ + 1                                                              IN401400
      IF (ICHK.GT.1) GO TO 220                                                 IN401500
      IF (NG.GT.9) GO TO 100                                                   IN401600
C     NG = 9 MEANS POLAR GRID                                                  IN401700
      DO 10 I=10,16,1                                                          IN401800
      P(I,IH) = P(9,IH)                                                        IN401900
      D(I,IH) = D(9,IH)                                                        IN402000
      T(I,IH) = T(9,IH)                                                        IN402100
      GLAT(I) = GLAT(9)                                                        IN402200
C     I=10-16 ALL AT 90 DEG                                                    IN402300
   10 GLON(I) = GLON(I-8)                                                      IN402400
C     LOWER RIGHT INTERPOLATION INDEX                                          IN402500
      IB = INT(CLON/45) + 1                                                    IN402600
C     LOWER LEFT INTERPOLATION INDEX                                           IN402700
      IA =IB+1                                                                 IN402800
      IF (IA.GT.8) IA = IA-8                                                   IN402900
C     POSITION OUTSIDE POLAR GRID                                              IN403000
      IF (ABS(CLAT).LT.75.) GO TO 20                                           IN403100
C     UPPER LEFT INTERPOLATION INDEX                                           IN403200
      IC = IA +8                                                               IN403300
C     UPPER RIGHT INTERPOLATION INDEX                                          IN403400
      ID = IB + 9                                                              IN403500
      GO TO 300                                                                IN403600
 20   CALL GEN4D                                                               IN403700
      IWSYM = "*"                                                              IN403800
      ICHK = ICHK + 1                                                          IN403900
      GO TO 5                                                                  IN404000
  100 XLON = CLON                                                              IN404100
      DO 105 I = 1,4                                                           IN404200
      DO 105 J = 1,4                                                           IN404300
      I16 = 4*(I-1) + J                                                        IN404400
      LAX(I16) = LA(I,J)                                                       IN404500
 105   CONTINUE                                                                IN404600
      IF (CLON.GT.345) XLON = CLON - 360.                                      IN404700
C.....CHECKS FOR POSITION WITHIN 16 POINT GRID 110=GOOD.  200=POSITION         IN404800
C          OUTSIDE GRID.                                                       IN404900
      IF (CLAT.GE.GLAT(1) .AND. CLAT.LT.GLAT(16) .AND. XLON.LE.GLON(1)         IN405000
     $  .AND.XLON.GT.GLON(16)) GO TO 110                                       IN405100
      GO TO 200                                                                IN405200
  110 IA = 1 + INT((GLON(1) - XLON) / 5)                                       IN405300
C.....IA = LOWER LEFT (REFERENCE) INTERPOLATION INDEX                          IN405400
      IA = IA + 4 * INT((CLAT - GLAT(1)) / 5)                                  IN405500
C     LOWER RIGHT INTERPOLATION INDEX                                          IN405600
```

```
      IB = IA + 1                                                       IN405700
C     UPPER LEFT INTERPOLATION INDEX                                    IN405800
      IC = IA + 4                                                       IN405900
C     UPPER RIGHT INTERPOLATION INDEX                                   IN406000
      ID = IA + 5                                                       IN406100
      IF(LAX(IA).EQ.NB(1).OR.LAX(IA).EQ.NB(2).OR.LAX(IB).NE.LAX(IA).    IN406200
     *  OR.LAX(IC).NE.LAX(IA).OR.LAX(ID).NE.LAX(IA))IWSYM="*"           IN406300
      GO TO 300                                                         IN406400
  200 CALL GEN4D                                                        IN406500
      IWSYM = "*"                                                       IN406600
      ICHK = ICHK + 1                                                   IN406700
      GO TO 5                                                           IN406800
  220 WRITE(6,250)                                                      IN406900
  250 FORMAT("  UNABLE TO GENERATE 4-D GRID")                           IN407000
      P4=0.                                                             IN407100
      D4=0.                                                             IN407200
      T4=0.                                                             IN407300
      RETURN                                                            IN407400
C.....INTERPOLZTION FOR POSITION INSIDE 16 POINT GRID OF POLAR GRID     IN407500
  300 CALL INTLL(P,IA,IB,IC,ID,P4,GLAT,GLON,CLAT,CLON,IH)               IN407600
      CALL INTLL(D,IA,IB,IC,ID,D4,GLAT,GLON,CLAT,CLON,IH)               IN407700
      CALL INTLL(T,IA,IB,IC,ID,T4,GLAT,GLON,CLAT,CLON,IH)               IN407800
C.....RELATIVE LONGITUDE DISPLACEMENT FROM REFERENCE POSITICN (IA)      IN407900
      DLON = (CLON - GLON(IA))/(GLON(IB) - GLON(IA))                    IN408000
C.....RELATIVE LATITUDE DISPLACEMENT FROM REFERENCE POSITION(IA)        IN408100
      DLAT = (CLAT - GLAT(IA))/(GLAT(IC) - GLAT(IA))                    IN408200
      DPX=P(IB,IH)-P(IA,IH)                                             IN408300
C.....DP/DX FOR GEOSTROPHIC WIND EQUATIONS                              IN408400
      DPX = DPX + (P(ID,IH) - P(IC,IH) - DPX)*DLAT                      IN408500
      DTX = T(IB,IH) - T(IA,IH)                                         IN408600
C.....DT/DX FOR THERMAL WIND EQUATIONS                                  IN408700
      DTX = DTX + (T(ID,IH) - T(IC,IH) - DTX)*DLAT                      IN408800
      DPY = P(IC,IH) - P(IA,IH)                                         IN408900
C.....DP/DY FOR GEOSTROPHIC WIND EQUATIONS                              IN409000
      DPY = DPY + (P(ID,IH) - P(IB,IH) - DPY)*DLON                      IN409100
      DTY = T(IC,IH) - T(IA,IH)                                         IN409200
C.....DT/DY FOR THERMAL WIND EQUATIONS                                  IN409300
      DTY = DTY + (T(ID,IH) - T(IB,IH) - DTY)*DLON                      IN409400
      IF (NG.GT.9) GO TO 310                                            IN409500
      DPXX = 0.                                                         IN409600
      DPYY = 0.                                                         IN409700
      DPXY = 0.                                                         IN409800
      RETURN                                                            IN409900
  310 DPXY = P(ID,IH) - P(IC,IH) - P(IB,IH) + P(IA,IH)                  IN410000
      IF (MOD(IB,4) .EQ.0) GO TO 320                                    IN410100
      I1 = IA                                                           IN410200
      I2 = IB + 1                                                       IN410300
      I3 = IC                                                           IN410400
      I4 = ID + 1                                                       IN410500
      SX=1.                                                             IN410600
      GO TO 330                                                         IN410700
  320 I1 = IA - 1                                                       IN410800
      I2 = IB                                                           IN410900
      I3 = IC - 1                                                       IN411000
      I4 = ID                                                           IN411100
      SX=-1.                                                            IN411200
```

```
 330  IF(LAX(I1).NE.LAX(IA).OR.LAX(I2).NE.LAX(IA).OR.LAX(I3).NE.             IN411300
     * LAX(IA).OR.LAX(I4).NE.LAX(IA)) GO TO 360                                IN411400
      DPXX = P(I2,IH) - P(I1,IH)                                               IN411500
      DPXX = DPXX + (P(I4,IH) - P(I3,IH) - DPXX)*DLAT                          IN411600
      IF (IC.GT.12) GO TO 340                                                  IN411700
      I1 = IA                                                                  IN411800
      I2 = IC + 4                                                              IN411900
      I3 = IB                                                                  IN412000
      I4 = ID + 4                                                              IN412100
      SY=1.                                                                    IN412200
      GO TO 350                                                                IN412300
 340  I1 = IA - 4                                                              IN412400
      I2 = IC                                                                  IN412500
      I3 = IB - 4                                                              IN412600
      I4 = ID                                                                  IN412700
      SY=-1.                                                                   IN412800
 350  IF(LAX(I1).NE.LAX(IA).OR.LAX(I2).NE.LAX(IA).OR.LAX(I3).NE.             IN412900
     * LAX(IA).OR.LAX(I4).NE.LAX(IA)) GO TO 360                                IN413000
      DPYY = P(I2,IH) - P(I1,IH)                                               IN413100
      DPYY = DPYY + (P(I4,IH) - P(I3,IH) - DPYY)*DLON                          IN413200
      DPXX =(DPXX - 2.*DPX )*SX                                                IN413300
      DPYY =(DPYY - 2.*DPY )*SY                                                IN413400
      RETURN                                                                   IN413500
 360  DPXX = 0.                                                                IN413600
      DPYY = 0.                                                                IN413700
      DPXY = 0.                                                                IN413800
      IWSYM = "*"                                                              IN413900
      RETURN                                                                   IN414000
      END                                                                      IN414100
```

```
      SUBROUTINE INTLL(F,IA,IB,IC,ID,FLL,GLAT,GLON,CLAT,CLON,IH)         INL00100
C.....INTERPOLATES FUNCTION (ARRAY) F FROM VALUES OF GLAT AND GLON AT    INL00200
C         INDEX VALUES IA, IB, IC, ID TO OUTPUT VALUE FLL AT HEIGHT IH   INL00300
C         AND POSITION CLAT, CLON                                        INL00400
      DIMENSION F(16,26),GLAT(16),GLON(16)                               INL00500
C.....NORMALIZES LONGITUDE DISPLACEMENT                                  INL00600
      IF(F(IA,IH)*F(IB,IH)*F(IC,IH)*F(ID,IH)) 20,10,20                   INL00700
   10 FLL=0.                                                             INL00800
      RETURN                                                             INL00900
   20 X=(CLON-GLON(IB))/(GLON(IA)-GLON(IB))                              INL01000
C.....NORMALIZES LATITUDE DISPLACEMENT                                   INL01100
      Y=(CLAT-GLAT(IA))/(GLAT(IC)-GLAT(IA))                              INL01200
C.....TWO DIMENSIONAL INTERPOLATION                                      INL01300
      FLL=F(IB,IH)+(F(ID,IH)-F(IB,IH))*Y+(F(IA,IH)-F(IB,IH))*X           INL01400
     1   +(F(IC,IH)-F(IA,IH)-F(ID,IH)+F(IB,IH))*X*Y                      INL01500
      RETURN                                                             INL01600
      END                                                                INL01700
```

```
      SUBROUTINE INTRP4 (LALON)
C
C        SUBROUTINE TO INTERPOLATE VALUES
C
      DIMENSION XLL(4),YLL(4),XO(4),YO(4)
C
      COMMON/INT/D(208,5),IG(5),DXY(2),DLA(4),DLO(4)
C
      DEGRAD=3.14159/180.
      LALO=IABS(LALON)
      L1=LALO/10000
      L2=LALO-L1*10000
      XL=L1/10.
      YL=L2/10.
      IF (IG(5)-2) 30,20,10
   10 IF (IG(5)-3) 30,30,50
C
C        INTERPOLATE FROM NMC GRID
C
   20 CONTINUE
      DO 25 L=1,26
      DO 22 J=1,4
   22 IF (D(L,J).LT.0.01) GO TO 25
      DO 24 K=1,8
      I=(K-1)*26+L
      D(I,5)=(1.-DXY(2))*((1.-DXY(1))*D(I,1)+DXY(1)*D(I,2))
     1 +DXY(2)*(((1.-DXY(1))*D(I,3))+DXY(1)*D(I,4))
   24 CONTINUE
   25 CONTINUE
      RETURN
C
C     INTERPOLATE FROM EQUATION FOR SOUTHERN HEMISPHERE GRID
C
   30 CONTINUE
      DO 32 J=1,2
      XLL(J)=DLA(J)
      YLL(J)=DLO(J)
      IF ((YL.GE.355.).AND.(YLL(J).LT.0.01)) YLL(J)=360.
   32 CONTINUE
      X=(YLL(1)-YL)/5.
      Y=(XL-XLL(1))/5.
      IF (IG(5).EQ.3) Y=-Y
      DO 38 L=1,26
      DO 36 J=1,4
   36 IF (D(L,J).LT.0.01) GO TO 38
      DO 37 K=1,8
      I=(K-1)*26+L
      D(I,5)=D(I,1)+X*(D(I,2)-D(I,1))+Y*(D(I,3)-D(I,1))+X*Y*
     1 (D(I,4)-D(I,3)-D(I,2)+D(I,1))
   37 CONTINUE
   38 CONTINUE
      RETURN
C
C        INTERPOLATE FROM ACROSS GRIDS
C
   50 CONTINUE
```

```
      IF (IG(5).NE.133) GO TO 55                                        INP05700
      IG(5)=3                                                           INP05800
      GO TO 30                                                          INP05900
   55 CONTINUE                                                          INP06000
      IF (IG(5).NE.333) GO TO 60                                        INP06100
      DLO(1)=(DLO(2)+DLO(3))/2.                                         INP06200
      DO 52 I=1,208                                                     INP06300
   52 D(I,4)=D(I,3)                                                     INP06400
      DLA(4)=DLA(3)                                                     INP06500
      DLO(4)=DLO(3)                                                     INP06600
   60 CONTINUE                                                          INP06700
      DO 62 I=1,4                                                       INP06800
      XLL(I)=DLA(I)                                                     INP06900
      YLL(I)=DLO(I)                                                     INP07000
      IF ((YL.GT.350.).AND.(YLL(I).LT.0.01)) YLL(I)=360.                INP07100
   62 CONTINUE                                                          INP07200
      ITH=0                                                             INP07300
      X=YLL(1)-YL                                                       INP07400
      Y=XL-XLL(1)                                                       INP07500
   63 CONTINUE                                                          INP07600
      DO 65 I=2,4                                                       INP07700
      XC(I)=YLL(1)-YLL(I)                                               INP07800
   65 YC(I)=XLL(I)-XLL(1)                                               INP07900
      TH2=3.14159/4                                                     INP08000
      TH3=3.14159/4                                                     INP08100
      IF (ABS(XC(2)).GT.0.01) TH2=ATAN(YC(2)/XC(2))                     INP08200
      IF (ABS(YC(3)).GT.0.01) TH3=ATAN(XC(3)/YC(3))                     INP08300
      IF (XC(2).LT.0.) TH2=3.14159+TH2                                  INP08400
      IF (XC(3).LT.0.) TH3=3.14159+TH3                                  INP08500
      DNN=COS(TH2+TH3)                                                  INP08600
      IF (ABS(DNN).GT.0.001) GO TO 66                                   INP08700
      ITH=ITH+1                                                         INP08800
      IF (ITH.EQ.2) GO TO 66                                            INP08900
      XLL(3)=XLL(4)                                                     INP09000
      YLL(3)=YLL(4)                                                     INP09100
      DO 61 I=1,208                                                     INP09200
   61 D(I,3)=D(I,4)                                                     INP09300
      GO TO 63                                                          INP09400
   66 CONTINUE                                                          INP09500
      ZA=SQRT(XC(2)**2+YC(2)**2)                                        INP09600
      IF (ITH.LT.2) GO TO 69                                            INP09700
      Z=SQRT(X**2+Y**2)                                                 INP09800
      E=0.                                                              INP09900
      Z4=0.                                                             INP10000
      GO TO 71                                                          INP10100
   69 CONTINUE                                                          INP10200
      EP=SQRT(XC(3)**2+YC(3)**2)                                        INP10300
      Z4=(YC(4)*COS(TH3)-YC(4)*SIN(TH3))/DNN                            INP10400
      E4=(YC(4)*COS(TH2)-XC(4)*SIN(TH2))/DNN                            INP10500
      Z=(X*COS(TH3)-Y*SIN(TH3))/DNN                                     INP10600
      E=(Y*COS(TH2)-X*SIN(TH2))/DNN                                     INP10700
      B=0.                                                              INP10800
      C=0.                                                              INP10900
      DD=0.                                                             INP11000
C                                                                       INP11100
   71 CONTINUE                                                          INP11200
```

```
      DO 70 L=1,26
      DO 68 J=1,4
   68 IF (D(L,J).LT.0.01) GO TO 70
      DO 67 K=1,4
      I=(K-1)*26+L
      A=D(I,1)
      IF (ZA.GT.0.01) B=(D(I,2)-D(I,1))/ZA
      IF (EB.GT.0.01) C=(D(I,3)-D(I,1))/EB
      IF ((ABS(Z4).GT.0.01).AND.(ABS(E4).GT.0.01))
     1 DD=(D(I,4)-A-B*Z4-C*E4)/(Z4*E4)
      D(I,5)=A+B*Z+C*E+DD*Z*E
   67 CONTINUE
   70 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INTRUV(UR,VR,H,PHI,SUH,SVH)                            INV00100
C.....FINDS RANDOM WIND STANDARD DEVIATION AT HEIGHT H (KM), LATITUDE   INV00200
C        PHI (DEGREES), FROM UR AND VR ARRAYS                           INV00300
      DIMENSION UR(25,10),VR(25,10)                                     INV00400
C.....I - LOWER HEIGHT INDEX                                             INV00500
      IF (H.LT.95.) I = 1 + INT(H) / 5                                  INV00600
      IF (H.GE.95.) I=19+(INT(H)-80)/20                                 INV00700
      IF (I.GT.25) I = 25                                               INV00800
C     UPPER HEIGHT INDEX                                                INV00900
      IP=I+1                                                            INV01000
      IF (IP.GT.25) IP=25                                               INV01100
C     LOWER LATITUDE INDEX                                              INV01200
      J=INT(PHI+110.)/20                                                INV01300
C      UPPER LATITUDE INDEX                                             INV01400
      JP=J+1                                                            INV01500
      IF (JP.GT.10) JP=10                                               INV01600
C.....PHI1 - LOWER LATITUDE FOR UR AND VR ARRAY VALUES                   INV01700
      PHI1=-110.+20.*J                                                  INV01800
C.....PHI2 - UPPER LATITUDE FOR UR AND VR ARRAY VALUES                   INV01900
      PHI2=-110.+20.*JP                                                 INV02000
      IF (I.GT.19) GO TO 10                                             INV02100
C      LOWER HEIGHT FOR UR AND VR ARRAY VALUES                          INV02200
      Z1=5.*(I-1)                                                       INV02300
      GO TO 20                                                          INV02400
10    Z1=20.*(I-15)                                                     INV02500
20    IF (IP.GT.19) GO TO 30                                            INV02600
C      UPPER HEIGHT FOR UR AND VR ARRAY VALUES                          INV02700
      Z2=5.*(IP-1)                                                      INV02800
      GO TO 40                                                          INV02900
   30 Z2 = 20. * (IP - 15)                                              INV03000
C      INTERPOLATE ON LATITUDE AT LOWER HEIGHT                          INV03100
   40 CALL INTERW(UR(I,J),VR(I,J),PHI1,UR(I,JP),VR(I,JP),PHI2,U1,V1,    INV03200
     $PHI)                                                              INV03300
C      INTERPOLATE ON LATITUDE AT UPPER HEIGHT                          INV03400
      CALL INTERW(UR(IP,J),VR(IP,J),PHI1,UR(IP,JP),VR(IP,JP),PHI2,U2,V2,INV03500
     $PHI)                                                              INV03600
C      INTERPOLATE ON HEIGHT                                            INV03700
      CALL INTERW(U1,V1,Z1,U2,V2,Z2,SUH,SVH,H)                          INV03800
      RETURN                                                            INV03900
      END                                                               INV04000
```

```
      SUBROUTINE JAC(Z,TZ,DENS)
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,
     .            NSAME,RP1, RD1, RT1, SP1. SD1, ST1, RU1, RV1, SU1, SV1,
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,
     .   IHR,MIN,NMORE,DX,HL,VL,DZ
      COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,Y,T,EM
      DIMENSION ALPHA(6),EI(6),RI(6),      B(7),DIT(6)
      QQ = 100.
      DATA ALPHA/0.0,0.0,0.0,0.0,-0.38,0.0/
      DATA EI/28.0134,31.9988,15.9994,39.948,4.0026,1.00797/
      DATA B/28.15204,-0.085586,1.284E-04,-1.0056E-05,-1.021E-05,
     11.5044E-06,9.9826E-08/
      AV=6.02257E23
      QN=.78110
      QO2=.20955
      QA=.009343
      QHE = 1.289E-5
      RK=8.31432
C
C     TEMPERATURE AT Z = 125 KM, EQ. 9
C
      TX=444.3807+.02385*T -392.8292*EXP(-.0021357*T)
      A2=2.*(T-TX)/3.14159265
C
C
      DIT(6)=0.
      M=10
      EPS=.0001
C
C     TEMPERATURE FOR 90_Z_125, EQ. 10
C
      T1=1.9*(TX-183.)/35.
      T4=3.*(TX-183.-2.*T1*35./3.)/(35.**4)
      T3=-T1/(3.*35.**2)+4.*T4*35./3.
      TZ=TX+T1*(Z-125.)+T3*(Z-125.)**3+T4*(Z-125.)**4
      IF (Z-105.) 43,43,40
C
C     MEAN MOLECULAR WEIGHT FOR 90_Z_105, EQ. 1
C
   43 Z2 = Z - QQ
      FM=B(1)+B(2)*Z2+B(3)*Z2**2+B(4)*Z2**3+B(5)*Z2**4+B(6)*Z2**5
     1+B(7)*Z2**6
      D=Z
70    CONTINUE
C
C     INTEGRATION OF EQ. 5 FOR DENSITY BETWEEN 90_Z_105
C
      A=90.
      FA=B(1)+B(2)*(A-QQ)+B(3)*(A-QQ)**2+B(4)*(A-QQ)**3+B(5)*(A-QQ)**4
     1+B(6)*(A-QQ)**5 +B(7)*(A-QQ)**6
      FA=FA*9.80655/((1.+A/6.356766E+3)**2)
      FA=FA/(TX+T1*(A-125.)+T3*(A-125.)**3 +T4*(A-125.)**4)
      FD=B(1)+B(2)*(D-QQ)+B(3)*(D-QQ)**2+B(4)*(D-QQ)**3+B(5)*(D-QQ)**4
     1+B(6)*(D-QQ)**5 +B(7)*(D-QQ)**6
      FD=FD*9.80665/((1.+D/6.356766E+3)**2)
      FD=FD/(TX+T1*(D-125.)+T3*(D-125.)**3 +T4*(D-125.)**4)
```

