

NASA Contractor Report 3256

The NASA/MSFC Global Reference
Atmospheric Model - MOD 3
(With Spherical Harmonic Wind Model)

C. G. Justus, G. R. Fletcher,
E. E. Gramling, and W. B. Pace

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C. G. Justus, G. R. Fletcher,
F. E. Gramling, and W. B. Pace
Georgia Institute of Technology
Atlanta, Georgia

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FOREWORD

The effort required to develop the Global Reference Atmospheric Model was sponsored by the Atmospheric Sciences Division, Space Sciences Laboratory, NASA Marshall Space Flight Center. This report represents the latest developmental work on the model and was accomplished under the technical monitorship of Mr. Orvel E. Smith, the NASA Contracting Officer's Representative. Qualified requestors may obtain copies of the computer program for this NASA/MSFC Global Reference Atmospheric Model upon request to the Chief, Atmospheric Sciences Division, Space Sciences Laboratory, NASA, Marshall Space Flight Center, Alabama 35812.

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1. INTRODUCTION

In response to needs for empirical model atmospheres of wider scope and application, Georgia Tech 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). This report describes additions to this model whereby winds can be computed from a spherical harmonic model, based on observed wind data, rather than using the geostrophic relations originally employed. This section describes the basic GRAM model and Section 3 provides a more detailed description of the GRAM program. Section 3 presents some sample results with the new spherical harmonic wind model. Section 4 and 5 are user's manual and programmer's manual section for the GRAM program.

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 an empirical 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 latitude-longitude dependent empirical model, which is a modification of the latitude dependent empirical model developed by Groves (1971), 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 earlier Mod 2 version of GRAM, 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

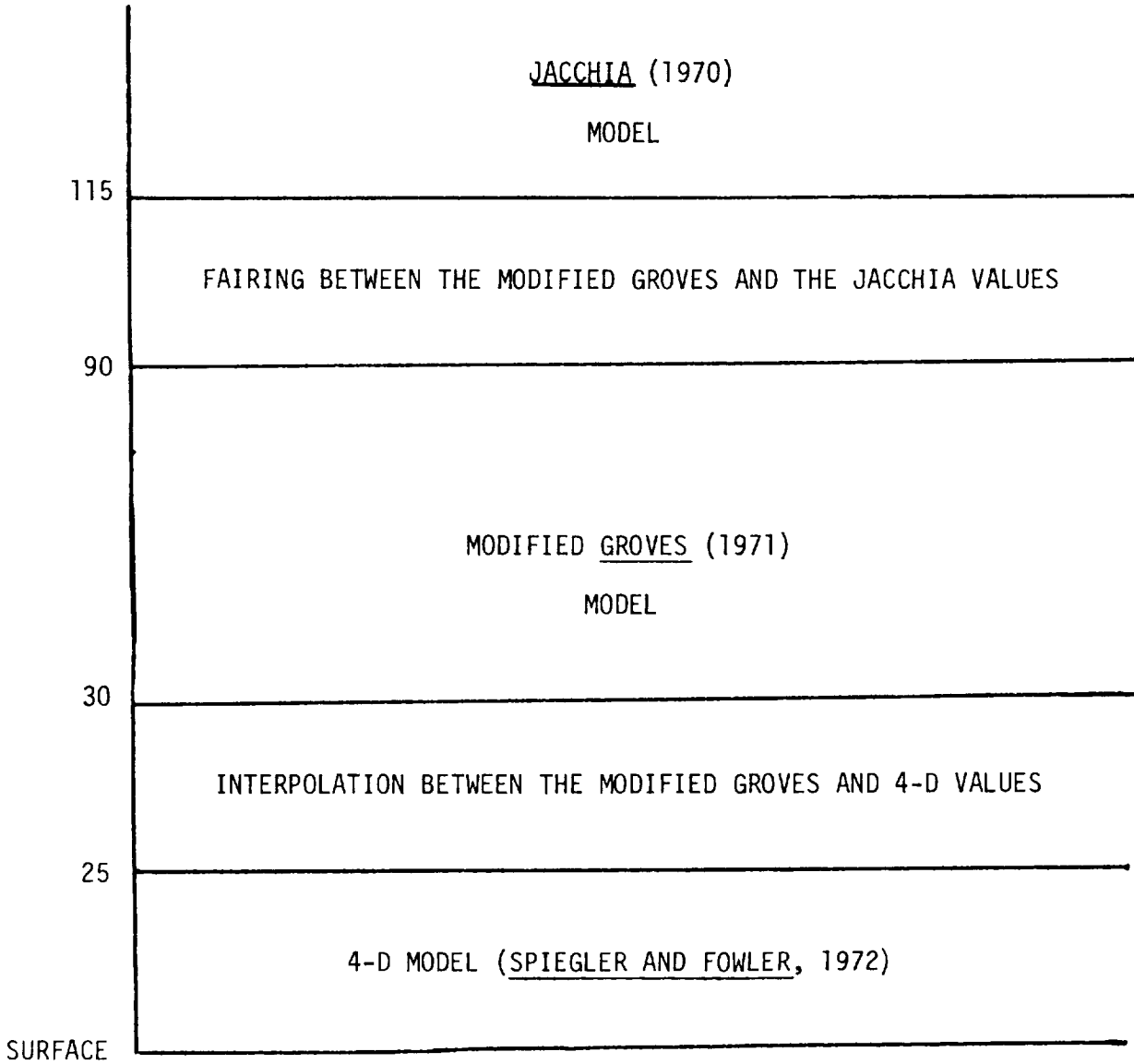


Figure 1.1 Schematic summary of the atmospheric regions in the Global Reference Atmospheric Model (GRAM) program and the simulation methods used for mean monthly values in each region

lag. That is, the southern hemisphere July is the same as the northern hemisphere January. In the 4-D region (≤ 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.

Below 25 km and above 90 km, the monthly mean geostrophic winds are computed from horizontal pressure gradients, estimated by finite differences. Near the equator, a newly devised interpolation scheme is used instead of the geostrophic relation (which approaches infinite values as the latitude approaches zero). In the height range 25 to 90 km, the newly developed spherical harmonic wind model is used, at all latitudes. Mean vertical winds, of the order of 1 cm/sec, are 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 in the regions below 25 km and above 90 km. In the 25-90 km height range, mean wind shear is computed from finite differences of the spherical harmonic winds at adjacent height levels.

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 earlier 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, 1972). 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 earlier Mod 2 version reported here, the use of a two scale perturbation model was 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 treated stochastically, however--no deterministic model of these physical processes is used.

The following sections give a technical description of the Global Reference Atmospheric Model - Mod 3 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 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 GRAM 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 $15^\circ \times 15^\circ$ 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-3 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

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

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

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

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

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 earlier Mod 2 version, additional 10 mb data for 1964 and 1964 (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.

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

$$s_y = (y - \langle y \rangle) / \langle y \rangle \quad (2.4)$$

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

$$G'_y = G_y(1 + s_y) \quad (2.5)$$

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 $5^\circ \times 5^\circ$ 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 $5^\circ \times 5^\circ$ 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 $5^\circ \times 5^\circ$ 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 ϕ_1 and ϕ_2 (which are at $\Delta\phi = 10^\circ$ apart). Two dimensional latitude-longitude interpolation between a square or rectangular array of positions at latitudes ϕ_1 and ϕ_2 and west longitudes λ_1 and λ_2 , is done by the relation

$$F(\phi, \lambda) = F_0 + (F_1 - F_0)\delta\phi + (F_2 - F_0)\delta\phi + (F_3 - F_1 - F_2 + F_0)\delta\phi \delta\lambda$$

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.

Interpolation of the random perturbation magnitudes is done linearly on the variance (σ^2) rather than linearly on the magnitude (σ). 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

$$u = -(1/\rho f) \partial p / \partial y \quad (2.6)$$

$$v = (1/\rho f) \partial p / \partial x \quad (2.7)$$

where ρ 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 computed in the 4-D height range, by finite differencing of the 4-D pressure data, and 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. In a recent comparison between the GRAM-computed winds and observed winds at Eglin AFB, Florida, the mean deviation was 1 m/s EW and -16 m/s NS, with an rms deviation of 60 m/s between model and observed. Thus, the mean winds are modeled with fair accuracy, and the rms deviation is about the same as the wind perturbation magnitude expected on the basis of the GRAM perturbation model.

2.6 Thermal Wind Shear

The wind shear components $\partial u / \partial z$ and $\partial v / \partial z$ in the 0-25 km and above 90 km height ranges are evaluated by the thermal wind equations

$$\partial u / \partial z = -(g/fT) \partial T / \partial y \quad (2.8)$$

$$\partial v / \partial z = (g/fT) \partial T / \partial x \quad (2.9)$$

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.

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 interpolation between about $+15^\circ$ and -15° latitude is used in the MOD-3 version of GRAM. This interpolation limit, being on the "minimum geostrophic latitude," is specified in the program input.

2.7 The Spherical Harmonic Wind Model

The spherical harmonic equation, including terms through second order in co-latitude (ϕ) and longitude (θ), are:

$$\begin{aligned}
 u(m, z, \theta, \phi) = & a_1 P_0(\mu) + a_2 P_1(\mu) \\
 & + [a_3 \cos\theta + a_4 \sin\theta] P_{11}(\mu) + a_5 P_2(\mu) \\
 & + [a_6 \cos\theta + a_7 \sin\theta] P_{21}(\mu) \\
 & + [a_8 \cos 2\theta + a_9 \sin 2\theta] P_{22}(\mu)
 \end{aligned}
 \tag{2.10}$$

where $\mu = \cos\phi$, m is month, z is height, u is either the wind component being modeled, and the a coefficients all depend on both m and z . The $P_{ij}(\mu)$ are Legendre functions given by

$$\begin{aligned}
P_0(\mu) &= 1 \\
P_1(\mu) &= \mu \\
P_2(\mu) &= (3\mu^2 - 1)/2 \\
P_{11}(\mu) &= (1 - \mu^2)^{1/2} \\
P_{21}(\mu) &= 3\mu(1 - \mu^2)^{1/2} \\
P_{22}(\mu) &= 3(1 - \mu^2)
\end{aligned}
\tag{2.11}$$

With the substitution of (2.11) into (2.10), the spherical harmonic model representation for a wind component becomes

$$\begin{aligned}
u(m, z, \theta, \phi) &= a_1 + a_2 \cos\phi + a_3 \cos\theta \sin\phi \\
&+ a_4 \sin\theta \sin\phi + a_5(3 \cos^2\phi - 1)/2 \\
&+ a_6 \cos\theta (3 \sin\phi \cos\phi) + a_3 \sin\theta (3 \sin\phi \cos\phi) \\
&+ a_8 (2 \cos^2\theta - 1) (3 \sin^2 \phi) + a_9 (2 \sin\theta \cos\theta) (3 \sin^2\phi)
\end{aligned}
\tag{2.12}$$

If (2.12) is the representation of the eastward wind component, then a completely analogous equation, with different coefficient values, is used to represent the northward wind component. Appendix A describes the data and processes used to evaluate the spherical harmonic coefficients which are used in the GRAM MOD-3. Values of the spherical harmonic coefficients used in the program are given in the "SCIDAT" data tape listing, in Appendix B.

Spherical harmonic winds are computed at all latitudes, within the height range 25-90 km. Geostrophic winds are used at latitudes above a selected "minimum geostrophic latitude," over the height ranges 0-20 and above 90. Smooth fairing between spherical harmonic winds and geostrophic winds is carried out between 20 and 25 km and between 90 and 95 km.

2.8 Mean Vertical Winds

GRAM also evaluates mean vertical winds from the slope of isentropic surfaces. On such surfaces, the entropy function ψ is constant, where ψ is

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

Therefore, on isentropic surfaces

$$\partial\psi/\partial t + u\partial\psi/\partial x + v\partial\psi/\partial y + w\partial\psi/\partial z = 0 \quad (2.14)$$

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

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

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

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

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 Two-Scale Random Perturbation Model

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 ρ_2' at the new location was computed from ρ_1' the density perturbation at the previous location by the relation

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

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

$$\langle \rho_2' \rho_1' \rangle = R \sigma_{\rho_1} \sigma_{\rho_2} \quad (2.18)$$

$$\langle \rho_2'^2 \rangle = \sigma_{\rho_2}^2 \quad (2.19)$$

where σ_{ρ_1} and σ_{ρ_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

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

In addition to the autocorrelation R (assumed the same for T' and ρ' 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

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

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

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

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

$$\bar{p} = \bar{\rho} R \bar{T} \quad (2.23)$$

and the mean plus large scale perturbations by

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

and the actual atmospheric parameters p , ρ , and T by

$$p = \rho R T \quad (2.25)$$

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

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

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

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

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

$$R_{\rho_S T_S} = \frac{(\sigma_{p_S/\bar{p}})^2 - (\sigma_{\rho_S/\bar{\rho}})^2 - (\sigma_{T_S/\bar{T}})^2}{2(\sigma_{\rho_S/\bar{\rho}})(\sigma_{T_S/\bar{T}})} \quad (2.29)$$

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 ρ_{L2} and ρ_{S2} at the new position are thus computed from the known perturbations ρ_{L1} and ρ_{S1} at the previous position by relations analogous to equation (2.17)

$$(\rho_{L2}/\bar{\rho}) = A_L(\rho_{L1}/\bar{\rho}_1) + B_L r_{L1} \quad (2.30)$$

$$(\rho_{S2}/\bar{\rho}) = A_S(\rho_{S1}/\bar{\rho}_1) + B_S r_{S1} \quad (2.31)$$

where A_L , B_L , A_S and B_S can each be determined (as before) from the conditions

$$\langle \rho_{L2} \rho_{L1} \rangle = R_L(\rho) \sigma_{\rho L2} \sigma_{\rho L1} \quad (2.32)$$

$$\langle \rho_{L2}^2 \rangle = \sigma_{\rho L2}^2 \quad (2.33)$$

$$\langle \rho_{S2} \rho_{S1} \rangle = R_S(\rho) \sigma_{\rho S2} \sigma_{\rho S1} \quad (2.34)$$

$$\langle \rho_{S2}^2 \rangle = \sigma_{\rho S2}^2 \quad (2.35)$$

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

$$(T_{L2}/\bar{T}_2) = C_L(T_{L1}/\bar{T}_1) + D_L(\rho_{L2}/\bar{\rho}_2) + E_L r_{L2} \quad (2.36)$$

$$(T_{S2}/\bar{T}_2) = C_S(T_{S1}/\bar{T}_1) + D_S(\rho_{S2}/\bar{\rho}_2) + E_S r_{S2} \quad (2.37)$$

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

$$u_{L2} = F_L u_{L1} + G_L \rho_{L2} + H_L r_{u_L} \quad (2.38)$$

$$u_{S2} = F_S u_{S1} + G_S \rho_{S2} + H_S r_{u_S} \quad (2.39)$$

and

$$v_{L2} = I_L v_{L1} + J_L u_{L2} + K_L r_{vL} \quad (2.40)$$

$$v_{S2} = I_S v_{S1} + J_S u_{S2} + K_S r_{vS} \quad (2.41)$$

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 multiplied 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

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

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

$$C = \frac{[R(T) \sigma_{T_2} / \sigma_{T_1}] \{ [1 - R_{T_2 \rho_2} R_{T_1 \rho_1}] / [1 - R^2(T) R_{T_1 \rho_1}^2] \}}{\quad} \quad (2.44)$$

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

$$E = \left[\sigma_{T_2}^2 - C^2 \sigma_{T_1}^2 - D^2 \sigma_{\rho_2}^2 - 2 C D R(T) R_{T_1 \rho_1} \sigma_{T_1} \sigma_{\rho_2} \right]^{1/2} \quad (2.46)$$

$$F = \left(\sigma_{u_2} / \sigma_{u_1} \right) \left\{ [R(u) - R(\rho) R_{u_2 \rho_2} R_{u_1 \rho_1}] / [1 - R^2(\rho) R_{u_1 \rho_1}^2] \right\} \quad (2.47)$$

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

$$H = [\sigma_{u_2}^2 - F^2 \sigma_{u_1}^2 - G^2 \sigma_{\rho_2}^2 - 2 F G R(\rho) R_{u_1 \rho_1} \sigma_{\rho_2} \sigma_{u_1}]^{1/2} \quad (2.49)$$

$$I = (\sigma_{v_2} / \sigma_{v_1}) \{ [R(v) - R(\rho) R_{v_2 \rho_2}^2 R_{v_1 \rho_1}] / [1 - R^2(\rho) R_{v_1 \rho_1}] \} \quad (2.50)$$

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

$$K = [\sigma_{v_2}^2 - I^2 \sigma_{v_1}^2 - J^2 \sigma_{\rho_2}^2 - 2 I J R(\rho) R_{v_1 \rho_1} \sigma_{\rho_2} \sigma_{v_1}]^{1/2} \quad (2.52)$$

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_ρ} , L_{H_ρ} , L_{Z_T} , L_{H_T} , L_{Z_u} and L_{H_u} by the relations

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

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

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

3. SAMPLE RESULTS

The ability of the GRAM program to model pressure, density, and temperature fields has been well documented in earlier reports (Justus, et al., 1974 a, b, 1975, 1976). The results shown here are confined to the new spherical harmonic wind model simulations of wind components in the 25 to 90 km height range. Figures 3.1 through 3.12 show observed and spherical harmonic model winds at three low-latitude sites (Kwajalein, Ft. Sherman and Ascension) at mid-latitude and high-latitude northern hemisphere sites (Kennedy SFC, and Ft. Churchill, respectively) and at a southern hemisphere site (Woomena), for the months of June and December. In all cases, the spherical harmonic model winds are seen to reproduce fairly well the features at the observed winds.

Data sources and methods used to evaluate the spherical harmonics appear in Appendix A. The spherical harmonic coefficient values are given in the SCIDAT tape listing in Appendix B.

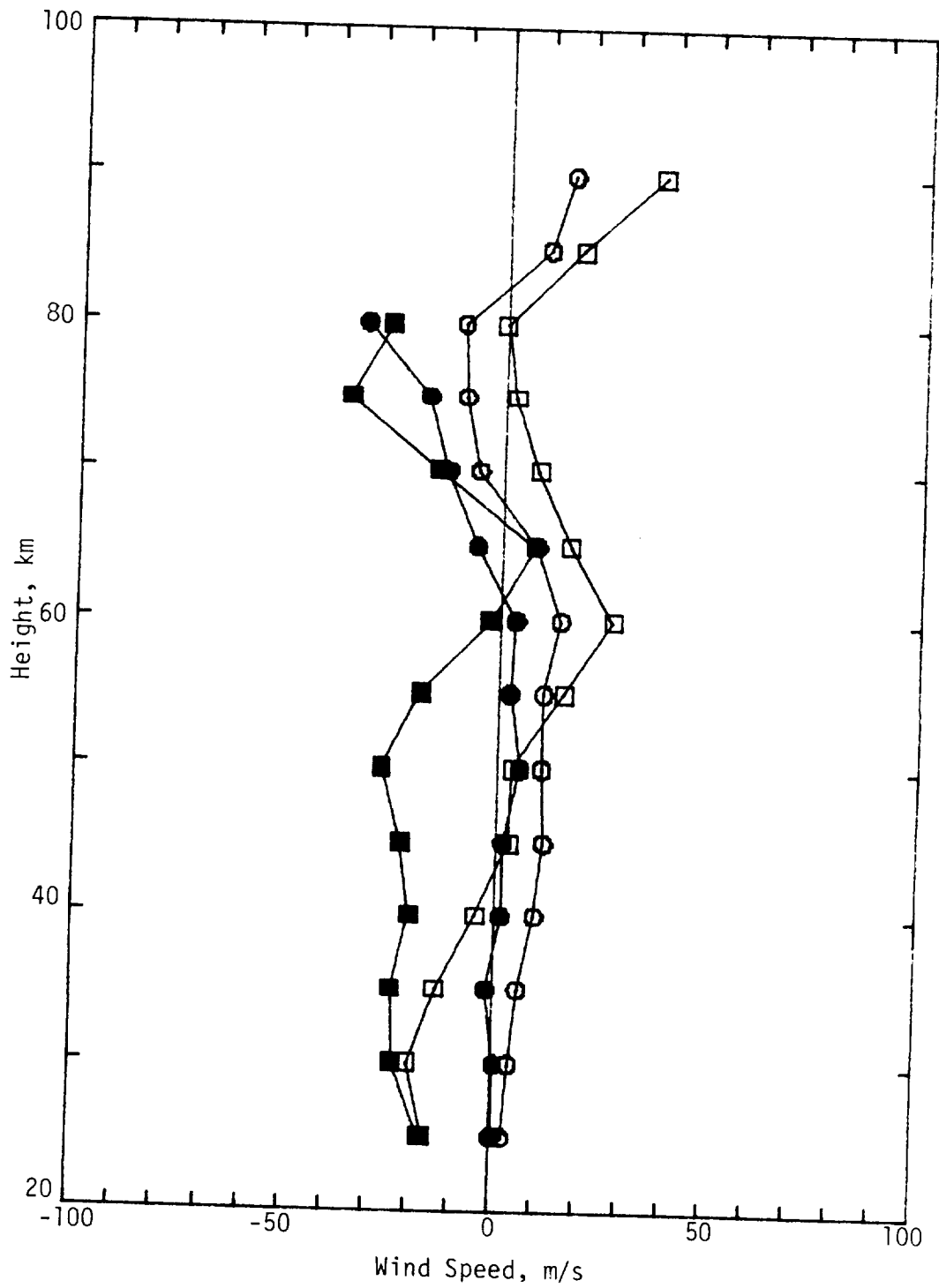


Figure 3.1. Observed (■ E-W, ● N-S) and Spherical Harmonic Model (□ E-W, ○ N-S) Winds for June at Kwajalein.

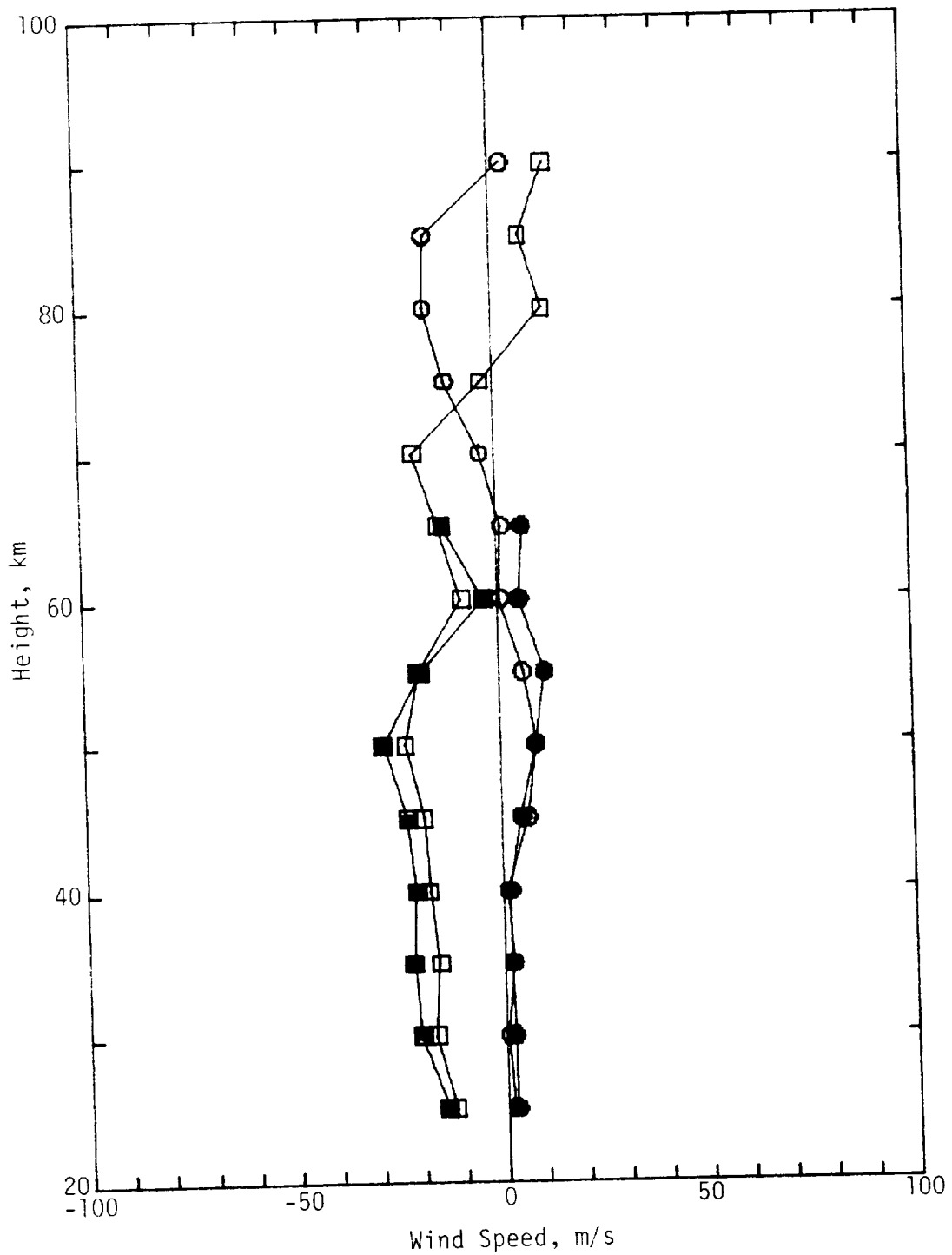


Figure 3.2. As in Figure 3.1 for Fort Sherman

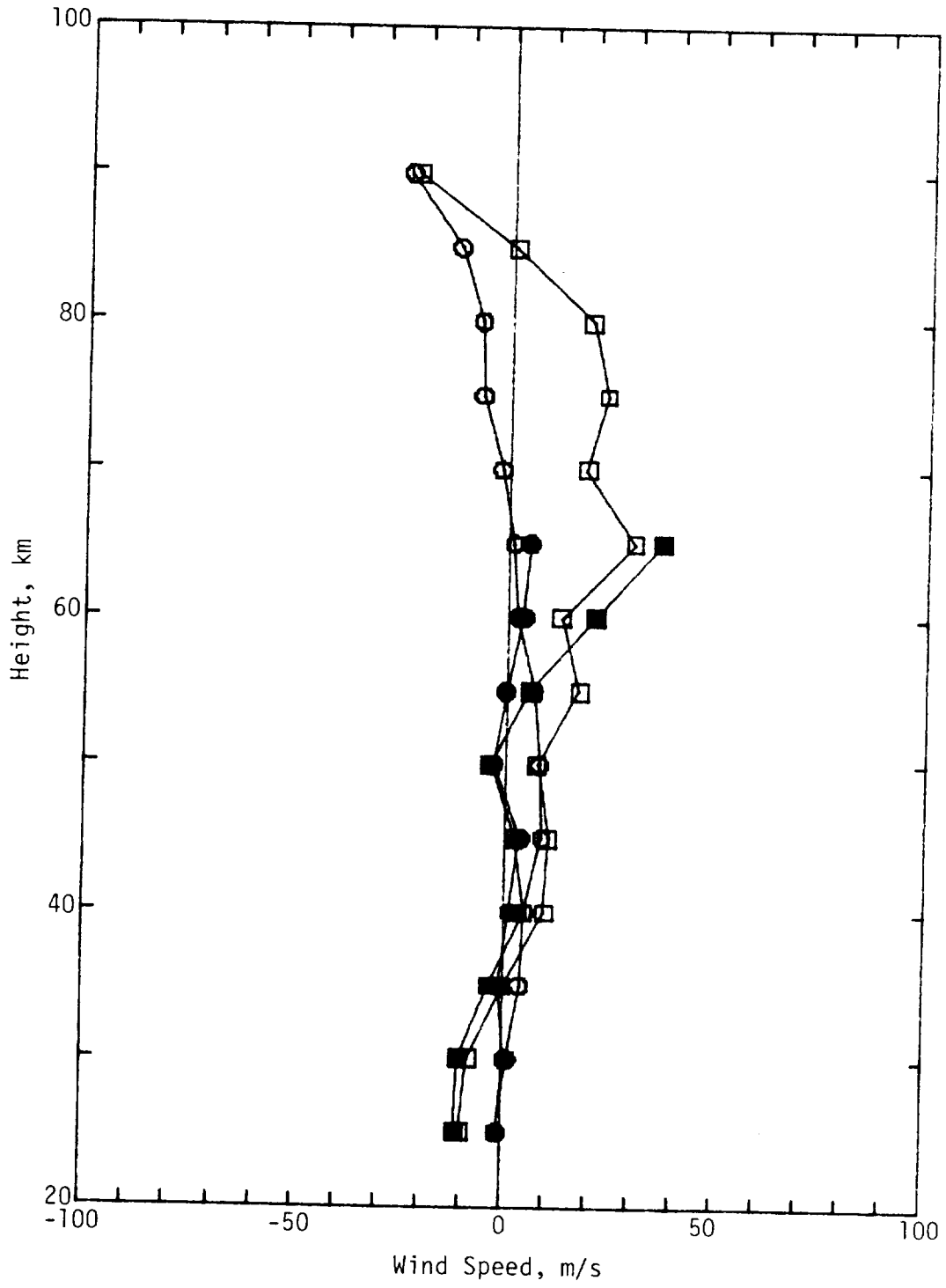


Figure 3.3. As in Figure 3.1 for Ascension.

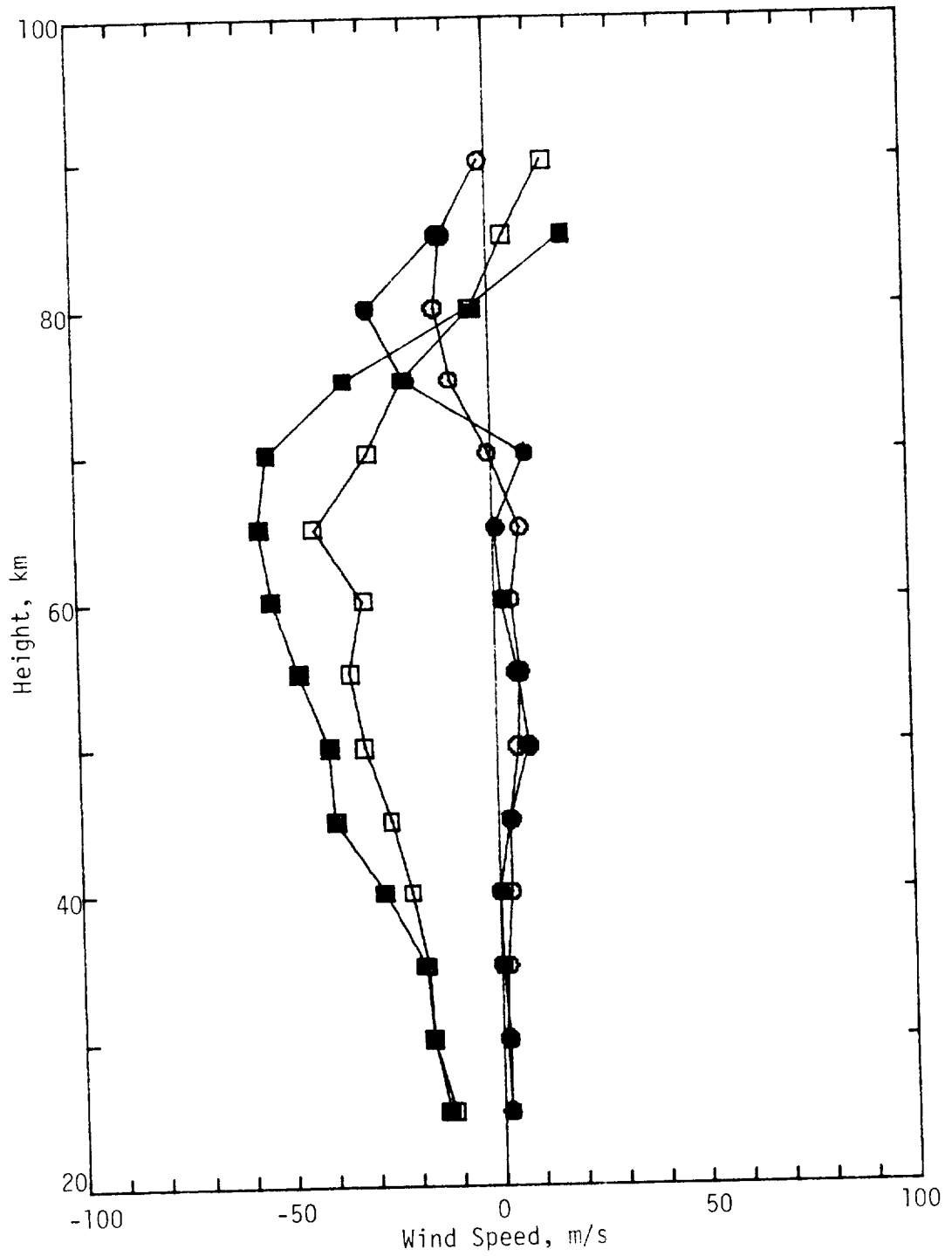


Figure 3.4. As in Figure 3.1 for Kennedy SFC.

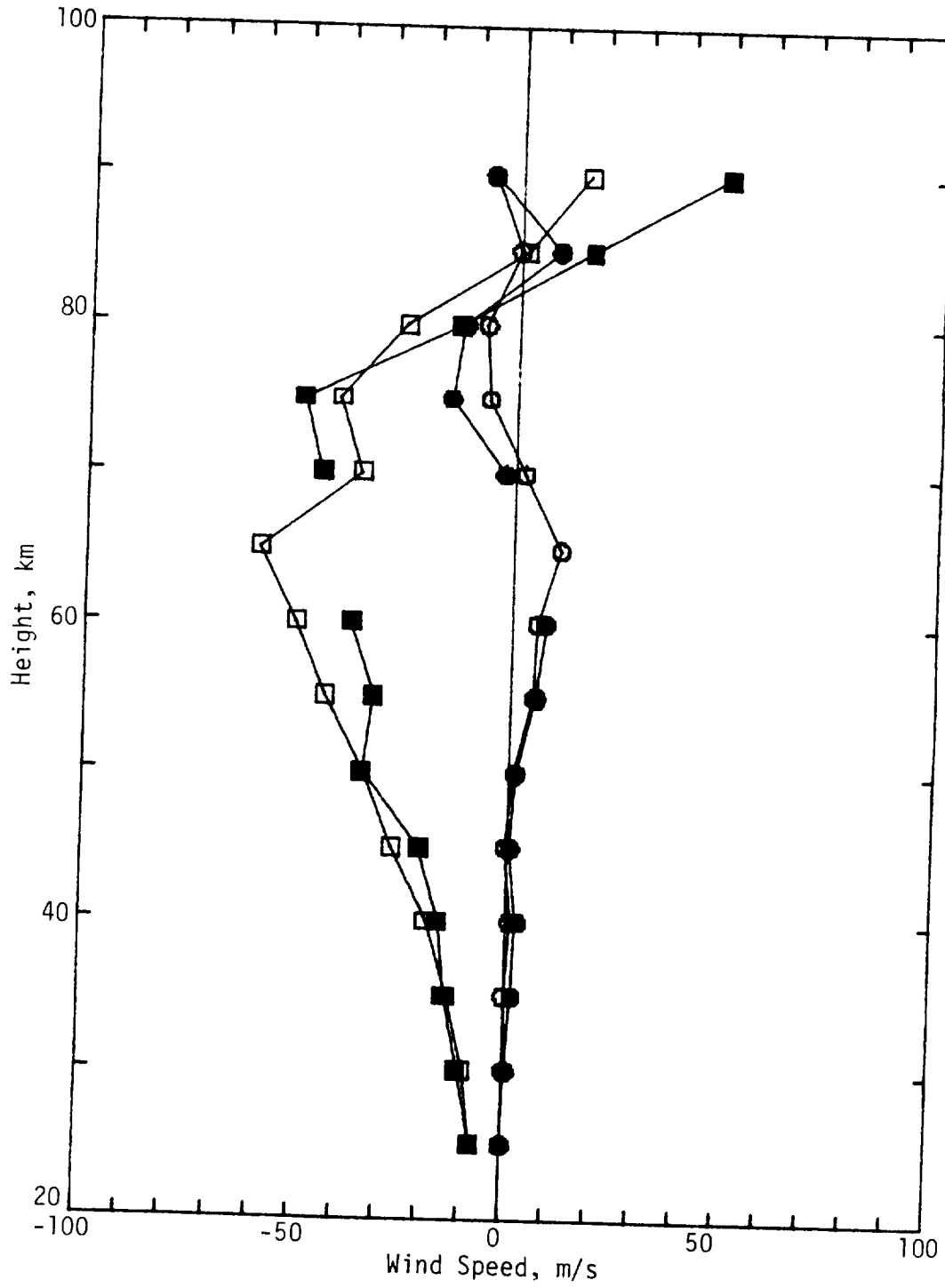


Figure 3.5. As in Figure 3.1 for Fort Churchill.

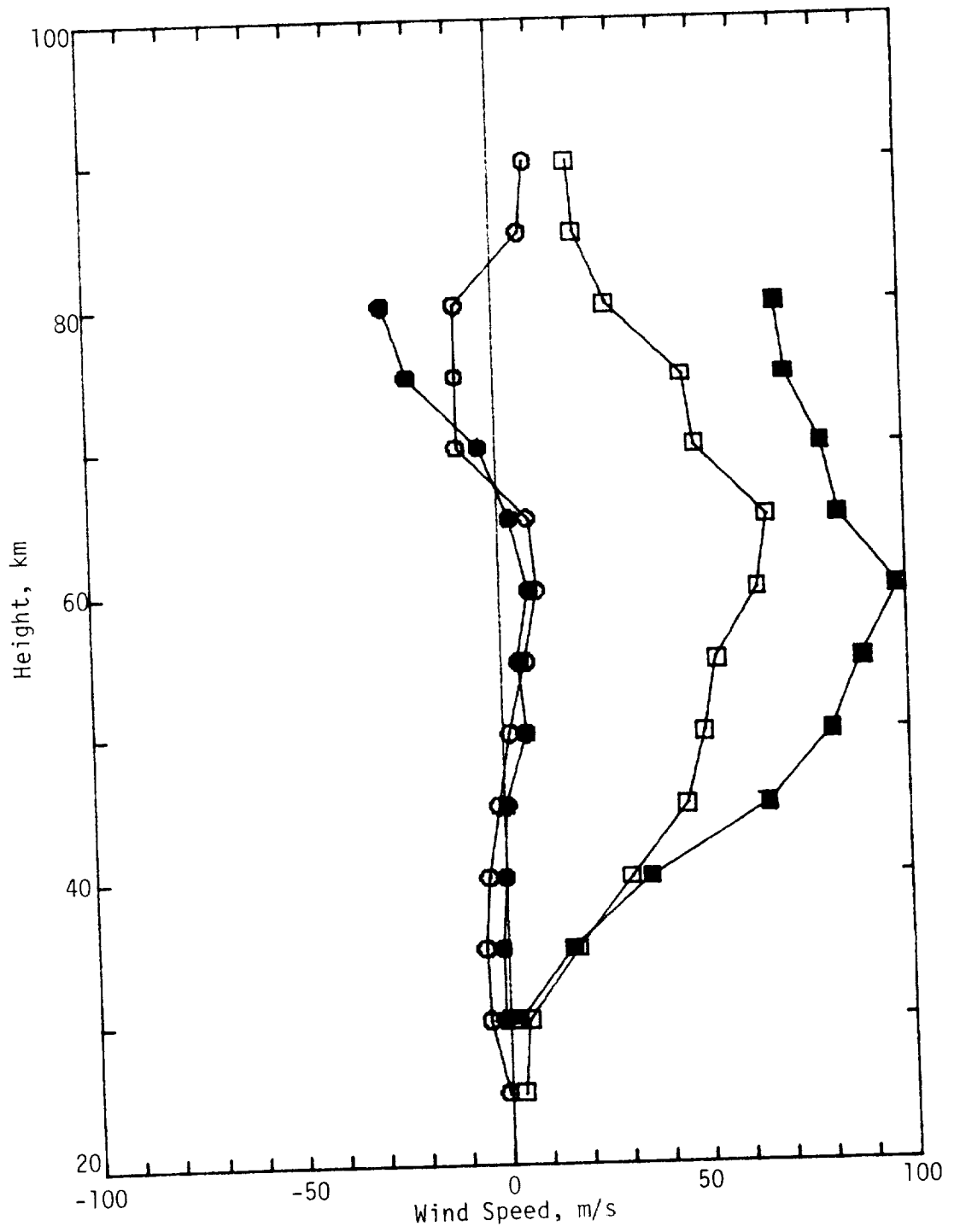


Figure 3.6. As in Figure 3.1 for Woomera.

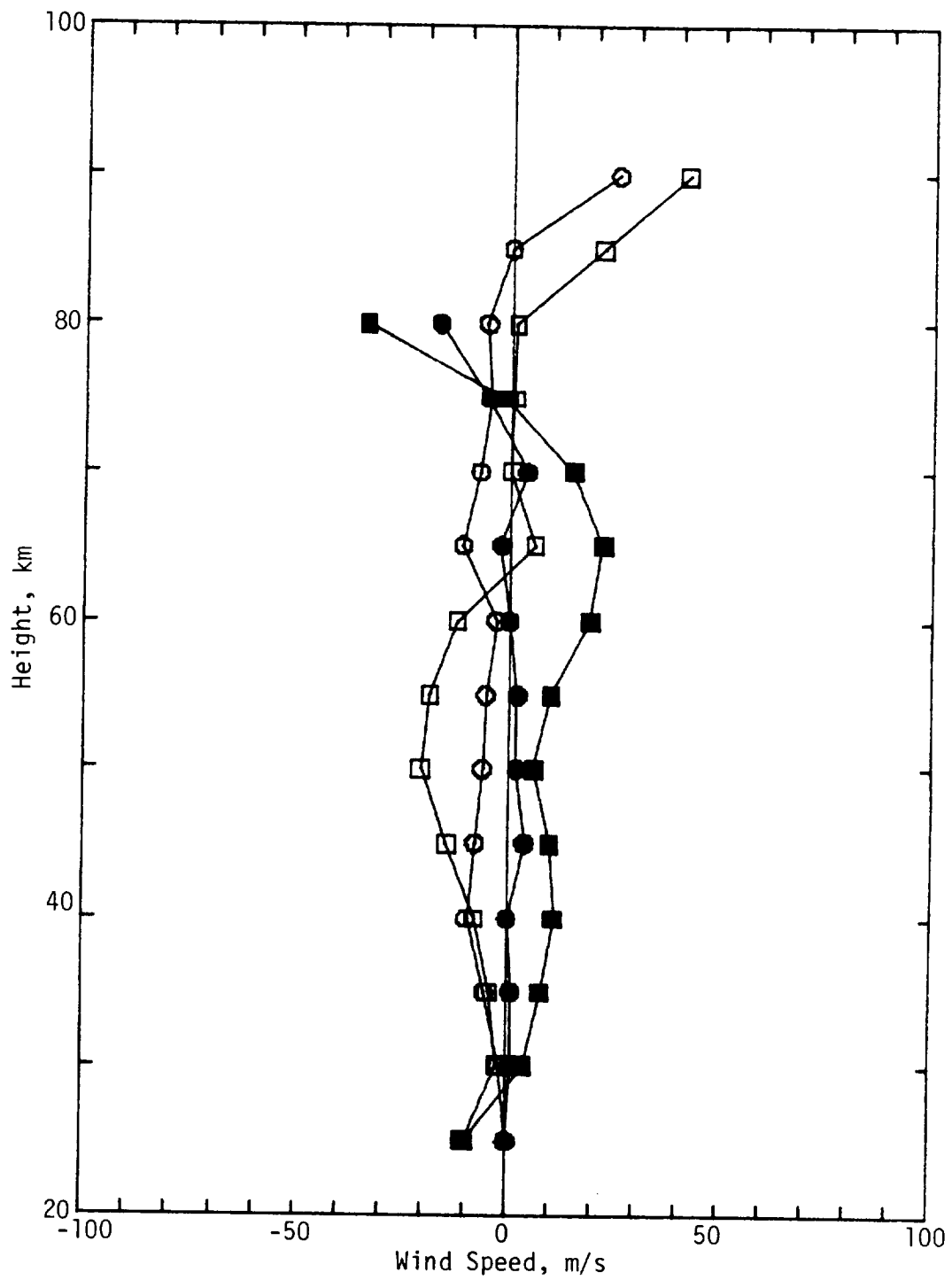


Figure 3.7. As in Figure 3.1 for December, Kwajalein.

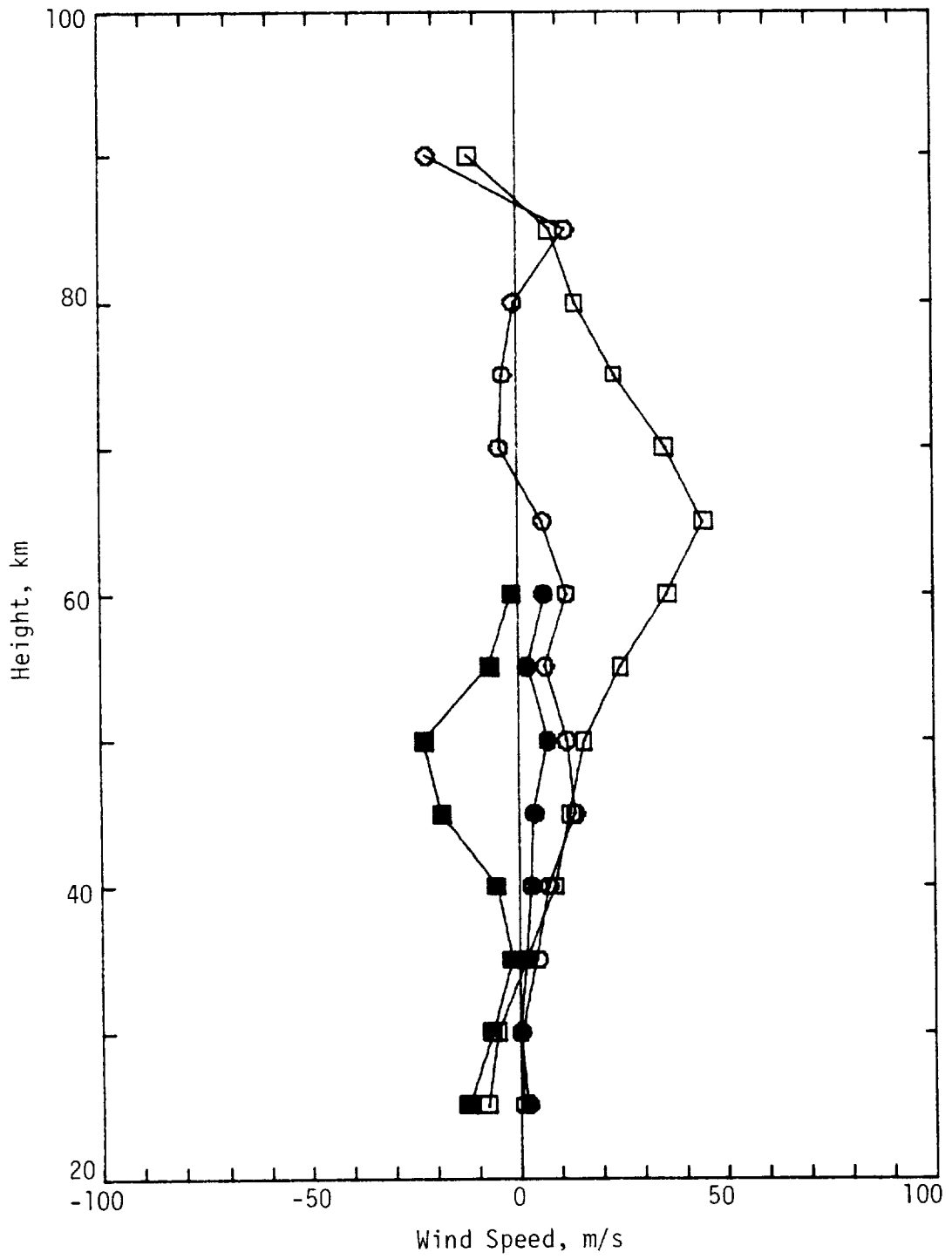


Figure 3.8. As in Figure 3.1 for December, Fort Sherman.

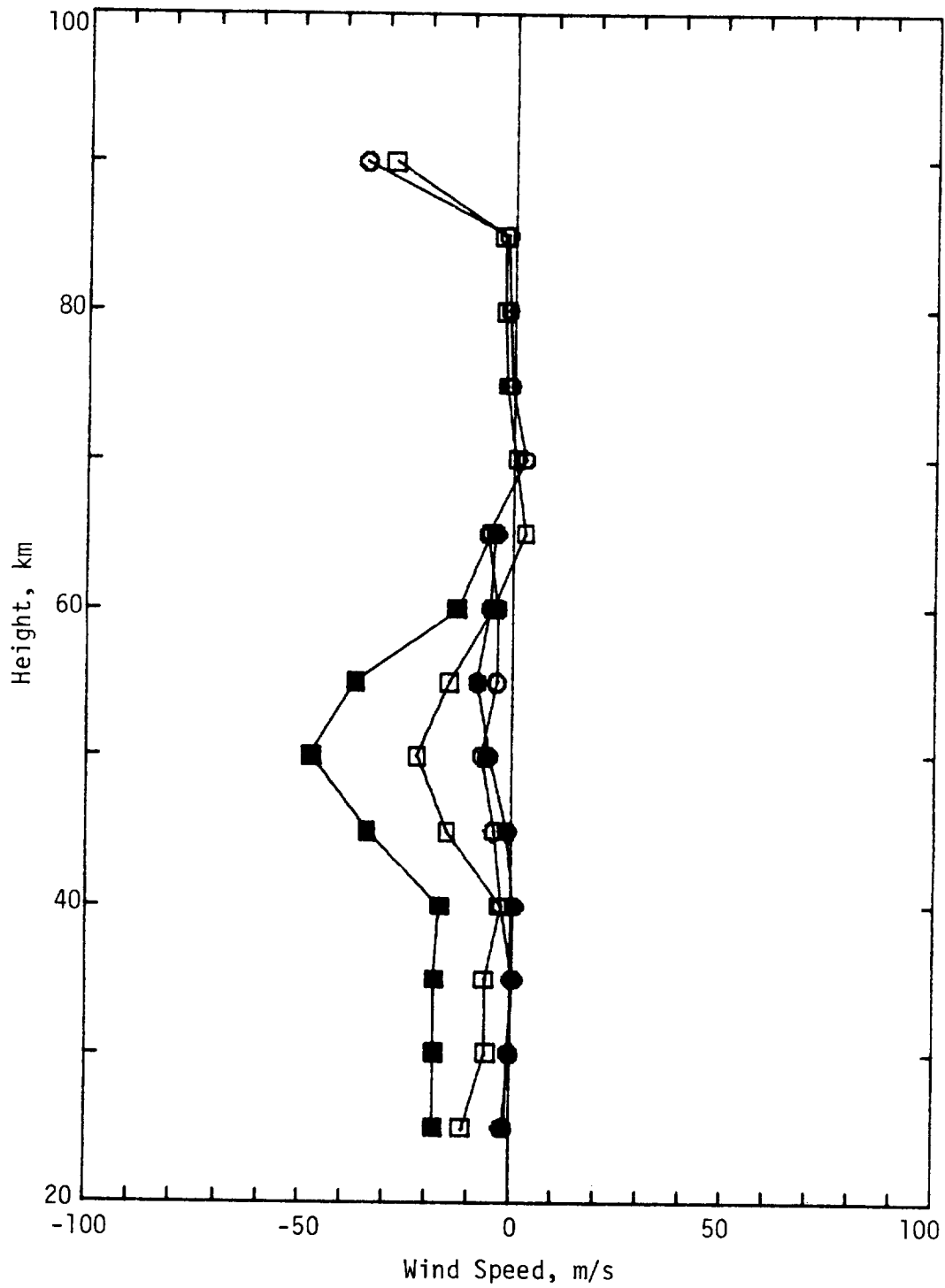


Figure 3.9. As in Figure 3.1 for December, Ascension.

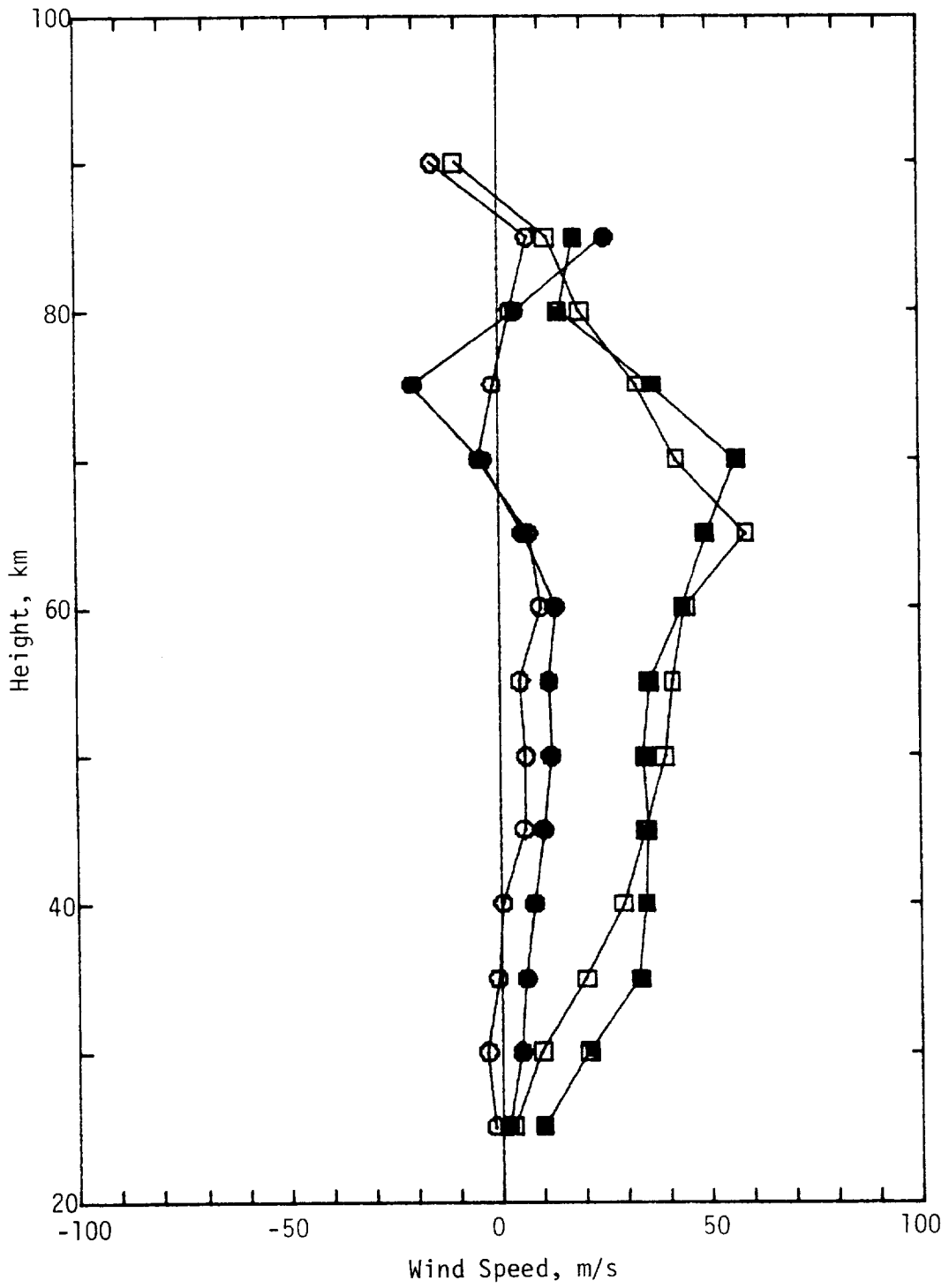


Figure 3.10. As in Figure 3.1 for December, Kennedy SFC.

