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Users Guide to LOWTRAN 7

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"This technical report has been reviewed and is approved for publication"

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LOWTRAN 7 is a low-resolution propagation model and computer code for predicting atmospheric transmittance and background radiance from 0 to 50,000 cm^{-1} at a resolution of 20 cm^{-1}. The code is based on the LOWTRAN 6 (1983) model. Multiple scattered radiation has been added to the model as well as new molecular band model parameters and new ozone and molecular oxygen absorption parameters for the UV. Other modifications include a wind dependent desert model, new cirrus cloud models, and new cloud and rain models. The code also includes new representative (geographical and seasonal) atmospheric models and updated aerosol models with options to replace them with user-derived values. An improved extra-terrestrial solar source function is also included. Six modes of program execution are allowed with the new model and computer code for a given slant path geometry.

This report contains a description to users for operating the LOWTRAN 7 computer code. It summarizes the capabilities of the new code, provides complete operating instructions as well as input and output from test cases for user validation. Also included are operating instructions for three programs that utilize LOWTRAN 7 output (plot, filter and scanning function programs).

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Preface

This report is the AFGL Users Guide to operating LOWTRAN 7. A more detailed scientific report describing the basic physical assumptions and theories utilized by the LOWTRAN models as well as the documented verification of the code will be forthcoming in a separate report.

Section 1.1 contains a brief discussion of the LOWTRAN model followed by a description of the basic capabilities and the additional features added to the LOWTRAN 7 computer code. Section 2 discusses the code structure, portability and availability. The complete operating instructions for LOWTRAN 7 are described in Section 3. Section 3 includes detailed explanations for the various modes of execution of the program, the many choices of utilizing models (molecular, aerosols and or particulates) included in the code, as well as the different methods of replacing these models by user inserted data.

A discussion of 4 test cases and a description of the program output to tapes 6, 7, and 8 are included in Section 4.

The three Appendixes describe the LOWTRAN 7 plot program, filter function program and newly written scanning function program.

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1. INTRODUCTION

1.1 The LOWTRAN 7 Model

The LOWTRAN 7 model[1] and computer code calculates atmospheric transmittance and background radiance for a given atmospheric path at low spectral resolution. This version is an extension and update of the current code, LOWTRAN 6[2] (and its predecessors LOWTRAN 5[3], LOWTRAN 4[4], LOWTRAN 3B[5], LOWTRAN 3[6], and LOWTRAN 2[7]). All the options and capabilities of the LOWTRAN 6 code have been retained.

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The LOWTRAN 7 code calculates atmospheric transmittance, atmospheric background radiance, single scattered solar and lunar radiance, direct solar irradiance, and multiple scattered solar and thermal radiance. The spectral resolution of the model is $20\ cm^{-1}$ (full width at half maximum) in steps of $5\ cm^{-1}$ from 0 to 50,000 cm^{-1} (0.2 μm to infinity). A single-parameter band model is used for molecular line absorption and the effects of molecular continuum-type absorption; molecular scattering, aerosol, and hydrometeor absorption and scattering are included. Refraction and earth curvature are considered in the calculation of the atmospheric slant path and attenuation amounts along the path. Representative atmospheric, aerosol, cloud, and rain models are provided in the code with options to replace them with user-provided theoretical or measured values.

A new atmospheric data base[8] consisting of separate molecular profiles (0 to 100 km) for thirteen (13) minor and trace gases is provided for use with the LOWTRAN 7 model. Six reference atmospheres, each defining temperature, pressure, density and mixing ratios for H_2O, O_3, CH_4, CO, and N_2O, all as a function of altitude (selected from the U.S. Standard Supplements, 1966[9] and the U.S. Standard Atmosphere 1976[10]) allow a range of climatological choices.

Separate band models and band model absorption parameters developed by Pierluissi and Maragoudakis[11] are included in the LOWTRAN 7 model and code for the following molecules: H_2O, O_3, N_2O, CH_4, CO, O_2, CO_2, NO, NO_2, NH_3, and SO_2. Analytic transmission functions (double-exponential) replace numerical tables used in previous LOWTRAN models. The new models were developed with and based on degraded line-by-line spectra[12] and validated against laboratory measurements.

The water vapor continuum absorption at 10 μm was modified from that of LOWTRAN 6. The self-density dependent continuum absorption values in this region were reduced approximately 20 percent based on Burch's laboratory measurements[13,14] and the atmospheric measurements of Devir et al.[15]

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New ultraviolet absorption parameters for molecular oxygen (Schumann-Runge bands, Herzberg continuum) have been added to the code.[16,17,18,19,20] The absorption data for ozone in this region (Hartley and Huggins bands) has been updated or improved based on more recent data[21,22,23,24] including the addition of temperature-dependent absorption coefficients.

An improved extra-terrestrial solar source function is included in the LOWTRAN 7 model. The data for this function are based on the work of VanHoosier et al[25,26], Neckel and Labs[27], Werhli[28], and Thekeakara.[29] It covers the spectral region from 0 to 57,470 cm^{-1} and is generally compatible with the resolution of the molecular absorption parameters of the LOWTRAN model.

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An efficient and accurate multiple scattering parameterization[30,31] has been implemented in the LOWTRAN model based on the two stream approximation and an adding method for combining atmospheric layers. An interface scheme was also developed using the k-distribution method to match the multiple scattering approach to the LOWTRAN band model calculation of molecular gaseous absorption. The error of the multiple scattering parameterization in solar and thermal radiance calculations considering all possible viewing angles is estimated to be less than 20 percent.