```
C      SFQ4, SIMPSONS RULE QUADRATURE  -  G.F.KUNCIR                        JAC05700
C      DEFINITIONS  -                                                       JAC05800
C        A = LOWER LIMIT OF INTEGRATION                                     JAC05900
C        D = UPPER LIMIT OF INTEGRATION                                     JAC06000
C        FUNC = INTEGRAND FUNCTION SUBPROGRAM                               JAC06100
C        EPS = RELATIVE ERROR CONVERGENCE CRITERION                         JAC06200
C        M = MAXIMUM NUMBER OF INTEGRATIONS                                 JAC06300
C        R = RESULT OF INTEGRATION                                          JAC06400
C        N = NUMBER OF INTEGRATIONS9RIQ&IRID TO FIND R                      JAC06500
C                                                                           JAC06600
       NINT = 1                                                             JAC06700
       N=0                                                                  JAC06800
       PREV=0.                                                              JAC06900
       SONE=(D-A)*(FA+FD)/2.                                                JAC07000
 71    N=N+1                                                                JAC07100
       IF (N-M) 72,72,75                                                    JAC07200
 72    NINT = 2 * NINT                                                      JAC07300
       STWO=0.                                                              JAC07400
       DEL=(D-A)/FLOAT(NINT)                                                JAC07500
       DO 73 I=1,NINT,2                                                     JAC07600
       X=A+DEL*FLOAT(I)                                                     JAC07700
       FX=B(1)+B(2)*(X-QQ)+B(3)*(X-QQ)**2+B(4)*(X-QQ)**3+B(5)*(X-QQ)**4     JAC07800
      1+B(6)*(X-QQ)**5 +B(7)*(X-QQ)**6                                      JAC07900
       FX=FX*9.80665/((1.+X/6.356766E+3)**2)                                JAC08000
       FX=FX/(TX+T1*(X-125.)+T3*(X-125.)**3 +T4*(X-125.)**4)                JAC08100
 73    STWO=STWO+FX                                                         JAC08200
       CUR=SONE+4.*DEL*STWO                                                 JAC08300
       IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 74,75,75                             JAC08400
 74    PREV=CUR                                                             JAC08500
       SONE=(SONE+CUR)/4.                                                   JAC08600
       GO TO 71                                                             JAC08700
 75    R=CUR/3                                                              JAC08800
       IF (Z-105.) 44,76,44                                                 JAC08900
   44  IF (D-105.) 76,55,76                                                 JAC09000
C                                                                           JAC09100
C      DENSITY FOR 90_Z_105                                                 JAC09200
C                                                                           JAC09300
 76    DENS=3.46E-9*183.*EM*EXP(-R/FK)/(TZ*28.878)                          JAC09400
       DL=ALOG10(DENS)                                                      JAC09500
       PAR=AV*DENS/EM                                                       JAC09600
       AN=ALOG10(QN*EM*PAR/28.96)                                           JAC09700
       AA=ALOG10(QA*EM*PAR/28.96)                                           JAC09800
       AHE=ALOG10(QHE*EM*PAR/28.96)                                         JAC09900
       AO=ALOG10(2.*PAR*(1.-EM/28.96))                                      JAC10000
       AO2=ALOG10(PAR*(EM*(1.+QO2)/28.96-1.))                               JAC10100
       AH=-0.                                                               JAC10200
       RETURN                                                               JAC10300
C                                                                           JAC10400
C      TEMPERATURE AND MEAN MOLECULAR WEIGHT AT Z=105 KM                    JAC10500
C                                                                           JAC10600
    40 Z3=105.                                                              JAC10700
       TZ3=TX+T1*(Z3-125.)+T3*(Z3-125)**3+T4*(Z3-125)**4                    JAC10800
       ZM3=B(1)+B(2)* 5.+B(3)* 25.+B(4)* 125.+B(5)* 5.**4.+B(6)* 5.**5.     JAC10900
      1+B(7)* 5.**6.                                                        JAC11000
       D=105.                                                               JAC11100
       GO TO 76                                                             JAC11200
```

```
C                                                                       JAC11300
C     DENSITY  AT  Z=105  KM                                            JAC11400
C                                                                       JAC11500
55    DEN1=3.46E-9*183.*ZM3*EXP(-R/FK)/(TZ3*28.878)                     JAC11600
      PAR=AV*DEN1/ZM3                                                   JAC11700
      DI(1)=QN*ZM3*PAR/28.96                                            JAC11800
      DI(2)=PAR*(ZM3*(1.+QO2)/28.96-1.)                                 JAC11900
      DI(3)=2.*PAR*(1.-ZM3/28.96)                                       JAC12000
      DI(4)=QA*ZM3*PAR/28.96                                            JAC12100
      DI(5)=QHE*ZM3*PAR/28.96                                           JAC12200
      IF(Z-125.) 56,56,90                                               JAC12300
56    CONTINUE                                                          JAC12400
C                                                                       JAC12500
C     INTEGRATION OF EQ. 6 FOR DENSITY ABOVE 105 KM                     JAC12600
C                                                                       JAC12700
      A1=105.                                                           JAC12800
      FA1=9.80665/((1.+A1/6.356766E+3)**2)                              JAC12900
      FA1=FA1/(TX+T1*(A1-125.)+T3*(A1-125.)**3+T4*(A1-125.)**4)         JAC13000
      D1=Z                                                              JAC13100
      FD1=9.80665/((1.+D1/6.356766E+3)**2)                              JAC13200
      IF(D1-125.) 45,45,50                                              JAC13300
   45 FD1=FD1/(TX+T1*(D1-125.)+T3*(D1-125.)**3+T4*(D1-125.)**4)         JAC13400
      GO TO 51                                                          JAC13500
50    FD1=FD1/(TX+A2*ATAN(T1*(D1-125.)*(1.+4.5E-6*(D1-125.)**2.5)/A2))  JAC13600
      TZ=TX+A2*ATAN(T1*(Z-125.)*(1.+4.5E-6*(Z-125.)**2.5)/A2)           JAC13700
51    N=0                                                               JAC13800
      NINT = 1                                                          JAC13900
      PREV=0                                                            JAC14000
      SONE=(D1-A1)*(FA1+FD1)/2.                                         JAC14100
81    N=N+1                                                             JAC14200
      IF (N-M) 82,82,85                                                 JAC14300
82    NINT = 2 * NINT                                                   JAC14400
      STWO=0.                                                           JAC14500
      DEL=(D1-A1)/FLOAT(NINT)                                           JAC14600
      DO 83 I=1,NINT,2                                                  JAC14700
      X1=A1+DEL*FLOAT(I)                                                JAC14800
      FX1=9.80665/((1.+X1/6.356766E+3)**2)                              JAC14900
      IF(X1-125.) 46,46,52                                              JAC15000
   46 FX1=FX1/(TX+T1*(X1-125.)+T3*(X1-125.)**3+T4*(X1-125.)**4)         JAC15100
      GO TO 83                                                          JAC15200
52    FX1=FX1/(TX+A2*ATAN(T1*(X1-125.)*(1.+4.5E-6*(X1-125.)**2.5)/A2))  JAC15300
83    STWO=STWO+FX1                                                     JAC15400
      CUR=SONE+4.*DEL*STWO                                              JAC15500
      IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 84,85,85                          JAC15600
84    PREV=CUR                                                          JAC15700
      SONE=(SONE+CUR)/4.                                                JAC15800
      GO TO 81                                                          JAC15900
85    R=CUR/3.                                                          JAC16000
C                                                                       JAC16100
C     DENSITY ABOVE 105 KM                                              JAC16200
C                                                                       JAC16300
      DO 41  I=1,5                                                      JAC16400
      DIT(I)=DI(I)*(TZ3/TZ)**(1.+ALPHA(I))*EXP(-EI(I)*R/FK)             JAC16500
   41 CONTINUE                                                          JAC16600
      DENS=0                                                            JAC16700
      DO 42 I=1.6                                                       JAC16800
```

```
      DENS=DENS+EI(I)*DIT(I)/AV                                          JAC16900
   42 CONTINUE                                                           JAC17000
C                                                                        JAC17100
C     MEAN MOLECULAR WEIGHT FOR Z 105 KM                                 JAC17200
C                                                                        JAC17300
      EM=DENS*AV/(DIT(1)+DIT(2)+DIT(3)+DIT(4)+DIT(5)+DIT(6))             JAC17400
C                                                                        JAC17500
C     LOG DENSITY                                                        JAC17600
C                                                                        JAC17700
      DL=ALOG10(DENS)                                                    JAC17800
      AN =ALOG10(DIT(1))                                                 JAC17900
      AO2=ALOG10(DIT(2))                                                 JAC18000
      AO =ALOG10(DIT(3))                                                 JAC18100
      AA =ALOG10(DIT(4))                                                 JAC18200
      AHE=ALOG10(DIT(5))                                                 JAC18300
      IF(Z-500.) 47,48,48                                                JAC18400
   47 DIT(6)=10.**(-6)                                                   JAC18500
   48 AH=ALOG10(DIT(6))                                                  JAC18600
      AN =AMAX1(-0., AN)                                                 JAC18700
      AO2=AMAX1(-0.,AO2)                                                 JAC18800
      AO =AMAX1(-0., AO)                                                 JAC18900
      AA =AMAX1(-0., AA)                                                 JAC19000
      AHE=AMAX1(-0.,AHE)                                                 JAC19100
      AH =AMAX1(-0., AH)                                                 JAC19200
      RETURN                                                             JAC19300
C                                                                        JAC19400
C     TEMPERATURE AND DENSITY AT Z=500 KM                                JAC19500
C                                                                        JAC19600
90    S=TX+A2*ATAN(T1*375.*(1.+4.5E-6*375.**2.5)/A2)                     JAC19700
      DI(6)=10.**(73.13-39.4*ALCG10(S)+5.5*ALOG10(S)*ALOG10(S))          JAC19800
      A1=500.                                                            JAC19900
      IF(Z-500.) 49,60,60                                                JAC20000
C                                                                        JAC20100
C     INTEGRATICN OF EQ. 6 FOR CENSITY FOR Z 125 KM                      JAC20200
C                                                                        JAC20300
   49 A1=Z                                                               JAC20400
   60 FA1=9.80665/((1.+A1/6.356766E+3)**2)                               JAC20500
      FA1=FA1/(TX+A2*ATAN(T1*(A1-125.)*(1.+4.5E-6*(A1-125.)**2.5)/A2))   JAC20600
      D1=Z                                                               JAC20700
      IF(Z-500.) 61,62,62                                                JAC20800
   61 D1=500.                                                            JAC20900
   62 FD1=9.80665/((1.+D1/6.356766E+3)**2)                               JAC21000
      FD1=FD1/(TX+A2*ATAN(T1*(D1-125.)*(1.+4.5E-6*(D1-125.)**2.5)/A2))   JAC21100
      N=0                                                                JAC21200
      NINT = 1                                                           JAC21300
      PREV=0                                                             JAC21400
      SONE=(D1-A1)*(FA1+FD1)/2.                                          JAC21500
91    N=N+1                                                              JAC21600
      IF (N-M) 92,92,95                                                  JAC21700
92    NINT = 2 * NINT                                                    JAC21800
      STWO=0.                                                            JAC21900
      DEL=(D1-A1)/FLOAT(NINT)                                            JAC22000
      DO 93 I=1,NINT,2                                                   JAC22100
      X1=A1+DEL*FLOAT(I)                                                 JAC22200
      FX1=9.80665/((1.+X1/6.356766E+3)**2)                               JAC22300
      FX1=FX1/(TX+A2*ATAN(T1*(X1-125.)*(1.+4.5E-6*(X1-125.)**2.5)/A2))   JAC22400
```

```
 93     STWO=STWO+FX1                                                                    JAC22500
        CUR=SONE+4.*DEL*STWO                                                             JAC22600
        IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 94,95,95                                         JAC22700
 94     PREV=CUR                                                                         JAC22800
        SONE=(SONE+CUR)/4.                                                               JAC22900
        GO TO 91                                                                         JAC23000
 95     R=CUR/3.                                                                         JAC23100
C                                                                                        JAC23200
C       TEMPERATURE AT Z 500 KM                                                          JAC23300
C                                                                                        JAC23400
        TZ=TX+A2*ATAN(T1*(Z-125.)*(1.+4.5E-6*(Z-125.)**2.5)/A2)                          JAC23500
        IF(Z-500.) 63,64,64                                                              JAC23600
    63 R=-R                                                                              JAC23700
C                                                                                        JAC23800
C       DENSITY OF HYDROGEN FOR Z 500 KM                                                 JAC23900
C                                                                                        JAC24000
    64 DIT(6)=DI(6)*(S/TZ)*EXP(-EI(6)*R/FK)                                              JAC24100
        GO TO 56                                                                         JAC24200
        END                                                                              JAC24300
```

```
      SUBROUTINE JACCH(Z,PHIR,THET,PH,DH,TH)
      COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,T,EM
      COMMON/ICTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,
     .           NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,
     $ M , IDA, IYR, H1, PHI1R,THET1R,G,PI,H,CLAT,CLON ,F10,F10B,AP,
     .     IHR,MIN,NMORE,DX,HL,VL,DZ
C
C     JACCH CALCULATES THE PRESSURE, DENSITY, AND TEMPERATURE AT A
C     POINT IN SPACE ABOVE 90 KM FOR A PARTICULAR TIME
C
C     INPUT
C     Z = HEIGHT IN KM
C     PHIR = LATITUDE IN RADIANS
C     THET = LONGITUDE IN DEGREES  (0 TO 360 DEGREES TURNING WESTWARD)
C     F10 = SOLAR RADIO NOISE FLUX (XE - 22 WATTS/M**2)
C     F10B = 81-DAY AVERAGE F10
C     AP = GEOMAGNETIC INDEX
C     M  = MONTH (FOR YEARLY MEAN VARIABLES M IS SET TO 13)
C     IDA = DAY OF MONTH
C     IYR = YEAR
C     IHR = HOUR OF DAY  (UNIVERSAL TIME)
C     MIN = MINUTE  (UNIVERSAL TIME)
C     XMJD = MEAN JULIAN DAY  (SET EQUAL TO ZERO FOR ANNUAL MEAN)
C     DD = DAY NUMBER WITH RESPECT TO JAN 0 OF YEAR IYR
C     OUTPUT
C     PH = PRESSURE IN UNITS OF NT/M**2
C     DH = DENSITY IN UNITS OF KG/M**3
C     TH = TEMPERATURE IN KELVIN DEGREES
C
C     DD = DAY NUMBER WITH RESPECT TO JAN 1 OF YEAR IYR
C
C     REPLACEMENT OF SUBROUTINE VARIABLES TO INSURE NO CHANGES IN THEM
C
      R = 8.31
      XLAT = PHIR
      XLONG = THET
      IF (M.EQ.13) GO TO 50
C
C     CALCULATE SOLAR DEC. AND HOUR ANGLE
C
      CALL TME
C
C     EXOSPHERIC TEMPERATURE
C
      CALL TINF
      GO TO 75
   50 T = 1000.0
C
C     TEMPERATURE, MOLECULAR WEIGHT, AND DENSITY WITHOUT SEASONAL
C        VARIATIONS
C
   75 CALL JAC(Z,TH,DH)
      IF (M.EQ.13) GO TO 300
      YDA = 365.0
      J1 = MOD(IYR,4)
      IF (J1.EQ.0) YDA = 366.0
```

```
      C1 = SIN((360. / YDA) * 0.0174532925 * (DD + 100.0))            JAH05700
      IF (PHIR) 80,70,80                                               JAH05800
   70 C2 = 0.0                                                         JAH05900
      GO TO 90                                                         JAH06000
   80 C2 = (SIN(PHIR) ** 2) * (PHIR / ABS(PHIR))                       JAH06100
C                                                                      JAH06200
C     DENSITY WITH SEASONAL VARIATIONS                                 JAH06300
C                                                                      JAH06400
   90 Z90 = Z - 90.0                                                   JAH06500
      DLRHO = 0.02 * Z90 * EXP(-0.045 * Z90) * C1 * C2                 JAH06600
      DH = DH * EXP(DLRHO)                                             JAH06700
C                                                                      JAH06800
C     MOLECULAR WEIGHT WITH SEASONAL VARIATION                         JAH06900
C                                                                      JAH07000
      IF (Z - 120.0) 100,100,150                                       JAH07100
  100 EM = EM + 0.006 * Z90 * C1                                       JAH07200
      GO TO 250                                                        JAH07300
  150 IF (Z - 230.0) 200,250,250                                       JAH07400
  200 DEM = EXP(-0.02424 * Z90) * (0.0316 * Z90 - 0.0002257 * Z90 * Z90)JAH07500
      EM = EM + DEM * C1*0.5                                           JAH07600
C                                                                      JAH07700
C     TEMPERATURE WITH SEASONAL VARIATIONS                             JAH07800
C                                                                      JAH07900
  250 IF (7-260.0) 270,300,300                                         JAH08000
  270 Z110 = Z - 110.0                                                 JAH08100
      DTH = -2.291753 * Z110 + 0.02154336 * Z110*Z110- 4.1766671E-05 * JAH08200
     1 (Z110 ** 3)                                                     JAH08300
      DTH = EXP(-0.290655 * SQRT(ABS(Z110)))* DTH                      JAH08400
      TH = TH +(DTH * C1 * C2 *TH) / 100.0                             JAH08500
C                                                                      JAH08600
C     DENSITY IN METRIC UNITS AND PRESSURE CALCULATED                  JAH08700
C                                                                      JAH08800
  300 DH = DH * 1000.0                                                 JAH08900
      PH =((DH * 8.31432 * TH) / EM) * 1000.0                          JAH09000
      RETURN                                                           JAH09100
      END                                                              JAH09200
```

```
      SUBROUTINE NORMAL(D1,D2)
C.....PRODUCES 2 RANDOM NUMBERS, D1, D2, PICKED FROM A NORMAL DIST.
C     WITH ZERO MEAN AND UNIT VARIANCE
      REAL L
   50 X = RAND(0)
      Y = 2*RAND(0) - 1
      XX = X**2
      YY = Y**2
      S = XX + YY
      IF (S-1) 51,51,50
   51 L = SQRT(-2*ALOG(RAND(0)))/S
      D1 = (XX-YY)*L
      D2 = 2*X*Y*L
      RETURN
      END
```

```
      SUBROUTINE PDTUV (PSP, DSP, TSP, CLAT, CLON, IH, PS, DS, TS,       PDT00100
     $ DPX, DPY, DTX, DTY,DP2X,DP2Y,DPXY)                                PDT00200
C.....INTERPOLATES STATIONARY PERTURBATIONS ON LATITUDE AND LONGITUDE   PDT00300
C         AT HEIGHT IH                                                  PDT00400
      DIMENSION PSP(8,10,12),DSP(8,10,12),TSP(8,10,12)                  PDT00500
      IF (IH.LT.52) GO TO 10                                            PDT00600
      IF (IH.GT.84) GO TO 20                                            PDT00700
C     HEIGHT INDEX K                                                    PDT00800
      K = ((IH+4)/8) - 4                                                PDT00900
      GO TO 30                                                          PDT01000
   10 K = (IH-20)/10                                                    PDT01100
      GO TO 30                                                          PDT01200
   20 K = 8                                                             PDT01300
   30 XLON = CLON                                                       PDT01400
      IF (CLON.LT.10.) XLON = 360. + CLON                               PDT01500
C     LOWER LONGITUDE INDEX J                                           PDT01600
      J = INT((XLON + 20.)/30.)                                         PDT01700
C.....DLON - RELATIVE LONGITUDE DEVIATION FROM CORNER REFERENCE LOCATIONPDT01800
      DLON = (XLON - 30.*J + 20.)/30.                                   PDT01900
C     UPPER LONGITUDE INDEX JP                                          PDT02000
      JP = J+1                                                          PDT02100
      IF (JP.GT.12) JP=1                                                PDT02200
C     LOWER LATITUDE INDEX I                                            PDT02300
      I = INT((CLAT + 110.)/20.)                                        PDT02400
C      UPPER LATITUDE INDEX IP                                          PDT02500
      IP = I+1                                                          PDT02600
      IF (IP.GT.10) IP=10                                               PDT02700
C.....DLAT - RELATIVE LATITUDE DEVIATION FROM CORNER REFERENCE LOCATION PDT02800
      DLAT = (CLAT-20.*I + 110.)/20.                                    PDT02900
C     PRESSURE LAT-LON INTERPOLATION                                    PDT03000
      PS=PSP(K,I,J)+(PSP(K,IP,J)-PSP(K,I,J))*DLAT+(PSP(K,I,JP)-PSP(K,I,JPDT03100
     1))*DLON+(PSP(K,IP,JP)-PSP(K,I,JP)-PSP(K,IP,J)+PSP(K,I,J))*DLAT*   PDT03200
     2DLON                                                              PDT03300
C     DENSITY LAT-LON INTERPOLATION                                     PDT03400
      DS=DSP(K,I,J)+(DSP(K,IP,J)-DSP(K,I,J))*DLAT+(DSP(K,I,JP)-DSP(K,I,JPDT03500
     1))*DLON+(DSP(K,IP,JP)-DSP(K,I,JP)-DSP(K,IP,J)+DSP(K,I,J))*DLAT*   PDT03600
     2DLON                                                              PDT03700
C     TEMPERATURE LAT-LON INTERPOLATION                                 PDT03800
      TS=TSP(K,I,J)+(TSP(K,IP,J)-TSP(K,I,J))*DLAT+(TSP(K,I,JP)-TSP(K,I,JPDT03900
     1))*DLON+(TSP(K,IP,JP)-TSP(K,I,JP)-TSP(K,IP,J)+TSP(K,I,J))*DLAT*   PDT04000
     2DLON                                                              PDT04100
C.....DPX - DP/DX FOR GEOSTROPHIC WINDS                                 PDT04200
      DPX = (PSP(K,I,J) - PSP(K,I,JP)) / 6.                             PDT04300
      DPX = DPX + ((PSP(K,IP,J) - PSP(K,IP,JP))/6. - DPX)*DLAT          PDT04400
C.....DPY - DP/DY FOR GEOSTROPHIC WINDS                                 PDT04500
      DPY=(PSP(K,IP,J)-PSP(K,I,J))/4.                                   PDT04600
      DPY = DPY + ((PSP(K,IP,JP) - PSP(K,I,JP))/4. - DPY)*DLON          PDT04700
C.....DTX - DT/DX FOR THERMAL WINDS                                     PDT04800
      DTX = (TSP(K,I,J) - TSP(K,I,JP)) / 6.                             PDT04900
      DTX = DTX + ((TSP(K,IP,J) - TSP(K,IP,JP))/6. - DTX)*DLAT          PDT05000
C.....DTY - DT/DY FOR THERMAL WINDS                                     PDT05100
      DTY = (TSP(K,IP,J) - TSP(K,I,J)) / 4.                             PDT05200
      DTY = DTY + ((TSP(K,IP,JP) - TSP(K,I,JP))/4. - DTY)*DLON          PDT05300
      IF (IP.GT.9) GO TO 90                                             PDT05400
      DPXY = (PSP(K,IP,J) - PSP(K,IP,JP) - PSP(K,I,J) + PSP(K,I,JP))/24.PDT05500
      JX = J - 1                                                        PDT05600
```