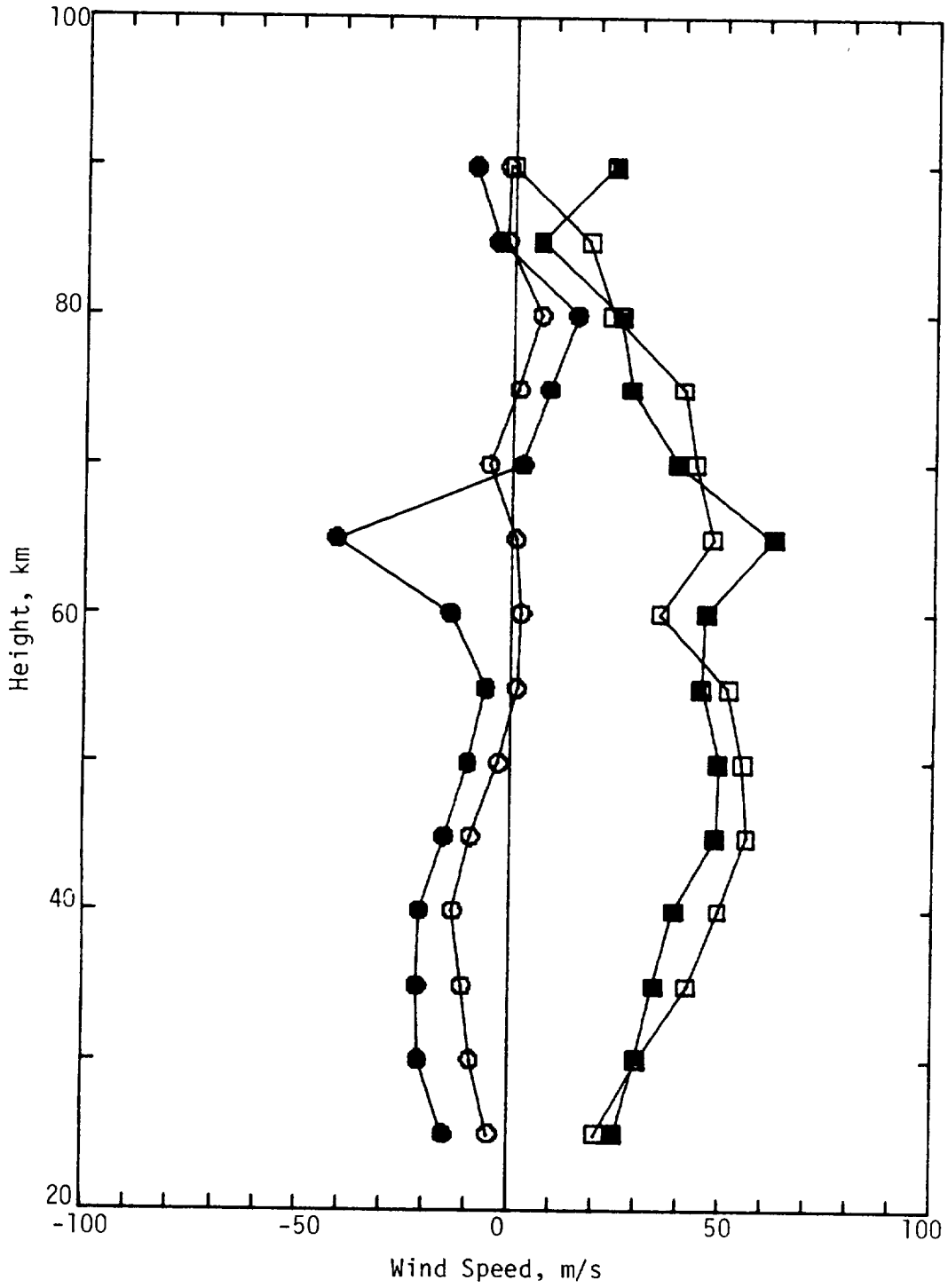


Figure 3.11. As in Figure 3.1 for December, Fort Churchill.

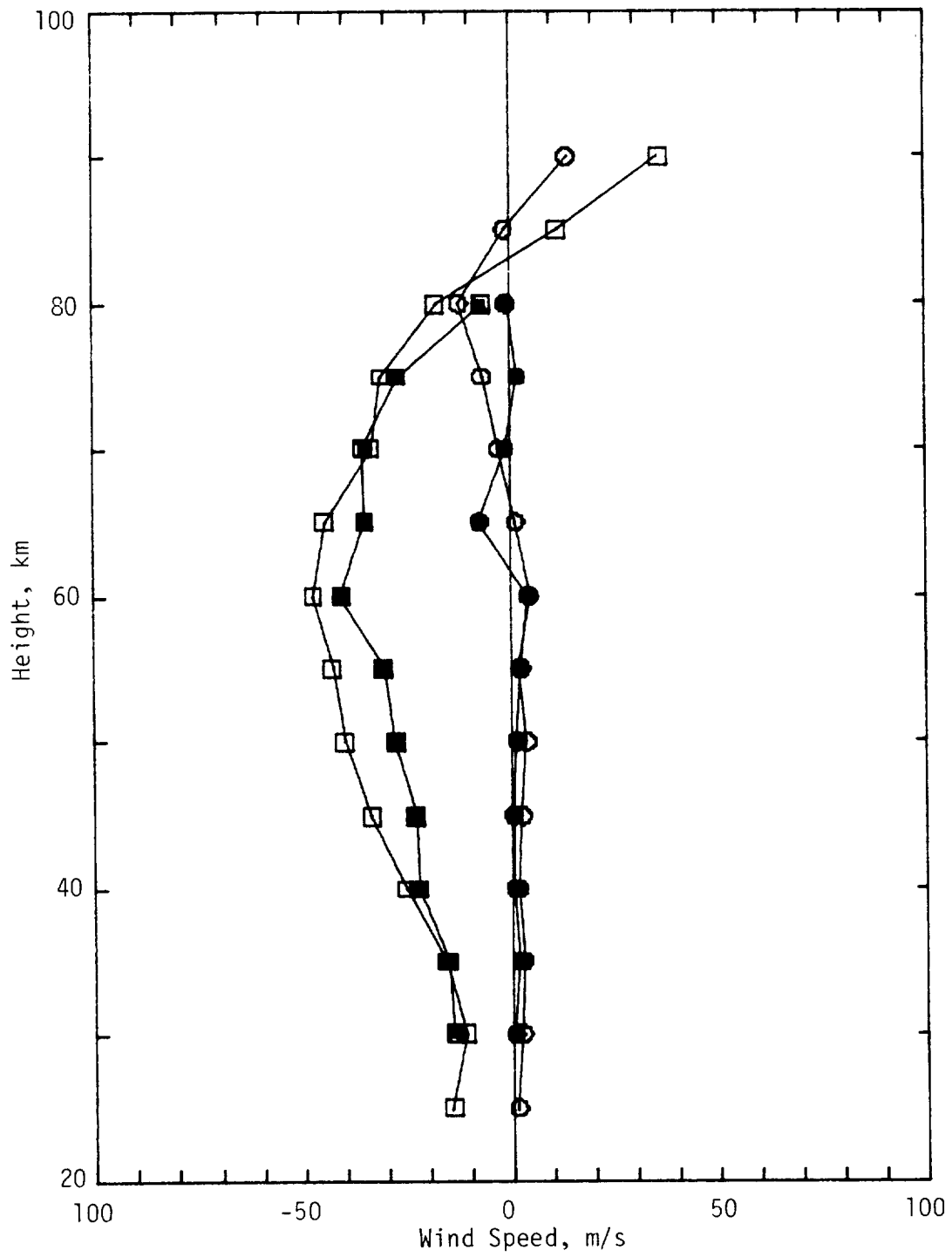


Figure 3.12. As in Figure 3.1 for December, Woomera.

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

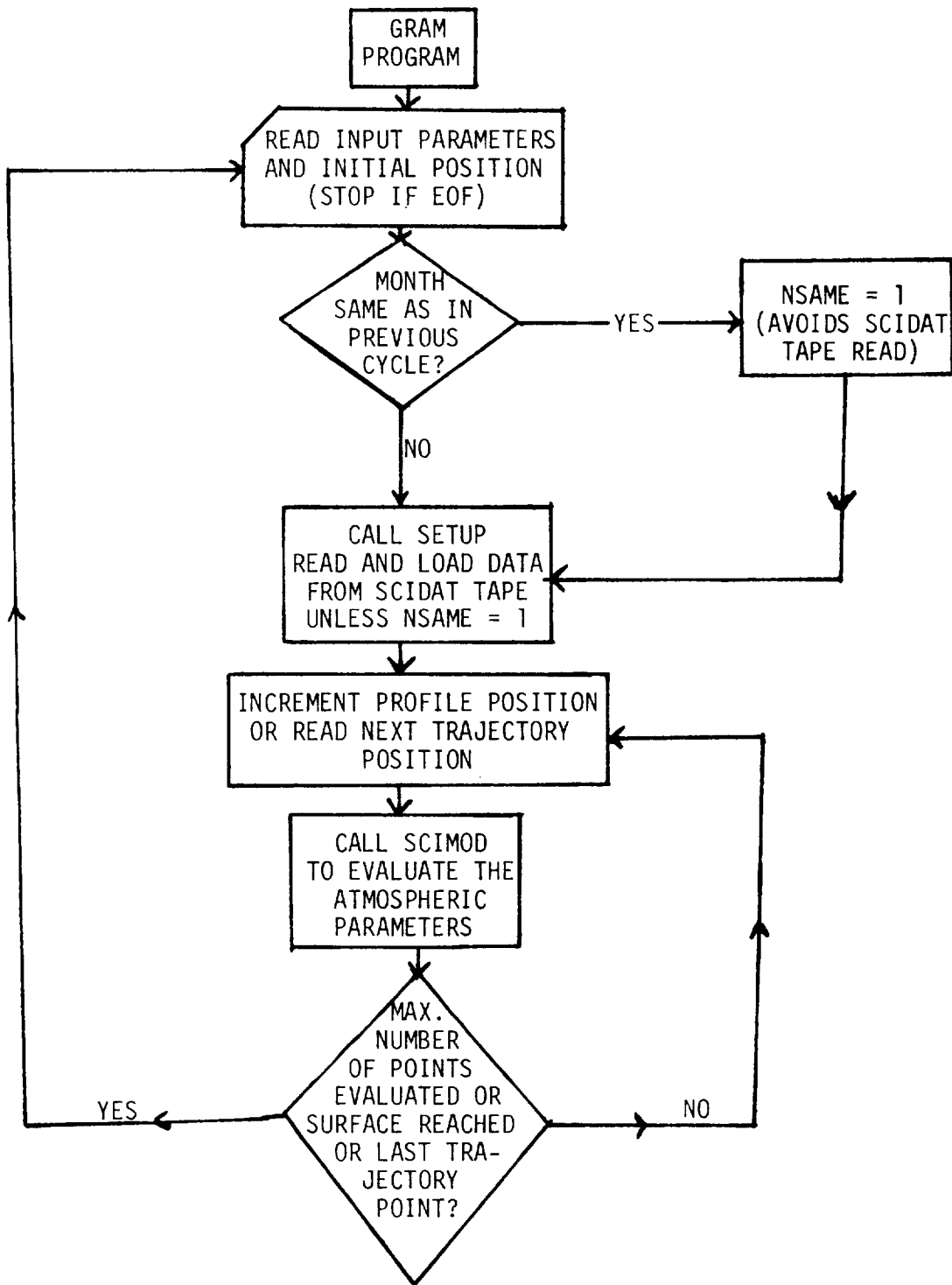


Figure 4.1: Simplified flow chart of the GRAM program.

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° latitude-longitude intersections westward from the Greenwich Meridian to 5° east. The EQN grid covers the latitudes from 0° to 15° 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° E, Lat. 0, 5, 10, 15. The SH grid contains all data from 5° south to the south

pole as follows: 1 = South Pole, 2-18 = Lon. 0, Lat. -5 to -85; 19-35 = Lon. 5° W, Lat. -5 to -85; ... 1209 - 1225 = Lon. 5° 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.

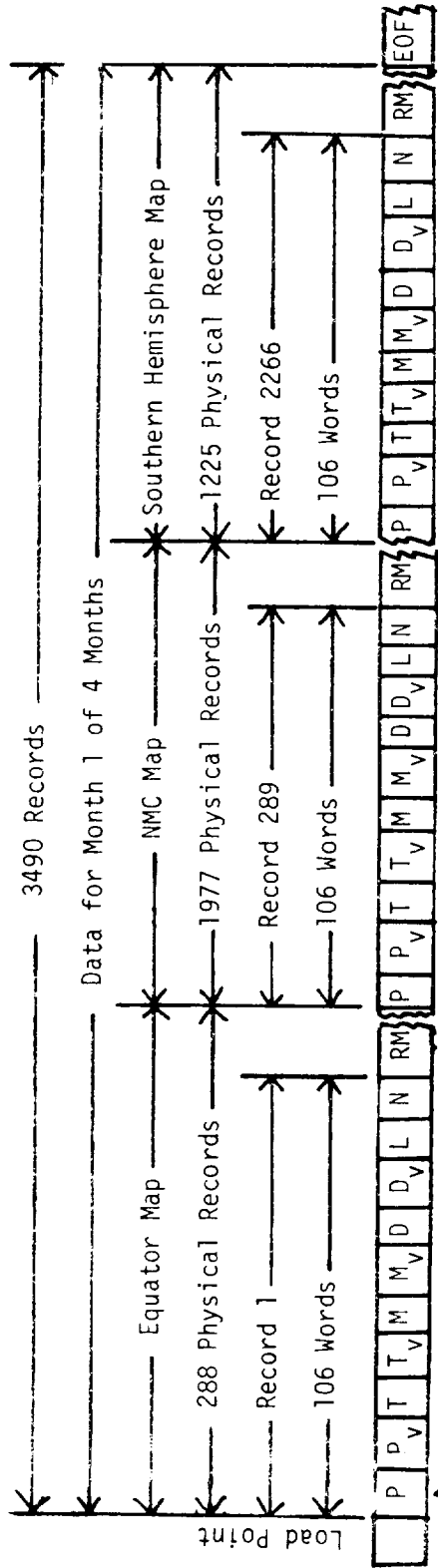
Each record consists of 106 36-bit words where the first 104 words contain the computed data for a point and the last two are identifiers. All data values are multiplied by 100 and converted to integer; they are then packed with two 18-bit values to a word. The data is arranged by level for each parameter; 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



- P - Pressure ($\text{mb} \times 10^2$)
- P_v - Pressure Variance ($\text{mb}^2 \times 10^2$)
- T - Temperature ($^{\circ}\text{k} \times 10^2$)
- T_v - Temperature Variance ($^{\circ}\text{k}^2 \times 10^2$)
- M - Moisture ($\text{g}/\text{m}^3 \times 10^2$)
- M_v - Moisture Variance ($\text{g}^2/\text{m}^6 \times 10^2$)
- D - Density ($\text{g}/\text{m}^3 \times 10^2$)
- D_v - Density Variance ($\text{g}^2/\text{m}^6 \times 10^2$)
- 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.

NMC Grid Data. 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 FORTRAN readable records with code "N" and 15 integers (A2, 15I7 Format) in each record.

Groves Data. The Groves (1971) data for monthly mean pressure, density, and temperature are tabulated at 10 degree latitude intervals from 0 to 90⁰ 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 Groves (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, ..., 90⁰ latitude values of the parameter expressed as a three digit integer, with an exponent common to all of the values in the field appearing at the end of the record. Thus a value of 276 with an expon-

ent 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 $^{\circ}\text{K}$. The Groves data set contains 702 FORTRAN readable records with 13 integer values (13I7) in each record (following the code word P, D, or T, in A2 format).

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

$$y_m = G_y (1 + s_y/1000) \quad (4.1)$$

Note that the stationary perturbation values at 90° latitude are always zero. However, there is a place for 90° 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-3 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 FORTRAN readable records, with 18 integer values (18I7) (following the code word S A2 format).

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 σ_p/p , σ_ρ/ρ , and σ_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 FORTRAN readable records with 17 integer values (17I7) in each record following the code word R (A2). For the code RW data, there are 325 records with the code word RW and 12 integers (A2, 12I7).

Large Scale Fraction Data. From daily difference analysis described in Section 2, the fraction of the total variance (σ^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 σ_L and σ_S are computed from the fractional data f_L in per mill (code P for pressure, density, and temperature or code PW for winds), by the relations

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

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

where σ_T is the total perturbation magnitude (code R or code RW data). The code P and code PW data sets each contain 25 FORTRAN readable records, with code word P or PW, followed by 17 integer values (A2, 17I7) on each record.

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 FORTRAN readable records, with code word CS or CL, followed by 12 integer values (A2, 12I7) in each record.

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° latitude, the amplitude and phase for 30° latitude, etc. out to the amplitude and phase for 90° latitude. There are 80 FORTRAN readable records in the QBO data set. Each record contains 11 integer values followed by a code word (QP, QD, QT, QU, or QV).

An end of file mark appears at the end of the code QV data.

The Spherical Harmonic (SP) Data. The spherical harmonic coefficient data consists of values of the 9 spherical harmonic coefficients (equation 2.12) for both northward and eastward wind components. Each record consists of the code (SP), the height (km), the month, and 9 spherical harmonic coefficients (in cm/s). Eastward wind component coefficients are first, followed by northward wind component coefficients.

A final end-of-file mark appears at the end of the SP data. Appendix B gives a brief summary of the data on the SCIDAT tape and a 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° in absolute magnitude, then a transformation

$$lat = (180^{\circ} - |lat|)(lat/|lat|) \quad (4.4)$$

$$lon = lon + 180^{\circ} \quad (4.5)$$

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° west longitude. If negative (east) longitudes are input they are converted to the 0 - 360° scale before being used by the program. At any time during the run if a longitude gets outside the 0 - 360° range it is put back into that range by adding or subtracting 360°, as necessary.

4. F10.7 (R): The solar 10.7 cm radio noise flux in units of 10^{-22} watts/m² (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 in-

put 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 successive 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 sub-routine 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 "ERROR 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 "ERROR 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 appli-

cation 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 $5^{\circ} \times 5^{\circ}$ 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 from 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, temperature, and winds are listed for each position. The thermal wind shear for the monthly mean winds, the percent deviation from the standard atmosphere (p , ρ , 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, $-180^\circ < \text{lat} < 0^\circ$, 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

$$lat = (180^\circ - |lat|)(lat/|lat|) \quad (4.6)$$

$$lon = lon + 180^\circ \quad (4.7)$$

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 geo-

strophic 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

$$y_m = G_y (1 + s_y/100) \quad (4.8)$$

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 (percent, 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 RECORDS 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 (N, P, D, T, S, R, RW, P, PW, CS, CL, QP, QD, QT, QU, QV, or SP; 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

MØNTH = 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. EXECUTION IS TERMINATED.

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

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 questionable wind values. The conditions which can produce this is a 4-D data consis-

tency check violation (i.e., unrealistic scale heights or unrealistic horizontal pressure gradients) within the 4 x 4 grid of 4-D data profiles.

Diagnostic 6: "PREMATURE END-OF-FILE FOUND ON UNIT M"

"CALLED FROM SUBROUTINE XXXXXX"

And end-of-file mark was encountered before it was expected by one of the following subroutines while it was loading the associated data.

<u>XXXXXX</u>	<u>DATA</u>
GETNMC	NMC GRID DATA
RTRAN	STATIONARY OR RANDOM PERTURBATION DATA
RTRAN1	GROVES DATA
RTRAN2	QBO DATA

UNIT m refers to the input unit number. This error should never occur while using the SCIDAT data type as the data source.

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 auto-correlations 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 ($|\text{latitude}| > 75^\circ$) or non-polar ($16\ 5^\circ \times 5^\circ$ 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.

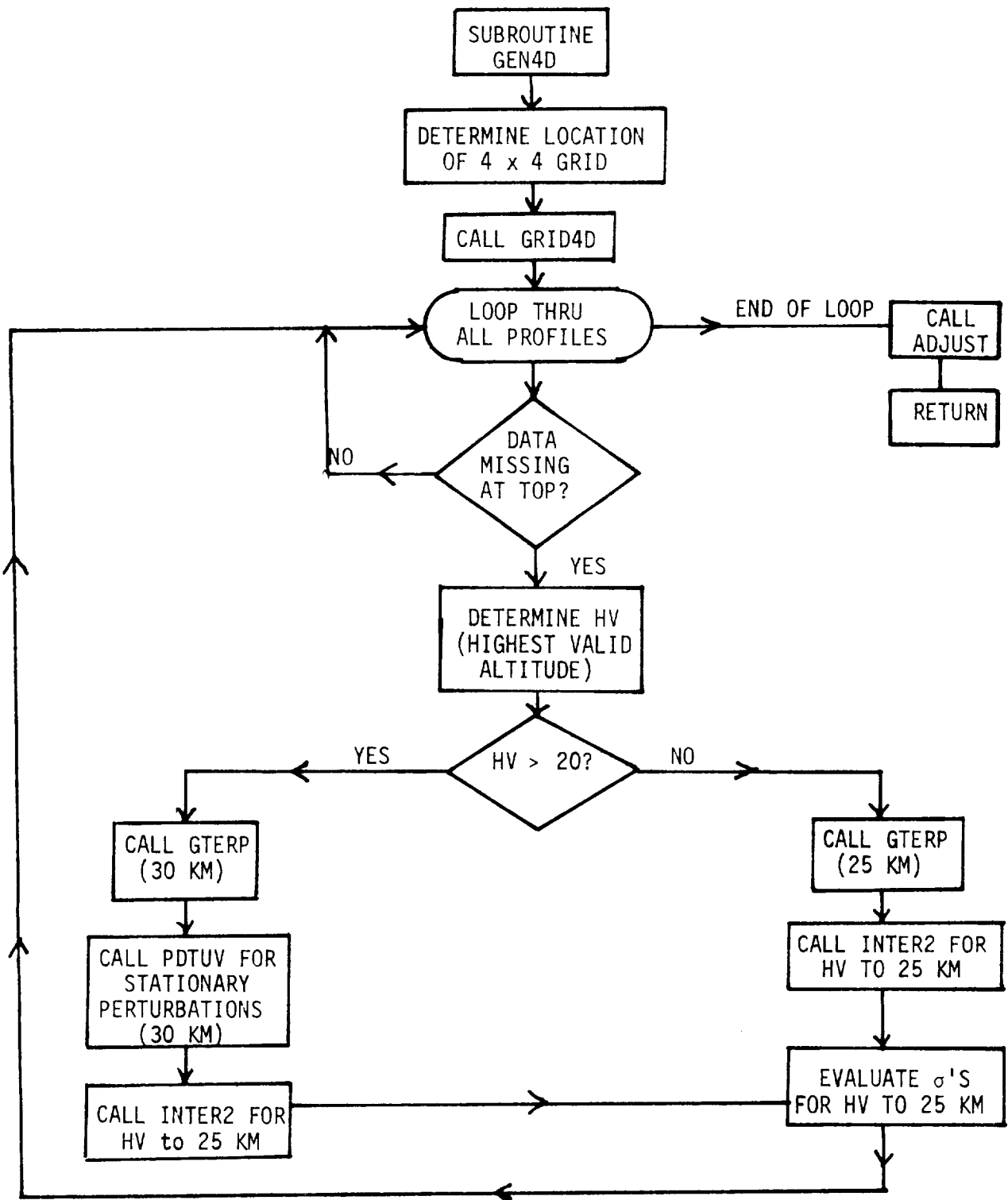


Figure 5.1: Simplified flow chart of the GEN4D subroutine.

- 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.
- GRØUP 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. This 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 GEINMC 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.
- SPHERE: Called by WIND, this subroutine evaluates the wind components by the spherical harmonic model.
- 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 geostrophic winds from input values of horizontal pressure gradient if the height is less than 25 km or more than 90 km. If the latitude is below the minimum geo-

strophic latitude, it evaluates geostrophic wind at minimum geostrophic north latitude and at minimum geostrophic south latitude and then interpolates in between. If the height is between 25 and 90 km, the spherical harmonic wind model is used. Between 20 and 25 km and between 90 and 95 km, a smooth fairing between geostrophic and spherical harmonic wind is used.

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 80 K decimal words core storage on Georgia Tech's CYBER. In order to take up less core storage (e.g., be accommodated into smaller core partitions), the program can be mapped in segmented form. An efficient segment 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, SPHERE, 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,

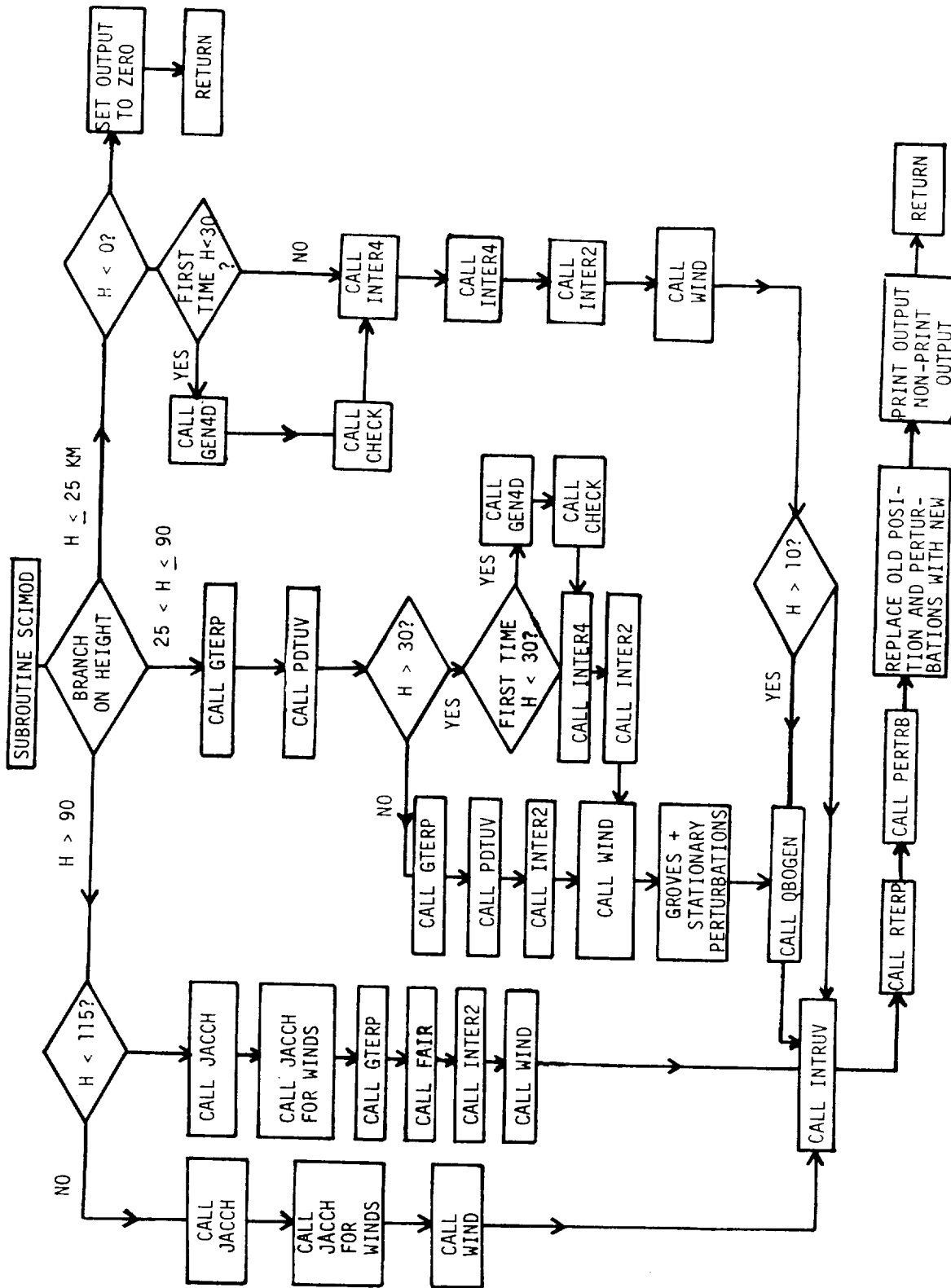


Figure 5.2: An abbreviated flow chart of the SCIMOD subroutine.

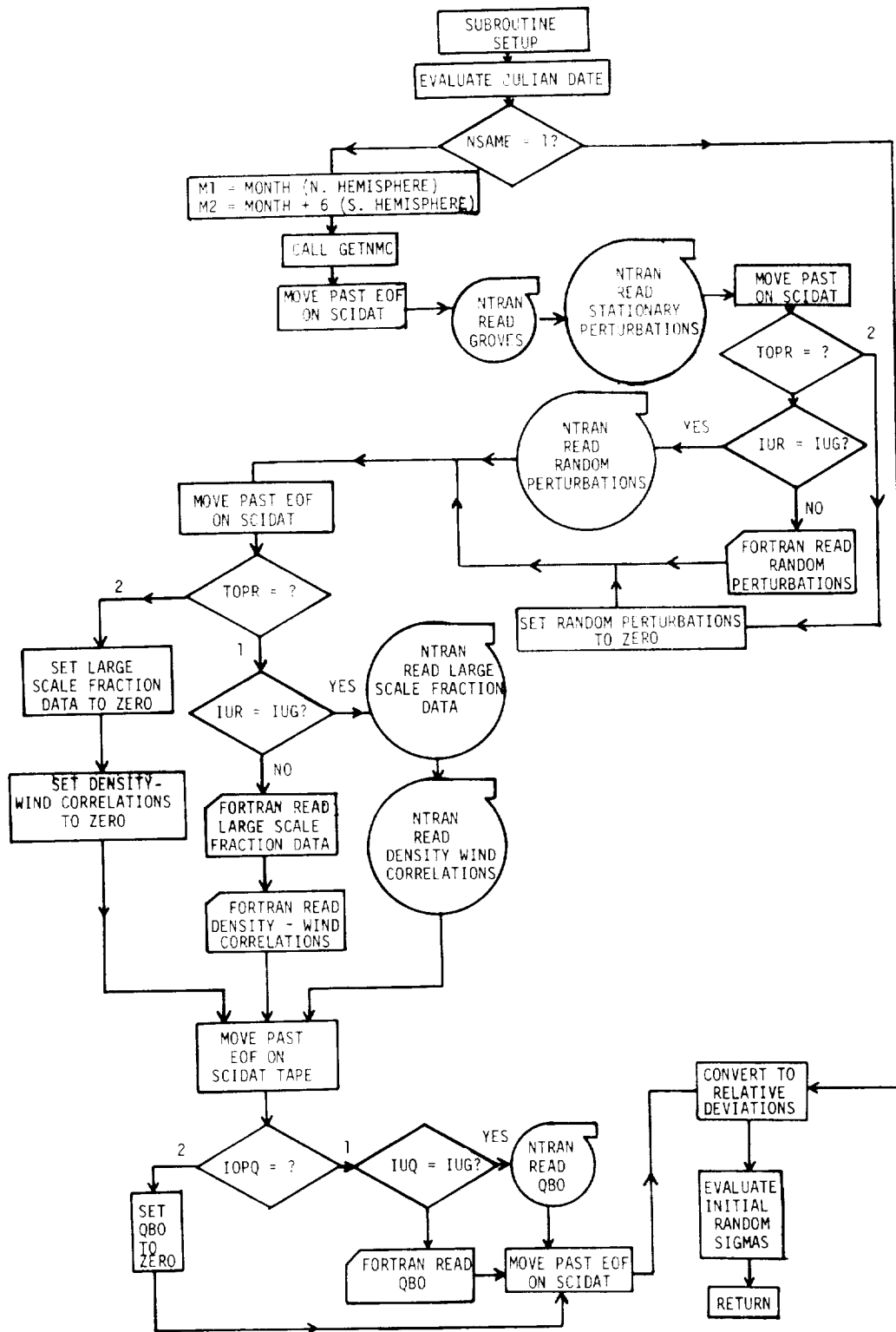


Figure 5.3: Abbreviated flow chart of the SETUP subroutine.

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, . GTERP, . INTERW, . INTERZ
  IN GRAM. INTER2, . INTRUV, . NORMAL, . PDTUV, . PERTRB, . PHASE
  IN GRAM. QBOGEN, . RAND, . RIG, . RTERP
  IN GRAM. SCIMOD, . SPHERE, . 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 overlaid (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 sub-

routines. 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 | HI |
| 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 in-

put 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) | RUIL, RVIL, RUIS, RVIS |
| 26-27. | Previous standard deviation of random winds (m/s), large scale (L) and small scale (S) | SUIL, SVIL, SUIS, SVIS |

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
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. The COMMON "CHIC" is used to transfer the spherical harmonics coefficients to the SPHERE subroutine.

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 ρ 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.

Subroutine TME. 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 SORT4, INTRP4 and SELEC4 are basically the MAIN PROGRAM, SORT, INTERP and INPUT as documented in the 4-D users reference manual and subsequent updates.

Some changes have been made.

In GRID4D, NTRAN MOVE 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 an 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 ERROR FOR RECORD NO 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 (IOTEM1 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(IOTEM1 in calling program) by TRID4D which results in a transfer to

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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 (IOTEM2 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 RECORDS 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 SCIMØD.

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APPENDIX A

THE SPHERICAL HARMONIC WIND MODEL

The spherical harmonic wind model is based on the second order spherical harmonic expansion relation (equation 2.12)

$$\begin{aligned} u(m, z, \theta, \phi) = & a_1 + a_2 \cos\phi + a_3 \cos\theta \sin\phi \\ & + a_4 \sin\theta \sin\phi + a_5 (3\cos^2\phi - 1)/2 \\ & + a_6 \cos\theta(3 \sin\phi \cos\theta) + a_7 \sin\theta(3 \sin\phi \cos\phi) \\ & + a_8 (2 \cos^2\theta - 1)(3 \sin^2\phi) + a_9(2 \sin\theta \cos\theta)(3 \sin^2\phi) \end{aligned} \quad (A-1)$$

where u is the eastward wind component (or a similar equation for v , the northward component), m is the month, z is the height, θ is the longitude, and ϕ is the co-latitude. The coefficients (a 's) must be estimated from observed data, as a function of month and height. Five kilometer height intervals were selected at which to evaluate the coefficients.

Estimation of the Model Coefficients

The spherical harmonic model may be expressed as a linear function by the transformation

$$\begin{aligned} x_1 &= 1 \\ x_2 &= \cos\phi \\ x_3 &= \cos\theta \sin\phi \\ x_4 &= \sin\theta \sin\phi \\ x_5 &= 3(\cos^2\phi - 1)/2 \end{aligned}$$

$$\begin{aligned}
 x_6 &= \cos\theta (3 \sin\phi \cos\phi) \\
 x_7 &= \sin\theta (3 \sin\phi \cos\phi) \\
 x_8 &= (2 \cos^2\theta - 1) (3 \sin^2\phi) \\
 x_9 &= (2 \sin\theta \cos\theta) (3 \sin^2\phi)
 \end{aligned}
 \tag{A-2}$$

Using this transformation, the model becomes

$$u = \sum_{i=1}^9 a_i x_i = \underline{A} \cdot \underline{X}
 \tag{A-3}$$

where \underline{A} and \underline{X} are 9-component vectors with components a_i and x_i , respectively. If similar coefficient b_i are defined for v , the northward component, its representation becomes

$$v = \underline{B} \cdot \underline{X}$$

Since the wind components vary with month and height, the \underline{A} and \underline{B} vectors will depend on month and height. Over altitudes 25 to 65 km the all a component of the \underline{A} and \underline{B} coefficient vectors are evaluated every 5 km, for each month. Above 65 km, where fewer wind observations were available, a 5 km height increment was still used, but only the 1st-order coefficients (1-4) were evaluated; the 2nd-order coefficients (5-9) were set identically to zero (see the printout of the spherical harmonic in the SCIDAT tape listing of Appendix B).

The least-squared error approach (Draper and Smith, 1966) was used to estimate the coefficient vectors \underline{A} and \underline{B} .

The Data

Four sources of wind data were available for this analysis. The most

extensive source was the SUMS tape from the World Data Center (NOAA, 1976). This tape contained monthly wind data averaged over the period 1969 to 1976. Up to 20 stations around the world reported winds in the altitude range 25 to 90 km. These stations were located primarily in the Western hemisphere.

Data from three Eastern hemisphere stations--Thumba, India; Volograd, USSR; and Heiss Island--were available (NASA, 1978). This also was monthly averaged data ranging from 25 to 60 km.

The third source of data was grenade soundings from four locations: Point Barrow, Alaska; Wallops Island, Virginia; Fort Churchill, Canada; and Natal/Ascension Island (Theon, et al., 1972). The Natal/Ascension data were annual means; the other stations were averaged over three seasons; summer, winter, and Equinox. A sinusoidally weighted interpolation scheme was used to estimate monthly wind averages. In this scheme, the summer and winter observations were assumed to be the extremes, and the equinox was the nominal wind value.

The fourth data source was from Woomera, Australia (Pearson and Johnson, 1973). Monthly average wind components from 30 to 80 km were available from this source.

The four data sources were combined and used as input to a multiple regression program for estimating the spherical harmonics coefficients, as previously described. Monthly wind averages based on less than three observations were filtered from the data.

Very little southern hemisphere wind data were available, resulting in erratic wind prediction at southern latitudes. To alleviate this problem, data from the northern hemisphere was used as southern hemisphere data, displaced by 6 months, with both latitude and longitude reversed.

The number of stations which had enough wind data for meaningful

averages varied considerably from one month to the next and from one altitude to the next. There was a maximum of 23 stations and a minimum of 5 stations at a given height. The geographic distribution of the stations was strongly biased towards the north-west quarter-sphere. These factors, along with the large variance in the wind data result in the spherical harmonics coefficients having large standard deviations. As a result of this, increased emphasis should be placed on perturbation analysis available in the GRAM program. As more and better wind data becomes available, the spherical harmonics model coefficients may be updated, and better results obtained.

The spherical harmonic model is used at all latitudes to calculate winds between the heights of 25 and 95 km. Between 20 and 25 km and between 90 and 95 km, a Fairing technique is used to smooth the winds between the spherical harmonic model values and the geostrophic winds. At low latitudes (below the "minimum geostrophic latitude" given in the input), the geostrophic relation is not used. Instead interpolation is done between plus and minus minimum geostrophic latitude (below 25 km and above 90 km only).

APPENDIX B

LISTING OF THE REVISED TAPE "SCIDAT-MOD-3" 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.

<u>Code</u>	<u>Data</u>	<u>Description</u>
N	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 (nt/m^2)	Month, height, values at latitudes 0, 10, 20, ... 90 exponent. Same format as in Groves report.
D	Groves Density (kg/m^3)	
T	Groves Temperature ($^{\circ}\text{K}$)	
S	Stationary Perturbations in monthly means (per mill)	Month, height, longitude, Δp at north latitude, 10, 30, 50, 70, 90, Δp same, ΔT same.
R	Random pressure, density and temperature perturbation magnitudes (per mill)	Month, height, Δp at north latitude 10, 30, 50, 70, 90, $\Delta \rho$ same, ΔT same
RW	Random magnitudes wind perturbation (m/s)	Month, height, Δu at north latitude 10, 30, 50, 70, 90, Δv 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

<u>Code</u>	<u>Data</u>	<u>Description</u>
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, $\langle \rho u \rangle_L$ 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)	
SP	Spherical harmonic coefficient	Height, month, and coefficient values a_1 - a_9 , cm/s.

The tape consists of six FORTRAN readable 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. Each record of the NMC grid data file contains the code (N) and x-y coordinates for 5 points. The Format is (A2, 15I7). 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 for the remaining values. The format for the Groves data is (A2, 13I7),

for the stationary perturbation it is (A2, 18I7), for the code-R data it is (A2, 17I7), for the code RW data it is (A2, 12I7), for the large scale fractional variances in thermodynamic variables it is (A2, 17I7), for the large scale fractional wind variances it is (A2, 12I7) for the density-velocity correlations (small scale and large scale) it is (A2, 12I7), and for the quasi-biennial data it is (A2, 11I7), and for the spherical harmonic it is (A2, 11I7). 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, the QBO data contain 80 records, and the spherical harmonics data contain 336 records.

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

*** MHC GRID DATA***

N	1	15	1	2	16	1	3	17	1	4	18	1	5	19	1
N	6	20	1	7	21	1	8	22	1	9	23	1	10	24	1
N	11	25	1	12	26	1	13	27	1	14	28	1	15	29	1
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N	21	35	2	22	36	2	23	37	2	24	38	2	25	39	2
N	26	40	2	27	41	2	28	42	2	29	43	2	30	44	2
N	31	45	2	32	46	2	33	47	2	34	48	2	35	49	2
N	36	50	2	37	51	2	38	52	2	39	53	2	40	54	2
N	41	55	3	42	56	3	43	57	3	44	58	3	45	59	3
N	46	60	3	47	61	3	48	62	3	49	63	3	50	64	3
N	51	65	3	52	66	3	53	67	3	54	68	3	55	69	3
N	56	70	3	57	71	3	58	72	3	59	73	3	60	74	3
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P	2	30	118	116	114	112	111	112	111	105	101	100	1	
P	2	35	581	572	560	543	531	523	517	485	466	459	0	
P	2	40	298	293	286	274	264	255	246	227	216	212	0	
P	2	45	157	156	152	144	137	130	122	110	103	100	0	
P	2	50	848	839	820	773	734	683	625	546	499	483	-1	
P	2	55	458	455	443	413	390	359	325	279	251	242	-1	
P	2	60	243	238	231	215	202	185	165	140	125	120	-1	
P	2	65	122	119	114	106	100	92	83	69	61	58	-1	
P	2	70	577	551	534	504	482	450	397	321	275	260	-2	
P	2	75	256	245	240	229	223	211	188	147	122	114	-2	
P	2	80	111	106	105	102	101	97	86	66	54	50	-2	
P	2	85	469	448	451	439	440	434	393	295	236	217	-3	

P	2	90	200	188	188	187	191	192	175	133	108	99	-3
F	2	95	355	802	797	784	814	843	792	600	495	446	-4
P	2	100	395	364	362	357	366	377	359	278	229	213	-4
P	2	105	199	182	178	171	174	179	174	135	112	104	-4
P	2	110	113	101	96	91	91	93	90	71	60	56	-4
P	3	25	251	246	244	240	240	243	238	225	217	215	1
F	3	30	118	117	115	113	112	112	110	105	102	101	1
P	3	35	582	575	566	552	533	529	521	501	489	485	0
P	3	40	299	297	290	279	267	262	255	242	234	232	0
P	3	45	159	158	154	146	139	135	130	121	116	114	0
P	3	50	860	859	833	781	741	718	675	616	581	569	-1
P	3	55	465	461	446	416	392	380	354	319	298	291	-1
P	3	60	244	241	231	214	203	196	181	162	151	147	-1
P	3	65	121	117	113	106	101	98	90	79	72	70	-1
P	3	70	569	547	528	503	487	475	434	372	335	322	-2
P	3	75	255	240	237	231	225	223	205	171	151	144	-2
P	3	80	110	105	105	103	102	102	94	76	65	62	-2
P	3	85	476	444	450	446	438	444	420	339	290	274	-3
P	3	90	206	191	191	188	187	191	182	146	124	117	-3
F	3	95	903	811	802	789	785	804	783	645	562	535	-4
P	3	100	419	374	362	354	354	365	355	298	264	252	-4
F	3	105	213	183	175	169	167	174	177	153	139	134	-4
P	3	110	122	104	96	89	88	94	98	86	79	76	-4
P	4	25	251	250	246	244	241	241	240	239	238	238	1
P	4	30	119	119	117	116	114	114	113	111	110	109	1
P	4	35	590	588	583	570	554	553	545	522	508	504	0
P	4	40	305	306	300	291	282	282	273	254	243	239	0
P	4	45	163	162	159	153	148	149	142	130	123	120	0
P	4	50	886	883	861	825	801	804	761	686	641	626	-1
P	4	55	478	473	462	439	427	430	407	363	337	328	-1
P	4	60	250	247	240	229	223	225	210	188	175	170	-1
P	4	65	123	121	119	114	111	112	106	93	85	83	-1
P	4	70	575	568	565	551	539	546	511	448	410	398	-2
P	4	75	253	250	257	253	250	253	240	209	190	184	-2
P	4	80	110	109	113	114	112	114	108	93	84	81	-2
P	4	85	479	471	494	493	478	475	458	392	352	339	-3
P	4	90	212	206	213	212	198	192	184	158	142	137	-3
P	4	95	920	880	900	873	813	769	754	658	600	581	-4
P	4	100	416	386	386	380	359	348	341	305	283	276	-4
P	4	105	202	182	178	172	165	167	176	164	157	154	-4
F	4	110	112	98	93	89	86	92	102	99	97	97	-4
P	5	25	251	254	250	249	247	246	249	254	257	258	1
P	5	30	120	120	120	118	117	117	118	120	121	122	1
P	5	35	595	598	595	584	576	577	581	586	589	590	0
P	5	40	309	311	307	299	298	300	299	292	288	286	0
P	5	45	164	165	163	159	158	160	159	155	153	152	0
P	5	50	889	896	882	859	861	880	869	832	810	802	-1
P	5	55	480	481	475	463	464	474	470	456	448	445	-1
P	5	60	253	254	248	242	244	250	248	239	234	232	-1
P	5	65	126	127	125	122	122	126	125	123	122	121	-1
P	5	70	582	597	600	587	591	607	608	596	589	586	-2
P	5	75	254	263	271	268	267	276	280	283	285	285	-2
P	5	80	111	115	118	115	115	118	121	121	121	121	-2
F	5	85	489	496	505	485	464	459	472	477	480	481	-3

P	5	90	213	214	215	199	181	169	170	170	170	170	-3
P	5	95	887	899	901	819	700	619	622	649	665	671	-4
P	5	100	379	379	382	351	308	276	280	292	299	302	-4
P	5	105	172	172	175	163	145	135	145	162	172	176	-4
P	5	110	91	88	89	84	78	79	89	100	107	109	-4
P	6	25	251	253	253	253	256	258	260	265	268	269	1
P	6	30	119	120	121	121	122	123	125	128	130	130	1
P	6	35	592	597	597	599	602	611	627	642	651	654	0
P	6	40	306	308	306	308	311	318	326	330	332	333	0
P	6	45	161	163	162	163	166	171	176	178	179	180	0
P	6	50	869	881	878	886	905	935	965	974	979	981	-1
P	6	55	468	474	474	477	487	508	528	537	542	544	-1
P	6	60	248	251	249	251	258	271	282	288	292	293	-1
P	6	65	125	127	126	125	128	137	144	150	154	155	-1
P	6	70	585	599	592	593	607	652	695	731	753	760	-2
P	6	75	255	265	264	262	265	286	313	335	348	353	-2
P	6	80	112	114	114	111	110	117	128	136	141	142	-2
P	6	85	486	487	479	456	423	423	453	483	501	507	-3
P	6	90	208	206	201	183	156	141	145	152	156	158	-3
P	6	95	853	852	833	737	577	480	489	526	548	556	-4
P	6	100	360	362	361	327	260	214	216	230	238	241	-4
P	6	105	162	164	167	156	127	108	112	124	131	134	-4
P	6	110	840	837	867	836	719	640	689	771	820	837	-5
P	7	25	250	252	256	259	263	265	269	274	277	278	1
P	7	30	118	119	122	123	125	128	130	133	135	135	1
P	7	35	582	591	600	605	622	640	653	662	667	669	0
P	7	40	299	301	305	309	318	331	340	345	348	349	0
P	7	45	157	158	161	163	169	177	184	185	186	186	0
P	7	50	84	85	87	88	91	96	101	102	103	103	0
P	7	55	454	457	466	470	492	521	551	564	572	574	-1
P	7	60	241	242	245	246	257	275	295	307	314	317	-1
P	7	65	122	123	123	122	128	139	152	159	163	165	-1
P	7	70	577	578	573	562	595	654	730	779	808	818	-2
P	7	75	255	256	253	245	257	284	322	348	364	369	-2
P	7	80	110	110	109	104	104	111	126	137	144	146	-2
P	7	85	471	471	460	423	395	393	425	452	468	474	-3
P	7	90	197	198	191	170	145	131	131	135	137	138	-3
P	7	95	803	812	793	688	569	479	458	456	455	454	-4
P	7	100	350	357	354	317	262	218	198	191	187	185	-4
P	7	105	168	170	168	153	132	110	101	98	96	96	-4
P	7	110	898	903	895	835	725	626	576	559	549	545	-5
P	8	25	250	253	257	260	264	265	270	276	280	281	1
P	8	30	118	120	122	123	126	128	130	132	133	134	1
P	8	35	581	592	595	606	623	640	648	650	651	652	0
P	8	40	298	301	303	307	319	330	335	332	330	330	0
P	8	45	157	158	158	161	169	175	178	177	176	176	0
P	8	50	848	844	852	863	907	946	971	963	958	957	-1
P	8	55	458	457	454	462	485	509	526	525	524	524	-1
P	8	60	243	240	240	241	252	266	280	281	282	282	-1
P	8	65	122	123	121	120	124	132	141	145	147	148	-1
P	8	70	577	584	579	563	571	615	676	709	729	735	-2
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	9	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
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	87	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	85	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
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	845	841	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	300	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	376	345	349	339	333	320	293	225	190	179	-8
D	1	95	148	146	139	138	141	143	131	103	86	91	-8
D	1	100	590	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	179	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	493	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	785	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
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
R	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
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	158	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	196	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	140	142	122	102	90	91	94	96	96	-8
D	7	100	580	591	581	500	399	333	310	305	300	301	-9
D	7	105	242	247	245	215	178	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	164	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	295	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
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	841	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	169	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	208	201	194	185	178	173	169	167	166	-5
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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	849	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	178	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
D	12	65	187	185	175	164	146	126	113	111	110	109	-6
D	12	70	980	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	189	189	184	169	150	138	125	117	115	-7
D	12	85	851	831	808	794	749	691	634	574	538	526	-8
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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	178	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	208	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	776	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	173	177	178	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
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T	1	45	265	266	269	268	263	251	242	236	223	219	0
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T	2	25	218	218	218	219	218	217	217	214	200	195	0
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T	5	55	269	267	265	265	267	268	270	271	273	274	0
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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
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T	6	60	255	256	253	252	252	256	259	264	267	268	0
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T	7	35	247	245	244	244	246	250	252	251	259	262	0
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T	7	45	265	265	268	268	271	274	278	279	293	284	0
T	7	50	271	271	273	272	274	276	281	285	293	296	0
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T	7	80	197	196	195	189	178	168	165	164	182	188	0
T	7	85	193	194	191	183	167	153	144	140	138	137	0
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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
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T	10	40	262	260	257	252	251	249	245	244	237	235	0
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STATIONARY PERTURBATIONS, CODE S