For LOWTRAN 7, all the existing aerosol models and the rain model in the previous LOWTRAN 6 model were extended through the millimeter wavelength region. In addition, the Navy Maritime model was modified to improve its wind speed dependence for the large particle component.* Water cloud models (cumulus, stratus, altostratus, strato-stratocumulus and nimbostratus) from FASCOD2[12] have also been added. Two new cirrus cloud models with a realistic wavelength dependence and separate absorption, scattering and asymmetry parameters were developed for LOWTRAN 7 as well as a new aerosol model for desert conditions with a wind speed dependence.[32,33] The program now provides for modified aerosol profiles over elevated surfaces, commonly referred to as the "Denver" case.[34]

For the stratospheric aerosols, additional combinations of the wavelength dependent extinction coefficient models (background stratospheric, aged volcanic or fresh volcanic) and the vertical distribution profiles (background and moderate, high or extreme volcanic), are available. The background stratospheric extinction model has been modified to utilize new refractive index data and size distribution measurements.[35]

2. DISCUSSION OF LOWTRAN 7 CODE

This section describes the LOWTRAN 7 program structure. Six tables are included that contain names and descriptions of each subroutine and block data routine as they appear within the program structure. Section 2.1 presents five figures depicting the program structure. Section 2.2 discusses program portability, FORTRAN compatibility, precision, and some specific comments related to

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* Gathman, S. (1988) Private Communication.

implementation of the program. Section 2.3 contains pertinent information on the program execution field length, and lastly Section 2.4 describes the availability of the program package.

2.1 LOWTRAN 7 Code Structure

A graphical representation of the LOWTRAN 7 main program structure is depicted in Figure 1. The structure for non-standard model, air mass, single scattering geometry, and transmittance modules are shown in Figures 2 through 5 respectively. Descriptions of the major executable subroutines shown in Figure 1 are given in Table 1. The subroutines in the non-standard model, air mass, single scattering geometry and transmittance modules are explained in Tables 2 through 5 respectively. Table 6 contains a brief description of the Block Data subroutines.

2.2 Portability

LOWTRAN 7 was developed on a CDC CYBER (a 60 bit-per-word machine) with the FORTRAN 77 (FORTRAN 5) compiler. A major effort has been made to give LOWTRAN 7 the capability to run in single precision on a 32 bit-per-word computer.

LOWTRAN 7 uses four files:

1. INPUT, read on UNIT = 5, containing LOWTRAN input directions. Maximum record length is 80 characters.
2. OUTPUT, written on UNIT = 6, containing the standard LOWTRAN output.
3. TAPE7, written on UNIT = 7, containing copies of the input cards and the spectral results (transmittance and/or radiance). Used as input by plot, filter and scanning function programs (see appendixes).
4. TAPE8, written on UNIT = 8, containing the transmittance for each individual gas. When running in the radiance mode the user may direct additional output to TAPE8 in one of the following ways:

    a. The black body and differential transmittance layer values for the line of sight or when running with multiple scattering

    b. The thermal and solar vertical fluxes by layer.

The unit numbers for these files are stored in the variables IRD(= 5), IPR(= 6), IPU(= 7), IPR1(= 8), which are carried in the common block IFIL. These files are accessed using OPEN statements in the main program.

For computers with virtual memory, the program must be compiled with "GLOBAL SAVE" or the local equivalent. Otherwise, information relating to the phase function is initialized in a first call to a subroutine, but lost in subseqent calls.

The cirrus cloud model includes an option to generate cirrus clouds at random altitudes. This option calls the machine dependent random number generator function subroutine RANF, which is called from RANDOM. The user will have to supply the local equivalent of RANF.

The user may find it useful to have the date and time printed at the beginning of each case. The statements required to do this are commented out in the main program with 'C@' in columns 1 and 2. The subroutines FDATE and FCLOCK, which return the date and time in A8 format, are commented

