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User's Guide for the Total-Ozone Mapping Spectrometer (TOMS) Instrument First-Year Ozone-T Data Set

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PREFACE

NIMBUS EXPERIMENT TEAM (NET) VALIDATION STATEMENT FOR FIRST YEAR SBUV/TOMS OZONE DATA SET

Total ozone and ozone vertical profile results for Solar Backscattered Ultraviolet/Total Ozone Mapping Spectrometer (SBUV/TOMS) operation from November 1978 to November 1979 are available. The algorithms used have been thoroughly tested; the instrument performance examined in detail; and the ozone results have been compared with Dobson, Umkehr, balloon, and rocket observations. The accuracy and precision of the satellite ozone data is good to at least within the ability of the ground truth to check and is self consistent to within the specifications of the instrument.

The primary input to the ozone retrieval algorithms is the ratio of the backscattered radiance to the incident solar radiance. Both radiance and irradiance are measured separately by the SBUV and TOMS instruments. Accuracy in the determination of this ratio depends upon the calibration accuracy of a diffuse reflector used to measure the solar irradiance. Precision in the measurement of this ratio is better than 0.5% for SBUV and 1.0% for TOMS. Prelaunch calibration uncertainties affect the absolute accuracy of these measurements. We are continuing to assess the magnitude of these uncertainties. During the first year of instrument operation inflight diffuser degradation is less than 1.5% at 339.8 nm and less than 3.0% at 273.5 nm. No correction for this has been applied to the data. This inflight degradation can introduce an apparent long term drift in an analysis of the data.

One of the major design improvements of the Nimbus 7 SBUV instrument over the BUV instrument on Nimbus 4 involved the employment of a system for the on-board subtraction of dark current. This has improved the instrument's performance to a point where no radiation induced signal has been observed in the South Atlantic anomaly to date.

Total ozone has been derived from both the SBUV and TOMS instruments. Analysis of the variance of comparisons between colocated TOMS and AD pair direct sun (00 code) Dobson observations shows that total ozone retrieval precision is better than 2% to within 10 degrees of the solar terminator. There are biases of -6.5% and -8.3% for TOMS and SBUV respectively when compared to the Dobson network. These biases are primarily due to inconsistancies in the ozone absorption coefficients used by the space and ground systems. If absorption coefficients available on a preliminary basis from the National Bureau of Standards were used for both SBUV/TOMS and the Dobson measurements, the biases would be less than 3%.

Vertical profiles of ozone have been derived from the SBUV step scan radiances at 273.5 nm and longer wavelengths using an optimum statistical inversion algorithm. Comparison with Umkehr measurements at Boulder and Arosa indicate that the precision of the derived layer ozone amounts is on the order of 5%.

The altitude range, for which the inferred SBUV profiles is determined primarily by the radiance measurements, depends on several factors including the solar zenith angle, the total ozone amount, and the shape of the ozone profile. This altitude range typically extends from 0.7 mbar (50 km) down to the peak of the ozone density profile (20-40 mb) or 22-26 km.The derived layer ozone amounts below this region as produced by the optimum statistical inversion algorithm depend on the a priori statistical information about the correlation between these layers and the observed total ozone and upper level profile amounts.

Variations of UV solar flux associated with the rotation of active regions on the sun (27-day solar rotation period) have been observed with the continuous scan solar observations (160-400 nm). However, no significant solar flux variation was observed at the wavelengths used for the total ozone and vertical profile retrievals. Therefore, a long term smoothed solar flux was used in the processing with no 27 day period component. To the extent that there may have actually been a small 27 day period in the real solar flux this would introduce a small (less than 1/2%) artifact in the data.

Ground truth for the SBUV ozone profile consists of Umkehr profiles, ozone balloon sondes, several optical ozone rocket sondes, and a chemiluminescent rocket sonde. This set of data was not sufficient to precisely determine the accuracy and validity range of the satellite retrievals or to evaluate possible latitudinal or temporal trends in the data. However, there are indications that the SBUV values may be slightly (5%) lower than the balloon and Umkehr measurements below the mixing ratio peak (5-7 mb). At upper levels the agreement with the optical ozonesonde rockets flown in November of 1979 for the International Ozone Rocket Intercomparison is within ± 5%.

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USER'S GUIDE FOR THE TOTAL-OZONE
MAPPING SPECTROMETER (TOMS) INSTRUMENT
FIRST-YEAR OZONE-T DATA SET

1. TOTAL-OZONE MAPPING SPECTROMETER EXPERIMENT

1.1 INTRODUCTION

The total-ozone mapping spectrometer (TOMS) was proposed by A. J. Krueger in order to provide global total-ozone mapping with high spatial resolution on a daily basis. The details of the TOMS instrument design is described in Heath et al.[1]

The combined SBUV/TOMS instrument has been supported by an experiment team consisting of D. F. Heath, Chairman, A. J. Krueger, C. L. Mateer, A. J. Miller, D. Cunnold, A. E. Green, A. Belmont, and W. L. Imhof. The SBUV/TOMS instrument was built by Beckman Instruments, Inc., of Anaheim, California. Algorithm development, evaluation of instrument performance, ground-truth validation, and data production efforts were carried out by A. J. Fleig, K. F. Klenk, P. K. Bhartia, H. W. Park, K. D. Lee, and V. G. Kaveeshwar of the Ozone Processing Team (OPT). The OPT is managed by A. J. Fleig and is supported by individuals from Systems and Applied Sciences Corporation and Goddard Space Flight Center.

This guide is intended for users of the Nimbus 7 TOMS first-year total-ozone data set. The TOMS instrument and the theoretical foundations behind the experiment are outlined in Section 1. The total-ozone algorithm is described in Section 2. For further discussion of the theory behind the algorithm, see Klenk et al.[2] and references therein. The ozone tape formats are described in Section 3. Table 1 lists external information used by the retrieval algorithm (namely, the absorption and scattering coefficients and the solar flux for

Table 1

External Input to Program

Vacuum Wavelength (nm)	Effective Ozone Absorption Coefficient (atm-cm^{-1})	Rayleigh Scattering Coefficient (atm^{-1})	Solar Flux (watt/cm^{3}/AU)	Prelaunch Radiance Calibration Constant (gain 1) (watt/cm^{3}/ster/count)
380.014	0.0	0.4499	1119.8	2.971 x 10^{-4}
359.962	0.0	0.5643	1137.7	3.309
339.861	0.0405	0.7186	1003.5	3.381
331.253	0.1676	0.8006	980.2	3.483
317.512	0.9264	0.9586	792.8	3.731
312.514	1.777	1.0257	667.7	3.995

each of the TOMS wavelengths). The correction functions used for obtaining albedos appear in Appendix A. Appendix B contains a sample Fortran program and job-control language (JCL) that can be used for reading a TOMS ozone tape. Appendix C contains information on ordering tapes. Appendix D contains a catalog of available tapes.

1.2 INSTRUMENT OVERVIEW

The total-ozone mapping spectrometer, an instrument on board the Nimbus 7 satellite, is designed to provide daily global coverage of the Earth's total ozone by measuring the backscattered ultraviolet (BUV) sunlight at six wavelength bands, each with a 1.0-nm bandpass. The band center wavelengths are given in Table 1. The TOMS also makes periodic measurements of the solar flux by deploying a diffuser plate to reflect sunlight directly into the instrument. The TOMS uses a single monochromator and a scanning mirror to sample the BUV radiation at 35 sample points every 8 seconds along a line perpendicular to the orbital plane. The scanning mirror moves the TOMS instantaneous field of view (IFOV) in 3-degree steps up to 51 degrees on each side of the nadir.