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S	1	30	130	-1	11	51	104	0	2	17	48	73	0	-6	-3	3	36	0
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S	1	30	190	15	28	87	169	0	19	22	43	86	0	-1	6	43	78	0
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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
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S	1	40	70	21	25	-70	-93	0	17	4	-102	-96	0	5	19	32	2	0
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S	1	40	130	-21	-43	-31	8	0	-20	-27	-5	-6	0	1	-16	-29	15	0
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S	1	40	190	-32	18	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
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S	1	52	190	-22	-13	96	183	0	-16	-13	104	195	0	-6	0	-7	-9	0
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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
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S	1	76	190	-36	11	142	297	0	-25	37	170	299	0	-10	-25	-23	0	0
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S	1	84	10	53	26	-105	-206	0	41	26	-92	-200	0	13	0	-13	-5	0
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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
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S	13	30	340	0	-5	-16	-32	0	1	-4	-7	-9	0	-1	-1	-10	-18	0
S	13	40	10	2	5	-13	-39	0	-1	-1	-16	-30	0	3	8	4	-8	0
S	13	40	40	3	9	-10	-33	0	0	1	-15	-27	0	3	7	4	-5	0
S	13	40	70	3	8	-14	-23	0	3	3	-19	-18	0	1	5	4	-3	0
S	13	40	100	0	-3	-15	-5	0	0	-2	-10	-1	0	0	0	-4	-2	0
S	13	40	130	-4	-6	4	27	0	-4	0	14	27	0	0	-5	-9	0	0
S	13	40	160	-3	0	31	55	0	0	7	42	53	0	-1	-6	-8	2	0
S	13	40	190	-6	3	44	61	0	-5	10	48	55	0	0	-6	-3	6	0
S	13	40	220	-3	3	38	44	0	-1	7	36	32	0	-1	-3	1	12	0
S	13	40	250	-1	-3	11	13	0	0	-3	4	4	0	-1	0	7	8	0
S	13	40	280	4	-4	-15	-17	0	3	-2	-20	-21	0	1	-1	5	4	0
S	13	40	310	6	-4	-29	-36	0	7	-5	-30	-35	0	0	1	2	0	0
S	13	40	340	4	-1	-24	-39	0	3	-5	-28	-33	0	1	5	3	-6	0
S	13	52	10	11	21	2	-37	0	10	18	2	-35	0	1	2	1	-1	0
S	13	52	40	15	28	7	-28	0	12	25	6	-27	0	3	3	0	0	0
S	13	52	70	11	27	5	-18	0	7	26	3	-18	0	3	1	1	0	0
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S	13	52	130	0	-8	0	27	0	1	-5	0	28	0	-1	-2	0	0	0
S	13	52	160	-4	-4	21	50	0	-2	-1	26	53	0	-1	-2	-3	-1	0
S	13	52	190	-3	-4	26	56	0	-1	-4	29	57	0	0	0	-2	0	0
S	13	52	220	-7	-12	18	40	0	-5	-11	19	40	0	0	0	0	1	0
S	13	52	250	-10	-18	0	7	0	-9	-17	-1	5	0	-1	0	1	2	0
S	13	52	280	-10	-15	-19	-21	0	-10	-15	-20	-23	0	0	0	1	2	0
S	13	52	310	-4	-15	-26	-36	0	-3	-16	-27	-38	0	0	1	2	2	0
S	13	52	340	6	0	-24	-40	0	5	-1	-25	-38	0	1	1	1	-1	0
S	13	60	10	10	19	-1	-42	0	14	24	7	-34	0	-3	-3	-7	-7	0
S	13	60	40	17	28	1	-32	0	15	31	12	-26	0	2	-3	-10	-6	0
S	13	60	70	14	27	3	-19	0	10	27	8	-17	0	4	0	-5	-2	0
S	13	60	100	4	8	-4	8	0	1	6	-7	4	0	4	1	2	4	0
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S	13	60	160	-5	-4	20	50	0	-4	-7	18	46	0	0	2	2	6	0
S	13	60	190	-4	-2	25	62	0	-3	-7	24	49	0	0	6	2	12	0
S	13	60	220	-6	-11	25	45	0	-7	-13	12	39	0	0	3	13	6	0
S	13	60	250	-12	-18	6	9	0	-11	-18	-4	7	0	-1	1	11	1	0
S	13	60	280	-10	-16	-19	-22	0	-10	-15	-17	-19	0	0	0	0	-2	0
S	13	60	310	-5	-16	-25	-38	0	-3	-13	-24	-32	0	-2	-1	-1	-6	0
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S	13	68	10	7	16	-9	-54	0	8	17	-3	-39	0	0	0	-6	-14	0
S	13	68	40	18	27	-10	-43	0	17	27	-1	-29	0	1	0	-8	-13	0
S	13	68	70	19	27	-4	-25	0	15	27	1	-19	0	4	1	-4	-5	0
S	13	68	100	7	8	-5	9	0	7	9	-3	10	0	2	0	-1	1	0
S	13	68	130	-4	-7	5	39	0	-2	-7	5	33	0	-1	0	0	7	0
S	13	68	160	-7	-3	23	60	0	-4	-3	20	51	0	0	1	3	9	0
S	13	68	190	-3	3	32	81	0	-5	0	22	62	0	0	3	8	17	0
S	13	68	220	-6	-8	40	56	0	-7	-12	27	40	0	0	1	12	16	0
S	13	68	250	-13	-19	19	12	0	-14	-17	8	6	0	0	0	12	7	0
S	13	68	280	-9	-14	-19	-25	0	-12	-15	-17	-23	0	3	1	1	0	0
S	13	68	310	-8	-18	-28	-47	0	-6	-14	-25	-40	0	-2	-1	-2	-7	0
S	13	68	340	7	-5	-36	-58	0	9	-4	-27	-45	0	0	-1	-7	-14	0
S	13	76	10	9	21	-12	-66	0	6	13	-15	-61	0	2	8	3	-6	0
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S	13	76	100	8	7	-9	7	0	8	8	-5	10	0	0	0	-2	-1	0
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S	13	76	160	-10	-7	19	67	0	-7	0	28	66	0	-2	-6	-8	0	0
S	13	76	190	-5	0	33	94	0	-3	6	38	90	0	-1	-4	-4	4	0
S	13	76	220	-7	-11	49	73	0	-6	-7	48	62	0	-1	-2	0	8	0
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S	13	84	10	12	28	-8	-71	0	10	24	-9	-70	0	2	3	1	-1	0
S	13	84	40	26	39	-12	-58	0	23	36	-11	-55	0	4	4	0	0	0
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S	13	84	160	-14	-14	9	64	0	-10	-11	15	67	0	-2	-3	-5	-2	0
S	13	84	190	-7	-3	27	95	0	-4	-3	32	97	0	-1	0	-3	-1	0
S	13	84	220	-10	-13	49	79	0	-10	-12	50	78	0	-1	0	0	1	0
S	13	84	250	-18	-19	36	26	0	-16	-18	33	23	0	-1	0	2	3	0
S	13	84	280	-6	-15	-12	-19	0	-7	-15	-13	-21	0	0	0	2	3	0
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S	13	84	340	8	0	-36	-73	0	6	-1	-39	-72	0	1	2	1	-1	0
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S	13	90	70	32	36	-6	-35	0	27	36	-1	-32	0	5	0	-3	-2	0
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S	13	90	280	-5	-15	-12	-18	0	-5	-15	-10	-15	0	0	0	0	0	0
S	13	90	310	-13	-16	-24	-48	0	-11	-15	-23	-43	0	-2	0	-1	-4	0
S	13	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	18	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	183	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	99	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	183	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	58	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	184	198	66	71	72	85	90
R	3	90	145	129	112	97	91	128	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	29	37	40	18	20	28	27	31
R	4	40	35	40	59	78	86	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	63	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	14	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
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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
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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
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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	18	14	21	23	16	14	12	18	19
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R	6	40	36	36	37	42	45	34	32	28	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
R	6	50	43	48	56	62	65	40	39	41	51	54	20	20	22	17	17
R	6	55	47	55	66	68	70	45	50	54	63	67	19	24	24	15	12
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R	6	65	57	75	85	81	81	52	70	82	59	60	31	34	31	29	29
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R	6	75	76	84	90	104	106	87	96	100	104	101	49	54	48	33	24
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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	58	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	100	53	110	79	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	100	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
R	9	50	38	63	74	81	86	36	51	55	62	65	21	26	25	27	28
R	9	55	43	69	86	93	95	39	58	69	77	86	19	26	25	24	24
R	9	60	50	78	99	109	115	42	70	81	85	90	25	32	29	35	34
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	115	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	88	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
R	10	25	15	28	32	39	41	17	27	23	46	51	14	17	17	20	21

R	10	30	19	33	42	43	43	18	29	30	36	37	15	20	21	21	21
R	10	35	26	42	55	56	56	21	33	40	36	34	16	21	26	30	35
R	10	40	31	52	69	76	81	28	39	53	50	52	18	24	31	40	44
R	10	45	35	65	84	100	107	35	47	63	66	70	18	29	34	43	47
R	10	50	39	83	100	123	133	36	53	80	92	99	19	38	30	41	45
R	10	55	44	104	114	143	155	41	76	95	117	129	19	36	30	38	38
R	10	60	50	120	128	165	178	44	129	111	132	147	25	39	34	45	45
R	10	65	61	110	144	188	204	53	119	133	160	175	32	27	31	46	49
R	10	70	72	106	148	209	228	71	120	153	189	209	43	35	35	42	42
R	10	75	79	102	144	218	233	90	123	165	233	255	50	54	50	47	45
R	10	80	92	90	124	198	213	84	116	157	238	246	53	65	66	62	58
R	10	85	108	94	104	162	181	103	104	146	224	243	64	72	75	86	86
R	10	90	143	122	102	113	124	125	133	143	184	197	110	133	132	126	123
R	10	100	132	132	132	132	132	154	154	154	154	154	75	75	75	75	75
R	10	120	183	183	183	183	183	79	79	79	79	79	211	211	211	211	211
R	10	140	125	125	125	125	125	72	72	72	72	72	146	146	146	146	146
R	10	160	90	90	90	90	90	65	65	65	65	65	105	105	105	105	105
R	10	180	71	71	71	71	71	58	58	58	58	58	81	81	81	81	81
R	10	200	61	61	61	61	61	52	52	52	52	52	69	69	69	69	69
R	11	25	16	36	24	54	60	17	16	19	43	49	15	26	18	28	30
R	11	30	20	55	34	65	71	19	34	25	56	64	16	28	19	30	33
R	11	35	28	75	44	77	84	24	45	38	66	73	18	38	26	40	42
R	11	40	33	97	53	98	107	30	72	45	75	83	18	41	31	52	56
R	11	45	37	122	66	123	134	36	109	54	97	108	19	33	35	52	56
R	11	50	40	124	80	146	160	39	129	65	117	129	20	24	31	48	52
R	11	55	46	117	93	166	181	40	118	77	146	161	19	20	35	41	41
R	11	60	52	104	108	179	194	48	116	86	164	178	24	23	37	43	44
R	11	65	58	98	125	189	205	55	108	120	188	203	32	27	41	46	48
R	11	70	70	94	127	190	209	69	108	139	200	215	43	39	45	47	49
R	11	75	77	89	121	181	200	88	110	145	209	222	51	61	65	61	60
R	11	80	92	92	114	158	169	82	104	139	204	221	52	63	71	80	83
R	11	85	109	105	111	130	134	102	100	130	185	199	66	71	72	85	90
R	11	90	145	129	112	98	92	128	151	153	153	154	108	121	122	115	113
R	11	100	132	132	132	132	132	154	154	154	154	154	75	75	75	75	75
R	11	120	183	183	183	183	183	79	79	79	79	79	211	211	211	211	211
R	11	140	125	125	125	125	125	72	72	72	72	72	146	146	146	146	146
R	11	160	90	90	90	90	90	65	65	65	65	65	105	105	105	105	105
R	11	180	71	71	71	71	71	58	58	58	58	58	81	81	81	81	81
R	11	200	61	61	61	61	61	52	52	52	52	52	69	69	69	69	69
R	12	25	21	18	45	34	30	21	22	31	31	32	16	17	22	33	35
R	12	30	24	24	57	55	53	24	21	51	40	36	18	21	24	39	42
R	12	35	31	33	62	71	73	29	29	64	60	61	19	24	29	52	58
R	12	40	36	43	67	99	105	35	40	65	64	65	19	29	38	58	63
R	12	45	39	52	79	129	138	39	49	73	98	104	20	29	41	52	54
R	12	50	42	61	89	153	165	41	49	82	127	137	21	24	35	46	48
R	12	55	47	69	97	168	182	44	64	92	161	173	18	27	38	48	49
R	12	60	51	76	107	175	189	50	73	94	175	188	23	36	39	50	53
R	12	65	57	80	114	171	186	53	90	121	187	203	31	39	47	51	54
R	12	70	69	79	111	161	176	68	93	131	189	203	44	45	49	53	55
R	12	75	76	78	103	141	152	86	97	129	182	195	52	67	73	70	69
R	12	80	94	93	106	118	121	80	95	123	167	179	52	61	75	92	97
R	12	85	110	112	114	104	100	102	96	117	147	156	65	70	70	84	87
R	12	90	146	133	118	88	72	130	163	159	127	114	106	111	114	107	105
R	12	100	132	132	132	132	132	154	154	154	154	154	75	75	75	75	75

R	12	120	183	183	183	183	183	79	79	79	79	79	211	211	211	211	211
R	12	140	125	125	125	125	125	72	72	72	72	72	146	146	146	146	146
R	12	160	90	90	90	90	90	65	65	65	65	65	105	105	105	105	105
R	12	180	71	71	71	71	71	58	58	58	58	58	81	81	81	81	81
R	12	200	61	61	61	61	61	52	52	52	52	52	69	69	69	69	69
R	13	25	20	38	46	77	95	22	30	35	58	77	15	19	30	43	98
R	13	30	24	46	63	104	126	21	39	40	74	92	17	24	38	53	104
R	13	35	33	56	90	136	159	28	45	57	92	113	21	26	49	62	110
R	13	40	40	67	118	177	202	34	57	82	120	139	21	28	71	85	114
R	13	45	46	76	145	220	250	41	67	111	161	183	23	27	50	70	122
R	13	50	54	88	167	255	289	49	78	138	209	236	22	26	41	60	75
R	13	55	59	96	184	282	321	56	86	162	244	277	20	28	39	56	63
R	13	60	63	104	199	309	353	66	102	183	272	306	29	33	39	58	92
R	13	65	65	104	209	331	386	61	108	208	304	342	35	35	44	50	77
R	13	70	77	102	203	349	416	74	116	226	342	391	46	44	54	44	67
R	13	75	86	100	182	341	422	94	120	227	377	441	52	62	80	65	59
R	13	80	102	102	152	290	377	90	111	212	385	469	54	65	106	116	94
R	13	85	121	116	135	195	281	112	118	191	332	423	68	74	128	164	171
R	13	90	158	140	173	134	194	135	149	180	219	298	109	117	165	185	189
R	13	100	192	192	192	192	192	224	224	224	224	224	97	97	97	97	97
R	13	120	183	183	183	183	183	79	79	79	79	79	211	211	211	211	211
R	13	140	125	125	125	125	125	72	72	72	72	72	146	146	146	146	146
R	13	160	90	90	90	90	90	65	65	65	65	65	105	105	105	105	105
R	13	180	71	71	71	71	71	58	58	58	58	58	81	81	81	81	81
R	13	200	61	61	61	61	61	52	52	52	52	52	69	69	69	69	69

RANDOM WINDS, CODE RW

RW	1	0	2	5	7	6	6	3	5	6	5	5
RW	1	5	6	10	13	11	11	4	9	12	11	11
RW	1	10	8	15	15	12	11	7	14	15	12	11
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
RW	1	65	21	38	45	37	35	21	25	38	47	49
RW	1	70	30	42	44	34	30	17	22	32	47	50
RW	1	75	35	38	45	51	52	32	43	46	42	40
RW	1	80	31	33	45	61	66	37	47	62	64	65
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	58	53	53	75	102	87	53	53
RW	1	120	72	64	62	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
RW	2	0	2	5	6	6	6	2	6	5	6	6
RW	2	5	6	10	12	11	10	4	9	12	11	11

RW	2	10	8	16	15	12	11	7	15	14	12	12
RW	2	15	9	12	10	11	11	7	11	9	11	12
RW	2	20	10	8	10	13	14	4	5	7	13	14
RW	2	25	12	9	14	16	17	3	3	12	12	13
RW	2	30	14	12	17	20	21	4	6	15	21	23
RW	2	35	16	19	22	21	20	7	8	17	25	27
RW	2	40	19	23	29	25	24	6	10	19	28	31
RW	2	45	24	26	35	31	30	10	13	21	33	36
RW	2	50	22	27	38	33	31	11	13	24	33	36
RW	2	55	20	27	39	39	38	16	15	21	31	34
RW	2	60	21	27	35	35	34	16	17	23	30	32
RW	2	65	20	37	44	36	34	21	24	36	44	47
RW	2	70	30	41	43	34	30	17	22	31	44	48
RW	2	75	35	38	45	49	50	32	41	45	42	41
RW	2	80	31	33	44	59	63	37	47	61	63	64
RW	2	85	41	35	46	57	60	56	61	74	60	61
RW	2	90	76	54	62	55	57	78	113	118	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
RW	3	0	2	5	6	5	5	3	5	6	5	5
RW	3	5	6	9	11	11	11	4	9	11	11	11
RW	3	10	8	15	14	11	10	7	14	14	11	10
RW	3	15	9	12	9	9	9	7	10	9	10	10
RW	3	20	10	7	9	11	11	4	5	7	10	11
RW	3	25	13	7	13	14	14	3	3	8	19	21
RW	3	30	13	11	13	15	15	4	4	8	19	22
RW	3	35	16	18	20	20	20	7	8	12	20	22
RW	3	40	19	19	26	24	23	6	8	13	21	24
RW	3	45	24	22	31	30	29	9	10	14	23	25
RW	3	50	21	22	32	29	28	10	11	17	23	25
RW	3	55	20	23	32	32	32	16	14	19	23	24
RW	3	60	22	26	31	32	32	15	16	20	25	27
RW	3	65	20	36	40	34	31	20	22	30	36	38
RW	3	70	29	38	40	32	29	17	21	28	38	40
RW	3	75	35	39	43	44	44	32	37	41	42	42
RW	3	80	31	34	41	52	55	37	47	59	60	61
RW	3	85	42	39	46	52	54	56	61	71	58	58
RW	3	90	76	56	56	53	54	76	100	109	55	56
RW	3	100	73	60	54	53	53	73	90	81	53	53
RW	3	120	71	65	52	52	52	71	79	52	52	52
RW	3	140	69	69	69	69	69	69	69	69	69	69
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
RW	3	200	87	87	87	87	87	87	87	87	87	87
RW	4	0	2	4	5	5	5	2	5	6	5	5
RW	4	5	5	8	11	10	10	4	8	12	11	10
RW	4	10	7	14	15	11	9	6	13	16	11	9
RW	4	15	7	11	9	9	10	6	10	9	8	8
RW	4	20	9	7	8	11	11	4	5	6	8	9
RW	4	25	12	5	5	7	8	3	3	3	5	5

RW	4	30	12	8	8	9	10	4	4	4	6	7
RW	4	35	17	14	14	11	11	8	6	8	8	9
RW	4	40	17	15	16	13	12	5	7	9	11	12
RW	4	45	23	19	20	16	15	9	8	9	10	10
RW	4	50	20	20	22	18	17	11	8	10	11	12
RW	4	55	21	22	25	21	20	16	12	15	14	14
RW	4	60	21	26	29	25	23	15	13	15	16	16
RW	4	65	20	34	35	29	27	20	19	20	21	21
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
RW	5	0	2	4	5	5	5	2	4	6	5	5
RW	5	5	5	7	11	10	9	4	7	11	10	9
RW	5	10	6	12	15	11	9	5	11	15	11	9
RW	5	15	8	10	9	6	5	6	10	9	6	5
RW	5	20	7	6	7	5	4	4	5	5	5	5
RW	5	25	12	4	3	3	3	3	2	2	3	4
RW	5	30	14	8	6	5	4	8	3	3	3	3
RW	5	35	15	10	10	8	8	9	6	7	5	5
RW	5	40	16	11	10	11	11	6	6	7	7	7
RW	5	45	22	15	14	18	19	19	8	8	8	8
RW	5	50	20	13	14	20	22	21	8	8	10	11
RW	5	55	19	15	16	28	31	23	10	12	11	11
RW	5	60	22	19	20	17	17	29	14	15	15	15
RW	5	65	18	28	29	23	21	20	20	20	18	18
RW	5	70	28	30	30	25	23	18	25	26	21	19
RW	5	75	35	39	41	35	33	31	32	42	45	46
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
RW	5	140	69	69	69	69	69	69	69	69	69	69
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
RW	6	0	2	4	5	4	4	2	4	5	5	4
RW	6	5	5	8	11	11	11	3	6	9	9	9
RW	6	10	6	11	14	12	11	5	9	14	12	11
RW	6	15	7	10	9	6	5	6	8	8	6	6
RW	6	20	7	6	6	5	4	4	5	5	4	4
RW	6	25	11	5	3	3	3	3	8	2	2	2
RW	6	30	12	7	4	3	3	3	8	2	2	2
RW	6	35	13	8	7	5	5	7	8	6	4	4
RW	6	40	17	9	8	6	6	6	8	6	5	4
RW	6	45	23	13	10	8	8	10	9	8	5	4

RW	6	50	20	13	41	10	10	10	10	10	7	5
RW	6	55	20	15	13	15	16	15	13	10	8	8
RW	6	60	20	16	15	15	16	15	13	17	13	14
RW	6	65	17	22	23	18	16	20	20	20	16	15
RW	6	70	27	26	26	21	20	18	28	27	17	12
RW	6	75	35	38	41	35	33	31	32	46	47	48
RW	6	80	32	41	47	44	43	37	49	51	43	40
RW	6	85	45	57	61	47	46	56	61	58	46	44
RW	6	90	81	95	86	50	50	75	92	100	50	49
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
RW	6	160	87	87	87	87	87	87	87	87	87	87
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
RW	7	0	2	3	4	4	4	2	3	5	4	4
RW	7	5	5	6	8	9	9	4	5	8	8	8
RW	7	10	6	8	14	12	11	4	7	14	12	11
RW	7	15	7	8	9	7	5	5	7	9	6	5
RW	7	20	7	5	6	4	4	4	4	5	4	3
RW	7	25	11	3	2	2	2	4	3	2	2	2
RW	7	30	12	4	3	2	2	4	3	2	2	2
RW	7	35	12	6	5	5	5	7	5	4	3	2
RW	7	40	14	7	8	6	6	7	6	6	4	3
RW	7	45	20	11	10	5	4	9	8	8	4	4
RW	7	50	24	9	9	6	4	11	8	7	5	5
RW	7	55	20	12	12	9	7	14	11	10	8	7
RW	7	60	25	17	12	8	7	19	15	18	13	11
RW	7	65	17	20	20	15	13	20	20	20	16	14
RW	7	70	27	24	24	20	18	18	29	27	15	8
RW	7	75	35	38	41	35	33	31	33	47	48	48
RW	7	80	32	42	48	45	44	37	49	50	41	37
RW	7	85	45	59	63	55	53	56	61	57	46	42
RW	7	90	82	100	91	76	70	75	94	101	80	72
RW	7	100	78	84	72	53	53	73	81	77	53	53
RW	7	120	73	67	52	52	52	71	67	52	52	52
RW	7	140	69	69	69	69	69	69	69	69	69	69
RW	7	160	87	87	87	87	87	87	87	87	87	87
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
RW	8	0	2	3	5	5	5	2	3	4	4	4
RW	8	5	5	5	8	9	9	4	5	9	8	8
RW	8	10	6	8	13	12	11	5	8	14	12	11
RW	8	15	7	8	10	7	6	5	7	10	7	5
RW	8	20	7	5	6	5	4	4	4	5	4	4
RW	8	25	10	3	3	3	3	3	2	2	2	2
RW	8	30	13	4	4	5	5	5	3	2	2	2
RW	8	35	14	7	6	6	7	7	6	5	3	3
RW	8	40	17	10	8	8	8	6	6	6	4	3
RW	8	45	24	13	11	8	7	9	9	8	5	4
RW	8	50	21	13	11	9	8	10	10	8	6	6
RW	8	55	17	17	13	12	11	13	12	11	8	7
RW	8	60	18	19	19	15	14	16	14	17	14	14
RW	8	65	17	22	23	18	16	20	20	20	16	15

RW	B	70	27	26	26	21	20	18	28	27	17	12
RW	B	75	35	38	41	35	33	31	32	46	47	48
RW	B	80	32	41	47	44	43	37	49	51	43	40
RW	B	85	45	57	61	47	46	56	61	58	46	44
RW	B	90	81	95	86	50	50	75	92	100	50	49
RW	B	100	100	87	69	53	53	100	85	76	53	53
RW	B	120	90	78	52	52	52	90	77	52	52	52
RW	B	140	69	69	69	69	69	69	69	69	69	69
RW	B	160	87	87	87	87	87	87	87	87	87	87
RW	B	180	87	87	87	87	87	87	87	87	87	87
RW	B	200	87	87	87	87	87	87	87	87	87	87
RW	9	0	2	4	5	6	6	2	3	5	5	5
RW	9	5	4	6	10	9	9	3	6	10	9	9
RW	9	10	5	10	15	12	10	4	9	16	12	10
RW	9	15	7	9	10	7	5	5	8	10	7	6
RW	9	20	8	6	7	5	5	4	4	6	5	5
RW	9	25	11	4	4	5	6	3	3	3	3	3
RW	9	30	13	6	5	7	8	3	5	3	5	5
RW	9	35	14	10	10	9	10	6	6	7	6	7
RW	9	40	19	12	11	12	13	5	7	7	8	9
RW	9	45	22	15	15	13	13	8	8	9	7	7
RW	9	50	16	15	15	15	15	8	8	9	9	9
RW	9	55	16	16	18	18	18	13	12	12	9	8
RW	9	60	18	20	22	21	21	14	13	16	17	17
RW	9	65	18	28	29	23	21	20	20	20	18	18
RW	9	70	28	30	30	25	23	18	25	26	21	19
RW	9	75	35	39	41	35	33	31	32	42	45	46
RW	9	80	31	38	43	43	43	37	48	52	49	48
RW	9	85	44	52	55	46	46	56	61	61	50	50
RW	9	90	79	82	72	50	50	73	86	98	51	51
RW	9	100	71	67	62	53	53	71	55	56	53	53
RW	9	120	64	51	52	52	52	64	51	52	52	52
RW	9	140	69	69	69	69	69	69	69	69	69	69
RW	9	160	87	87	87	87	87	87	87	87	87	87
RW	9	180	87	87	87	87	87	87	87	87	87	87
RW	9	200	87	87	87	87	87	87	87	87	87	87
RW	10	0	3	4	6	5	5	2	4	6	5	5
RW	10	5	5	7	11	10	9	4	7	12	10	9
RW	10	10	6	12	15	13	13	5	11	16	12	10
RW	10	15	7	11	10	9	8	5	9	11	8	7
RW	10	20	8	7	7	8	8	4	5	7	8	8
RW	10	25	12	6	7	9	9	4	3	6	9	9
RW	10	30	15	8	9	9	9	4	4	7	11	12
RW	10	35	16	15	14	12	11	6	6	9	13	15
RW	10	40	17	19	16	13	12	6	6	11	14	15
RW	10	45	19	22	21	15	13	8	8	12	14	15
RW	10	50	16	22	23	19	16	9	9	12	16	17
RW	10	55	17	22	26	23	22	13	13	16	18	18
RW	10	60	21	26	29	29	27	16	13	16	22	24
RW	10	65	20	34	35	29	27	20	19	20	21	21
RW	10	70	28	35	35	30	28	17	19	24	26	26
RW	10	75	36	40	41	35	33	31	31	36	42	44
RW	10	80	31	34	38	41	42	37	47	54	56	57
RW	10	85	43	45	46	45	46	56	62	65	55	56

RW	10	90	77	59	48	49	49	72	77	95	54	54
RW	10	100	74	60	50	53	53	71	69	50	53	53
RW	10	120	72	60	52	52	52	70	60	52	52	52
RW	10	140	69	69	69	69	69	69	69	69	69	69
RW	10	160	87	87	87	87	87	87	87	87	87	87
RW	10	180	87	87	87	87	87	87	87	87	87	87
RW	10	200	87	87	87	87	87	87	87	87	87	87
RW	11	0	3	5	6	6	6	2	5	6	6	5
RW	11	5	5	8	11	11	10	4	8	12	11	11
RW	11	10	7	13	15	12	10	6	12	16	12	11
RW	11	15	8	11	10	8	8	6	10	10	9	9
RW	11	20	9	7	8	9	9	4	5	7	10	10
RW	11	25	11	7	8	11	12	3	4	7	13	15
RW	11	30	16	12	12	12	11	4	6	9	17	18
RW	11	35	15	26	18	15	15	7	8	12	19	21
RW	11	40	16	18	19	20	21	5	9	13	19	21
RW	11	45	22	20	23	25	26	9	12	14	20	22
RW	11	50	20	22	27	25	24	10	13	18	24	26
RW	11	55	21	23	29	32	32	14	15	20	23	24
RW	11	60	21	24	31	32	31	15	17	21	26	27
RW	11	65	20	36	40	34	31	20	22	30	36	38
RW	11	70	29	38	40	32	29	17	21	28	38	40
RW	11	75	35	39	43	44	44	32	37	41	42	42
RW	11	80	31	34	41	52	55	37	47	59	60	61
RW	11	85	42	39	46	52	54	56	61	71	58	58
RW	11	90	76	56	56	53	54	76	100	109	55	56
RW	11	100	74	60	54	53	53	74	90	81	53	53
RW	11	120	71	65	52	52	52	71	79	52	52	52
RW	11	140	69	69	69	69	69	69	69	69	69	69
RW	11	160	87	87	87	87	87	87	87	87	87	87
RW	11	180	87	87	87	87	87	87	87	87	87	87
RW	11	200	87	87	87	87	87	87	87	87	87	87
RW	12	0	2	5	7	6	6	3	5	6	6	6
RW	12	5	5	9	12	11	11	4	9	12	11	11
RW	12	10	8	15	15	11	10	7	15	15	12	10
RW	12	15	9	12	10	9	9	7	12	10	10	10
RW	12	20	10	8	10	10	11	4	6	9	11	12
RW	12	25	10	34	14	14	13	2	34	10	12	13
RW	12	30	17	13	19	18	18	4	6	14	19	21
RW	12	35	17	20	22	22	23	8	9	18	23	25
RW	12	40	20	24	23	27	28	7	13	22	28	30
RW	12	45	27	29	27	30	30	11	14	23	29	31
RW	12	50	25	31	31	32	31	12	15	25	30	30
RW	12	55	23	32	33	35	35	17	17	23	31	33
RW	12	60	23	29	34	35	35	18	21	23	30	32
RW	12	65	20	37	44	36	34	21	24	36	44	47
RW	12	70	30	41	43	34	30	17	22	31	44	48
RW	12	75	35	38	45	49	50	32	41	45	42	41
RW	12	80	31	33	44	59	63	37	47	61	63	64
RW	12	85	41	35	46	57	60	56	61	74	60	60
RW	12	90	76	54	62	55	56	78	113	118	56	57
RW	12	100	74	59	57	53	53	75	99	85	53	53
RW	12	120	72	64	52	52	52	72	84	52	52	52
RW	12	140	69	69	69	69	69	69	69	69	69	69

RW	12	160	87	87	87	87	87	87	87	87	87	87
RW	12	180	87	87	87	87	87	87	87	87	87	87
RW	12	200	87	87	87	87	87	87	87	87	87	87
RW	13	0	3	5	6	5	5	3	5	6	5	5
RW	13	5	6	10	11	10	10	4	8	11	10	10
RW	13	10	8	18	15	12	11	6	12	15	12	11
RW	13	15	10	16	10	9	9	6	10	10	9	9
RW	13	20	10	11	10	11	11	4	5	7	9	10
RW	13	25	11	11	10	11	11	3	10	7	10	11
RW	13	30	14	9	12	13	13	4	5	9	13	14
RW	13	35	15	15	16	16	15	7	7	11	16	17
RW	13	40	17	17	20	18	18	6	8	13	18	20
RW	13	45	23	20	24	22	21	11	10	14	20	22
RW	13	50	21	21	29	23	22	12	11	16	22	24
RW	13	55	20	22	27	27	27	16	13	17	22	23
RW	13	60	21	24	27	27	26	17	16	19	23	25
RW	13	65	19	32	35	29	27	20	21	27	30	31
RW	13	70	28	34	35	29	26	17	24	28	32	33
RW	13	75	35	39	42	41	40	31	35	43	44	44
RW	13	80	31	36	43	49	51	37	48	56	55	54
RW	13	85	43	47	52	52	54	56	61	66	56	56
RW	13	90	78	73	68	57	57	75	97	106	63	62
RW	13	100	76	69	60	53	53	75	81	74	53	53
RW	13	120	72	76	52	52	52	71	72	52	52	52
RW	13	140	69	69	69	69	69	69	69	69	69	69
RW	13	160	87	87	87	87	87	87	87	87	87	87
RW	13	180	87	87	87	87	87	87	87	87	87	87
RW	13	200	87	87	87	87	87	87	87	87	87	87

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

P, D, T ANNUAL PERCENTS, CODE P

P	13	0	761	599	498	435	415	633	504	414	361	341	485	495	762	829	852
P	13	5	734	610	535	488	473	617	522	455	417	401	472	495	758	827	851
P	13	10	707	622	572	540	530	601	540	497	472	461	459	496	753	825	850
P	13	15	679	633	608	592	587	586	557	538	527	522	447	496	749	824	849
P	13	20	652	644	645	644	645	570	575	579	582	582	434	497	745	822	848
P	13	25	621	643	663	673	677	616	613	611	611	610	445	519	732	803	827
P	13	30	607	672	719	747	757	500	591	656	695	707	390	454	740	828	857
P	13	35	571	696	784	938	856	459	613	722	788	810	362	520	752	850	883
P	13	40	531	692	808	877	900	508	654	758	821	841	412	588	714	790	815
P	13	45	523	690	802	869	892	534	670	766	824	844	440	551	630	678	693
P	13	50	495	667	789	863	887	491	649	762	830	853	418	493	545	577	588
P	13	55	471	646	770	846	871	483	636	746	812	834	430	472	502	520	526
P	13	60	517	655	753	813	832	587	673	734	771	784	544	570	588	600	604
P	13	65	550	642	707	747	760	681	710	730	742	747	677	703	722	733	737
P	13	70	583	629	662	682	688	648	663	673	679	681	574	587	597	602	604
P	13	75	616	616	616	616	616	615	615	615	615	615	471	471	471	471	471
P	13	80	637	637	637	637	637	571	571	571	571	571	455	455	455	455	455
P	13	85	657	657	657	657	657	526	526	526	526	526	439	439	439	439	439
P	13	90	678	678	678	678	678	482	482	482	482	482	422	422	422	422	422
P	13	100	719	719	719	719	719	393	393	393	393	393	390	390	390	390	390
P	13	120	599	599	599	599	599	328	328	328	328	328	325	325	325	325	325
P	13	140	479	479	479	479	479	262	262	262	262	262	260	260	260	260	260

P	13	160	360	360	360	360	360	197	197	197	197	197	195	195	195	195	195
P	13	180	240	240	240	240	240	131	131	131	131	131	130	130	130	130	130
P	13	200	120	120	120	120	120	66	66	66	66	66	65	65	65	65	65
PW	13	0	961	911	866	873	828	320	606	921	693	733					
PW	13	5	941	904	869	847	840	321	599	892	721	759					
PW	13	10	922	897	873	857	852	323	591	864	748	785					
PW	13	15	903	890	876	867	864	324	583	835	775	810					
PW	13	20	884	883	880	877	876	327	575	806	803	836					
PW	13	25	864	878	887	892	894	344	575	739	839	872					
PW	13	30	854	872	885	892	895	324	552	751	832	859					
PW	13	35	821	858	885	901	906	304	545	786	890	918					
PW	13	40	794	854	896	921	930	328	550	706	944	974					
PW	13	45	798	853	899	927	937	349	537	618	920	943					
PW	13	50	768	831	876	903	912	339	489	650	856	889					
PW	13	55	734	761	781	793	797	366	450	649	771	811					
PW	13	60	721	686	662	647	642	469	550	674	749	773					
PW	13	65	743	720	704	694	690	601	713	794	842	858					
PW	13	70	765	753	745	740	739	694	750	790	814	822					
PW	13	75	787	787	787	787	787	787	787	787	787	787					
PW	13	80	760	760	760	760	760	760	760	760	760	760					
PW	13	85	734	734	734	734	734	734	734	734	734	734					
PW	13	90	707	707	707	707	707	707	707	707	707	707					
PW	13	100	654	654	654	654	654	654	654	654	654	654					
PW	13	120	615	615	615	615	615	615	615	615	615	615					
PW	13	140	575	575	575	575	575	575	575	575	575	575					
PW	13	160	536	536	536	536	536	536	536	536	536	536					
PW	13	180	496	496	496	496	496	496	496	496	496	496					
PW	13	200	457	457	457	457	457	457	457	457	457	457					

SMALL & LARGE SCALE U-D AND V-D ANNUAL CORRELATIONS, CODE CS, CL

CS	13	0	-55	-17	-47	-65	-70	108	-27	-122	-181	-201					
CS	13	5	-61	-22	-42	-54	-58	82	-29	-107	-156	-173					
CS	13	10	-67	-26	-38	-44	-46	56	-32	-93	-131	-144					
CS	13	15	-74	-31	-33	-34	-34	30	-34	-78	-106	-116					
CS	13	20	-80	-36	-28	-24	-22	4	-36	-64	-82	-88					
CS	13	25	-86	-71	-60	-54	-52	1	-73	-125	-157	-168					
CS	13	30	-122	-67	-28	-4	4	-56	-75	-88	-97	-100					
CS	13	35	-113	-46	2	30	40	-75	-25	11	32	39					
CS	13	40	-72	-8	37	65	75	-101	15	98	147	163					
CS	13	45	-51	-9	22	40	46	-152	-8	95	157	177					
CS	13	50	-107	-52	-12	10	18	-169	-38	55	111	129					
CS	13	55	-213	-89	0	52	70	-183	-72	8	56	72					
CS	13	60	-102	-108	-15	41	60	-173	-93	-37	-2	9					
CS	13	65	-137	-77	15	68	87	-231	-56	68	143	168					
CS	13	70	-143	-82	19	79	99	-256	-58	82	168	196					
CS	13	75	-149	-86	24	89	112	-283	-61	97	193	225					
CS	13	80	-155	-91	29	99	124	-309	-63	112	218	253					
CS	13	85	-162	-96	34	110	136	-335	-65	126	243	281					
CS	13	90	-168	-100	38	120	148	-361	-67	141	268	310					
CS	13	100	-181	-109	48	140	172	-413	-72	170	318	366					
CS	13	120	-181	-109	48	140	172	-413	-72	170	318	366					
CS	13	140	-181	-109	48	140	172	-413	-72	170	318	366					
CS	13	160	-181	-109	48	140	172	-413	-72	170	318	366					
CS	13	180	-181	-109	48	140	172	-413	-72	170	318	366					

CS	13	200	-181	-109	48	140	172	-413	-72	170	318	366
CL	13	0	308	-207	-576	-796	-869	23	145	235	289	309
CL	13	5	289	-202	-553	-763	-832	23	136	218	268	287
CL	13	10	270	-197	-530	-729	-795	23	126	202	248	265
CL	13	15	251	-191	-507	-696	-759	24	117	185	227	242
CL	13	20	232	-186	-484	-663	-722	24	107	169	207	220
CL	13	25	283	-150	-459	-644	-705	-18	69	131	169	182
CL	13	30	223	-159	-432	-595	-650	74	116	147	165	172
CL	13	35	56	-202	-385	-495	-532	30	107	163	196	207
CL	13	40	96	-183	-382	-502	-542	-4	40	71	90	96
CL	13	45	163	-170	-407	-549	-596	34	-30	-76	-102	-111
CL	13	50	137	-180	-405	-540	-586	50	-47	-116	-157	-171
CL	13	55	126	-144	-335	-450	-489	36	-50	-110	-146	-159
CL	13	60	79	-108	-240	-320	-347	-2	-84	-143	-178	-190
CL	13	65	60	-138	-277	-361	-390	26	-94	-160	-200	-214
CL	13	70	41	-133	-254	-328	-353	26	-111	-180	-222	-237
CL	13	75	22	-127	-231	-294	-316	27	-127	-199	-243	-259
CL	13	80	3	-122	-208	-261	-280	27	-144	-219	-265	-282
CL	13	85	-16	-117	-185	-227	-243	27	-160	-238	-287	-304
CL	13	90	-36	-111	-162	-194	-206	27	-177	-258	-309	-327
CL	13	100	-74	-101	-116	-127	-132	28	-210	-297	-352	-372
CL	13	120	-74	-101	-116	-127	-132	28	-210	-297	-352	-372
CL	13	140	-74	-101	-116	-127	-132	28	-210	-297	-352	-372
CL	13	160	-74	-101	-116	-127	-132	28	-210	-297	-352	-372
CL	13	180	-74	-101	-116	-127	-132	28	-210	-297	-352	-372
CL	13	200	-74	-101	-116	-127	-132	28	-210	-297	-352	-372

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

QUASI-BIENNIAL OSCILLATIONS, CODE QP, QD, BT, 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	9	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	689	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	189	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	408	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	128	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	460	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	488	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	798	3	800
QV	90	0	801	0	828	0	849	0	859	0	863

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

SPHERICAL HARMONICS COEFFICIENTS, CODE SP

SP	25	1	-711	840	245	675	1188	-20	245	86	62
SP	30	1	-881	1246	272	770	1010	87	347	140	3
SP	35	1	-1051	1566	160	1006	1014	351	393	46	-221
SP	40	1	-1302	1834	85	1243	1499	416	288	-12	-475
SP	45	1	-1367	2771	-88	1384	2240	768	-131	-166	-642
SP	50	1	-1242	3707	-117	1218	2056	850	-298	-202	-783
SP	55	1	-591	3511	-638	2072	-255	1210	-447	-98	-920
SP	60	1	221	3594	-379	2791	-2082	1333	-683	-44	-1075
SP	65	1	-1197	4623	-66	3334	-4594	-355	2211	574	-442
SP	70	1	559	3331	-237	2488	0	0	0	0	0
SP	75	1	641	2705	16	2047	0	0	0	0	0
SP	80	1	607	2290	29	507	0	0	0	0	0
SP	85	1	1206	933	-595	139	0	0	0	0	0
SP	90	1	986	-566	-3359	-250	0	0	0	0	0
SP	25	1	10	-240	-76	-67	-212	160	-223	-42	-16
SP	30	1	-35	-355	-61	-52	-346	233	-242	-47	-29
SP	35	1	-92	-541	-37	38	-480	304	-226	-66	-37
SP	40	1	-4	-698	46	290	-713	350	-312	-110	-78
SP	45	1	137	-260	-117	150	-543	686	-271	-157	-132
SP	50	1	125	-490	-231	316	-743	649	18	-159	-264
SP	55	1	142	-781	-220	414	-368	222	235	-94	-167
SP	60	1	106	-1023	-101	728	-226	-145	334	-12	-59
SP	65	1	-317	-1126	531	250	24	-658	924	274	-140
SP	70	1	-350	-512	582	-375	0	0	0	0	0
SP	75	1	9	324	350	-237	0	0	0	0	0
SP	80	1	109	1667	603	-290	0	0	0	0	0
SP	85	1	-50	-1062	-237	1865	0	0	0	0	0
SP	90	1	-157	735	-2659	704	0	0	0	0	0
SP	25	2	-576	761	0	619	1379	-144	159	21	72
SP	30	2	-625	1125	215	724	1673	-177	296	110	33
SP	35	2	-396	1332	139	1073	1976	159	510	29	-218
SP	40	2	-1096	1658	201	1197	2355	375	626	-4	-451
SP	45	2	-844	2425	-38	1476	2520	739	310	-118	-581
SP	50	2	-250	2920	-136	1515	1211	270	433	-21	-375
SP	55	2	61	2993	155	1962	-1220	-63	684	243	-370
SP	60	2	501	2825	346	2292	-2378	504	903	320	-384
SP	65	2	-761	2642	197	2929	-4014	-181	3096	556	-313
SP	70	2	1532	3063	-587	1289	0	0	0	0	0
SP	75	2	690	2086	-273	816	0	0	0	0	0
SP	80	2	37	1593	-1908	385	0	0	0	0	0
SP	85	2	-16	1431	-1589	-888	0	0	0	0	0
SP	90	2	630	-60	-3774	-1464	0	0	0	0	0
SP	25	2	101	-41	-138	-184	-170	149	-326	-52	-25
SP	30	2	176	222	-175	-366	-189	403	-530	-89	-28
SP	35	2	235	70	-160	-324	-113	350	-669	-114	-11
SP	40	2	336	135	-135	-339	-282	489	-805	-171	-48
SP	45	2	357	-75	-31	47	-304	555	-629	-155	-153
SP	50	2	432	-416	-181	209	-343	348	-537	-223	-72

SP	55	2	194	-486	-338	478	-662	580	-44	-165	-175
SP	60	2	386	-762	83	642	-665	799	-83	-164	-277
SP	65	2	-72	-321	337	-42	-515	51	123	52	-114
SP	70	2	-471	-453	575	2	0	0	0	0	0
SP	75	2	113	156	597	-55	0	0	0	0	0
SP	80	2	293	1331	-320	-76	0	0	0	0	0
SP	85	2	576	-841	-1548	1420	0	0	0	0	0
SP	90	2	-446	1008	-2070	-1156	0	0	0	0	0
SP	25	3	-327	312	23	274	1498	194	-167	-32	28
SP	30	3	-522	274	415	676	1906	320	285	114	-69
SP	35	3	-580	211	535	887	2146	459	612	15	-215
SP	40	3	-256	173	108	1070	2035	538	472	-83	-433
SP	45	3	420	375	-291	1092	1076	232	286	-135	-210
SP	50	3	1029	852	-115	964	515	500	208	-82	-217
SP	55	3	1670	865	-401	952	-112	260	80	39	-82
SP	60	3	1550	544	218	1108	-693	-154	682	240	-141
SP	65	3	96	271	769	1527	-865	-490	2872	852	-46
SP	70	3	1418	2048	-33	-300	0	0	0	0	0
SP	75	3	269	1289	804	-434	0	0	0	0	0
SP	80	3	-71	1299	474	-409	0	0	0	0	0
SP	85	3	209	467	276	-540	0	0	0	0	0
SP	90	3	1088	-155	-4063	-761	0	0	0	0	0
SP	25	3	90	-56	-94	-100	-81	27	-189	-20	-1
SP	30	3	56	-130	-126	-78	-188	87	-190	-33	-32
SP	35	3	129	-238	-62	-92	-264	-7	-243	-37	-2
SP	40	3	128	-197	-73	-23	-320	-38	-257	-53	-33
SP	45	3	127	-278	-16	138	-495	112	-59	-39	-156
SP	50	3	169	-208	-175	63	-121	-94	93	-55	-62
SP	55	3	257	-79	-399	85	-182	297	55	-119	-182
SP	60	3	216	-49	-34	259	-292	-58	381	37	-17
SP	65	3	126	422	220	-359	-705	371	-49	-67	-105
SP	70	3	-288	80	-22	-187	0	0	0	0	0
SP	75	3	-238	530	-135	408	0	0	0	0	0
SP	80	3	162	1723	-518	-777	0	0	0	0	0
SP	85	3	1130	-427	-1869	431	0	0	0	0	0
SP	90	3	-304	430	-2055	200	0	0	0	0	0
SP	25	4	-459	-592	112	322	1273	10	234	30	117
SP	30	4	-319	-819	472	499	1488	121	533	95	-50
SP	35	4	14	-1099	449	473	1576	177	551	-42	-17
SP	40	4	599	-1216	250	98	1190	249	397	-110	-17
SP	45	4	1314	-1392	-96	-213	820	115	138	-192	136
SP	50	4	1637	-1969	-73	-198	-92	-94	334	-108	170
SP	55	4	2596	-1601	-364	-1082	331	-343	-438	-121	345
SP	60	4	2774	-2098	122	-764	343	307	-336	59	236
SP	65	4	2621	-3036	495	-284	760	-92	-30	221	204
SP	70	4	1634	-2286	-31	140	0	0	0	0	0
SP	75	4	90	-1584	355	638	0	0	0	0	0
SP	80	4	-169	-2090	-40	756	0	0	0	0	0
SP	85	4	334	52	-982	-1153	0	0	0	0	0
SP	90	4	900	438	-3888	-1663	0	0	0	0	0
SP	25	4	-10	-73	-55	-22	-181	-182	57	14	10
SP	30	4	-44	213	-31	-116	-206	-151	40	-2	73
SP	35	4	41	78	124	-120	-231	-309	-34	17	114
SP	40	4	8	296	127	-231	-304	-270	-53	11	130

SP	45	4	15	27	301	10	-516	-580	252	77	117
SP	50	4	358	336	203	-369	-187	-687	-103	-45	254
SP	55	4	475	388	-23	-307	-157	-287	-165	-107	171
SP	60	4	140	70	0	-148	-194	-396	356	-6	142
SP	65	4	387	503	447	-536	272	150	-23	-56	-14
SP	70	4	16	704	181	-504	0	0	0	0	0
SP	75	4	-88	679	269	-775	0	0	0	0	0
SP	80	4	139	1645	-278	-1611	0	0	0	0	0
SP	85	4	1084	-32	-1414	-66	0	0	0	0	0
SP	90	4	234	149	-2049	-472	0	0	0	0	0
SP	25	5	-461	-827	-193	21	1236	46	115	-87	120
SP	30	5	-405	-1138	201	-89	1062	167	435	-31	-43
SP	35	5	-83	-1761	207	-266	1067	-47	548	-81	134
SP	40	5	505	-2029	246	-892	211	-135	569	-47	270
SP	45	5	820	-2363	-1	-1575	-64	-223	440	-147	428
SP	50	5	1257	-3345	153	-1889	135	-538	459	-87	439
SP	55	5	2076	-2684	-104	-3002	369	-366	-829	-409	788
SP	60	5	2429	-4467	-650	-1679	446	404	-1180	-326	402
SP	65	5	3059	-5203	478	-1232	1932	420	-1539	-42	317
SP	70	5	941	-3887	249	-847	0	0	0	0	0
SP	75	5	421	-4788	50	316	0	0	0	0	0
SP	80	5	849	-4199	-179	1288	0	0	0	0	0
SP	85	5	719	-676	-992	-420	0	0	0	0	0
SP	90	5	901	-278	-2890	1279	0	0	0	0	0
SP	25	5	-35	195	-111	31	-265	-31	4	-18	16
SP	30	5	-46	301	-74	-95	-232	-117	21	3	42
SP	35	5	70	178	55	-50	-230	-234	-108	-19	38
SP	40	5	99	261	197	-78	-137	-317	-168	-8	62
SP	45	5	220	212	206	-170	-429	-538	-53	-22	80
SP	50	5	269	354	-189	-206	-550	-447	-90	-139	184
SP	55	5	168	831	-170	-581	-596	-344	170	-102	187
SP	60	5	213	962	-103	-587	-737	-331	108	-57	209
SP	65	5	289	1171	290	-673	-573	194	-203	-172	7
SP	70	5	37	522	308	-681	0	0	0	0	0
SP	75	5	-176	498	693	-1183	0	0	0	0	0
SP	80	5	-280	1163	-25	-1525	0	0	0	0	0
SP	85	5	231	439	-813	-487	0	0	0	0	0
SP	90	5	411	-673	-1671	960	0	0	0	0	0
SP	25	6	-433	-1575	84	15	1535	116	119	-22	-8
SP	30	6	-198	-2625	221	134	1958	137	217	61	-261
SP	35	6	66	-3324	271	-292	1993	-209	316	38	36
SP	40	6	384	-3602	441	-1109	1744	-342	312	74	322
SP	45	6	294	-4194	89	-1700	1736	-749	298	-26	784
SP	50	6	117	-4549	-56	-2116	1806	-891	201	-97	952
SP	55	6	723	-4788	-194	-2134	879	-704	-313	-1	808
SP	60	6	1306	-3750	-699	-2945	-512	-10	-1143	-301	892
SP	65	6	2527	-6108	334	-2552	887	469	-1842	-110	442
SP	70	6	1425	-4104	595	-2907	0	0	0	0	0
SP	75	6	1331	-5958	328	-733	0	0	0	0	0
SP	80	6	965	-4838	21	1085	0	0	0	0	0
SP	85	6	939	-1013	-1067	124	0	0	0	0	0
SP	90	6	672	204	-3358	1253	0	0	0	0	0
SP	25	6	-57	412	-111	-94	-364	-26	-18	-34	40
SP	30	6	-192	836	35	-246	-656	-201	15	-5	66

SP	85	10	334	-52	-982	1153	0	0	0	0	0
SP	90	10	900	-438	-3888	1663	0	0	0	0	0
SP	25	10	2	-6	-39	60	-84	148	54	14	-8
SP	30	10	12	-66	-15	30	8	175	-34	-20	-58
SP	35	10	18	58	96	34	-57	337	-30	10	-94
SP	40	10	59	-89	97	82	-163	351	-145	-14	-107
SP	45	10	179	140	312	-52	-356	629	5	24	-122
SP	50	10	450	-9	276	178	-176	849	-218	-59	-276
SP	55	10	679	-380	14	321	40	425	-357	-131	-270
SP	60	10	323	-351	-5	301	49	361	157	-55	-99
SP	65	10	85	109	510	172	-322	-17	297	-9	2
SP	70	10	-68	-36	300	154	0	0	0	0	0
SP	75	10	-35	589	151	117	0	0	0	0	0
SP	80	10	589	-459	-403	931	0	0	0	0	0
SP	85	10	1084	32	-1414	66	0	0	0	0	0
SP	90	10	234	-149	-2049	472	0	0	0	0	0
SP	25	11	-481	648	-167	131	1300	-212	186	-51	-32
SP	30	11	-408	1089	158	137	1413	-370	464	-20	114
SP	35	11	-109	1610	282	374	1268	-244	629	-4	95
SP	40	11	519	2112	268	853	508	-84	530	6	-56
SP	45	11	800	2554	33	1340	256	96	461	-55	-155
SP	50	11	1000	3016	273	1903	-60	250	765	71	-186
SP	55	11	973	2377	-120	2930	-871	316	554	-64	-583
SP	60	11	661	2208	-111	2959	-1655	280	502	-56	-728
SP	65	11	-539	2535	783	2808	-1888	-286	2335	559	-363
SP	70	11	321	2900	87	1592	0	0	0	0	0
SP	75	11	-486	2952	676	1088	0	0	0	0	0
SP	80	11	-302	1562	179	1170	0	0	0	0	0
SP	85	11	719	676	-992	420	0	0	0	0	0
SP	90	11	901	278	-2890	-1279	0	0	0	0	0
SP	25	11	2	-102	-83	-57	-146	61	-24	-16	-5
SP	30	11	21	-179	-65	13	-197	146	-85	-9	-36
SP	35	11	116	-66	32	-76	-287	296	-249	-48	-48
SP	40	11	182	-144	174	-117	-272	413	-386	-56	-59
SP	45	11	275	5	160	-50	-644	643	-273	-73	-84
SP	50	11	315	-218	-223	61	-524	523	-281	-186	-198
SP	55	11	210	-655	-112	436	-579	481	61	-124	-180
SP	60	11	301	-781	88	500	-658	494	76	-35	-88
SP	65	11	-178	-161	461	81	-1029	231	316	-68	-75
SP	70	11	-119	-240	422	374	0	0	0	0	0
SP	75	11	45	580	261	374	0	0	0	0	0
SP	80	11	247	193	-378	741	0	0	0	0	0
SP	85	11	231	-439	-813	487	0	0	0	0	0
SP	90	11	411	673	-1671	-960	0	0	0	0	0
SP	25	12	-477	1433	108	116	1639	-239	211	11	56
SP	30	12	-391	2297	148	44	1631	-321	440	105	282
SP	35	12	-190	2904	231	538	1481	-34	648	126	54
SP	40	12	-67	3051	442	1389	1093	156	899	222	-307
SP	45	12	-143	3594	125	1885	1107	590	818	113	-642
SP	50	12	-723	3746	-8	2408	403	851	1182	94	-815
SP	55	12	-201	3969	295	2394	26	835	490	-47	-763
SP	60	12	-492	2533	7	3708	-1961	477	835	97	-993
SP	65	12	-582	5098	-124	3359	-3499	682	1094	203	-640
SP	70	12	-28	3114	-282	3238	0	0	0	0	0