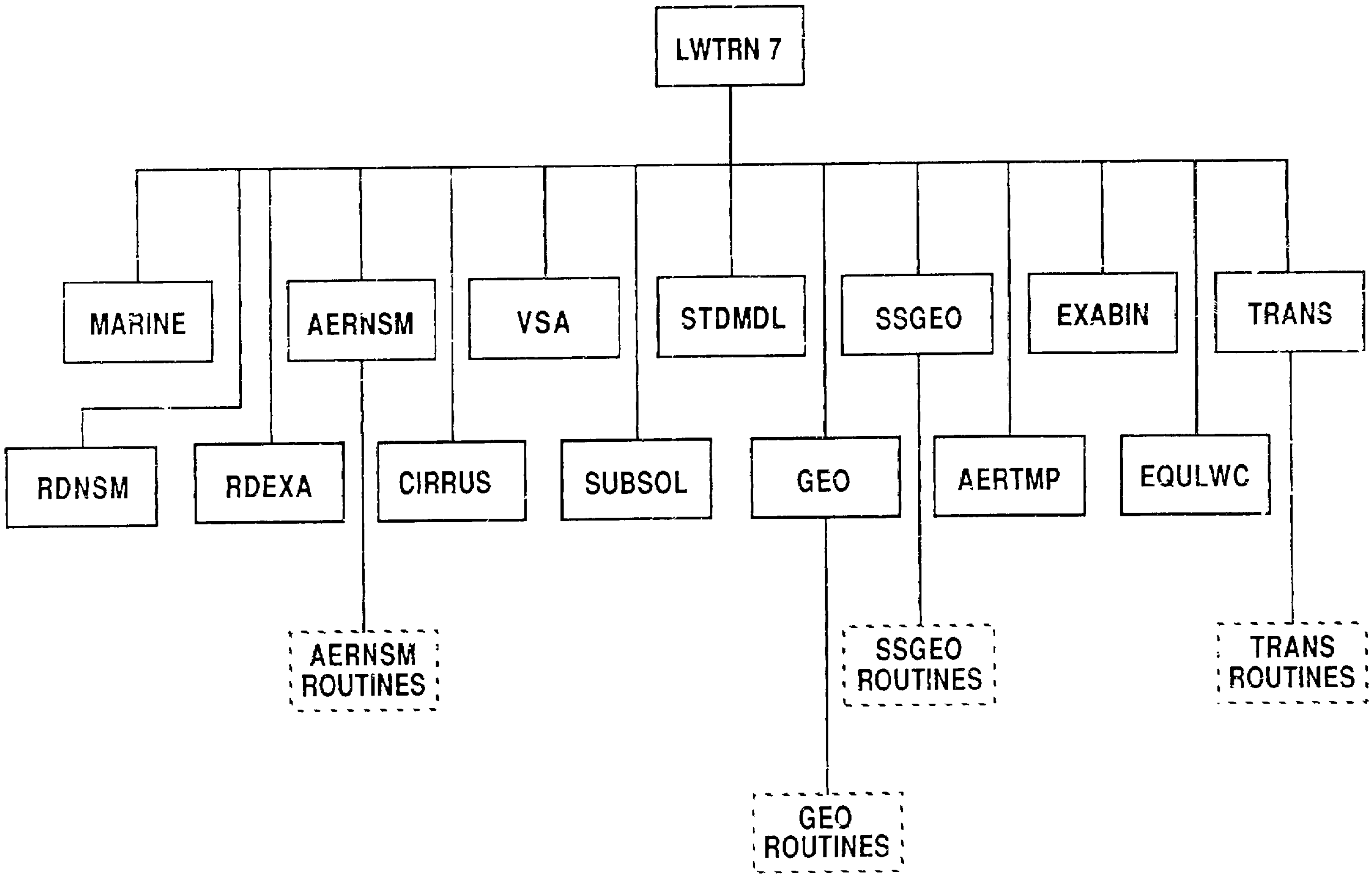

Figure 1. LOWTRAN 7 Main Program Structure. The boxes enclosed by dashes are modules of subroutines for calculations of non-standard models, air mass geometry, single scattering geometry and transmittance.

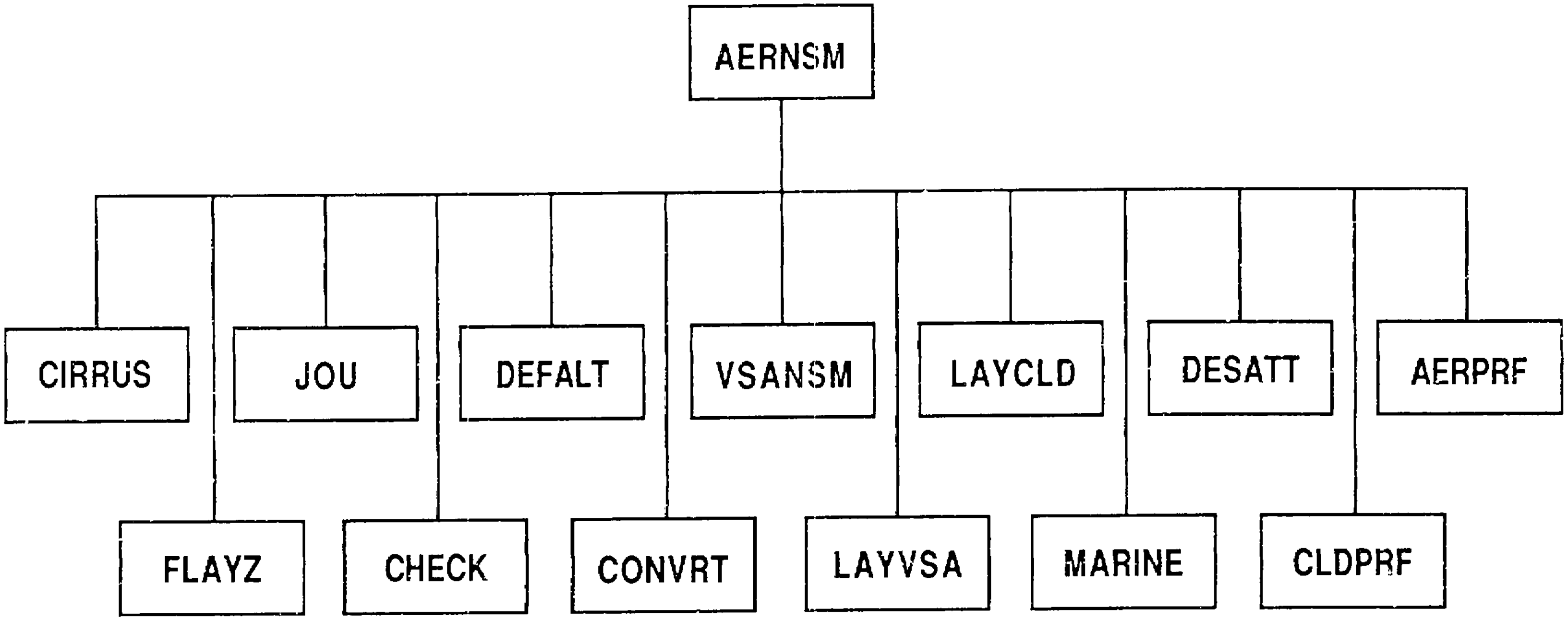

Figure 2. Program Structure for the Aerosol and Non-Standard Model Subroutines.