1.3 THEORETICAL FOUNDATIONS

The UV radiation received by the TOMS instrument in the total-ozone bands consists mainly of solar radiation that has penetrated through the stratosphere and has been reflected back by the dense tropospheric air and the surface. Ozone, being concentrated in the stratosphere above the region in which most of the radiation is backscattered, acts as an attenuator of this radiation. By determining the amount of this attenuation in the ozone absorption bands, the amount of ozone above the reflecting surface can be accurately estimated. More than 90 percent of the ozone is located above the tropopause, whereas all clouds, most of the aerosols, and approximately 80 percent of the atmosphere are located below it. This almost complete separation of the ozone from the scatterers and reflectors minimizes errors caused by vertical profile shape, clouds, aerosols, and other tropospheric variables.

The TOMS measures the intensity, I, of the BUV light at six wavelengths at each scene sample. It also periodically measures the solar flux, F, at the satellite at these six wavelengths. The ratio, I/F (sometimes called the Earth's geometric albedo), is used to determine the total ozone, Ω. The pressure, P_0, of the reflecting surface and three angles must also be known for accurate ozone retrieval. The solar zenith angle, Θ_0, from the IFOV and the zenith angle of the satellite, Θ, also from the IFOV, are needed for calculating the optical slant path, S (= $\sec\Theta + \sec\Theta_0$), of the UV light down through the atmosphere and back to the satellite. The azimuth angle, ϕ, between the Sun and the satellite (from the IFOV) is also needed for calculating the scattering phase function.

For π units of incident solar flux, the total backscattered radiance, I, at wavelength λ can be expressed as the sum of two terms after Dave[3] as follows:

$$I(\lambda, \Theta, \Theta_0, \phi, R, P_0, \Omega,) = I_0 (\lambda, \Theta, \Theta_0, \phi, P_0, \Omega, \measuredangle) + \frac{T (\lambda, \Theta, \Theta_0, \phi, P_0, \Omega, \measuredangle) R}{1 - RS^b(\lambda, P_0, \Omega, \measuredangle)} \qquad (1)$$

where R is the effective reflectivity of the reflecting surface, $\measuredangle$ represents the dependence on ozone profile shape, T is the atmospheric transmission, and S^b is the atmosphere-to-surface backscatter fraction. The arguments are given in parentheses.

The first term of equation 1, I_0, is the intensity of the purely atmospheric backscattered radiation that is the intensity when the surface reflectivity is zero. The second term is the direct and diffuse radiation reflected by the surface. The two longest TOMS wavelengths, 380 and 360 nm, being outside the ozone absorption band, are used to determine the effective Lambertian surface reflectivity, R. The four shortest wavelengths are used in pairs (A-pair:

2.5 and 331.2 nm and B-pair: 317.5 and 339.8 nm) to determine the total ozone, Ω.

2. TOMS TOTAL-OZONE ALGORITHM

The total-ozone retrieval program reads a RUT-T tape (raw-units tape) that has had terrain pressures, THIR cloud data, and snow/ice thicknesses merged onto it. The total-ozone data are written onto a tape called the OZONE-T tape. The algorithm is fundamentally very simple. Given the optical slant path, S, the scene reflectivity, R, and the surface pressure, P_0, the average columnar amount of total ozone, Ω, in the IFOV is obtained by a lookup and interpolation procedure, using a table of precomputed radiances. The following paragraphs outline the various steps in the algorithm.

2.1 COMPUTATION OF THEORETICAL RADIANCES

The radiance tables were created by using a set of 21 climatological ozone vertical profiles.[4] These profiles were determined for three latitude bands using balloon ozonesondes. There are three profiles for low latitudes (Ω = 0.2 to 0.3 atm-cm in 0.05-atm steps), eight for midlatitudes (0.2 to 0.55 atm-cm), and ten for high latitudes (0.2 to 0.65 atm-cm).

The 21 precomputed radiance tables (called standard tables) were calculated by using the auxiliary equation solution to the radiative transfer equation.[3] The ozone absorption coefficients are based on the measurements of Inn and Tanaka[5] using Vigroux's[6] temperature coefficients. The computation of the band-averaged coefficients is described by Klenk.[7] These absorption coefficients are listed in Table 1. The reflecting surface is assumed to be Lambertian. For each of the 21 standard profiles, radiances are computed for reflecting surface pressures of 1.0 and 0.4 atm. The tables have an upper limit on the solar zenith angle of 85.7 degrees.

2.2 COMPUTATION OF NORMALIZED RADIANCES (I/F)

The algorithm uses a nominal value of the solar flux, F (given in Table 1), calculated by using the prelaunch irradiance calibration constants and measurements made soon after launch:

$$F_\lambda = K_\lambda\ C_\lambda\ (d_0)\ F_1(\alpha,\ \beta)\ R^2(d_0) \tag{2}$$

where

F_λ = solar flux at wavelength λ normalized to 1 AU

K_λ = prelaunch irradiance calibration constant at λ

$C_\lambda(d_0)$ = measured counts at wavelength λ on day d_0, the first measurement of the solar flux after launch

$F_1(\alpha, \beta)$ = angular response function of the diffuser plate

$R(d_0)$ = Sun/Earth distance on day d_0 in AU

= $1-0.0167 \cos (2\pi(d_0-4)/365.25)$

In addition, a nominal value of the backscattered intensity is calculated:

$$I_\lambda = k_\lambda\ C'_\lambda\ (d) \tag{3}$$

where

$C'_\lambda(d)$ = measured BUV counts at wavelength λ on day d

k_λ = prelaunch radiance calibration constant

The corrected value of I/F used is obtained from the nominal values of I and F by applying a time-varying correction function, F_2, that is given in Appendix A:

$$\left(\frac{I_\lambda}{F_\lambda}\right)_{\text{corrected}} = \left(\frac{I_\lambda}{F_\lambda}\right) R^2(d)\, F_2'(t) \tag{4}$$

Correction function $F_2'(t)$ accounts for any actual changes in the solar output with time and changes in the instrument throughput with time. For the calculation of the albedos (I/F), instrumental and solar flux changes need not be known separately.

It is convenient to convert the albedos into an attenuation number, called the N-value, and defined as:

$$N_\lambda = -100 \log_{10} \left(\frac{I_\lambda}{F_\lambda}\right) \tag{5}$$

2.3 CALCULATION OF REFLECTIVITY

For wavelengths in which no ozone absorption occurs, the measured radiance, I_M, can be used to infer the reflectivity of the reflecting surface in the IFOV. Removing the ozone dependence from equation 1 and solving for the reflectivity, R,

$$R = \frac{I_M - I_0(\lambda,\theta,\theta_0,\phi,P_0)}{T(\lambda,\theta,\theta_0,\phi,P_0) + S^b(\lambda,P_0)\cdot[I_M - I_0(\lambda,\theta,\theta_0,\phi,P_0)]} \tag{6}$$

where I_0, T, and S^b are computed from the standard tables. The reflectivity used in the algorithm is an average of the 360- and 380-nm reflectivities.