```
      IF (JX.LT.1) JX = JX + 12                                         PDT05700
      IY = I - 1                                                        PDT05800
      DP2X = (PSP(K,I,JX) - PSP(K,I,JP))/6.                             PDT05900
      DP2X = DP2X + ((PSP(K,IP,JX) - PSP(K,IP,JP))/6. - DP2X)*DLAT      PDT06000
      DP2Y = (PSP(K,IP,J) - PSP(K,IY,J))/4.                             PDT06100
      DP2Y = DP2Y + ((PSP(K,IP,JP) - PSP(K,IY,JP))/4.- DP2Y)*DLON       PDT06200
      RETURN                                                            PDT06300
   90 DP2X = 0.                                                         PDT06400
      DP2Y = 0.                                                         PDT06500
      DPXY = 0.                                                         PDT06600
      RETURN                                                            PDT06700
      END                                                               PDT06800
```

```
      SUBROUTINE PERTRB
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,NSAME,
     $PL1,DL1,TL1,SPL1,SDL1,STL1,UL1,VL1,SUL1,SVL1,MN,IDA,IYR,
     1PH,PLAT,
     * PLON,G,R,CH,CLAT,CLON,F10,F10B,AP,IHR,MIN,NMORE,DX,HL,VL,DZ,
     2R,EPS,IOPP,LOOK,IET,FLAT,PS1,DS1,TS1,US1,VS1,SPS1,SDS1,
     3STS1,SUS1,SVS1,UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2
      COMMON /COMPER/SP2,SD2,ST2,P2,D2,T2,U2,V2,SU2,SV2,CP,
     1PS2,DS2,TS2,US2,VS2,
     2PL2,DL2,TL2,UL2,VL2,
     3SPS2,SDS2,STS2,SUS2,SVS2,
     4SPL2,SDL2,STL2,SUL2,SVL2
      COMMON/WINCOM/ DUM(11),T
      DX  =      R*SQRT((CLAT-PLAT)**2 + (COS(CLAT)*(CLON-PLON))**2)
C.....DX IS HORIZONTAL DISTANCE BETWEEN POSITIONS PLAT,PLON AND CLAT,CLO
      AH = 900.
      BH = 6.
C     HORIZONTAL WAVELENGTH, KM
      HLL= AH + BH*CH
      DPHI = (90. - PHI1)**2
      DHGT = 0.22 + 0.00258*(SQRT(ABS(CH)**3))
      IF (DHGT.GT.5.) DHGT = 5.
      VDS = (11.0 - 2.102E-4*DPHI)*DHGT
      VTS = (3.0 + 5.146E-4*DPHI)*DHGT
      VUS = (6.2 - 3.615E-4*DPHI)*DHGT
      VDL = (20.7 - 1.346E-3*DPHI)*DHGT
      VTL = 7.3*DHGT
      VUL = (31.2 - 3.503E-3*DPHI)*DHGT
      HLS = 20. + .0125*CH*CH
      IF(HLS.GT.400.) HLS = 400.
      HLS = (DX/HLS)**2
      HLL = (DX/HLL)**2
      RDS = 1./EXP(SQRT(HLS + (DZ/VDS)**2))
      RTS = 1./EXP(SQRT(HLS + (DZ/VTS)**2))
      RVS = 1./EXP(SQRT(HLS + (DZ/VUS)**2))
      RDL = 1./EXP(SQRT(HLL + (DZ/VDL)**2))
      RTL = 1./EXP(SQRT(HLL + (DZ/VTL)**2))
      RVL = 1./EXP(SQRT(HLL + (DZ/VUL)**2))
      CALL CORLAT(AS,BS,CS,DS,ES,FS,GS,HS,AIS,AJS,AKS,SPS1,SPS2,SDS1,
     1 SDS2,STS1,STS2,SUS1,SUS2,SVS1,SVS2,UDS1,UDS2,VDS1,VDS2,RDS,RTS,
     2RVS)
      CALL CORLAT(AL,BL,CL,DL,EL,FL,GL,HL,AIL,AJL,AKL,SPL1,SPL2,SDL1,
     1 SDL2,STL1,STL2,SUL1,SUL2,SVL1,SVL2,UDL1,UDL2,VDL1,VDL2,
     2RDL,RTL,RVL)
      CALL NORMAL(ZD,ZT)
      DS2=AS*DS1+BS*ZD
      TS2=CS*TS1+DS*DS2+ES*ZT
      PS2=DS2+TS2
      CALL NORMAL(ZD,ZT)
      US2=FS*US1+GS*DS2+HS*ZD
      VS2=AIS*VS1+AJS*DS2+AKS*ZT
      CALL NORMAL(ZD,ZT)
      DL2=AL*DL1+BL*ZD
      TL2=CL*TL1+DL*DL2+EL*ZT
      PL2=DL2+TL2
      CALL NORMAL(ZD,ZT)
```

```
      UL2=FL*UL1+GL*DL2+HL*ZD                                           PER05700
      VL2=AIL*VL1+AJL*DL2+AKL*ZT                                        PER05800
      P2=PS2+PL2                                                        PER05900
      D2=DS2+DL2                                                        PER06000
      T2=TS2+TL2                                                        PER06100
      U2=US2+UL2                                                        PER06200
      V2=VS2+VL2                                                        PER06300
      UDL1=UDL2                                                         PER06400
      UDS1=UDS2                                                         PER06500
      VDL1=VDL2                                                         PER06600
      VDS1=VDS2                                                         PER06700
      RETURN                                                            PER06800
      END                                                               PER06900
```

```
      SUBROUTINE PHASE(D1,X1,D2,X2,D,X)                                 PHA00100
      PER = 870.                                                        PHA00200
      IF (X2-X1) 20,10,20                                               PHA00300
   10 D = D1                                                            PHA00400
      RETURN                                                            PHA00500
   20 DA = D1                                                           PHA00600
      DB = D2                                                           PHA00700
      PER2 = PER/2.                                                     PHA00800
      IF(ABS(DB-DA).LE.PER2)GO TO 30                                    PHA00900
      IF (DA.LT.PER2) DA = DA + PER                                     PHA01000
      IF (DB.LT.PER2) DB = DB + PER                                     PHA01100
   30 DA = DA + (DB - DA)*(X - X1)/(X2 - X1)                            PHA01200
      IF (DA.GT.PER) DA = DA - PER                                      PHA01300
      IF(DA.LT.0.)DA=DA+PER                                             PHA01400
      D = DA                                                            PHA01500
      RETURN                                                            PHA01600
      END                                                               PHA01700
```

```
      SUBROUTINE QBOGEN
C.....COMPUTES QBO VALUES PQ,DQ,TQ,UQ,VQ AT HEIGHT H, LATITUDE PHI
C        ON JULIAN DAY XMJD FROM ARRAYS OF AMPLITUDES PAQ,DAQ,TAQ,
C        UAQ,VAQ AND PHASES PDQ,DCQ,TDQ,UDQ,VDQ.
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,
     .            NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,PI,H,PHIR,THETR,F10,F10B,AP,
     .   IHR,MIN,NMORE,DX,HL,VL,DZ
      COMMON/POTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)
     . ,PSP(8,10,12)
     . ,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),
     . PDQ(17,5),DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),
     .UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10)
     . ,PQ,DQ,TQ,UQ,VQ
     . ,PA,DA,TA,UA,VA,IOPQ
      IF (XMJD.GT.0.AND.IOPQ.EQ.1) GO TO 10
C     SETS QBO VALUES TO ZERO FOR ANNUAL MEAN
      PQ =0.
      DQ=0.
      TQ=0.
      UQ=0.
      VQ=0.
      RETURN
C     LOWER HEIGHT INDEX
   10 IH = INT((H-5.)/5.)
      IF (IH.LT.1) IH=1
C     UPPER HEIGHT INDEX
      IP = IH + 1
      IF (IP.GT.17) IP = 17
      PHA = ABS(PHI)
C    LOWER LATITUDE INDEX

      JL = INT((   PHA     + 10.)/20.)
C     UPPER LATITUDE INDEX
      JP = JL + 1
      IF (JL.LE.0) JL=1
      IF (JP.GT.5) JP=5
C     JULIAN DAY FOR JAN 0, 1966
      XMJD0 = 2439126
C     TIME RELATIVE TO JAN 0, 1966
      TMJD = XMJD-XMJD0
C     2*PI/PERIOD,PERIOD = 870 DAYS
      PER = 870.
      TP = 6.2831853/PER
C     LOWER HEIGHT
      HI = 5. + 5.*IH
C     LOWER LATITUDE
      PHIJ = 20.*JL - 10.
C     UPPER LATITUDE
      PHIP = 20.*JP-10.
C.....INTERPOLATES QBO P,D,T AMPLITUDE ON LATITUDE AT LOWER HEIGHT
      CALL INTERZ(PAQ(IH,JL),DAQ(IH,JL),TAQ(IH,JL),PHIJ,PAQ(IH,JP),
     1DAQ(IH,JP),TAQ(IH,JP),PHIP,PA1,DA1,TA1,PHA)
C     UPPER HEIGHT
      HP = 5.+5.*IP
C.....INTERPOLATES QBO P,D,T AMPLITUDE ON LATITUDE AT UPPER HEIGHT
```

```
      CALL INTERZ(PAQ(IP,JL),DAQ(IP,JL),TAQ(IP,JL),PHIJ,PAQ(IP,JP),     QB005700
     2DAQ(IP,JP),TAQ(IP,JP),PHIP,PA2,DA2,TA2,PHA)                       QB005800
C.....INTERPOLATES QBO P,D,T AMPLITUDE ON HEIGHT AT LATITUDE PHI        QB005900
      CALL INTERZ(PA1,DA1,TA1,HI,PA2,DA2,TA2,HP,PA,DA,TA,H)             QB006000
C.....INTERPOLATES QBO P,D,T,U,V PHASE ON LATITUDE AND HEIGHT           QB006100
      CALL PHASE(PDQ(IH,JL),PHIJ,PDQ(IH,JP),PHIP,PD1,PHA)               QB006200
      CALL PHASE(DDQ(IH,JL),PHIJ,DDQ(IH,JP),PHIP,DD1,PHA)               QB006300
      CALL PHASE(TDQ(IH,JL),PHIJ,TDQ(IH,JP),PHIP,TD1,PHA)               QB006400
      CALL PHASE(PDQ(IP,JL),PHIJ,PDQ(IP,JP),PHIP,PD2,PHA)               QB006500
      CALL PHASE(DDQ(IP,JL),PHIJ,DDQ(IP,JP),PHIP,DD2,PHA)               QB006600
      CALL PHASE(TDQ(IP,JL),PHIJ,TDQ(IP,JP),PHIP,TD2,PHA)               QB006700
      CALL PHASE(PD1,HI,PD2,HP,PD,H)                                    QB006800
      CALL PHASE(DD1,HI,DD2,HP,DD,H)                                    QB006900
      CALL PHASE(TD1,HI,TD2,HP,TD,H)                                    QB007000
      CALL PHASE(UDQ(IH,JL),PHIJ,UDQ(IH,JP),PHIP,UD1,PHA)               QB007100
      CALL PHASE(VDQ(IH,JL),PHIJ,VDQ(IH,JP),PHIP,VD1,PHA)               QB007200
      CALL PHASE(UDQ(IP,JL),PHIJ,UDQ(IP,JP),PHIP,UD2,PHA)               QB007300
      CALL PHASE(VDQ(IP,JL),PHIJ,VDQ(IP,JP),PHIP,VD2,PHA)               QB007400
      CALL PHASE(UD1,HI,UD2,HP,UD,H)                                    QB007500
      CALL PHASE(VD1,HI,VD2,HP,VD,H)                                    QB007600
C.....INTERPOLATES QBO WIND AMPLITUDE ON LATITUDE AT LOWER HEIGHT       QB007700
      CALL INTERW(UAQ(IH,JL),VAQ(IH,JL),PHIJ,UAQ(IH,JP),VAQ(IH,JP),     QB007800
     5PHIP,UA1,VA1,PHA)                                                 QB007900
C.....INTERPOLATES QBO WIND AMPLITUDES ON LATITUDE AT UPPER HEIGHT      QB008000
      CALL INTERW(UAQ(IP,JL),VAQ(IP,JL),PHIJ,UAQ(IP,JP),VAQ(IP,JP),     QB008100
     6PHIP,UA2,VA2,PHA)                                                 QB008200
C.....INTERPOLATES QBO WIND AMPLITUDES ON HEIGHT AT LATITUDE PHI        QB008300
      CALL INTERW(UA1,VA1,HI,UA2,VA2,HP,UA,VA,H)                        QB008400
C.....EVALUATES QBO VALUES FROM INTERPOLATED AMPLITUDES AND PHASES      QB008500
      PQ=PA*COS(TP*(TMJD-PD))                                           QB008600
      DQ=DA*COS(TP*(TMJD-DD))                                           QB008700
      TQ=TA*COS(TP*(TMJD-TD))                                           QB008800
      UQ=UA*COS(TP*(TMJD-UD))                                           QB008900
      VQ=VA*COS(TP*(TMJD-VD))                                           QB009000
      RETURN                                                            QB009100
      END                                                               QB009200
```

```
      FUNCTION RAND(X0)                                                 RAN00100
C.....PRODUCES A RANDOM NUMBER FROM A UNIFORM DIST. FROM 0 TO +1        RAN00200
      INTEGER X0                                                        RAN00300
      IF (X0.NE.0) X = X0/262144.                                       RAN00400
      X = X*509                                                         RAN00500
      X = X - INT(X)                                                    RAN00600
      RAND = X                                                          RAN00700
      RETURN                                                            RAN00800
      END                                                               RAN00900
```

```
      SUBROUTINE RIG                                                    RIG00100
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,CD,XMJD,PHI1,PHI,           RIG00200
     .           NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,RIG00300
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,    RIG00400
     .   IHR,MIN,NMORE,DX,HL,VL,DZ,B,EPS                                RIG00500
C.....GRAVITY G AT H, LATITUDE PHIR (RADIANS)                            RIG00600
C.....RADIUS RI FROM CENTER OF EARTH TO HEIGHT H                         RIG00700
C.....B = POLAR EARTH RADIUS, EPS = ECCENTRICITY                         RIG00800
      CPHI2 = COS(PHIR) ** 2                                            RIG00900
C       EARTH RADIUS                                                    RIG01000
      RI = B / SQRT(1. - EPS * CPHI2)                                   RIG01100
C     C2PHI = COS(2*PHIR)                                               RIG01200
      C2PHI = 2. * CPHI2 - 1.                                           RIG01300
C     C4PHI = COS(4*PHIR)                                               RIG01400
      C4PHI = 8. * CPHI2 * (CPHI2 - 1.) + 1.                            RIG01500
C.....G AT SURFACE                                                      RIG01600
      G = 9.80616 * (1. - 0.0026373 * C2PHI + 0.0000059 * C2PHI * C2PHI)RIG01700
C.....EFFECTIVE RADIUS                                                  RIG01800
      RE = 2. * G / (3.085462E-3 + C2PHI * 2.27E-6 - C4PHI * 2.E-9)     RIG01900
C       G AT HEIGHT H                                                   RIG02000
      G = G / (1. + (H / RE)) ** 2                                      RIG02100
C       RADIUS AT HEIGHT H                                              RIG02200
      RI = RI + H                                                       RIG02300
      END                                                               RIG02400
```

```
      SUBROUTINE RTERP(H,PHI,PR,DR,TR,P,D,T)                            RTP00100
C.....COMPUTES RANDOM PERTURBATION STANDARD DEVIATIONS P,D,T AT         RTP00200
C        HEIGHT H (KM), LATITUDE PHI(DEGREES) FROM SIGMA ARRAYS         RTP00300
C        PR,DR,AND TR                                                   RTP00400
      DIMENSION PR(20,10),DR(20,10),TR(20,10)                           RTP00500
C.....I = LOWER HEIGHT INDEX                                            RTP00600
      IF (H.LT.95.) I = INT((H-20.)/5.)                                 RTP00700
      IF (H.GE.95.) I = 14 + INT((H-80.)/20.)                           RTP00800
      IP = I+1                                                          RTP00900
      IF (IP.GT.20) IP = 20                                             RTP01000
C      LOWER LATITUDE INDEX                                             RTP01100
      J = INT((PHI + 110.)/20.)                                         RTP01200
      JP = J+1                                                          RTP01300
      IF (JP.GT.10) JP=10                                               RTP01400
      IF (I.GT.14) GO TO 10                                             RTP01500
C     LOWER HEIGHT FOR PR,TR,DR  ARRAYS                                 RTP01600
      Z1=5.*I+20.                                                       RTP01700
      GO TO 20                                                          RTP01800
   10 Z1=20.*(I-10)                                                     RTP01900
   20 IF (IP.GT.14) GO TO 30                                            RTP02000
C     UPPER HEIGHT FOR PR,DR,TR ARRAYS                                  RTP02100
      Z2=5.*IP+20.                                                      RTP02200
      GO TO 40                                                          RTP02300
   30 Z2=20.*(IP-10)                                                    RTP02400
   40 PHI1=-110.+20.*J                                                  RTP02500
      PHI2=-110.+20.*JP                                                 RTP02600
C.....INTERPOLATE ON LATITUDE AT LOWER HEIGHT                           RTP02700
      CALL INTERZ(PR(I,J),DR(I,J),TR(I,J),PHI1,PR(I,JP),DR(I,JP),       RTP02800
     1            TR(I,JP),PHI2,P1,D1,T1,PHI)                           RTP02900
C.....INTERPOLATE ON LATITUDE AT UPPER HEIGHT                           RTP03000
      CALL INTERZ(PR(IP,J),DR(IP,J),TR(IP,J),PHI1,PR(IP,JP),DR(IP,JP),  RTP03100
     1            TR(IP,JP),PHI2,P2,D2,T2,PHI)                          RTP03200
C.....INTERPOLATION ON HEIGHT USING LATITUDE INTERPOLATED VALUES        RTP03300
      CALL INTERZ(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,H)                      RTP03400
      RETURN                                                            RTP03500
      END                                                               RTP03600
```

```
      SUBROUTINE RTRAN(N)                                               RTR00100
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG                                   RTR00200
      COMMON/COTRAN/NDATA(19),I1,I2,I3,I4(10),I5                        RTR00300
C.....ENTRY POINT FOR NTRAN READ OF STATIONARY PERTURBATION DATA, AND   RTR00400
C          RANDOM PERTURBATION DATA IN SETUP                            RTR00500
      CALL NTRAN(IUG,2,N,NDATA,L,22)                                    RTR00600
      RETURN                                                            RTR00700
      ENTRY RTRAN1                                                      RTR00800
C.....ENTRY POINT FOR NTRAN READ OF GROVES DATA IN SETUP                RTR00900
      CALL NTRAN(IUG,2,19,NDATA,L,22)                                   RTR01000
      I1=NDATA(1)                                                       RTR01100
      I2=NDATA(2)                                                       RTR01200
      I3=NDATA(3)                                                       RTR01300
      I5=NDATA(14)                                                      RTR01400
      DO 1 I=1,10                                                       RTR01500
    1 I4(I)=NDATA(I+3)                                                  RTR01600
      RETURN                                                            RTR01700
      ENTRY RTRAN2                                                      RTR01800
C.....ENTRY POINT FOR NTRAN READ OF QBO PARAMETERS IN SETUP             RTR01900
     CALL NTRAN(IUG,2,12,NDATA,L,22)                                    RTR02000
      I1=NDATA(1)                                                       RTR02100
      I3=NDATA(2)                                                       RTR02200
      DO 2 I=1,10                                                       RTR02300
    2 I4(I)=NDATA(2+I)                                                  RTR02400
      RETURN                                                            RTR02500
      END                                                               RTR02600
```

```
      SUBROUTINE SCIMOD                                                 SCI00100
C.....COMPUTES VALUES P,D,T,U,V AND SHEAR DUH,DVH FROM INPUT AND        SCI00200
C        ARRAYS IN COMMON PDTCOM.  INPUT TO SCIMOD IS                   SCI00300
C        G = GRAVITY AT POSITION       RI = RADIUS AT HEIGHT H          SCI00400
C        PHIR = LATITUDE (RADIANS)     THETR = LONGITUDE (RADIANS)      SCI00500
C        F10 = F10.7 SOLAR FLUX        F10B = MEAN F10.7 FLUX           SCI00600
C        AP = SOLAR-GEOMAGNETIC A SUB P INDEX                           SCI00700
C        MN/IDA/IYR = DATA (IYR = FULL YEAR-1900)                       SCI00800
C        IHR,MIN = TIME                H1 = PREVIOUS HEIGHT             SCI00900
C        PHI1R = PREVIOUS LATITUDE     THET1R = PREVIOUS LONGITUDE      SCI01000
C        RP1,RD1,RT1 = PREVIOUS RANDOM PERTURBATIONS                    SCI01100
C        SP1,SD1,ST1 = PREVIOUS RANCOM STANDARD DEVIATIONS (SIGMAS)     SCI01200
C        RU1,RV1 = PREVIOUS RANDOM WINDS                                SCI01300
C        SU1,SV1 = PREVIOUS RANDOM WIND SIGMAS                          SCI01400
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,           SCI01500
     .NSAME,RP1L,RD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L,          SCI01600
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,    SCI01700
     .   IHR,MIN,NMORE,DX,HL,VL,DZ,B,EPS,IOPP,LOOK,IET,FLAT,            SCI01800
     1RP1S,RD1S,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,                SCI01900
     2UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2                           SCI02000
      COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)        SCI02100
     . ,PSP(8,10,12)                                                    SCI02200
     . ,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),        SCI02300
     . PDQ(17,5),DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),     SCI02400
     .UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10),  PQ  SCI02500
     . ,DQ,TQ,UQ,VQ,PQA,DQA,TQA,UA,VA,IOPQ,                             SCI02600
     1PLP(25,10),DLP(25,10),TLP(25,10),                                 SCI02700
     2ULP(25,10),VLP(25,10),UDL(25,10),                                 SCI02800
     3VDL(25,10),UDS(25,10),VDS(25,10)                                  SCI02900
      COMMON /C4/ GLAT(16),GLON(16),NG,P4D(16,26),D4D(16,26),T4D(16,26),SCI03000
     .  SP4(16,26),SD4(16,26),ST4(16,26),THET1,THET                     SCI03100
      COMMON/COMPER/SPH,SDH,STH,PRH,DRH,TRH,URH,VRH,SUH,SVH,CP,         SCI03200
     1PRHS,DRHS,TRHS,URHS,VRHS,PRHL,DRHL,TRHL,URHL,VRHL,                SCI03300
     2SPHS,SDHS,STHS,SUHS,SVHS,SPHL,SDHL,STHL,SUHL,SVHL                 SCI03400
      COMMON/WINCOM/DGH,FCORY,DX5,DY5,DPX,DPY,DPXX,DPXY,DPYY,UGH,VGH,   SCI03500
     $    TGH,DTX,DTY,DUH,DVH,PGH                                       SCI03600
      COMMON/CHK/PCK(4,4,3),DCK(4,4,3),NO(2)                            SCI03700
      COMMON/CHIC/LA(4,4),NB(2),IWSYM                                   SCI03800
C      FACTOR FOR RADIANS TO DEGREES                                    SCI03900
      FAC = 57.2957795                                                  SCI04000
      IWSYM = " "                                                       SCI04100
      PQ=0.                                                             SCI04200
      DQ=0.                                                             SCI04300
      TQ=0.                                                             SCI04400
      PRH=0.                                                            SCI04500
      DRH=0.                                                            SCI04600
      TRH=0.                                                            SCI04700
      URH=0.                                                            SCI04800
      VRH=0.                                                            SCI04900
      UQ=0.                                                             SCI05000
      VQ=0.                                                             SCI05100
      PQA=0.                                                            SCI05200
      DQA=0.                                                            SCI05300
      TQA=0.                                                            SCI05400
      UA=0.                                                             SCI05500
      VA=0.                                                             SCI05600
```