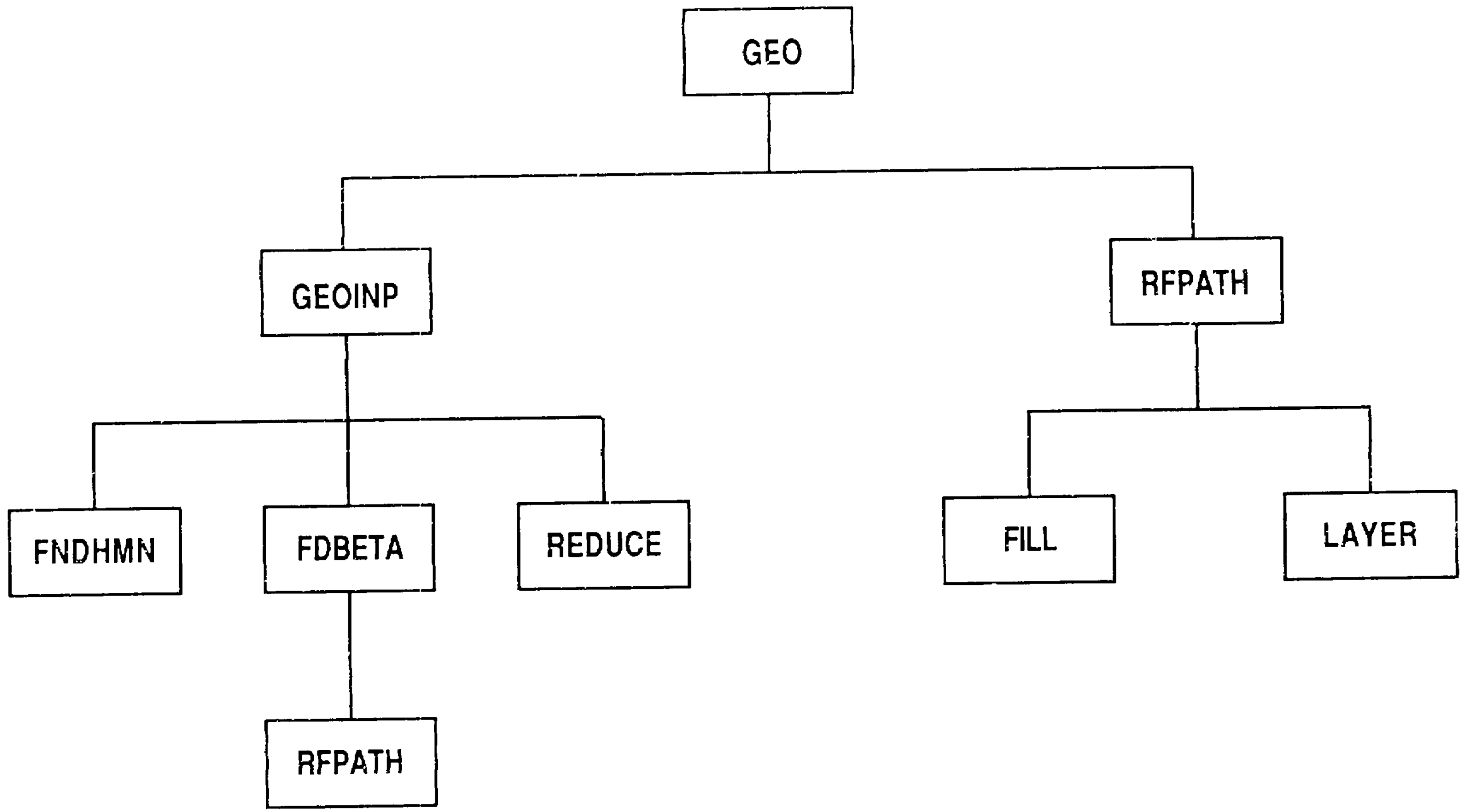

Figure 3. Program Structure for the Air Mass Geometry Subroutines.

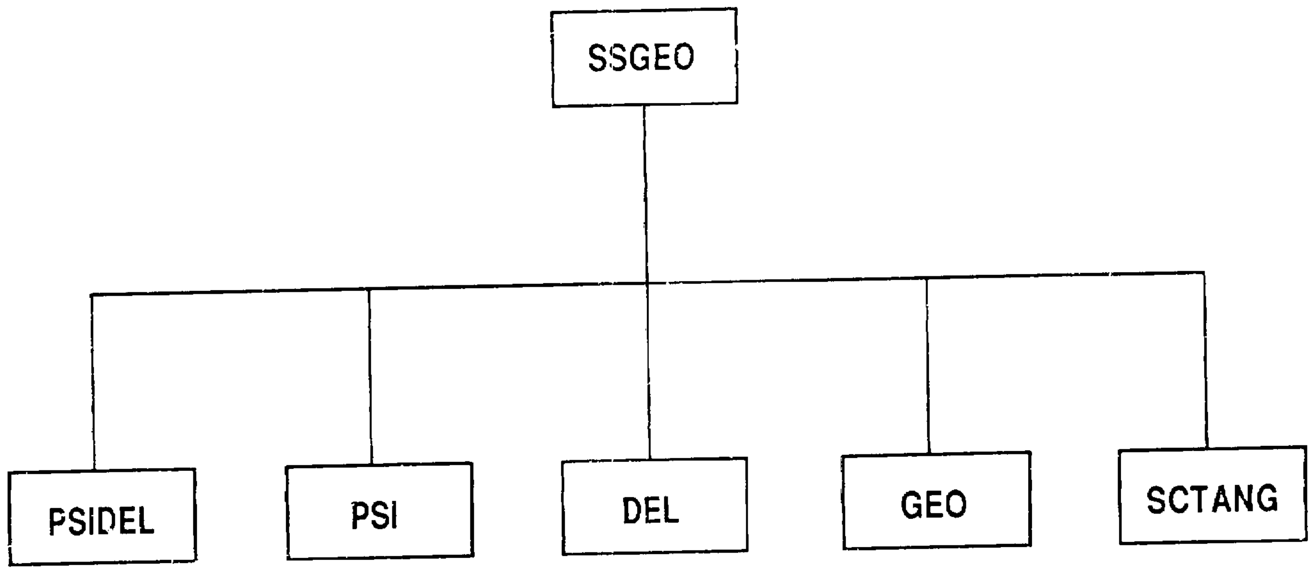

Figure 4. Program Structure for the Single Scattering Geometry Subroutines.