2.4 CALCULATION OF TOTAL OZONE

A-pair and B-pair N-values used in the total-ozone algorithm are defined as:

$$N_A = N_{312.5} - N_{331.2} \tag{7a}$$

$$N_B = N_{317.5} - N_{339.8} \tag{7b}$$

The algorithm calculates the total ozone by a simple linear interpolation between adjacent N-values in the standard tables. This is done for each of the two pressure levels of the tables, 1.0 and 0.4 atm, to be combined later according to the IFOV pressure.

An important step is the selection of the proper set of climatological standard tables from the three sets available. When the slant path is less than 6.0, this decision is made entirely on the basis of the latitude of the IFOV, as follows:

Latitude (degrees)	Use
0 to 20	Low-latitude tables
20 to 30	Mix low- and mid-latitude tables
30 to 60	Mid-latitude tables
60 to 70	Mix mid- and high-latitude tables
70 to 90	High-latitude tables

In the latitude mixing regions, the ozone values from two tables are combined linearly by latitude to avoid discontinuites.

A different table selection scheme is used when the slant path is 6.0 or greater (solar ZA ≥ 78.5 degrees at the nadir, solar ZA ≥ 74.5 degrees at the extreme off-nadir) because of the increased sensitivity of total ozone to the profile shape. This selection between the mid- and high-latitude tables is made on the basis of the measured A-pair N-value, N^A_{meas}. Theoretical A-pair N-values are interpolated from the tables by using Ω^B_{mid} and Ω^B_{high}, which gives N^A_{mid} and N^A_{high}. The weight used in mixing mid- and high-latitude tables is then obtained as follows:

$$\mathrm{WEIGHT} = \frac{N^A_{meas} - N^A_{mid}}{N^A_{high} - N^A_{mid}} \tag{8}$$

and is used to combine the two ozone values:

$$\Omega^B = \Omega^B_{high} \cdot \mathrm{WEIGHT} + \Omega^B_{mid} \cdot (1-\mathrm{WEIGHT}) \tag{9}$$

A "table index" (= WEIGHT + 2.0) is calculated to indicate how the mid- and high-latitude tables were mixed. To avoid a discontinuity, the total-ozone values calculated from the low slant path ($S < 6.0$) and the high slant path ($S \geq 6.0$) methods are combined linearly by slant path between $S = 6.0$ and $S = 8.0$. Note that, in the high slant-path method, A-pair ozone is not calculated.

2.5 CALCULATION OF THE IFOV PRESSURE

The average pressure of the reflecting surface in the IFOV must be determined in order to properly combine the 1.0- and 0.4-atm total-ozone values. The algorithm uses two methods to find this pressure: (1) using the reflectivity and (2) using data from the temperature/humidity infrared radiometer (THIR).

2.5.1 Method 1

In the first method, the terrain pressure is combined with the cloud-top pressure according to the reflectivity and the presence or absence of snow. A latitude-dependent climatological average cloud-top pressure obtained from THIR studies is calculated according to:

$$P_{\text{cloud}} = 0.3 + 0.15\ (1-\cos 2\cdot \text{lat})\ \text{atm} \qquad (10)$$

The average IFOV pressure, P_0, is obtained as follows:

$$P_0 = f\ P_{\text{cloud}} + (1-f)\ P_{\text{terrain}} \qquad (11)$$

where the estimated fractional cloudiness, f, is obtained by using the measured reflectivity, R, and snow/ice information as follows:

<u>No Snow</u>	<u>With Snow</u> (≥0.5 inches thick)	
$f = 0$	$f = 0$	R 0.2
$f = 1$	$f = 0.5$	R 0.6
$f = \frac{R - 0.2}{0.4}$	$f = \frac{R - 0.2}{0.8}$	$0.2 < R < 0.6$

2.5.2 Method 2

The second method uses THIR cloud data when available. The THIR is an instrument that is on board the Nimbus 7. THIR 11.5-μm radiances are used to determine the cloud-top pressures P_{cloud}, and the fraction of cloudiness, f, in the TOMS IFOV. These are contained on the RUT tape. The equation for the THIR-derived IFOV pressure is identical to equation 11.

Because the ozone retrieval is very sensitive to IFOV pressure at low reflectivities, limits are set on the use of THIR pressures. At low reflectivities ($R \leq 0.2$), terrain pressure is used regardless of THIR. To prevent unreasonably low THIR pressures, a latitude-dependent minimum allowable cloud-top pressure is defined, as follows:

$$P^{\text{min}}_{\text{cloud}} = 0.1 + 0.15\ (1-\cos 2\cdot \text{lat})\ \text{atm} \qquad (12)$$

This is used to compute a minimum acceptable THIR pressure given by:

$$P^{min}_{THIR} = f\ P^{min}_{cloud} + (1-f)\ P_{terrain} \tag{13}$$

The fractional cloudiness in equation 13 is the same as that of Method 1. The actual THIR IFOV pressure is reported on the ozone tape, but, if it is less than P^{min}_{THIR}, the total-ozone calculations are made by using P^{min}_{THIR}.

When IFOV pressures are determined from the reflectivity and from THIR, both a non-THIR ozone and a THIR ozone are calculated for each pair (or for B-pair only at $S \geq 6.0$) by a linear interpolation of the ozone values derived by using the 1.0- and 0.4-atm tables. The ozone values calculated represent the total ozone down to the terrain height. In the presence of clouds, the reported ozone implicitly includes a climatologically determined amount of ozone below the cloud.

2.6 CALCULATION OF BEST OZONE

After adjusting for the IFOV pressure, the A-pair and B-pair ozone values are combined to get a single "best" ozone estimate. The weighting of the A- and B-pair ozone is done on the basis of the slant path, S. At small values ($S \leq 2.5$), the A-pair ozone is preferable because algorithmic errors are usually larger for the B-pair ozone. At large values ($S \geq 5.0$), the B-pair ozone is preferable because the A-pair becomes more sensitive to the shape of the ozone profile. Because, at intermediate values of the slant path, the A-and B-pair sensitivities to the ozone profile and to algorithmic errors are comparable, a weighted mean is taken as the best ozone. Thus, best ozone, Ω_{Best}, is computed as:

$$\Omega_{Best} = \Omega_A \qquad (S \le 2.5) \qquad (14a)$$

$$\Omega_{Best} = \Omega_A \frac{(5.0 - S)}{2.5} + \Omega_B \frac{(S - 2.5)}{2.5} \qquad (2.5 < S < 5.0) \qquad (14b)$$

$$\Omega_{Best} = \Omega_B \qquad (S \ge 5.0) \qquad (14c)$$

2.7 VALIDITY CHECKS

The algorithm contains several validity checks for maintaining data quality. In processing before the ozone determination, several checks are made on the solar zenith angle, satellite attitude, and instrument status to ensure the quality of the radiances and other geophysical input. This section describes the quality checks performed on the derived reflectivity and ozone to identify bad scans caused by either bad input (which passed preprocessing checks) or limitations of the ozone algorithm. Figure 1 is a flow chart of the quality checks.

The computed total ozone for each pair must be within the dynamic range of the radiance tables. For low, mid, and high latitudes, the ranges are 0.18 to 0.35, 0.18 to 0.60, and 0.18 to 0.65 atm-cm, respectively. If A- or B-pair ozone exceeds the range, it is set to -999, best ozone is set to -999, and quality flag = 9 is assigned.

Next, a check is made on the best reflectivity. The reflectivity must be no less than -0.05 and no greater than +1.05. If this range is exceeded, the best ozone is set to -999, and quality flag = 8 is assigned.