```
      PSH=0.
      DSH=0.
      TSH=0.
      MONTH=MN
C     PRESENT LATITUDE, DEG
      PHI = PHIR*FAC
C     PRESENT LONGITUDE, DEG
      THET = THETR*FAC
C     PREVIOUS LATITUDE, DEG
      PHI1 = PHI1R*FAC
C     PREVIOUS LONGITUDE, DEG
      THET1 = THET1R*FAC
C.....FCORY = NORTH COMPONENT CORIOLIS FACTOR TIMES DISTANCE FOR
C           5 DEGREES OF LATITUDE
      DY5 = 5000.*RI/FAC
      DX5 = DY5*COS(PHIR)
      FCORY = DY5*SIN(PHIR)/(120.*FAC)
C.....IN JACCHIA OR MIXED GROVES-JACCHIA HEIGHT RANGE
    8 IF(H.GT.90.0) GO TO 10
C.....IN 4-D DATA HEIGHT RANGE
      IF (H.LE.25.0) GO TO 500
C       IN GROVES OR MIXED GROVES 4D HEIGHT RANGE
      GO TO 200
C.....IN MIXED JACCHIA-GROVES RANGE, NEED TO FAIR DATA
 10   IF (H.LT.115.) GO TO 20
C.....FOLLOWING IS THE PURE JACCHIA HEIGHT RANGE SECTION
C.....JACCHIA VALUES AT CURRENT POSITION
      CALL JACCH(H,PHIR,THET,PH,DH,TH)
      PHIN = PHIR + 5. / FAC
      THETE = THET - 5.
C.....JACCHIA VALUES AT CURRENT POSITION+5 DEGREES LAT, FOR DP/DY AND
C           DT/DY
      CALL JACCH(H,PHIN,THET,PHN,DHN,THN)
C.....JACCHIA VALUES AT CURRENT POSITION-5 DEGREES LON, FOR DP/DX AND
C           DT/DX
      CALL JACCH(H,PHIR,THETE,PHE,DHE,THE)
C       DP/DY FOR GEOSTROPHIC WIND
      DPY=PHN-PH
C       DP/DX FOR GEOSTROPHIC WIND
      DPX=PHE-PH
C       DT/DX FOR THERMAL WIND SHEAR
      DTX = THE - TH
C       DT/DY FOR THERMAL WIND SHEAR
      DTY = THN - TH
      CALL WIND
C       CHANGE NOTATION FOR OUTPUT
      PGH=PH
      DGH=DH
      TGH=TH
      UH = UGH
      VH = VGH
      HB = H + 5.
      CP = 7.*PH/(2.*DH*TH)
      CALL JACCH(HB,PHIR,THET,PB,DB,TB)
      DTZ = (TB - TH)/5000.
C.....VERTICAL MEAN WIND
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      WGH = -CP*(UH*DTX/DX5 + VH*DTY/DY5)/(G + CP*DTZ + UH*DUH+VH*DVH)
C      GO TO RANDOM PERTURBATIONS SECTION
      GO TO 800
C.....FOLLOWING IS THE MIXED JACCHIA-GROVES HEIGHT RANGE SECTION
C      LOWER HEIGHT INDEX
 20   IHA = 5*(INT(H)/5)
C       UPPER HEIGHT INDEX
      IHB = IHA + 5
C     LOWER HEIGHT FOR INTERPOLATION
      HA = IHA*1.
C     UPPER HEIGHT FOR INTERPOLATION
      HB = IHB*1.
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON
      CALL JACCH(HA,PHIR,THET,PJA,DJA,TJA)
      PHIN = PHIR + 5. / FAC
      THETE = THET - 5.
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON+5 DEGREES
C        LAT, FOR DP/DY AND DT/DY
      CALL JACCH(HA,PHIN,THET,PJN,DJN,TJN)
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON-5 DEGREES
C        LON, FOR DP/DX, AND DT/DX
      CALL JACCH(HA,PHIR,THETE,PJE,DJE,TJE)
C     JACCHIA DP/DY AT LOWER HEIGHT
      DPXJA=PJE-PJA
C      JACCHIA DP/DY AT LOWER HEIGHT
      DPYJA=PJN-PJA
C      JACCHIA DT/DX AT LOWER HEIGHT
      DTXJA = TJE - TJA
C      JACCHIA DT/DY AT LOWER HEIGHT
      DTYJA = TJN - TJA
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT-LON
      CALL JACCH(HB,PHIR,THET,PJB,DJB,TJB)
      PHIN = PHIR + 5. / FAC
      THETE=THETE-5
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT/LON+5 DEGREES
C        LAT, FOR DP/DY AND DT/DY
      CALL JACCH(HB,PHIN,THET,PJN,DJN,TJN)
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT-LON-5 DEGREES
C        LON, FOR DP/DX AND DT/DX
      CALL JACCH(HB,PHIR,THETE,PJE,DJE,TJE)
C     JACCHIA DP/DX FOR GEOSTROPHIC WINDS
      DPXJB = PJE - PJB
C      JACCHIA DP/DY FOR GEOSTOPHIC WINDS
      DPYJB = PJN - PJB
C     JACCHIA DT/DX FOR THERMAL WIND SHEAR
      DTXJB = TJE - TJB
C      JACCHIA DT/DY FOR THERMAL WIND SHEAR
      DTYJB = TJN - TJB
C.....GROVES AT LOWER HEIGHT, TO BE FAIRED WITH JACCHIA
      CALL GTERP(IHA,PHI,PGA,DGA,TGA,PG,DG,TG,DPYGA,DTYGA,DP2YGA)
C.....GROVES AT UPPER HEIGHT, TO BE FAIRED WITH JACCHIA
      CALL GTERP(IHB,PHI,PGB,DGB,TGB,PG,DG,TG,DPYGB,DTYGB,DP2YGB)
C.....FAIRED RESULTS AT LOWER HEIGHT
      CALL FAIR(PGA,DGA,TGA,PJA,DJA,TJA,IHA,P1,D1,T1,       DPYGA,
     $ DPXJA,DPYJA,DPXA,DPYA,       DTYGA,DTXJA,DTYJA,DTXA,DTYA)
C.....FAIRED RESULTS AT UPPER HEIGHT
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      CALL FAIR(PGB,DGB,TGB,PJB,DJB,TJB,IHB,P2,D2,T2,       DPYGB,          SCI16900
     ↑DPXJB,DPYJB,DPXB,DPYB,      DTYGB,DTXJB,DTYJB,DTXB,DTYB)              SCI17000
C.....HEIGHT INTERPOLATION ON FAIRED P,D,T                                  SCI17100
      CALL INTER2(P1,D1,T1,HA,P2,D2,T2,HB,PH,DH,TH,H)                       SCI17200
C.....HEIGHT INTERPOLATION ON FAIRED DP/DX,DP/DY                            SCI17300
      CALL INTERW(DPXA,DPYA,HA,DPXB,DPYB,HB,DPX,DPY,H)                      SCI17400
C.....HEIGHT INTERPOLATION ON FAIRED DT/DX,DT/DY                            SCI17500
      CALL INTERW(DTXA,DTYA,HA,DTXB,DTYB,HB,DTX,DTY,H)                      SCI17600
C.....EASTWARD COMPONENT OF GEOSTROPHIC WIND                                SCI17700
      CALL WIND                                                             SCI17800
C      CHANGE OF VARIABLES FOR OUTPUT                                       SCI17900
      PGH=PH                                                                SCI18000
      DGH=DH                                                                SCI18100
      TGH=TH                                                                SCI18200
      UH = UGH                                                              SCI18300
      VH = VGH                                                              SCI18400
      CP = 7.*PH/(2.*DH*TH)                                                 SCI18500
      DTZ = (T2 - T1)/5000.                                                 SCI18600
C.....VERTICAL MEAN WIND                                                    SCI18700
      WGH = -CP*(UH*DTX/DX5 + VH*DTY/DY5)/(G + CP*DTZ + UH*DUH + VH*DVH)SCI18800
C      GO TO RANDOM PERTURBATIONS SECTION                                   SCI18900
      GO TO 800                                                             SCI19000
C.....THE FOLLOWING SECTION IS FOR GROVES OR MIXED GROVES 4D HEIGHTS        SCI19100
C      UPPER HEIGHT INDEX                                                   SCI19200
 200  IHGB = 5*(INT(H)/5) + 5                                               SCI19300
      IF (IHGB.GT.90) IHGB=90                                               SCI19400
C     UPPER HEIGHT                                                          SCI19500
      HGB = IHGB*1.                                                         SCI19600
C.....GROVES AT UPPER HEIGHT                                                SCI19700
      CALL GTERP(IHGB,PHI,PGB,DGB,TGB,PG,DG,TG,DPYGB,DTYGB,DP2YGB)          SCI19800
C.....UPPER STATIONARY PERTURBATION HEIGHT = 40                             SCI19900
      IF (H.LT.40.0) GO TO 210                                              SCI20000
C.....UPPER STATIONARY PERTURBATION HEIGHT = 90                             SCI20100
      IF (H.GT.84.0) GO TO 220                                              SCI20200
C.....UPPER STATIONARY PERTURBATION HEIGHT = 52,60,68,76,OR 84              SCI20300
      IHSB = 8*((INT(H) + 4)/8) + 4                                         SCI20400
C.....UPPER STATIONARY PERTURBATION HEIGHT = 52                             SCI20500
      IF (IHSB.LT.52.0) IHSB = 52                                           SCI20600
      GO TO 230                                                             SCI20700
  210 IHSB = 10*(INT(H)/10) + 10                                            SCI20800
      GO TO 230                                                             SCI20900
 220  IHSB = 90                                                             SCI21000
C     UPPER STATIONARY PERTURBATION HEIGHT                                  SCI21100
 230  HSB = IHSB*1.                                                         SCI21200
C.....STATIONARY PERTURBATIONS AT UPPER HEIGHT                              SCI21300
      CALL PDTUV(PSP,DSP,TSP,PHI,THET,IHSB,PSB,DSB,TSB,DPXSB,DPYSB,         SCI21400
     ↑ DTXSB,DTYSB,DP2XSB,DP2YSB,DPXYSB)                                    SCI21500
C      MIXED GROVES 4D SECTION                                              SCI21600
      IF (H.LT.30.0) GO TO 300                                              SCI21700
C     LOWER HEIGHT INDEX                                                    SCI21800
      IHGA = IHGB - 5                                                       SCI21900
C     LOWER HEIGHT INDEX                                                    SCI22000
      HGA = IHGA*1.                                                         SCI22100
C.....GROVES AT LOWER HEIGHT                                                SCI22200
      CALL GTERP(IHGA,PHI,PGA,DGA,TGA,PG,DG,TG,DPYGA,DTYGA,DP2YGA)          SCI22300
C.....LOWER STATIONARY PERTURBATION HEIGHT = 30                             SCI22400
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      IF (H.LT.40.0) GO TO 240                                          SCI22500
C.....LOWER STATIONARY PERTURBATION HEIGHT = 52,60,68,76, OR 84         SCI22600
      IHSA = 8*((INT(H) + 4)/8) - 4                                     SCI22700
C.....LOWER STATIONARY PERTURBATIONS HEIGHT = 40                        SCI22800
      IF (IHSA.LT.40.0) IHSA = 40                                       SCI22900
      GO TO 250                                                         SCI23000
  240 IHSA = 30                                                         SCI23100
C     LOWER STATIONARY PERTURBATION HEIGHT                              SCI23200
  250 HSA = IHSA*1.                                                     SCI23300
C.....STATIONARY PERTURBATIONS AT LOWER HEIGHT                          SCI23400
      CALL FDTUV(PSP,DSP,TSP,PHI,THET,IHSA,PSA,DSA,TSA,DPXSA,DPYSA,     SCI23500
     $ DTXSA,DTYSA,DP2XSA,DP2YSA,DPXYSA)                                SCI23600
C.....GROVES VALUES HEIGHT INTERPOLATIONS                               SCI23700
      CALL INTERZ(PGA,DGA,TGA,HGA,PGB,DGB,TGB,HGB,PGH,DGH,TGH,H)        SCI23800
C.....STATIONARY PERTURBATION HEIGHT INTERPOLATION                      SCI23900
      CALL INTERZ(PSA,DSA,TSA,HSA,PSB,DSB,TSB,HSB,PSH,DSH,TSH,H)        SCI24000
C     QUASI-BIENNIAL VALUES                                             SCI24100
      CALL QBOGEN                                                       SCI24200
C.....HEIGHT INTERPOLATION OF GROVES DP/DY, DT/DY, AND D2P/DY2          SCI24300
      CALL INTERZ(DPYGA,DTYGA,DP2YGA,HGA,DPYGB,DTYGB,DP2YGB,HGB,DPYG,   SCI24400
     $   DTYG,DP2YG,H)                                                  SCI24500
C.....HEIGHT INTERPOLATION OF STATIONARY PERTURBATION DP/DX AND DP/DY   SCI24600
      CALL INTERW(DPXSA,DPYSA,HSA,DPXSB,DPYSB,HSB,DPXS,DPYS,H)          SCI24700
C.....HEIGHT INTERPOLATION OF STATIONARY PERTURBATION DT/DX AND DT/DY   SCI24800
      CALL INTERW(DTXSA,DTYSA,HSA,DTXSB,DTYSB,HSB,DTXS,DTYS,H)          SCI24900
C.....HEIGHT INTERPOLATION OF STATIONARY PERTURBATION D2P/DX2,D2P/DY2,  SCI25000
C              AND D2P/DXDY                                             SCI25100
      CALL INTERZ(DP2XSA,DP2YSA,DPXYSA,HSA,DP2XSB,DP2YSB,DPXYSB,HSB,    SCI25200
     $       DP2XS,DP2YS,DPXYS,H)                                       SCI25300
C.....UNPERTURBED (MONTHLY MEAN) VALUES FOR OUTPUT                       SCI25400
      TGH = TGH * (1. + TSH)                                            SCI25500
      PGH = PGH * (1. + PSH)                                            SCI25600
      DGH = DGH * (1. + DSH)                                            SCI25700
C     TOTAL DT/DX                                                       SCI25800
      DTX =        DTXS * TGH                                           SCI25900
C     TOTAL DT/DY                                                       SCI26000
      DTY = TGH*DTYS + DTYG*(1. + TSH + DTYS)                           SCI26100
C     TOTAL DP/DX                                                       SCI26200
      DPX =        DPXS * PGH                                           SCI26300
C     TOTAL DP/DY                                                       SCI26400
      DPY = PGH*DPYS + DPYG*(1. + PSH + DPYS)                           SCI26500
C     D2P/DX2                                                           SCI26600
      DPXX = PGH*(2.*DPXS - DP2XS)                                      SCI26700
      DPYY = PGH*(2.*DPYS - DP2YS) +  (2.*DPYG - DP2YG)*(1. +PSH+DPYS)  SCI26800
     $     - (DPYG - DP2YG)*DP2YS                                       SCI26900
C     D2P/DXDY                                                          SCI27000
      DPXY = (PGH + DPYG)*DPXYS + DPYG*DPXS                             SCI27100
      CALL WIND                                                         SCI27200
C.....UNPERTURBED VALUES PLUS QBO PERTURBATIONS                         SCI27300
      PH = (1. + PQ) * PGH                                              SCI27400
      DH = DGH * (1. + DQ)                                              SCI27500
      TH = (1. + TQ) * TGH                                              SCI27600
C     GEOSTROPHIC WIND PLUS QBO WIND PERTURBATIONS                      SCI27700
      UH=UGH+UQ                                                         SCI27800
      VH=VGH+VQ                                                         SCI27900
      CP = 7.*PGH/(2.*DGH*TGH)                                          SCI28000
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      DTZ = (TGB*(1.+TSB) - TGA*(1.+TSA))/5000.                         SCI28100
C.....VERTICAL MEAN WIND                                                SCI28200
      WGH=-CP*(UGH*DTX/DX5+VGH*DTY/DY5)/(G+CP*DTZ+VGH*DUH+VGH*DVH)      SCI28300
C       GO TO RANDOM PERTURBATIONS SECTION                              SCI28400
      GO TO 800                                                         SCI28500
C.....THE FOLLOWING IS THE MIXED GROVES 4D SECTION                       SCI28600
C.....GENERATE GRID OF 4D PROFILES IF PREVIOUS HEIGHT GE 30              SCI28700
  300 IF (H1.GE.30..OR.LOOK.EQ.1) CALL GEN4D                             SCI28800
      IHCK = 24                                                         SCI28900
      DO 310 KND = 1,3                                                  SCI29000
      IKND = IHCK + KND                                                 SCI29100
      IF (IKND.GT.26)IKND=26                                            SCI29200
      DO 310 IND = 1,4                                                  SCI29300
      DO 310 JND = 1,4                                                  SCI29400
      PCK(IND,JND,KND) = P4D(4*(IND-1)+JND,IKND)                        SCI29500
      DCK(IND,JND,KND) = D4D(4*(IND-1)+JND,IKND)                        SCI29600
  310 CONTINUE                                                          SCI29700
      CALL CHECK                                                        SCI29800
C.....LAT-LON INTERPOLATION OF 4D DATA AT 25 KM                         SCI29900
      CALL INTER4(            PHI,THET,25.,   P4D,D4D,T4D,P4A,D4A,T4A,  SCI30000
     $ DPX4,DPY4,DTX4,DTY4,DPXXA,DPYYA,DPXYA)                          SCI30100
C       GROVES PLUS STATIONARY PERTURBATIONS                            SCI30200
      PB = PGB*(1. + PSB)                                               SCI30300
C       P,D,T                                                           SCI30400
      DB = DGB*(1. + DSB)                                               SCI30500
      TB = TGB*(1. + TSB)                                               SCI30600
      DPXB = PGB*DPXSB                                                  SCI30700
      DPYB = PGB*DPYSB + DPYGB*(1. + PSB + DPYSB)                       SCI30800
      DPXXB = PGB*(2.*DPXSB - DP2XSB)                                   SCI30900
      DPYYB = PGB*(2.*DPYSB - DP2YSB) + (2.*DPYGB - DP2YGB)*            SCI31000
     $  (1. + PSB + DPYSB) - (DPYGB - DP2YGB)*DP2YSB                    SCI31100
      DPXYB = (PGB + DPYGB)*DPXYSB + DPYGB*DPXSB                        SCI31200
      DTXB = TGB*DTXSB                                                  SCI31300
      DTYB = TGB*DTYSB + DTYGB*(1. + TSB + DTYSB)                       SCI31400
C.....HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT  SCI31500
C          DP/DX AND DP/DY                                              SCI31600
      CALL INTERW(DPX4,DPY4,25.,DPXB,DPYB,HSB,DPX,DPY,H)                SCI31700
C.....HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT  SCI31800
C          P,D,T                                                        SCI31900
      CALL INTER2(P4A,D4A,T4A,25.,PB,DB,TB,HGB,PGH,DGH,TGH,H)           SCI32000
C.....HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT  SCI32100
C          DT/DX AND DT/DY                                              SCI32200
      CALL INTERW(DTX4,DTY4,25.,DTXB,DTYB,HSB,DTX,DTY,H)                SCI32300
C.....HEIGHT INTERPOLATION BETWEEN 4D AT 25 KM AND GROVES AT UPPER      SCI32400
C     HEIGHT D2P/DX2, D2P/DY2, AND D2P/DXDY                             SCI32500
      CALL INTERZ(DPXXA,DPYYA,DPXYA,25.,DPXXB,DPYYB,DPXYB,HGB,DPXX,     SCI32600
     $     DPYY,DPXY,H)                                                 SCI32700
      IF (IOPQ.EQ.2) GO TO 350                                          SCI32800
C     QUASI BIENNIAL PERTURBATIONS                                      SCI32900
      CALL QBOGEN                                                       SCI33000
C     ADD QBO PERTURBATIONS TO P,D,T                                    SCI33100
  350 PH=PGH*(1.+PQ)                                                    SCI33200
      DH=DGH*(1.+DQ)                                                    SCI33300
      TH=TGH*(1.+TQ)                                                    SCI33400
      CALL WIND                                                         SCI33500
C     ADD QBO WIND PERTURBATIONS                                        SCI33600
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      UH=UGH+U0
      VH=VGH+V0
      CP = 7.*PGH/(2.*DGH*TGH)
      DTZ = (TB - T4A)/(1000.*(HGB - 25.))
C.....VERTICAL MEAN WIND
      WGH=-CP*(UGH*DTX/DX5+VGH*DTY/DY5)/(G+CP*DTZ+UGH*DUH+VGH*DVH)
C     GO TO RANDOM PERTURBATIONS SECTION
      GO TO 800
  500 IF (H.GE.0.0) GO TO 510
      IF (H.LT.-0.015) GO TO 505
C     IF -15 METER LE H LT 0 , H IS SET TO 0
      H = 0.
      GO TO 510
C     NO MORE COMPUTATIONS TO BE MADE IF HEIGHT LT -5 M
  505 NMORE = 0
       RETURN
C.....GENERATE GRID OF 4D PROFILES IF PREVIOUS HEIGHT GE 30
 510  IF (H1.GE.30..OR.LOOK.EQ.1) CALL GEN4D
C      LOWER HEIGHT INDEX
       IHA=INT(H)
C      LOWER HEIGHT INDEX
       HA = IHA*1.
      IWSX = IWSYM
      IHCK=IHA-1
      DO 511 KND=1,3
      IKND = IHCK + KND
      IF (IKND.LT.1)IKND = 1
      IF (IKND.GT.26)IKND = 26
      DO 511 IND=1,4
      DO 511 JND = 1,4
      PCK(IND,JND,KND)=P4D(4*(IND-1)+JND,IKND)
      DCK(IND,JND,KND)=D4D(4*(IND-1)+JND,IKND)
511   CONTINUE
      CALL CHECK
C      UPPER HEIGHT INDEX
       IHB = IHA + 1
       IF(IHB.LE.25) GO TO 513
       IHA=24
       HA=24.
       IHB=25
C       UPPER HEIGHT
  513 HB = IHB*1.
C.....LAT-LON INTERPOLATION OF 4D VALUES AT UPPER HEIGHT
  515 CALL INTER4(            PHI,THET,IHB,    P4D,D4D,T4D,PB,DB,TB,
     $ DPX4B,DPY4B,DTX4B,DTY4B,DPXXB,DPYYB,DPXYB)
      IF(IHA.EQ.0.AND.PB*DB*TB.LE.0.)GO TO 520
      GO TO 540
  520 IHB=IHB+1
C.....LOOP TO FIND LOWEST VALID HEIGHT
      HB=HB+1.
      GO TO 515
  540 IF(IHA.GT.0)CALL INTER4(            PHI,THET,IHA,    P4D,D4D,T4D,
     1PA,DA,TA,DPX4A,DPY4A,DTX4A,DTY4A,DPXXA,DPYYA,DPXYA)
      IF(IWSYM.EQ."*")IWSX = IWSYM
      IF(IHA.EQ.0.OR.(PA*DA*TA.LE.0.AND.IHA.LT.10.AND.PB*DB*TB.GT.0.))
     1GO TO 550
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      GO TO 600                                                                 SCI39300
C.....LAT-LON INTERPOLATION OF 4D VALUES AT LOWER HEIGHT                        SCI39400
  550 CALL INTER4(            PHI,THET,0,    P4D,D4D,T4D,                       SCI39500
     .PA,DA,TA,DPX4A,DPY4A,DTX4A,DTY4A,DPXXA,DPYYA,DPXYA)                       SCI39600
      IF(IWSYM.EQ."*")IWSX = IWSYM                                              SCI39700
      IF(TA-TB)560,570,560                                                      SCI39800
  560 TZ=(TA-TB)/ALOG(TA/TB)                                                    SCI39900
      GO TO 575                                                                 SCI40000
  570 TZ=TA                                                                     SCI40100
C ...COMPUTES HEIGHT OF SURFACE                                                 SCI40200
  575 HA=HB+0.28705*TZ*ALOG(PB/PA)/G                                            SCI40300
      IF(H.GT.HA-.04) GO TO 600                                                 SCI40400
      PH=0.                                                                     SCI40500
      DH=0.                                                                     SCI40600
      TH=0.                                                                     SCI40700
      PGH=0.                                                                    SCI40800
      DGH=0.                                                                    SCI40900
      TGH=0.                                                                    SCI41000
      GO TO 800                                                                 SCI41100
C.....HEIGHT INTERPOLATION OF P,D,T                                             SCI41200
  600 CALL INTER2(PA,DA,TA,HA,PB,DB,TB,HB,PGH,DGH,TGH,H)                        SCI41300
C.....HEIGHT INTERPOLATION OF DP/DX AND DP/DY                                   SCI41400
      CALL INTERW(DPX4A,DPY4A,HA,DPX4B,DPY4B,HB,DPX,DPY,H)                      SCI41500
C.....HEIGHT INTERPOLATION OF DT/DX AND DT/DY                                   SCI41600
      CALL INTERW(DTX4A,DTY4A,HA,DTX4B,DTY4B,HB,DTX,DTY,H)                      SCI41700
C.....HEIGHT INTERPOLATION OF D2P/DX2, D2P/DY2, AND D2P/DXDY                    SCI41800
      CALL INTERZ(DPXXA,DPYYA,DPXYA,HA,DPXXB,DPYYB,DPXYB,HB,DPXX,DPYY,          SCI41900
     $DPXY,H)                                                                   SCI42000
C       CHANGE OF NOTATION FOR OUTPUT                                           SCI42100
      PH = PGH                                                                  SCI42200
      DH = DGH                                                                  SCI42300
      TH = TGH                                                                  SCI42400
      IF(PH*DH*TH.LE.0.) GO TO 800                                              SCI42500
      CALL WIND                                                                 SCI42600
C       CHANGE OF NOTATION FOR OUTPUT                                           SCI42700
      UH = UGH                                                                  SCI42800
      VH = VGH                                                                  SCI42900
      CP = 7.*PGH/(2.*DGH*TGH)                                                  SCI43000
      DTZ = (TB - TA)/(1000.*(HB - HA))                                         SCI43100
C.... VERTICAL MEAN WIND                                                        SCI43200
      WGH = -CP*(UGH*DTX/DX5 + VGH*DTY/DY5)/(G+CP*DTZ+UH*DUH+VH*DVH)            SCI43300
C     QBO=0 IF H LT 10                                                          SCI43400
      IF (H.LT.10.) GO TO 800                                                   SCI43500
      IF (IOPQ.EQ.2) GO TO 650                                                  SCI43600
C     COMPUTES QUASI BIENNIAL PERTURBATIONS                                     SCI43700
      CALL QBOGEN                                                               SCI43800
C     ADDS QBO PERTURBATIONS TO P,D,T                                           SCI43900
  650 PH=PGH*(1.+PQ)                                                            SCI44000
      DH=DGH*(1.+DQ)                                                            SCI44100
      TH=TGH*(1.+TQ)                                                            SCI44200
C     ADDS QBO WIND PERTURBATIONS TO U,V                                        SCI44300
      UH=UGH+UQ                                                                 SCI44400
      VH=VGH+VQ                                                                 SCI44500
C.....THE FOLLOWING IS THE RANDOM PERTURBATIONS SECTION                         SCI44600
C.....NO RANDOM PERTURBATIONS IF IOPR GT 1                                      SCI44700
  800 IF (IOPR.GT.1) GO TO 830                                                  SCI44800
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C.....INTERPOLATES RANDOM WIND MAGNITUDES TO HEIGHT H, LATITUDE PHI      SCI44900
      CALL INTRUV(UR,VR,H,PHI,SUH,SVH)                                   SCI45000
      CALL INTRUV(PLP,DLP,H,PHI,PLPH,DLPH)                               SCI45100
      CALL INTRUV(TLP,DLP,H,PHI,TLPH,DLPH)                               SCI45200
      CALL INTRUV(ULP,VLP,H,PHI,ULPH,VLPH)                               SCI45300
      CALL INTRUV(UDL,VDL,H,PHI,UDL2,VDL2)                               SCI45400
      CALL INTRUV(UDS,VDS,H,PHI,UDS2,VDS2)                               SCI45500
      SUHL=SQRT(ULPH*ABS(SUH))                                           SCI45600
      SUHS=SQRT((1.-ULPH)*ABS(SUH))                                      SCI45700
      SVHL=SQRT(VLPH*ABS(SVH))                                           SCI45800
      SVHS=SQRT((1.-VLPH)*ABS(SVH))                                      SCI45900
      SUH = SQRT(ABS(SUH))                                               SCI46000
      SVH = SQRT(ABS(SVH))                                               SCI46100
C.....IF H LE 25 USE 4D DATA RANDOM P,D,T SIGMAS                         SCI46200
      IF (H.LE.25.) GO TO 810                                            SCI46300
C.....INTERPOLATE PR,DR,TR ARRAYS TO GET P,D,T SIGMAS AT HEIGHT H,       SCI46400
C         LATITUDE PHI                                                   SCI46500
      CALL RTERP(H,PHI,PR,DR,TR,SPH,SDH,STH)                             SCI46600
      GO TO 820                                                          SCI46700
C.....LAT-LON INTERPOLATION ON P,D,T SIGMAS AT LOWER HEIGHT              SCI46800
  810 CALL INTER4(            PHI,THET,IHA,    SP4,SD4,ST4,PA,DA,TA,     SCI46900
     $ DPX,DPY,DTX,DTY,DPXX,DPYY,DPXY)                                   SCI47000
C.....LAT-LON INTERPOLATION ON P,D,T SIGMSA AT UPPER HEIGHT              SCI47100
      CALL INTER4(            PHI,THET,IHB,    SP4,SD4,ST4,PB,DB,TB,     SCI47200
     $ DPX,DPY,DTX,DTY,DPXX,DPYY,DPXY)                                   SCI47300
C.....HEIGHT INTERPOLATION OF SIGMAS                                     SCI47400
      CALL INTERZ(PA,DA,TA,    HA,PB,DB,TB,    HB,SPH,SDH,STH,H)         SCI47500
      IF(PH*DH*TH.LE.0.) GO TO 825                                       SCI47600
C.....HEIGHT DISPLACEMENT BETWEEN PREVIOUS AND CURRENT POSITION          SCI47700
  820 DZ = H1 - H                                                        SCI47800
      SPHL=SQRT(PLPH*ABS(SPH))                                           SCI47900
      SPHS=SQRT((1.-PLPH)*ABS(SPH))                                      SCI48000
      SDHL=SQRT(DLPH*ABS(SDH))                                           SCI48100
      SDHS=SQRT((1.-DLPH)*ABS(SDH))                                      SCI48200
      STHL=SQRT(TLPH*ABS(STH))                                           SCI48300
      STHS=SQRT((1.-TLPH)*ABS(STH))                                      SCI48400
      SPH = SQRT(ABS(SPH))                                               SCI48500
      SDH = SQRT(ABS(SDH))                                               SCI48600
      STH = SQRT(ABS(STH))                                               SCI48700
C.....COMPUTES HORIZONTAL DIXPLACEMENT DX BETWEEN PREVIOUS AND CURRENT   SCI48800
C         POSITION, HORIZONTAL SCALE HL, AND VERTICAL SCALE VL           SCI48900
C.....COMPUTES PERTURBATION VALUES PRH,DRH,TRH,URH AND VRH               SCI49000
      CALL PERTRB                                                        SCI49100
C     ADDS RANDOM PERTURBATIONS TO PH,DH,TH                              SCI49200
      PH = PH*(1. + PRH)                                                 SCI49300
      DH = DH*(1. + DRH)                                                 SCI49400
      TH = TH*(1. + TRH)                                                 SCI49500
C     ADDS RANDOM WINDS TO UH,VH                                         SCI49600
      UH=UH+URH                                                          SCI49700
      VH=VH+VRH                                                          SCI49800
C.....SETS PREVIOUS RANDOM PERTURBATION IN P,D,T TO CURRENT              SCI49900
C         PERTURBATIONS, FOR NEXT CYCLE                                  SCI50000
  825 RP1S= PRHS                                                         SCI50100
      RD1S= DRHS                                                         SCI50200
      RT1S= TRHS                                                         SCI50300
      RP1L=PRHL                                                          SCI50400
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      RD1L=DRHL                                                         SCI50500
      RT1L=TRHL                                                         SCI50600
C.....SETS PREVIOUS MAGNITUDES FO CURRENT VALUES, FOR NEXT CYCLE        SCI50700
      SP1S=SPHS                                                         SCI50800
      SD1S= SDHS                                                        SCI50900
      ST1S=STHS                                                         SCI51000
      SP1L=SPHL                                                         SCI51100
      SD1L=SDHL                                                         SCI51200
      ST1L=STHL                                                         SCI51300
C.....SETS PREVIOUS WIND PERTURBATION VALUES TO CURRENT VALUES,         SCI51400
C        FOR NEXT CYCLE                                                 SCI51500
      RU1S=URHS                                                         SCI51600
      RV1S=VRHS                                                         SCI51700
      RU1L=URHL                                                         SCI51800
      RV1L=VRHL                                                         SCI51900
C.....SETS PREVIOUS WIND PERTURBATION MAGNITUDES TO CURRENT VALUES,     SCI52000
C        FOR NEXT CYCLE                                                 SCI52100
      SU1S=SUHS                                                         SCI52200
      SV1S=SVHS                                                         SCI52300
      SU1L=SUHL                                                         SCI52400
      SV1L=SVHL                                                         SCI52500
C.....SETS PREVIOUS HEIGHT TO CURRENT HEIGHT, FOR NEXT CYCLE            SCI52600
  830 H1 = H                                                            SCI52700
C.....SETS PREVIOUS LATITUDE TO CURRENT LATITUDE, FOR NEXT CYCLE        SCI52800
      PHI1R=PHIR                                                        SCI52900
C.....SETS PREVIOUS LONGITUDE TO CURRENT LONGITUDE, FOR NEXT CYCLE      SCI53000
      THET1R=THETR                                                      SCI53100
C     SETS NMORE TO COMPUTE MORE DATA ON NEXT CYCLE                     SCI53200
      NMORE = 1                                                         SCI53300
C.....NO MORE DATA IF P, D, OR T LEQ 0                                  SCI53400
      IF(PH*DH*TH.LE.0.) RETURN                                         SCI53500
      CALL STDATM(H,TS,PS,DS)                                           SCI53600
      IF ((PS*DS*TS).GT.0.) GO TO 870                                   SCI53700
      PGHP=0.                                                           SCI53800
      DGHP=0.                                                           SCI53900
      TGHP=0.                                                           SCI54000
      PHP=0.                                                            SCI54100
      DHP=0.                                                            SCI54200
      THP=0.                                                            SCI54300
      GO TO 880                                                         SCI54400
  870 PGHP=100.*(PGH-PS)/PS                                             SCI54500
      DGHP=100.*(DGH-DS)/DS                                             SCI54600
      TGHP=100.*(TGH-TS)/TS                                             SCI54700
      PHP=100.*(PH-PS)/PS                                               SCI54800
      DHP=100.*(DH-DS)/DS                                               SCI54900
      THP=100.*(TH-TS)/TS                                               SCI55000
C     CONVERTS QBO P,D,T TO PERCENT                                     SCI55100
  880 PQ=100.*PQ                                                        SCI55200
      DQ=100.*DQ                                                        SCI55300
      TQ=100.*TQ                                                        SCI55400
C     CONVERTS RANDOM P,D,T TO PERCENT                                  SCI55500
      PRH=100.*PRH                                                      SCI55600
      DRH=100.*DRH                                                      SCI55700
      TRH=100.*TRH                                                      SCI55800
      PRHS=100.*PRHS                                                    SCI55900
      DRHS=100.*DRHS                                                    SCI56000
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      TRHS=100.*TRHS                                                    SCI56100
      PRHL=100.*PRHL                                                    SCI56200
      DRHL=100.*DRHL                                                    SCI56300
      TRHL=100.*TRHL                                                    SCI56400
      SPHS = 100.*SPHS                                                  SCI56500
      SDHS = 100.*SDHS                                                  SCI56600
      STHS = 100.*STHS                                                  SCI56700
      SPHL = 100.*SPHL                                                  SCI56800
      SDHL = 100.*SDHL                                                  SCI56900
      STHL = 100.*STHL                                                  SCI57000
C     CONVERTS WIND SHEAR TO M/S/KM                                     SCI57100
      DUH = DUH * 1000.                                                 SCI57200
      DVH = DVH * 1000.                                                 SCI57300
C      CONVERTS VERTICAL WIND TO CM/S                                   SCI57400
      WGH = WGH*100.                                                    SCI57500
      PQA=PQA*100.                                                      SCI57600
      DQA=DQA*100.                                                      SCI57700
      TQA=TQA*100.                                                      SCI57800
      SPH=SPH*100.                                                      SCI57900
      SDH=SDH*100.                                                      SCI58000
      STH=STH*100.                                                      SCI58100
      PSH=PSH*100.                                                      SCI58200
      DSH=DSH*100.                                                      SCI58300
      TSH=TSH*100.                                                      SCI58400
      IF (IOPP.NE.0)                                                    SCI58500
     * WRITE(IOPP,951) H,PHI,THET,PGHP,DGHP,TGH,UGH,VGH,SPH,SDH,STH,    SCI58600
     1SUH,SVH,PGH,DGH,IET,MN                                            SCI58700
  951 FORMAT(F5.1,F6.2,F7.2,2F5.1,3F5.0,5F5.1,2E10.3,I5,I3)             SCI58800
      WRITE(6,900) H,PHI,THET,PGH,DGH,TGH,UGH,IWSYM,VGH,PH,DH,TH,UH,    SCI58900
     * IWSYM,VH,DUH,                                                    SCI59000
     $ DVH,WGH,IET,PGHP,DGHP,TGHP,PHP,DHP,THP,PSH,DSH,TSH,PQ,DQ,TQ,UQ,  SCI59100
     $ VQ,PQA,DQA,TQA,UA,VA,PRHS,DRHS,TRHS,URHS,VRHS,SPHS,SDHS,STHS,    SCI59200
     1SUHS,SVHS,PRHL,DRHL,TRHL,URHL,VRHL,SPHL,SDHL,STHL,SUHL,SVHL,      SCI59300
     2PRH,DRH,TRH,URH,VRH,SPH,SDH,STH,SUH,SVH                           SCI59400
  900 FORMAT(1X,F6.2,2F7.2,2(2E9.3,2F6.0,A1,F5.0),2F5.1,23X,F6.2/1X,    SCI59500
     $ I5,14X,2(2( F8.1," "),F6.1," ",11X),10X,                         SCI59600
     $3F5.1,10X," SP",/102X,3F5.1,2F5.0," DBO"/102X,3F5.1,2F5.0," MAG"/1SCI59700
     $02X,3F5.1,2F5.0," RANS",/102X,3F5.1,2F5.0," SIGS",/               SCI59800
     2102X,3F5.1,2F5.0," RANL",/                                        SCI59900
     3102X,3F5.1,2F5.0," SIGL",/                                        SCI60000
     4102X,3F5.1,2F5.0," RANT",/                                        SCI60100
     5102X,3F5.1,2F5.0," SIGT",/)                                       SCI60200
      RETURN                                                            SCI60300
      END                                                               SCI60400
```