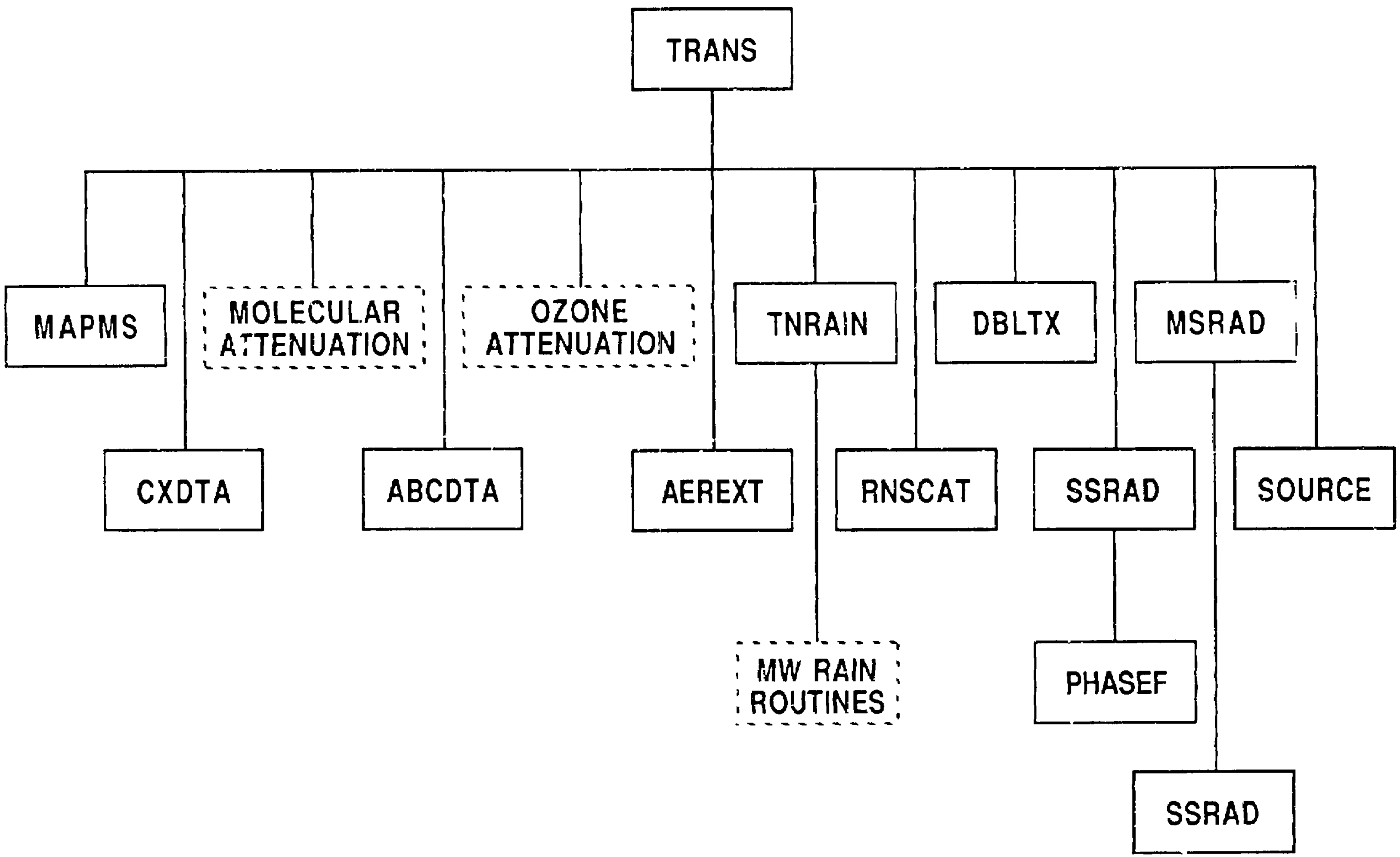

Figure 5. Program Structure for the Transmittance Subroutines. The dashed boxes labeled molecular attenuation, ozone attenuation and MW rain routines are modules of subroutines for their respective calculations.

Table 1. Description of LOWTRAN 7 Subroutines

LWTRN 7	–	Main driver program. Reads control cards.
MARINE	–	Determines aerosol extinction and absorption coefficients for the Navy maritime model.
RDNSM	–	Reads user input data when MODEL 7 and VSA options are selected.
JOU	–	Interpretive routine for JCHAR.
CHECK	–	Units conversion for pressure and temperature.
DEFALT	–	Chooses a stored atmospheric profile and interpolates default values for a specific altitude.
CONVRT	–	Accommodates uniform data input for model 0 or 7.
WATVAP	–	Computes water vapor number density (mol cm^{-3}) to accommodate "JCHAR" definitions specified by user.
RDEXA	–	IHAZE 7 or ICLD 11 triggers up to 4 regions of user input.
AERNSM	–	Defines model atmosphere, aerosol profile and cloud profile.
CIRRUS	–	Generates altitude profiles of cirrus cloud density.
RANDOM	–	Calls machine-dependent function RANF, that is a uniform random number generator.
VSA	–	Army vertical structure algorithm of aerosol extinction and relative humidity for low visibility/low ceiling conditions.
SUBSOL	–	Calculates the subsolar point angles based upon time and day.
STDMDL	–	Sets up scaled densities from the model atmosphere.
GEO	–	Driver for air mass subroutines. Calculates attenuator amounts for the slant path. (GEO can be called by both SSGEO and the main driver.)
AERTMP	–	Defines temperature for each aerosol altitude region.
SSGEO	–	Obtains attenuator amounts from scattering points along optical path to the extraterrestial source.
EXABIN	–	Loads aerosol extinction, absorption and scattering.
EWULWC	–	Calculates liquid water content of standard aerosols.
TRANS	–	Calculates transmittance, atmospheric radiance, and solar/lunar scattered radiance for slant path. Sets up data for double exponential band model. Evaluates vertical profiles of optical quantities required for multiple scattering calculations.

Table 2. Description of AERNSM Subroutines

AERNSM	–	Defines model atmosphere, aerosol profile and cloud profile.
CIRR18	–	New cirrus profile and new optically thin cirrus profile.
FLAYZ	–	Final LOWTRAN altitude boundaries.
JOU	–	Interpretive routine for JCHAR.
CHECK	–	Units conversion for Pressure and Temperature.
DEFALT	–	Chooses a stored atmospheric profile and interpolates default values for a specific altitude.
CONVRT	–	Accommodates uniform data input for MODEL 0 or 7.
WATVAP	–	Computes water vapor number density (mol cm^{-3}) to accommodate "JCHAR" definitions specified by user.
VSANSM	–	Used with VSA and MODEL 7.
LAYVSA	–	Layering of atmosphere with VSA model.
LAYCLD	–	Layering of atmosphere with ICLD 1 to 11.
MARINE	–	Determines aerosol extinction and absorption coefficients for the Navy maritime model.
DESATT	–	Determines aerosol extinction and absorption coefficients.
CLDPRF	–	Standard cloud profiles.
AERPRF	–	Compute density profiles for aerosols.

Table 3. Description of AIR MASS Subroutines

Subroutine		Description
GEO	–	Driver for air mass subroutines. Calculates attenuator amounts for the slant path
GEOINP	–	Interprets geometry input parameters into the standard form H1, H2, ANGLE, and LEN.
FNDHMN	–	Calculates HMIN, the minimum altitude along the path and PHI, the zenith angle at H2.
REDUCE	–	Eliminates slant path segments that extend beyond the highest profile altitude.
FDBETA	–	Calculates angle, given H1, H2, and BETA by iteration.
RFPATH	–	Determines the refracted path and the absorber amounts through all the layers.
FILL	–	Defines the boundaries of the slant path and interpolates densities at these boundaries.
LAYER	–	Calculates the path and amounts through one layer.
RADREF	–	Computes radius of curvature of the refracted ray for a horizontal path.
FINDSH	–	Finds layer boundaries and scale height at ground for index of refraction.
SCALHT	–	Calculates scale height of index of refraction.
ANDEX	–	Computes index of refraction at a specific height.
EXPINT	–	Performs exponential interpolations for the geometry routines.