A second check is made on the reflectivity. The 380- and 360-nm reflectivities must differ by no more than 0.10. If the difference is greater than 0.10, the best ozone is set to -999, and quality flag = 7 is assigned. Significant differences in the two reflectivities could result from instrument calibration errors or from

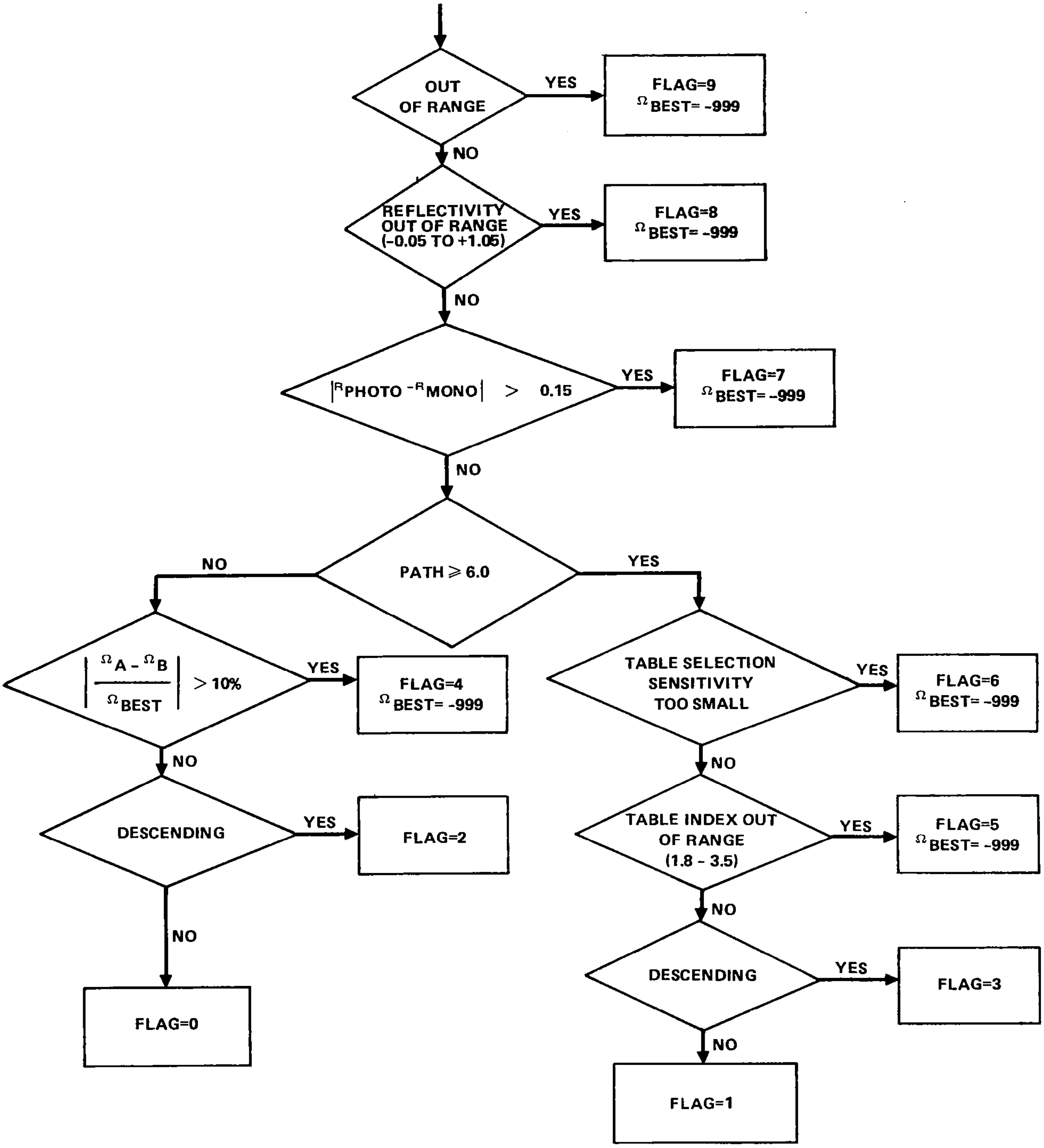

Figure 1. Quality Flags

significant departures of the real atmosphere and surface from the algorithmic model.

If the data pass flags 9, 8, and 7, the slant-path length is checked. Two additional checks are made on low slant-path data ($S < 6.0$), and three are made on high slant-path data ($S \geq 6.0$).

For low slant-path data, the difference between the A-pair and the B-pair ozone is checked. If this difference exceeds 10 percent of the best ozone, quality flag = 4 is assigned, and the best ozone is set to -999.

Low slant-path data that pass flag 4 can be considered to be good data. A final check is made to determine if the scan occurred during the ascending or the descending part of the orbit. Although, for the most part, the satellite is over the dark side of the Earth during the descending part of the orbit, it is possible to retrieve ozone from both the ascending and descending parts of the orbit during summer when the polar region is in sunlight. Descending scans are assigned quality flag = 2, and a normal best ozone is reported. If the scan is an ascending scan, quality flag = 0 is assigned.

Ascending scans are preferable to descending scans at the same latitude because the solar zenith angle is smaller. Descending data are taken at a local time several hours different from local noon time, when most of the TOMS data are taken. Also, Dobson stations usually make measurements around local noon. Thus, the use of descending data should be avoided when diurnal variations are important, as in zonal means or Dobson comparisons.

For high slant-path data, the sensitivity of the table selection scheme is calculated. Low sensitivity means that the table selection scheme is only weakly sensitive to differences between the mid- and high-latitude profiles. If the sensitivity is low, flag = 6 is assigned, and the best ozone is set to -999.

The table index is also checked for high slant-path data. The table index must be no less than 1.8 and no greater than 3.5. Studies of the table selection scheme have shown that these limits are rarely exceeded. This prevents the effective selected profiles from varying too much from either mid- or high-latitude profiles. If the limits are exceeded, quality flag = 5 is assigned, and the best ozone is set to -999.

For the same reasons as for the low slant path, the high slant-path data that have passed the other flags are checked last for being in the ascending or descending part of the orbit. Descending data are assigned quality flag = 3, ascending scans are assigned quality flag = 1, and a best ozone is reported for both.

3. TAPE FORMATS

The TOMALL program creates an output tape called the OZONE-T tape. This tape can be described in terms of its physical structure and/or its logical structure.

3.1 PHYSICAL STRUCTURE OF OZONE-T TAPE

The OZONE-T tape is a multiple-file binary tape written in fixed-block (FB) format on an IBM 360 machine. It contains a header file, followed by files for each orbit of data and, finally, a trailer file.

The first file is a special file called the standard header, written in a standard format common to all archivable tapes produced by the Nimbus Operational System (NOPS). This contains two identical blocks of 630 characters written in EBCDIC. Each block consists of five 126-character lines.

Lines 1 and 2 are written according to a standardized format called the NOPS Standard Header Record. The standard header records contain the following information:

- Nimbus-7 NOPS tape product format specification number consisting of 30 characters. For all OZONE-T tapes, the character string is $_{b}$NIMBUS-7$_{b}$ NOPS$_{b}$SPEC$_{b}$NO$_{b}$T634091. The subscript "b" indicates a blank.

- Tape sequence number consisting of a two-character code identifying the tape (for OZONE-T, this is FF) a 5-character sequence number unique to each tape, a hyphen, and a one-digit number specifying the copy number. An example for an OZONE-T tape is FF92411-2.