SP	35	6	-157	1006	155	-462	-879	-436	-9	-47	136
SP	40	6	-318	1645	209	-946	-1241	-614	135	-63	298
SP	45	6	246	864	148	-699	-914	-791	-206	-143	278
SP	50	6	384	337	-14	-370	-561	-785	-116	-143	250
SP	55	6	333	388	-103	-316	-249	-480	107	-46	261
SP	60	6	292	780	-290	-888	-500	-499	326	-32	246
SP	65	6	331	1407	63	-1012	-259	-1	178	-65	177
SP	70	6	-382	851	367	-166	0	0	0	0	0
SP	75	6	-779	494	336	-520	0	0	0	0	0
SP	80	6	-825	748	514	-1044	0	0	0	0	0
SP	85	6	-101	1061	-624	-1611	0	0	0	0	0
SP	90	6	-475	-1188	-2589	1459	0	0	0	0	0
SP	25	7	-505	-1126	67	-458	1185	-176	-182	-58	-20
SP	30	7	-470	-1820	187	-476	1450	-282	-214	-13	-35
SP	35	7	-467	-2415	194	-502	1719	-637	-352	-119	259
SP	40	7	-653	-2654	95	-868	2154	-453	-431	-160	371
SP	45	7	-1023	-3595	-561	-1244	2744	-831	-599	-370	755
SP	50	7	-769	-4327	-227	-1226	2755	-630	-660	-281	832
SP	55	7	358	-4608	-523	-1668	1009	-1045	-1133	-159	837
SP	60	7	1613	-3206	-525	-3314	-440	-1038	-2134	-342	1225
SP	65	7	2712	-6106	-124	-2458	1206	1016	-1677	37	217
SP	70	7	1877	-6369	-331	-1201	0	0	0	0	0
SP	75	7	1209	-7179	21	-123	0	0	0	0	0
SP	80	7	662	-5700	233	1133	0	0	0	0	0
SP	85	7	1206	-933	-595	-139	0	0	0	0	0
SP	90	7	986	566	-3359	250	0	0	0	0	0
SP	25	7	-100	522	-44	-130	-392	-98	-54	-11	44
SP	30	7	-109	625	0	-199	-454	-157	-41	-3	68
SP	35	7	-37	502	8	-68	-476	-336	-230	-64	80
SP	40	7	-57	889	64	-446	-809	-313	-165	-81	99
SP	45	7	-46	929	-17	-522	-841	-568	120	-68	156
SP	50	7	4	712	-125	-432	-608	-566	299	-81	189
SP	55	7	-95	1052	-110	-616	-516	-237	568	-13	135
SP	60	7	-77	1186	-51	-831	-843	149	556	10	46
SP	65	7	-121	-1178	912	966	1939	301	1394	547	-73
SP	70	7	-433	379	357	310	0	0	0	0	0
SP	75	7	-365	-67	251	-101	0	0	0	0	0
SP	80	7	-382	-158	818	-819	0	0	0	0	0
SP	85	7	-50	1062	-237	-1865	0	0	0	0	0
SP	90	7	-157	-735	-2659	-704	0	0	0	0	0
SP	25	8	-503	-907	-61	-516	1300	64	3	-32	-69
SP	30	8	-505	-1429	98	-575	1529	11	17	-4	-82
SP	35	8	-764	-1731	108	-833	2151	-403	158	-107	242
SP	40	8	-818	-2281	267	-918	2610	-565	214	-121	359
SP	45	8	-748	-3038	-391	-1373	2830	-1013	-10	-333	721
SP	50	8	155	-3256	-185	-1596	1214	-397	-74	-198	525
SP	55	8	1177	-4372	-84	-1196	297	121	-320	-48	320
SP	60	8	1988	-3365	-63	-2127	-521	-276	-728	-32	480
SP	65	8	3314	-4647	-191	-1687	746	663	-1323	-164	154
SP	70	8	1986	-4586	-244	-725	0	0	0	0	0
SP	75	8	1094	-7017	-537	1277	0	0	0	0	0
SP	80	8	445	-6044	-1835	2684	0	0	0	0	0
SP	85	8	-16	-1431	-1589	888	0	0	0	0	0
SP	90	8	630	60	-3774	1464	0	0	0	0	0

SP	25	8	83	127	-103	116	-187	-85	-277	-32	11
SP	30	8	196	-164	-67	205	74	-318	-364	-35	40
SP	35	8	264	-160	-2	258	127	-281	-525	-51	-7
SP	40	8	352	-65	33	209	42	-370	-600	-88	21
SP	45	8	358	247	35	-205	5	-428	-473	-102	93
SP	50	8	371	553	-148	-322	-461	-208	-382	-191	-20
SP	55	8	74	722	-201	-616	-506	-412	201	-74	131
SP	60	8	202	722	229	-622	-636	-614	212	-73	267
SP	65	8	-9	946	476	-356	-307	83	132	92	91
SP	70	8	-581	768	486	-311	0	0	0	0	0
SP	75	8	-386	340	375	-702	0	0	0	0	0
SP	80	8	-150	-277	-35	-867	0	0	0	0	0
SP	85	8	576	841	-1549	-1420	0	0	0	0	0
SP	90	8	-446	-1008	-2070	1156	0	0	0	0	0
SP	25	9	-269	-356	27	-243	1470	-207	-255	-54	-35
SP	30	9	-405	-511	409	-570	1975	-468	88	42	58
SP	35	9	-559	-561	546	-677	2290	-734	434	-76	321
SP	40	9	-119	-499	228	-926	2151	-755	241	-155	443
SP	45	9	538	-453	-556	-1153	1473	-529	-146	-367	479
SP	50	9	1386	-1205	-76	-785	932	-711	-240	-215	412
SP	55	9	2083	-1673	-427	-471	-212	-318	-355	-94	89
SP	60	9	2545	-1784	-167	-455	30	188	-566	-86	70
SP	65	9	2982	-3117	508	145	2456	-226	-273	354	136
SP	70	9	1774	-3800	-109	1306	0	0	0	0	0
SP	75	9	295	-4635	715	2044	0	0	0	0	0
SP	80	9	-14	-4175	481	2512	0	0	0	0	0
SP	85	9	209	-467	276	540	0	0	0	0	0
SP	90	9	1088	155	-4063	761	0	0	0	0	0
SP	25	9	80	101	-85	58	-101	2	-168	-12	-6
SP	30	9	83	131	-122	5	-51	-66	-174	-31	21
SP	35	9	164	199	-27	30	-69	31	-238	-29	-20
SP	40	9	164	180	-55	-44	-82	83	-260	-53	-19
SP	45	9	177	96	-57	-47	-143	-148	-70	-41	76
SP	50	9	73	387	-251	-183	-158	116	182	-66	57
SP	55	9	123	260	-246	-224	-258	-281	324	-37	167
SP	60	9	217	-290	44	-104	186	226	467	87	-82
SP	65	9	9	731	268	-314	-684	152	171	5	8
SP	70	9	-363	590	-31	-302	0	0	0	0	0
SP	75	9	-458	427	-51	-1171	0	0	0	0	0
SP	80	9	42	-666	-593	-147	0	0	0	0	0
SP	85	9	1130	427	-1869	-431	0	0	0	0	0
SP	90	9	-304	-430	-2055	-200	0	0	0	0	0
SP	25	10	-421	413	75	-150	1225	-149	143	2	-53
SP	30	10	-381	690	360	-380	1334	-390	485	17	134
SP	35	10	-189	836	352	-244	1362	-571	665	-77	262
SP	40	10	448	1119	240	43	727	-511	558	-93	146
SP	45	10	1179	1153	-73	290	62	-438	365	-118	37
SP	50	10	1433	1438	-56	492	-669	-290	636	-10	-64
SP	55	10	1898	1051	-332	1338	-880	126	463	68	-302
SP	60	10	1641	396	209	1752	-1305	-36	606	215	-502
SP	65	10	1295	1441	423	1174	-226	-742	1498	481	-110
SP	70	10	712	-130	-424	1418	0	0	0	0	0
SP	75	10	-782	1499	296	89	0	0	0	0	0
SP	80	10	-991	198	35	1168	0	0	0	0	0

SP	75	12	-84	3674	-23	1902	0	0	0	0	0
SP	80	12	-85	2077	-160	1227	0	0	0	0	0
SP	85	12	939	1013	-1067	-124	0	0	0	0	0
SP	90	12	672	-204	-3358	-1253	0	0	0	0	0
SP	25	12	8	-250	-112	-23	-196	46	-105	-42	-23
SP	30	12	-74	-412	19	-37	-348	239	-182	-42	4
SP	35	12	-70	-665	134	220	-607	454	-167	-73	-56
SP	40	12	-112	-873	139	432	-796	710	-204	-135	-168
SP	45	12	315	-544	-12	473	-925	928	-451	-241	-278
SP	50	12	538	-184	-124	211	-468	911	-484	-259	-299
SP	55	12	450	-404	-18	284	-33	524	-118	-113	-313
SP	60	12	345	-749	-328	881	-265	535	142	-74	-283
SP	65	12	-50	-1017	-31	812	-191	540	529	-27	-407
SP	70	12	-194	-186	563	-300	0	0	0	0	0
SP	75	12	-260	645	351	-250	0	0	0	0	0
SP	80	12	-345	1191	409	12	0	0	0	0	0
SP	85	12	-101	-1061	-624	1611	0	0	0	0	0
SP	90	12	-475	1188	-2589	-1459	0	0	0	0	0

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

APPENDIX C

SAMPLE INPUT AND OUTPUT FOR THE GRAM PROGRAM

Input to GRAM is as follows:

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

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 is desired set height increment negative.

CARD 1	<p>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.</p> <p>TIME INCREMENT - Time displacement (seconds) between successive positions for automatically generated profiles (new time = old time + time increment)</p> <p>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.</p> <p>OUTPUT OPTION - 0 for no non-print output of atmospheric parameter values, or value equal to unit number to get non-print output.</p> <p>MIN. GEOSTROPH. LAT. - Lowest latitude (magnitude) for which geostrophic winds are to be used in 4-D (0-25 km) and Jacchia (above 90 km) height segments. Otherwise, interpolation is used to fill in winds. In middle heights (25-90 km), the spherical harmonic model is used at all latitudes.</p>
CARD 2	<p>GROVES INPUT UNIT - Unit number for tape containing Groves and stationary perturbations (SCIDAT tape in Appendix A). Use any available unit number.</p> <p>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.</p> <p>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.</p> <p>4-D INPUT UNIT - Unit number for 4-D input data tape. Use any available unit number.</p> <p>RANDOM OPTION - 1 means compute random perturbation output, 2 means do not compute random perturbation output.</p> <p>QBO OPTION - 1 means compute QBO output, 2 means do not compute QBO output.</p> <p>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.</p> <p>NMC READ OPTION - 0 means read NMC grid data from SCIDAT tape, otherwise these data are read from cards.</p> <p>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.</p>

CARD 2 (cont'd.)

(OPTIONAL)*	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.
	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: 92.0, 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., 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 TO GRAM IS AS FOLLOWS

JULIAN DATE - Computed from input date, set equal to zero for month 13 (annual average)

INITIAL STAND- - Computed for initial position on input data
ARD DEVIATIONS
IN P, D, T, U,
V FOR LARGE
SCALE AND SMALL
SCALE

HEIGHT, LAT, LON, TIME	-	Position and time where atmospheric parameters are evaluated
UNPERTURBED PRES- SURE DENSITY, TEMPERATURE AND GEOSTROPHIC WIND (monthly mean values)	-	Computed from Jacchia, 4-D, or Groves - plus - stationary perturbations, depending on height.
TOTAL PRESSURE, DENSITY, TEMPE- RATURE, 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.

APPENDIX D - GRAM PROGRAM LISTING

Following is a listing of the Global Reference Atmospheric Model (GRAM) - Mod 3. Sequence numbers containing a four character subroutine code and a four digit number appear on the right of the printout.

C	FIRST DATA CARD READS INITIAL HEIGHT (KM), INITIAL LATITUDE (DEG)	GRAM	1
C	INITIAL LONGITUDE (DEG), F10.7, MEAN F10.7, AP, MONTH, DAY,	GRAM	2
C	YEAR (TOTAL YEAR - 1900), GREENWICH HOUR, MINUTES, SECONDS,	GRAM	3
C	LATITUDE INCREMENT (DEG), LONGITUDE INCREMENT (DEG),	GRAM	4
C	HEIGHT DECREASE (KM), MAXIMUM NUMBER OF POSITIONS (EXCLUDING	GRAM	5
C	INITIAL POSITION) TO BE COMPUTED, TIME INCREMENT BETWEEN	GRAM	6
C	POSITIONS, TRAJECTORY OPTION, OUTPUT OPTION, MINIMUM GEOSTROPHIC	GRAM	7
C	LATITUDE	GRAM	8
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,MMCOP,DD,XMJD,PHI1,PHI	GRAM	9
	, NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,	GRAM	10
	\$ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,	GRAM	11
	, IHR,MIN,MMORE,DX,HL,VL,DZ,B,EPS,IOPP,LOOK,IET,GLAT,	GRAM	12
	1RP1S,RD1S,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,	GRAM	13
	2UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2	GRAM	14
	COMMON/CHIC/LA(4,4),NB(2),IWSYM,UCCOEF(14,9),VCCOEF(14,9)	GRAM	15
	COMMON/WINCOM/ DUMSTF(17),UPRE,VPRE,DUPRE,DVPRE	GRAM	16
9090	FORMAT('1 ***** GLOBAL REFERENCE ATMOSPHERE - MOD 3 *****')	GRAM	17
	PI=3.1415927	GRAM	18
	FAC=0.017453293	GRAM	19
	LOOK=0	GRAM	20
	MONTH = 0	GRAM	21
	IOPT=0	GRAM	22
	H=0.	GRAM	23
	5 IF (IOPT.EQ.0.OR.(IOPT.GT.0.AND.H.LT.0.)) GO TO 6	GRAM	24
	READ(IOPT,10) IET,H,PHI,THET	GRAM	25
10	FORMAT()	GRAM	26
	GO TO 5	GRAM	27
6	MN = MONTH	GRAM	28
	NSAME = 0	GRAM	29
	READ(5,10,END=90) H1,PHI1,THET1,F10,F10B,AP,MN,IDA ,IYR,IHR,MINO,GRAM	GRAM	30
	1 ISECO,DPHI,DTHET,DH,NMAX,INCT,IOPT,IOPP,GLAT	GRAM	31
91	REWIND 4	GRAM	32
	WRITE(6,9090)	GRAM	33
	IF (ABS(PHI1).LE.90.)GO TO 7	GRAM	34
	PHI1=SIGN(180,-ABS(PHI1),PHI1)	GRAM	35
	THET1=THET1+180.	GRAM	36
	IF (THET1.GT.360.)THET1=THET1-360.	GRAM	37
7	IF (THET1.LT.0.) THET1=THET1+360	GRAM	38
	GLAT = ABS(GLAT)	GRAM	39
	IF (GLAT.LT. 5.) GLAT = 5.	GRAM	40
	IF (GLAT.GE.18.) GLAT = 17.999	GRAM	41
	GLATF=GLAT*FAC	GRAM	42
	WRITE(6,9010) H1,PHI1,THET1,F10,F10B,AP,MN,IDA ,IYR,IHR,MINO,	GRAM	43
	\$ ISECO,DPHI,DTHET,DH,NMAX,INCT,IOPT,IOPP,GLAT	GRAM	44
C	SET NSAME TO AVOID SETUP	GRAM	45
15	IF (MN.EQ.MONTH) NSAME = 1	GRAM	46
C	LOOKUP ON MULTIPLE PASSES	GRAM	47
	MONTH = MN	GRAM	48
C	CONVERT LATITUDE TO RADIANS	GRAM	49
	PHI1R=PHI1*FAC	GRAM	50
C	CONVERT LONGITUDE TO RADIANS	GRAM	51
	THET1R=THET1*FAC	GRAM	52
C	CONVERT LATITUDE INCREMENT TO RADIANS	GRAM	53
	DPHIR=DPHI*FAC	GRAM	54

C	CONVERT LONGITUDE INCREMENT TO RADIAN	GRAM 55
	DTHETR=DTHET*FAC	GRAM 56
C	READ DATA TAPE TO INITIALISE ARRAYS	GRAM 57
	CALL SETUP	GRAM 58
	NT = 1	GRAM 59
	IF(IOPT.EQ.0) GO TO 18	GRAM 60
	READ(IOPT,10) IET,H,PHI,THET	GRAM 61
	IF(ABS(PHI).LE.90.) GO TO 16	GRAM 62
	PHI = SIGN(180.-ABS(PHI),PHI)	GRAM 63
	THET = THET + 180.	GRAM 64
16	IF(THET.LT.0.)THET=THET+360.	GRAM 65
	IF(THET.GT.360.) THET = THET - 360.	GRAM 66
	PHIR=PHI*FAC	GRAM 67
	THETR=THET*FAC	GRAM 68
	GO TO 19	GRAM 69
18	H = H1 - DH	GRAM 70
C,....	DISPLACES POSITION BEFORE EVALUATION OF ATMOSPHERIC PARAMETERS	GRAM 71
	IET = INCT	GRAM 72
	PHIR=PHIR+DPHIR	GRAM 73
	THETR=THETR+DTHETR	GRAM 74
	IF (ABS(PHIR).LE.PI/2.) GO TO 17	GRAM 75
	PHIR = SIGN(PI-ABS(PHIR),PHIR)	GRAM 76
	THETR = THETR + PI	GRAM 77
17	IF (THETR.GT.2.*PI) THETR = THETR - 2.*PI	GRAM 78
	IF (THETR.LT.0.) THETR = THETR + 2.*PI	GRAM 79
C	A=EQUATORIAL EARTH RADIUS, B = POLAR EARTH RADIUS	GRAM 80
C	EPS= EARTH ECCENTRICITY	GRAM 81
19	A = 6378.160	GRAM 82
	B = 6356.7747	GRAM 83
	EPS=(1.-(B*B)/(A*A))	GRAM 84
C,....	COMPUTES RADIUS TO HEIGHT H, AND GRAVITY AT HEIGHT AND	GRAM 85
C	LATITUDE PHIR	GRAM 86
	CALL RIG	GRAM 87
	ISEC=ISECO+IET	GRAM 88
	ISEC=MOD(ISEC,60)	GRAM 89
	MIN = MINO + IET/60	GRAM 90
	INR = IHRO + MIN / 60	GRAM 91
	MIN = MOD(MIN,60)	GRAM 92
C,....	COMPUTES P,D,T,U,V AT FIRST POSITION AFTER INITILL POSITION	GRAM 93
	IF(H1.LE.30.) LOOK=1	GRAM 94
	IF(ABS(PHIR).GT.GLATF) GO TO 195	GRAM 95
	PHIS=PHIR	GRAM 96
	DPHIS=(PHIR+GLATF)/(2.*GLATF)	GRAM 97
	PHIR=GLATF	GRAM 98
	CALL SCIMOD(0)	GRAM 99
	UP2=UPRE	GRAM 100
	VP2=VPRE	GRAM 101
	DUP2=DUPRE	GRAM 102
	DUP2=DUPRE	GRAM 103
	PHIR=-GLATF	GRAM 104
	CALL SCIMOD(0)	GRAM 105
	UP1=UPRE	GRAM 106
	VP1=VPRE	GRAM 107
	DUP1=DUPRE	GRAM 108

	DVP1=DVPRE	GRAM 109
	UPRE=UP1+(UP2-UP1)*DPHIS	GRAM 110
	VPRE=VP1+(VP2-VP1)*DPHIS	GRAM 111
	DUPRE=DUP1+(DUP2-DUP1)*DPHIS	GRAM 112
	DVPRE=DVP1+(DVP2-DVP1)*DPHIS	GRAM 113
	PHIR=PHIS	GRAM 114
195	CALL SCIMOD(1)	GRAM 115
20	NT = NT + 1	GRAM 116
	IF (IOPT,EQ,0) GO TO 22	GRAM 117
	READ(IOPT,10) IET,H,PHI,THET	GRAM 118
	IF(H,LT,0,)GO TO 5	GRAM 119
	IF(ABS(PHI),LE,90,)GO TO 21	GRAM 120
	PHI=SIGN(180,-ABS(PHI),PHI)	GRAM 121
	THET=THET+180.	GRAM 122
21	IF(THET,LT,0,)THET=THET+360.	GRAM 123
	IF(THET,GT,360,)THET=THET-360.	GRAM 124
	PHIR=PHI*FAC	GRAM 125
	THETR=THET*FAC	GRAM 126
	GO TO 25	GRAM 127
C	INCREMENT THE HEIGHT	GRAM 128
22	H = H1 - DH	GRAM 129
	IF (H ,LT. 0,0) GO TO 5	GRAM 130
C	INCREMENT THE LATITUDE	GRAM 131
	PHIR=PHIR+DPHIR	GRAM 132
C	INCREMENT THE LONGITUDE	GRAM 133
	THETR=THETR+DTHETR	GRAM 134
C....	READS NEW INPUT IF ABS(LAT) GTR 90 DEG	GRAM 135
	IF (ABS(PHIR),LE,PI/2) GO TO 23	GRAM 136
	PHIR=SIGN(PI-ABS(PHIR),PHIR)	GRAM 137
	THETR=THETR+PI	GRAM 138
23	IF (THETR,GT,2.*PI) THETR = THETR - 2. * PI	GRAM 139
	IF (THETR,LT,0,) THETR = THETR + 2. * PI	GRAM 140
C	INCREMENT THE TIME	GRAM 141
	IET=IET+INCT	GRAM 142
25	MIN=MIND+IET/60	GRAM 143
	ISEC=ISECO+IET	GRAM 144
	ISEC=MOD(ISEC,60)	GRAM 145
	IHR=IHR0+MIN/60	GRAM 146
	MIN=MOD(MIN,60)	GRAM 147
C	COMPUTE RADIUS AND GRAVITY AT NEW POSITION	GRAM 148
	CALL RIG	GRAM 149
C	COMPUTE P,D,T,U,V, AT NEW POSITION	GRAM 150
	IF(ABS(PHIR).GT,GLATF) GO TO R0	GRAM 151
	PHIS=PHIR	GRAM 152
	DPHIS=(PHIR+GLATF)/(2.*GLATF)	GRAM 153
	PHIR=GLATF	GRAM 154
	CALL SCIMOD(0)	GRAM 155
	UP2=UPRE	GRAM 156
	VP2=VPRE	GRAM 157
	DUP2=DUPRE	GRAM 158
	DVP2=DVPRE	GRAM 159
	PHIR=-GLATF	GRAM 160
	CALL SCIMOD(0)	GRAM 161
	UP1=UPRE	GRAM 162

VP1=VPRE	GRAM 163
DUP1=DUPRE	GRAM 164
DVP1=DVPRE	GRAM 165
UPRE=UP1+(UP2-UP1)*DPHIS	GRAM 166
VPRE=VP1+(VP2-VP1)*DPHIS	GRAM 167
DUPRE=DUP1+(DUP2-DUP1)*DPHIS	GRAM 168
DVPRE=DVP1+(DVP2-DVP1)*DPHIS	GRAM 169
PHIR=PHIS	GRAM 170
80 CALL SCIMOD(1)	GRAM 171
	GRAM 172
C....,READS NEW INPUT IF NMORE = 0 OR MAX POINTS COMPUTED	GRAM 173
IF(NMORE.EQ.0.OR.(IOPT.EQ.0.AND.NT.GE.NMAX)) GO TO 5	GRAM 174
C CYCLE TO NEW POSITION	GRAM 175
GO TO 20	GRAM 176
90 STOP	GRAM 177
9010 FORMAT(' INITIAL HEIGHT = ',F7.2,' KM',T43,'INITIAL LAT = ',	GRAM 178
1F6.2,' DEG',T83,'INITIAL WEST LON = ',F6.2,' DEG',/, ' F10.7 = ',F	GRAM 179
8.2,	GRAM 180
2T43,'MEAN F10.7 = ',F7.2,T83,'AP = ',F8.2,/, ' DATE = ',I2,/,I2,	GRAM 181
3,/,I2,T43,'GREENWICH TIME = ',I2,":",I2,":",I2,/, ' LAT INCREMENT	GRAM 182
4= ',F6.2,' DEG',T43,'WEST LON INCREMENT = ',F6.2,' DEG',T83,'HEI',	GRAM 183
\$"GHT INCR",	GRAM 184
5"EMENT = ',F7.2,' KM',/, ' MAXIMUM NUMBER OF POSITIONS = ',I4,T43,	GRAM 185
6"TIME INCREMENT = ',I4,' SEC',/2X,'TRAJECTORY OPTION = ',I4,	GRAM 186
7T43,'OUTPUT OPTION = ',I2,T83,'MIN GEOSTROPH LAT = ',F5.1,/,	GRAM 187
END	GRAM 188
SUBROUTINE ADJUST	ADJU 1
COMMON/C4/DUM1(32),NG,P(16,26),D(16,26),T(16,26),SP(16,26)	ADJU 2
\$,SD(16,26),ST(16,26),DU1,DU2,HS	ADJU 3
COMMON/ADJCOM/A(26,3), B(26), X(26), KOUNT	ADJU 4
DIMENSION PQ(26), QQ(26), UC(26), VC(26), WC(26), U(26), V(26),	ADJU 5
\$ W(26)	ADJU 6
C ASSUMPTIONS@	ADJU 7
C HS IS THE SURFACE LEVEL	ADJU 8
C ALL DATA VALUES ABOVE SURFACE LEVEL ARE IN 1 KM INCREMENTS	ADJU 9
E1=0.075	ADJU 10
E2=0.150	ADJU 11
MAXIT=3	ADJU 12
KSMAX=10	ADJU 13
HSJ = HS	ADJU 14
IF (HS.LT.0.) HSJ = 0.	ADJU 15
JJ=INT(HSJ+2.)	ADJU 16
STEST=0.05	ADJU 17
ISS=1	ADJU 18
CONST=28703./980.665	ADJU 19
N=26	ADJU 20
ITER=0	ADJU 21
UC(1)=SQRT(SP(KOUNT,1))	ADJU 22
VC(1)=SQRT(SD(KOUNT,1))	ADJU 23
WC(1)=SQRT(ST(KOUNT,1))	ADJU 24
DO 5 I=JJ,N	ADJU 25
UC(I)=SQRT(SP(KOUNT,I))	ADJU 26
VC(I)=SQRT(SD(KOUNT,I))	ADJU 27
5 WC(I)=SQRT(ST(KOUNT,I))	ADJU 28

MM=N-1	ADJU 29
NP=N+1	ADJU 30
C.....SETS UP QUADRATURE FACTORS	ADJU 31
PQ(1)=500.*(FLOAT(INT(HSJ+1.))-HS)/(CONST*T(KOUNT,1))	ADJU 32
QQ(1)=500.*(FLOAT(INT(HSJ+1.))-HS)/(CONST*T(KOUNT,JJ))	ADJU 33
DO 15 I=JJ,MM	ADJU 34
IP=I+1	ADJU 35
PQ(I)=500./(CONST*T(KOUNT,I))	ADJU 36
15 QQ(I)=500./(CONST*T(KOUNT,IP))	ADJU 37
GO TO 58	ADJU 38
12 MM=N-1	ADJU 39
NP=N+1	ADJU 40
DO 14 I=1,26	ADJU 41
U(I)=UC(I)*UC(I)	ADJU 42
V(I)=VC(I)*VC(I)	ADJU 43
W(I)=WC(I)*WC(I)	ADJU 44
14 CONTINUE	ADJU 45
C.....INITIALIZE A(I,J)	ADJU 46
DO 20 I=1,26	ADJU 47
DO 20 J=1,3	ADJU 48
20 A(I,J)=0,	ADJU 49
C.....SETS UP COEFFICIENTS	ADJU 50
I2=0	ADJU 51
DO 35 I=1,MM	ADJU 52
IF(I.GT.1.AND.I.LT.JJ) GO TO 55	ADJU 53
AW=1./SP(KOUNT,I)	ADJU 54
BW=1./SD(KOUNT,I)	ADJU 55
CW=1./ST(KOUNT,I)	ADJU 56
IM=I-1	ADJU 57
IF(I.EQ.JJ) IM=1	ADJU 58
IP=I+1	ADJU 59
IF (I.EQ.1) IP=JJ	ADJU 60
I2=I2+1	ADJU 61
AW1=1./SP(KOUNT,IP)	ADJU 62
BW1=1./SD(KOUNT,IP)	ADJU 63
CW1=1./ST(KOUNT,IP)	ADJU 64
IF(I.EQ.1) GO TO 25	ADJU 65
A(I2,1)=-((1.-QQ(IM))*((1.+PQ(I))/AW+(1./BW+1./CW)*PQ(I)*QQ(IM)))	ADJU 66
25 A(I2,2)=(((1.-QQ(I))*2)/AW1+((1.+PQ(I))*2)/AW+(1./BW+1./CW)	ADJU 67
\$ *(PQ(I))*2)+(1./BW1+1./CW1)*QQ(I))*2	ADJU 68
IF(I.EQ.MM) GO TO 30	ADJU 69
A(I2,3)=-((1.-QQ(I))*((1.+PQ(IP))/AW1+(1./BW1+1./CW1)*	ADJU 70
\$ PQ(IP)*QQ(IP))	ADJU 71
30 B(I2)=U(IP)-U(I)-(U(I)-V(I)+W(I))*PQ(I)-(U(IP)-V(IP)+W(IP))*QQ(I)	ADJU 72
35 CONTINUE	ADJU 73
CALL DIAGEQ(I2)	ADJU 74
C.....FINDS CORRECTIONS	ADJU 75
AW=1./SP(KOUNT,1)	ADJU 76
BW=1./SD(KOUNT,1)	ADJU 77
CW=1./ST(KOUNT,1)	ADJU 78
UC(1)=SQRT(U(1)+X(1)*((1.+PQ(1))/AW))	ADJU 79
VC(1)=SQRT(V(1)-X(1)*PQ(1)/BW)	ADJU 80
WC(1)=SQRT(W(1)+X(1)*PQ(1)/CW)	ADJU 81
AW=1./SP(KOUNT,N)	ADJU 82

BW=1./SD(KOUNT,N)	ADJU 83
CW=1./ST(KOUNT,N)	ADJU 84
UC(N)=SQRT(U(N)-X(I2)*Q(NM)/AW)	ADJU 85
VC(N)=SQRT(V(N)-X(I2)*Q(NM)/BW)	ADJU 86
WC(N)=SQRT(W(N)+X(I2)*Q(NM)/CW)	ADJU 87
I2=1	ADJU 88
DO 40 I=JJ,NM	ADJU 89
I2=I2+1	ADJU 90
I2N=I2-1	ADJU 91
AW=1./SP(KOUNT,I)	ADJU 92
BW=1./SD(KOUNT,I)	ADJU 93
CW=1./ST(KOUNT,I)	ADJU 94
IM=I-1	ADJU 95
IF(I.EB,JJ)IM=1	ADJU 96
UC(I)=ABS(U(I) +(-X(I2N)*Q(IM)+X(I2)*Q(I))/AW)	ADJU 97
UC(I)=SQRT(UC(I))	ADJU 98
VC(I)=ABS(V(I) -(X(I2N)*Q(IM)+X(I2)*Q(I))/BW)	ADJU 99
VC(I)=SQRT(VC(I))	ADJU 100
WC(I)=ABS(W(I) +(X(I2N)*Q(IM)+X(I2)*Q(I))/CW)	ADJU 101
40 WC(I)=SQRT(WC(I))	ADJU 102
C.....BETS ADJUSTED VALUES	ADJU 103
C..... ADJUSTS ON TRIANGLE INEQUALITIES	ADJU 104
58 K=0	ADJU 105
DO 68 I=1,N	ADJU 106
IF(I.GT.1.AND.I.LT.JJ) GO TO 68	ADJU 107
AU=UC(I)	ADJU 108
AV=VC(I)	ADJU 109
AM=WC(I)	ADJU 110
AMAX=AMAX1(AU,AV,AM)	ADJU 111
EE=E1*AMAX	ADJU 112
EF=E2*AMAX	ADJU 113
AW=SP(KOUNT,I)	ADJU 114
BW=SD(KOUNT,I)	ADJU 115
CW=ST(KOUNT,I)	ADJU 116
COR=AU+AV-AM-EE	ADJU 117
DIV=AM+BW+CW	ADJU 118
IF(COR.GT.0.) GO TO 60	ADJU 119
COR=(AU+AV-AM-EF)/DIV	ADJU 120
AU=AU-COR*AW	ADJU 121
AV=AV-COR*BW	ADJU 122
AM=AM-COR*CW	ADJU 123
GO TO 64	ADJU 124
60 COR=AU+AV+AM-EE	ADJU 125
IF(COR.GT.0.) GO TO 62	ADJU 126
COR=(AU+AV+AM-EF)/DIV	ADJU 127
AU=AU-COR*AW	ADJU 128
AV=AV+COR*BW	ADJU 129
AM=AM-COR*CW	ADJU 130
GO TO 64	ADJU 131
62 COR=-AU+AV+AM-EE	ADJU 132
IF(COR.GT.0.) GO TO 66	ADJU 133
COR=(-AU+AV+AM-EF)/DIV	ADJU 134
AU=AU+COR*AW	ADJU 135
AV=AV-COR*BW	ADJU 136

AM=AM-COR*CM	ADJU 137
64 K=K+1	ADJU 138
66 UC(I)=AU	ADJU 139
VC(I)=AV	ADJU 140
WC(I)=AM	ADJU 141
68 CONTINUE	ADJU 142
KMAX=K	ADJU 143
100 IF((ITER.EQ.0).OR.(KMAX.NE.0)) GO TO 110	ADJU 144
GO TO 112	ADJU 145
110 ITER=ITER+1	ADJU 146
IF(ITER.LE.MAXIT) GO TO 12	ADJU 147
112 IF (ISS.NE.1) GO TO 999	ADJU 148
114 ITER=1	ADJU 149
ISS=2	ADJU 150
VTA=VC(1)	ADJU 151
WTA=WC(1)	ADJU 152
DO 120 I=JJ,NM	ADJU 153
IM=I-1	ADJU 154
IF(I.EQ.JJ)IM=1	ADJU 155
VTB=VC(I)	ADJU 156
WTB=WC(I)	ADJU 157
VC(I)=(VC(I+1)+2.*VTB+VTA)*0.25	ADJU 158
WC(I)=(WC(I+1)+2.*WTB+WTA)*0.25	ADJU 159
VTA=VTB	ADJU 160
WTA=WTB	ADJU 161
120 CONTINUE	ADJU 162
GO TO 12	ADJU 163
C.....CALCULATE THE CORRECTED VARIANCES	ADJU 164
999 DO 1010 I=1,N	ADJU 165
IF(I.GT.1.AND.I.LT.JJ) GO TO 1010	ADJU 166
SP(KOUNT,I)=UC(I)**2	ADJU 167
SD(KOUNT,I)=VC(I)**2	ADJU 168
ST(KOUNT,I)=WC(I)**2	ADJU 169
1010 CONTINUE	ADJU 170
RETURN	ADJU 171
END	ADJU 172
SUBROUTINE CHECK	CHEC 1
COMMON/CHK/P(4,4,3),RHO(4,4,3),NO(2)	CHEC 2
COMMON/WINCOM/DGH,FCORY,DX5,DY5	CHEC 3
COMMON/CHIC/LA(16),NB(2),IWSYM,UCOEF(14,9),VCOEF(14,9)	CHEC 4
NB(1) = 0	CHEC 5
NB(2) = 0	CHEC 6
CALL GROUP	CHEC 7
NS=0	CHEC 8
NR=1	CHEC 9
IF(NO(1).EQ.0.AND.NO(2).EQ.0) GO TO 1000	CHEC 10
DO 640 KL=1,2	CHEC 11
IF (NO(KL).EQ.0) GO TO 640	CHEC 12
450 CONTINUE	CHEC 13
NNR=4*NR	CHEC 14
IF(NO(KL).LE.NNR) GO TO 500	CHEC 15
NR=NR+1	CHEC 16
GO TO 450	CHEC 17
500 CONTINUE	CHEC 18

I1=NR	CHEC 19
J1=NO(KL)-(NR-1)*4	CHEC 20
SH1 = 6.	CHEC 21
SH2 = 6.	CHEC 22
DP = P(I1,J1,2) - P(I1,J1,1)	CHEC 23
IF (DP) 510,520,510	CHEC 24
510 SH1 = ABS(P(I1,J1,2)/DP)	CHEC 25
520 DP = P(I1,J1,2) - P(I1,J1,3)	CHEC 26
IF (DP) 530,540,530	CHEC 27
530 SH2 = ABS(P(I1,J1,2)/DP)	CHEC 28
540 IF(SH1.LT.4.0.OR.SH2.LT.4.0) GO TO 640	CHEC 29
IF(SH1.GT.9.0.OR.SH2.GT.9.0) GO TO 640	CHEC 30
NR=1	CHEC 31
NS=NS+1	CHEC 32
640 CONTINUE	CHEC 33
RETURN	CHEC 34
1000 IWSYM = '*'	CHEC 35
RETURN	CHEC 36
END	CHEC 37
SUBROUTINE CORLAT(A,B,C,D,E,F,G,H,AI,AJ,AK,SP1,SP2,SD1,SD2,ST1,	CORL 1
1 ST2,SU1,SU2,SV1,SV2,UD1,UD2,VD1,VD2,RD,RT,RV)	CORL 2
IF(SD1*ST1*SD2*ST2.GT.0.) GO TO 5	CORL 3
C....DEFAULT VALUES AVOID DIVISION BY ZERO	CORL 4
IF(SD1.LE.0.) SD1=0.001	CORL 5
IF(ST1.LE.0.) ST1=0.001	CORL 6
IF(SD2.LE.0.) SD2=0.001	CORL 7
IF(ST2.LE.0.) ST2=0.001	CORL 8
IF(RD.LE.0.) RD = .00001	CORL 9
IF(RT.LE.0.) RT = .00001	CORL 10
IF(RV.LE.0.) RV = .00001	CORL 11
5 CONTINUE	CORL 12
IF(ABS(TD1).LE.0.) TD1 = 0.001	CORL 13
IF (ABS(UD1).LE.0.) UD1 = 0.001	CORL 14
IF (ABS(VD1).LE.0.) VD1 = 0.001	CORL 15
IF (ABS(SU1).LE.0.) SU1 = 0.001	CORL 16
IF (ABS(SV1).LE.0.) SV1 = 0.001	CORL 17
IF (ABS(UD1).GE.1.) UD1 = 0.99*UD1/ABS(UD1)	CORL 18
IF (ABS(VD1).GE.1.) VD1 = 0.99*VD1/ABS(VD1)	CORL 19
A=RD*SD2/SD1	CORL 20
B=SD2*SQRT(1-RD*RD)	CORL 21
TD2=(SP2*SP2-SD2*SD2-ST2*ST2)/(2*SD2*ST2)	CORL 22
TD1=(SP1*SP1-SD1*SD1-ST1*ST1)/(2*SD1*ST1)	CORL 23
IF(ABS(TD2).GE.1.0) TD2=0.99*TD2/ABS(TD2)	CORL 24
IF(ABS(TD1).GE.1.0) TD1=0.99*TD1/ABS(TD1)	CORL 25
C=(ST2/ST1)*(RT-RD*TD2*TD1)/(1-TD1*TD1*RD*RD)	CORL 26
D=(RT*ST2*ST1-C*ST1*ST1)/(A*TD1*SD1*ST1)	CORL 27
E= ST2*ST2-C*C*ST1*ST1-D*D*SD2*SD2-2*C*D*RD*TD1*ST1*SD2	CORL 28
IF(E.GE.0.) GO TO 10	CORL 29
E=0.	CORL 30
10 E=SQRT(E)	CORL 31
F=(SU2/SU1)*(RV-RD*UD2*UD1)/(1-RD*RD*UD1*UD1)	CORL 32
G=(RV*SU2-F*SU1)/(RD*UD1*SD2)	CORL 33
H= SU2*SU2-F*F*SU1*SU1-G*G*SD2*SD2-2*F*G*RD*UD1*SD2*SU1	CORL 34
IF(H.GE.0.) GO TO 15	CORL 35

	H=0,	CORL 36
15	H=SQRT(H)	CORL 37
	AI=(SV2/SV1)*(RV-RD*VD2*VD1)/(1-RD*RD*VD1*VD1)	CORL 38
	AJ=(RV*SV2-AI*SV1)/(RD*VD1*SD2)	CORL 39
	AK= SV2*SV2-AI*AI*SV1*SV1-AJ*AJ*SD2*SD2-2*AI*AJ*RD*VD1*SD2*SV1	CORL 40
	IF(AK,GE,0.) GO TO 25	CORL 41
	AK=0.	CORL 42
25	AK=SQRT(AK)	CORL 43
	RETURN	CORL 44
	END	CORL 45
	SUBROUTINE DIAGEQ(N)	DIAG 1
C	A(I,J)=DIAG. TERMS, I=ROW NO., J=DIAG. NO.	DIAG 2
C	B(I)=RIGHT SIDE TERMS	DIAG 3
C	N=NO. OF ROWS	DIAG 4
C	K=NO. OF BORDER DIAGONALS, M=K+1=INDES OF PRIM. DIAG	DIAG 5
C	2KH=TOTAL NO. OF DIAGS.	DIAG 6
C	X(I)=SOLUTION	DIAG 7
	COMMON/ADJCOM/A(26,3), B(26), X(26)	DIAG 8
	K = 1	DIAG 9
	M=K+1	DIAG 10
	DO 30 L=1,M	DIAG 11
	ALM=A(L,M)	DIAG 12
	A(L,M)=1.	DIAG 13
	IF(L,EQ,N) GO TO 15	DIAG 14
	I2=MINO(K,M-L)	DIAG 15
	DO 10 I=1,I2	DIAG 16
	MPI=M+I	DIAG 17
10	A(L,MPI)=A(L,MPI)/ALM	DIAG 18
15	B(L)=B(L)/ALM	DIAG 19
	IF(L,EQ,N) GO TO 30	DIAG 20
	DO 25 I=1,I2	DIAG 21
	LPI=L+I	DIAG 22
	FACT=A(LPI,M-I)	DIAG 23
	DO 20 J=1,I2	DIAG 24
	MJI=M+J-I	DIAG 25
20	A(LPI,MJI)=A(LPI,MJI)-A(L,M+J)*FACT	DIAG 26
25	B(LPI)=B(LPI)-B(L)*FACT	DIAG 27
30	CONTINUE	DIAG 28
	X(N)=B(N)	DIAG 29
	NN1=N-1	DIAG 30
	DO 50 L=1,NN1	DIAG 31
	NML=N-L	DIAG 32
	SUM=0.	DIAG 33
	I2=MINO(K,L)	DIAG 34
	DO 40 I=1,I2	DIAG 35
40	SUM=SUM+A(NML,M+I)*X(NML+I)	DIAG 36
50	X(NML)=B(NML)-SUM	DIAG 37
	RETURN	DIAG 38
	END	DIAG 39
	SUBROUTINE FAIR (PG, DG, TG, PJ, DJ, TJ, IH, P, D, T,	FAIR 1
	\$ DPYG, DPXJ, DPYJ, DPX, DPY, DTYG, DTXJ, DTYJ, DTX, DTY)	FAIR 2
C....	,FAIRS BETWEEN GROVES AND JACCHIA VALUES 90 LE HEIGHT LE 115 KM	FAIR 3
	DIMENSION CZ(6)	FAIR 4
C....	,FAIRING VALUES	FAIR 5

	DATA CZ /1.0,0.9045085,0.6545085,0.3454915,0.0954915,0.0/	FAIR 6
C	HEIGHT INDEX	FAIR 7
	I = (IH - 85)/5	FAIR 8
C	GROVES FAIRING COEFFICIENT	FAIR 9
	CZI = CZ(I)	FAIR 10
C	JACCHIA FAIRING COEFFICIENT	FAIR 11
	SZI = 1.0 - CZI	FAIR 12
C	FAIRED TEMPERATURE	FAIR 13
	T = TG*CZI + TJ*SZI	FAIR 14
C	FAIRED PRESSURE	FAIR 15
	P = EXP(ALOG(PG)*CZI + ALOG(PJ)*SZI)	FAIR 16
C	FAIRED DENSITY	FAIR 17
	D = EXP(ALOG(DG)*CZI + ALOG(DJ)*SZI)	FAIR 18
	DPX = DPXJ	FAIR 19
C	DP/DY FOR GEOSTROPHIC WINDS	FAIR 20
	DPY=DPYG*CZI+DPYJ*SZI	FAIR 21
	DTX = DTXJ	FAIR 22
C	DT/DY FOR THERMAL WINDS	FAIR 23
	DTY = DTYG * CZI + DTYJ * SZI	FAIR 24
	RETURN	FAIR 25
	END	FAIR 26
	SUBROUTINE GEN4D	GEN4 1
C....	GENERATES NG = 9 OR 16 4D PROFILES P,D,T AND SIGMAS SP,SD,ST AT	GEN4 2
C	GRID OF LATITUDES AND LONGITUDES GLAT,GLON, CURRENT LATITUDE,	GEN4 3
C	LONGITUDE=CLAT,CLON, PREVIOUS LATITUDE, LONGITUDE=PLAT,PLON,	GEN4 4
	COMMON/C4/GLAT(16),GLON(16),NG,P(16,26),D(16,26),T(16,26),	GEN4 5
	\$ SP(16,26),SD(16,26),ST(16,26),PLON,CLON,HS	GEN4 6
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,MHCOP,DDD,XMJD,PLAT,CLAT,	GEN4 7
	\$ NSAME,RP1,RD1,RT1,SP1,SD1,ST1,RU1,RV1,SU1,SV1,	GEN4 8
	\$ MN,IDA,IYR,H1,PHI1R,THET1R,GZ,RI,Z,PHIR,THETR,F10,F10B,AP,	GEN4 9
	\$ IHR,MIN,NMORE,DX,HL,VL,DZ,B,EPS,IOPP,LOOK,DUMMY(20)	GEN4 10
	COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19),	GEN4 11
	1 PSP(8,10,12),DSP(8,10,12),TSP(8,10,12)	GEN4 12
	2,PAQ(17,5),DAQ(17,5),TAQ(17,5),	GEN4 13
	3PDQ(17,5),DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),	GEN4 14
	4UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10),	GEN4 15
	SPQ,DQ,TQ,UQ,VQ,PQA,DQA,TQA,UA,VA,IOPQ	GEN4 16
	\$,PLP(25,10),DLP(25,10),TLP(25,10),ULP(25,10),VLP(25,10),UDL(25,	GEN4 17
	* 10),VDL(25,10),UDS(25,10),VDS(25,10)	GEN4 18
	COMMON/ADJCOM/DUM(130),KOUNT	GEN4 19
	COMMON/IPRTP/ IPRT	GEN4 20
	IF(NSAME.EQ.1) RETURN	GEN4 21
	IPRT=0	GEN4 22
	LOOK=0	GEN4 23
	F = 0.017453293	GEN4 24
	NG = 16	GEN4 25
	DX = PLON - CLON	GEN4 26
C....	LONGITUDE DISPLACEMENT FROM PREVIOUS TO CURRENT POSITION	GEN4 27
	DY = CLAT - PLAT	GEN4 28
C....	LATITUDE DISPLACEMENT FROM PREVIOUS TO CURRENT POSITION	GEN4 29
	IF (DY) 20,10,20	GEN4 30
10	IF (DX) 15,12,15	GEN4 31
12	K = 0	GEN4 32
	GO TO 40	GEN4 33

15 THETA = 180. + SIGM(90.,DX)	GEN4 34
GO TO 30	GEN4 35
20 THETA = ATAN(DX/DY)/F	GEN4 36
IF (DY.GT.0.) THETA = THETA + 180.	GEN4 37
IF (THETA.LT.0.) THETA = THETA + 360.	GEN4 38
C.....THETA = AZIMUTH ANGLE OF TRAJECTORY, USED TO ORIENT LAT-LON GRID	GEN4 39
30 K = INT((THETA + 67.5)/45.)	GEN4 40
C INDEX USED IN COMPUTED GO TO FOR 110 THRU 180	GEN4 41
IF (K.GT.8) K=K-8	GEN4 42
C NORTH POLAR GRID	GEN4 43
IF (CLAT.GT.75.0.AND.K.GE.3.AND.K.LE.7)GO TO 200	GEN4 44
C SOUTH POLAR GRID	GEN4 45
IF (CLAT.LT.-75.0.AND.(K.GE.7.OR.K.LE.3))GO TO 200	GEN4 46
C.....INITIAL ESTIMATE OF REFERENCE LATITUDE (LOWER LEFT GRID POINT)	GEN4 47
40 LATO = 5*INT(CLAT/5.)	GEN4 48
IF (CLAT.LT.0.) LATO = LATO - 5	GEN4 49
C.....INITIAL ESTIMATE OF REFERENCE LONGITUDE (LOWER LEFT GRID POINT)	GEN4 50
LONO=5*INT(CLOW/5.)	GEN4 51
C.....ADJUSTS LATO,LONO ACCORDING TO DIRECTION OF TRAJECTORY AZIMUTH	GEN4 52
IF (K.GT.0) GO TO 100	GEN4 53
LATO = LATO - 5	GEN4 54
LONO= LONO + 10	GEN4 55
GO TO 190	GEN4 56
100 GO TO (110,120,130,140,150,160,170,180),K	GEN4 57
110 LATO = LATO-10	GEN4 58
LONO = LONO + 10	GEN4 59
GO TO 190	GEN4 60
120 LATO = LATO-10	GEN4 61
LONO = LONO+15	GEN4 62
GO TO 190	GEN4 63
130 LATO = LATO-5	GEN4 64
LONO = LONO+15	GEN4 65
GO TO 190	GEN4 66
140 LONO = LONO+15	GEN4 67
GO TO 190	GEN4 68
150 LONO = LONO+10	GEN4 69
GO TO 190	GEN4 70
160 LONO = LONO+5	GEN4 71
GO TO 190	GEN4 72
170 LATO = LATO-5	GEN4 73
LONO = LONO+5	GEN4 74
GO TO 190	GEN4 75
180 LATO = LATO-10	GEN4 76
LONO = LONO+5	GEN4 77
190 IF (LONO.GT.360) LONO = LONO - 360	GEN4 78
DLI=1.25	GEN4 79
IF(ABS(CLAT).GE.18) GO TO 192	GEN4 80
DLI=3.0	GEN4 81
LATO=-18	GEN4 82
192 DO 195 I=1,4	GEN4 83
I12 = I+12	GEN4 84
DO 195 J=I,I12,4	GEN4 85
GLAT(J) = LATO + 1.25*(J-I)	GEN4 86
C.....LATITUDE, LONGITUDE GRID AT 5 DEGREE INTERVALS	GEN4 87

195	GLOW(J) = LOWO - 5. * (I - 1)	GEN4	88
	GO TO 400	GEN4	89
C	POLAR GRID	GEN4	90
200	MG = 9	GEN4	91
	DO 210 J=1,8	GEN4	92
C....	POLAR GRID LATITUDES 1-8 = +75 (N) OR -75 (N)	GEN4	93
	GLAT(J) = SIGN(75.,CLAT)	GEN4	94
C....	POLAR GRID LONGITUDES 1-8 AT 45 DEG INTERVALS	GEN4	95
	210 GLOW(J) = 45.*(J-1)	GEN4	96
C....	POLAR GRID LATITUDE 9 = POLE +93 OR -90	GEN4	97
	GLAT(9) = SIGN(90.,CLAT)	GEN4	98
C....	POLAR GRID LONGITUDE 9 = 0	GEN4	99
	GLOW(9) = 0.	GEN4	100
C....	GENERATES 16 PROFILES (OR 9 PROFILES FOR POLAR GRID)	GEN4	101
400	CALL GRID4D	GEN4	102
	DO 600 I=1,MG	GEN4	103
	CHECK=P(I,26)*D(I,26)*T(I,26)*SP(I,26)*SD(I,26)*ST(I,26)	GEN4	104
C	CHECK FOR ZERO DATA AT HEIGHT 25	GEN4	105
	IHV=26	GEN4	106
	SPR=SP(I,26)	GEN4	107
	SDR=SD(I,26)	GEN4	108
	STR=ST(I,26)	GEN4	109
	IF (CHECK.GT.0.) GO TO 491	GEN4	110
	DO 420 J1=1,25,1	GEN4	111
	J=26-J1	GEN4	112
	CHECK = P(I,J) * D(I,J) * T(I,J) * SP(I,J) * SD(I,J) * ST(I,J)	GEN4	113
C	FINDS INDEX IHV OF HIGHEST HEIGHT WITH NON-ZERO DATA	GEN4	114
	IHV = J	GEN4	115
	IF (CHECK.GT.0.) GO TO 440	GEN4	116
420	CONTINUE	GEN4	117
C	HEIGHT = HEIGHT INDEX - 1	GEN4	118
440	Z1 = IHV - 1.	GEN4	119
C	SPR,SDR,STR=SIGMAS AT HEIGHT Z1	GEN4	120
	SPR = SP(I,IHV)	GEN4	121
	SDR=SD(I,IHV)	GEN4	122
	STR=ST(I,IHV)	GEN4	123
C....	IF HEIGHT Z1 GEQ 20 KM, USE GROVES AT 30 KM FOR INTERPOLATION,	GEN4	124
C	OTHERWISE USE GROVES AT 25 KM	GEN4	125
	IF (IHV.GE.21) GO TO 480	GEN4	126
C....	EVALUATES GROVES AT 25 KM FOR INTERPOLATION AND	GEN4	127
C	FILL IN OF ZERO DATA	GEN4	128
	CALL 6TERP(25,GLAT(I),P2,D2,T2,PG,DG,TG,DPY,DTY,DP2Y)	GEN4	129
	IHP = IHV + 1	GEN4	130
	DO 450 K=IHP,26	GEN4	131
C....	AVOIDS INTERPOLATION OF P,D,T IF ONLY SIGMAS ARE ZERO	GEN4	132
	IF ((P(I,K)*D(I,K)*T(I,K)).GT.0.) GO TO 445	GEN4	133
	H=K-1	GEN4	134
C....	INTERPOLATES BETWEEN 4D AT HEIGHT Z1 AND GROVES AT 25 TO FILL	GEN4	135
C	IN MISSING DATA	GEN4	136
	CALL INTER2(P(I,IHV),D(I,IHV),T(I,IHV),Z1,P2,D2,T2,25.,PH,DH,TH,H)	GEN4	137
	P(I,K)=PH	GEN4	138
	D(I,K)=DH	GEN4	139
	T(I,K)=TH	GEN4	140
445	SP(I,K) = SPR	GEN4	141