Table 4. Description of SSGEO Subroutines

SSGEO	–	Obtains attenuator amounts from scattering points along optical path to the extraterrestrial source.
PSIDEL	–	Calculates the relative azimuth between the line of sight and the direct solar/lunar path.
PSI	–	Returns solar azimuth relative to line-of-sight at current scattering location.
DEL	–	Returns solar zenith angle at any point along optical path.
GEO	–	Driver for air mass subroutines. Calculates attenuator amounts for the slant path.
SCTANG	–	Returns the scattering angle at any point along the optical path.

Table 5. Description of TRANS Subroutines

TRANS	–	Calculates transmittance, atmospheric radiance, and solar/lunar scattered radiance for slant path. Sets up data for double exponential band model. Evaluates vertical profiles of optical quantities required for multiple scattering calculation.
MAPMS	–	Mapping routine from line of sight to vertical path.
CXDTA	–	Locates coefficient for double exponential.
C4DTA	–	Returns N_2 continuum absorption coefficient at required wavenumber.
ABCDTA	–	Moves double exponential coefficients into new arrays.
SLF296	–	Loads self-broadened water vapor continuum at 296°K.
SLF260	–	Loads self-broadened water vapor continuum at 260°K.
FRN296	–	Loads foreign-broadened water vapor continuum at 296°K.
SINT	–	Performs interpolation for water vapor continuum
C6DTA	–	Returns Rayleigh molecular scattering attenuation coefficient at required wavenumber.
C8DTA	–	Returns Chappuis ozone visible absorption coefficient at required wavenumber (13000 to 24200 cm^{-1}).
HNO3	–	Determines nitric acid absorption coefficient at required wavenumber.
AEREXT	–	Interpolates aerosol attenuation coefficients and asymmetry parameter to required wavenumber.
GAMFOG	–	Computes attenuation of equivalent liquid water content in clouds.
INDEX	–	Calculates real and imaginary part of refractive index of water.
DEBYE	–	Calculates wavenumber dependence of dielectric constant of water.
HERTDA	–	UV O_2 Herzberg continuum - analytic function.
SCHRUN	–	UV O_2 Schumann-Runge band model parameters.
O3HHT0	–	UV O_3 Hartley band temperature dependent coefficient: constant term (24370 to 40800 cm^{-1}).
O3INT	–	Interpolation for Hartley band.
O3HHT1	–	UV O_3 Hartley band temperature dependent coefficient: linear term.
O3INT	–	Interpolation for Hartley band.

Table 5. Description of TRANS Subroutines (Continued)

O3HHT2	–	UV O_3 Hartley band temperature dependent coefficient: quadratic term.
O3INT	–	Interpolation for Hartley band.
O3UV	–	UV O_3 interpolation for 40800-54054 cm^{-1} region.
O2CONT	–	O_2 continuum for 1395-1760 cm^{-1} region.
O2INT	–	Interpolation for O_2 continuum.
TNRAIN	–	Calculates extinction due to rain as a function of rain rate.
GMRAIN	–	Computes attenuation of condensed water in the form of rain.
RNSCAT	–	Calculates extinction, scattering and asymmetry parameter due to rain in microwave region.
DBLTX	–	Transmittance from new double exponential band model.
SSRAD	–	Performs the layer by layer single scattering radiance sum.
PHASEF	–	Chooses correct phase function based on relative humidity, frequency, scattering angle, and model.
INTERP	–	Performs linear or logarithmic interpolation.
PF	–	Returns the appropriate phase function from the stored database.
HENGNS	–	Calculates phase function using Henyey-Greenstein method.
MSRAD	–	Sets up profiles of optical properties for vertical path. Evaluates path integral of source function, multiple scattered radiance contribution.
SOURCE	–	Contains solar intensity data and calculates lunar intensity.
FLXADD	–	Calculates upward and downward fluxes. Multiple scattered source function is evaluated from fluxes using the stream approximation.
SOURCE	–	Calculates solar intensity data and calculates lunar intensity.
SUN	–	Evaluates extraterrestrial solar irradiances.

Table 6. Description of Block Data Subroutines

MLATMB	-	Model atmospheric data. Six stored atmospheric models.
TITLE	-	Titles for output.
PRFDTA	-	Aerosol profile data.
EXTDTA	-	Aerosol and cloud extinction, absorption and asymmetry parameters.
SF296	-	Self-broadened absorption coefficients for water vapor continuum at 296°K.
SF260	-	Self-broadened absorption coefficients for water vapor continuum at 260°K.
BFH2O	-	Foreign-broadened absorption coefficients for water vapor continuum at 296°K.
C4D	-	Nitrogen continuum absorption coefficients and visible ozone absorption coefficients.
MARDTA	-	Navy marine aerosol extinction and absorption data.
PHSDTA	-	70 averaged phase functions and truth table identifying correct phase function.
MDTA	-	Cloud and rain modeled atmospheric data.
DSTDTA	-	Desert aerosol extinction, absorption coefficients and asymmetry parameters for 4 wind speeds.
ATMCOM	-	Initializes constants used in program.
ABCD	-	Stores the absorber model parameter for each gas for the double exponential formulation and the coefficients of each gas for the k-distribution.
BO3HH0	-	Contains O_3 Hartley-Huggins cross sections for 273K: constant term.
BO3HH1	-	O_3 Hartley-Huggins cross sections: linear term.
BO3HH2	-	O_3 Hartley-Huggins cross sections: quadratic term.
O3UVFD	-	O_3 UV absorption coefficients (40800 to 54054 cm^{-1}).
BO2C	-	O_2 continuum equivalent coefficients (1395-1760 cm^{-1}).
CPTRCG	-	Band model absorption coefficients for trace gases.
CPUMIX	-	Band model absorption coefficients for uniformly mixed gases.
CPH2O	-	Band model absorption coefficients for water vapor.
CPO3	-	Band model absorption coefficients for ozone.
WVBNRG	-	Specification for wave number band region limits for each gas absorber.
SHUMG	-	Schumann - Runge O_2 band model.
SOLAR	-	Extraterrestrial solar spectral irradiances.

and located at the end of the main program LWTRN7. The user will have to modify these subroutines as necessary.