- Subsystem identification code consisting of 4-characters preceded and followed by blanks. For OZONE-T, this is $_{b}$TOMS$_{b}$.

- Generation and destination facilities consisting of four characters each are given. An example is SACC$_{b}$TO$_{b}$IPD$_{b}$. In this example SACC is the computer facility that generated the OZONE-T tape and IPD in the destination of the tape.

- The beginning and ending dates of data coverage are given as $_{b}$START$_{b}$19YY$_{b}$DDD$_{b}$HHMMSS$_{b}$TO$_{b}$19YY$_{b}$DDD$_{b}$HHMMSS$_{b}$, where YY is the year, DDD is the Julian day of the year, HHMMSS are the hour, minute and second of the day. For the OZONE-T tape, the ending date is not the true ending date of the data on the tape but a fill date (i.e., 1999$_{b}$365$_{b}$240000). In order to avoid unnecessary processing complications, the true ending date does not appear in the header record.

- The tape generation data is given in a similar format as above: GEN$_{b}$19YY$_{b}$DDD$_{b}$HHMMSS$_{b}$.

The following character string is an example of an OZONE-T header record:

```
NIMBUS-7 NOPS SPEC NO T634091 SQ NO FF92411-2 TOMS SACC TO IPD
START 1979 241 144022 TO 1999 365 240000 GEN 1981 101 144824
```

Lines 3, 4, and 5 are used by the subsystem analyst for further identification of the data tape. Line 3 of the header file is usually left blank. Lines 4 and 5 contain information about the processing software such as program name, version number, and version date.

The rest of the files on the tape each contain a variable number of blocks, each 16,128 bytes long. The first word of each block contains a 32-bit block identifier as shown in Figure 2.

Bits:	1-12	13-16	17	18	19-24	25-32
	Block No.	Spare	1 if last block	1 for each block on last file	Record ID	Spare

Figure 2. Block Identifier

Record identifications (ID's) are as follows:

04 - for 1st block on data files
19 - for intermediate blocks on data files
54 - for the last block on data files
59 - for all blocks on trailer file

3.2 LOGICAL STRUCTURE OF TAPE

Data files follow the IPD header file, one for each orbit of data on the tape. For most users of the tapes, it will be more convenient to treat the data files as a collection of logical records, each

1008 bytes long. (Note that 16 of these records are blocked together before writing on the tape.)

The first record of each file contains processing information about the data that follow. Its format is described in Table 2. Each of the following records contain information from a single 8-second scan of the TOMS instrument. The format appears in Table 3 and the detailed data-word descriptions appear in Table 4. Normally, the scans begin when the satellite enters daylight at the southern terminator and end when it enters darkness in the north.

During this time, the TOMS scans approximately 375 to 400 times: therefore, under normal operating conditions, one file on the tape should contain as many data records.

Table 5 describes the last record of useful information on each file. It follows the last data record of the file and contains a processing summary of the preceding orbit of data. Following this "last" record will be dummy records to fill the last block. These dummy records keep all blocks the same length and should be ignored.

The record type can be identified by word 2 (I*2; first half of word 2) of each record. It contains the logical sequence number of the records within the file. It begins at 1 for the first record of the file and is incremented by 1 for each successive record. For the last record, which contains the processing summary (and dummy records following), the negative of the logical sequence number is written.

The last file on the tape is called a trailer file. It contains 16 identical copies of a trailer record (to fill one block) described in Table 6. It can be identified by its logical sequence number of -1. It contains a processing summary of the entire tape, similar to that of the last record of each data file.

Table 2

Format of First Record on Data Files*

Word	Description
1	Block identifier
2	Logical Sequence number
3	Orbit number
4-7	Date of job run
8	Day of first good scan
9	GMT (secs of day) of first good scan
10	Subsatellite latitude (degrees x 10^2) for first scan
11	Subsatellite longitude (degrees x 10^2) for first scan
12	Scan-skipping factor
13	Sample-skipping factor
14	Maximum solar zenith angle processed
15	Maximum scan angle processed
16	Minimum subsatellite latitude processed
17	Maximum subsatellite latitude processed
18-23	Solar radiance F-values (380, 360, 312.5, 317.5, 331.2, 339.8 nm)
24-47	Calibration constants
48-50	Spare (-77)
51	GMT of orbit's right ascending node
52	Year at start of orbit (e.g., 1978)
53-252	Spare (-77)

(Continued)

*The logical sequence number is a 16-bit integer (I*2) that occupies the left half of word 2. Words 4 through 7 contain EBCDIC characters (e.g., MON DEC 10, 1978). The remaining words are in IBM floating-point format (R*4).

Table 2 (Continued)

Detailed Description of First Record on Data Files	
Word	Description
10	Latitudes range from -90 to +90 degrees, southern latitudes being negative.
11	Longitudes range from -180 to +180 degrees, western longitudes being negative.
12	The scan-skipping option is a program option that allows the processing of only every nth scan, where n is the scan-skipping factor. It was not used for the archived first-year data set (i.e., all scans were processed).
13	The sample-skipping option allows the processing of only every nth sample in each scan, where n is the sample-skipping factor. It was not used for the archived first-year data set (i.e., all samples were processed).
18-23	The solar irradiance values for the six wavelengths for the current day, given in units of watts/cm^3/AU.
24-47	The counts to radiance conversion factors are in units of watts/cm^3/steradian/count and are given for each of the four gain ranges for each of the six wavelengths in order: words 24 through 27, 380 nm; ...; words 44 through 47, 339.8 nm.

Table 3

Format of Data Records*

Word	Byte 1	Byte 2	Byte 3	Byte 4
1	Block identifier			
2	Logical sequence number		Day of year at start of scan	
3	GMT (seconds of day) at start of scan			
4	Spare			
5	Spare (0)		ϕ Angle at sample 1	
6	IFOV latitude		IFOV longitude	
7	IFOV solar zenith angle		N_{A}/P^{*}_{THIR}	
8	R-Best		N_{B}/P^{*}_{Refl}	
9	Ω-Best$_{Refl}$		Ω_{B-Refl}	
10	Ω-Best$_{THIR}$		$N_{331.2}/P^{*}_{terrain}$	
11	Ω_{A-Refl} or table index		$N_{339.8}/t^{*}_{SNOW}$	
12	QUALITY FLAG		$N_{380.0}/N^{*}_{360.0}$	
13-250	Same as 6 through 12 for samples 2 to 35			
251-252	Spare			

*All quantities are written as integer and are either 2 bytes (I*2) or 4 bytes (I*4) long, as shown. The starred quantities are 2 decimal digits long and are packed with N-values (3 decimal digits).