SD(I,K)=SDR	GEN4 142
C.....SETS MISSING SIGMAS EQUAL TO SIGMAS AT HEIGHT Z1	GEN4 143
450 ST(I,K)=STR	GEN4 144
GO TO 500	GEN4 145
C.....EVALUATES GROVES AT 30 KM FOR INTERPOLATION AND FILL IN OF	GEN4 146
C ZERO DATA	GEN4 147
480 CALL BTERP(30,GLAT(I),P2,D2,T2,PG,DG,TG,DPY,DTY,DP2Y)	GEN4 148
CALL PDTUV(PSP,DSP,TSP,GLAT(I),GLON(I),30,DP,DD,DT,DPX,DPY,DTX,DTY)	GEN4 149
C COMPUTE PERTURBATIONS TO GROVES MODEL	GEN4 150
\$,DP2X,DP2Y,DPXY)	GEN4 151
C.....ADD STATIONARY PERTURBATIONS TO GROVES MODEL	GEN4 152
P2 = P2*(1. + DP)	GEN4 153
D2 = D2*(1. + DD)	GEN4 154
T2 = T2*(1. + DT)	GEN4 155
IHP = IHP + 1	GEN4 156
DO 490 K=IHP,26	GEN4 157
C.....AVOIDS INTERPOLATING P,D,T IF ONLY SIGMAS ARE ZERO	GEN4 158
IF ((P(I,K)*D(I,K)*T(I,K)).GT.0.) GO TO 485	GEN4 159
H=K-1	GEN4 160
C.....INTERPOLATES BETWEEN 4D AT HEIGHT Z1 AND GROVES AT 30 KM TO	GEN4 161
C FILL IN MISSING DATA	GEN4 162
CALL INTER2(P(I,IHP),D(I,IHP),T(I,IHP),Z1,P2,D2,T2,30.,PH,DH,TH,H)	GEN4 163
P(I,K)=PH	GEN4 164
D(I,K)=DH	GEN4 165
T(I,K)=TH	GEN4 166
485 SP(I,K) = SPR	GEN4 167
SD(I,K)=SDR	GEN4 168
C SET MISSING SIGMAS AT HEIGHT 1	GEN4 169
490 ST(I,K) = STR	GEN4 170
491 CONTINUE	GEN4 171
IHP = IHP - 1	GEN4 172
DO 492 K=2,9	GEN4 173
IF (SP(I,K) .LE. 0.) SP(I,K) = SP(I,1)	GEN4 174
IF (SD(I,K) .LE. 0.) SD(I,K) = SD(I,1)	GEN4 175
492 IF (ST(I,K) .LE. 0.) ST(I,K) = ST(I,1)	GEN4 176
DO 495 K=10,IHP	GEN4 177
C.....SETS ALL ZERO SIGMAS TO SIGMA AT HEIGHT Z1	GEN4 178
IF (SP(I,K).LE.0.0.AND.P(I,K).GT.0.) SP(I,K) = SPR	GEN4 179
IF (SD(I,K).LE.0.0.AND.D(I,K).GT.0.) SD(I,K) = SDR	GEN4 180
495 IF (ST(I,K).LE.0.0.AND.T(I,K).GT.0.) ST(I,K) = STR	GEN4 181
500 PA = P(I,1)	GEN4 182
TA = T(I,1)	GEN4 183
R =287.05	GEN4 184
G=6Z*(1.+(Z/(RI-Z))**2)	GEN4 185
K = 2	GEN4 186
510 PB = P(I,K)	GEN4 187
TB = T(I,K)	GEN4 188
IF ((PB*TB) .GT. 0.) GO TO 520	GEN4 189
K = K + 1	GEN4 190
GO TO 510	GEN4 191
520 IF (TA-TB) 560, 570, 560	GEN4 192
560 TZ = (TA-TB) / ALOG(TA/TB)	GEN4 193
GO TO 575	GEN4 194
570 TZ = TA	GEN4 195

575 HS = K-1.+0.001*R*TZ*ALOG(PB/PA)/G	GEN4 196
KM=K-2	GEN4 197
IF(ABS(K-1-HS),GT,0.1) GO TO 578	GEN4 198
GAM=TB-T(I,K+1)	GEN4 199
IF(GAM) 582,590,582	GEN4 200
578 IF(TA-TB) 580,590,580	GEN4 201
580 GAM=(TA-TB)/(K-1-HS)	GEN4 202
582 KM1=KM+1	GEN4 203
IF(ABS(GAM),GT,6) GAM=SIGN(G,GAM)	GEN4 204
DO 585 JD=1,KM1,1	GEN4 205
J=JD-1	GEN4 206
TJ=TA-GAM*(J-HS)	GEN4 207
PJ=PA*(TJ/TA)**(G/(R*GAM*0.001))	GEN4 208
DJ=PJ/(R*TJ)	GEN4 209
P(I,J+1)=PJ	GEN4 210
D(I,J+1)=DJ	GEN4 211
585 T(I,J+1)=TJ	GEN4 212
GO TO 599	GEN4 213
590 KM1=KM+1	GEN4 214
DO 595 JD=1,KM1,1	GEN4 215
J=JD-1	GEN4 216
TJ=TA	GEN4 217
PJ=PA*EXP(-G*(J-HS)/(R*0.001*TJ))	GEN4 218
DJ=PJ/(R*TJ)	GEN4 219
P(I,J+1)=PJ	GEN4 220
D(I,J+1)=DJ	GEN4 221
595 T(I,J+1)=TJ	GEN4 222
IF(NSAME,EQ,2) NSAME=1	GEN4 223
599 HS=0.	GEN4 224
KOUNT = I	GEN4 225
CALL ADJUST	GEN4 226
600 CONTINUE	GEN4 227
RETURN	GEN4 228
END	GEN4 229
SUBROUTINE GETNMC	GETN 1
C	GETN 2
C READS 'SETUP' DATA TAPE, OR MMC GRID DATA CARDS,	GETN 3
C AND WRITES SCRATCH FILE FOR USE BY SELEC4.	GETN 4
C	GETN 5
DIMENSION IP(15)	GETN 6
C	GETN 7
COMMON /IOTEMP/ IOTEM1,IUTEM2,IUG,MMCP,IDUM(60)	GETN 8
C	GETN 9
NREC=0	GETN 10
IF(MMCP.NE,0) GO TO 2	GETN 11
C	GETN 12
1 READ(IUG,300,END=90) N,IP	GETN 13
300 FORMAT(A2,19I7)	GETN 14
IF(N.NE,'N') GO TO 6	GETN 15
GO TO 3	GETN 16
2 READ(5,100) (IP(I),I=1,15)	GETN 17
100 FORMAT(15I5)	GETN 18
3 DO 4 I=1,15,3	GETN 19
M=IP(I)	GETN 20

IF(M,LT,1) GO TO 5	GETN 21
IJ=IP(I+1)*1000+IP(I+2)	GETN 22
WRITE(IOTEM2) IJ	GETN 23
NREC=NREC+1	GETN 24
4 CONTINUE	GETN 25
IF(NMCOP,NE,0) GO TO 2	GETN 26
GO TO 1	GETN 27
5 IF(NREC,NE,1977) GO TO 6	GETN 28
C MOVES PAST FIRST EOF ON UNIT IUG	GETN 29
41 READ(IUG,9999,END=42) IDUMMY	GETN 30
9999 FORMAT(A10)	GETN 31
GO TO 41	GETN 32
42 RETURN	GETN 33
6 WRITE(6,200) NREC,IOTEM2	GETN 34
200 FORMAT(1H1/1X,I6,' RECORDS WRITTEN BY GETNMC IN SCRATCH FILE',I3)	GETN 35
STOP	GETN 36
90 WRITE(6,400) IUG	GETN 37
400 FORMAT('1 PREMATURE END-OF-FILE FOUND ON UNIT ',I2/ Z'0 CALLED FROM SUBROUTINE GETNMC.')	GETN 38
STOP	GETN 39
END	GETN 40
SUBROUTINE GRID4D	GRID 1
INTEGER FLD	GRID 2
REAL LAT,LOM	GRID 3
COMMON/C4/LAT(16),LOM(16),NP,P(16,26),R(16,26),T(16,26),SP(16,26),	GRID 4
* SR(16,26),ST(16,26)	GRID 5
COMMON /PDTCOM/ IT,MONTH	GRID 6
C	GRID 7
C S	GRID 8
C SUBROUTINE TO SELECT PRESSURE, TEMPERATURE, AND DENSITY PROFILES (GRID	GRID 9
C TOGETHER WITH THE NORMALIZED VARIANCES IN EACH, AT UP TO 16 *GRID	GRID 10
C AT LAT/LOMS SELECTED BY CALLING PROGRAM.	GRID 11
C	GRID 12
C USES NASA HUNTSVILLE MSFC 4-D DATA TAPES	GRID 13
C	GRID 14
C DIMENSION IN(107),BUFFER(64)	GRID 15
C	GRID 16
C COMMON /IOTEMP/ IOTEM1,IOTEM2	GRID 17
C COMMON /POINT/ IPT(16,5),LL(16),DXY(16,2)	GRID 18
C COMMON /ORDER/ IPTN(16,5),IREAD(65,3)	GRID 19
C COMMON /INT/ D(208,5),IG(5),DYX(2),DLA(4),DLO(4)	GRID 20
C	GRID 21
C INTEGER IOTEM1,READ,WRITE	GRID 22
C	GRID 23
C	GRID 24
C INITIALIZE	GRID 25
C	GRID 26
C ZERO=0.0	GRID 27
C ONE=1.0	GRID 28
C TEN=10.0	GRID 29
C HUNDR=100.0	GRID 30
C THOU=1000.0	GRID 31
C READ=6H READ	GRID 32
C WRITE=6H WRITE	GRID 33

C		GRID 34
	N=MONTH-1-((2*MONTH)/9)*4	GRID 35
	IF(MONTH.EQ.13) M=0	GRID 36
	NUMEOF = 0	GRID 37
	CALL MTRAN(IT,10,22)	GRID 38
	IF (N.EQ.0) GO TO 20	GRID 39
	CALL MTRAN(IT,8,M,22)	GRID 40
C		GRID 41
C	APPROPRIATE 4-D INPUT TAPE NOW POSITIONED - FILE NEEDED PROFILES	GRID 42
C		GRID 43
C		GRID 44
	20 CALL SELECA	GRID 45
C		GRID 46
	IRC=0	GRID 47
	IRN=1	GRID 48
	IF(IREAD(IRN,3),EQ.0) GO TO 39	GRID 49
21	JT=IT	GRID 50
	M=READ	GRID 51
22	CALL MTRAN(IT,2,106,IN,L,22)	GRID 52
	IRC =IRC +1	GRID 53
	IF (L.EQ.-2) GO TO 39	GRID 54
	IF (L.LT.0) WRITE(6,23) IT,L,IRC	GRID 55
23	FORMAT(' INPUT UNIT NO. ',I3,' IN ERROR (' ,I2,') FOR RECORD NO. ',I5	GRID 56
	1)	GRID 57
	IF(IRC.LT.IREAD(IRN,3)) GO TO 22	GRID 58
	IF(IRC.GT.IREAD(IRN,3)) GO TO 39	GRID 59
24	I=IREAD(IRN,1)	GRID 60
	J=IREAD(IRN,2)	GRID 61
	IF(IRN.EQ.1) GO TO 25	GRID 62
	IF(IREAD(IRN,3),EQ.IREAD(IRN-1,3)) GO TO 27	GRID 63
25	IP=FLD(12,12,IN(106))	GRID 64
	MP=FLD(24,12,IN(106))	GRID 65
	IF((MP.NE.MONTH).OR.(IP.NE.IPT(I,J))) GO TO 39	GRID 66
	DO 26 IK=1,106,1	GRID 67
	K=107-IK	GRID 68
	IN(K+1)=IN(K)	GRID 69
26	CONTINUE	GRID 70
27	FLD(0,18,IN(1)) = I	GRID 71
	FLD(18,18,IN(1)) = J	GRID 72
	JT=JOTEM1	GRID 73
	M=WRITE	GRID 74
	WRITE(JOTEM1) IN	GRID 75
	IRN=IRN+1	GRID 76
	IF(IREAD(IRN,3),EQ.IRC) GO TO 24	GRID 77
	IF(IREAD(IRN,3),EQ.0) GO TO 28	GRID 78
	GO TO 21	GRID 79
C		GRID 80
C	INTERPOLATE TO GIVEN LAT/LOW FROM GRID DATA	GRID 81
C		GRID 82
	28 M=READ	GRID 83
	DO 38 II=1,MP	GRID 84
	DO 29 I=1,208	GRID 85
	DO 29 J=1,5	GRID 86
	D(I,J)=0.0	GRID 87

29	CONTINUE	GRID 88
	DO 32 J=1,4	GRID 89
	IF(IPT(II,J),EQ,0) GO TO 32	GRID 90
	FLD(0,18,INDEX) = II	GRID 91
	FLD(18,18,INDEX) = J	GRID 92
	REWIND IOTEM1	GRID 93
30	READ(IOTEM1,END=39) IM	GRID 94
	IF(IN(1),NE,INDEX) GO TO 30	GRID 95
	DO 31 I=2,105	GRID 96
	J2=2*I-2	GRID 97
	J1=J2-1	GRID 98
	D(J1,J)=FLD(0,18,IN(I))/HUNDR	GRID 99
	D(J2,J)=FLD(18,18,IN(I))/HUNDR	GRID 100
31	CONTINUE	GRID 101
	DLA(J)=FLD(0,18,IN(106))/TEN	GRID 102
	RLO(J)=FLD(18,18,IN(106))/TEN	GRID 103
32	CONTINUE	GRID 104
C		GRID 105
C	IF NECESSARY, INTERPOLATE	GRID 106
C		GRID 107
	LALO=LL(II)	GRID 108
	DO 33 I=1,5	GRID 109
	IG(I)=IPT(II,I)	GRID 110
33	CONTINUE	GRID 111
	IF(IG(2),NE,0) GO TO 35	GRID 112
	DO 34 I=1,208	GRID 113
	D(I,5)=D(I,1)	GRID 114
34	CONTINUE	GRID 115
	GO TO 37	GRID 116
35	IF(IG(5),NE,2) GO TO 36	GRID 117
	DYX(1)=DXY(II,1)	GRID 118
	DYX(2)=DXY(II,2)	GRID 119
C		GRID 120
36	CALL INTRPA (LALO)	GRID 121
C		GRID 122
37	DO 38 I=1,26	GRID 123
	P(II,I)=D(I,5)*HUNDR	GRID 124
	R(II,I)=D(I+156,5)/THOU	GRID 125
	T(II,I) =D(I+52,5)	GRID 126
	DIVIDE=ONE	GRID 127
	IF(P(II,I),GT,ZERO) DIVIDE=(P(II,I)/HUNDR)**2	GRID 128
	SP(II,I)=D(I+26,5)/DIVIDE	GRID 129
	DIVIDE=ONE	GRID 130
	IF(R(II,I),GT,ZERO) DIVIDE=(THOU*R(II,I))**2	GRID 131
	SR(II,I)=D(I+182,5)/DIVIDE	GRID 132
	DIVIDE=ONE	GRID 133
	IF(T(II,I),GT,ZERO) DIVIDE=T(II,I)**2	GRID 134
	ST(II,I)=D(I+78,5)/DIVIDE	GRID 135
38	CONTINUE	GRID 136
	RETURN	GRID 137
39	WRITE(6,40) JT,IRC,IREAD(IRN,3),MP,MONTH,IP,I,J,IPT(I,J),IRN,M,L	GRID 138
40	FORMAT(' ***** UNIT NO.,I3,' IN ERROR',I7,' RECORDS READ/'	GRID 139
	1' IREAD(IRN,3) =',I5,' MP =',I3,' MONTH =',I3,	GRID 140
	2' IP =',I5,' IPT(',I2,',',I1,') =',I5,' IRN =',I3/A6,' STATUS',I5)GRID 141	

STOP	GRID 142
END	GRID 143
SUBROUTINE GROUP	GROU 1
DIMENSION KOU(2)	GROU 2
COMMON/CHIC/LA(4,4),NB(2),IWSYN,UCCOEF(14,9),VCCOEF(14,9)	GROU 3
COMMON /CHK/P(4,4,3),DEN(4,4,3),NO(2)	GROU 4
COMMON /WINCOM/DGH,FCORY,DX5,DY5	GROU 5
FCORX = FCORY*DX5/DY5	GROU 6
KK=1	GROU 7
DO 100 I=1,4	GROU 8
DO 100 J=1,4	GROU 9
LA(I,J)=4*(I-1)+J	GROU 10
100 CONTINUE	GROU 11
200 CONTINUE	GROU 12
DO 250 M=1,4	GROU 13
DO 250 N=1,4	GROU 14
IF (KK.EQ.1) GO TO 210	GROU 15
I=5-M	GROU 16
J=5-N	GROU 17
NN=-1	GROU 18
N4=-1	GROU 19
GO TO 220	GROU 20
210 CONTINUE	GROU 21
I=M	GROU 22
J=N	GROU 23
NN=1	GROU 24
N4=1	GROU 25
220 CONTINUE	GROU 26
IF (N.EQ.4) GO TO 225	GROU 27
DINX=FCORX*(DEN(I,J+NN,2)+DEN(I,J,2))/2	GROU 28
VY=(P(I,J+NN,2)-P(I,J,2))/DINX	GROU 29
IF(ABS(VY).GT.100) GO TO 225	GROU 30
LA(I,J)=MINO(LA(I,J),LA(I,J+NN))	GROU 31
LA(I,J+NN)=LA(I,J)	GROU 32
225 CONTINUE	GROU 33
IF(M.EQ.4) GO TO 250	GROU 34
DINY=FCORY*(DEN(I+N4,J,2)+DEN(I,J,2))/2	GROU 35
VX=(P(I+N4,J,2)-P(I,J,2))/DINY	GROU 36
IF(ABS(VX).GT.100) GO TO 250	GROU 37
LA(I,J)=MINO(LA(I,J),LA(I+N4,J))	GROU 38
LA(I+N4,J)=LA(I,J)	GROU 39
250 CONTINUE	GROU 40
KK=KK+1	GROU 41
IF(KK.EQ.2) GO TO 200	GROU 42
NO(1)=0	GROU 43
NO(2)=0	GROU 44
II=1	GROU 45
DO 400 LL=1,11	GROU 46
KOU(II)=1	GROU 47
DO 300 I=1,4	GROU 48
DO 300 J=1,4	GROU 49
IF(LA(I,J).EQ.LL) KOU(II)=KOU(II)+1	GROU 50
300 CONTINUE	GROU 51
IF (KOU(II).GE.7) NO(II)=LL	GROU 52

IF (KOU(II).GE.7) II=2	GROU 53
400 CONTINUE	GROU 54
RETURN	GROU 55
END	GROU 56
SUBROUTINE GTERP(IH,PHI,P,D,T,PG,DG,TG,DPY,DTY,DP2Y)	GTER 1
C,....INTERPOLATES GROVES DATA TO HEIGHT IH AND LATITUDE PHI	GTER 2
DIMENSION PG(18,19),TG(18,19),DG(18,19)	GTER 3
C HEIGHT INDEX	GTER 4
I=(IH-20)/5	GTER 5
C LOWER LATITUDE INDEX	GTER 6
J=INT((PHI+100.)/10.)	GTER 7
IF (J.LT.1) J=1	GTER 8
IF (J.GT.18) J=18	GTER 9
C UPPER LATITUDE INDEX	GTER 10
JP=J+1	GTER 11
C,....CHECK FOR DENSITY OR TEMPERATURE LEQ 0	GTER 12
CHK=DG(I,J)*TG(I,J)*DG(I,JP)*TG(I,JP)	GTER 13
IF (CHK) 10,10,20	GTER 14
10 P=PG(I,J)	GTER 15
D=DG(I,J)	GTER 16
T=TG(I,J)	GTER 17
GO TO 30	GTER 18
C,....LATITUDE DEVIATION FROM GROVES ARRAY POSITION	GTER 19
20 PHIF=(PHI+100.-10.*J)/10.	GTER 20
TL=TG(I,J)+(TG(I,JP)-TG(I,J))*PHIF	GTER 21
C LATITUDE INTERPOLATION	GTER 22
DL=DG(I,J)+(DG(I,JP)-DG(I,J))*PHIF	GTER 23
R1=PG(I,J)/(DG(I,J)*TG(I,J))	GTER 24
R2=PG(I,JP)/(DG(I,JP)*TG(I,JP))	GTER 25
C INTERPOLATED GAS CONSTANT	GTER 26
R=R1+(R2-R1)*PHIF	GTER 27
C PRESSURE COMPUTED FROM INTERPOLATED GAS CONSTANT	GTER 28
P=DL*R*TL	GTER 29
D=DL	GTER 30
T=TL	GTER 31
C DP/DY FOR GEOSTOPHIC WINDS	GTER 32
30 DPY=(PG(I,JP)-PG(I,J))*0.5	GTER 33
C DT/DY FOR THERMAL WINDS	GTER 34
DTY=(TG(I,JP)-TG(I,J))*0.5	GTER 35
JM=J-1	GTER 36
IF (JM.LT.1) JM=JP	GTER 37
DP2Y=(PG(I,JP)-PG(I,JM))*0.5	GTER 38
IF (ABS(PHI)-90.) 50,40,40	GTER 39
40 DPY=0.	GTER 40
DTY=0.	GTER 41
DP2Y=0.	GTER 42
50 CONTINUE	GTER 43
RETURN	GTER 44
END	GTER 45
SUBROUTINE INTERW(U1,V1,Z1,U2,V2,Z2,U,V,Z)	INTE 1
IF (Z1-Z2) 20,10,20	INTE 2
10 U=U1	INTE 3
C SETS U,V=U1,V1 IF Z1=Z2	INTE 4
V=V1	INTE 5

RETURN	INTE 6
20 A = (Z-Z1)/(Z2-Z1)	INTE 7
U = U1 + (U2-U1) * A	INTE 8
V = V1 + (V2-V1) * A	INTE 9
C.....LINEAR INTERPOLATION BETWEEN U1,V1 AT HEIGHT Z1 AND U2,V2 AT	INTE 10
C HEIGHT Z2, OUTPUT IS U,V AT HEIGHT Z	INTE 11
RETURN	INTE 12
END	INTE 13
SUBROUTINE INTERZ(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,Z)	INTE 1
5 IF (Z1 - Z2) 20,10,20	INTE 2
10 P = P1	INTE 3
D = D1	INTE 4
C SETS P, D, T = P1,D1,T1, IF Z1 = Z2	INTE 5
T = T1	INTE 6
RETURN	INTE 7
20 A = (Z - Z1) / (Z2 - Z1)	INTE 8
T = T1 + (T2 - T1)*A	INTE 9
D = D1 + (D2 - D1)*A	INTE 10
P = P1 + (P2 - P1) * A	INTE 11
C.....LINEAR INTERPOLATION BETWEEN P1,D1,T1 AT HEIGHT Z1 AND P2,D2,T2	INTE 12
C AT HEIGHT Z2 TO OUTPUT VALUES OF P,D,T AT HEIGHT Z	INTE 13
RETURN	INTE 14
END	INTE 15
SUBROUTINE INTER2(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,Z)	INTE 1
C.....INTERPOLATES BETWEEN P1,D1,T1 AT HEIGHT Z1 AND P2,D2,T2 AT	INTE 2
C HEIGHT Z2 TO OUTPUT VALUES OF P,D,T AT HEIGHT Z	INTE 3
C.....CHECKS FOR T1,D1,T2,D2 PRODUCT = 0, FOR GAS CONSTANT INTERPOLATION	INTE 4
CHK=T1*D1*T2*D2	INTE 5
IF (CHK) 10,10,5	INTE 6
5 IF (Z1 - Z2) 20,10,20	INTE 7
10 P = P1	INTE 8
D = D1	INTE 9
C SETS P,D,T = P1,D1,T1 IF Z1=Z2	INTE 10
T = T1	INTE 11
RETURN	INTE 12
20 IF(P1*D1*T1*P2*D2*T2,LE,0.)GO TO 30	INTE 13
A=ALOG(D2/D1)/(Z2-Z1)	INTE 14
C LINEAR INTERPOLATION ON LOG D	INTE 15
DZ= D1*EXP(A*(Z - Z1))	INTE 16
A=(Z-Z1)/(Z2-Z1)	INTE 17
C LINEAR INTERPOLATION ON T	INTE 18
TZ= T1 + A*(T2-T1)	INTE 19
R1=P1/(D1*T1)	INTE 20
R2=P2/(D2*T2)	INTE 21
C LINEAR INTERPOLATION ON GAS CONSTANT R	INTE 22
R=(R2-R1)*A+R1	INTE 23
C PRESSURE FROM PERFECT GAS LAW	INTE 24
P = DZ * R * TZ	INTE 25
D = DZ	INTE 26
T = TZ	INTE 27
RETURN	INTE 28
30 P=0.	INTE 29
D=0.	INTE 30
T=0.	INTE 31

RETURN	INTE 32
END	INTE 33
SUBROUTINE INTER4 (CLAT, CLON, IZ, P, D, T,	INTE 1
\$ P4, D4, T4, DPX, DPY, DTX, DTY, DPXX, DPYY, DPXY)	INTE 2
COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XHJD,PHI1,PHI,	INTE 3
.NSAME	INTE 4
C.....INTERPOLATES BETWEEN 4D ARRAYS P(I,IH),D(I,IH),T(I,IH) AT GRID	INTE 5
C LOCATIONS LATITUDE GLAT(I) LONGITUDE GLON(I).	INTE 6
C CLAT,CLON = CURRENT LATITUDE, LONGITUDE	INTE 7
C IZ = HEIGHT NG = NUMBER OF 4D GRID POSITIONS	INTE 8
C OUTPUT = P4,D4,T4, AND DERIVATIVES DPX,DPY,DTX,DTY	INTE 9
COMMON /CA/ GLAT(16),GLON(16),NG	INTE 10
COMMON/CHIC/LA(4,4),NB(2),IWSYM,Ucoef(14,9),VCOEF(14,9)	INTE 11
DIMENSION P(16,26),D(16,26),T(16,26),LAX(16)	INTE 12
IWSYM = ' '	INTE 13
ICLK = 0	INTE 14
C HEIGHT INDEX = HEIGHT + 1	INTE 15
IH = IZ + 1	INTE 16
5 IF (ICLK.GT.1) GO TO 220	INTE 17
IF (NG.GT.9) GO TO 100	INTE 18
C NG = 9 MEANS POLAR GRID	INTE 19
DO 10 I=10,16,1	INTE 20
P(I,IH) = P(9,IH)	INTE 21
D(I,IH) = D(9,IH)	INTE 22
T(I,IH) = T(9,IH)	INTE 23
GLAT(I) = GLAT(9)	INTE 24
C I=10-16 ALL AT 90 DEG	INTE 25
10 GLON(I) = GLON(I-8)	INTE 26
C LOWER RIGHT INTERPOLATION INDEX	INTE 27
IB = INT(CLON/45) + 1	INTE 28
C LOWER LEFT INTERPOLATION INDEX	INTE 29
IA = IB+1	INTE 30
IF (IA.GT.8) IA = IA-8	INTE 31
C POSITION OUTSIDE POLAR GRID	INTE 32
IF (ABS(CLAT).LT.75.) GO TO 20	INTE 33
C UPPER LEFT INTERPOLATION INDEX	INTE 34
IC = IA + 8	INTE 35
C UPPER RIGHT INTERPOLATION INDEX	INTE 36
ID = IB + 8	INTE 37
GO TO 300	INTE 38
20 IF(NSAME.EQ.1) NSAME=2	INTE 39
CALL GEN4D	INTE 40
IWSYM = '*'	INTE 41
ICLK = ICLK + 1	INTE 42
GO TO 5	INTE 43
100 XLON = CLON	INTE 44
DO 105 I = 1,4	INTE 45
DO 105 J = 1,4	INTE 46
I16 = 4*(I-1) + J	INTE 47
LAX(I16) = LA(I,J)	INTE 48
105 CONTINUE	INTE 49
IF (CLON.GT.345) XLON = CLON - 360.	INTE 50
C.....CHECKS FOR POSITION WITHIN 16 POINT GRID 110=GOOD. 200=POSITION	INTE 51
C OUTSIDE GRID.	INTE 52


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      IF (CLAT,GE,GLAT(1) ,AND. CLAT,LT,GLAT(16) ,AND. XLON,LE,GLON(1) INTE 53
      $ .AND,XLON,GT,GLON(16)) GO TO 110 INTE 54
      GO TO 200 INTE 55
110  NDL=5 INTE 56
      IF(ABS(CLAT),LT,18) NDL=12 INTE 57
      IA = 1 + INT((GLON(1) - XLON) / 5) INTE 58
C.....IA = LOWER LEFT (REFERENCE) INTERPOLATION INDEX INTE 59
      IA = IA + 4 * INT((CLAT - GLAT(1)) / NDL) INTE 60
C      LOWER RIGHT INTERPOLATION INDEX INTE 61
      IB = IA + 1 INTE 62
C      UPPER LEFT INTERPOLATION INDEX INTE 63
      IC = IA + 4 INTE 64
C      UPPER RIGHT INTERPOLATION INDEX INTE 65
      ID = IA + 5 INTE 66
      IF(LAX(IA),EQ,NB(1),OR,LAX(IA),EQ,NB(2),OR,LAX(IB),NE,LAX(IA),
      $ OR,LAX(IC),NE,LAX(IA),OR,LAX(ID),NE,LAX(IA))IWSYM="*" INTE 68
      GO TO 300 INTE 69
200  IF(NSAME,EQ,1)NSAME=2 INTE 70
      CALL GEN4D INTE 71
      IWSYM = "*" INTE 72
      ICHK = ICHK + 1 INTE 73
      GO TO 5 INTE 74
220  WRITE(6,250) INTE 75
250  FORMAT("  UNABLE TO GENERATE 4-D GRID") INTE 76
      P4=0, INTE 77
      D4=0, INTE 78
      T4=0, INTE 79
      RETURN INTE 80
C.....INTERPOLZTION FOR POSITION INSIDE 16 POINT GRID OR POLAR GRID INTE 81
300  CALL INTLL(P,IA,IB,IC,ID,P4,GLAT,GLON,CLAT,CLOW,IN) INTE 82
      CALL INTLL(D,IA,IB,IC,ID,D4,GLAT,GLON,CLAT,CLOW,IN) INTE 83
      CALL INTLL(T,IA,IB,IC,ID,T4,GLAT,GLON,CLAT,CLOW,IN) INTE 84
C.....RELATIVE LONGITUDE DISPLACEMENT FROM REFERENCE POSITION (IA) INTE 85
      DLON = (CLOW - GLON(IA))/(GLON(IB) - GLON(IA)) INTE 86
C.....RELATIVE LATITUDE DISPLACEMENT FROM REFERENCE POSITION(IA) INTE 87
      DLAT = (CLAT - GLAT(IA))/(GLAT(IC) - GLAT(IA)) INTE 88
      DPX=P(IB,IN)-P(IA,IN) INTE 89
C.....DP/DX FOR GEOSTROPHIC WIND EQUATIONS INTE 90
      DPX = DPX + (P(ID,IN) - P(IC,IN) - DPX)*DLAT INTE 91
      DTX = T(IB,IN) - T(IA,IN) INTE 92
C.....DT/DX FOR THERMAL WIND EQUATIONS INTE 93
      DTX = DTX + (T(ID,IN) - T(IC,IN) - DTX)*DLAT INTE 94
      DPY = P(IC,IN) - P(IA,IN) INTE 95
C.....DP/DY FOR GEOSTROPHIC WIND EQUATIONS INTE 96
      DPY = DPY + (P(ID,IN) - P(IB,IN) - DPY)*DLON INTE 97
      DTY = T(IC,IN) - T(IA,IN) INTE 98
C.....DT/DY FOR THERMAL WIND EQUATIONS INTE 99
      DTY = DTY + (T(ID,IN) - T(IB,IN) - DTY)*DLON INTE 100
      IF(NG,GT,9) GO TO 315 INTE 101
      DPX=DPX/9, INTE 102
      DTX=DTX/9, INTE 103
      DPY=DPY/3, INTE 104
      DTY=DTY/3, INTE 105
315  IF(ABS(CLAT),GT,18) GO TO 312 INTE 106

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	DPY=DPY*5./12	INTE 107
	DTY=DTY*5./12	INTE 108
312	IF (NG.GT.9) GO TO 310	INTE 109
	DPXX = 0.	INTE 110
	DPYY = 0.	INTE 111
	DPXY = 0.	INTE 112
	RETURN	INTE 113
310	DPXY = P(ID,IH) - P(IC,IH) - P(IB,IH) + P(IA,IH)	INTE 114
	IF (MOD(IB,4) .EQ.0) GO TO 320	INTE 115
	I1 = IA	INTE 116
	I2 = IB + 1	INTE 117
	I3 = IC	INTE 118
	I4 = ID + 1	INTE 119
	SX=1.	INTE 120
	GO TO 330	INTE 121
320	I1 = IA - 1	INTE 122
	I2 = IB	INTE 123
	I3 = IC - 1	INTE 124
	I4 = ID	INTE 125
	SX=-1.	INTE 126
330	IF(LAX(I1),NE,LAX(IA),OR,LAX(I2),NE,LAX(IA),OR,LAX(I3),NE, * LAX(IA),OR,LAX(I4),NE,LAX(IA)) GO TO 360	INTE 127
	DPXX = P(I2,IH) - P(I1,IH)	INTE 128
	DPXX = DPXX + (P(I4,IH) - P(I3,IH) - DPXX)*DLAT	INTE 129
	IF (IC.GT.12) GO TO 340	INTE 130
	I1 = IA	INTE 131
	I2 = IC + 4	INTE 132
	I3 = IB	INTE 133
	I4 = ID + 4	INTE 134
	SY=1.	INTE 135
	GO TO 350	INTE 136
340	I1 = IA - 4	INTE 137
	I2 = IC	INTE 138
	I3 = IB - 4	INTE 139
	I4 = ID	INTE 140
	SY=-1.	INTE 141
350	IF(LAX(I1),NE,LAX(IA),OR,LAX(I2),NE,LAX(IA),OR,LAX(I3),NE, * LAX(IA),OR,LAX(I4),NE,LAX(IA)) GO TO 360	INTE 142
	DPYY = P(I2,IH) - P(I1,IH)	INTE 143
	DPYY = DPYY + (P(I4,IH) - P(I3,IH) - DPYY)*DLON	INTE 144
	DPXX =(DPXX - 2.*DPX)*SX	INTE 145
	DPYY =(DPYY - 2.*DPY)*SY	INTE 146
	RETURN	INTE 147
360	DPXX = 0.	INTE 148
	DPYY = 0.	INTE 149
	DPXY = 0.	INTE 150
	IWSYM = '*'	INTE 151
	RETURN	INTE 152
	END	INTE 153
	SUBROUTINE INTLL(F,IA,IB,IC,ID,FLL,GLAT,GLON,CLAT,CLOW,IH)	INTE 154
C....	INTERPOLATES FUNCTION (ARRAY) F FROM VALUES OF GLAT AND GLON AT	INTE 155
C	INDEX VALUES IA, IB, IC, ID TO OUTPUT VALUE FLL AT HEIGHT IH	INTL 1
C	AND POSITION CLAT, CLOW	INTL 2
	DIMENSION F(16,26),GLAT(16),GLON(16)	INTL 3
		INTL 4
		INTL 5

C,....NORMALIZES LONGITUDE DISPLACEMENT	INTL 6
IF(F(IA,IH)*F(IB,IH)*F(IC,IH)*F(ID,IH)) 20,10,20	INTL 7
10 FLL=0.	INTL 8
RETURN	INTL 9
20 X=(GLON-GLON(IB))/(GLON(IA)-GLON(IB))	INTL 10
C,....NORMALIZES LATITUDE DISPLACEMENT	INTL 11
Y=(GLAT-GLAT(IA))/(GLAT(IC)-GLAT(IA))	INTL 12
C,....TWO DIMENSIONAL INTERPOLATION	INTL 13
FLL=F(IB,IH)+(F(ID,IH)-F(IB,IH))*Y+(F(IA,IH)-F(IB,IH))*X	INTL 14
1 +(F(IC,IH)-F(IA,IH)-F(ID,IH)+F(IB,IH))*X*Y	INTL 15
RETURN	INTL 16
END	INTL 17
SUBROUTINE INTRP4 (LALON)	INTR 1
C	INTR 2
C SUBROUTINE TO INTERPOLATE VALUES	INTR 3
C	INTR 4
C DIMENSION XLL(4),YLL(4),XC(4),YC(4)	INTR 5
C	INTR 6
C COMMON/INT/D(208,5),IG(5),DXY(2),DLA(4),DLO(4)	INTR 7
C	INTR 8
DEGRAD=3.14159/180.	INTR 9
LALO=IABS(LALON)	INTR 10
L1=LALO/10000	INTR 11
L2=LALO-L1*10000	INTR 12
XL=L1/10.	INTR 13
YL=L2/10.	INTR 14
IF (IG(5)-2) 30,20,10	INTR 15
10 IF (IG(5)-3) 30,30,50	INTR 16
C	INTR 17
C INTERPOLATE FROM MHC GRID	INTR 18
C	INTR 19
20 CONTINUE	INTR 20
DO 25 L=1,26	INTR 21
DO 22 J=1,4	INTR 22
22 IF (D(L,J).LT.0.01) GO TO 25	INTR 23
DO 24 K=1,8	INTR 24
I=(K-1)*26+L	INTR 25
D(I,5)=(1,-DXY(2))*((1,-DXY(1))*D(I,1)+DXY(1)*D(I,2))	INTR 26
1 +DXY(2)*(((1,-DXY(1))*D(I,3))+DXY(1)*D(I,4))	INTR 27
24 CONTINUE	INTR 28
25 CONTINUE	INTR 29
RETURN	INTR 30
C	INTR 31
C INTERPOLATE FROM EQUATION FOR SOUTHERN HEMISPHERE GRID	INTR 32
C	INTR 33
30 CONTINUE	INTR 34
DO 32 J=1,2	INTR 35
XLL(J)=DLA(J)	INTR 36
YLL(J)=DLO(J)	INTR 37
IF ((YL,GE,355.),AND,(YLL(J).LT,0.01)) YLL(J)=360.	INTR 38
32 CONTINUE	INTR 39
X=(YLL(1)-YL)/5.	INTR 40
Y=(XL-XLL(1))/5.	INTR 41
IF (IG(5).EQ.3) Y=-Y	INTR 42

DO 38 L=1,26	INTR 43
DO 36 J=1,4	INTR 44
36 IF (D(L,J).LT.0.01) GO TO 38	INTR 45
DO 37 K=1,8	INTR 46
I=(K-1)*26+L	INTR 47
D(I,5)=D(I,1)+X*(D(I,2)-D(I,1))+Y*(D(I,3)-D(I,1))+X*Y*	INTR 48
1 (D(I,4)-D(I,3)-D(I,2)+D(I,1))	INTR 49
37 CONTINUE	INTR 50
38 CONTINUE	INTR 51
RETURN	INTR 52
C	INTR 53
C INTERPOLATE FROM ACROSS GRIDS	INTR 54
C	INTR 55
50 CONTINUE	INTR 56
IF (IG(5).NE.1133) GO TO 55	INTR 57
IG(5)=3	INTR 58
GO TO 30	INTR 59
55 CONTINUE	INTR 60
IF (IG(5).NE.333) GO TO 60	INTR 61
DLO(1)=(DLO(2)+DLO(3))/2.	INTR 62
DO 52 I=1,208	INTR 63
52 D(I,4)=D(I,3)	INTR 64
DLA(4)=DLA(3)	INTR 65
DLO(4)=DLO(3)	INTR 66
60 CONTINUE	INTR 67
DO 62 I=1,4	INTR 68
XLL(I)=DLA(I)	INTR 69
YLL(I)=DLO(I)	INTR 70
IF ((YL.GT.350.).AND.(YLL(I).LT.0.01)) YLL(I)=360.	INTR 71
62 CONTINUE	INTR 72
ITH=0	INTR 73
X=YLL(1)-YL	INTR 74
Y=XL-XLL(1)	INTR 75
63 CONTINUE	INTR 76
DO 65 I=2,4	INTR 77
XC(I)=YLL(1)-YLL(I)	INTR 78
65 YC(I)=XLL(1)-XLL(I)	INTR 79
TH2=3.14159/4	INTR 80
TH3=3.14159/4	INTR 81
IF (ABS(XC(2)).GT.0.01) TH2=ATAN(YC(2)/XC(2))	INTR 82
IF (ABS(YC(3)).GT.0.01) TH3=ATAN(XC(3)/YC(3))	INTR 83
IF (XC(2).LT.0.) TH2=3.14159+TH2	INTR 84
IF (XC(3).LT.0.) TH3=3.14159+TH3	INTR 85
DWN=COS(TH2+TH3)	INTR 86
IF (ABS(DWN).GT.0.001) GO TO 66	INTR 87
ITH=ITH+1	INTR 88
IF (ITH.EQ.2) GO TO 66	INTR 89
XLL(3)=XLL(4)	INTR 90
YLL(3)=YLL(4)	INTR 91
DO 61 I=1,208	INTR 92
61 D(I,3)=D(I,4)	INTR 93
GO TO 63	INTR 94
66 CONTINUE	INTR 95
ZA=SQRT(XC(2)**2+YC(2)**2)	INTR 96

IF (ITH.LT.2) GO TO 69	INTR 97
Z=SQRT(X**2+Y**2)	INTR 98
E=0.	INTR 99
Z4=0.	INTR 100
GO TO 71	INTR 101
69 CONTINUE	INTR 102
EB=SQRT(XC(3)**2+YC(3)**2)	INTR 103
Z4=(XC(4)*COS(TH3)-YC(4)*SIN(TH3))/DWN	INTR 104
E4=(YC(4)*COS(TH2)-XC(4)*SIN(TH2))/DWN	INTR 105
Z=(X*COS(TH3)-Y*SIN(TH3))/DWN	INTR 106
E=(Y*COS(TH2)-X*SIN(TH2))/DWN	INTR 107
R=0.	INTR 108
C=0.	INTR 109
DD=0.	INTR 110
C	INTR 111
71 CONTINUE	INTR 112
DO 70 L=1,26	INTR 113
DO 68 J=1,4	INTR 114
68 IF (D(L,J).LT.0.01) GO TO 70	INTR 115
DO 67 K=1,8	INTR 116
I=(K-1)*26+L	INTR 117
A=D(I,1)	INTR 118
IF (ZA.GT.0.01) B=(D(I,2)-D(I,1))/ZA	INTR 119
IF (EB.GT.0.01) C=(D(I,3)-D(I,1))/EB	INTR 120
IF ((ABS(Z4).GT.0.01).AND.(ABS(E4).GT.0.01))	INTR 121
1 DD=(D(I,4)-A-B*Z4-C*E4)/(Z4*E4)	INTR 122
D(I,5)=A+B*Z+C*E+DD*Z*E	INTR 123
67 CONTINUE	INTR 124
70 CONTINUE	INTR 125
RETURN	INTR 126
END	INTR 127
SUBROUTINE INTRUV(UR,VR,H,PHI,SUH,SVH)	INTR 1
C....FINDS RANDOM WIND STANDARD DEVIATION AT HEIGHT H (KM), LATITUDE	INTR 2
C PHI (DEGREES), FROM UR AND VR ARRAYS	INTR 3
DIMENSION UR(25,10),VR(25,10)	INTR 4
C....I - LOWER HEIGHT INDEX	INTR 5
IF (H.LT.95.) I = 1 + INT(H) / 5	INTR 6
IF (H.GE.95.) I=19+(INT(H)-80)/20	INTR 7
IF (I.GT.25) I = 25	INTR 8
C UPPER HEIGHT INDEX	INTR 9
IP=I+1	INTR 10
IF (IP.GT.25) IP=25	INTR 11
C LOWER LATITUDE INDEX	INTR 12
J=INT(PHI+110.)/20	INTR 13
C UPPER LATITUDE INDEX	INTR 14
JP=J+1	INTR 15
IF (JP.GT.10) JP=10	INTR 16
C....PHI1 - LOWER LATITUDE FOR UR AND VR ARRAY VALUES	INTR 17
PHI1=-110.+20.*J	INTR 18
C....PHI2 - UPPER LATITUDE FOR UR AND VR ARRAY VALUES	INTR 19
PHI2=-110.+20.*JP	INTR 20
IF (I.GT.19) GO TO 10	INTR 21
C LOWER HEIGHT FOR UR AND VR ARRAY VALUES	INTR 22
Z1=5.*(I-1)	INTR 23

	GO TO 20	INTR	24
10	Z1=20,*(I-15)	INTR	25
20	IF (IP,GT,19) GO TO 30	INTR	26
C	UPPER HEIGHT FOR UR AND VR ARRAY VALUES	INTR	27
	Z2=5,*(IP-1)	INTR	28
	GO TO 40	INTR	29
30	Z2 = 20, * (IP - 15)	INTR	30
C	INTERPOLATE ON LATITUDE AT LOWER HEIGHT	INTR	31
40	CALL INTERM(UR(I,J),VR(I,J),PHI1,UR(I,JP),VR(I,JP),PHI2,U1,V1, \$PHI)	INTR	32
C	INTERPOLATE ON LATITUDE AT UPPER HEIGHT	INTR	34
	CALL INTERM(UR(IP,J),VR(IP,J),PHI1,UR(IP,JP),VR(IP,JP),PHI2,U2,V2, \$PHI)	INTR	35
C	INTERPOLATE ON HEIGHT	INTR	37
	CALL INTERM(U1,V1,Z1,U2,V2,Z2,SUM,SVH,H)	INTR	38
	RETURN	INTR	39
	END	INTR	40
	SUBROUTINE JAC(Z,TZ,DEMS)	JAC	1
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI, MSAME,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	JAC	2
	COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,Y,T,EM	JAC	3
	DIMENSION ALPHA(6),EI(6),DI(6), B(7),DIT(6)	JAC	4
	BQ = 100.	JAC	5
	DATA ALPHA/0.0,0.0,0.0,0.0,0.0,-0.38,0.0/	JAC	6
	DATA EI/28.0134,31.9988,15.9994,39.948,4.0026,1.00797/	JAC	7
	DATA R/28.15204,-0.085586,1.284E-04,-1.0056E-05,-1.021E-05, 11.5044E-06,9.9826E-08/	JAC	8
	AV=6.02257E23	JAC	9
	QN=.78110	JAC	10
	QD2=.20955	JAC	11
	QA=.009343	JAC	12
	QME = 1.289E-5	JAC	13
	FK=8.31432	JAC	14
C		JAC	15
C	TEMPERATURE AT Z = 125 KM, EQ. 9	JAC	16
C		JAC	17
	TX=444.3807+.02385*T -392.8292*EXP(-.0021357*T)	JAC	18
	A2=2,*(T-TX)/3.14159265	JAC	19
C		JAC	20
C		JAC	21
	DIT(6)=0.	JAC	22
	M=10	JAC	23
	EPS=.0001	JAC	24
C		JAC	25
C	TEMPERATURE FOR 90%ZZ125, EQ. 10	JAC	26
C		JAC	27
	T1=1.9*(TX-183.)/35.	JAC	28
	T4=3,*(TX-183,-2,*.T1*35./3.)/(35,**.4)	JAC	29
	T3=-T1/(3,*.35,**.2)+4,*.T4*35./3.	JAC	30
	TZ=TX+T1*(Z-125.)+T3*(Z-125.)**3+T4*(Z-125.)**4	JAC	31
	IF (Z-105.) 43,43,40	JAC	32
C		JAC	33

C	MEAN MOLECULAR WEIGHT FOR 90ZZZ105, EQ. 1	JAC	38
C		JAC	39
43	Z2 = Z - QQ	JAC	40
	EM=B(1)+B(2)*Z2+B(3)*Z2**2+B(4)*Z2**3+B(5)*Z2**4+B(6)*Z2**5	JAC	41
	1+B(7)*Z2**6	JAC	42
	D=Z	JAC	43
70	CONTINUE	JAC	44
C		JAC	45
C	INTEGRATION OF EQ. 5 FOR DENSITY BETWEEN 90ZZZ105	JAC	46
C		JAC	47
	A=90.	JAC	48
	FA=B(1)+B(2)*(A-QQ)+B(3)*(A-QQ)**2+B(4)*(A-QQ)**3+B(5)*(A-QQ)**4	JAC	49
	1+B(6)*(A-QQ)**5 +B(7)*(A-QQ)**6	JAC	50
	FA=FA*9.80655/((1.+A/6.356766E+3)**2)	JAC	51
	FA=FA/(TX+T1*(A-125.)+T3*(A-125.)**3 +T4*(A-125.)**4)	JAC	52
	FD=B(1)+B(2)*(D-QQ)+B(3)*(D-QQ)**2+B(4)*(D-QQ)**3+B(5)*(D-QQ)**4	JAC	53
	1+B(6)*(D-QQ)**5 +B(7)*(D-QQ)**6	JAC	54
	FD=FD*9.80665/((1.+D/6.356766E+3)**2)	JAC	55
	FD=FD/(TX+T1*(D-125.)+T3*(D-125.)**3 +T4*(D-125.)**4)	JAC	56
C	SRQ4, SIMPSONS RULE QUADRATURE - G.F.KUNCIR	JAC	57
C	DEFINITIONS -	JAC	58
C	A = LOWER LIMIT OF INTEGRATION	JAC	59
C	D = UPPER LIMIT OF INTEGRATION	JAC	60
C	FUNC = INTEGRAND FUNCTION SUBPROGRAM	JAC	61
C	EPS = RELATIVE ERROR CONVERGENCE CRITERION	JAC	62
C	M = MAXIMUM NUMBER OF INTEGRATIONS	JAC	63
C	R = RESULT OF INTEGRATION	JAC	64
C	M = NUMBER OF INTEGRATIONS9RIQ&IRID TO FIND R	JAC	65
C		JAC	66
	NINT = 1	JAC	67
	N=0	JAC	68
	PREV=0.	JAC	69
	SOME=(D-A)*(FA+FD)/2.	JAC	70
71	N=M+1	JAC	71
	IF (M-N) 72,72,75	JAC	72
72	NINT = 2 * NINT	JAC	73
	STWO=0.	JAC	74
	DEL=(D-A)/FLOAT(NINT)	JAC	75
	DO 73 I=1,NINT,2	JAC	76
	X=A+DEL*FLOAT(I)	JAC	77
	FX=B(1)+B(2)*(X-QQ)+B(3)*(X-QQ)**2+B(4)*(X-QQ)**3+B(5)*(X-QQ)**4	JAC	78
	1+B(6)*(X-QQ)**5 +B(7)*(X-QQ)**6	JAC	79
	FX=FX*9.80665/((1.+X/6.356766E+3)**2)	JAC	80
	FX=FX/(TX+T1*(X-125.)+T3*(X-125.)**3 +T4*(X-125.)**4)	JAC	81
73	STWO=STWO+FX	JAC	82
	CUR=SOME+4.*DEL*STWO	JAC	83
	IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 74,75,75	JAC	84
74	PREV=CUR	JAC	85
	SOME=(SOME+CUR)/4.	JAC	86
	GO TO 71	JAC	87
75	R=CUR/3	JAC	88
	IF (Z-105.) 44,76,44	JAC	89
44	IF (D-105.) 76,55,76	JAC	90
C		JAC	91

C	DENSITY FOR 90ZZ105	JAC	92
C		JAC	93
76	DENS=3.46E-9*183.*EM*EXP(-R/FK)/(TZ*28.878)	JAC	94
	DL=ALOG10(DEMS)	JAC	95
	PAR=AV*DEMS/EM	JAC	96
	AN=ALOG10(QN*EM*PAR/28.96)	JAC	97
	AA=ALOG10(QA*EM*PAR/28.96)	JAC	98
	AHE=ALOG10(QHE*EM*PAR/28.96)	JAC	99
	A0=ALOG10(2.*PAR*(1.-EM/28.96))	JAC	100
	A02=ALOG10(PAR*(EM*(1.+002)/28.96-1.))	JAC	101
	AH=0.	JAC	102
	RETURN	JAC	103
C		JAC	104
C	TEMPERATURE AND MEAN MOLECULAR WEIGHT AT Z=105 KM	JAC	105
C		JAC	106
40	Z3=105.	JAC	107
	TZ=TX+T1*(Z3-125.)+T3*(Z3-125)**3+T4*(Z3-125)**4	JAC	108
	ZM3=B(1)+B(2)*5.+B(3)*25.+B(4)*125.+B(5)*5.**4.+B(6)*5.**5.	JAC	109
	1+B(7)*5.**6.	JAC	110
	D=105.	JAC	111
	GO TO 70	JAC	112
C		JAC	113
C	DENSITY AT Z=105 KM	JAC	114
C		JAC	115
55	DEN1=3.46E-9*183.*ZM3*EXP(-R/FK)/(TZ3*28.878)	JAC	116
	PAR=AV*DEN1/ZM3	JAC	117
	DI(1)=QN*ZM3*PAR/28.96	JAC	118
	DI(2)=PAR*(ZM3*(1.+002)/28.96-1.)	JAC	119
	DI(3)=2.*PAR*(1.-ZM3/28.96)	JAC	120
	DI(4)=QA*ZM3*PAR/28.96	JAC	121
	DI(5)=QHE*ZM3*PAR/28.96	JAC	122
	IF(Z-125.) 56,56,90	JAC	123
56	CONTINUE	JAC	124
C		JAC	125
C	INTEGRATION OF EQ. 6 FOR DENSITY ABOVE 105 KM	JAC	126
C		JAC	127
	R=0.	JAC	128
	D1=125.	JAC	129
	A1=105.	JAC	130
400	CONTINUE	JAC	131
	FA1=9.80665/((1.+A1/6.356766E+3)**2)	JAC	132
	FA1=FA1/(TX+T1*(A1-125.)+T3*(A1-125)**3+T4*(A1-125)**4)	JAC	133
	FD1=9.80665/((1.+D1/6.356766E+3)**2)	JAC	134
	IF(D1-125.) 45,45,50	JAC	135
45	FD1=FD1/(TX+T1*(D1-125.)+T3*(D1-125)**3+T4*(D1-125)**4)	JAC	136
	GO TO 51	JAC	137
50	FD1=FD1/(TX+A2*ATAN(T1*(D1-125.)*(1.+4.5E-6*(D1-125.))**2.5)/A2))	JAC	138
	TZ=TX+A2*ATAN(T1*(Z-125.)*(1.+4.5E-6*(Z-125.))**2.5)/A2)	JAC	139
51	N=0	JAC	140
	NINT = 1	JAC	141
	PREV=0	JAC	142
	SOME=(D1-A1)*(FA1+FD1)/2.	JAC	143
81	N=N+1	JAC	144
	IF (N-N) 82,82,85	JAC	145