```
      SUBROUTINE SELEC4
      INTEGER SCRCH2
      COMMON/C4/XL(16),YL(16),NP
C
C     SUBROUTINE TO SELECT POINTS FOR INTERPOLATION
C
      COMMON /ICTEMP/ SCRCH1,SCRCH2
      COMMON /POINT/ IPT(16,5),LL(16),DXY(16,2)
      COMMON /ORDER/ IPTN(16,5),IREAD(65,3)
C
      DIMENSION                 IC(4),IL(2),JL(2),LIML(51),LIMU(51)
C
      DATA  LIML/15,14,13,12,11,10,9,8,7,6,5,4,3,2,23*1,2,3,4,5,6,7,8,9,
     110,11,12,13,14,15/
      DATA  LIMU/33,34,35,36,37,38,39,40,41,42,43,44,45,46,23*47,46,45,
     144,43,42,41,40,39,38,37,36,35,34,33/
      DATA PI/3.14159/
C
C
C         INITIALIZE
C
      PI4=PI/4.
      DEGRAD=PI/180.
      DO 1 I=1,16
      DO 1 J=1,5
    1 IPT(I,J)=0
C
C         MAJOR LOOP FOR POINTS
C
      DO 100 II=1,NP
C
      LA=ABS(XL(II))*10.+.5
      LO=YL(II)*10.+.5
      LL(II)=LA*10000+LO
      IF (XL(II).LT.0.) LL(II)=-LL(II)
C
      IF (XL(II)-15.1) 15,30,30
   15 IF (XL(II)) 50,40,40
C
C         NMC GRID
C
   30 IPT(II,5)=2
      EL=(350-YL(II))*DEGRAD
      PHI=XL(II)*DEGRAD
      R=31.204359052*(SIN(PI4-PHI/2.)/COS(PI4-PHI/2.))
      XX=R*COS(EL)+24.
      YY=R*SIN(EL)+26.
      I=XX
      J=YY
      DX=XX-I
      DY=YY-J
      DXY(II,1)=DX
      DXY(II,2)=DY
      IF (XL(II).GT.17.18) GO TO 31
      IF ((J.LT.1).OR.(J.GT.51)) GO TO 70
      IF ((I.LT.LIML(J)).OR.(I.GT.LIMU(J))) GO TO 70
```