Table 4

Detailed Description of Selected Words

Word	Comment
5	ϕ angle at sample 1: The ϕ angle for the first sample; the angle between the Sun and the satellite measured at the IFOV.
6	IFOV latitude and longitude in units of 10^{-2} degrees. Negative latitudes apply to the Southern Hemisphere. Longitude moves from -180 to +180 degrees, where east is positive.
7	IFOV solar zenith angle in units of 10^{-2} degrees.
7	N_A/P^*_{THIR}, A-pair N-value packed with the THIR pressure, $= \mathrm{INT}(N_{312.5} - N_{331.2})\ 100 + (P_{THIR}(\mathrm{atm}) \cdot 100) - 1$
8	R-best, best reflectivity in percent units obtained by combining the 380- and 360-nm non-THIR reflectivity estimates.
8	N_B/P^*_{Refl}, B-pair N-value packed with the pressure derived from the reflectivity, $(P_{Refl}) = \mathrm{INT}(N_{317.5} - N_{339.8}) \cdot 100 + (P_{Refl}(\mathrm{atm}) \cdot 100) - 1$
	(Continued)

Table 4 (Continued)

	Detailed Description of Data Record
Word	Comment
9	Ω -best$_{Refl}$, best total-ozone estimate in m-atm-cm, using the pressure derived from the reflectivity (P_{Refl}).
9	Ω $_{B\text{-}Refl}$, B-pair total ozone, using P_{Refl}.
10	Ω best$_{THIR}$, best total-ozone estimate in units of m-atm-cm, using the pressure derived from THIR, (P_{THIR}).
10	$N_{331.2}/P^*_{terrain}$, 331.2-nm N-value packed with the terrain pressure, ($P_{terrain}$) $= \mathrm{INT}(N_{331.2}) \cdot 100 + (P_{terrain}(\mathrm{atm}) \cdot 100) - 1$
11	Ω $_{A\text{-}Refl}$ or table index: At low slant path (<6.0), this word contains the A-pair total ozone in m-atm-cm, obtained by using P_{Refl}. At high slant path (≥6.0), it contains the table selection index (times 10) obtained by using the A-pair N-value. An index of 20 refers to mid-latitude tables and 30 to high-latitude tables. Intermediate values denote a linear mixture of the two tables.
11	$N_{339.8}/t^*_{SNOW}$, 339.8-nm N-value packed with the snow/ ice depth (t_{snow}) in inches, $= (\mathrm{INT}(N_{339.8}) \cdot 100$ + snow depth (integer inches) (Continued)

Table 4 (Continued)

	Detailed Description of Data Record
Word	**Comment**
12	Quality flag, a number from 0 to 9, indicating the quality of the data. Flag 0 is the highest quality; flag 9 is the lowest. Flags 4 through 9 indicate that the data are unusable, and, for these, the best ozone is filled with -999. The reasons for the flags are: 0 - Low slant-path length (<6.0), good sample. 1 - High path length (≤6.0), good sample. 2 - Low path length, good, but taken during the descending part of the orbit (sunlit polar night). 3 - High path length, good but descending orbit data. 4 - Low path length, A-pair and B-pair total-ozone estimates differ by more than 10 percent of the best total-ozone estimate. 5 - High path length, table index is out of range (less than 18 or greater than 35). 6 - High path length, table selection scheme has low sensitivity. 7 - 380- and 360-nm reflectivities differ by more than 0.1. 8 - Best reflectivity out of range (less than -0.05 or greater than +1.05).

(Continued)

Table 4 (Continued)

	Detailed Description of Data Record
Word	Comment
	9 - A-pair or B-pair total ozone exceeds the dynamic range of the tables. The dynamic ranges are: 180 to 350 DU (latitude $< 25°$) 180 to 600 DU (latitude 25° to 55°) 180 to 650 DU (latitude $> 55°$)
12	$N_{380.0}/N^*_{360.0}$ $= \mathrm{INT}(N_{380.0}) \cdot 100 + \mathrm{INT}(N_{380.0} - N_{360.0}) + 10$

Table 5

Format of Last Record on Data File*

Word	Description
1	Block identifier
2	Negative logical sequence number (2 most significant bytes)
3	Orbit number
4	Day of last scan on file
5	GMT (sec) for last scan on file
6	Latitude (-90.0 to +90.0) for last scan (degrees x 10^2)
7	Longitude (+180, +E, -W) for last scan (degrees x 10^2)
8	Number of input/output errors for this file
9	Number of scans read from RUT tape file
10	Number of scans written on file
11	Number of good samples written on file
12	Number of samples out of range (total)
	Number of samples out of range for:
13	Zenith angle >85.7 degrees
14	Latitude out of range (= 0 for first year data)
15	Counts out of range (negative)
16	Number of samples written that were bad (total)
	Number of samples written that were bad for:
17	Ozone out of range (quality flag 9)
18	Best reflectivity out of range (flag 8)
19	$R_{380.0} - R_{360.0}$ difference too large (flag 7)
20	Low sensitivity, high path length (flag 6)
21	Exceeds table index limits, high path (flag 5)
22	A-B difference too large, low path (flag 4)
23	Number of samples descending, high path (flag 3)
24	Number of samples descending, low path (flag 2)
25	Number of samples good, high path (flag 1)
26	Number of samples good, low path (flag 0)
27-252	Spare

*The logical sequence number is a 16-bit integer (I*2) that occupies the left half of word 2. Words 3 through 252 are in IBM floating-point format (R*4).

Table 6

Format of Trailer File Record*

Word	Description
1	Block identifier
2	Trailer file identifier (-1) (2 most significant bytes)
3	Orbit number of last orbit on tape
4	Day of last scan on tape
5	GMT of last scan on tape (sec)
6	Latitude for last scan (degrees x 10^2)
7	Longitude for last scan (degrees x 10^2)
8	Number of input/output errors for tape
9	Number of scans read from input RUT tapes
10	Number of scans written on this tape
11	Number of good samples written on tape
12	Number of samples out of range (total)
	Number of samples out of rannge for:
13	Zenith angle >85.7 degrees
14	Latitude out of range (= 0 for first year data)
15	Counts out of range (negative)
16	Number of samples written that were bad (total)
	Number of samples written that were bad for:
17	Ozone out of range (quality flag 9)
18	Best reflectivity out of range (flag 8)
19	$R_{380.0} - R_{360.0}$ difference too large (flag 7)
20	Low sensitivity, high path length (flag 6)
21	Exceeds table index limits, high path (flag 5)
22	A-B difference too large, low path (flag 4)
	(Continued)

*The trailer file identifier (= -1) is a 16-bit integer (I*2) that occupies the left half of word 2. Words 3 through 30 are in IBM floating-point format (R*4). Words 31 onward contain information that identifies the input RUT tapes that were used to create the OZONE-T tape. The starting year and date of data for each tape is written in EBCDIC format as shown.

Table 6 (Continued)

Word	Description
23	Number of samples descending, high path (flag 3)
24	Number of samples descending, low path (flag 2)
25	Number of samples good, high path (flag 1)
26	Number of samples good, low path (flag 0)
27-28	Spare (-77)
29	Number of files on tape
30	Number RUT tapes read in creating this tape (N)
31-32	YYDDD for first input tape (EBCDIC)
33-34	YYDDD for second input tape (EBCDIC)
.....	....
.....	YYDDD for Nth and last input tape (EBCDIC)
31+2*N	Start orbit number
.....	End orbit number
.....	RUT IPD history (128 EBCDIC characters)

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APPENDIX A

F_2' CORRECTION FUNCTION

The F_2' function used for correcting the albedos is a function of the orbit number, n. For orbits $n \leq 101$, F_2' is given by:

$$F_2'(n) = 1.0$$

For orbits $102 < n \leq 113$, F_2' is given by:

$$F_2'(n) = 1.0 + \frac{0.031\ (n-102)}{11}$$

For orbits $113 < n \leq 127$, F_2' is given by:

$$F_2'(n) = 1.031 + \frac{0.025\ (n-113)}{14}$$

For orbits $n > 127$, F_2' is given by:

$$F_2'(n) = A_0 + A_1 n + A_2 n^2 = A_3 n^3 + A_4 n^4$$

using the coefficients given in Table A-1.