82	NINT = 2 * NINT	JAC	146
	STWO=0,	JAC	147
	DEL=(D1-A1)/FLOAT(NINT)	JAC	148
	DO 83 I=1,NINT,2	JAC	149
	X1=A1+DEL*FLOAT(I)	JAC	150
	FX1=9.80665/((1.+X1/6.356766E+3)**2)	JAC	151
	IF(X1-125.) 46,46,52	JAC	152
46	FX1=FX1/(TX+T1*(X1-125.))+T3*(X1-125.)**3+T4*(X1-125.)**4)	JAC	153
	GO TO 83	JAC	154
52	FX1=FX1/(TX+A2*ATAN(T1*(X1-125.)*(1.+4.5E-6*(X1-125.))**2.5)/A2))	JAC	155
83	STWO=STWO+FX1	JAC	156
	CUR=SOME+4.*DEL*STWO	JAC	157
	IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 84,85,85	JAC	158
84	PREV=CUR	JAC	159
	SOME=(SOME+CUR)/4.	JAC	160
	GO TO 81	JAC	161
85	R=CUR/3.+R	JAC	162
	IF(A1.EQ.125.) GO TO 430	JAC	163
	D1=Z	JAC	164
	A1=125.	JAC	165
	GO TO 400	JAC	166
430	CONTINUE	JAC	167
C		JAC	168
C	DENSITY ABOVE 105 KM	JAC	169
C		JAC	170
	DO 41 I=1,5	JAC	171
	DIT(I)=DI(I)*(TZ3/TZ)**(1.+ALPHA(I))*EXP(-EI(I)*R/FK)	JAC	172
41	CONTINUE	JAC	173
	DENS=0	JAC	174
	DO 42 I=1,6	JAC	175
	DENS=DENS+EI(I)*DIT(I)/AV	JAC	176
42	CONTINUE	JAC	177
C		JAC	178
C	MEAN MOLECULAR WEIGHT FOR Z 105 KM	JAC	179
C		JAC	180
	EM=DENS*AV/(DIT(1)+DIT(2)+DIT(3)+DIT(4)+DIT(5)+DIT(6))	JAC	181
C		JAC	182
C	LOG DENSITY	JAC	183
C		JAC	184
	DL=ALOG10(DENS)	JAC	185
	AM =ALOG10(DIT(1))	JAC	186
	A02=ALOG10(DIT(2))	JAC	187
	A0 =ALOG10(DIT(3))	JAC	188
	AA =ALOG10(DIT(4))	JAC	189
	AHE=ALOG10(DIT(5))	JAC	190
	IF(Z-500.) 47,48,48	JAC	191
47	DIT(6)=10.**(-6)	JAC	192
48	AH=ALOG10(DIT(6))	JAC	193
	AN =AMAX1(-0., AM)	JAC	194
	A02=AMAX1(-0.,A02)	JAC	195
	A0 =AMAX1(-0., A0)	JAC	196
	AA =AMAX1(-0., AA)	JAC	197
	AHE=AMAX1(-0.,AHE)	JAC	198
	AH =AMAX1(-0., AH)	JAC	199

	RETURN	JAC 200
C		JAC 201
C	TEMPERATURE AND DENSITY AT Z=500 KM	JAC 202
C		JAC 203
90	S=TX+A2*ATAN(T1*375.*(1.+4.5E-6*375.**2.5)/A2)	JAC 204
	DI(6)=10.*(73.13-39.4*ALOG10(S)+5.5*ALOG10(S)*ALOG10(S))	JAC 205
	A1=500.	JAC 206
	IF(Z-500.) 49,60,60	JAC 207
		JAC 208
C		JAC 209
C	INTEGRATION OF EQ. 6 FOR DENSITY FOR Z 125 KM	JAC 210
C		JAC 211
	49 A1=Z	JAC 211
60	FA1=9.80665/((1.+A1/6.356766E+3)**2)	JAC 212
	FA1=FA1/(TX+A2*ATAN(T1*(A1-125.)*(1.+4.5E-6*(A1-125.))**2.5)/A2))	JAC 213
	D1=Z	JAC 214
	IF(Z-500.) 61,62,62	JAC 215
61	D1=500.	JAC 216
62	FD1=9.80665/((1.+D1/6.356766E+3)**2)	JAC 217
	FD1=FD1/(TX+A2*ATAN(T1*(D1-125.)*(1.+4.5E-6*(D1-125.))**2.5)/A2))	JAC 218
	N=0	JAC 219
	NINT = 1	JAC 220
	PREV=0	JAC 221
	SONE=(D1-A1)*(FA1+FD1)/2.	JAC 222
91	N=N+1	JAC 223
	IF (N-N) 92,92,95	JAC 224
92	NINT = 2 * NINT	JAC 225
	STWO=0.	JAC 226
	DEL=(D1-A1)/FLOAT(NINT)	JAC 227
	DO 93 I=1,NINT,2	JAC 228
	X1=A1+DEL*FLOAT(I)	JAC 229
	FX1=9.80665/((1.+X1/6.356766E+3)**2)	JAC 230
	FX1=FX1/(TX+A2*ATAN(T1*(X1-125.)*(1.+4.5E-6*(X1-125.))**2.5)/A2))	JAC 231
93	STWO=STWO+FX1	JAC 232
	CUR=SONE+4.*DEL*STWO	JAC 233
	IF (EPS*ABS(CUR)-ABS(CUR-PREV)) 94,95,95	JAC 234
94	PREV=CUR	JAC 235
	SONE=(SONE+CUR)/4.	JAC 236
	GO TO 91	JAC 237
95	R=CUR/3.	JAC 238
		JAC 239
C		JAC 240
C	TEMPERATURE AT Z 500 KM	JAC 241
C		JAC 242
	TZ=TX+A2*ATAN(T1*(Z-125.)*(1.+4.5E-6*(Z-125.))**2.5)/A2)	JAC 242
	IF(Z-500.) 63,64,64	JAC 243
63	R=-R	JAC 244
		JAC 245
C		JAC 246
C	DENSITY OF HYDROGEN FOR Z 500 KM	JAC 247
C		JAC 248
64	DIT(6)=DI(6)*(S/TZ)*EXP(-EI(6)*R/FK)	JAC 248
	GO TO 56	JAC 249
	END	JAC 250
	SUBROUTINE JACCH(Z,PHIR,THET,PH,DH,TH)	JACC 1
	COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,T,EM	JACC 2
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOF,DD,XMJD,PHI1,PHI,	JACC 3

.	NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,JACC	4
\$ M ,	IDA, IYR, H1, PHIR,THET1R,G,RI,H,CLAT,CLON ,F10,F10B,AP,	JACC 5
.	IHR,MIN,MMORE,DX,HL,VL,DZ	JACC 6
C		JACC 7
C	JACCH CALCULATES THE PRESSURE, DENSITY, AND TEMPERATURE AT A	JACC 8
C	POINT IN SPACE ABOVE 90 KM FOR A PARTICULAR TIME	JACC 9
C		JACC 10
C	INPUT	JACC 11
C	Z = HEIGHT IN KM	JACC 12
C	PHIR = LATITUDE IN RADIAN	JACC 13
C	THET = LONGITUDE IN DEGREES (0 TO 360 DEGREES TURNING WESTWARD)	JACC 14
C	F10 = SOLAR RADIO NOISE FLUX (XE - 22 WATTS/M**2)	JACC 15
C	F10B = 81-DAY AVERAGE F10	JACC 16
C	AP = GEOMAGNETIC INDEX	JACC 17
C	M = MONTH (FOR YEARLY MEAN VARIABLES M IS SET TO 13)	JACC 18
C	IDA = DAY OF MONTH	JACC 19
C	IYR = YEAR	JACC 20
C	IHR = HOUR OF DAY (UNIVERSAL TIME)	JACC 21
C	MIN = MINUTE (UNIVERSAL TIME)	JACC 22
C	XMJD = MEAN JULIAN DAY (SET EQUAL TO ZERO FOR ANNUAL MEAN)	JACC 23
C	DD = DAY NUMBER WITH RESPECT TO JAN 0 OF YEAR IYR	JACC 24
C		JACC 25
C	OUTPUT	JACC 26
C	PH = PRESSURE IN UNITS OF NT/M**2	JACC 27
C	DH = DENSITY IN UNITS OF KG/M**3	JACC 28
C	TH = TEMPERATURE IN KELVIN DEGREES	JACC 29
C		JACC 30
C	DD = DAY NUMBER WITH RESPECT TO JAN 1 OF YEAR IYR	JACC 31
C		JACC 32
C	REPLACEMENT OF SUBROUTINE VARIABLES TO INSURE NO CHANGES IN THEM	JACC 33
C		JACC 34
	R = 0.31	JACC 35
	XLAT = PHIR	JACC 36
	XLONG = THET	JACC 37
	IF (M,EQ,13) GO TO 50	JACC 38
C		JACC 39
C	CALCULATE SOLAR DEC. AND HOUR ANGLE	JACC 40
C		JACC 41
C	CALL THE	JACC 42
C		JACC 43
C	EXOSPHERIC TEMPERATURE	JACC 44
C		JACC 45
	CALL TINF	JACC 46
	GO TO 75	JACC 47
	50 T = 1000.0	JACC 48
C		JACC 49
C	TEMPERATURE, MOLECULAR WEIGHT, AND DENSITY WITHOUT SEASONAL	JACC 50
C	VARIATIONS	JACC 51
C		JACC 52
	75 CALL JAC(Z,TH,DH)	JACC 53
	IF (M,EQ,13) GO TO 300	JACC 54
	YDA = 365.0	JACC 55
	J1 = MOD(IYR,4)	JACC 56
	IF (J1,EQ,0) YDA = 366.0	JACC 57

	C1 = SIN((360. / YDA) * 0.0174532925 * (DD + 100.0))	JACC	58
	IF (PHIR) 80,70,80	JACC	59
70	C2 = 0.0	JACC	60
	GO TO 90	JACC	61
80	C2 = (SIN(PHIR) ** 2) * (PHIR / ABS(PHIR))	JACC	62
C		JACC	63
C	DENSITY WITH SEASONAL VARIATIONS	JACC	64
C		JACC	65
90	Z90 = Z - 90.0	JACC	66
	DLRHO = 0.02 * Z90 * EXP(-0.045 * Z90) * C1 * C2	JACC	67
	DH = DH * EXP(DLRHO)	JACC	68
C		JACC	69
C	MOLECULAR WEIGHT WITH SEASONAL VARIATION	JACC	70
C		JACC	71
	IF (Z - 120.0) 100,100,150	JACC	72
100	EM = EM + 0.006 * Z90 * C1	JACC	73
	GO TO 250	JACC	74
150	IF (Z - 230.0) 200,250,250	JACC	75
200	DEM = EXP(-0.02424 * Z90) * (0.0316 * Z90 - 0.0002257 * Z90 * Z90)	JACC	76
	EM = EM + DEM * C1*.5	JACC	77
C		JACC	78
C	TEMPERATURE WITH SEASONAL VARIATIONS	JACC	79
C		JACC	80
250	IF (Z-260.0) 270,300,300	JACC	81
270	Z110 = Z - 110.0	JACC	82
	DTH = -2.291753 * Z110 + 0.02154336 * Z110*Z110- 4.1766671E-05 * \$ (Z110 ** 3)	JACC	83
	DTH = EXP(-0.290655 * SQRT(ABS(Z110))) * DTH	JACC	84
	TH = TH + (DTH * C1 * C2 * TH) / 100.0	JACC	85
C		JACC	86
C	DENSITY IN METRIC UNITS AND PRESSURE CALCULATED	JACC	87
C		JACC	88
300	DH = DH * 1000.0	JACC	89
	PH = ((DH * 8.31432 * TH) / EM) * 1000.0	JACC	90
	RETURN	JACC	91
	END	JACC	92
	SUBROUTINE NORMAL(D1,D2)	JACC	93
C,...	PRODUCES 2 RANDOM NUMBERS, D1, D2, PICKED FROM A NORMAL DIST.	NORM	1
C	WITH ZERO MEAN AND UNIT VARIANCE	NORM	2
	REAL L	NORM	3
50	X = RAND(0)	NORM	4
	Y = 2**RAND(0) - 1	NORM	5
	XX = X**2	NORM	6
	YY = Y**2	NORM	7
	S = XX + YY	NORM	8
	IF (S-1) 51,51,50	NORM	9
51	L = SQRT(-2**ALOG(RAND(0)))/S	NORM	10
	D1 = (XX-YY)*L	NORM	11
	D2 = 2**X*Y*L	NORM	12
	RETURN	NORM	13
	END	NORM	14
	SUBROUTINE PDTUV (PSP, DSP, TSP, CLAT, CLON, IH, PS, DS, TS, \$ DPX, DPY, DTX, DTY, DP2X, DP2Y, DPXY)	NORM	15
C,...	INTERPOLATES STATIONARY PERTURBATIONS ON LATITUDE AND LONGITUDE	PDTU	1
		PDTU	2
		PDTU	3

C	AT HEIGHT IH	PDTU 4
	DIMENSION PSP(8,10,12),DSP(8,10,12),TSP(8,10,12)	PDTU 5
	IF (IH,LT,52) GO TO 10	PDTU 6
	IF (IH,GT,84) GO TO 20	PDTU 7
C	HEIGHT INDEX K	PDTU 8
	K = ((IH+4)/8) - 4	PDTU 9
	GO TO 30	PDTU 10
10	K = (IH-20)/10	PDTU 11
	GO TO 30	PDTU 12
20	K = 8	PDTU 13
30	XLOW = CLOW	PDTU 14
	IF (CLOW,LT,10.) XLOW = 360. + CLOW	PDTU 15
C	LOWER LONGITUDE INDEX J	PDTU 16
	J = INT((XLOW + 20.)/30.)	PDTU 17
C,....	DLON - RELATIVE LONGITUDE DEVIATION FROM CORNER REFERENCE LOCATION	PDTU 18
	DLON = (XLOW - 30.*J + 20.)/30.	PDTU 19
C	UPPER LONGITUDE INDEX JP	PDTU 20
	JP = J+1	PDTU 21
	IF (JP,GT,12) JP=1	PDTU 22
C	LOWER LATITUDE INDEX I	PDTU 23
	I = INT((CLAT + 110.)/20.)	PDTU 24
C	UPPER LATITUDE INDEX IP	PDTU 25
	IP = I+1	PDTU 26
	IF (IP,GT,10) IP=10	PDTU 27
C,....	DLAT - RELATIVE LATITUDE DEVIATION FROM CORNER REFERENCE LOCATION	PDTU 28
	DLAT = (CLAT-20.*I + 110.)/20.	PDTU 29
C	PRESSURE LAT-LOW INTERPOLATION	PDTU 30
	PS=PSP(K,I,J)+(PSP(K,IP,J)-PSP(K,I,J))*DLAT+(PSP(K,I,JP)-PSP(K,I,JP	PDTU 31
	1))*DLON+(PSP(K,IP,JP)-PSP(K,I,JP)-PSP(K,IP,J)+PSP(K,I,J))*DLAT*	PDTU 32
	2DLON	PDTU 33
C	DENSITY LAT-LOW INTERPOLATION	PDTU 34
	DS=DSP(K,I,J)+(DSP(K,IP,J)-DSP(K,I,J))*DLAT+(DSP(K,I,JP)-DSP(K,I,JP	PDTU 35
	1))*DLON+(DSP(K,IP,JP)-DSP(K,I,JP)-DSP(K,IP,J)+DSP(K,I,J))*DLAT*	PDTU 36
	2DLON	PDTU 37
C	TEMPERATURE LAT-LOW INTERPOLATION	PDTU 38
	TS=TSP(K,I,J)+(TSP(K,IP,J)-TSP(K,I,J))*DLAT+(TSP(K,I,JP)-TSP(K,I,JP	PDTU 39
	1))*DLON+(TSP(K,IP,JP)-TSP(K,I,JP)-TSP(K,IP,J)+TSP(K,I,J))*DLAT*	PDTU 40
	2DLON	PDTU 41
C,....	DPX - DP/DX FOR GEOSTROPHIC WINDS	PDTU 42
	DPX = (PSP(K,I,J) - PSP(K,I,JP)) / 6.	PDTU 43
	DPX = DPX + ((PSP(K,IP,J) - PSP(K,IP,JP))/6. - DPX)*DLAT	PDTU 44
C,....	DPY - DP/DY FOR GEOSTROPHIC WINDS	PDTU 45
	DPY=(PSP(K,IP,J)-PSP(K,I,J))/4.	PDTU 46
	DPY = DPY + ((PSP(K,IP,JP) - PSP(K,I,JP))/4. - DPY)*DLON	PDTU 47
C,....	DTX - DT/DX FOR THERMAL WINDS	PDTU 48
	DTX = (TSP(K,I,J) - TSP(K,I,JP)) / 6.	PDTU 49
	DTX = DTX + ((TSP(K,IP,J) - TSP(K,IP,JP))/6. - DTX)*DLAT	PDTU 50
C,....	DTY - DT/DY FOR THERMAL WINDS	PDTU 51
	DTY = (TSP(K,IP,J) - TSP(K,I,J)) / 4.	PDTU 52
	DTY = DTY + ((TSP(K,IP,JP) - TSP(K,I,JP))/4. - DTY)*DLON	PDTU 53
	IF (IP,GT,9) GO TO 90	PDTU 54
	DPXY = (PSP(K,IP,J) - PSP(K,IP,JP) - PSP(K,I,J) + PSP(K,I,JP))/24.	PDTU 55
	JX = J - 1	PDTU 56
	IF (JX,LT,1) JX = JX + 12	PDTU 57

	IY = I - 1	PDTU 58
	DP2X = (PSP(K,I,JX) - PSP(K,I,JP))/6.	PDTU 59
	DP2X = DP2X + ((PSP(K,IP,JX) - PSP(K,IP,JP))/6. - DP2X)*DLAT	PDTU 60
	DP2Y = (PSF(K,IP,J) - PSF(K,IY,J))/4.	PDTU 61
	DP2Y = DP2Y + ((PSP(K,IP,JP) - PSP(K,IY,JP))/4. - DP2Y)*DLON	PDTU 62
	RETURN	PDTU 63
90	DP2X = 0.	PDTU 64
	DP2Y = 0.	PDTU 65
	DPXY = 0.	PDTU 66
	RETURN	PDTU 67
	END	PDTU 68
	SUBROUTINE PERTRB	PERT 1
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,MNCOP,DD,XHJD,PHI1,PHI,NSAME,	PERT 2
	*PL1,DL1,TL1,SPL1,SDL1,STL1,UL1,VL1,SUL1,SVL1,NM,IDA,IYR,	PERT 3
	IPH,PLAT,	PERT 4
	* PLOW,G,R,CH,CLAT,CLON,F10,F10B,AP,IHR,MIN,MNORE,DX,HL,VL,DZ,	PERT 5
	ZB,EPS,IOPP,LOOK,IET,FLAT,PS1,DS1,TS1,US1,VS1,SPS1,SDS1,	PERT 6
	3STS1,SUS1,SVS1,UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2	PERT 7
	COMMON /COMPER/SP2,SD2,ST2,P2,D2,T2,U2,V2,SU2,SV2,CP,	PERT 8
	1PS2,DS2,TS2,US2,VS2,	PERT 9
	2PL2,DL2,TL2,UL2,VL2,	PERT 10
	3SPS2,SDS2,STS2,SUS2,SVS2,	PERT 11
	4SPL2,SDL2,STL2,SUL2,SVL2	PERT 12
	COMMON/WINCOM/ DUM(11),T	PERT 13
	DLON = ABS(CLON-PLON)	PERT 14
	PI = 3.1415927	PERT 15
	IF(DLON.GT.PI) DLON = 2.*PI - DLON	PERT 16
	DX = R*SQRT((CLAT-PLAT)**2 + (COS(CLAT)*(DLON))**2)	PERT 17
C....	DX IS HORIZONTAL DISTANCE BETWEEN POSITIONS PLAT,PLON AND CLAT,CLOPER	PERT 18
	AH = 900.	PERT 19
	BH = 6.	PERT 20
C	HORIZONTAL WAVELENGTH, KM	PERT 21
	HLL = AH + BH*CH	PERT 22
	DPHI = (90. - ABS(PHI1))**2	PERT 23
	DHGT = 0.22 + 0.0025B*(SQRT(ABS(CH)**3))	PERT 24
	IF (DHGT.GT.5.) DHGT = 5.	PERT 25
	VDS = (11.0 - 2.102E-4*DPHI)*DHGT	PERT 26
	VTS = (3.0 + 5.146E-4*DPHI)*DHGT	PERT 27
	VUS = (6.2 - 3.615E-4*DPHI)*DHGT	PERT 28
	VDL = (20.7 - 1.346E-3*DPHI)*DHGT	PERT 29
	VTL = 7.3*DHGT	PERT 30
	VVL = (31.2 - 3.503E-3*DPHI)*DHGT	PERT 31
	HLS = 20. + .0125*CH*CH	PERT 32
	IF(HLS.GT.400.) HLS = 400.	PERT 33
	HLS = (DX/HLS)**2	PERT 34
	HLL = (DX/HLL)**2	PERT 35
	RDS = SQRT(HLS + (DZ/VDS)**2)	PERT 36
	IF(RDS.LE.100.)GO TO 10	PERT 37
	RDS = 0.	PERT 38
	GO TO 20	PERT 39
10	RDS = 1./EXP(RDS)	PERT 40
20	RTS = SQRT(HLS + (DZ/VTS)**2)	PERT 41
	IF(RTS.LE.100.)GO TO 30	PERT 42
	RTS = 0.	PERT 43

	GO TO 40	PERT 44
30	RTS=1./EXP(RTS)	PERT 45
40	RVS=SQRT(HLS+(DZ/VUS)**2)	PERT 46
	IF(RVS,LE,100.)GO TO 50	PERT 47
	RVS=0.	PERT 48
	GO TO 60	PERT 49
50	RVS=1./EXP(RVS)	PERT 50
60	RDL=SQRT(HLL+(DZ/VTL)**2)	PERT 51
	IF(RDL,LE,100.)GO TO 70	PERT 52
	RDL=0.	PERT 53
	GO TO 80	PERT 54
70	RDL=1./EXP(RDL)	PERT 55
80	RTL=SQRT(HLL+(DZ/VTL)**2)	PERT 56
	IF(RTL,LE,100.)GO TO 90	PERT 57
	RTL=0.	PERT 58
	GO TO 100	PERT 59
90	RTL=1./EXP(RTL)	PERT 60
100	RVL=SQRT(HLL+(DZ/VUL)**2)	PERT 61
	IF(RVL,LE,100.)GO TO 110	PERT 62
	RVL=0.	PERT 63
	GO TO 120	PERT 64
110	RVL=1./EXP(RVL)	PERT 65
120	CONTINUE	PERT 66
	CALL CORLAT(AS,BS,CS,DS,ES,FS,GS,HS,AIS,AJS,AKS,SPS1,SPS2,SDS1,	PERT 67
	1 SDS2,STS1,STS2,SUS1,SUS2,SVS1,SVS2,UDS1,UDS2,VDS1,VDS2,RDS,RTS,	PERT 68
	2RVS)	PERT 69
	CALL CORLAT(AL,BL,CL,DL,EL,FL,GL,HL,AJL,AJL,AKL,SPL1,SPL2,SDL1,	PERT 70
	1 SDL2,STL1,STL2,SUL1,SUL2,SVL1,SVL2,UDL1,UDL2,VDL1,VDL2,	PERT 71
	2RDL,RTL,RVL)	PERT 72
	CALL NORMAL(ZD,ZT)	PERT 73
	DS2=AS*DS1+BS*ZD	PERT 74
	TS2=CS*TS1+DS*DS2+ES*ZT	PERT 75
	PS2=DS2+TS2	PERT 76
	CALL NORMAL(ZD,ZT)	PERT 77
	US2=FS*US1+GS*DS2+HS*ZD	PERT 78
	VS2=AIS*VS1+AJS*DS2+AKS*ZT	PERT 79
	CALL NORMAL(ZD,ZT)	PERT 80
	DL2=AL*DL1+BL*ZD	PERT 81
	TL2=CL*TL1+DL*DL2+EL*ZT	PERT 82
	PL2=DL2+TL2	PERT 83
	CALL NORMAL(ZD,ZT)	PERT 84
	UL2=FL*UL1+GL*DL2+HL*ZD	PERT 85
	VL2=AJL*VL1+AJL*DL2+AKL*ZT	PERT 86
	P2=PS2+PL2	PERT 87
	D2=DS2+DL2	PERT 88
	T2=TS2+TL2	PERT 89
	U2=US2+UL2	PERT 90
	V2=VS2+VL2	PERT 91
	UDL1=UDL2	PERT 92
	UDS1=UDS2	PERT 93
	VDL1=VDL2	PERT 94
	VDS1=VDS2	PERT 95
	RETURN	PERT 96
	END	PERT 97

	SUBROUTINE PHASE(D1,X1,D2,X2,D,X)	PHAS	1
	PER = 870.	PHAS	2
	IF (X2-X1) 20,10,20	PHAS	3
10	D = D1	PHAS	4
	RETURN	PHAS	5
20	DA = D1	PHAS	6
	DB = D2	PHAS	7
	PER2 = PER/2.	PHAS	8
	IF (ABS(DB-DA),LE,PER2)GO TO 30	PHAS	9
	IF (DA,LT,PER2) DA = DA + PER	PHAS	10
	IF (DB,LT,PER2) DB = DB + PER	PHAS	11
30	DA = DA + (DB - DA)*(X - X1)/(X2 - X1)	PHAS	12
	IF (DA,GT,PER) DA = DA - PER	PHAS	13
	IF (DA,LT,0.)DA=DA+PER	PHAS	14
	D = DA	PHAS	15
	RETURN	PHAS	16
	END	PHAS	17
	SUBROUTINE QBOGEN	QBOG	1
C....	COMPUTES QBO VALUES PQ,DQ,TQ,UQ,VQ AT HEIGHT H, LATITUDE PHI	QBOG	2
C	ON JULIAN DAY XMJD FROM ARRAYS OF AMPLITUDES PAQ,DAQ,TAQ,	QBOG	3
C	UAQ,VAQ AND PHASES PDQ,DDQ,TDQ,UDQ,VDQ.	QBOG	4
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DDD,XMJD,PHI1,PHI,	QBOG	5
	NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RUI, RVI, SU1, SV1,QBOG	QBOG	6
	\$ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,	QBOG	7
	INR,MIN,MNORE,DX,HL,VL,DZ	QBOG	8
	COMMON/PDTCOM/IUA,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)	QBOG	9
	,PSP(8,10,12)	QBOG	10
	,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),	QBOG	11
	PDQ(17,5),DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),	QBOG	12
	UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10)	QBOG	13
	,PQ,DQ,TQ,UQ,VQ	QBOG	14
	,PA,DA,TA,UA,VA,IOPQ	QBOG	15
	IF (XMJD,GT,0,AND,IOPQ,EQ,1) GO TO 10	QBOG	16
C	SETS QBO VALUES TO ZERO FOR ANNUAL MEAN	QBOG	17
	PQ=0.	QBOG	18
	DQ=0.	QBOG	19
	TQ=0.	QBOG	20
	UQ=0.	QBOG	21
	VQ=0.	QBOG	22
	RETURN	QBOG	23
C	LOWER HEIGHT INDEX	QBOG	24
10	IH = INT((H-5.)/5.)	QBOG	25
	IF (IH,LT,1) IH=1	QBOG	26
C	UPPER HEIGHT INDEX	QBOG	27
	IP = IH + 1	QBOG	28
	IF (IP,GT,17) IP = 17	QBOG	29
	PHA = ABS(PHI)	QBOG	30
C	LOWER LATITUDE INDEX	QBOG	31
	JL = INT((PHA + 10.)/20.)	QBOG	32
C	UPPER LATITUDE INDEX	QBOG	34
	JP = JL + 1	QBOG	35
	IF (JL,LE,0) JL=1	QBOG	36
	IF (JP,GT,5) JP=5	QBOG	37

C	JULIAN DAY FOR JAN 0, 1966	QB0G 38
	XMJDO = 2439126	QB0G 39
C	TIME RELATIVE TO JAN 0, 1966	QB0G 40
	TMJD = XMJD-XMJDO	QB0G 41
C	2*PI/PERIOD, PERIOD = 870 DAYS	QB0G 42
	PER = 870,	QB0G 43
	TP = 6.2831853/PER	QB0G 44
C	LOWER HEIGHT	QB0G 45
	HI = 5. + 5.*IH	QB0G 46
C	LOWER LATITUDE	QB0G 47
	PHIJ = 20.*JL - 10,	QB0G 48
C	UPPER LATITUDE	QB0G 49
	PHIP = 20.*JP-10,	QB0G 50
C,....	INTERPOLATES QBO P,D,T AMPLITUDE ON LATITUDE AT LOWER HEIGHT	QB0G 51
	CALL INTERZ(PAQ(IH,JL),DAQ(IH,JL),TAQ(IH,JL),PHIJ,PAQ(IH,JP),	QB0G 52
	1DAQ(IH,JP),TAQ(IH,JP),PHIP,PA1,DA1,TA1,PHA)	QB0G 53
C	UPPER HEIGHT	QB0G 54
	HP = 5.+5.*IP	QB0G 55
C,....	INTERPOLATES QBO P,D,T AMPLITUDE ON LATITUDE AT UPPER HEIGHT	QB0G 56
	CALL INTERZ(PAQ(IP,JL),DAQ(IP,JL),TAQ(IP,JL),PHIJ,PAQ(IP,JP),	QB0G 57
	2DAQ(IP,JP),TAQ(IP,JP),PHIP,PA2,DA2,TA2,PHA)	QB0G 58
C,....	INTERPOLATES QBO P,D,T AMPLITUDE ON HEIGHT AT LATITUDE PHI	QB0G 59
	CALL INTERZ(PA1,DA1,TA1,HI,PA2,DA2,TA2,HP,PA,DA,TA,H)	QB0G 60
C,....	INTERPOLATES QBO P,D,T,U,V PHASE ON LATITUDE AND HEIGHT	QB0G 61
	CALL PHASE(PDQ(IH,JL),PHIJ,PDQ(IH,JP),PHIP,PD1,PHA)	QB0G 62
	CALL PHASE(DDQ(IH,JL),PHIJ,DDQ(IH,JP),PHIP,DD1,PHA)	QB0G 63
	CALL PHASE(TDQ(IH,JL),PHIJ,TDQ(IH,JP),PHIP,TD1,PHA)	QB0G 64
	CALL PHASE(PDQ(IP,JL),PHIJ,PDQ(IP,JP),PHIP,PD2,PHA)	QB0G 65
	CALL PHASE(DDQ(IP,JL),PHIJ,DDQ(IP,JP),PHIP,DD2,PHA)	QB0G 66
	CALL PHASE(TDQ(IP,JL),PHIJ,TDQ(IP,JP),PHIP,TD2,PHA)	QB0G 67
	CALL PHASE(PD1,HI,PD2,HP,PD,H)	QB0G 68
	CALL PHASE(DD1,HI,DD2,HP,DD,H)	QB0G 69
	CALL PHASE(TD1,HI,TD2,HP,TD,H)	QB0G 70
	CALL PHASE(UDQ(IH,JL),PHIJ,UDQ(IH,JP),PHIP,UD1,PHA)	QB0G 71
	CALL PHASE(VDQ(IH,JL),PHIJ,VDQ(IH,JP),PHIP,VD1,PHA)	QB0G 72
	CALL PHASE(UDQ(IP,JL),PHIJ,UDQ(IP,JP),PHIP,UD2,PHA)	QB0G 73
	CALL PHASE(VDQ(IP,JL),PHIJ,VDQ(IP,JP),PHIP,VD2,PHA)	QB0G 74
	CALL PHASE(UD1,HI,UD2,HP,UD,H)	QB0G 75
	CALL PHASE(VD1,HI,VD2,HP,VD,H)	QB0G 76
C,....	INTERPOLATES QBO WIND AMPLITUDE ON LATITUDE AT LOWER HEIGHT	QB0G 77
	CALL INTERW(UAQ(IH,JL),VAQ(IH,JL),PHIJ,UAQ(IH,JP),VAQ(IH,JP),	QB0G 78
	5PHIP,UA1,VA1,PHA)	QB0G 79
C,....	INTERPOLATES QBO WIND AMPLITUDES ON LATITUDE AT UPPER HEIGHT	QB0G 80
	CALL INTERW(UAQ(IP,JL),VAQ(IP,JL),PHIJ,UAQ(IP,JP),VAQ(IP,JP),	QB0G 81
	6PHIP,UA2,VA2,PHA)	QB0G 82
C,....	INTERPOLATES QBO WIND AMPLITUDES ON HEIGHT AT LATITUDE PHI	QB0G 83
	CALL INTERW(UA1,VA1,HI,UA2,VA2,HP,UA,VA,H)	QB0G 84
C,....	EVALUATES QBO VALUES FROM INTERPOLATED AMPLITUDES AND PHASES	QB0G 85
	PQ=PA*COS(TP*(TMJD-PD))	QB0G 86
	DQ=DA*COS(TP*(TMJD-DD))	QB0G 87
	TQ=TA*COS(TP*(TMJD-TD))	QB0G 88
	UQ=UA*COS(TP*(TMJD-UD))	QB0G 89
	VQ=VA*COS(TP*(TMJD-VD))	QB0G 90
	RETURN	QB0G 91

END	QBOG	92
FUNCTION RAND(X0)	RAND	1
C....,PRODUCES A RANDOM NUMBER FROM A UNIFORM DIST. FROM 0 TO +1	RAND	2
INTEGER X0	RAND	3
IF (X0.NE.0) X = X0/262144.	RAND	4
X = X*509	RAND	5
X = X - INT(X)	RAND	6
RAND = X	RAND	7
RETURN	RAND	8
END	RAND	9
SUBROUTINE RIG	RIG	1
COMMON/IOTEMP/IOTEK1,IOTEK2,IUG,MMCOP,DD,XMJD,PHI1,PHI,	RIG	2
, NSAME,RP1, RD1, RT1, SP1, SD1, ST1, RU1, RV1, SU1, SV1,	RIG	3
\$ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AF,	RIG	4
, INR,MIN,MMORE,DX,HL,VL,DZ,B,EPS	RIG	5
IRP1S,RD1S,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,	RIG	6
ZUDS1,VDS1,UDL1,VDL1,UOS2,VDS2,UDL2,VDL2	RIG	7
C....,GRAVITY G AT H, LATITUDE PHIR (RADIANS)	RIG	8
C....,RADIUS RI FROM CENTER OF EARTH TO HEIGHT H	RIG	9
C....,B = POLAR EARTH RADIUS, EPS = ECCENTRICITY	RIG	10
CPHI2 = COS(PHIR) ** 2	RIG	11
C EARTH RADIUS	RIG	12
RI = B / SBRT(1. - EPS * CPHI2)	RIG	13
C C2PHI = COS(2*PHIR)	RIG	14
C2PHI = 2. * CPHI2 - 1.	RIG	15
C C4PHI = COS(4*PHIR)	RIG	16
C4PHI = 8. * CPHI2 * (CPHI2 - 1.) + 1.	RIG	17
C....,G AT SURFACE	RIG	18
G = 9.80616 * (1. - 0.0026373 * C2PHI + 0.0000059 * C2PHI * C2PHI)	RIG	19
C....,EFFECTIVE RADIUS	RIG	20
RE = 2. * G / (3.085462E-3 + C2PHI * 2.27E-6 - C4PHI * 2.E-9)	RIG	21
C G AT HEIGHT H	RIG	22
G = G / (1. + (H / RE)) ** 2	RIG	23
C RADIUS AT HEIGHT H	RIG	24
RI = RI + H	RIG	25
END	RIG	26
SUBROUTINE RTERP(H,PHI,PR,DR,TR,P,D,T)	RTER	1
C....,COMPUTES RANDOM PERTURBATION STANDARD DEVIATIONS P,D,T AT	RTER	2
C HEIGHT H (KM), LATITUDE PHI(DEGREES) FROM SIGMA ARRAYS	RTER	3
C PR,DR,AND TR	RTER	4
DIMENSION PR(20,10),DR(20,10),TR(20,10)	RTER	5
C....,I = LOWER HEIGHT INDEX	RTER	6
IF (H.LT.95.) I = INT((H-20.)/5.)	RTER	7
IF (H.GE.95.) I = 14 + INT((H-80.)/20.)	RTER	8
IP = I+1	RTER	9
IF (IP.GT.20) IP = 20	RTER	10
C LOWER LATITUDE INDEX	RTER	11
J = INT((PHI + 110.)/20.)	RTER	12
JP = J+1	RTER	13
IF (JP.GT.10) JP=10	RTER	14
IF (I.GT.14) GO TO 10	RTER	15
C LOWER HEIGHT FOR PR,TR,DR ARRAYS	RTER	16
Z1=5.*I+20.	RTER	17
GO TO 20	RTER	18

10 Z1=20,*(I-10)	RTER 19
20 IF (IP.GT.14) GO TO 30	RTER 20
C UPPER HEIGHT FOR PR,DR,TR ARRAYS	RTER 21
Z2=5,*(IP+20,	RTER 22
GO TO 40	RTER 23
30 Z2=20,*(IP-10)	RTER 24
40 PHI1=-110,+20,*J	RTER 25
PHI2=-110,+20,*JP	RTER 26
C.....INTERPOLATE ON LATITUDE AT LOWER HEIGHT	RTER 27
CALL INTERZ(PR(I,J),DR(I,J),TR(I,J),PHI1,PR(I,JP),DR(I,JP),	RTER 28
1 TR(I,JP),PHI2,P1,D1,T1,PHI)	RTER 29
C.....INTERPOLATE ON LATITUDE AT UPPER HEIGHT	RTER 30
CALL INTERZ(PR(IP,J),DR(IP,J),TR(IP,J),PHI1,PR(IP,JP),DR(IP,JP),	RTER 31
1 TR(IP,JP),PHI2,P2,D2,T2,PHI)	RTER 32
C.....INTERPOLATION ON HEIGHT USING LATITUDE INTERPOLATED VALUES	RTER 33
CALL INTERZ(P1,D1,T1,Z1,P2,D2,T2,Z2,P,D,T,H)	RTER 34
RETURN	RTER 35
END	RTER 36
SUBROUTINE RTRAN	RTRA 1
COMMON/IOTEMP/IOTEM1,IOTEM2,IUG	RTRA 2
COMMON/COTRAN/NDATA(19),I1,I2,I3,I4(10),I5	RTRA 3
C.....ENTRY POINT TO READ STATIONARY PERTURBATION DATA, AND	RTRA 4
C RANDOM PERTURBATION DATA IN SETUP	RTRA 5
IWHERE=2H,	RTRA 6
READ(IUG,100,END=3) NDATA	RTRA 7
100 FORMAT(A2,19I7)	RTRA 8
RETURN	RTRA 9
ENTRY RTRAN1	RTRA 10
C.....ENTRY POINT TO READ GROVES DATA IN SETUP	RTRA 11
IWHERE=2H1,	RTRA 12
READ(IUG,100,END=3) NDATA	RTRA 13
I1=NDATA(1)	RTRA 14
I2=NDATA(2)	RTRA 15
I3=NDATA(3)	RTRA 16
I5=NDATA(14)	RTRA 17
DO 1 I=1,10	RTRA 18
1 I4(I)=NDATA(I+3)	RTRA 19
RETURN	RTRA 20
ENTRY RTRAN2	RTRA 21
C.....ENTRY POINT TO READ QBO PARAMETERS IN SETUP	RTRA 22
IWHERE=2H2,	RTRA 23
READ(IUG,100,END=3) NDATA	RTRA 24
I1=NDATA(1)	RTRA 25
I3=NDATA(2)	RTRA 26
DO 2 I=1,10	RTRA 27
2 I4(I)=NDATA(2+I)	RTRA 28
RETURN	RTRA 29
3 WRITE(6,200) IUG,IWHERE	RTRA 30
200 FORMAT('1 PREMATURE END-OF-FILE FOUND ON UNIT ',I2/ %'0 CALLED FROM SUBROUTINE RTRAN',A2)	RTRA 31
STOP	RTRA 32
END	RTRA 33
SUBROUTINE SCIMDI(NPOP)	RTRA 34
C.....COMPUTES VALUES P,D,T,U,V AND SHEAR DUH,DVH FROM INPUT AND	SCIM 1
	SCIM 2

C	ARRAYS IN COMMON PDTCOM, INPUT TO SCIMOD ISX	SCIM	3
C	G = GRAVITY AT POSITION RI = RADIUS AT HEIGHT H	SCIM	4
C	PHIR = LATITUDE (RADIAN) THETR = LONGITUDE (RADIAN)	SCIM	5
C	F10 = F10.7 SOLAR FLUX F10B = MEAN F10.7 FLUX	SCIM	6
C	AP = SOLAR-GEOMAGNETIC A SUB P INDEX	SCIM	7
C	MN/IDA/IYR = DATA (IYR = FULL YEAR-1900)	SCIM	8
C	IHRZMIN = TIME H1 = PREVIOUS HEIGHT	SCIM	9
C	PHI1R = PREVIOUS LATITUDE THET1R = PREVIOUS LONGITUDE	SCIM	10
C	RP1,RD1,RT1 = PREVIOUS RANDOM PERTURBATIONS	SCIM	11
C	SP1,SD1,ST1 = PREVIOUS RANDOM STANDARD DEVIATIONS (SIGMAS)	SCIM	12
C	RU1,RV1 = PREVIOUS RANDOM WINDS	SCIM	13
C	SU1,SV1 = PREVIOUS RANDOM WIND SIGMAS	SCIM	14
	COMMON/IPRTP/ IPRT	SCIM	15
	COMMON/IOTEMP/IOTEK1,IOTEK2,IUG,NMCOP,DD,XMJD,PHI1,PHI,	SCIM	16
	,NSAME,RP1L,RD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L,	SCIM	17
	\$ MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,	SCIM	18
	, IHR,MIN,NMORE,DX,HL,VL,DZ,B,EPS,IOPP,LOOK,IET,FLAT,	SCIM	19
	1RP1S,RD1S,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,	SCIM	20
	2UDS1,VDS1,UDL1,VDL1,UDS2,VDS2,UDL2,VDL2	SCIM	21
	COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)	SCIM	22
	,PSP(8,10,12)	SCIM	23
	,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),	SCIM	24
	,FDB(17,5),DDQ(17,5),TDB(17,5),PR(20,10),DR(20,10),TR(20,10),	SCIM	25
	,UAQ(17,5),VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10), PQ	SCIM	26
	,DQ,TQ,UQ,VQ,PQA,DQA,TQA,UA,VA,IOPQ,	SCIM	27
	1PLP(25,10),GLP(25,10),TLP(25,10),	SCIM	28
	2ULP(25,10),VLP(25,10),UDL(25,10),	SCIM	29
	3VDL(25,10),UDS(25,10),VDS(25,10)	SCIM	30
	COMMON /C4/ GLAT(16),GLON(16),NG,P4D(16,26),D4D(16,26),T4D(16,26),	SCIM	31
	, SP4(16,26),SD4(16,26),ST4(16,26),THET1,THET,DUMMY	SCIM	32
	COMMON/COMPER/SPH,SDH,STH,PRH,DRH,TRH,URH,VRH,SUH,SVH,CP,	SCIM	33
	1PRHS,DRHS,TRHS,URHS,VRHS,PRHL,DRHL,TRHL,URHL,VRHL,	SCIM	34
	2SPHS,SDHS,STHS,SUHS,SVHS,SPHL,SDHL,STHL,SUHL,SVHL	SCIM	35
	COMMON/WINCOM/DH,FCORY,DX5,DY5,DPX,DPY,DPXX,DPXY,DPYY,UGH,VGH,	SCIM	36
	\$ TH,DTX,DTY,DUH,DVH,PH,UPRE,VPRE,DUPRE,DVPRE	SCIM	37
	COMMON/CHK/PCK(4,4,3),DCK(4,4,3),NO(2)	SCIM	38
	COMMON/CHIC/LA(4,4),NB(2),IWSYM,UCCOEF(14,9),VCCOEF(14,9)	SCIM	39
C	FACTOR FOR RADIAN TO DEGREE	SCIM	40
	FAC = 57.2957795	SCIM	41
	IWSYM = ' '	SCIM	42
	IF(NPDF,NE,0) GO TO 6	SCIM	43
	UPRE=0.	SCIM	44
	VPRE=0.	SCIM	45
	DUPRE=0.	SCIM	46
	DVPRE=0.	SCIM	47
6	PQ=0.	SCIM	48
	DQ=0.	SCIM	49
	TQ=0.	SCIM	50
	PRH=0.	SCIM	51
	DRH=0.	SCIM	52
	TRH=0.	SCIM	53
	URH=0.	SCIM	54
	VRH=0.	SCIM	55
	UQ=0.	SCIM	56

VQ=0.	SCIM 57
PQA=0.	SCIM 58
DQA=0.	SCIM 59
TQA=0.	SCIM 60
UA=0.	SCIM 61
VA=0.	SCIM 62
PSH=0.	SCIM 63
DSH=0.	SCIM 64
TSH=0.	SCIM 65
MONTH=MN	SCIM 66
C PRESENT LATITUDE, DEG	SCIM 67
PHI = PHIR*FAC	SCIM 68
C PRESENT LONGITUDE, DEG	SCIM 69
THET = THETR*FAC	SCIM 70
C PREVIOUS LATITUDE, DEG	SCIM 71
PHI1 = PHI1R*FAC	SCIM 72
C PREVIOUS LONGITUDE, DEG	SCIM 73
THET1 = THET1R*FAC	SCIM 74
C....FCORY = NORTH COMPONENT CORIOLIS FACTOR TIMES DISTANCE FOR	SCIM 75
C 5 DEGREES OF LATITUDE	SCIM 76
DYS = 5000.*RI/FAC	SCIM 77
DX5 = DYS* $\cos(\text{PHIR})$	SCIM 78
FCORY = DYS* $\sin(\text{PHIR})/(120.*\text{FAC})$	SCIM 79
C....IN JACCHIA OR MIXED GROVES-JACCHIA HEIGHT RANGE	SCIM 80
8 IF (H.GT,90,0) GO TO 10	SCIM 81
C....IN 4-D DATA HEIGHT RANGE	SCIM 82
IF (H.LE,25,0) GO TO 500	SCIM 83
C IN GROVES OR MIXED GROVES 4D HEIGHT RANGE	SCIM 84
GO TO 200	SCIM 85
C....IN MIXED JACCHIA-GROVES RANGE, NEED TO FAIR DATA	SCIM 86
10 IF (H.LT,115,.) GO TO 20	SCIM 87
C....FOLLOWING IS THE PURE JACCHIA HEIGHT RANGE SECTION	SCIM 88
C....JACCHIA VALUES AT CURRENT POSITION	SCIM 89
CALL JACCH(H,PHIR,THET,PH,DH,TH)	SCIM 90
PHIN = PHIR + 5. / FAC	SCIM 91
THETE = THET - 5.	SCIM 92
C....JACCHIA VALUES AT CURRENT POSITION+5 DEGREES LAT, FOR DP/DY AND	SCIM 93
C DT/DY	SCIM 94
CALL JACCH(H,PHIN,THETE,PHN,DHN,THN)	SCIM 95
C....JACCHIA VALUES AT CURRENT POSITION-5 DEGREES LON, FOR DP/DX AND	SCIM 96
C DT/DX	SCIM 97
CALL JACCH(H,PHIR,THETE,PHE,DHE,THE)	SCIM 98
C DP/DY FOR GEOSTROPHIC WIND	SCIM 99
DPY=PHN-PH	SCIM 100
C DP/DX FOR GEOSTROPHIC WIND	SCIM 101
DPX=PHE-PH	SCIM 102
C DT/DX FOR THERMAL WIND SHEAR	SCIM 103
DTX = THE - TH	SCIM 104
C DT/DY FOR THERMAL WIND SHEAR	SCIM 105
DTY = THN - TH	SCIM 106
C CHANGE NOTATION FOR OUTPUT	SCIM 107
PGH=PH	SCIM 108
DGH=DH	SCIM 109
TGH=TH	SCIM 110

CALL WIND	SCIM 111
UH = UGH	SCIM 112
VH = VGH	SCIM 113
HB = H + 5.	SCIM 114
CP = 7.*PH/(2.*DH*TH)	SCIM 115
CALL JACCH(HB,PHIR,THET,PB,DB,TR)	SCIM 116
DTZ = (TR - TH)/5000.	SCIM 117
C.....VERTICAL MEAN WIND	SCIM 118
WGH = -CP*(UH*DTX/DX5 + VH*DTY/DY5)/(G + CP*DTZ + UH*DUH+VH*DVH)	SCIM 119
C GO TO RANDOM PERTURBATIONS SECTION	SCIM 120
GO TO 800	SCIM 121
C.....FOLLOWING IS THE MIXED JACCHIA-GROVES HEIGHT RANGE SECTION	SCIM 122
C LOWER HEIGHT INDEX	SCIM 123
20 IHA = 5*(INT(H)/5)	SCIM 124
C UPPER HEIGHT INDEX	SCIM 125
IHB = IHA + 5	SCIM 126
C LOWER HEIGHT FOR INTERPOLATION	SCIM 127
HA = IHA*1.	SCIM 128
C UPPER HEIGHT FOR INTERPOLATION	SCIM 129
HB = IHB*1.	SCIM 130
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON	SCIM 131
CALL JACCH(HA,PHIR,THET,PJA,DJA,TJA)	SCIM 132
PHIN = PHIR + 5. / FAC	SCIM 133
THETE = THET - 5.	SCIM 134
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON+5 DEGREES	SCIM 135
C LAT, FOR DP/DY AND DT/DY	SCIM 136
CALL JACCH(HA,PHIN,THET,PJN,DJN,TJN)	SCIM 137
C.....JACCHIA VALUES AT LOWER HEIGHT, CURRENT LAT-LON-5 DEGREES	SCIM 138
C LON, FOR DP/DX, AND DT/DX	SCIM 139
CALL JACCH(HA,PHIR,THETE,PJE,DJE,TJE)	SCIM 140
C JACCHIA DP/DY AT LOWER HEIGHT	SCIM 141
DPXJA=PJE-PJA	SCIM 142
C JACCHIA DP/DY AT LOWER HEIGHT	SCIM 143
DPYJA=PJN-PJA	SCIM 144
C JACCHIA DT/DX AT LOWER HEIGHT	SCIM 145
DTXJA = TJE - TJA	SCIM 146
C JACCHIA DT/DY AT LOWER HEIGHT	SCIM 147
DTYJA = TJN - TJA	SCIM 148
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT-LON	SCIM 149
CALL JACCH(HB,PHIR,THET,PJB,DJB,TJB)	SCIM 150
PHIN = PHIR + 5. / FAC	SCIM 151
THETE=THETE-5	SCIM 152
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT/LON+5 DEGREES	SCIM 153
C LAT, FOR DP/DY AND DT/DY	SCIM 154
CALL JACCH(HB,PHIN,THET,PJN,DJN,TJN)	SCIM 155
C.....JACCHIA VALUES AT UPPER HEIGHT, CURRENT LAT-LON-5 DEGREES	SCIM 156
C LON, FOR DP/DX AND DT/DX	SCIM 157
CALL JACCH(HB,PHIR,THETE,PJE,DJE,TJE)	SCIM 158
C JACCHIA DP/DX FOR GEOSTROPHIC WINDS	SCIM 159
DPXJB = PJE - PJB	SCIM 160
C JACCHIA DP/DY FOR GEOSTROPHIC WINDS	SCIM 161
DPYJB = PJN - PJB	SCIM 162
C JACCHIA DT/DX FOR THERMAL WIND SHEAR	SCIM 163
DTXJB = TJE - TJB	SCIM 164