```
   31 IC(1)=I*1000+J
      IF ((ABS(DX).GT..1).OR.(ABS(DY).GT..1)) GO TO 32
      IP=1
      GO TO 35
   32 CONTINUE
      IF (XL(II).GT.17.18) GO TO 34
      IF ((((I.GT.(LIMU(J)-1)).AND.((J.GE.15).AND.(J.LE.37)))
     1 .OR.(J.GT.50)) GO TO 70
      IF ((I+1.GT.LIMU(J+1)).OR.(I.LT.LIML(J+1))) GO TO 80
      IF ((I.EQ.LIMU(J)).OR.(I.EQ.LIML(J))) GO TO 80
   34 IP=4
      IC(2)=(I+1)*1000+J
      IC(3)=I*1000+J+1
      IC(4)=(I+1)*1000+J+1
   35 CONTINUE
      CALL NTRAN(SCRCH2,10,22)
      DO 38 IPG=1,1977
      CALL NTRAN(SCRCH2,2,1,IJ,L,22)
      DO 38 K=1,IP
   38 IF(IC(K).EQ.IJ) IPT(II,K)=IPG
      GO TO 100
C
C         EQUATORIAL GRID
C
   40 IPT(II,5)=1
      L1=XL(II)
      L2=YL(II)
      IL(1)=L1/5
      IL(2)=IL(1)+1
      JL(1)=(L2/5)+1
      JL(2)=JL(1)-1
      DO 45 K1=1,2
      DO 45 K2=1,2
      IF ((ABS(XL(II)-IL(K1)*5).GT.0.1).OR.(ABS(YL(II)-JL(K2)*5).GT.0.1)
     1 ) GO TO 45
      IF (JL(K2).EQ.72) JL(K2)=0
      IPT(II,1)=JL(K2)*4+IL(K1)+1
      GO TO 100
   45 CONTINUE
      IF (JL(1).EQ.72) JL(1)=0
      IPT(II,1)=JL(1)*4+IL(1)+1
      IPT(II,2)=JL(2)*4+IL(1)+1
      IPT(II,3)=JL(1)*4+IL(2)+1
      IPT(II,4)=JL(2)*4+IL(2)+1
      GO TO 100
C
C         SOUTHERN HEMISPHERE
C
   50 IPT(II,5)=3
      L1=XL(II)
      L2=YL(II)
      IF (ABS(XL(II)).LT.85.0) GO TO 51
      IPT(II,1)=1
      IF (ABS(XL(II)+90.).LT.0.11) GO TO 100
   51 CONTINUE
      IL(1)=(L1/5)-1
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      JL(1)=(L2/5)+1                                                    SEL10900
      IL(2)=IL(1)+1                                                     SEL11000
      JL(2)=JL(1)-1                                                     SEL11100
      DO 52 K1=1,2                                                      SEL11200
      DO 52 K2=1,2                                                      SEL11300
      IF ((ABS(XL(II)-IL(K1)*5).GT.0.1).OR.(ABS(YL(II)-JL(K2)*5).GT.0.1)SEL11400
     1  ) GO TO 52                                                      SEL11500
      IF (JL(K2).EQ.72) JL(K2)=0                                        SEL11600
      IPT(II,1)=JL(K2)*17-IL(K1)+1                                      SEL11700
      IF (IL(K).NE.0) GO TO 100                                         SEL11800
      IPT(II,1)=JL(K2)*4+1                                              SEL11900
      IPT(II,5)=1                                                       SEL12000
      GO TO 100                                                         SEL12100
   52 CONTINUE                                                          SEL12200
      IF (JL(1).EQ.72) JL(1)=0                                          SEL12300
      IF (IPT(II,1).EQ.1) GO TO 54                                      SEL12400
      IPT(II,1)=JL(1)*17-IL(1)+1                                        SEL12500
      IPT(II,2)=JL(2)*17-IL(1)+1                                        SEL12600
      IF (IL(2)) 55,53,55                                               SEL12700
   53 IPT(II,3)=JL(1)*4+1                                               SEL12800
      IPT(II,4)=JL(2)*4+1                                               SEL12900
      IPT(II,5)=1133                                                    SEL13000
      GO TO 100                                                         SEL13100
   54 IPT(II,2)=JL(1)*17-IL(2)+1                                        SEL13200
      IPT(II,3)=JL(2)*17-IL(2)+1                                        SEL13300
      IPT(II,5)=333                                                     SEL13400
      GO TO 100                                                         SEL13500
   55 CONTINUE                                                          SEL13600
      IPT(II,3)=JL(1)*17-IL(2)+1                                        SEL13700
      IPT(II,4)=JL(2)*17-IL(2)+1                                        SEL13800
      GO TO 100                                                         SEL13900
C                                                                       SEL14000
C     BODERLINE POINTS                                                  SEL14100
C                                                                       SEL14200
   70 CONTINUE                                                          SEL14300
C     TWO NMC, TWO EQUATORIAL                                           SEL14400
      IPT(II,5)=2211                                                    SEL14500
      L=YL(II)                                                          SEL14600
      IPT(II,1)=((L/5)+2)*4                                             SEL14700
      IPT(II,2)=IPT(II,1)-4                                             SEL14800
      IF (L.GE.355) IPT(II,1)=4                                         SEL14900
C                                                                       SEL15000
      IF (J.LT.1) J=1                                                   SEL15100
      IF (J.GT.51) J=51                                                 SEL15200
      IF (I.LT.LIML(J)) I=LIML(J)                                       SEL15300
      IF (I.GT.LIMU(J)) I=LIMU(J)                                       SEL15400
      IC(1)=I*1000+J                                                    SEL15500
      IF ((J.LT.15).OR.(J.GT.37)) GO TO 72                              SEL15600
      IC(2)=I*1000+J+1                                                  SEL15700
      GO TO 76                                                          SEL15800
   72 IF ((J.NE.1).AND.(J.NE.51)) GO TO 74                              SEL15900
      IF (I.EQ.LIMU(J)) GO TO 73                                        SEL16000
      IC(2)=(I+1)*1000+J                                                SEL16100
      GO TO 76                                                          SEL16200
   73 IC(2)=(I-1)*1000+J                                                SEL16300
      GO TO 76                                                          SEL16400
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   74 IF (I.EQ.LIML(J)) GO TO 75                                       SEL16500
      IC(2)=LIMU(J+1)*1000+J+1                                         SEL16600
      GO TO 76                                                         SEL16700
   75 IC(2)=LIML(J+1)*1000+J+1                                         SEL16800
C                                                                      SEL16900
 76   JCALL NTRAN(SCRCH2,10,22)                                        SEL17000
      DO 77 IPG=1,1977                                                 SEL17100
      CALL NTRAN(SCRCH2,2,1,IJ,L,22)                                   SEL17200
      DO 77 K=1,2                                                      SEL17300
   77 IF(IC(K).EQ.IJ) IPT(II,K+2)=IPG                                  SEL17400
      GO TO 100                                                        SEL17500
C                                                                      SEL17600
   80 CONTINUE                                                         SEL17700
C     THREE NMC, ONE EQUATORIAL                                        SEL17800
      IPT(II,5)=2212                                                   SEL17900
      IC(2) = 0                                                        SEL18000
      L=YL(II)                                                         SEL18100
      IPT(II,2)=((L/5)+1)*4                                            SEL18200
      IF (L.GE.355) IPT(II,2)=4                                        SEL18300
      IF (I.EQ.LIML(J)) GO TO 84                                       SEL18400
      IF (J.GT.37) GO TO 82                                            SEL18500
      IC(1)=I*1000+J                                                   SEL18600
      IC(3)=I*1000+J+1                                                 SEL18700
      IC(4)=(I+1)*1000+J+1                                             SEL18800
      GO TO 88                                                         SEL18900
   82 IC(1)=(I+1)*1000+J                                               SEL19000
      IC(3)=I*1000+J                                                   SEL19100
      IC(4)=I*1000+J+1                                                 SEL19200
      GO TO 88                                                         SEL19300
   84 IF (J.GT.37) GO TO 86                                            SEL19400
      IC(1)=(I-1)*1000+J+1                                             SEL19500
      IC(3)=I*1000+J+1                                                 SEL19600
      IC(4)=I*1000+J                                                   SEL19700
      GO TO 88                                                         SEL19800
   86 IC(1)=(I+1)*1000+J+1                                             SEL19900
      IC(3)=(I+1)*1000+J                                               SEL20000
      IC(4)=I*1000+J                                                   SEL20100
C                                                                      SEL20200
 88   CALL NTRAN(SCRCH2,10,22)                                         SEL20300
      DO 89 IPG=1,1977                                                 SEL20400
      CALL NTRAN(SCRCH2,2,1,IJ,L,22)                                   SEL20500
      DO 89 K=1,4                                                      SEL20600
      IF(IC(K).EQ.0) GO TO 89                                          SEL20700
      IF(IC(K).EQ.IJ) IPT(II,K)=IPG                                    SEL20800
   89 CONTINUE                                                         SEL20900
C                                                                      SEL21000
  100 CONTINUE                                                         SEL21100
      DO 150 I=1,16                                                    SEL21200
      DO 150 J=1,5                                                     SEL21300
  150 IPTN(I,J)=IPT(I,J)                                               SEL21400
      CALL SORT4(NP)                                                   SEL21500
      RETURN                                                           SEL21600
      END                                                              SEL21700
```