Table A-1

F_2' Correction Function

Vacuum Wavelength (nm)	A_0	A_1	A_2	A_3	A_4
380.014	1.053	2.85×10^{-5}	-2.58×10^{-8}	8.40×10^{-12}	-9.35×10^{-16}
359.962	1.052	3.25×10^{-5}	-2.73×10^{-8}	8.83×10^{-12}	-9.81×10^{-16}
312.514	1.052	3.37×10^{-5}	-2.43×10^{-8}	8.27×10^{-12}	-9.64×10^{-16}
317.512	1.052	3.47×10^{-5}	-2.58×10^{-8}	8.35×10^{-12}	-9.31×10^{-16}
331.253	1.052	3.42×10^{-5}	-2.59×10^{-8}	8.40×10^{-12}	-9.40×10^{-16}
339.861	1.052	3.26×10^{-5}	-2.60×10^{-8}	8.53×10^{-12}	-9.57×10^{-16}

APPENDIX B

SAMPLE FORTRAN PROGRAM FOR THE OZONE-T TAPE

```
C SAMPLE FORTRAN PROGRAM FOR READING THE OZONE-T TAPE ON THE GSFC 360/91
C OR 360/75
C
      REAL*8 TAPEIN
      INTEGER*2 I2BUF(2,252)
      INTEGER*4 IBUF(252)
      REAL*4 BUFFER(252)
      EQUIVALENCE (I2BUF(1,1),BUFFER(1),IBUF(1))
      NAMELIST/LIST/ TAPEIN,IFILIN,IFILEN
C
C**** READ THE NAMELIST VARIABLES FROM UNIT 5. TAPEIN = TAPE NAME,
C         IFILIN = THE FIRST FILE DESIRED, IFILEN = LAST FILE DESIRED
    5 READ(5,LIST,END=999)
C**** MOUNT THE TAPE ON UNIT 10
      CALL MOUNT(1,10,TAPEIN,2)
      DO 500 IFILE=IFILIN,IFILEN
C
C**** POSITION TO CORRECT FILE
      IF (IFILE.GT.2)CALL POSN(1,10,IFILE)
C
   10 CONTINUE
C**** READ ONE LOGICAL RECORD FROM UNIT 10
      CALL FREAD(BUFFER,10,LEN,&900,&910)
C
C**** CHECK LOGICAL SEQUENCE NUMBER
C  **** HEADER RECORD (FIRST RECORD ON DATA FILE) FOUND, FIND THE
C       ORBIT NUMBER (ORBN) AND THE YEAR, THEN READ NEXT LOGICAL RECORD
      IF(I2BUF(1,2) .NE. 1 ) GO TO 20
      ORBN=BUFFER(3)
      YEAR=BUFFER(52)
      GO TO 10
C  **** TRAILER RECORD (LAST RECORD ON DATA FILE) FOUND, GO TO NEXT
C       FILE
   20 IF(I2BUF(1,2) .LT. -1) GO TO 500
C  **** TRAILER FILE RECORD FOUND, READ NEXT NAMELIST STEP, STOP IF
C       NO MORE NAMELIST STEPS
      IF(I2BUF(1,2) .EQ. -1 ) GO TO 5
C
C**** DAY OF YEAR
      IDAY=I2BUF(2,2)
C**** GREENWICH MEAN TIME IN SECONDS
      IGMT=IBUF(3)
C
C**** FIND DATA FOR EACH SAMPLE OF THE CURRENT SCAN
C**** NSAMP EQUALS THE SAMPLE NUMBER
C
      DO 50 NSAMP=1,35
      I=6+(NSAMP-1)*7
C**** DATA QUALITY FLAG
      IFLAG=I2BUF(1,I+6)
      IF(IFLAG.LT.0) GO TO 50
```

```
C**** IFOV SOLAR ZENITH ANGLE
      ZA=I2BUF(1,I+1)/100.
C**** IFOV LATITUDE IN DEGREES
      XLAT=I2BUF(1,I)/100.
C**** IFOV LONGITUDE IN DEGREES
      XLONG=I2BUF(2,I)/100.
C**** BEST REFLECTIVITY (PERCENT)
      REFL=I2BUF(1,I+2)
C**** BEST OZONE (FROM REFLECTIVITY PRESSURE)
      OZONE=I2BUF(1,I+3)
C**** A-PAIR OZONE (FROM REFLECTIVITY PRESSURE)
      OZONA=I2BUF(1,I+5)
C**** B-PAIR OZONE (FROM REFLECTIVITY PRESSURE)
      OZONB=I2BUF(2,I+3)
C**** THIR BEST OZONE
      OZTHIR=I2BUF(1,I+4)
C
C**** UNPACK N VALUES
C
C**** A-PAIR
      NA=I2BUF(2,I+1)/100
C**** B-PAIR
      NB=I2BUF(2,I+2)/100
C**** 331.2 NM
      N3312=I2BUF(2,I+4)/100
C**** 339.8 NM
      N3398=I2BUF(2,I+5)/100
C**** 380 NM
      N3800=I2BUF(2,I+6)/100
C**** 360 NM
      N3600=(I2BUF(2,I+6)/100)*100-I2BUF(2,I+6)+10+N3800
C
C**** UNPACK PRESSURES (ATMOSPHERES)
C
C**** THIR PRESSURE
      PTHIR=(I2BUF(2,I+1)-(I2BUF(2,I+1)/100)*100+1)/100.
C**** REFLECTIVITY PRESSURE
      PREFL=(I2BUF(2,I+2)-(I2BUF(2,I+2)/100)*100+1)/100.
C**** TERRAIN PRESSURE
      PTERN=(I2BUF(2,I+4)-(I2BUF(2,I+4)/100)*100+1)/100.
C
C**** UNPACK SNOW DEPTH (INCHES)
      ISNOW=I2BUF(2,I+5)-(I2BUF(2,I+5)/100)*100
C
   50 CONTINUE
C
      GO TO 10
  500 CONTINUE
  900 CONTINUE
  910 CONTINUE
      GO TO 5
  999 STOP
      END
```

```
//ZMDGG    JOB (F12345678D,T,L00001,001001)
//*OZONE-T   JCL
// EXEC FORTRANG
//SYSIN DD DISP=SHR,DSN=ZMDGG.MANUAL.FORT(TOMS)
// EXEC LINKGO,REGION.GO=200K
//GO.FT06F001 DD SYSOUT=A
//GO.FT10F001 DD DISP=(OLD,PASS),UNIT=(6250,,DEFER),
// LABEL=(,NL),VOL=SER=WONG,
// DCB=(RECFM=FB,LRECL=1008,BLKSIZE=16128,BUFNO=1)
//GO.DATA5 DD *,DCB=BLKSIZE=3200
 &LIST TAPEIN='L7820',IFILIN=2,IFILEN=15,  &END
 &LIST TAPEIN='L7820',IFILIN=16,IFILEN=27, &END
// EXEC NOTIFYTS
/*
//
END OF DATA
```

APPENDIX C

Data Availability and Cost

TOMS Ozone-T data tapes are archived and available from the National Space Science Data Center (NSSDC). The NSSDC will furnish limited quantities of data to qualified users without charge. The NSSDC may establish a nominal charge for production and dissemination if a large volume of data is requested. Whenever a charge is required, a cost estimate will be provided to the user prior to filling the data request.