C	JACCHIA DT/DY FOR THERMAL WIND SHEAR	SCIM 165
	DTYJB = TJM - TJB	SCIM 166
C....	GROVES AT LOWER HEIGHT, TO BE FAIRED WITH JACCHIA	SCIM 167
	CALL GTERP(IHA,PHI,PGA,DGA,TGA,PG,DG,TG,DPYGA,DTYGA,DP2YGA)	SCIM 168
C....	GROVES AT UPPER HEIGHT, TO BE FAIRED WITH JACCHIA	SCIM 169
	CALL GTERP(IHB,PHI,PGB,DGB,TGB,PG,DG,TG,DPYGB,DTYGB,DP2YGB)	SCIM 170
C....	FAIRED RESULTS AT LOWER HEIGHT	SCIM 171
	CALL FAIR(PGA,DGA,TGA,PJA,DJA,TJA,IHA,P1,D1,T1,DPYGA,	SCIM 172
	\$DPXJA,DPYJA,DPXA,DPYA,DTYGA,DTXJA,DTYJA,DTXA,DTYA)	SCIM 173
C....	FAIRED RESULTS AT UPPER HEIGHT	SCIM 174
	CALL FAIR(PGB,DGB,TGB,PJB,DJB,TJB,IHB,P2,D2,T2,DPYGB,	SCIM 175
	\$DPXJB,DPYJB,DPXB,DPYB,DTYGB,DTXJB,DTYJB,DTXB,DTYB)	SCIM 176
C....	HEIGHT INTERPOLATION ON FAIRED P,D,T	SCIM 177
	CALL INTER2(P1,D1,T1,HA,P2,D2,T2,HB,PH,DH,TH,H)	SCIM 178
C....	HEIGHT INTERPOLATION ON FAIRED DP/DX,DP/DY	SCIM 179
	CALL INTERW(DPXA,DPYA,HA,DPXB,DPYB,HB,DPX,DPY,H)	SCIM 180
C....	HEIGHT INTERPOLATION ON FAIRED DT/DX,DT/DY	SCIM 181
	CALL INTERW(DTXA,DTYA,HA,DTXB,DTYB,HB,DTX,DTY,H)	SCIM 182
C....	EASTWARD COMPONENT OF GEOSTROPHIC WIND	SCIM 183
	CALL WIND	SCIM 184
C	CHANGE OF VARIABLES FOR OUTPUT	SCIM 185
	PGH=PH	SCIM 186
	DGH=DH	SCIM 187
	TGH=TH	SCIM 188
	UH = UGH	SCIM 189
	VH = VGH	SCIM 190
	CP = 7.*PH/(2.*DH*TH)	SCIM 191
	DTZ = (T2 - T1)/5000.	SCIM 192
C....	VERTICAL MEAN WIND	SCIM 193
	WGH = -CP*(UH*DTX/DX5 + VH*DTY/DY5)/(G + CP*DTZ + UH*DUH + VH*DVH)	SCIM 194
C	GO TO RANDOM PERTURBATIONS SECTION	SCIM 195
	GO TO 800	SCIM 196
C....	THE FOLLOWING SECTION IS FOR GROVES OR MIXED GROVES 4D HEIGHTS	SCIM 197
C	UPPER HEIGHT INDEX	SCIM 198
200	IHGB = 5*(INT(H)/5) + 5	SCIM 199
	IF (IHGB.GT.90) IHGB=90	SCIM 200
C	UPPER HEIGHT	SCIM 201
	HGB = IHGB*1.	SCIM 202
C....	GROVES AT UPPER HEIGHT	SCIM 203
	CALL GTERP(IHGB,PHI,PGB,DGB,TGB,PG,DG,TG,DPYGB,DTYGB,DP2YGB)	SCIM 204
C....	UPPER STATIONARY PERTURBATION HEIGHT = 40	SCIM 205
	IF (H.LT.40.0) GO TO 210	SCIM 206
C....	UPPER STATIONARY PERTURBATION HEIGHT = 90	SCIM 207
	IF (H.GT.84.0) GO TO 220	SCIM 208
C....	UPPER STATIONARY PERTURBATION HEIGHT = 52,60,68,76,OR 84	SCIM 209
	IHSB = 8*((INT(H) + 4)/8) + 4	SCIM 210
C....	UPPER STATIONARY PERTURBATION HEIGHT = 52	SCIM 211
	IF (IHSB.LT.52.0) IHSB = 52	SCIM 212
	GO TO 230	SCIM 213
210	IHSB = 10*(INT(H)/10) + 10	SCIM 214
	GO TO 230	SCIM 215
220	IHSB = 90	SCIM 216
C	UPPER STATIONARY PERTURBATION HEIGHT	SCIM 217
230	HSB = IHSB*1.	SCIM 218

C.....	STATIONARY PERTURBATIONS AT UPPER HEIGHT	SCIM 219
	CALL PDTUV(PSP,DSP,TSP,PHI,THET,IHGB,PSB,DSB,TSB,DPXSB,DPYSB,	SCIM 220
	\$ DTXSB,DTYSB,DP2XSB,DP2YSB,DPXYSB)	SCIM 221
C	MIXED GROVES 4D SECTION	SCIM 222
	IF (H,LT,30,0) GO TO 300	SCIM 223
C	LOWER HEIGHT INDEX	SCIM 224
	IHGA = IHGB - 5	SCIM 225
C	LOWER HEIGHT INDEX	SCIM 226
	HGA = IHGA*1.	SCIM 227
C.....	GROVES AT LOWER HEIGHT	SCIM 228
	CALL GTERP(IHGA,PHI,PGA,DGA,TGA,PG,DG,TG,DPYGA,DTYGA,DP2YGA)	SCIM 229
C.....	LOWER STATIONARY PERTURBATION HEIGHT = 30	SCIM 230
	IF (H,LT,40,0) GO TO 240	SCIM 231
C.....	LOWER STATIONARY PERTURBATION HEIGHT = 52,60,68,76, OR 84	SCIM 232
	IHSA = 8*((INT(H) + 4)/8) - 4	SCIM 233
C.....	LOWER STATIONARY PERTURBATIONS HEIGHT = 40	SCIM 234
	IF (IHSA,LT,40,0) IHSA = 40	SCIM 235
	GO TO 250	SCIM 236
	240 IHSA = 30	SCIM 237
C	LOWER STATIONARY PERTURBATION HEIGHT	SCIM 238
	250 HSA = IHSA*1.	SCIM 239
C.....	STATIONARY PERTURBATIONS AT LOWER HEIGHT	SCIM 240
	CALL PDTUV(PSP,DSP,TSP,PHI,THET,IHSA,PSA,DSA,TSA,DPXSA,DPYSA,	SCIM 241
	\$ DTXSA,DTYSA,DP2XSA,DP2YSA,DPXYSA)	SCIM 242
C.....	GROVES VALUES HEIGHT INTERPOLATIONS	SCIM 243
	CALL INTER2(PGA,DGA,TGA,HGA,PGH,DGH,TGH,H)	SCIM 244
C.....	STATIONARY PERTURBATION HEIGHT INTERPOLATION	SCIM 245
	CALL INTERZ(PSA,DSA,TSA,HSA,PSB,DSB,TSB,HSB,PSH,DSH,TSH,H)	SCIM 246
C	QUASI-BIENNIAL VALUES	SCIM 247
	CALL OROGEN	SCIM 248
C.....	HEIGHT INTERPOLATION OF GROVES DP/DY, DT/DY, AND D2P/DY2	SCIM 249
	CALL INTERZ(DPYGA,DTYGA,DP2YGA,HGA,DPYGB,DTYGB,DP2YGB,HGB,DPYG,	SCIM 250
	\$ DTYG,DP2YG,H)	SCIM 251
C.....	HEIGHT INTERPOLATION OF STATIONARY PERTURBATION DP/DX AND DP/DY	SCIM 252
	CALL INTERM(DPXSA,DPYSA,HSA,DPXSB,DPYSB,HSB,DPXS,DPYS,H)	SCIM 253
C.....	HEIGHT INTERPOLATION OF STATIONARY PERTURBATION DT/DX AND DT/DY	SCIM 254
	CALL INTERM(DTXSA,DTYSA,HSA,DTXSB,DTYSB,HSB,DTXS,DTYS,H)	SCIM 255
C.....	HEIGHT INTERPOLATION OF STATIONARY PERTURBATION D2P/DX2,D2P/DY2,	SCIM 256
	AND D2P/DXDY	SCIM 257
C	CALL INTERZ(DP2XSA,DP2YSA,DPXYS,A,HSA,DP2XSB,DP2YSB,DPXYSB,HSB,	SCIM 258
	\$ DP2XS,DP2YS,DPXYS,H)	SCIM 259
C.....	UNPERTURBED (MONTHLY MEAN) VALUES FOR OUTPUT	SCIM 260
	TGH = TGH * (1. + TSH)	SCIM 261
	PGH = PGH * (1. + PSH)	SCIM 262
	DGH = DGH * (1. + DSH)	SCIM 263
C	TOTAL DT/DX	SCIM 264
	DTX = DTXS * TGH	SCIM 265
C	TOTAL DT/DY	SCIM 266
	DTY = TGH*DTYS + DTYG*(1. + TSH + DTYS)	SCIM 267
C	TOTAL DP/DX	SCIM 268
	DPX = DPXS * PGH	SCIM 269
C	TOTAL DP/DY	SCIM 270
	DPY = PGH*DPYS + DPYG*(1. + PSH + DPYS)	SCIM 271
C	D2P/DX2	SCIM 272

	DPXX = PGH*(2.*DPXS - DP2XS)	SCIM 273
	DPYY = PGH*(2.*DPYS - DP2YS) + (2.*DPYG - DP2YG)*(1. +PSH+DPYS)	SCIM 274
	\$ - (DPYG - DP2YG)*DP2YS	SCIM 275
C	D2P/DXDY	SCIM 276
	DPXY = (PGH + DPYG)*DPXYS + DPYG*DPXS	SCIM 277
C....	UNPERTURBED VALUES PLUS QBO PERTURBATIONS	SCIM 278
	PH = (1. + PQ) * PGH	SCIM 279
	DH = DGH * (1. + DQ)	SCIM 280
	TH = (1. + TQ) * TGH	SCIM 281
	CALL WIND	SCIM 282
C	GEOSTROPHIC WIND PLUS QBO WIND PERTURBATIONS	SCIM 283
	UH=UGH+UB	SCIM 284
	VH=VGH+VB	SCIM 285
	CP = 7.*PGH/(2.*DGH*TGH)	SCIM 286
	DTZ = (TGB*(1.+TSB) - TGA*(1.+TSA))/5000.	SCIM 287
C....	VERTICAL MEAN WIND	SCIM 288
	WGH=-CP*(UGH*DTX/DX5+VGH*DTY/DY5)/(G+CP*DTZ+VGH*DUH+VGH*DVH)	SCIM 289
C	GO TO RANDOM PERTURBATIONS SECTION	SCIM 290
	GO TO 800	SCIM 291
C....	THE FOLLOWING IS THE MIXED GROVES 4D SECTION	SCIM 292
C....	GENERATE GRID OF 4D PROFILES IF PREVIOUS HEIGHT GE 30	SCIM 293
300	IF (H1,GE,30.,OR,LOOK,EQ,1) CALL GEN4D	SCIM 294
	IHCK = 24	SCIM 295
	DO 310 KND = 1,3	SCIM 296
	IKND = IHCK + KND	SCIM 297
	IF (IKND,GT,26)IKND=26	SCIM 298
	DO 310 IND = 1,4	SCIM 299
	DO 310 JND = 1,4	SCIM 300
	PCK(IND,JND,KND) = P4D(4*(IND-1)+JND,IKND)	SCIM 301
	DCK(IND,JND,KND) = D4D(4*(IND-1)+JND,IKND)	SCIM 302
310	CONTINUE	SCIM 303
	CALL CHECK	SCIM 304
C....	LAT-LON INTERPOLATION OF 4D DATA AT 25 KM	SCIM 305
	CALL INTER4(PHI,THET,25, P4D,D4D,T4D,P4A,D4A,T4A,	SCIM 306
	\$ DPX4,DPY4,DTX4,DTY4,DPXA,DPYA,DPXYA)	SCIM 307
C	GROVES PLUS STATIONARY PERTURBATIONS	SCIM 308
	PB = PGB*(1. + PSB)	SCIM 309
C	P,D,T	SCIM 310
	DB = DGB*(1. + DSB)	SCIM 311
	TB = TGB*(1. + TSB)	SCIM 312
	DPXB = PGB*DPXSB	SCIM 313
	DPYB = PGB*DPYSB + DPYGB*(1. + PSB + DPYSB)	SCIM 314
	DPXXB = PGB*(2.*DPXSB - DP2XSB)	SCIM 315
	DPYYB = PGB*(2.*DPYSB - DP2YSB) + (2.*DPYGB - DP2YGB)*	SCIM 316
	\$ (1. + PSB + DPYSB) - (DPYGB - DP2YGB)*DP2YSB	SCIM 317
	DPXYB = (PGB + DPYGB)*DPXYSB + DPYGB*DPXSB	SCIM 318
	DTXB = TGB*DTXSB	SCIM 319
	DTYB = TGB*DTYSB + DTYGB*(1. + TSB + DTYSB)	SCIM 320
C....	HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT	SCIM 321
C	DP/DX AND DP/DY	SCIM 322
	CALL INTERM(DPX4,DPY4,25.,DPXB,DPYB,HSB,DPX,DPY,H)	SCIM 323
C....	HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT	SCIM 324
C	P,D,T	SCIM 325
	CALL INTER2(P4A,D4A,T4A,25.,PB,DB,TB,HGB,PGH,DGH,TGH,H)	SCIM 326

C....	HEIGHT INTERPOLATION BETWEEN 4D AT 25 AND GROVES AT UPPER HEIGHT	SCIM 327
C	DT/DX AND DT/DY	SCIM 328
	CALL INTERW(DTX4,DTY4,25.,DTXB,DTYB,HGB,DTX,DTY,H)	SCIM 329
C....	HEIGHT INTERPOLATION BETWEEN 4D AT 25 KM AND GROVES AT UPPER	SCIM 330
C	HEIGHT D2P/DX2, D2P/DY2, AND D2P/DXDY	SCIM 331
	CALL INTERZ(DPXXA,DPYYA,DPXYA,25.,DPXXB,DPYYB,DPXYB,HGB,DPXX,	SCIM 332
	\$ DPYY,DPXY,H)	SCIM 333
	IF (IOPQ.EQ.2) GO TO 350	SCIM 334
C	QUASI BIENNIAL PERTURBATIONS	SCIM 335
	CALL QBOGEN	SCIM 336
C	ADD QRO PERTURBATIONS TO P,D,T	SCIM 337
350	PH=PGH*(1.+PB)	SCIM 338
	DH=DGH*(1.+PB)	SCIM 339
	TH=TGH*(1.+PB)	SCIM 340
	CALL WIND	SCIM 341
C	ADD QBO WIND PERTURBATIONS	SCIM 342
	UH=UGH+UQ	SCIM 343
	VH=VGH+VQ	SCIM 344
	CP = 7.*PGH/(2.*DGH*TGH)	SCIM 345
	DTZ = (TB - TAA)/(1000.*(HGB - 25.))	SCIM 346
C....	VERTICAL MEAN WIND	SCIM 347
	WGH=-CP*(UGH*DTX/DX5+VGH*DTY/DY5)/(G+CP*DTZ+UGH*DUH+VGH*DVH)	SCIM 348
C	GO TO RANDOM PERTURBATIONS SECTION	SCIM 349
2000	FORMAT(' LATITUDE',/16F8.3)	SCIM 350
2001	FORMAT(' LONGITUDE',/16F8.3,/' PRESSURE')	SCIM 351
2002	FORMAT(1X,I2,16F8.0)	SCIM 352
	GO TO 800	SCIM 353
500	IF (H.GE.0.0) GO TO 510	SCIM 354
	IF (H.LT.-0.015) GO TO 505	SCIM 355
C	IF -15 METER LE H LT 0 , H IS SET TO 0	SCIM 356
	H = 0.	SCIM 357
	GO TO 510	SCIM 358
C	NO MORE COMPUTATIONS TO BE MADE IF HEIGHT LT -5 M	SCIM 359
505	NHORE = 0	SCIM 360
	RETURN	SCIM 361
C....	GENERATE GRID OF 4D PROFILES IF PREVIOUS HEIGHT GE 30	SCIM 362
510	IF (H1.GE.30..OR,LOOK.EQ.1) CALL GEN4D	SCIM 363
C	LOWER HEIGHT INDEX	SCIM 364
	IHA=INT(H)	SCIM 365
C	LOWER HEIGHT INDEX	SCIM 366
	HA = IHA*1.	SCIM 367
	IWSX = IWSYM	SCIM 368
	IHCK=IHA-1	SCIM 369
	DO 511 KND=1,3	SCIM 370
	IKND = IHCK + KND	SCIM 371
	IF (IKND.LT.1)IKND = 1	SCIM 372
	IF (IKND.GT.26)IKND = 26	SCIM 373
	DO 511 IND=1,4	SCIM 374
	DO 511 JND = 1,4	SCIM 375
	PCK(IND,JND,KND)=P4D(4*(IND-1)+JND,IKND)	SCIM 376
	DCK(IND,JND,KND)=D4D(4*(IND-1)+JND,IKND)	SCIM 377
511	CONTINUE	SCIM 378
	CALL CHECK	SCIM 379
C	UPPER HEIGHT INDEX	SCIM 380

IHB = IHA + 1	SCIM 381
IF(IHB.LE.25) GO TO 513	SCIM 382
IHA=24	SCIM 383
HA=24.	SCIM 384
IHB=25	SCIM 385
C UPPER HEIGHT	SCIM 386
513 HB = IHB*1.	SCIM 387
C.....LAT-LON INTERPOLATION OF 4D VALUES AT UPPER HEIGHT	SCIM 388
515 CALL INTER4(PHI,THET,IHB, P4D,D4D,T4D,PB,DB,TB,	SCIM 389
\$ DPX4B,DPY4B,DTX4B,DTY4B,DPXXB,DPYYB,DPXYB)	SCIM 390
IF(IHA.EQ.0.AND.PB*DB*TB.LE.0.)GO TO 520	SCIM 391
GO TO 540	SCIM 392
520 IHB=IHB+1	SCIM 393
C.....LOOP TO FIND LOWEST VALID HEIGHT	SCIM 394
HB=HB+1.	SCIM 395
GO TO 515	SCIM 396
540 IF(IHA.GT.0)CALL INTER4(PHI,THET,IHA, P4D,D4D,T4D,	SCIM 397
IPA,DA,TA,DPX4A,DPY4A,DTX4A,DTY4A,DPXXA,DPYYA,DPXYA)	SCIM 398
IF(IWSYM.EQ.'*')IWSX = IWSYM	SCIM 399
IF(IHA.EQ.0.OR.(PA*DA*TA.LE.0.AND.IHA.LT.10.AND.PB*DB*TB.GT.0.))	SCIM 400
160 TO 550	SCIM 401
GO TO 600	SCIM 402
C.....LAT-LON INTERPOLATION OF 4D VALUES AT LOWER HEIGHT	SCIM 403
550 CALL INTER4(PHI,THET,0, P4D,D4D,T4D,	SCIM 404
,PA,DA,TA,DPX4A,DPY4A,DTX4A,DTY4A,DPXXA,DPYYA,DPXYA)	SCIM 405
IF(IWSYM.EQ.'*')IWSX = IWSYM	SCIM 406
IF(TA-TB)560,570,560	SCIM 407
560 TZ=(TA-TB)/ALOG(TA/TB)	SCIM 408
GO TO 575	SCIM 409
570 TZ=TA	SCIM 410
C ...COMPUTES HEIGHT OF SURFACE	SCIM 411
575 HA=HB+0.28705*TZ*ALOG(PB/PA)/G	SCIM 412
IF(H.GT.HA-.04) GO TO 600	SCIM 413
PH=0.	SCIM 414
DH=0.	SCIM 415
TH=0.	SCIM 416
PGH=0.	SCIM 417
DGH=0.	SCIM 418
TGH=0.	SCIM 419
GO TO 800	SCIM 420
C.....HEIGHT INTERPOLATION OF P,D,T	SCIM 421
600 CALL INTER2(PA,DA,TA,HA,PB,DB,TB,HB,PGH,DGH,TGH,H)	SCIM 422
C.....HEIGHT INTERPOLATION OF DP/DX AND DP/DY	SCIM 423
CALL INTERW(DPX4A,DPY4A,HA,DPX4B,DPY4B,HB,DPX,DPY,H)	SCIM 424
C.....HEIGHT INTERPOLATION OF DT/DX AND DT/DY	SCIM 425
CALL INTERW(DTX4A,DTY4A,HA,DTX4B,DTY4B,HB,DTX,DTY,H)	SCIM 426
C.....HEIGHT INTERPOLATION OF D2P/DX2, D2P/DY2, AND D2P/DXDY	SCIM 427
CALL INTERZ(DPXXA,DPYYA,DPXYA,HA,DPXXB,DPYYB,DPXYB,HB,DPXX,DPYY,	SCIM 428
\$DPXY,H)	SCIM 429
C CHANGE OF NOTATION FOR OUTPUT	SCIM 430
PH = PGH	SCIM 431
DH = DGH	SCIM 432
TH = TGH	SCIM 433
IF(PH*DH*TH.LE.0.) GO TO 800	SCIM 434

	CALL WIND	SCIM 435
C	CHANGE OF NOTATION FOR OUTPUT	SCIM 436
	UH = UGH	SCIM 437
	VH = VGH	SCIM 438
	CP = 7.*PGH/(2.*DGH*TGH)	SCIM 439
	DTZ = (TB - TA)/(1000.*(HB - HA))	SCIM 440
C....	VERTICAL MEAN WIND	SCIM 441
	WGH = -CP*(UGH*DTX/DXS + VGH*DTY/DYS)/(G+CP*DTZ+UH*DUH+VH*DVH)	SCIM 442
C	QBO=0 IF H LT 10	SCIM 443
	IF (H,LT,10.) GO TO 800	SCIM 444
	IF (IOPQ,EQ,2) GO TO 650	SCIM 445
C	COMPUTES QUASI BIENNIAL PERTURBATIONS	SCIM 446
	CALL QBOGEN	SCIM 447
C	ADDS QBO PERTURBATIONS TO P,D,T	SCIM 448
	650 PH=FGH*(1.+PQ)	SCIM 449
	DH=DGH*(1.+DQ)	SCIM 450
	TH=TGH*(1.+TQ)	SCIM 451
C	ADDS QBO WIND PERTURBATIONS TO U,V	SCIM 452
	UH=UGH+UQ	SCIM 453
	VH=VGH+VQ	SCIM 454
C....	THE FOLLOWING IS THE RANDOM PERTURBATIONS SECTION	SCIM 455
C....	NO RANDOM PERTURBATIONS IF IOPR GT 1	SCIM 456
	800 CONTINUE	SCIM 457
	IF (H,GT,30) GO TO 512	SCIM 458
	IF (IPRT,NE,0,OR,IWSYM,NE,*) GO TO 512	SCIM 459
	WRITE(6,2000) (GLAT(I),I=1,16)	SCIM 460
	WRITE(6,2001) (GLON(I),I=1,16)	SCIM 461
	DO 504 I=1,26	SCIM 462
	IH=I-1	SCIM 463
	WRITE(6,2002) IH,(PAD(J,I),J=1,16)	SCIM 464
	504 CONTINUE	SCIM 465
	IPRT=IPRT+1	SCIM 466
	512 CONTINUE	SCIM 467
	IF (IOPR,GT,1) GO TO 830	SCIM 468
C....	INTERPOLATES RANDOM WIND MAGNITUDES TO HEIGHT H, LATITUDE PHI	SCIM 469
	CALL INTRUV(UH,VR,H,PHI,SUH,SVH)	SCIM 470
	CALL INTRUV(PLP,DLP,H,PHI,PLPH,DLPH)	SCIM 471
	CALL INTRUV(TLP,DLP,H,PHI,TLPH,DLPH)	SCIM 472
	CALL INTRUV(ULP,VLP,H,PHI,ULPH,VLPH)	SCIM 473
	CALL INTRUV(UDL,VDL,H,PHI,UDL2,VDL2)	SCIM 474
	CALL INTRUV(UDS,VDS,H,PHI,UDS2,VDS2)	SCIM 475
	SUHL=SQRT(ULPH*ABS(SUH))	SCIM 476
	SUHS=SQRT((1.-ULPH)*ABS(SUH))	SCIM 477
	SVHL=SQRT(VLPH*ABS(SVH))	SCIM 478
	SVHS=SQRT((1.-VLPH)*ABS(SVH))	SCIM 479
	SUH = SQRT(ABS(SUH))	SCIM 480
	SVH = SQRT(ABS(SVH))	SCIM 481
C....	IF H LE 25 USE 4D DATA RANDOM P,D,T SIGMAS	SCIM 482
	IF (H,LE,25.) GO TO 810	SCIM 483
C....	INTERPOLATE PR,DR,TR ARRAYS TO GET P,D,T SIGMAS AT HEIGHT H,	SCIM 484
C	LATITUDE PHI	SCIM 485
	CALL RTERP(H,PHI,PR,DR,TR,SPH,SDH,STH)	SCIM 486
	GO TO 820	SCIM 487
C....	LAT-LON INTERPOLATION ON P,D,T SIGMAS AT LOWER HEIGHT	SCIM 488

810 CALL INTER4(PHI,THET,IHA,	SP4,SD4,ST4,PA,DA,TA,	SCIM 489
	\$ DPX,DPY,DTX,DTY,DPXX,DPYY,DPXY)		SCIM 490
C.....LAT-LOW INTERPOLATION ON P,D,T SIGMSA AT UPPER HEIGHT			SCIM 491
CALL INTER4(PHI,THET,IHB,	SP4,SD4,ST4,PB,DB,TB,	SCIM 492
	\$ DPX,DPY,DTX,DTY,DPXX,DPYY,DPXY)		SCIM 493
C.....HEIGHT INTERPOLATION OF SIGMAS			SCIM 494
CALL INTERZ(PA,DA,TA,	HA,PB,DB,TB,	HB,SPH,SDH,STH,H)	SCIM 495
IF(PH#DH#TH,LE,0.) GO TO 825			SCIM 496
C.....HEIGHT DISPLACEMENT BETWEEN PREVIOUS AND CURRENT POSITION			SCIM 497
820 DZ = H1 - H			SCIM 498
SPHL=SQRT(PLPH#ABS(SPH))			SCIM 499
SPHS=SQRT((1.-PLPH)#ABS(SPH))			SCIM 500
SDHL=SQRT(DLPH#ABS(SDH))			SCIM 501
SDHS=SQRT((1.-DLPH)#ABS(SDH))			SCIM 502
STHL=SQRT(TLPH#ABS(STH))			SCIM 503
STHS=SQRT((1.-TLPH)#ABS(STH))			SCIM 504
SPH = SQRT(ABS(SPH))			SCIM 505
SDH = SQRT(ABS(SDH))			SCIM 506
STH = SQRT(ABS(STH))			SCIM 507
C.....COMPUTES HORIZONTAL DIXPLACEMENT DX BETWEEN PREVIOUS AND CURRENT			SCIM 508
C POSITION, HORIZONTAL SCALE HL, AND VERTICAL SCALE VL			SCIM 509
C.....COMPUTES PERTURBATION VALUES PRH,DRH,TRH,URH AND VRH			SCIM 510
CALL PERTRB			SCIM 511
C ADDS RANDOM PERTURBATIONS TO PH,DH,TH			SCIM 512
PH = PH*(1. + PRH)			SCIM 513
DH = DH*(1. + DRH)			SCIM 514
TH = TH*(1. + TRH)			SCIM 515
C ADDS RANDOM WINDS TO UH,VH			SCIM 516
UH=UH+URH			SCIM 517
VH=VH+VRH			SCIM 518
C.....SETS PREVIOUS RANDOM PERTURBATION IN P,D,T TO CURRENT			SCIM 519
C PERTURBATIONS, FOR NEXT CYCLE			SCIM 520
825 RP1S= PRHS			SCIM 521
RD1S= DRHS			SCIM 522
RT1S= TRHS			SCIM 523
RP1L=PRHL			SCIM 524
RD1L=DRHL			SCIM 525
RT1L=TRHL			SCIM 526
C.....SETS PREVIOUS MAGNITUDES FO CURRENT VALUES, FOR NEXT CYCLE			SCIM 527
SP1S=SPHS			SCIM 528
SD1S= SDHS			SCIM 529
ST1S=STHS			SCIM 530
SP1L=SPHL			SCIM 531
SD1L=SDHL			SCIM 532
ST1L=STHL			SCIM 533
C.....SETS PREVIOUS WIND PERTURBATION VALUES TO CURRENT VALUES,			SCIM 534
C FOR NEXT CYCLE			SCIM 535
RU1S=URHS			SCIM 536
RV1S=VRHS			SCIM 537
RU1L=URHL			SCIM 538
RV1L=VRHL			SCIM 539
C.....SETS PREVIOUS WIND PERTURBATION MAGNITUDES TO CURRENT VALUES,			SCIM 540
C FOR NEXT CYCLE			SCIM 541
SU1S=SUHS			SCIM 542

SVIS=SVMS	SCIM 543
SU1L=SUML	SCIM 544
SV1L=SVHL	SCIM 545
C.....SETS PREVIOUS HEIGHT TO CURRENT HEIGHT, FOR NEXT CYCLE	SCIM 546
830 H1 = H	SCIM 547
C.....SETS PREVIOUS LATITUDE TO CURRENT LATITUDE, FOR NEXT CYCLE	SCIM 548
PH1R=PHIR	SCIM 549
C.....SETS PREVIOUS LONGITUDE TO CURRENT LONGITUDE, FOR NEXT CYCLE	SCIM 550
THET1R=THETR	SCIM 551
C SETS NMORE TO COMPUTE MORE DATA ON NEXT CYCLE	SCIM 552
NMORE = 1	SCIM 553
C.....NO MORE DATA IF P, D, OR T LEQ 0	SCIM 554
IF(PH*DH*TH.LE.0.) RETURN	SCIM 555
CALL STDATN(H,TS,PS,DS)	SCIM 556
IF ((PS*DS*TS).GT.0.) GO TO 870	SCIM 557
PGHP=0.	SCIM 558
DGHP=0.	SCIM 559
TGHP=0.	SCIM 560
PHP=0.	SCIM 561
DHP=0.	SCIM 562
THP=0.	SCIM 563
GO TO 880	SCIM 564
870 PGHP=100.*(PGH-PS)/PS	SCIM 565
DGHP=100.*(DGH-DS)/DS	SCIM 566
TGHP=100.*(TGH-TS)/TS	SCIM 567
PHP=100.*(PH-PS)/PS	SCIM 568
DHP=100.*(DH-DS)/DS	SCIM 569
THP=100.*(TH-TS)/TS	SCIM 570
C CONVERTS QBO P,D,T TO PERCENT	SCIM 571
880 PQ=100.*PQ	SCIM 572
DQ=100.*DQ	SCIM 573
TQ=100.*TQ	SCIM 574
C CONVERTS RANDOM P,D,T TO PERCENT	SCIM 575
PRH=100.*PRH	SCIM 576
DRH=100.*DRH	SCIM 577
TRH=100.*TRH	SCIM 578
PRHS=100.*PRHS	SCIM 579
DRHS=100.*DRHS	SCIM 580
TRHS=100.*TRHS	SCIM 581
PRHL=100.*PRHL	SCIM 582
DRHL=100.*DRHL	SCIM 583
TRHL=100.*TRHL	SCIM 584
SPHS = 100.*SPHS	SCIM 585
SDHS = 100.*SDHS	SCIM 586
STHS = 100.*STHS	SCIM 587
SPHL = 100.*SPHL	SCIM 588
SDHL = 100.*SDHL	SCIM 589
STHL = 100.*STHL	SCIM 590
C CONVERTS WIND SHEAR TO M/S/KM	SCIM 591
DUH = DUH * 1000.	SCIM 592
DVH = DVH * 1000.	SCIM 593
C CONVERTS VERTICAL WIND TO CM/S	SCIM 594
WGH = WGH*100.	SCIM 595
PQA=PQA*100.	SCIM 596

	DQA=DQA*100.	SCIM 597
	TQA=TQA*100.	SCIM 598
	SPH=SPH*100.	SCIM 599
	SDH=SDH*100.	SCIM 600
	STH=STH*100.	SCIM 601
	PSH=PSH*100.	SCIM 602
	DSH=DSH*100.	SCIM 603
	TSH=TSH*100.	SCIM 604
	IF(WPOP,NE,0) GO TO 920	SCIM 605
	UPRE=UGH	SCIM 606
	VPRE=VGH	SCIM 607
	DUPRE=DUH/1000.	SCIM 608
	DVPRE=DVH/1000.	SCIM 609
	RETURN	SCIM 610
920	IF (IOPP,NE,0)	SCIM 611
	* WRITE(IOPP,951) H,PHI,THET,PGHP,DGHP,TGH,UGH,VGH,SPH,SDH,STH,	SCIM 612
	1SUN,SUH,PGH,DGH,FLOAT(IET),FLOAT(MN),TGHP	SCIM 613
951	FORMAT(F5.1,7F7.2,5F6.2,2E10.3,F5.0,F3.0,F7.2)	SCIM 614
	WRITE(6,900) H,PHI,THET,PGH,DGH,TGH,UGH,IWSYM,VGH,PH,DH,TH,UH,	SCIM 615
	* IWSYM,VH,DUH,	SCIM 616
	\$ DMH,WGH,IET,PGHP,DGHP,TGHP,PHP,DHP,THP,PSH,DSH,TSH,PQ,DQ,TQ,UQ,	SCIM 617
	\$ VQ,PGA,DQA,TQA,UA,VA,PRNS,DRNS,TRNS,URNS,VRNS,SPNS,SDNS,STNS,	SCIM 618
	1SUNS,SVNS,PRHL,DRHL,TRHL,URHL,VRHL,SPHL,SDHL,STHL,SUHL,SUHL,	SCIM 619
	2PRH,DRH,TRH,URH,VRH,SPH,SDH,STH,SUH,SUH	SCIM 620
900	FORMAT(1X,F6.2,2F7.2,2(2E9.3,2F6.0,A1,F5.0),2F5.1,23X,F6.2/1X,	SCIM 621
	\$ 15,14X,2(2(F8.1,"Z"),F6.1,"Z",11X),10X,	SCIM 622
	\$3F5.1,10X," SP"/102X,3F5.1,2F5.0," QBO"/102X,3F5.1,2F5.0," MAG"/1	SCIM 623
	\$02X,3F5.1,2F5.0," RANS"/102X,3F5.1,2F5.0," SIGS"/,	SCIM 624
	2102X,3F5.1,2F5.0," RANL"/,	SCIM 625
	3102X,3F5.1,2F5.0," SIGL"/,	SCIM 626
	4102X,3F5.1,2F5.0," RANT"/,	SCIM 627
	5102X,3F5.1,2F5.0," SIGT"/,	SCIM 628
	RETURN	SCIM 629
	END	SCIM 630
	SUBROUTINE SELE4	SELE 1
	INTEGER IOTEM2	SELE 2
	COMMON/C4/XL(16),YL(16),NP	SELE 3
C		SELE 4
C	S	SELE 5
C	SUBROUTINE TO SELECT POINTS FOR INTERPOLATION	SELE 6
C		SELE 7
	COMMON /IOTEMP/ IOTEM1,IOTEM2	SELE 8
	COMMON /POINT/ IPT(16,5),LL(16),DXY(16,2)	SELE 9
	COMMON /ORDER/ IPTN(16,5),IREAD(65,3)	SELE 10
C		SELE 11
C	DIMENSION	SELE 12
	IC(4),IL(2),JL(2),LIML(51),LINU(51)	SELE 13
	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,SELE	SELE 14
	110,11,12,13,14,15/	SELE 15
	DATA LINU/33,34,35,36,37,38,39,40,41,42,43,44,45,46,23*47,46,45,	SELE 16
	144,43,42,41,40,39,38,37,36,35,34,33/	SELE 17
	DATA PI/3.14159/	SELE 18
C		SELE 19
C		SELE 20

C	INITIALIZE	SELE 21
C		SELE 22
	PI4=PI/4.	SELE 23
	DEGRAD=PI/180.	SELE 24
	DO 1 I=1,16	SELE 25
	DO 1 J=1,5	SELE 26
	1 IPT(I,J)=0	SELE 27
C		SELE 28
C	MAJOR LOOP FOR POINTS	SELE 29
C		SELE 30
C	DO 100 II=1,NP	SELE 31
C		SELE 32
	LA=ABS(XL(II))*10+.5	SELE 33
	LO=YL(II)*10+.5	SELE 34
	LL(II)=LA*10000+LO	SELE 35
	IF (XL(II),LT,0.) LL(II)=-LL(II)	SELE 36
C		SELE 37
	IF (XL(II)-15.1) 15,30,30	SELE 38
	15 IF (XL(II)) 50,40,40	SELE 39
C		SELE 40
C	MNC GRID	SELE 41
C		SELE 42
	30 IPT(II,5)=2	SELE 43
	EL=(350-YL(II))*DEGRAD	SELE 44
	PHI=XL(II)*DEGRAD	SELE 45
	R=31.204359052*(SIN(PI4-PHI/2.)/COS(PI4-PHI/2.))	SELE 46
	XX=R*COS(EL)+24.	SELE 47
	YY=R*SIN(EL)+26.	SELE 48
	I=XX	SELE 49
	J=YY	SELE 50
	DX=XX-I	SELE 51
	DY=YY-J	SELE 52
	DXY(II,1)=DX	SELE 53
	DXY(II,2)=DY	SELE 54
	IF (XL(II),GT,17.18) GO TO 31	SELE 55
	IF ((J,LT,1),OR,(J,GT,51)) GO TO 70	SELE 56
	IF ((I,LT,LIML(J)),OR,(I,GT,LIMU(J))) GO TO 70	SELE 57
	31 IC(1)=I*1000+J	SELE 58
	IF ((ABS(DX),GT,.1),OR,(ABS(DY),GT,.1)) GO TO 32	SELE 59
	IP=1	SELE 60
	GO TO 35	SELE 61
	32 CONTINUE	SELE 62
	IF (XL(II),GT,17.18) GO TO 34	SELE 63
	IF (((I,GT,(LIMU(J)-1)),AND,((J,GE,15),AND,(J,LE,37)))	SELE 64
	1 ,OR,(J,GT,50)) GO TO 70	SELE 65
	IF ((I+1,GT,LIMU(J+1)),OR,(I,LT,LIML(J+1))) GO TO 80	SELE 66
	IF ((I,EQ,LIMU(J)),OR,(I,EQ,LIML(J))) GO TO 80	SELE 67
	34 IP=4	SELE 68
	IC(2)=(I+1)*1000+J	SELE 69
	IC(3)=I*1000+J+1	SELE 70
	IC(4)=(I+1)*1000+J+1	SELE 71
	35 CONTINUE	SELE 72
	REWIND IOTEM2	SELE 73
	DO 38 IP6=1,1977	SELE 74

READ(IOTEM2) IJ	SELE 75
DO 38 K=1,IP	SELE 76
38 IF(IC(K),EQ,IJ) IPT(II,K)=IPG	SELE 77
GO TO 100	SELE 78
C	SELE 79
EQUATORIAL GRID	SELE 80
C	SELE 81
40 IPT(II,5)=1	SELE 82
L1=XL(II)	SELE 83
L2=YI(II)	SELE 84
IL(1)=L1/5	SELE 85
IL(2)=IL(1)+1	SELE 86
JL(1)=(L2/5)+1	SELE 87
JL(2)=JL(1)-1	SELE 88
DO 45 K1=1,2	SELE 89
DO 45 K2=1,2	SELE 90
IF ((ABS(XL(II)-IL(K1)*5).GT.0.1).OR.(ABS(YI(II)-JL(K2)*5).GT.0.1)	SELE 91
1) GO TO 45	SELE 92
IF (JL(K2),EQ,72) JL(K2)=0	SELE 93
IPT(II,1)=JL(K2)*4+IL(K1)+1	SELE 94
GO TO 100	SELE 95
45 CONTINUE	SELE 96
IF (JL(1),EQ,72) JL(1)=0	SELE 97
IPT(II,1)=JL(1)*4+IL(1)+1	SELE 98
IPT(II,2)=JL(2)*4+IL(1)+1	SELE 99
IPT(II,3)=JL(1)*4+IL(2)+1	SELE 100
IPT(II,4)=JL(2)*4+IL(2)+1	SELE 101
GO TO 100	SELE 102
C	SELE 103
SOUTHERN HEMISPHERE	SELE 104
C	SELE 105
50 IPT(II,5)=3	SELE 106
L1=XL(II)	SELE 107
L2=YI(II)	SELE 108
IF (ABS(XL(II)).LT.85.0) GO TO 51	SELE 109
IPT(II,1)=1	SELE 110
IF (ABS(XL(II)+90.).LT.0.11) GO TO 100	SELE 111
51 CONTINUE	SELE 112
IL(1)=(L1/5)-1	SELE 113
JL(1)=(L2/5)+1	SELE 114
IL(2)=IL(1)+1	SELE 115
JL(2)=JL(1)-1	SELE 116
DO 52 K1=1,2	SELE 117
DO 52 K2=1,2	SELE 118
IF ((ABS(XL(II)-IL(K1)*5).GT.0.1).OR.(ABS(YI(II)-JL(K2)*5).GT.0.1)	SELE 119
1) GO TO 52	SELE 120
IF (JL(K2),EQ,72) JL(K2)=0	SELE 121
IPT(II,1)=JL(K2)*17-IL(K1)+1	SELE 122
IF (IL(K),NE,0) GO TO 100	SELE 123
IPT(II,1)=JL(K2)*4+1	SELE 124
IPT(II,5)=1	SELE 125
GO TO 100	SELE 126
52 CONTINUE	SELE 127
IF (JL(1),EQ,72) JL(1)=0	SELE 128

IF (IPT(II,1),EQ,1) GO TO 54	SELE 129
IPT(II,1)=JL(1)*17-IL(1)+1	SELE 130
IPT(II,2)=JL(2)*17-IL(1)+1	SELE 131
IF (IL(2)) 55,53,55	SELE 132
53 IPT(II,3)=JL(1)*4+1	SELE 133
IPT(II,4)=JL(2)*4+1	SELE 134
IPT(II,5)=1133	SELE 135
GO TO 100	SELE 136
54 IPT(II,2)=JL(1)*17-IL(2)+1	SELE 137
IPT(II,3)=JL(2)*17-IL(2)+1	SELE 138
IPT(II,5)=333	SELE 139
GO TO 100	SELE 140
55 CONTINUE	SELE 141
IPT(II,3)=JL(1)*17-IL(2)+1	SELE 142
IPT(II,4)=JL(2)*17-IL(2)+1	SELE 143
GO TO 100	SELE 144
C	SELE 145
C BODERLINE POINTS	SELE 146
C	SELE 147
70 CONTINUE	SELE 148
C TWO MMC, TWO EQUATORIAL	SELE 149
IPT(II,5)=2211	SELE 150
L=YL(II)	SELE 151
IPT(II,1)=(L/5)+2)*4	SELE 152
IPT(II,2)=IPT(II,1)-4	SELE 153
IF (L,GE,355) IPT(II,1)=4	SELE 154
C	SELE 155
IF (J,LT,1) J=1	SELE 156
IF (J,GT,51) J=51	SELE 157
IF (I,LT,LIML(J)) I=LIML(J)	SELE 158
IF (I,GT,LIMU(J)) I=LIMU(J)	SELE 159
IC(1)=I*1000+J	SELE 160
IF ((J,LT,15),OR,(J,GT,37)) GO TO 72	SELE 161
IC(2)=I*1000+J+1	SELE 162
GO TO 76	SELE 163
72 IF ((J,NE,1),AND,(J,NE,51)) GO TO 74	SELE 164
IF (I,EB,LIMU(J)) GO TO 73	SELE 165
IC(2)=(I+1)*1000+J	SELE 166
GO TO 76	SELE 167
73 IC(2)=(I-1)*1000+J	SELE 168
GO TO 76	SELE 169
74 IF (I,EQ,LIML(J)) GO TO 75	SELE 170
IC(2)=LIMU(J+1)*1000+J+1	SELE 171
GO TO 76	SELE 172
75 IC(2)=LIML(J+1)*1000+J+1	SELE 173
C	SELE 174
76 REWIND IOTEM2	SELE 175
DO 77 IPG=1,1977	SELE 176
READ(IOTEM2) IJ	SELE 177
DO 77 K=1,2	SELE 178
77 IF (IC(K),EB,IJ) IPT(II,K+2)=IPG	SELE 179
GO TO 100	SELE 180
C	SELE 181
80 CONTINUE	SELE 182

C	THREE NMC, ONE EQUATORIAL	SELE 183
	IPT(II,5)=2212	SELE 184
	IC(2) = 0	SELE 185
	L=YL(II)	SELE 186
	IPT(II,2)=(L/5+1)*4	SELE 187
	IF (L.GE.355) IPT(II,2)=4	SELE 188
	IF (I.EQ.LIML(J)) GO TO 84	SELE 189
	IF (J.GT.37) GO TO 82	SELE 190
	IC(1)=I*1000+J	SELE 191
	IC(3)=I*1000+J+1	SELE 192
	IC(4)=(I+1)*1000+J+1	SELE 193
	GO TO 88	SELE 194
82	IC(1)=(I+1)*1000+J	SELE 195
	IC(3)=I*1000+J	SELE 196
	IC(4)=I*1000+J+1	SELE 197
	GO TO 88	SELE 198
84	IF (J.GT.37) GO TO 86	SELE 199
	IC(1)=(I-1)*1000+J+1	SELE 200
	IC(3)=I*1000+J+1	SELE 201
	IC(4)=I*1000+J	SELE 202
	GO TO 88	SELE 203
86	IC(1)=(I+1)*1000+J+1	SELE 204
	IC(3)=(I+1)*1000+J	SELE 205
	IC(4)=I*1000+J	SELE 206
C		SELE 207
88	REWIND IOTEM2	SELE 208
	DO 89 IPG=1,1977	SELE 209
	READ(IOTEM2) IJ	SELE 210
	DO 89 K=1,4	SELE 211
	IF(IC(K).EQ.0) GO TO 89	SELE 212
	IF(IC(K).EQ.IJ) IPT(II,K)=IPG	SELE 213
	89 CONTINUE	SELE 214
C		SELE 215
100	CONTINUE	SELE 216
	DO 150 I=1,16	SELE 217
	DO 150 J=1,5	SELE 218
150	IPTM(I,J)=IPT(I,J)	SELE 219
	CALL SORT4(MP)	SELE 220
	RETURN	SELE 221
	END	SELE 222
	SUBROUTINE SETUP	SETU 1
	COMMON/COTRAM/NDATA(19),IC,MI,IH,IX(10),IEX	SETU 2
	DIMENSION IP(5),ID(5),IT(5),IDAY(12),BUFFER(64)	SETU 3
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOP,DD,XMJD,PHI1,PHI,	SETU 4
	,NSAME,RP1L,RD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L,	SETU 5
	\$ MN, IDD, IYR, H1, PHI1R,THETA1R,DUMS(21),RP1S,RD1S	SETU 6
	,RT1S,RU1S,RV1S,SP1S,SD1S,ST1S,SU1S,SV1S,UDS1,VDS1,	SETU 7
	2UDL1,VDL1,UDS2,VDS2,UDL2,VDL2	SETU 8
	COMMON/PDTCOM/IU4,MONTH,IOPR,PG(18,19),TG(18,19),DG(18,19)	SETU 9
	,PSP(8,10,12)	SETU 10
	1,DSP(8,10,12),TSP(8,10,12),PAQ(17,5),DAQ(17,5),TAQ(17,5),PDQ(17,5)	SETU 11
	2,DDQ(17,5),TDQ(17,5),PR(20,10),DR(20,10),TR(20,10),UAQ(17,5)	SETU 12
	3,VAQ(17,5),UDQ(17,5),VDQ(17,5),UR(25,10),VR(25,10),	SETU 13
	* PQ,DQ,TQ,UQ,VQ,PQA,DQA,	SETU 14

.	TBA,UA,VA,IOPQ,PLP(25,10),DLP(25,10),TLP(25,10)	SETU 15
1,	ULP(25,10),VLP(25,10),UBL(25,10),VDL(25,10),UDS(25,10)	SETU 16
2,	VDS(25,10)	SETU 17
	COMMON/CHIC/DUM(18),IWSYM,Ucoef(14,9),VCOEF(14,9)	SETU 18
	DIMENSION IDUM(9)	SETU 19
	DATA IDAY/0,31,59,90,120,151,181,212,243,273,304,334/	SETU 20
	XMJD = 0.	SETU 21
	IF (MN.GT.12) GO TO 2	SETU 22
	IDA = IDAY(MN) + IDD	SETU 23
	DD = IDA	SETU 24
	IF (MOD(IYR,4).EQ.0.AND.MN.GT.2) IDA = IDA + 1	SETU 25
	XMJD = 2439856. + 365. * (IYR - 68.) + IDA + INT((IYR - 65.)	SETU 26
	\$/ 4.)	SETU 27
C....	SECOND DATA CARD READS, FREE FIELD, THE FOLLOWING DATA:	SETU 28
C	IUG = UNIT NUMBER FOR GROVES DATA TAPE	SETU 29
C	IUR = UNIT NUMBER FOR RANDOM SIGMA DATA	SETU 30
C	(IF IUR=IUG UNIT IUG WILL BE READ)	SETU 31
C	IUQ = UNIT NUMBER FOR QBO DATA	SETU 32
C	(IF IUQ=IUG DATA ON TAPE ON UNIT IUG WILL BE READ)	SETU 33
C	IUA = UNIT FOR 4-D INPUT P,D,T 0-25KM DATA	SETU 34
C	IOPR = RANDOM OUTPUT OPTION	SETU 35
C....	IOPR=1 RANDOM OUTPUT IOPR=2 NO RANDOM OUTPUT	SETU 36
C	IOPQ = QBO OUTPUT OPTION	SETU 37
C....	IOPQ=1 QBO OUTPUT IOPQ=2 NO QBO OUTPUT	SETU 38
C	NR1 = STARTING RANDOM NUMBER	SETU 39
C	NMCOP = NMC GRID DATA READ OPTION	SETU 40
C....	NMCOP=0 READS NMC GRID DATA FROM UNIT IUG, OTHERWISE READS FORM	SETU 41
C	CARDS	SETU 42
C....	IITEM1=UNIT FOR 4-D P, D, T DATA (SCRATCH FILE, DOES NOT NEED TO	SETU 43
C	BE ASSIGNED)	SETU 44
C....	IITEM2=UNIT FOR NMC GRID POINTS (SCRATCH FILE, DOES NOT NEED TO	SETU 45
C	BE ASSIGNED)	SETU 46
2	READ(5,10) IUG,IUR,IUQ,IUA,IOPR,IOPQ,NR1,NMCOP,IITEM1,IITEM2	SETU 47
10	FORMAT()	SETU 48
	WRITE(6,9000) IUG,IUR,IUQ,IUA,IOPR,IOPQ,NR1,NMCOP,IITEM1,IITEM2	SETU 49
	*,XMJD	SETU 50
	IF (IOPR.LT.1.OR.IOPR.GT.2) GO TO 666	SETU 51
	IF (IOPQ.LT.1.OR.IOPQ.GT.2) GO TO 666	SETU 52
	MONTH=MN	SETU 53
	IF (IOPR.EQ.2) GO TO 7	SETU 54
	R=RAND(NR1)	SETU 55
	R = RAND(0)	SETU 56
	R = RAND(0)	SETU 57
C....	THIRD DATA CARD READS FREE FIELD, THE FOLLOWING DATA:	SETU 58
C	RP1 = INITIAL RANDOM PRESSURE PERTURBAIIONS, PERCENT	SETU 59
C	RD1 = INITIAL RANDOM DENSITY PERTURBATION, PERCENT	SETU 60
C	RT1 = INITIAL RANDOM TEMPERATURE PERTURBATION, PERCENT	SETU 61
C	SD1 = INITIAL STANDARD DEVIATION FOR RANDOM DENSITY	SETU 62
C	PERTURBATION, PERCENT	SETU 63
C	RU1 = INITIAL EASTWARD WIND PERTURBATION, M/S	SETU 64
C	RV1 = INITIAL NORTHWARD WIND PERTURBATION, M/S	SETU 65
C	SU1 = INITIAL STANDARD DEVIATION FOR RANDOM EASTWARD WIND, M/S	SETU 66
C	SV1 = INITIAL STANDARD DEVIATION FOR RANDOM NORTHWARD WIND, M/S	SETU 67
	READ(5,10) RP1L,RP1S,RD1L,RD1S,RT1L,RT1S,RU1L,RU1S,RV1L,RV1S	SETU 68

RP1=RP1L+RP1S	SETU 69
RD1=RD1S+RD1L	SETU 70
RT1=RT1S+RT1L	SETU 71
RU1=RU1L+RU1S	SETU 72
RV1=RV1L+RV1S	SETU 73
C AVOIDS TAPE SEARCH IF CURRENT MONTH IS SAME AS PREVIOUS MONTH	SETU 74
IF(NSAME.GT.0) GO TO 621	SETU 75
7 IF (NSAME.EQ.1) GO TO 621	SETU 76
CALL GETNMC	SETU 77
C.....LOADS NMC GRID DATA FROM INPUT UNIT TO SCRATCHFILE UNIT IOTEM2	SETU 78
IF (MONTH.LT.13) GO TO 12	SETU 79
M1=13	SETU 80
M2=13	SETU 81
C.....MONTH=13 IS ANNUAL AVERAGE CASE	SETU 82
GO TO 13	SETU 83
12 M1=MONTH	SETU 84
M2=MONTH + 6	SETU 85
C.....SOUTHERN HEMISPHERE DATA IS 6 MONTHS DISPLACED FOR GROVES,	SETU 86
C STATIONARY PERTURBATIONS, AND RANDOM PERTURBATIONS	SETU 87
IF (M2.GT.12) M2=M2 - 12	SETU 88
13 DO 100 I=1,234	SETU 89
CALL RTRAM1	SETU 90
C.....READS GROVES PRESSURE DATA	SETU 91
IF (IC.NE.*P*) GO TO 666	SETU 92
IF (M1.EQ.M1) GO TO 30	SETU 93
IF (M1.EQ.M2) GO TO 40	SETU 94
GO TO 100	SETU 95
30 KS=1	SETU 96
GO TO 50	SETU 97
40 KS=-1	SETU 98
50 IH=(IH-20)/5	SETU 99
TENX=10.**IEX	SETU 100
DO 60 J=1,10	SETU 101
K=10+KS*(J-1)	SETU 102
60 PG(IH,K) = IX(J)*TENX	SETU 103
C.....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE	SETU 104
100 CONTINUE	SETU 105
DO 200 I=1,234	SETU 106
CALL RTRAM1	SETU 107
C.....READS GROVES DENSITY DATA	SETU 108
IF(IC.NE.*D*) GO TO 666	SETU 109
IF (M1.EQ.M1) GO TO 130	SETU 110
IF (M1.EQ.M2) GO TO 140	SETU 111
GO TO 200	SETU 112
130 KS=1	SETU 113
GO TO 150	SETU 114
140 KS=-1	SETU 115
150 IH=(IH-20)/5	SETU 116
TENX=10.**IEX	SETU 117
DO 160 J=1,10	SETU 118
K=10+KS*(J-1)	SETU 119
160 DG(IH,K) = IX(J)*TENX	SETU 120
C.....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE	SETU 121
200 CONTINUE	SETU 122