The sample output included on the LOWTRAN 7 tape was generated on a CDC CYBER that has 14 decimal digits of precision. The output for these same cases generated in a 32 bit-per-word machine with about seven decimal digits of precision (for example, an IBM 370 or 4341 or a VAX) should agree with the sample to within about four decimal digits. When calculating the radiance where the absorber amounts are very small, the truncation error of a 32 bit-per-word machine might cause the radiance to be zero.

2.3 Execution Field Length

There are several techniques available to the user to reduce the executable field length of a program. On CDC CYBER systems, the program may be run using the SEGMENT loader, which effectively creates an overlay structure. File 2 of the LOWTRAN 7 tape (Section 2.4) gives the segment loader directives that reduce the field length to less than $207{,}000_8$. Users of other systems who wish to create overlays should consult the structure chart in Figure 1 and the SEGMENT input directives for guidance. If certain program options are not required, the field length can be reduced by not including the corresponding subroutines.

2.4 Availability

The LOWTRAN 7 package is available from:

National Climatic Data Center, NOAA
Environmental Data Services
Federal Building
Asheville, NC 28801
(704) 259-0682

The package is normally distributed on magnetic tape with the following characteristics:

1. 9 track, 1600 BPI
2. unlabeled
3. ASCII
4. fixed-length records, 140 characters-per-record, one record per block.

The tape has 16 files. The contents of these files are as follows:

1. LOWTRAN 7 source code
2. SEGMENT input direction (relevant to CDC/NOS/BE systems only)
3. INPUT file for test cases
4. OUTPUT file for test cases
5. TAPE 7 file for test cases
6. TAPE 8 file for test cases
7. Source code for plot program (see Appendix A)
8. INPUT file for test cases of plot program
9. OUTPUT file for test cases of plot program
10. Source code for filter program (see Appendix B)

11. INPUT file for test cases of filter program
12. OUTPUT file for test cases of filter program
13. Source code for scanning function program (see Appendix C)
14. INPUT file for test case of scanning function program
15. OUTPUT file for test case of scanning function program
16. List of all LOWTRAN phase functions.

The record length for all the files is 140 characters; however, for files containing source code, INPUT files, and phase functions. only the first 80 characters contain information. Users who require a different format should contact the National Climatic Data Center. The tape presently costs $101.00.

3. INSTRUCTIONS FOR USING LOWTRAN 7

The instructions for using LOWTRAN 7 are similar to those for previous versions. However, many new parameters have been added necessitating the addition of five new optional cards. The new parameters are principally required for reading in user supplied vertical profiles of atmospheric constituent gases, rain and cloud inputs, and aerosols.

In general, for standard atmospheric models, five input cards are required to run the program for a given problem. For a specific problem a combination of several of the fourteen additional optional control cards are possible. The formats for the five main cards, fourteen optional cards, and definitions of the input parameters are given below.

3.1 Input Data and Formats

The use of the word 'CARD' is equivalent to editing with 80 columns.

The program is activated by submission of a five (or more) card sequence as follows:

CARD 1: MODEL, ITYPE, IEMSCT, IMULT, M1, M2, M3, M4, M5, M6, MDEF, IM, NOPRT, TBOUND, SALB
FORMAT (13I5, F8.3, F7.2)

CARD 2: IHAZE, ISEASN, IVULCN, ICSTL, ICLD, IVSA, VIS, WSS, WHH, RAINRT, GNDALT
FORMAT (6I5, 5F10.3)

OPTIONAL CARDS

CARD 2A:	CTHIK, CALT, CEXT, ISEED FORMAT (3F10.3, I10)	(If ICLD=18, 19, or 20)
CARD 2B:	ZCVSA, ZTVSA, ZINVSA FORMAT (3F10.3)	(If IVSA=1)
CARD 2C:	ML, IRD1, IRD2, TITLE FORMAT (3I5, 18A4)	(If MODEL=0 or 7, and IM=1)

CARDS 2C1 THROUGH 2C3 (AS REQUIRED) ARE REPEATED ML TIMES

CARD 2C1: ZMDL, P, T, WMOL(1), WMOL(2), WMOL(3), JCHAR
FORMAT (F10.3, 5E10.3, 15A1)

CARD 2C2: (WMOL(J), J=4, 12) (If IRD1=1)
FORMAT (8E10.3)

CARD 2C3: AHAZE, EQLWCZ, RRATZ, IHA1, ICLD1, IVUL1,
ISEA1, ICHR1 (If IRD2=1)
FORMAT (10X, 3F10.3, 5I5)

CARD 2D: IREG (1 TO 4) (If IHAZE=7 or ICLD=11)
FORMAT (4I5)

CARD 2D1: AWCCON, TITLE
FORMAT (E10.3, 18A4)

CARD 2D2: (VX(I), EXTC(N,I), ABSC(N,I), ASYM(N,I), I=1, 47)
(If IHAZE=7 or ICLD=11)
FORMAT (3(F6.2, 2F7.5, F6.4))

<u>CARD 3</u>: H1, H2, ANGLE, RANGE, BETA, RO, LEN
FORMAT (6F10.3,I5)

ALTERNATE CARD 3: H1, H2, ANGLE, IDAY, RO, ISOURC, ANGLEM (If IEMSCT=3)
FORMAT (3F10.3, I5, 5X, F10.3, I5, F10.3)

OPTIONAL CARDS:

CARD 3A1: IPARM, IPH, IDAY, ISOURC (IEMSCT=2)
FORMAT (4I5)

CARD 3A2: PARM1, PARM2, PARM3, PARM4, TIME, PSIPO, ANGLEM, G
FORMAT (8F10.3) (If IEMSCT=2)

CARD 3B1: NANGLS (If IPH=1)
FORMAT (I5)

CARD 3B2(1 TO NANGLS): (If IPH=1)
(ANGF (I), F(1,I), F(2,I), F(3,I), F(4,I), I=1, NANGLS)
FORMAT (5E10.3)

<u>CARD 4</u>: V1, V2, DV
FORMAT (3F10.3)

<u>CARD 5</u>: IRPT
FORMAT (I5)

Definitions of these quantities will be discussed in Section 3.2.