Domestic requests for data should be addressed to:

National Space Science Data Center
Code 601
NASA/Goddard Space Flight Center
Greenbelt, MD 20771

All requests from foreign researchers must be specifically addressed to:

Director, World Data Center A for Rockets and Satellites
Code 601
NASA/Goddard Space Flight Center
Greenbelt, MD 20771 USA

When ordering data from either NSSDC or the World Data Center, a user should specify why the data are needed, the subject of his work, the name of the organization with which he is connected, and any government contracts he may have for performing his study. Each request should specify the experiment data desired, the time period of interest, plus any other information that would facilitate the handling of the data request.

A user requesting data on magnetic tapes should provide additional information concerning the plans for using the data, i.e. what computers and operating systems will be used. In this context, the NSSDC is compiling a library of routines that can unpack or transform the contents of many of the data sets into formats that are appropriate for the user's computer. NSSDC will provide, upon request, information concerning its services.

When requesting data on magnetic tape, the user must specify whether he will supply new tapes prior to the processing, or return the original NSSDC tapes after the data have been copied.

Data product order forms may be obtained from NSSDC/World Data Center A.

APPENDIX D
TOMS Ozone-T Tape Catalog
First Year

Week Number(1)	Orbit Range(2)	Day Range(3)	Number of Files(4)
01A	102-133	304-306	032
01B	135-162	307-308	030
02A	165-194	309-311	031
02B	195-227	311-313	033
02C	228-258	313-315	029
03A	259-304	316-319	048
03B	305-355	319-322	034
04A	356-429	323-328	062
04B	430-452	328-330	025
05A	453-522	330-335	060
05B	523-549	335-336	027
06A	554-620	338-342	046
06B	621-645	342-343	026
07A	647-734	344-350	063
07B	735-742	350-350	010
08A	743-803	351-355	063
08B	804-825	355-356	024
09A	841-903	358-362	049
09B	904-936	362-364	035
10A	950-1008	365-005	045
10B	1009-1032	005-006	026

(1) A,B,C refer to the number of tapes needed to make up one week's data.

(2) See the data inventory in the "User's Guide for the SBUV and TOMS First Year RUT-S and RUT-T Data Sets" for orbit availability for each day.

(3) The data set begins on 10/31/78 (day 304) and ends on 11/3/79 (day 307). Data on the tapes is grouped into days based on the starting time of the orbits. Therefore, minor variations in day ranges may be noted as compared to the data inventory (see the "User's Guide for the SBUV and TOMS First Year RUT-S and RUT-T Data Sets") which groups orbits into days based on the ending time of the orbits.

(4) Number of files includes the header and trailer files plus one file for each orbit present.

TOMS Ozone-T Tape Catalog
First Year (continued)

Week Number	Orbit Range	Day Range	Number of Files
11A	1034-1107	007-012	062
11B	1108-1130	012-013	025
12A	1131-1209	014-019	062
12B	1210-1213	019-020	006
13A	1228-1291	021-025	055
13B	1292-1323	025-027	032
14A	1324-1384	028-032	062
14B	1385-1420	032-034	038
15A	1421-1481	035-039	063
15B	1482-1517	039-041	024
16A	1518-1593	042-047	063
16B	1594-1614	047-048	023
17A	1617-1692	049-054	062
17B	1693-1710	054-055	020
18A	1711-1777	056-060	065
18B	1778-1807	060-062	029
19A	1808-1904	063-069	067
20A	1905-1968	070-074	063
20B	1969-1986	074-075	020
21A	2003-2080	077-082	062
21B	2081-2097	082-083	018
22A	2101-2172	084-089	063
22B	2173-2194	089-090	024
23A	2196-2258	091-095	064
23B	2259-2291	095-097	035
24A	2292-2350	098-102	061
24B	2351-2374	102-103	026
25A	2389-2449	105-109	062
25B	2450-2484	109-111	037
26A	2500-2580	113-118	063
27A	2582-2647	119-123	066
27B	2648-2678	123-125	010

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Week Number	Orbit Range	Day Range	Number of Files
28A	2679-2757	126-131	066
28B	2758-2775	131-132	015
29A	2776-2839	133-137	064
29B	2840-2871	137-139	033
30A	2886-2947	141-145	063
30B	2948-2968	145-146	023
31A	2969-3055	147-153	051
31B	3056-3065	153-153	012
32A	3066-3125	154-158	047
32B	3126-3148	158-159	023
33A	3163-3203	161-164	041
34A	3299-3355	170-174	040
35A	3357-3402	175-178	045
35B	3403-3450	178-181	046
35C	3451-3452	181-181	004
36A	3453-3501	182-185	051
36B	3502-3548	185-188	049
37A	3550-3589	189-191	042
37B	3590-3640	191-195	050
37C	3641-3645	195-195	007
38A	3646-3695	196-199	051
38B	3696-3738	199-202	045
38C	3739-3742	202-203	006
39A	3743-3785	203-206	043
39B	3786-3838	206-209	053
39C	3839-3839	209-209	003
40A	3840-3885	210-213	048
40B	3886-3927	213-216	044
40C	3928-3935	216-216	010
41A	3937-3980	217-220	043
41B	3981-4027	220-223	046
41C	4028-4032	223-223	007

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Week Number	Orbit Range	Day Range	Number of Files
42A	4033-4079	224-227	049
42B	4080-4124	227-230	038
42C	4125-4129	230-230	007
43A	4131-4171	231-233	043
43B	4172-4218	234-237	048
43C	4219-4226	237-237	009
44A	4227-4275	238-241	049
44B	4276-4320	241-244	047
44C	4321-4322	244-244	004
45A	4324-4363	245-247	042
45B	4364-4405	247-250	042
45C	4408-4419	251-251	012
46A	4420-4463	252-253	041
46B	4464-4505	255-258	044
46C	4506-4514	258-258	011
47A	4520-4567*	259-262	044
47B	*4567-4606	262-265	042
47C	4607-4613	265-265	009
48A	4614-4652	266-268	040
48B	4563-4687	268-271	036
48C	4688-4710	271-272	025
49A	4711-4746	273-275	022
49B	4747-4781	275-278	035
49C	4782-4803	278-279	025
50A	4807-4847*	280-282	043
50B	*4847-4890	282-286	044
50C	4891-4902	286-286	014
51A	4904-4943	287-289	041
51B	4944-4980	289-292	039

*Duplicated orbit from input tape.

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Week Number	Orbit Range	Day Range	Number of Files
51C	4981-4997	292-293	017
52A	5001-5042	294-297	043
52B	5043-5077	297-299	036
52C	5078-5096	299-300	021
53A	5097-5129	301-303	035
53B	5130-5170	303-306	043
53C	5171-5193	306-307**	024

**Last orbit ends on day 308, 11/4/79.

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16. Abstract

Total-ozone and ozone vertical profile results for Solar Backscattered Ultraviolet/Total-Ozone Mapping Spectrometer (SBUV/TOMS) Nimbus 7 operation from November 1978 to November 1979 are available. The algorithms used have been thoroughly tested, the instrument performance has been examined in detail, and the ozone results have been compared with Dobson, Umkehr, balloon, and rocket observations. The accuracy and precision of the satellite ozone data are good to at least within the ability of the ground truth to check and are self-consistent to within the specifications of the instrument.

The "TOMS User's Guide" describes the TOMS experiment and algorithms used. It also provides detailed information on the data available on computer tape, including how to order tapes from the National Space Science Data Center.

17. Key Words (Selected by Author(s))

Ozone, Total ozone, Nimbus 7 SBUV/
TOMS, Ultraviolet radiation,
Atmospheric ozone

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