```
      SUBROUTINE SETUP
      COMMON/COTRAN/NDATA(19),IC,MI,IH,IX(10),IEX
      DIMENSION IP(5),ID(5),IT(5),IDAY(12),BUFFER(64)
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,
     .NSAME,RP1L,PD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L.
     $ MN, IDD, IYR, H1, PHI1R,THETA1R,CUMS(21),RP1S,RD1S
     1,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,UDS1,VDS1,
     2UDL1,VDL1,UDS2,VDS2,UDL2,VDL2
      COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)
     . ,PSP(8,10,12)
     1,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),PDQ(17,5)
     2 ,DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),UAQ(17,5)
     3 ,VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10),
     * PQ,DQ,TQ,UQ,VQ,PQA,DQA,
     .  TQA,UA,VA,IOPQ,PLP(25,10),DLP(25,10),TLP(25,10)
     1,ULP(25,10),VLP(25,10),UDL(25,10),VDL(25,10),UDS(25,10)
     2,VDS(25,10)
      DATA IDAY/0,31,59,90,120,151,181,212,243,273,304,334/
      XMJD = 0.
      IF (MN.GT.12) GO TO 2
      IDA = IDAY(MN) + IDD
      DD = IDA
      IF (MOD(IYR,4).EQ.0.AND.MN.GT.2) IDA = IDA + 1
      XMJD = 2439856. + 365. * (IYR -   68.) + IDA + INT((IYR -   65.)
     $ / 4.)
C.....SECOND DATA CARD READS, FREE FIELD, THE FOLLOWING DATA_
C        IUG = UNIT NUMBER FOR GROVES DATA TAPE
C        IUR = UNIT NUMBER FOR RANDOM SIGMA DATA
C                  (IF IUR=IUG UNIT IUG WILL BE READ)
C        IUQ = UNIT NUMBER FOR QBO DATA
C                  (IF IUQ=IUG DATA ON TAPE ON UNIT IUG WILL BE READ)
C        IU4 = UNIT FOR 4-D INPUT P,D,T 0-25KM DATA
C        IOPR = RANDOM OUTPUT OPTION
C.....IOPR=1 RANDOM OUTPUT                IOPR=2 NO RANDOM OUTPUT
C        IOPQ = QBO OUTPUT OPTION
C.....IOPQ=1 QBO OUTPUT                   IOPQ=2 NO QBO OUTPUT
C        NR1 = STARTING RANDOM NUMBER
C        NMCOP = NMC GRID DATA READ OPTION
C.....NMCOP=0  READS NMC GRID DATA FROM UNIT IUG, OTHERWISE READS FORM
C        CARDS
C.....IOTEM1=UNIT FOR 4-D P, D, T DATA (SCRATCH FILE, DOES NOT NEED TO
C        BE ASSIGNED)
C.....IOTEM2=UNIT FOR NMC GRID POINTS (SCRATCH FILE, DOES NOT NEED TO
C        BE ASSIGNED)
  2   READ(5,10) IUG,IUR,IUQ,IU4,IOPR,IOPQ,NR1,NMCOP,IOTEM1,IOTEM2
 10    FORMAT( )
      WRITE(6,9000) IUG,IUR,IUQ,IU4,IOPR,IOPQ,NR1,NMCOP,IOTEM1,IOTEM2
     $ ,XMJD
      IF (IOPR.LT.1.OR.IOPR.GT.2) GO TO 666
      IF (IOPQ.LT.1.OR.IOPQ.GT.2) GO TO 666
      MONTH=MN
      IF (IOPR.EQ.2) GO TO 7
      R=RAND(NR1)
      R = RAND(0)
      P = RAND(0)
C.....THIRD DATA CARD READS FREE FIELD, THE FOLLOWING DATA_
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C     RP1L,RP1S = INITIAL RANDOM PRESSURE PERTURBAIIONS, PERCENT        SET05700
C     RD1L,RD1S = INITIAL RANDOM DENSITY PERTURBATION, PERCENT          SET05800
C     RT1L,RT1S = INITIAL RANDOM TEMPERATURE PERTURBATION, PERCENT      SET05900
C     RU1L,RU1S = INITIAL EASTWARD WIND PERTURBATION, M/S               SET06000
C     RV1L,RV1S = INITIAL NORTHWARD WIND PERTURBATION, M/S              SET06100
C     ( S MEANS SMALL SCALE, L MEANS LARGE SCALE, TOTAL PERTURBATIONS   SET06200
C     ARE SUM OF LARGE AND SMALL PARTS)                                 SET06300
      READ(5,10)  RP1L,RP1S,RD1L,RD1S,RT1L,RT1S,RU1L,RU1S,RV1L,RV1S     SET06400
      RP1=RP1L+RP1S                                                     SET06500
      RD1=RD1S+RD1L                                                     SET06600
      RT1=RT1S+RT1L                                                     SET06700
      RU1=RU1L+RU1S                                                     SET06800
      RV1=RV1L+RV1S                                                     SET06900
C     AVOIDS TAPE SEARCH IF CURRENT MONTH IS SAME AS PREVIOUS MONTH     SET07000
    7 IF (NSAME.EQ.1) GO TO 621                                         SET07100
      CALL GETNMC                                                       SET07200
C.....LOADS NMC GRID DATA FROM INPUT UNIT TO SCRATCHFILE UNIT IOTEM2    SET07300
      IF (MONTH.LT.13) GO TO 12                                         SET07400
      M1=13                                                             SET07500
      M2=13                                                             SET07600
C.....MONTH=13 IS ANNUAL AVERAGE CASE                                   SET07700
      GO TO 13                                                          SET07800
   12 M1=MONTH                                                          SET07900
      M2=MONTH + 6                                                      SET08000
C.....SOUTHERN HEMISPHERE DATA IS 6 MONTHS DISPLACED FOR GROVES,        SET08100
C          STATIONARY PERTURBATIONS, AND RANDOM PERTURBATIONS           SET08200
      IF (M2.GT.12) M2=M2 - 12                                          SET08300
   13 DO 100 I=1,234                                                    SET08400
   15 CALL RTRAN1                                                       SET08500
C.....READS GROVES PRESSURE DATA                                        SET08600
      IF (IC.NE."P") GO TO 666                                          SET08700
      IF (MI.EQ.M1) GO TO 30                                            SET08800
      IF (MI.EQ.M2) GO TO 40                                            SET08900
      GO TO 100                                                         SET09000
   30 KS=1                                                              SET09100
      GO TO 50                                                          SET09200
   40 KS=-1                                                             SET09300
   50 IH=(IH-20)/5                                                      SET09400
      TENX=10.**IEX                                                     SET09500
      DO 60 J=1,10                                                      SET09600
      K=10+KS*(J-1)                                                     SET09700
   60 PG(IH,K) = IX(J)*TENX                                             SET09800
C.....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE                  SET09900
  100 CONTINUE                                                          SET10000
      DO 200 I=1,234                                                    SET10100
  115 CALL RTRAN1                                                       SET10200
C.....READS GROVES DENSITY DATA                                         SET10300
      IF(IC.NE."D") GO TO 666                                           SET10400
      IF (MI.EQ.M1) GO TO 130                                           SET10500
      IF (MI.EQ.M2) GO TO 140                                           SET10600
      GO TO 200                                                         SET10700
  130 KS=1                                                              SET10800
      GO TO 150                                                         SET10900
  140 KS=-1                                                             SET11000
  150 IH=(IH-20)/5                                                      SET11100
      TENX=10.**IEX                                                     SET11200
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      DO 160 J=1,10                                                     SET11300
      K=10+KS*(J-1)                                                     SET11400
  160 DG(IH,K) = IX(J)*TENX                                             SET11500
C.....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE                   SET11600
  200 CONTINUE                                                          SET11700
      DO 300 I=1,234                                                    SET11800
  215 CALL RTRAN1                                                       SET11900
C.....READS GROVES TEMPERATURE DATA                                      SET12000
      IF (IC.NE."T") GO TO 666                                          SET12100
      IF (MI.EQ.M1) GO TO 230                                           SET12200
      IF (MI.EQ.M2) GO TO 240                                           SET12300
      GO TO 300                                                         SET12400
  230 KS=1                                                              SET12500
      GO TO 250                                                         SET12600
  240 KS=-1                                                             SET12700
  250 IH=(IH-20)/5                                                      SET12800
      TENX=10.**IEX                                                     SET12900
      DO 260 J=1,10                                                     SET13000
      K=10+KS*(J-1)                                                     SET13100
  260 TG(IH,K) = IX(J)*TENX                                             SET13200
C.....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE                   SET13300
  300 CONTINUE                                                          SET13400
      IF (MONTH.LT.13) GO TO 308                                        SET13500
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL                          SET13600
      DO 304 I=1,18                                                     SET13700
      DO 304 J=1,9                                                      SET13800
      J20=20-J                                                          SET13900
      PG(I,J)=PG(I,J20)                                                 SET14000
      DG(I,J)=DG(I,J20)                                                 SET14100
      TG(I,J)=TG(I,J20)                                                 SET14200
  304 CONTINUE                                                          SET14300
  308 DO 360 I=1,1248                                                   SET14400
  310 FORMAT (1X,A1,I2,I3,I5,2(5I4,4X),5I4)                             SET14500
      CALL RTRAN(19)                                                    SET14600
C.....READS STATIONARY PERTURBATIONS DATA (TO BE STORED IN PSP, DSP, ANDSET14700
C        TSP ARRAYS)                                                    SET14800
      IC=NDATA(1)                                                       SET14900
      MI=NDATA(2)                                                       SET15000
      IH=NDATA(3)                                                       SET15100
      LON=NDATA(4)                                                      SET15200
      DO 311 K=1,5                                                      SET15300
      IP(K)=NDATA(4+K)                                                  SET15400
      ID(K)=NDATA(9+K)                                                  SET15500
  311 IT(K)=NDATA(14+K)                                                 SET15600
      IF (IC.NE."S") GO TO 666                                          SET15700
      IF (MI.EQ.M1) GO TO 320                                           SET15800
      IF (MI.EQ.M2) GO TO 330                                           SET15900
      GO TO 360                                                         SET16000
  320 KS=1                                                              SET16100
      GO TO 340                                                         SET16200
  330 KS=-1                                                             SET16300
  340 ISH=2+(IH-44)/8                                                   SET16400
      L=(LON+20)/30                                                     SET16500
      IF(IH.LT.52) ISH = (IH-20)/10                                     SET16600
      IF (IH.GT.84) ISH=8                                               SET16700
      DO 350 J=1,5                                                      SET16800
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```
      K=5+KS*(J+(KS-1)/2)                                               SET16900
      PSP(ISH,K,L) = IP(J)/1000.                                        SET17000
      DSP(ISH,K,L) = ID(J)/1000.                                        SET17100
  350 TSP(ISH,K,L) = IT(J)/1000.                                        SET17200
C.....CONVERSION TO REAL AND STORAGE IN ARRAYS COMPLETE                 SET17300
  360 CONTINUE                                                          SET17400
      IF (MONTH.LT.13) GO TO 368                                        SET17500
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL                         SET17600
      DO 364 I=1,8                                                      SET17700
      DO 364 K=1,12                                                     SET17800
      DO 364 J=1,5                                                      SET17900
      J10=11-J                                                          SET18000
      PSP(I,J,K)=PSP(I,J10,K)                                           SET18100
      DSP(I,J,K)=DSP(I,J10,K)                                           SET18200
      TSP(I,J,K)=TSP(I,J10,K)                                           SET18300
  364 CONTINUE                                                          SET18400
C     MOVES PAST 2ND EOF ON UNIT IUG                                    SET18500
 368  CALL NTRAN(IUG,3,1,22)                                            SET18600
      IF(IOPR.EQ.2) GO TO 440                                           SET18700
C.....IOPR=1 READS RANDOM SIGMAS,  IOPR=2 ZEROS RANDOM SIGMAS           SET18800
  370 DO 430 I=1,260                                                    SET18900
      IF (IUR.EQ.IUG) GO TO 375                                         SET19000
      READ (IUR,380) IC,MI,IH,IP,ID,IT                                  SET19100
C.....USES FORTRAN READ ON UNIT IUR IF IUR NEQ IUG                      SET19200
  380 FORMAT (1X,A1,I2,I4,3(1X,5I4))                                    SET19300
      GO TO 385                                                         SET19400
  375 CALL RTRAN(18)                                                    SET19500
C.....USES NTRAN READ ON UNIT IUG IF IUR = IUG                          SET19600
      IC=NDATA(1)                                                       SET19700
      MI=NDATA(2)                                                       SET19800
      IH=NDATA(3)                                                       SET19900
      DO 381 K=1,5                                                      SET20000
      IP(K)=NDATA(3+K)                                                  SET20100
      ID(K)=NDATA(8+K)                                                  SET20200
  381 IT(K)=NDATA(13+K)                                                 SET20300
  385 IF (IC.NE."R") GO TO 666                                          SET20400
   20 FORMAT (1X,A1,I3,I4,1X,11I5)                                      SET20500
C     M1 = NORTHERN HEMISPHERE MONTH                                    SET20600
      IF (MI.EQ.M1) GO TO 390                                           SET20700
C       SOUTHERN HEMISPHERE MONTH                                       SET20800
      IF (MI.EQ.M2) GO TO 400                                           SET20900
C.....M2 = M1 + 6   UNLESS M1 = M2 = 13                                 SET21000
      GO TO 430                                                         SET21100
  390 KS=1                                                              SET21200
      GO TO 410                                                         SET21300
  400 KS=-1                                                             SET21400
  410  IF (IH.LT.95) IHR=(IH-20)/5                                      SET21500
C     IHR = HEIGHT INDEX                                                SET21600
      IF (IH.GE.95) IHR = 14 + (IH - 80) / 20                           SET21700
      DO 420 J=1,5                                                      SET21800
      K = 5 + KS * (J + (KS - 1) / 2)                                   SET21900
C.....K = LATITUDE INDEX 1-5 = LAT -90 TO -10, 6-10 = LAT +10 TO +90    SET22000
      PR(IHR,K) =(IP(J)/1000.)**2                                       SET22100
      DR(IHR,K) =(ID(J)/1000.)**2                                       SET22200
  420 TR(IHR,K) =(IT(J)/1000.)**2                                       SET22300
  430 CONTINUE                                                          SET22400
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      IF (MONTH.LT.13) GO TO 460
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL
      DO 435 I=1,20
      DO 435 J=1,5
      J10=11-J
      PR(I,J)=PR(I,J10)
      DR(I,J)=DR(I,J10)
      TR(I,J)=TR(I,J10)
  435 CONTINUE
      GO TO 460
  440 DO 450 I=1,20
      DO 450 J=1,10
      PR(I,J) = 0.
      DR(I,J) = 0.
  450 TR(I,J) = 0.
C.....RANDOM SIGMAS ARE ZEROED IF ICPR=2
      DO 455 I=1,25
      DO 455 J=1,10
      UR(I,J)=0.
  455 VR(I,J) = 0.
      GO TO 500
  460 DO 490 I=1,325
      IF (IUR.EQ.IUG) GO TO 462
      READ(IUR,465) IC,MI,IH,IP,ID
C.....READS RANDOM WIND STANDARD DEVIATIONS WITH FORTRAN READ FROM
C         UNIT IUR IF IUR NEQ IUG
  465 FORMAT(1X,A2,I2,I4,2(1X,5I4))
      GO TO 467
  462 CALL RTRAN(13)
C.....USES NTRAN READ FROM UNIT IUG IF IUR = IUG
      IC=NDATA(1)
      MI=NDATA(2)
      IH=NDATA(3)
      DO 461 K=1,5
      IP(K)=NDATA(3+K)
  461 ID(K)=NDATA(8+K)
  467 IF (IC.NE."RW") GO TO 666
C     NORTHERN HEMISPHERE MONTH
      IF (MI.EQ.M1) GO TO 470
C     SOUTHERN HEMISPHERE MONTH
      IF (MI.EQ.M2) GO TO 475
      GO TO 490
  470 KS=1
      GO TO 480
  475 KS=-1
  480 IF (IH.LT.95) IHR=1+IH/5
C     HEIGHT INDEX
      IF (IH.GE.95) IHR=19+(IH-80)/20
      DO 485 J=1,5
C     LATITUDE INDEX
      K=5+KS*(J+(KS-1)/2)
      UR(IHR,K)=(IP(J)**2)*1.
  485 VR(IHR,K)=(ID(J)**2)*1.
  490 CONTINUE
      IF (MONTH.LT.13) GO TO 500
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL
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      DO 495 I=1,25                                                     SET28100
      DO 495 J=1,5                                                      SET28200
      J10=11-J                                                          SET28300
      UP(I,J)=UR(I,J10)                                                 SET28400
      VP(I,J)=VR(I,J10)                                                 SET28500
  495 CONTINUE                                                          SET28600
C     MOVES PAST 3RD EOF ON UNIT IUG                                    SET28700
 500  CALL NTRAN(IUG,8,1,22)                                            SET28800
      IF(IOPR.EQ.2) GO TO 900                                           SET28900
  799 DO 840 I=1,25                                                     SET29000
      IF(IUR.EQ.IUG) GO TO 800                                          SET29100
      READ(IUR,780) IC,MI,IH,IP,ID,IT                                   SET29200
C.....USES FORTRAN READ ON UNIT IUR IF IUR NEQ IUG                      SET29300
      GO TO 820                                                         SET29400
  800 CALL RTRAN(18)                                                    SET29500
C.....USES NTRAN READ ON UNIT IUG IF IUR EQ IUG                         SET29600
      IC=NDATA(1)                                                       SET29700
       MI=NDATA(2)                                                      SET29800
      IH=NDATA(3)                                                       SET29900
      DO 810 K=1,5                                                      SET30000
      IP(K)=NDATA(3+K)                                                  SET30100
      ID(K)=NDATA(8+K)                                                  SET30200
  810 IT(K)=NDATA(13+K)                                                 SET30300
  820 IF(IH.GT.90) IH=70+(IH/4)                                         SET30400
      IH=1+(IH/5)                                                       SET30500
      IF(IC.NE."P".OR.IH.NE.I) GO TO 666                                SET30600
      DO 830 J=1,5                                                      SET30700
      PLP(I,J+5)=IP(J)/1000.                                            SET30800
      PLP(I,6-J)=IP(J)/1000.                                            SET30900
      DLP(I,J+5)=ID(J)/1000.                                            SET31000
      DLP(I,6-J)=ID(J)/1000.                                            SET31100
      TLP(I,J+5)=IT(J)/1000.                                            SET31200
  830 TLP(I,6-J)=IT(J)/1000.                                            SET31300
  840 CONTINUE                                                          SET31400
      DO 865 I=1,25                                                     SET31500
      IF(IUR.EQ.IUG) GO TO 845                                          SET31600
      READ(IUR,465) IC,MI,IH,IP,ID                                      SET31700
      GO TO 855                                                         SET31800
  845 CALL RTRAN(13)                                                    SET31900
      IC=NDATA(1)                                                       SET32000
      MI=NDATA(2)                                                       SET32100
      IH=NDATA(3)                                                       SET32200
      DO 850 K=1,5                                                      SET32300
      IP(K)=NDATA(3+K)                                                  SET32400
  850 ID(K)=NDATA(8+K)                                                  SET32500
  855 IF(IH.GT.90) IH=70+(IH/4)                                         SET32600
      IH=1+(IH/5)                                                       SET32700
      IF(I.NE.IH.OR.IC.NE."PW") GO TO 666                               SET32800
      DO 860 J=1,5                                                      SET32900
      ULP(I,J+5)=IP(J)/1000.                                            SET33000
      ULP(I,6-J)=IP(J)/1000.                                            SET33100
      VLP(I,J+5)=ID(J)/1000.                                            SET33200
  860 VLP(I,6-J)=ID(J)/1000.                                            SET33300
  865 CONTINUE                                                          SET33400
      DO 888 I=1,25                                                     SET33500
      IF(IUR.EQ.IUG) GO TO 870                                          SET33600
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      READ(IUR,868)IC,MI,IH,IP,ID                                       SET33700
  868 FORMAT(1X,A2,I2,I4,2(1X,5I5))                                     SET33800
      GO TO 880                                                         SET33900
  870 CALL RTRAN(13)                                                    SET34000
      IC=NDATA(1)                                                       SET34100
      MI=NDATA(2)                                                       SET34200
      IH=NDATA(3)                                                       SET34300
      DO 875 K=1,5                                                      SET34400
      IP(K)=NDATA(3+K)                                                  SET34500
  875 ID(K)=NDATA(8+K)                                                  SET34600
  880 IF(IH.GT.90) IH=70+(IH/4)                                         SET34700
      IH=1+(IH/5)                                                       SET34800
      IF(IH.NE.I.OR.IC.NE."CS")GO TO 666                                SET34900
      DO 885 J=1,5                                                      SET35000
      UDS(I,J+5)=(IP(J)/1000.)                                          SET35100
      UDS(I,6-J)=(IP(J)/1000.)                                          SET35200
      VDS(I,J+5)=(ID(J)/1000.)                                          SET35300
  885 VDS(I,6-J)=(ID(J)/1000.)                                          SET35400
  888 CONTINUE                                                          SET35500
      DO 898 I=1,25                                                     SET35600
      IF(IUR.EQ.IUG) GO TO 890                                          SET35700
      READ(IUR,868)IC,MI,IH,IP,ID                                       SET35800
      GO TO 894                                                         SET35900
  890 CALL RTRAN(13)                                                    SET36000
      IC=NDATA(1)                                                       SET36100
      MI=NDATA(2)                                                       SET36200
      IH=NDATA(3)                                                       SET36300
      DO 892 K=1,5                                                      SET36400
      IP(K)=NDATA(3+K)                                                  SET36500
  892 ID(K)=NDATA(3+K)                                                  SET36600
  894 IF(IH.GT.90) IH= 70+(IH/4)                                        SET36700
      IH=1+(IH/5)                                                       SET36800
      IF(IH.NE.I.OR.IC.NE."CL") GO TO 666                               SET36900
      DO 896 J=1,5                                                      SET37000
      UDL(I,J+5)=(IP(J)/1000.)                                          SET37100
      UDL(I,6-J)=(IP(J)/1000.)                                          SET37200
      VDL(I,J+5)=(ID(J)/1000.)                                          SET37300
  896 VDL(I,6-J)=(ID(J)/1000.)                                          SET37400
  898 CONTINUE                                                          SET37500
      GO TO 910                                                         SET37600
  900 DO 905 I=1,25                                                     SET37700
      DO 905 J=1,10                                                     SET37800
      PLP(I,J)=0.                                                       SET37900
      DLP(I,J)=0.                                                       SET38000
      TLP(I,J)=0.                                                       SET38100
      ULP(I,J)=0.                                                       SET38200
      VLP(I,J)=0.                                                       SET38300
      UDS(I,J)=0.                                                       SET38400
      UDL(I,J)=0.                                                       SET38500
      VDS(I,J)=0.                                                       SET38600
      VDL(I,J)=0.                                                       SET38700
  905 CONTINUE                                                          SET38800
C.....MOVES PAST NEXT EOF ON TAPE                                       SET38900
  910 CALL NTRAN(IUG,8,1,22)                                            SET39000
      IF (IOPO.EQ.2) GO TO 600                                          SET39100
C.....IOPO=1 READS OBO PARAMETERS,  IOPO=2 ZEROS THESE PARAMETERS       SET39200
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```
  513 DO 530 I=1,16                                                     SET39300
      IF (IUQ.EQ.IUG) GO TO 525                                         SET39400
      READ(IUQ,520) IC,IH,IX                                            SET39500
C.....READS WITH FORTRAN FROM UNIT IUQ IF IUQ NEQ IUG                   SET39600
  520 FORMAT (1X,A2,I3,5(I4,I5))                                        SET39700
      GO TO 527                                                         SET39800
  525 CALL RTRAN2                                                       SET39900
C.....READS WITH NTRAN FROM UNIT IUG IF IUQ = IUG                       SET40000
  527 IF (IC.NE."QP") GO TO 666                                         SET40100
      IH = (IH-5)/5                                                     SET40200
      DO 530 J=1,5                                                      SET40300
C.....CONVERT FROM INTEGER PER MIL - QBO PRESSURE AMPLITUDE              SET40400
      PAQ(IH,J) = IX(2*J-1)/1000.                                       SET40500
C.....QBO PRESSURE PHASE (DAYS PAST JAN 0, 1966)                        SET40600
  530 PDQ(IH,J) = IX(2*J)*1.                                            SET40700
      DO 531 I = 1,5                                                    SET40800
      PAQ(1,I) = 0.                                                     SET40900
 531  CALL PHASE(PDQ(2,I),15.,PDQ(3,I),20.,PDQ(1,I),10.)                SET41000
      DO 540 I=1,16                                                     SET41100
      IF (IUQ.EQ.IUG) GO TO 535                                         SET41200
      READ (IUQ,520) IC,IH,IX                                           SET41300
      GO TO 537                                                         SET41400
  535 CALL RTRAN2                                                       SET41500
  537 IF (IC.NE."QD") GO TO 666                                         SET41600
      IH=(IH-5)/5                                                       SET41700
      DO 540 J=1,5                                                      SET41800
C...CONVERT FROM INTEGER PER MIL - QBO DENSITY AMPLITUDE                 SET41900
      DAQ(IH,J) = IX(2*J-1)/1000.                                       SET42000
C.....QBO DENSITY PHASE (DAYS PAST JAN 0, 1966)                         SET42100
  540 DDQ(IH,J)=IX(2*J)*1.                                              SET42200
      DO 541 I = 1,5                                                    SET42300
      DAQ(1,I) = 0.                                                     SET42400
 541  CALL PHASE(DDQ(2,I),15.,DDQ(3,I),20.,DDQ(1,I),10.)                SET42500
      DO 550 I=1,16                                                     SET42600
      IF (IUQ.EQ.IUG) GO TO 545                                         SET42700
      READ (IUQ,520) IC,IH,IX                                           SET42800
      GO TO 547                                                         SET42900
  545 CALL RTRAN2                                                       SET43000
  547 IF (IC.NE."QT") GO TO 666                                         SET43100
      IH = (IH- 5)/5                                                    SET43200
      DO 550 J=1,5                                                      SET43300
C.....CONVERTS FROM INTEGER PER MIL - QBO TEMPERATURE AMPLITUDE          SET43400
      TAQ(IH,J) = IX(2*J-1)/1000.                                       SET43500
C.....QBO TEMPERATURE PHASE                                             SET43600
  550 TDQ(IH,J) = IX(2*J)*1.                                            SET43700
      DO 551 I = 1,5                                                    SET43800
      TAQ(1,I) = 0.                                                     SET43900
 551  CALL PHASE(TDQ(2,I),15.,TDQ(3,I),20.,TDQ(1,I),10.)                SET44000
      DO 560 I=1,16                                                     SET44100
      IF (IUQ.EQ.IUG) GO TO 555                                         SET44200
C.....READS WITH FORTRAN IF IUQ NEQ IUG                                 SET44300
      READ(IUQ,520) IC,IH,IX                                            SET44400
      GO TO 557                                                         SET44500
  555 CALL RTRAN2                                                       SET44600
C.....READS WITH NTRAN IF IUQ = IUG                                     SET44700
  557 IF (IC.NE."QU") GO TO 666                                         SET44800
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      IH=(IH- 5)/5                                                      SET44900
      DO 560 J=1,5                                                      SET45000
C.....EASTWARD WIND QBO AMPLITUDE - CONVERTED TO M/S                    SET45100
      UAQ(IH,J) = IX(2 * J - 1) / 10.                                   SET45200
C.....EASTWARD WIND QBO PHASE (DAYS PAST JAN 0, 1966)                   SET45300
  560 UDQ(IH,J)=IX(2*J)*1.                                              SET45400
      DO 561 I = 1,5                                                    SET45500
      UAQ(1,I) = 0.                                                     SET45600
 561  CALL PHASE(UDQ(2,I),15.,UDQ(3,I),20.,UDQ(1,I),10.)                SET45700
      DO 570 I=1,16                                                     SET45800
       IF (IUQ.EQ.IUG) GO TO 565                                        SET45900
      READ(IUQ,520) IC,IH,IX                                            SET46000
      GO TO 567                                                         SET46100
  565 CALL RTRAN2                                                       SET46200
  567 IF (IC.NE."QV") GO TO 666                                         SET46300
      IH=(IH- 5)/5                                                      SET46400
      DO 570 J=1,5                                                      SET46500
C.....NORTHWARD WIND QBO AMPLITUDE - CONVERTED TO M/S                   SET46600
      VAQ(IH,J) = IX(2 * J - 1) / 10.                                   SET46700
C.....NORTHWARD WIND QBO PHASE (DAYS PAST JAN 0,1966)                   SET46800
  570 VDQ(IH,J)=IX(2*J)*1.                                              SET46900
      DO 571 I = 1,5                                                    SET47000
      VAQ(1,I) = 0.                                                     SET47100
 571  CALL PHASE(VDQ(2,I),15.,VDQ(3,I),20.,VDQ(1,I),10.)                SET47200
      GO TO 620                                                         SET47300
  600 DO 610 I=1,16                                                     SET47400
      DO 610 J=1,5                                                      SET47500
      PAQ(I,J) = 0.                                                     SET47600
      DAQ(I,J) = 0.                                                     SET47700
      TAQ(I,J) = 0.                                                     SET47800
      PDQ(I,J) = 0.                                                     SET47900
      DDQ(I,J) = 0.                                                     SET48000
      TDQ(I,J) = 0.                                                     SET48100
      UAQ(I,J)=0.                                                       SET48200
      UDQ(I,J)=0.                                                       SET48300
      VAQ(I,J)=0.                                                       SET48400
      VDQ(I,J)=0.                                                       SET48500
  610 CONTINUE                                                          SET48600
C.....ZEROS QBO PARAMETERS IF IOPQ = 2                                  SET48700
C     REWINDS TAPE UNIT IUG                                             SET48800
 620  CALL NTRAN(IUG,10,22)                                             SET48900
 621  R=H1                                                              SET49000
      IF(H1.LT.25.) R=25.                                               SET49100
      CALL RTERP(R ,PHI1,PR,DR,TR,SP1,SD1,ST1)                          SET49200
      CALL INTRUV(PLP,DLP,H1,PHI1,PLP1,DLP1)                            SET49300
      CALL INTRUV(TLP,DLP,H1,PHI1,TLP1,R)                               SET49400
      SP1L=SQRT(PLP1*ABS(SP1))*100.                                     SET49500
      SP1S=SQRT((1.-PLP1)*ABS(SP1))*100.                                SET49600
      SD1L=SQRT(DLP1*ABS(SD1))*100.                                     SET49700
      SD1S=SQRT((1.-DLP1)*ABS(SD1))*100.                                SET49800
      ST1L=SQRT(TLP1*ABS(ST1))*100.                                     SET49900
      ST1S=SQRT((1.-TLP1)*ABS(ST1))*100.                                SET50000
      CALL INTRUV(UR,VR,H1,PHI1,SU1,SV1)                                SET50100
      CALL INTRUV(ULP,VLP,H1,PHI1,ULP1,VLP1)                            SET50200
      SU1L=SQRT(ULP1*ABS(SU1))                                          SET50300
      SU1S=SQRT((1.-ULP1)*ABS(SU1))                                     SET50400
```

```
      SV1L=SQRT(VLP1*ABS(SV1))                                          SET50500
      SV1S=SQRT((1.-VLP1)*ABS(SV1))                                     SET50600
      CALL  INTRUV( UDL,VDL,H1,PHI1,UDL1,VDL1)                          SET50700
      CALL  INTRUV(UDS,VDS,H1,PHI1,UDS1,VDS1)                           SET50800
      UDL1=UDL1*100.                                                    SET50900
      VDL1=VDL1*100.                                                    SET51000
      UDS1=UDS1*100.                                                    SET51100
      VDS1=VDS1*100.                                                    SET51200
626   WRITE(6,9001) RP1L,RD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L,  SET51300
     1"LARGE"                                                           SET51400
      WRITE(6,9001)RP1S,RD1S,RT1S,SP1S,SD1S,ST1S,RU1S,RV1S              SET51500
     1,SU1S,SV1S,"SMALL"                                                SET51600
      WRITE(6,9002)UDL1,VDL1,UDS1,VDS1                                  SET51700
      WRITE(6,9003)                                                     SET51800
      RP1L=RP1L/100.                                                    SET51900
      RD1L=RD1L/100.                                                    SET52000
      RT1L=RT1L/100.                                                    SET52100
      SP1L=(SP1L/100.)                                                  SET52200
      SD1L=(SD1L/100.)                                                  SET52300
      ST1L=(ST1L/100.)                                                  SET52400
      RP1S=RP1S/100.                                                    SET52500
      RD1S=RD1S/100.                                                    SET52600
      RT1S=RT1S/100.                                                    SET52700
      SP1S=SP1S/100.                                                    SET52800
      SD1S=SD1S/100.                                                    SET52900
      ST1S=ST1S/100.                                                    SET53000
      UDL1=UDL1/100.                                                    SET53100
      VDL1=VDL1/100.                                                    SET53200
      UDS1=UDS1/100.                                                    SET53300
      VDS1=VDS1/100.                                                    SET53400
      WRITE(6,630)                                                      SET53500
      RETURN                                                            SET53600
 666  WRITE(6,700) IUG,IUR,IUQ,IOPR,IOPQ,NR1,NMCOP,IOTEM1,IOTEM2,       SET53700
     $MONTH,IC,MI,IH,IX,IEX,IP,ID,IT,SD1                                SET53800
 700  FORMAT(" ERROR IN SETUP INPUT",/,1X,5I3,I10,4I3,A2,I3,I4,/,11I4,  SET53900
     $/,15I4,/,F10.1)                                                   SET54000
      STOP                                                              SET54100
 630  FORMAT(27X,"UNPERTURBED (MONTHLY MEAN)",11X,"MEAN PLUS PERTURBATIOSET54200
     1NS",9X,"THERMAL",/,23X,2(34("-"),2X),3X,"WIND",6X,"PERTURBATION VASET54300
     2LUES",/," HEIGHT   LAT    WEST   PRES.    DENS.   TEMP  GEOSTROPH.SET54400
     3   PRES.    DENS.   TEMP      TOTAL       SHEAR",/,2X,"(KM)",11X,"LOSET54500
     4N",4X,"(NT/       (KG/     (DEG  WIND (M/S)    (NT/      (KG/     (DEG  SET54600
     5WIND (M/S)   (M/S/KM) ",28("-"),/," TIME      (DEG)   (DEG)",2("   M**SET54700
     62)     M**3)    KEL-   ",10("-")),2X,8("-"),"  P     D     T     U    V SET54800
     7  W"/" (SEC)",35X,"VIN)    E-W    N-S",20X,"VIN)     E-W    N-S  E-W  NSET54900
     8-S (_)   (_)   (_)   M/S  M/S CM/S"/)                             SET55000
9000  FORMAT("  GROVES INPUT UNIT = ",I2,T43,"RANDOM INPUT UNIT = ",I2, SET55100
     1T83,"OBO INPUT UNIT = ",I2,/,"  4-D INPUT UNIT = ",I2,T43,"RANDOM SET55200
     2OPTION = ",I2,T83,"OBO OPTION = ",I2,/,"  FIRST RANDOM NUMBER = ",SET55300
     2I5,                                                               SET55400
     3/,"  NMC READ OPTION = ",I2,T43,"4-D P,D,T DATA SCRATCH UNIT = ", SET55500
     4I2,/,"  NMC GRID POINTS SCRATCH UNIT = ",I2,T43,"JULIAN DATE = ", SET55600
     5F9.1,/)                                                           SET55700
9001  FORMAT("  INITIAL P,D,T = ",3(F6.2,"      "),T60,"SIGMA P,D,T = ",SET55800
     13(F6.2,"      "),/,"  INITIAL U,V = ",2(F7.2," M/S    "),T60,"SIGMA SET55900
     2U,V = ",2(F7.2," M/S    "),  7X,A5,1X,"SCALE"/)                   SET56000
```

```
9003 FORMAT(//"  **  PERCENT DEVIATIONS FROM 1962 US STANDARD "          SET56100
    1 ,"ATMOSPHERE APPEAR BELOW PRESSURE, DENSITY AND TEMPERATURE ",    SET56200
    2 "VALUES  **"//)                                                   SET56300
9002 FORMAT("  INITIAL UDL,VDL = ",2(F6.2," _ "),                       SET56400
    1T60,"INITIAL UDS,VDS = ",2(F6.2," _ "))                            SET56500
     END                                                                SET56600
```

```
      SUBROUTINE SORT4(NP)
C
C                SORTS POINTS FOR SEQUENTIAL TAPE READING
C
C           ASSIGNS POINT NUMBERS BY ORDER ON TAPE, NOT BY GRID
C
      COMMON /ORDER/ IPT (16,5),IREAD(65,3)
C
      DO 1 I=1,65
      DO 1 J=1,3
    1 IREAD(I,J)=0
      DO 9 I=1,NP
      IF(IPT(I,5).LT.1)  GO  TO 10
      IF(IPT(I,5).EQ.1)  GO  TO 9
      IF(IPT(I,5).EQ.2)  GO  TO 2
      IF(IPT(I,5).EQ.3)  GO  TO 4
      IF(IPT(I,5).EQ.1133)GO TO 6
      IF(IPT(I,5).EQ.2211)  GO TO 7
      IF(IPT(I,5).EQ.2212)GO TO 8
      IF  (IPT(I,5).EQ.333)  GO TO 4
      GO TO 10
    2 DO 3 J=1,4
      IF(IPT(I,J).LT.1) GO TO 3
      IPT(I,J)=IPT(I,J)+288
    3 CONTINUE
      GO TO 9
    4 DO 5 J=1,4
      IF(IPT(I,J).LT.1) GO TO 5
      IPT(I,J)=IPT(I,J)+2265
    5 CONTINUE
      GO TO 9
    6 IF(IPT(I,1).GT.0)IPT(I,1)=IPT(I,1)+2265
      IF(IPT(I,2).GT.0)IPT(I,2)=IPT(I,2)+2265
      GO TO 9
    7 IF(IPT(I,3).GT.0)IPT(I,3)=IPT(I,3)+288
      IF(IPT(I,4).GT.0)IPT(I,4)=IPT(I,4)+288
      GO TO 9
    8 IF(IPT(I,1).GT.0)IPT(I,1)=IPT(I,1)+288
      IF(IPT(I,3).GT.0)IPT(I,3)=IPT(I,3)+288
      IF(IPT(I,4).GT.0)IPT(I,4)=IPT(I,4)+288
    9 CONTINUE
C
C            REORDERS POINT NUMBERS FOR READ
C
   10 IR=0
      DO 13 K=1,NP
      DO 13 L=1,4
      MP=IPT(K,L)
      IF(MP.LT.1)  GO TO 13
   11 II=K
      JJ=L
      DO 12 I=1,NP
      DO 12 J=1,4
      IF  (IPT(I,J).LT.1) GO TO 12
      IF(IPT(I,J).GT.3490)  GO TO 12
      IF(IPT(I,J).GE.MP)  GO TO 12
```