DO 300 I=1,234	SETU 123
CALL RTRAN1	SETU 124
C....READS GROVES TEMPERATURE DATA	SETU 125
IF (IC.NE.'T*') GO TO 666	SETU 126
IF (MI.EQ.M1) GO TO 230	SETU 127
IF (MI.EQ.M2) GO TO 240	SETU 128
GO TO 300	SETU 129
230 KS=1	SETU 130
GO TO 250	SETU 131
240 KS=-1	SETU 132
250 IH=(IH-20)/5	SETU 133
TENX=10.**IEX	SETU 134
DO 260 J=1,10	SETU 135
K=10+KS*(J-1)	SETU 136
260 TG(IH,K) = IX(J)*TENX	SETU 137
C....CONVERSION TO REAL AND STORAGE IN ARRAY COMPLETE	SETU 138
300 CONTINUE	SETU 139
IF (MONTH.LT.13) GO TO 308	SETU 140
C....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL	SETU 141
DO 304 I=1,18	SETU 142
DO 304 J=1,9	SETU 143
J20=20-J	SETU 144
PG(I,J)=PG(I,J20)	SETU 145
DG(I,J)=DG(I,J20)	SETU 146
TG(I,J)=TG(I,J20)	SETU 147
304 CONTINUE	SETU 148
308 DO 360 I=1,1248	SETU 149
CALL RTRAN	SETU 150
C....READS STATIONARY PERTURBATIONS DATA (TO BE STORED IN PSP, DSP, AND	SETU 151
C TSP ARRAYS)	SETU 152
IC=NDATA(1)	SETU 153
MI=NDATA(2)	SETU 154
IH=NDATA(3)	SETU 155
LON=NDATA(4)	SETU 156
DO 311 K=1,5	SETU 157
IP(K)=NDATA(4+K)	SETU 158
ID(K)=NDATA(9+K)	SETU 159
311 IT(K)=NDATA(14+K)	SETU 160
IF (IC.NE.'S*') GO TO 666	SETU 161
IF (MI.EQ.M1) GO TO 320	SETU 162
IF (MI.EQ.M2) GO TO 330	SETU 163
GO TO 360	SETU 164
320 KS=1	SETU 165
GO TO 340	SETU 166
330 KS=-1	SETU 167
340 ISH=2+(IH-44)/8	SETU 168
L=(LON+20)/30	SETU 169
IF (IH.LT.52) ISH = (IH-20)/10	SETU 170
IF (IH.GT.84) ISH=8	SETU 171
DO 350 J=1,5	SETU 172
K=5+KS*(J+(KS-1)/2)	SETU 173
PSP(ISH,K,L) = IP(J)/1000.	SETU 174
DSP(ISH,K,L) = ID(J)/1000.	SETU 175
350 TSP(ISH,K,L) = IT(J)/1000.	SETU 176

C.....CONVERSION TO REAL AND STORAGE IN ARRAYS COMPLETE	SETU 177
360 CONTINUE	SETU 178
IF (MONTH,LT,13) GO TO 368	SETU 179
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL	SETU 180
DO 364 I=1,8	SETU 181
DO 364 K=1,12	SETU 182
DO 364 J=1,5	SETU 183
J10=11-J	SETU 184
PSP(I,J,K)=PSP(I,J10,K)	SETU 185
DSP(I,J,K)=DSP(I,J10,K)	SETU 186
TSP(I,J,K)=TSP(I,J10,K)	SETU 187
364 CONTINUE	SETU 188
C MOVES PAST 2ND EOF ON UNIT IUG	SETU 189
368 READ(IUG,9999,END=369) IDUMMY	SETU 190
9999 FORMAT(A1)	SETU 191
GO TO 368	SETU 192
369 CONTINUE	SETU 193
IF(IOPR,EQ,2) GO TO 440	SETU 194
C.....IOPR=1 READS RANDOM SIGMAS, IOPR=2 ZEROS RANDOM SIGMAS	SETU 195
DO 430 I=1,260	SETU 196
IF (IUR,EQ,IUG) GO TO 375	SETU 197
READ (IUR,380) IC,MI,IH,IP,ID,IT	SETU 198
C.....USES FORTRAN READ ON UNIT IUR IF IUR NEQ IUG	SETU 199
380 FORMAT (1X,A1,I2,I4,3(1X,5I4))	SETU 200
GO TO 385	SETU 201
375 CALL RTRAM	SETU 202
C.....READS FROM UNIT IUG IF IUG = IUR	SETU 203
IC=NDATA(1)	SETU 204
MI=NDATA(2)	SETU 205
IH=NDATA(3)	SETU 206
DO 381 K=1,5	SETU 207
IP(K)=NDATA(3+K)	SETU 208
ID(K)=NDATA(8+K)	SETU 209
381 IT(K)=NDATA(13+K)	SETU 210
385 IF (IC.NE.'R') GO TO 666	SETU 211
C M1 = NORTHERN HEMISPHERE MONTH	SETU 212
IF (MI,EQ,M1) GO TO 390	SETU 213
C SOUTHERN HEMISPHERE MONTH	SETU 214
IF (MI,EB,M2) GO TO 400	SETU 215
C.....M2 = M1 + 6 UNLESS M1 = M2 = 13	SETU 216
GO TO 430	SETU 217
390 KS=1	SETU 218
GO TO 410	SETU 219
400 KS=-1	SETU 220
410 IF (IH,LT,95) IHR=(IH-20)/5	SETU 221
C IHR = HEIGHT INDEX	SETU 222
IF (IH,GE,95) IHR = 14 + (IH - 80) / 20	SETU 223
DO 420 J=1,5	SETU 224
K = 5 + KS * (J + (KS - 1) / 2)	SETU 225
C.....K = LATITUDE INDEX 1-5 = LAT -90 TO -10, 6-10 = LAT +10 TO +90	SETU 226
PR(IHR,K) =(IP(J)/1000.)**2	SETU 227
DR(IHR,K) =(ID(J)/1000.)**2	SETU 228
420 TR(IHR,K) =(IT(J)/1000.)**2	SETU 229
430 CONTINUE	SETU 230

IF (MONTH,LT,13) GO TO 460	SETU 231
C.....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL	SETU 232
DO 435 I=1,20	SETU 233
DO 435 J=1,5	SETU 234
J10=11-J	SETU 235
PR(I,J)=PR(I,J10)	SETU 236
DR(I,J)=DR(I,J10)	SETU 237
TR(I,J)=TR(I,J10)	SETU 238
435 CONTINUE	SETU 239
GO TO 460	SETU 240
440 DO 450 I=1,20	SETU 241
DO 450 J=1,10	SETU 242
PR(I,J) = 0.	SETU 243
DR(I,J) = 0.	SETU 244
450 TR(I,J) = 0.	SETU 245
C.....RANDOM SIGMAS ARE ZEROED IF IOPR=2	SETU 246
DO 455 I=1,25	SETU 247
DO 455 J=1,10	SETU 248
UR(I,J)=0.	SETU 249
455 VR(I,J) = 0.	SETU 250
GO TO 500	SETU 251
460 DO 490 I=1,325	SETU 252
IF (IUR,EQ,IUG) GO TO 462	SETU 253
READ(IUR,465) IC,MI,IH,IP,ID	SETU 254
C.....READS RANDOM WIND STANDARD DEVIATIONS WITH FORTRAN READ FROM	SETU 255
C UNIT IUR IF IUR NEQ IUG	SETU 256
465 FORMAT(1X,A2,I2,I4,2(1X,5I4))	SETU 257
GO TO 467	SETU 258
462 CALL RTRAN	SETU 259
C.....READS FROM UNIT IUG IF IUG = IUR	SETU 260
IC=NDATA(1)	SETU 261
MI=NDATA(2)	SETU 262
IH=NDATA(3)	SETU 263
DO 461 K=1,5	SETU 264
IP(K)=NDATA(3+K)	SETU 265
461 ID(K)=NDATA(8+K)	SETU 266
467 IF (IC,NE,"RW") GO TO 666	SETU 267
C NORTHERN HEMISPHERE MONTH	SETU 268
IF (MI,EQ,M1) GO TO 470	SETU 269
C SOUTHERN HEMISPHERE MONTH	SETU 270
IF (MI,EQ,M2) GO TO 475	SETU 271
GO TO 490	SETU 272
470 KS=1	SETU 273
GO TO 480	SETU 274
475 KS=-1	SETU 275
480 IF (IH,LT,95) IHR=1+IH/5	SETU 276
C HEIGHT INDEX	SETU 277
IF (IH,GE,95) IHR=19+(IH-80)/20	SETU 278
DO 485 J=1,5	SETU 279
C LATITUDE INDEX	SETU 280
K=5+KS*(J+(KS-1)/2)	SETU 281
UR(IHR,K)=(IP(J)**2)*1.	SETU 282
485 VR(IHR,K)=(ID(J)**2)*1.	SETU 283
490 CONTINUE	SETU 284

IF (MONTH,LT,13) GO TO 500	SETU 285
C....ANNUAL MEAN CASE - BOTH HEMISPHERES EQUAL	SETU 286
DO 495 I=1,25	SETU 287
DO 495 J=1,5	SETU 288
J10=11-J	SETU 289
UR(I,J)=UR(I,J10)	SETU 290
VR(I,J)=VR(I,J10)	SETU 291
495 CONTINUE	SETU 292
C MOVES PAST 3RD EOF ON UNIT IUG	SETU 293
IF(IOPR,EQ,2) GO TO 900	SETU 294
500 READ(IUG,9999,END=501) IDUMMY	SETU 295
GO TO 500	SETU 296
501 CONTINUE	SETU 297
DO 840 I=1,25	SETU 298
IF(IUR,EQ,IUG) GO TO 800	SETU 299
READ(IUR,380) IC,MI,IH,IP,ID,IT	SETU 300
C....USES FORTRAN READ ON UNIT IUR IF IUR NEQ IUG	SETU 301
GO TO 820	SETU 302
800 CALL RTRAN	SETU 303
C....READS FROM UNIT IUG IF IUR = IUG	SETU 304
IC=NDATA(1)	SETU 305
MI=NDATA(2)	SETU 306
IH=NDATA(3)	SETU 307
DO 810 K=1,5	SETU 308
IP(K)=NDATA(3+K)	SETU 309
ID(K)=NDATA(8+K)	SETU 310
810 IT(K)=NDATA(13+K)	SETU 311
820 IF(IH,GT,90) IH=70+(IH/4)	SETU 312
IH=1+(IH/5)	SETU 313
IF(IC,NE,"P",OR,IH,NE,1) GO TO 666	SETU 314
DO 830 J=1,5	SETU 315
PLP(I,J+5)=IP(J)/1000.	SETU 316
PLP(I,6-J)=IP(J)/1000.	SETU 317
DLP(I,J+5)=ID(J)/1000.	SETU 318
DLP(I,6-J)=ID(J)/1000.	SETU 319
TLP(I,J+5)=IT(J)/1000.	SETU 320
830 TLP(I,6-J)=IT(J)/1000.	SETU 321
840 CONTINUE	SETU 322
DO 865 I=1,25	SETU 323
IF(IUR,EQ,IUG) GO TO 845	SETU 324
READ(IUR,465) IC,MI,IH,IP,ID	SETU 325
GO TO 855	SETU 326
845 CALL RTRAN	SETU 327
IC=NDATA(1)	SETU 328
MI=NDATA(2)	SETU 329
IH=NDATA(3)	SETU 330
DO 850 K=1,5	SETU 331
IP(K)=NDATA(3+K)	SETU 332
850 ID(K)=NDATA(8+K)	SETU 333
855 IF(IH,GT,90) IH=70+(IH/4)	SETU 334
IH=1+(IH/5)	SETU 335
IF(I,NE,IH,OR,IC,NE,"PM") GO TO 666	SETU 336
DO 860 J=1,5	SETU 337
ULP(I,J+5)=IP(J)/1000.	SETU 338

ULP(I,6-J)=IP(J)/1000.	SETU 339
VLP(I,J+5)=ID(J)/1000.	SETU 340
860 VLF(I,6-J)=ID(J)/1000.	SETU 341
865 CONTINUE	SETU 342
DO 888 I=1,25	SETU 343
IF(IUR.EQ.IUG) GO TO 870	SETU 344
READ(IUR,868)IC,MI,IH,IP,ID	SETU 345
868 FORMAT(1X,A2,I2,I4,2(1X,5I5))	SETU 346
GO TO 880	SETU 347
870 CALL RTRAM	SETU 348
IC=NDATA(1)	SETU 349
MI=NDATA(2)	SETU 350
IH=NDATA(3)	SETU 351
DO 875 K=1,5	SETU 352
IP(K)=NDATA(3+K)	SETU 353
875 ID(K)=NDATA(8+K)	SETU 354
880 IF(IH.GT.90) IH=70+(IH/4)	SETU 355
IH=1+(IH/5)	SETU 356
IF(IH.NE.I.OR.IC.NE.'CS')GO TO 666	SETU 357
DO 885 J=1,5	SETU 358
UDS(I,J+5)=(IP(J)/1000.)	SETU 359
UDS(I,6-J)=(IP(J)/1000.)	SETU 360
VDS(I,J+5)=(ID(J)/1000.)	SETU 361
885 VDS(I,6-J)=(ID(J)/1000.)	SETU 362
888 CONTINUE	SETU 363
DO 898 I=1,25	SETU 364
IF(IUR.EQ.IUG) GO TO 890	SETU 365
READ(IUR,868)IC,MI,IH,IP,ID	SETU 366
GO TO 894	SETU 367
890 CALL RTRAM	SETU 368
IC=NDATA(1)	SETU 369
MI=NDATA(2)	SETU 370
IH=NDATA(3)	SETU 371
DO 892 K=1,5	SETU 372
IP(K)=NDATA(3+K)	SETU 373
892 ID(K)=NDATA(8+K)	SETU 374
894 IF(IH.GT.90) IH= 70+(IH/4)	SETU 375
IH=1+(IH/5)	SETU 376
IF(IH.NE.I.OR.IC.NE.'CL') GO TO 666	SETU 377
DO 896 J=1,5	SETU 378
UDL(I,J+5)=(IP(J)/1000.)	SETU 379
UDL(I,6-J)=(IP(J)/1000.)	SETU 380
VDL(I,J+5)=(ID(J)/1000.)	SETU 381
896 VDL(I,6-J)=(ID(J)/1000.)	SETU 382
898 CONTINUE	SETU 383
GO TO 910	SETU 384
900 DO 905 I=1,25	SETU 385
DO 905 J=1,10	SETU 386
PLP(I,J)=0.	SETU 387
DLP(I,J)=0.	SETU 388
TLP(I,J)=0.	SETU 389
ULP(I,J)=0.	SETU 390
VLP(I,J)=0.	SETU 391
UDS(I,J)=0.	SETU 392

UDL(I,J)=0.	SETU 393
VDS(I,J)=0.	SETU 394
VDL(I,J)=0.	SETU 395
905 CONTINUE	SETU 396
C.....MOVES PAST NEXT EOF ON TAPE	SETU 397
IF (IOPQ.EQ.2) GO TO 600	SETU 398
910 READ(IUG,9999,END=911) IDUMMY	SETU 399
GO TO 910	SETU 400
911 CONTINUE	SETU 401
C.....IOPB=1 READS QBO PARAMETERS; IOPQ=2 ZEROS THESE PARAMETERS	SETU 402
DO 530 I=1,16	SETU 403
IF (IUQ.EQ.IUG) GO TO 525	SETU 404
READ(IUQ,520) IC,IH,IX	SETU 405
C.....READS WITH FORTRAN FROM UNIT IUQ IF IUQ NEQ IUG	SETU 406
520 FORMAT (IX,A2,I3,5(I4,I5))	SETU 407
GO TO 527	SETU 408
525 CALL RTRAN2	SETU 409
C.....READS FROM UNIT IUG IF IUQ = IUG	SETU 410
527 IF (IC.NE.'BP') GO TO 666	SETU 411
IH = (IH-5)/5	SETU 412
DO 530 J=1,5	SETU 413
C.....CONVERT FROM INTEGER PER MIL - QBO PRESSURE AMPLITUDE	SETU 414
PAQ(IH,J) = IX(2*J-1)/1000.	SETU 415
C.....QBO PRESSURE PHASE (DAYS PAST JAN 0, 1966)	SETU 416
530 PDQ(IH,J) = IX(2*J)*1.	SETU 417
DO 531 I = 1,5	SETU 418
PAQ(1,I) = 0.	SETU 419
531 CALL PHASE(PDQ(2,I),15.,PDQ(3,I),20.,PDQ(1,I),10.)	SETU 420
DO 540 I=1,16	SETU 421
IF (IUQ.EQ.IUG) GO TO 535	SETU 422
READ (IUQ,520) IC,IH,IX	SETU 423
GO TO 537	SETU 424
535 CALL RTRAN2	SETU 425
537 IF (IC.NE.'BD') GO TO 666	SETU 426
IH=(IH-5)/5	SETU 427
DO 540 J=1,5	SETU 428
C...CONVERT FROM INTEGER PER MIL - QBO DENSITY AMPLITUDE	SETU 429
DAQ(IH,J) = IX(2*J-1)/1000.	SETU 430
C.....QBO DENSITY PHASE (DAYS PAST JAN 0, 1966)	SETU 431
540 DDQ(IH,J)=IX(2*J)*1.	SETU 432
DO 541 I = 1,5	SETU 433
DAQ(1,I) = 0.	SETU 434
541 CALL PHASE(DDQ(2,I),15.,DDQ(3,I),20.,DDQ(1,I),10.)	SETU 435
DO 550 I=1,16	SETU 436
IF (IUQ.EQ.IUG) GO TO 545	SETU 437
READ (IUQ,520) IC,IH,IX	SETU 438
GO TO 547	SETU 439
545 CALL RTRAN2	SETU 440
547 IF (IC.NE.'BT') GO TO 666	SETU 441
IH = (IH- 5)/5	SETU 442
DO 550 J=1,5	SETU 443
C.....CONVERTS FROM INTEGER PER MIL - QBO TEMPERATURE AMPLITUDE	SETU 444
TAQ(IH,J) = IX(2*J-1)/1000.	SETU 445
C.....QBO TEMPERATURE PHASE	SETU 446

550 TDQ(IH,J) = IX(2*J)*1.	SETU 447
DO 551 I = 1,5	SETU 448
TAQ(1,I) = 0.	SETU 449
551 CALL PHASE(TDQ(2,I),15.,TDQ(3,I),20.,TDQ(1,I),10.)	SETU 450
DO 560 I=1,16	SETU 451
IF (IUQ.EQ.IUG) GO TO 555	SETU 452
C....READS WITH FORTRAN IF IUQ NEQ IUG	SETU 453
READ(IUG,520) IC,IH,IX	SETU 454
GO TO 557	SETU 455
555 CALL RTRAM2	SETU 456
C....READS FROM UNIT IUG IF IUQ = IUG	SETU 457
557 IF (IC.NE."QU") GO TO 666	SETU 458
IH=(IH- 5)/5	SETU 459
DO 560 J=1,5	SETU 460
C....EASTWARD WIND QBO AMPLITUDE - CONVERTED TO M/S	SETU 461
UAQ(IH,J) = IX(2 * J - 1) / 10.	SETU 462
C....EASTWARD WIND QBO PHASE (DAYS PAST JAN 0, 1966)	SETU 463
560 UDQ(IH,J)=IX(2*J)*1.	SETU 464
DO 561 I = 1,5	SETU 465
UAD(1,I) = 0.	SETU 466
561 CALL PHASE(UDQ(2,I),15.,UDQ(3,I),20.,UDQ(1,I),10.)	SETU 467
DO 570 I=1,16	SETU 468
IF (IUQ.EQ.IUG) GO TO 565	SETU 469
READ(IUG,520) IC,IH,IX	SETU 470
GO TO 567	SETU 471
565 CALL RTRAM2	SETU 472
567 IF (IC.NE."QU") GO TO 666	SETU 473
IH=(IH- 5)/5	SETU 474
DO 570 J=1,5	SETU 475
C....NORTHWARD WIND QBO AMPLITUDE - CONVERTED TO M/S	SETU 476
VAQ(IH,J) = IX(2 * J - 1) / 10.	SETU 477
C....NORTHWARD WIND QBO PHASE (DAYS PAST JAN 0,1966)	SETU 478
570 VDD(IH,J)=IX(2*J)*1.	SETU 479
DO 571 I = 1,5	SETU 480
VAD(1,I) = 0.	SETU 481
571 CALL PHASE(VDD(2,I),15.,VDD(3,I),20.,VDD(1,I),10.)	SETU 482
GO TO 611	SETU 483
600 DO 610 I=1,IUG	SETU 484
DO 610 J=1,5	SETU 485
PAQ(I,J) = 0.	SETU 486
DAQ(I,J) = 0.	SETU 487
TAR(I,J) = 0.	SETU 488
PDR(I,J) = 0.	SETU 489
DDR(I,J) = 0.	SETU 490
TDR(I,J) = 0.	SETU 491
UAB(I,J)=0.	SETU 492
UDB(I,J)=0.	SETU 493
VAB(I,J)=0.	SETU 494
VDB(I,J)=0.	SETU 495
610 CONTINUE	SETU 496
C....MOVE PAST NEXT EOF ON TAPE.	SETU 497
611 READ(IUG,9999,END=609) IDUMMY	SETU 498
GO TO 611	SETU 499
609 CONTINUE	SETU 500

C...READ IN SPHERICAL HARMONICS COEFFICIENTS.....	SETU 501
DO 615 IFR=1,MN	SETU 502
DO 613 JFR=1,14	SETU 503
READ(IUG,640)IF1,IF2,(IDUM(I),I=1,9)	SETU 504
640 FORMAT(2X,19I7)	SETU 505
DO 613 I=1,9	SETU 506
613 UCDEF(JFR,I)=FLOAT(IDUM(I))/100.	SETU 507
DO 612 JFR=1,14	SETU 508
READ(IUG,640)IF1,IF2,(IDUM(I),I=1,9)	SETU 509
DO 612 I=1,9	SETU 510
612 VCDEF(JFR,I)=FLOAT(IDUM(I))/100.	SETU 511
615 CONTINUE	SETU 512
C....ZEROS QBO PARAMETERS IF IOPQ = 2	SETU 513
C....REWINDS TAPE UNIT IUG	SETU 514
REWIND IUG	SETU 515
C	SETU 516
621 R=H1	SETU 517
IF(H1,LT,25.) R=25.	SETU 518
CALL RTERP(R ,PHI1,PR,DR,TR,SP1,SD1,ST1)	SETU 519
CALL INTRUV(PLP,DLP,H1,PHI1,PLP1,DLP1)	SETU 520
CALL INTRUV(TLP,DLP,H1,PHI1,TLP1,R)	SETU 521
SP1L=SQRT(PLP1*ABS(SP1))*100.	SETU 522
SP1S=SQRT((1,-PLP1)*ABS(SP1))*100.	SETU 523
SD1L=SQRT(DLP1*ABS(SD1))*100.	SETU 524
SD1S=SQRT((1,-DLP1)*ABS(SD1))*100.	SETU 525
ST1L=SQRT(TLP1*ABS(ST1))*100.	SETU 526
ST1S=SQRT((1,-TLP1)*ABS(ST1))*100.	SETU 527
CALL INTRUV(UR,VR,H1,PHI1,SU1,SV1)	SETU 528
CALL INTRUV(ULP,VLP,H1,PHI1,ULP1,VLP1)	SETU 529
SU1L=SQRT(ULP1*ABS(SU1))	SETU 530
SU1S=SQRT((1,-ULP1)*ABS(SU1))	SETU 531
SV1L=SQRT(VLP1*ABS(SV1))	SETU 532
SV1S=SQRT((1,-VLP1)*ABS(SV1))	SETU 533
CALL INTRUV(UDL,VDL,H1,PHI1,UDL1,VDL1)	SETU 534
CALL INTRUV(UDS,VDS,H1,PHI1,UDS1,VDS1)	SETU 535
UDL1=UDL1*100.	SETU 536
VDL1=VDL1*100.	SETU 537
UDS1=UDS1*100.	SETU 538
VDS1=VDS1*100.	SETU 539
WRITE(6,9001) RP1L,RD1L,RT1L,SP1L,SD1L,ST1L,RU1L,RV1L,SU1L,SV1L,	SETU 540
1*LARGE"	SETU 541
WRITE(6,9001) RP1S,RD1S,RT1S,SP1S,SD1S,ST1S,RU1S,RV1S	SETU 542
1,SU1S,SV1S,"SMALL"	SETU 543
WRITE(6,9002)UDL1,VDL1,UDS1,VDS1	SETU 544
WRITE(6,9003)	SETU 545
RP1L=RP1L/100.	SETU 546
RD1L=RD1L/100.	SETU 547
RT1L=RT1L/100.	SETU 548
SP1L=(SP1L/100.)	SETU 549
SD1L=(SD1L/100.)	SETU 550
ST1L=(ST1L/100.)	SETU 551
RP1S=RP1S/100.	SETU 552
RD1S=RD1S/100.	SETU 553
RT1S=RT1S/100.	SETU 554

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SP1S=SP1S/100. SETU 555
SD1S=SD1S/100. SETU 556
ST1S=ST1S/100. SETU 557
UDL1=UDL1/100. SETU 558
VDL1=VDL1/100. SETU 559
UDS1=UDS1/100. SETU 560
VDS1=VDS1/100. SETU 561
WRITE(6,630) SETU 562
RETURN SETU 563
666 WRITE(6,700) IUG,IUR,IUO,IOPR,IOPQ,NR1,NMCP,IOTEM1,IOTEM2, SETU 564
$MONTH,IC,MI,IH,IX,IEX,IP,ID,IT,SD1 SETU 565
700 FORMAT(' ERROR IN SETUP INPUT',/,1X,5I3,I10,4I3,A2,I3,I4,/,11I4, SETU 566
$,15I4,/,F10.1) SETU 567
STOP SETU 568
630 FORMAT(27X,'UNPERTURBED (MONTHLY MEAN)',11X,'MEAN PLUS PERTURBATIOSETU 569
1NS',9X,'THERMAL',/,23X,2(34('-'),2X),3X,'WIND',6X,'PERTURBATION VASETU 570
2LUES',/, 'HEIGHT LAT WEST PRES. DENS. TEMP GEOSTROPH. SETU 571
3 PRES. DENS. TEMP TOTAL SHEAR',/,2X,'(KM)',11X,'LOSETU 572
4N',4X,'(NT/ (KG/ (DEG WIND (M/S) (NT/ (KG/ (DEG SETU 573
5WIND (M/S) (M/S/KM) ',28('-'),/, ' TIME (DEG) (DEG)',2(' M**SETU 574
62) **3) KEL- ',10('-'),2X,8('-'),' P D T U V SETU 575
7 W'/' (SEC)',35X,'VIN) E-W N-S',20X,'VIN) E-W N-S E-W NSETU 576
8-S (%) (%) (%) M/S M/S CM/S'//) SETU 577
9000 FORMAT(' GROVES INPUT UNIT = ',I2,T43,'RANDOM INPUT UNIT = ',I2, SETU 578
1T83,'QBO INPUT UNIT = ',I2,/, ' 4-D INPUT UNIT = ',I2,T43,'RANDOM SETU 579
2OPTION = ',I2,T83,'QBO OPTION = ',I2,/, ' FIRST RANDOM NUMBER = ',SETU 580
215, SETU 581
3/, ' NMC READ OPTION = ',I2,T43,'4-D P,D,T DATA SCRATCH UNIT = ', SETU 582
4I2,/, ' NMC GRID POINTS SCRATCH UNIT = ',I2,T43,'JULIAN DATE = ', SETU 583
5F9.1,/) SETU 584
9001 FORMAT(' INITIAL P,D,T = ',3(F6.2,' % '),T60,'SIGMA P,D,T = ', SETU 585
13(F6.2,' % '),/, ' INITIAL U,V = ',2(F7.2,' M/S '),T60,'SIGMA SETU 586
2U,V = ',2(F7.2,' M/S '), 7X,A5,1X,'SCALE'//) SETU 587
9003 FORMAT('// ** PERCENT DEVIATIONS FROM 1962 US STANDARD ' SETU 588
1 'ATMOSPHERE APPEAR BELOW PRESSURE, DENSITY AND TEMPERATURE ', SETU 589
2 'VALUES **'//) SETU 590
9002 FORMAT(' INITIAL UDL,VDL = ',2(F6.2,' % '), SETU 591
1T60,'INITIAL UDS,VDS = ',2(F6.2,' % ')) SETU 592
END SETU 593
SUBROUTINE SORT4(NP) SORT 1
C SORT 2
C SORTS POINTS FOR SEQUENTIAL TAPE READING SORT 3
C SORT 4
C ASSIGNS POINT NUMBERS BY ORDER ON TAPE, NOT BY GRID SORT 5
C SORT 6
COMMON /ORDER/ IPT (16,5),IREAD(65,3) SORT 7
C SORT 8
DO 1 I=1,65 SORT 9
DO 1 J=1,3 SORT 10
1 IREAD(I,J)=0 SORT 11
DO 9 I=1,NP SORT 12
IF(IPT(I,5).LT.1) GO TO 10 SORT 13
IF(IPT(I,5).EQ.1) GO TO 9 SORT 14
IF(IPT(I,5).EQ.2) GO TO 2 SORT 15

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IF(IPT(I,5),EQ,3) GO TO 4	SORT 16
IF(IPT(I,5),EQ,1133)GO TO 6	SORT 17
IF(IPT(I,5),EQ,2211) GO TO 7	SORT 18
IF(IPT(I,5),EQ,2212)GO TO 8	SORT 19
IF (IPT(I,5),EQ,333) GO TO 4	SORT 20
GO TO 10	SORT 21
2 DO 3 J=1,4	SORT 22
IF(IPT(I,J),LT,1) GO TO 3	SORT 23
IPT(I,J)=IPT(I,J)+288	SORT 24
3 CONTINUE	SORT 25
GO TO 9	SORT 26
4 DO 5 J=1,4	SORT 27
IF(IPT(I,J),LT,1) GO TO 5	SORT 28
IPT(I,J)=IPT(I,J)+2265	SORT 29
5 CONTINUE	SORT 30
GO TO 9	SORT 31
6 IF(IPT(I,1),GT,0)IPT(I,1)=IPT(I,1)+2265	SORT 32
IF(IPT(I,2),GT,0)IPT(I,2)=IPT(I,2)+2265	SORT 33
GO TO 9	SORT 34
7 IF(IPT(I,3),GT,0)IPT(I,3)=IPT(I,3)+288	SORT 35
IF(IPT(I,4),GT,0)IPT(I,4)=IPT(I,4)+288	SORT 36
GO TO 9	SORT 37
8 IF(IPT(I,1),GT,0)IPT(I,1)=IPT(I,1)+288	SORT 38
IF(IPT(I,3),GT,0)IPT(I,3)=IPT(I,3)+288	SORT 39
IF(IPT(I,4),GT,0)IPT(I,4)=IPT(I,4)+288	SORT 40
9 CONTINUE	SORT 41
C	SORT 42
C REORDERS POINT NUMBERS FOR READ	SORT 43
C	SORT 44
10 IR=0	SORT 45
DO 13 K=1,NP	SORT 46
DO 13 L=1,4	SORT 47
MP=IPT(K,L)	SORT 48
IF(MP,LT,1) GO TO 13	SORT 49
11 II=K	SORT 50
JJ=L	SORT 51
DO 12 I=1,NP	SORT 52
DO 12 J=1,4	SORT 53
IF (IPT(I,J),LT,1) GO TO 12	SORT 54
IF(IPT(I,J),GT,3490) GO TO 12	SORT 55
IF(IPT(I,J),GE,MP) GO TO 12	SORT 56
II=I	SORT 57
JJ=J	SORT 58
MP=IPT(I,J)	SORT 59
12 CONTINUE	SORT 60
IF(IPT(II,JJ),GT,3490) GO TO 14	SORT 61
IR=IR+1	SORT 62
IREAD(IR,1)=II	SORT 63
IREAD(IR,2)=JJ	SORT 64
IREAD(IR,3)=IPT(II,JJ)	SORT 65
IPT(II,JJ)=IPT(II,JJ)+9000	SORT 66
MP=IPT(K,L)	SORT 67
IF(MP,GT,3490) GO TO 13	SORT 68
GO TO 11	SORT 69

13	CONTINUE	SORT	70
14	RETURN	SORT	71
	END	SORT	72
	SUBROUTINE SPHERE(MN, IH, PHIR, THETR, US, VS)	SPHE	1
	COMMON/CHIC/DUM(18), IWSYM, UCDEF(14,9), VCDEF(14,9)	SPHE	2
	DIMENSION Z(9)	SPHE	3
	COSPHI=COS(PHIR)	SPHE	4
	COSTHET=COS(THETR)	SPHE	5
	SINPHI=SIN(PHIR)	SPHE	6
	SINTHET=SIN(THETR)	SPHE	7
	Z(1)=1.	SPHE	8
	Z(2)=SINPHI	SPHE	9
	Z(3)=COSTHET*COSPHI	SPHE	10
	Z(4)=SINTHET*COSPHI	SPHE	11
	Z(5)=(3*(SINPHI**2)-1)/2.	SPHE	12
	Z(6)=COSTHET*(3*COSPHI*SINPHI)	SPHE	13
	Z(7)=SINTHET*(3*COSPHI*SINPHI)	SPHE	14
	Z(8)=(2*(COSTHET)**2-1)*(3*(COSPHI)**2)	SPHE	15
	Z(9)=(2*SINTHET*COSTHET)*(3*(COSPHI)**2)	SPHE	16
5	IH5=IH/5-4	SPHE	17
	IFR=9	SPHE	18
	IF(IH.GT.65)IFR=4	SPHE	19
	US=0.	SPHE	20
	VS=0.	SPHE	21
	DO 10 I=1,IFR	SPHE	22
	US=US+Z(I)*UCDEF(IH5,I)	SPHE	23
	VS=VS+Z(I)*VCDEF(IH5,I)	SPHE	24
10	CONTINUE	SPHE	25
	RETURN	SPHE	26
	END	SPHE	27
	SUBROUTINE STDATM(Z,T,P,D)	STDA	1
	DIMENSION ZS(35),TMS(35),WMS(35),PS(35)	STDA	2
	DATA (ZS(I),I=1,35)/0., 11.019, 20.063, 32.162, 47.35,	STDA	3
	* 52.429, 61.591, 79.944, 90., 95., 100., 105., 110., 115.,	STDA	4
	* 120., 135., 150., 155., 160., 165., 170., 180., 190., 210.,	STDA	5
	* 230., 265., 300., 350., 400., 450., 500.,550.,600., 650., 700./	STDA	6
	DATA (TMS(I),I=1,35)/288.15, 216.65,216.65, 228.65, 270.65,270.65,	STDA	7
	* 252.65, 180.65, 180.65, 0., 210.65, 0., 260.65, 0., 360.65,	STDA	8
	* 0., 960.65, 0., 1110.65, 0., 1210.65, 0., 1350.65, 0., 1550.65,	STDA	9
	* 0., 1830.65, 0., 2160.65, 0., 2420.65, 0., 2590.65, 0.,	STDA	10
	* 2700.65/	STDA	11
	DATA (WMS(I),I=1,35)/28.9644, 28.9644, 28.9644, 28.9644, 28.9644,	STDA	12
	* 28.9644, 28.9644, 28.9644, 28.9644, 28.94, 28.88, 28.75, 28.56,	STDA	13
	* 28.32, 28.07, 27.37, 26.92, 26.79, 26.66, 26.52, 26.45, 26.15,	STDA	14
	* 25.85, 25.27, 24.69, 23.67, 22.66, 21.24, 19.94, 18.82, 17.94,	STDA	15
	* 17.29, 16.84, 16.50, 16.17/	STDA	16
	DATA (PS(I),I=1,35)/1013.25, 226.32, 54.7487, 8.68014, 1.10905,	STDA	17
	* .590005, .182099, 1.0377E-2, 1.6438E-3, 0., 3.0075E-4, 0.,	STDA	18
	* 7.3544E-5, 0., 2.5217E-5, 0., 5.0617E-6, 0., 3.6943E-6, 0.,	STDA	19
	* 2.7926E-6, 0., 1.6852E-6, 0., 6.9604E-7, 0., 1.8838E-7, 0.,	STDA	20
	* 4.0304E-8, 0., 1.0957E-8, 0., 3.4502E-9, 0., 1.1918E-9/	STDA	21
	IF(Z.LT.0.) GO TO 91	STDA	22
	R0=6356.36	STDA	23
	G0=9.8066	STDA	24

WMO=28.9644	STDA 25
RS=8314.32	STDA 26
ZM=Z*1000.	STDA 27
ROM=6356360.	STDA 28
IF(Z.GE.90.) GO TO 6	STDA 29
DO 3 I=1,8	STDA 30
IF(ZS(I).LE.Z.AND.Z.LT.ZS(I+1)) GO TO 5	STDA 31
3 CONTINUE	STDA 32
5 ZL=INT(ZS(I))*1.	STDA 33
ZU=INT(ZS(I+1))*1.	STDA 34
ZLM=ZL*1000.	STDA 35
ZUM=ZU*1000.	STDA 36
IF(I.EQ.8) ZU=88.743	STDA 37
WM=WMO	STDA 38
HT=(RO*Z)/(RO+Z)	STDA 39
HM=HT*1000.	STDA 40
G=(TMS(I+1)-TMS(I))/(ZU-ZL)	STDA 41
GM=G*.001	STDA 42
IF(G.LT.0..OR.G.GT.0.) GO TO 12	STDA 43
P=PS(I)*EXP(-(GO*WMO*(HM-ZLM))/(RS*TMS(I)))*100.	STDA 44
GO TO 13	STDA 45
12 P=PS(I)*((TMS(I)/(TMS(I)+G*(HT-ZL)))*((GO*WMO)/(RS*GM)))*100.	STDA 46
13 T=TMS(I)+G*(HT-ZL)	STDA 47
GO TO 25	STDA 48
6 DO 7 I=9,33,2	STDA 49
IF(ZS(I).LE.Z.AND.Z.LT.ZS(I+2)) GO TO 8	STDA 50
7 CONTINUE	STDA 51
81 T=0.	STDA 52
P=0.	STDA 53
D=0.	STDA 54
RETURN	STDA 55
8 ZL=ZS(I)	STDA 56
ZU=ZS(I+2)	STDA 57
ZLM=ZL*1000.	STDA 58
ZUM=ZU*1000.	STDA 59
ZMID=ZS(I+1)	STDA 60
A0=WMS(I)	STDA 61
A2=-2.*(2.*WMS(I+1)-WMS(I+2)-A0)/((ZU-ZL)**2.)	STDA 62
A1=(WMS(I+2)-A0-A2*((ZU-ZL)**2.))/(ZU-ZL)	STDA 63
WM=A0+A1*(Z-ZL)+A2*((Z-ZL)**2.)	STDA 64
G=(TMS(I+2)-TMS(I))/(ZS(I+2)-ZS(I))	STDA 65
GM=G*.001	STDA 66
TK=ZLM-(TMS(I)/GM)	STDA 67
S=(WMO*GO*ROM*ROM)/(RS*GM)	STDA 68
A=((ROM+ZM)*(ZLM-TK)/((ZM-TK)*(ROM+ZLM)))	STDA 69
B=(S/((TK+ROM)**2.))	STDA 70
P=PS(I)*(((ROM+ZM)*(ZLM-TK)/((ZM-TK)*(ROM+ZLM)))*((S/((TK+ROM)	STDA 71
1**2.)))*EXP((-S*(ZLM-ZM)/((TK+ROM)*(ZM+ROM)*(ZLM+ROM)))*100.	STDA 72
TM=TMS(I)+G*(Z-ZS(I))	STDA 73
T=(WM/WMO)*TM	STDA 74
25 D=(WM*P)/(RS*T)	STDA 75
26 RETURN	STDA 76
END	STDA 77
SUBROUTINE TINF	TINF 1

```

COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOF,DD,XMJD,PHI1,PHI,          TINF  2
.      NSAME,RF1, RD1, RT1, SF1, SD1, ST1, RU1, RV1, SU1, SV1,TINF  3
$ MN, IDA, IYR, HI, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,GI,  TINF  4
.      IHR,MIN,NMOR,DX,HL,VL,DZ                                TINF  5
COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,TE,EM                    TINF  6
C                                                                TINF  7
C SURROUTINE TINF CALCULATES THE EXOSPHERIC TEMPERATURE ACCORDING TO JATINF  8
C SAO NO. 313 ,1970.                                          TINF  9
C                                                                TINF 10
C LIST                                                         TINF 11
C F10 = SOLAR RADIO NOISE FLUX (XE-22 WATTS/M**2)            TINF 12
C F10B= 91-DAY AVERAGE F10                                   TINF 13
C GI = GEOMAGNETIC ACTIVITY INDEX,AP                         TINF 14
C LAT = GEOGRAPHIC LATITUDE AT PERIGEE (IN RAD)              TINF 15
C SDA = SOLAR DECLINATION ANGLE (IN RAD)                      TINF 16
C SHA = SOLAR HOUR ANGLE                                      TINF 17
C DY = D/Y (DAY NUMBER/TROPICAL YEAR)? 1                     TINF 18
C R = 0.31 (DIURNAL FACTOR)                                  TINF 19
C                                                                TINF 20
C CONSTANTS -- C=SOLAR ACTIVITY VARIATION, BETA,ETC. = DIURNAL VARIATITINF 21
C D=GEOMAGNETIC VARIATION, E=SIMIANNUAL VARIATION,          TINF 22
C                                                                TINF 23
C C1 = 383.0                                                  TINF 24
C C2 = 3.32                                                    TINF 25
C C3 = 1.80                                                    TINF 26
C                                                                TINF 27
C PI = 3.14159265                                             TINF 28
C COM = 0.01745329252                                         TINF 29
C BETA= -37.0*COM                                             TINF 30
C GAMMA= 43.0*COM                                             TINF 31
C P = 6.0*COM                                                 TINF 32
C XM = 2.5                                                     TINF 33
C XMN = 3.0                                                    TINF 34
C                                                                TINF 35
C D1 = 28.0                                                    TINF 36
C D2 = 0.03                                                    TINF 37
C D3 = 1.0                                                      TINF 38
C D4 = 100.0                                                    TINF 39
C D5 = -0.08                                                    TINF 40
C                                                                TINF 41
C E1 = 2.41                                                    TINF 42
C E2 = 0.349                                                    TINF 43
C E3 = 0.206                                                    TINF 44
C E4 = 360.*COM                                                TINF 45
C E5 = 226.5*COM                                               TINF 46
C E6 = 720.*COM                                                TINF 47
C E7 = 247.6*COM                                               TINF 48
C E8 = 0.1145                                                  TINF 49
C E9 = 0.5                                                      TINF 50
C E10= E4                                                       TINF 51
C E11= 342.3*COM                                              TINF 52
C E12= 2.16                                                    TINF 53
C                                                                TINF 54
C SOLAR ACTIVITY VARIATION                                    TINF 55

```

C		TINF	56
	TC = C1 + C2*F10B + C3*(F10 - F10B)	TINF	57
C		TINF	58
C	DIURNAL VARIATION	TINF	59
C		TINF	60
	ETA = 0.5*ABS(XLAT - SDA)	TINF	61
	THETA = 0.5*ABS(XLAT + SDA)	TINF	62
	TAU = SHA + BETA + P*SIN(SHA + GAMMA)	TINF	63
	TPI=2*PI	TINF	64
	IF(TAU) 210,230,230	TINF	65
210	IF(TAU+PI) 220,250,250	TINF	66
220	TAU=TAU+TPI	TINF	67
	GO TO 210	TINF	68
230	IF(TAU-PI) 250,250,240	TINF	69
240	TAU=TAU-TPI	TINF	70
	GO TO 230	TINF	71
250	CONTINUE	TINF	72
	A1 =(SIN(THETA))*XM	TINF	73
	A2 =(COS(ETA))*XM	TINF	74
	A3 =(COS(TAU/2.))*XMN	TINF	75
	B1 = 1.0 + R*A1	TINF	76
	B2 =(A2-A1)/B1	TINF	77
	TV = B1*(1. + R*B2*A3)	TINF	78
	TL = TC*TV	TINF	79
C		TINF	80
C	GEOMAGNETIC VARIATION	TINF	81
C		TINF	82
	TG = D3*GI + D4*(1-EXP(D5*GI))	TINF	83
C		TINF	84
C	SEMIANNUAL VARIATION	TINF	85
C		TINF	86
	G3 = 0.5*(1.0 + SIN(E10*DY + E11))	TINF	87
	G3 = G3**E12	TINF	88
	TAU1 = DY + E8*(G3 - E9)	TINF	89
	G1 = E2 + E3*(SIN(E4*TAU1 + E5))	TINF	90
	G2 = SIN(E6*TAU1 + E7)	TINF	91
	TS = E1 + F10B*G1*G2	TINF	92
C		TINF	93
C	EXOSPHERIC TEMPERATURE	TINF	94
C		TINF	95
	TE = TL + TG + TS	TINF	96
	RETURN	TINF	97
	END	TINF	98
	SUBROUTINE TME	TME	1
	COMMON/COMJAC/XLAT,XLONG,SDA,SHA,DY,R,T,EM	TME	2
	COMMON/IOTEMP/IOTEM1,IOTEM2,IUG,NMCOF,DD,XMJD,PHI1,PHI,	TME	3
	. NSAME,RP1, RD1, RT1, SF1, SD1, ST1, RU1, RV1, SU1, SV1,TME	TME	4
	* MN, IDA, IYR, H1, PHI1R,THET1R,G,RI,H,PHIR,THETR,F10,F10B,AP,	TME	5
	. IHR,MIN,NMOR,DX,HL,VL,DZ	TME	6
C		TME	7
C	LIST	TME	8
C	INPUT	TME	9
C	MN=MONTH. IDA=DAY. IYR=YEAR. HR = HOUR. MIN = MINUTE	TME	10
C	XLAT = LATITUDE (INPUT-GEOCENTRIC LATITUDE.)	TME	11

C	XLONG= LONGITUDE(INPUT-GEOCENTRIC LONGITUDE. OUTPUT -180 TO + 180)	TME	12
C	OUTPUT	TME	13
C	SDA = SOLAR DECLINATION ANGLE (IN RAD)	TME	14
C	SHA = SOLAR HOUR ANGLE (IN RAD)	TME	15
C	DD = DAY NUMBER FROM 1JAN.	TME	16
C	DY = DD/TROPICAL YEAR	TME	17
C		TME	18
C		TME	19
C	SET CONSTANTS	TME	20
C		TME	21
	YEAR = 365.2422	TME	22
	YR=IYR	TME	23
	6 DY = DD/YEAR	TME	24
	30 FMJD = XMJD - 2435839.	TME	25
C		TME	26
C	COMPUTE GREENWICH MEAN TIME IN MINUTES GMT	TME	27
C		TME	28
	XHR = IHR	TME	29
	XMIN = MIN	TME	30
	GMT = 60*XHR + XMIN	TME	31
C		TME	32
C	COMPUTE GREENWICH MEAN POSITION - GP (IN DEG)	TME	33
C		TME	34
	XJ = (XMJD - 2415020.0)/(36525.0)	TME	35
	A1=99.6909833	TME	36
	A2 = 36000.76854	TME	37
	A3 = 0.00038708	TME	38
	A4 = 0.25068447	TME	39
	GP = A1 + A2*XJ + A3*XJ*XJ + A4*GMT	TME	40
	N = GP/360.	TME	41
	XN = N	TME	42
	GP = GP - XN*360.	TME	43
C		TME	44
C	COMPUTE RIGHT ASCENSION POINT - RAP (IN DEG)	TME	45
C		TME	46
C	1ST CONVERT GEOCENTRIC LONGITUDE TO DEG LONGITUDE - WEST NEG \$ EAST	TME	47
C		TME	48
	IFACT = XLONG/180.	TME	49
	XFACT = IFACT	TME	50
	XLONG = 360. * XFACT - XLONG	TME	51
C		TME	52
	RAP = GP + XLONG	TME	53
	N = RAP/360.	TME	54
	XN = N	TME	55
	RAP = RAP - XN*360.	TME	56
C		TME	57
C	COMPUTE CELESTIAL LONGITUDE - XLS (IN RAD) - -PI/2 TO +PI/2	TME	58
C		TME	59
	B1 = 0.017203	TME	60
	B2 = 0.0335	TME	61
	B3 = 1.410	TME	62
	Y1 = B1*FMJD	TME	63
	XLS = Y1 + B2*SIN(Y1) - B3	TME	64
	TPI = 6.28318	TME	65

N = XLS/TPI	THE	66
XN = N	THE	67
XLS = XLS - XN*TPI	THE	68
C	THE	69
C COMPUTE SOLAR DECLINATION ANGLE - SDA (IN RAD)	THE	70
C	THE	71
B4 = (TPI/360.)*23.45	THE	72
SDA = ASIN(SIN(XLS)*SIN(B4))	THE	73
C	THE	74
C COMPUTE RIGHT ASCENSION OF SUN - RAS (IN RAD) - -PI/2 TO +PI/2	THE	75
C	THE	76
RAS = ASIN(TAN(SDA)/TAN(B4))	THE	77
C	THE	78
C PUT RAS IN SAME QUADRANT AS XLS	THE	79
C	THE	80
PI = 3.14159265	THE	81
PI2 = PI/2.	THE	82
PI32 = 3.*PI2	THE	83
RAS = ABS(RAS)	THE	84
TEMP = ABS(XLS)	THE	85
IF(TEMP - PI2) 130,130,100	THE	86
100 IF(TEMP - PI) 105,105,110	THE	87
105 RAS = PI - RAS	THE	88
GO TO 130	THE	89
110 IF(TEMP - PI32) 115,115,120	THE	90
115 RAS = PI + RAS	THE	91
GO TO 130	THE	92
120 RAS = TPI - RAS	THE	93
130 IF (XLS) 135,140,140	THE	94
135 RAS = -RAS	THE	95
140 CONTINUE	THE	96
C	THE	97
C COMPUTE SOLAR HOUR ANGLE - SHA (IN DEG) - -	THE	98
C	THE	99
SHA = RAP*(PI/180.) - RAS	THE	100
IF(SHA) 210,230,230	THE	101
210 IF(SHA+PI) 220,250,250	THE	102
220 SHA=SHA+TPI	THE	103
GO TO 210	THE	104
230 IF(SHA-PI) 250,250,240	THE	105
240 SHA=SHA-TPI	THE	106
GO TO 230	THE	107
250 CONTINUE	THE	108
C	THE	109
RETURN	THE	110
END	THE	111
SUBROUTINE WIND	WIND	1
COMMON /WINCOM/RHO,FCORY,DX5,DY5,PX,PY,PXX,PXY,PYY,U,V, T,TX,TY,	WIND	2
\$ DU,DV,P,UPRE,VPRE,DUPRE,DVPRE	WIND	3
COMMON /IOTEMP/DUM1(7),PHI,DUM2(11),MN,DK2A(5),G,R,H,PHIR,	WIND	4
\$THETR,DUM3(15),FLAT	WIND	5
COMMON/CHIC/DUM(18),IWSYN,UCOEF(14,9),VCOEF(14,9)	WIND	6
ABSPHI=ABS(PHI)	WIND	7
IF (RHO.GT.0.,AND.ABSPHI .GT.0.) GO TO 20	WIND	8

U = 0.	WIND 9
V = 0.	WIND 10
IF(ABSPHI .LE.0) GO TO 31	WIND 11
RETURN	WIND 12
20 FCORX = FCORY*IX5/DY5	WIND 13
U = -PY/(FCORY*RHO)	WIND 14
V = FX/(FCORX*RHO)	WIND 15
DU = -(G*TY)/(FCORY*T)	WIND 16
DV = (G*TX)/(FCORX*T)	WIND 17
31 IF(H.GT.20.AND.H.LT.95.)GOTO 99	WIND 18
IF(ABSPHI.GE.FLAT) RETURN	WIND 19
U=UPRE	WIND 20
V=VPRE	WIND 21
DU=DUPRE	WIND 22
DV=DVPRE	WIND 23
RETURN	WIND 24
C...SPHERICAL HARMONICS SECTION.....	WIND 25
99 IH=INT(H)	WIND 26
IF(IH.LE.25)GOTO 130	WIND 27
IF(IH.GE.90)GOTO 140	WIND 28
IH1=5*INT(H/5.)	WIND 29
IH2=IH1+5	WIND 30
CALL SPHERE(MN,IH1,PHIR,THETR,US,VS)	WIND 31
CALL SPHERE(MN,IH2,PHIR,THETR,US2,VS2)	WIND 32
FACS=(H-IH1)/5.	WIND 33
U=US+(US2-US)*FACS	WIND 34
V=VS+(VS2-VS)*FACS	WIND 35
DU=(US2-US)/5000.	WIND 36
DV=(VS2-VS)/5000.	WIND 37
RETURN	WIND 38
C...LOW ALTITUDE FAIRING	WIND 39
130 CALL SPHERE(MN,25,PHIR,THETR,US,VS)	WIND 40
FACS=(H-20.)/5.	WIND 41
FACG=1.-FACS	WIND 42
U=FACG*U+FACS*US	WIND 43
V=FACG*V+FACS*VS	WIND 44
CALL SPHERE(MN,30,PHIR,THETR,US2,VS2)	WIND 45
DUS=(US2-US)/5000.	WIND 46
DVS=(VS2-VS)/5000.	WIND 47
RETURN	WIND 48
C...HIGH ALTITUDE FAIRING	WIND 49
140 CALL SPHERE(MN,90,PHIR,THETR,US,VS)	WIND 50
FACS=(H-90.)/5.	WIND 51
FACG=1.-FACS	WIND 52
U=FACS*U+FACG*US	WIND 53
V=FACS*V+FACG*VS	WIND 54
CALL SPHERE(MN,85,PHIR,THETR,US2,VS2)	WIND 55
DUS=(US-US2)/5000.	WIND 56
DVS=(VS-VS2)/5000.	WIND 57
DU=FACG*DU+FACS*DUS	WIND 58
DV=FACG*DV+FACS*DVS	WIND 59
RETURN	WIND 60
END	WIND 61

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 80K on the Georgia Tech CDC. The CDC System routines require more core than the Univac routine so there is no comparison between the system. See Section 5.1.
- c. Magnetic Tapes - All 4-D data tapes are 7 tracks. Proper and SCIDAT data tapes are 9 track. 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 1.3)
- 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 words 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. Program Specifications (cont'd.)
 - 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

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16. ABSTRACT This report describes recent improvements in the Global Reference Atmospheric Model (NASA TM X-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 small-scale and large-scale random perturbations. The newer version reported here incorporates a spherical harmonic wind model for the height range 25-90 km. Parameters for the model were determined from wind data determined by Meteorological Rocket Network soundings, and by grenade releases at higher altitudes. For all latitudes and longitudes in the 25-90 km height range, winds are evaluated by the new spherical harmonic model. Below 25 km and above 90 km, the GRAM program continues to use the geostrophic wind equations and data for pressure, in order to compute the mean wind. Another new feature of the program is that, in the altitudes where the geostrophic wind relations are used, an interpolation scheme is employed for estimating winds at low latitudes, where the geostrophic wind relations begin to mesh down. Several sample wind profiles are given, as computed by the new spherical harmonic wind model.			
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