```
      II=I                                                              SOR05700
      JJ=J                                                              SOR05800
      MP=IPT(I,J)                                                       SOR05900
   12 CONTINUE                                                          SOR06000
      IF(IPT(II,JJ).GT.3490) GO TO 14                                   SOR06100
      IR=IR+1                                                           SOR06200
      IREAD(IR,1)=II                                                    SOR06300
      IREAD(IR,2)=JJ                                                    SOR06400
      IREAD(IR,3)=IPT(II,JJ)                                            SOR06500
      IPT(II,JJ)=IPT(II,JJ)+9000                                        SOR06600
      MP=IPT(K,L)                                                       SOR06700
      IF(MP.GT.3490) GO TO 13                                           SOR06800
      GO TO 11                                                          SOR06900
   13 CONTINUE                                                          SOR07000
   14 RETURN                                                            SOR07100
      END                                                               SOR07200
```

```
      SUBROUTINE STDATM(Z,T,P,D)
      DIMENSION ZS(35),TMS(35),WMS(35),PS(35)
      DATA (ZS(I),I=1,35)/0., 11.019, 20.063, 32.162, 47.35,
     * 52.429, 61.591, 79.944, 90., 95., 100., 105., 110., 115.,
     * 120., 125., 150., 155., 160., 165., 170., 180., 190., 210.,
     * 230., 265., 300., 350., 400., 450., 500.,550.,600., 650., 700./
      DATA (TMS(I),I=1,35)/288.15, 216.65,216.65, 228.65, 270.65,270.65,
     * 252.65, 180.65, 180.65, 0., 210.65, 0., 260.65, 0., 360.65,
     * 0., 960.65, 0., 1110.65, 0., 1210.65, 0., 1350.65, 0., 1550.65,
     * 0., 1830.65, 0., 2160.65, 0., 2420.65, 0., 2590.65, 0.,
     * 2700.65/
      DATA (WMS(I),I=1,35)/28.9644, 28.9644, 28.9644, 28.9644, 28.9644,
     * 28.9644, 28.9644, 28.9644, 28.9644, 28.94, 28.88, 28.75, 28.56,
     * 28.32, 28.07, 27.37, 26.92, 26.79, 26.66, 26.52, 26.45, 26.15,
     * 25.85, 25.27, 24.69, 23.67, 22.66, 21.24, 19.94, 18.82, 17.94,
     * 17.29, 16.84, 16.50, 16.17/
      DATA (PS(I),I=1,35)/1013.25, 226.32, 54.7487, 8.68014, 1.10905,
     * .590005, .182099, 1.0377E-2, 1.6438E-3, 0., 3.0075E-4, 0.,
     * 7.3544E-5, 0., 2.5217E-5, 0., 5.0617E-6, 0., 3.6943E-6, 0.,
     * 2.7926E-6, 0., 1.6852E-6, 0., 6.9604E-7, 0., 1.8838E-7, 0.,
     * 4.0304E-8, 0., 1.0957E-8, 0., 3.4502E-9, 0., 1.1918E-9/
      IF(Z.LT.0.) GO TO 81
      RO=6356.36
      GO=9.8066
      WMO=28.9644
      RS=8314.32
      ZM=Z*1000.
      ROM=6356360.
      IF(Z.GE.90.) GO TO 6
      DO 3 I=1,8
      IF(ZS(I).LE.Z.AND.Z.LT.ZS(I+1)) GO TO 5
    3 CONTINUE
    5 ZL=INT(ZS(I))*1.
      ZU=INT(ZS(I+1))*1.
      ZLM=ZL*1000.
      ZUM=ZU*1000.
      IF(I.EQ.8) ZU=88.743
      WM=WMO
      HT=(RO*Z)/(RO+Z)
      HM=HT*1000.
      G=(TMS(I+1)-TMS(I))/(ZU-ZL)
      GM=G*.001
      IF(G.LT.0..OR.G.GT.0.) GO TO 12
      P=PS(I)*EXP(-(GO*WMO*(HM-ZLM))/(RS*TMS(I)))*100.
      GO TO 13
   12 P=PS(I)*((TMS(I)/(TMS(I)+G*(HT-ZL)))**((GO*WMO)/(RS*GM)))*100.
   13 T=TMS(I)+G*(HT-ZL)
      GO TO 25
    6 DO 7 I=9,33,2
      IF(ZS(I).LE.Z.AND.Z.LT.ZS(I+2)) GO TO 8
    7 CONTINUE
   81 T=0.
      P=0.
      D=0.
      RETURN
    8 ZL=ZS(I)
```

```
      ZU=ZS(I+2)                                                        ST005700
      ZLM=ZL*1000.                                                      ST005800
      ZUM=ZU*1000.                                                      ST005900
      ZMID=ZS(I+1)                                                      ST006000
      A0=WMS(I)                                                         ST006100
      A2=-2.*(2.*WMS(I+1)-WMS(I+2)-A0)/((ZU-ZL)**2.)                    ST006200
      A1=(WMS(I+2)-A0-A2*((ZU-ZL)**2.))/(ZU-ZL)                         ST006300
      WM=A0+A1*(Z-ZL)+A2*((Z-ZL)**2.)                                   ST006400
      G=(TMS(I+2)-TMS(I))/(ZS(I+2)-ZS(I))                               ST006500
      GM=G*.001                                                         ST006600
      TK=ZLM-(TMS(I)/GM)                                                ST006700
      S=(WMO*GO*ROM*ROM)/(RS*GM)                                        ST006800
      A=((ROM+ZM)*(ZLM-TK)/((ZM-TK)*(ROM+ZLM)))                         ST006900
      B=(S/((TK+ROM)**2.))                                              ST007000
      P=PS(I)*(((ROM+ZM)*(ZLM-TK)/((ZM-TK)*(ROM+ZLM)))**(S/((TK+ROM)    ST007100
     1**2.)))*EXP((-S*(ZLM-ZM))/((TK+ROM)*(ZM+ROM)*(ZLM+ROM)))*100.     ST007200
      TM=TMS(I)+G*(Z-ZS(I))                                             ST007300
      T=(WM/WMC)*TM                                                     ST007400
   25 D=(WM*P)/(RS*T)                                                   ST007500
   26 RETURN                                                            ST007600
      END                                                               ST007700
```

```
      SUBROUTINE TINF                                                   TIN00100
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,           TIN00200
     .          NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,TIN00300
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETP,F10,F10B,GI,    TIN00400
     .   IHR,MIN,NMORE,DX,HL,VL,DZ                                      TIN00500
      COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,TE,EM                       TIN00600
C                                                                       TIN00700
C SUROUTINE TINF CALCULATES THE EXOSPHERIC TEMPERATURE ACCORDING TO JATIN00800
C     SAO NO. 313 ,1970.                                                TIN00900
C                                                                       TIN01000
C LIST                                                                  TIN01100
C     F10 = SOLAR RADIO NOISE FLUX (XE-22 WATTS/M**2)                   TIN01200
C     F10B= 81-DAY AVERAGE F10                                          TIN01300
C     GI  = GEOMAGNETIC ACTIVITY INDEX,AP                               TIN01400
C     LAT = GEOGRAPHIC LATITUDE AT PERIGEE  (IN RAD)                    TIN01500
C     SDA = SOLAR DECLINATION ANGLE         (IN RAD)                    TIN01600
C     SHA = SOLAR HOUR ANGLE                                            TIN01700
C     DY  = D/Y (DAY NUMBER/TROFICAL YEAR)? 1                           TIN01800
C     R = 0.31  (DIURNAL FACTOR)                                        TIN01900
C                                                                       TIN02000
C CONSTANTS -- C=SOLAR ACTIVITY VARIATION. BETA,ETC. = DIURNAL VARIATITIN02100
C              D=GEOMAGNETIC VARIATION. E=SIMIANNUAL VARIATION.         TIN02200
C                                                                       TIN02300
      C1 = 383.0                                                        TIN02400
      C2 =   3.32                                                       TIN02500
      C3 =   1.80                                                       TIN02600
C                                                                       TIN02700
      PI = 3.14159265                                                   TIN02800
      CON = 0.01745329252                                               TIN02900
      BETA= -37.0*CON                                                   TIN03000
      GAMMA= 43.0*CON                                                   TIN03100
      P   =  6.0*CON                                                    TIN03200
      XM  =  2.5                                                        TIN03300
      XNN =  3.0                                                        TIN03400
C                                                                       TIN03500
      D1 =  28.0                                                        TIN03600
      D2 =   0.03                                                       TIN03700
      D3 =   1.0                                                        TIN03800
      D4 = 100.0                                                        TIN03900
      D5 =  -0.08                                                       TIN04000
C                                                                       TIN04100
      E1 =   2.41                                                       TIN04200
      E2 =   0.349                                                      TIN04300
      E3 =   0.206                                                      TIN04400
      E4 = 360.*CON                                                     TIN04500
      E5 = 226.5*CON                                                    TIN04600
      E6 = 720.*CON                                                     TIN04700
      E7 = 247.6*CON                                                    TIN04800
      E8 =   0.1145                                                     TIN04900
      E9 =   0.5                                                        TIN05000
      E10= E4                                                           TIN05100
      E11= 342.3*CON                                                    TIN05200
      E12=  2.16                                                        TIN05300
C                                                                       TIN05400
C SOLAR ACTIVITY VARIATION                                              TIN05500
C                                                                       TIN05600
```

```
      TC = C1 + C2*F10B + C3*(F10 - F10P)                               TIN05700
C                                                                       TIN05800
C DIURNAL VARIATION                                                     TIN05900
C                                                                       TIN06000
      ETA    = 0.5*ABS(XLAT - SDA)                                      TIN06100
      THETA  = 0.5*ABS(XLAT + SDA)                                      TIN06200
      TAU    = SHA + BETA + P*SIN(SHA + GAMMA)                          TIN06300
      TPI=2*PI                                                          TIN06400
      IF(TAU) 210,230,230                                               TIN06500
  210 IF(TAU+PI) 220,250,250                                            TIN06600
  220 TAU=TAU+TPI                                                       TIN06700
      GO TO 210                                                         TIN06800
  230 IF(TAU-PI) 250,250,240                                            TIN06900
  240 TAU=TAU-TPI                                                       TIN07000
      GO TO 230                                                         TIN07100
  250 CONTINUE                                                          TIN07200
      A1 =(SIN(THETA))**XM                                              TIN07300
      A2 =(COS(ETA))**XM                                                TIN07400
      A3 =(COS(TAU/2.))**XNN                                            TIN07500
      B1 = 1.0 + R*A1                                                   TIN07600
      B2 =(A2-A1)/B1                                                    TIN07700
      TV = B1*( 1. + R*B2*A3)                                           TIN07800
      TL = TC*TV                                                        TIN07900
C                                                                       TIN08000
C GEOMAGNETIC VARIATION                                                 TIN08100
C                                                                       TIN08200
      TG = D3*GI + D4*(1-EXP(D5*GI))                                    TIN08300
C                                                                       TIN08400
C SEMIANNUAL VARIATION                                                  TIN08500
C                                                                       TIN08600
      G3 = 0.5*(1.0 + SIN(E10*DY +E11) )                                TIN08700
      G3 = G3**E12                                                      TIN08800
      TAU1 = DY + E8*(G3 - E9)                                          TIN08900
      G1 = E2 + E3*(SIN(E4*TAU1 + E5))                                  TIN09000
      G2 = SIN(E6*TAU1+ E7)                                             TIN09100
      TS = E1 + F10B*G1*G2                                              TIN09200
C                                                                       TIN09300
C EXOSPHERIC TEMPERATURE                                                TIN09400
C                                                                       TIN09500
      TE = TL + TG + TS                                                 TIN09600
      RETURN                                                            TIN09700
      END                                                               TIN09800
```

```
      SUBROUTINE TME                                                    TME00100
      COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,T,EM                        TME00200
      COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,           TME00300
     .           NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,TME00400
     $ MN, IDA, IYR, H1, PHI1R,THET1R,G,FI,H,PHIR,THETR,F10,F10B,AP,    TME00500
     .   IHR,MIN,NMORE,DX,HL,VL,DZ                                      TME00600
C                                                                       TME00700
C LIST                                                                  TME00800
C INPUT                                                                 TME00900
C     MN=MONTH.  IDA=DAY. IYR=HEAR. HR = HOUR.  MIN = MINUTE            TME01000
C     XLAT = LATITUDE (INPUT-GEOCENTRIC LATITUDE.)                      TME01100
C     XLONG= LONGITUDE(INPUT-GEOCENTRIC LONGITUDE. OUTPUT  -180 TO + 180)TME01200
C OUTPUT                                                                TME01300
C     SDA  = SOLAR DECLINATION ANGLE (IN RAD)                           TME01400
C     SHA  = SOLAR HOUR ANGLE (IN RAD)                                  TME01500
C     DD   = DAY NUMBER FROM 1JAN.                                      TME01600
C     DY   = DD/TROPICAL YEAR                                           TME01700
C                                                                       TME01800
C                                                                       TME01900
C SET CONSTANTS                                                         TME02000
C                                                                       TME02100
      YEAR = 365.2422                                                   TME02200
      YR=IYR                                                            TME02300
    6 DY = DD/YEAR                                                      TME02400
   30 FMJD = XMJD - 2435839.                                            TME02500
C                                                                       TME02600
C  COMPUTE GREENWICH MEAN TIME IN MINUTES GMT                           TME02700
C                                                                       TME02800
      XHR =IHR                                                          TME02900
      XMIN = MIN                                                        TME03000
      GMT = 60*XHR + XMIN                                               TME03100
C                                                                       TME03200
C  COMPUTE GREENWICH MEAN POSITION - GP (IN DEG)                        TME03300
C                                                                       TME03400
      XJ = (XMJD - 2415020.0)/(36525.0)                                 TME03500
      A1=99.6909833                                                     TME03600
      A2 = 36000.76854                                                  TME03700
      A3 = 0.00038708                                                   TME03800
      A4 = 0.25068447                                                   TME03900
      GP = A1 + A2*XJ + A3*XJ*XJ + A4*GMT                               TME04000
      N = GP/360.                                                       TME04100
      XN = N                                                            TME04200
      GP = GP - XN*360.                                                 TME04300
C                                                                       TME04400
C  COMPUTE RIGHT ASCENSION POINT - RAP (IN DEG)                         TME04500
C                                                                       TME04600
C     1ST CONVERT GEOCENTRIC LONGITUDE TO DEG LONGITUDE - WEST NEG $ EASTME04700
C                                                                       TME04800
      IFACT = XLONG/180.                                                TME04900
      XFACT = IFACT                                                     TME05000
      XLONG = 360. * XFACT - XLONG                                      TME05100
C                                                                       TME05200
      RAP = GP + XLONG                                                  TME05300
      N = RAP/360.                                                      TME05400
      XN = N                                                            TME05500
      RAP = RAP - XN*360.                                               TME05600
```

```
C
C  COMPUTE CELESTIAL LONGITUDE - XLS (IN RAD) - -PI/2 TO +PI/2
C
      B1 = 0.017203
      B2 = 0.0335
      B3 = 1.410
      Y1 = B1*FMJD
      XLS = Y1 + B2*SIN(Y1) - B3
      TPI = 6.28319
      N = XLS/TPI
      XN = N
      XLS = XLS - XN*TPI
C
C  COMPUTE SOLAR DECLINATION ANGLE - SDA (IN RAD)
C
      B4 = (TPI/360.)*23.45
      SDA = ASIN(SIN(XLS)*SIN(B4))
C
C  COMPUTE RIGHT ASCENSION OF SUN - RAS (IN RAD) - -PI/2 TO +PI/2
C
      RAS = ASIN(TAN(SDA)/TAN(B4))
C
C  PUT RAS IN SAME QUADRANT AS XLS
C
      PI = 3.14159265
      PI2 = PI/2.
      PI32= 3.*PI2
      RAS = ABS(RAS)
      TEMP = ABS(XLS)
      IF(TEMP - PI2) 130,130,100
  100 IF(TEMP - PI) 105,105,110
  105 RAS = PI - RAS
      GO TO 130
  110 IF(TEMP - PI32) 115,115,120
  115 RAS = PI + RAS
      GO TO 130
  120 RAS = TPI - RAS
  130 IF (RAS) 135,140,140
  135 RAS = -RAS
  140 CONTINUE
C
C  COMPUTE SOLAR HOUR ANGLE - SHA (IN DEG) - -
C
      SHA = RAP*(PI/180.) - RAS
      IF(SHA) 210,230,230
  210 IF(SHA+PI) 220,250,250
  220 SHA=SHA+TPI
      GO TO 210
  230 IF(SHA-PI) 250,250,240
  240 SHA=SHA-TPI
      GO TO 230
  250 CONTINUE
C
      RETURN
      END
```

```
      SUBROUTINE WIND
      COMMON /WINCOM/RHO,FCORY,DX5,DY5,PX,PY,PXX,PXY,PYY,U,V,  T,TX,TY,
     $   DU,DV,P
      COMMON /ICTEMP/DUM1(7),PHI,DUM2(17),G,R,H,DUM3(17),FLAT
      COMMON/CHIC/DUM(18),IWSYM
      IF (RHO.GT.0..AND.ABS(PHI).GT.0.) GO TO 20
      U = 0.
      V = 0.
      RETURN
20    FCORX = FCORY*DX5/DY5
      U = - PY/(FCORY*RHO)
      V =   PX/(FCORX*RHO)
      DU = -(G*TY)/(FCORY*T)
      DV =  (G*TX)/(FCORX*T)
      IF (ABS(PHI).GE.FLAT.OR.H.GE.90.) RETURN
      UG = U
      VG = V
      DUG = DU
      DVG = DV
      AL = 1./RHO
      F = FCORY/DY5
      TX = TX/DX5
      TY = TY/DY5
      PX = PX/DX5
      PY = PY/DY5
      PXX = PXX/DX5**2
      PYY = PYY/DY5**2
      PXY = PXY/(DX5*DY5)
      ALX = AL*((TX/T) - (PX/P))
      ALY = AL*((TY/T) - (PY/P))
      F2 = F*F
      GZX = AL*PX
      GZY = AL*PY
      GZXX = AL*PXX + 2.*PX*ALX
      GZYY = AL*PYY + 2.*PY*ALY
      GZXY = AL*PXY + (PX*ALY + PY*ALX)
      A = - GZXY/F
      C = (GZXX - GZYY)/F
      B = F2 + C*C + 4.*A*A + 2.*(GZXX + GZYY)
      IF (B.GT.0.) GO TO 30
      B = 0.
      IWSYM = "*"
30    D = 1.
      IF (PHI.LT.0.) D = -1.
      B = -F + D*SQRT(B)
      C = ((C + B)/2.) + F
      B = C - B - 2.*F
      D = -A*A - B*C
      U = (A*GZX + B*GZY)/D
      V = (-A*GZY + C*GZX)/D
      D = G/(T*D)
      DU = D*(A*TX + B*TY)
      DV = D*(-A*TY + C*TX)
      WCHK = H*H
      IF (H.LT.30.) WCHK = 900.
      SP = U*U + V*V
```

```
      SPG = UG*UG + VG*VG                                               WIN05700
      IF (SP.GT.SPG) GO TO 60                                           WIN05800
      RETURN                                                            WIN05900
   60 U = UG                                                            WIN06000
      V = VG                                                            WIN06100
      DU = DUG                                                          WIN06200
      DV = DVG                                                          WIN06300
      IF (SP.GT.WCHK) IWSYM = "*"                                       WIN06400
      RETURN                                                            WIN06500
      END                                                               WIN06600
```

# APPENDIX E

## SUMMARY OF PROGRAM CHARACTERISTICS
## (Program Operating Environment)

1. Hardware

   a. Computer - Univac 1108 (implemented at Georgia Tech on the CDC Cyber 74 System)

   b. Core Requirements - Approximately 45K on the Georgia Tech CDC. The CDC System routines require more core than the Univac routine so there is no comparison between the system. It will be necessary to segment the program. See Section 5.1.

   c. Magnetic Tapes - All tapes are 7 tracks. Tapes required are:

      1 program tape (if the program is stored in UNIVAC COPOUT tape format), 1 "SCIDAT" data tape (see Section 4.2), from 1 to 4 4-D data tapes, depending on the number of months to be used under control of one run card (see Section 4.1 and Appendix B.

   d. Card Punch - not required unless optional card output is desired.

   e. Plotter - none required

   f. Drum or Disk - 2 temporary drum or disk files are required. No permanent drum or disk files are created by a program run unless optional non-print output is generated as a permanent disk or drum file.

   g. Other Hardware - none

2. Software

   a. Operating System - UNIVAC EXEC 8 (Georgia Tech version is CDC NOS 1.1)

   b. Language - FORTRAN IV (UNIVAC FORTRAN V)

   c. Type of Run - Batch

   d. Library Subroutines - NTRAN and FLD are UNIVAC subroutines. NTRAN reads 36 bit binary integer word records. FLD manipulates word bits and is used to break up 4-D data tape 36 bit words into two 18 bit integer words.

   e. Program Overlays - (Optional) - see Section 5.1

3. Program Specifications

   a. Common - See Sections 5.2 - 5.4

3. <u>Program Specifications (cont'd.)</u>

b. Program Segments - See Sections 5.2 - 5.4

c. Program Subroutines - See Section 5.1

d. Listing - See Appendix D.

e. Flow Charts - See Figures 5.1, 5.2, 5.3

f. Sample Input - See Appendix C.

g. Sample Output - See Appendix C.

h. Diagnostic Messages - See Section 4.5