3.2 Basic Instructions

The various quantities to be specified on each of the five control cards along with the fourteen optional cards (summarized in Section 3.1) will be discussed in this section.

3.2.1 CARD 1: MODEL, ITYPE, IEMSCT, IMULT, M1, M2, M3, M4, M5, M6, MDEF, IM, NOPRT, TBOUND, SALB
FORMAT (13I5, F8.3, F7.2)

MODEL selects one of the six geographical-seasonal model atmospheres or specifies that user-defined meteorological data are to be used.

MODEL = 0 If meteorological data are specified (horizontal path only)
1 Tropical Atmosphere
2 Midlatitude Summer
3 Midlatitude Winter
4 Subarctic Summer
5 Subarctic Winter
6 1976 US Standard
7 If a new model atmosphere (e.g. radiosonde data) is to be read in.
(NOTE: MODEL = 0 Used for horizontal path only)

ITYPE Indicates the type of atmospheric path.

ITYPE = 1 For a horizontal (constant-pressure) path
2 Vertical or slant path between two altitudes
3 For a vertical or slant path to space

IEMSCT Determines the mode of execution of the program.

IEMSCT = 0 Program execution in transmittance mode
1 Program execution in thermal radiance mode
2 Program execution in radiance mode with solar/lunar single scattered radiance included
3 Program calculates directly transmitted solar irradiance

IMULT Determines execution with multiple scattering

IMULT = 0 Program executed without multiple scattering
1 Program executed with multiple scattering
(NOTE: IEMSCT must equal 1 or 2 for multiple scattering)

M1, M2, M3, M4, M5, and M6 are used to modify or supplement the altitude profiles of temperature and pressure, water vapor, ozone, methane, nitrous oxide and carbon monoxide from the atmospheric models stored in the program.

MDEF Uses the default (U.S. Standard) profiles for the remaining species.

For normal operation of program (MODEL 1 to 6)
Set M1=M2=M3=0, M4=M5=M6=MDEF=0

These parameters are reset to default values by MODEL (1 to 6) when they are equal to zero

When M1=0	M1 reset to 'MODEL'
When M2=0	M2 reset to 'MODEL'
When M3=0	M3 reset to 'MODEL'
When M4=0	M4 reset to 'MODEL'
When M5=0	M5 reset to 'MODEL'
When M6=0	M6 reset to 'MODEL'
When MDEF=0	MDEF reset to 1 for all remaining species (not needed with MODEL 1 to 6).

If MODEL=0 or 7 and if:

a. M1 through M6 are zero then the JCHAR parameter on card 2C.1 should be utilized to supply the necessary amounts.

or

b. M1 through M6 are non-zero then the chosen default profiles will be utilized provided the specific JCHAR option is blank.

M1=1 to 6	Default temperature and pressure to specified model atmosphere
M2=1 to 6	Default H_2O to specified model atmosphere
M3=1 to 6	Default O_3 to specified model atmosphere
M4=1 to 6	Default CH_4 to specified model atmosphere
M5=1 to 6	Default N_2O to specified model atmosphere
M6=1 to 6	Default CO to specified model atmosphere
MDEF=1	Use default profiles for CO_2, O_2, NO, SO_2, NO_2, NH_3, HNO_3, (not needed with MODEL 1 to 6).

If MODEL=0 or MODEL=7, the program expects to read user supplied atmospheric profiles. Set: IM=1 for first run. To then rerun the same user-atmosphere for a series of cases set IM=0; LOWTRAN will reuse the previously read data.

IM=0	For normal operation of program or when subsequent calculations are to be run with the MODEL data set last read in.
1	When user input data are to be read initially.
NOPRT=0	For normal operation of program. Controls TAPE6 output
1	To minimize printing of transmittance or radiance table and atmospheric profiles
-1	Controls TAPE 8 output
TBOUND	=Boundary temperature (°K), used in the radiation mode (if IEMSCT=1 or 2) for slant paths that intersect the earth or terminate at a grey boundary (for example, cloud, target). If TBOUND is left blank and the path intersects the Earth, the program will use the temperature of the first atmospheric level as the boundary temperature.
SALB	=Surface albedo of the Earth at the location and average frequency of the calculation (0.0 to 1.0). If SALB is left blank the program assumes the surface is a blackbody (with emissivity equal to 1; for example, SALB=0).

Table 7 summarizes the use of the five control parameters MODEL, ITYPE, IEMSCT, IMULT, and NOPRT on CARD 1.

Table 7. LOWTRAN CARD 1 Input Parameters: MODEL, ITYPE, IEMSCT, IMULT and NOPRT

CARD 1		MODEL, ITYPE, IEMSCT, IMULT, M1, M2, M3, M4, M5, M6, MDEF, IM, NOPRT, TBOUND, SALB FORMAT (13I5, F8.3, F7.2)							
COL 5	MODEL	COL 10	ITYPE	COL 15	IEMSCT	COL 20	IMULT	COL 65	NOPRT
0	User-defined*	1	Horizontal path	0	Transmittance	0	Without multiple scattering	-1	TAPE 8 Output
1	Tropical	2	Slant path H1 to H2	1	Radiance	1	With multiple scattering	0	TAPE 6 Normal output
2	Midlatitude summer	3	Slant path to space	2	Radiance with solar/lunar scattering			1	TAPE 6 Short output
3	Midlatitude winter			3	Transmitted solar irradiance				
4	Subarctic summer								
5	Subarctic winter								
6	1976 U. S. Standard								
7	User-defined*								
M1, M2, M3, M4, M5, M6, MDEF, IM, TBOUND, SALB are left blank for standard cases. *Options for non-standard models.									

3.2.2 CARD 2: IHAZE, ISEASN, IVULCN, ICSTL, ICLD, IVSA, VIS, WSS, WHH, RAINRT, GNDALT FORMAT (6I5, 5F10.3)

IHAZE, ISEASN, IVULCN, and VIS select the altitude and seasonal-dependent aerosol profiles and aerosol extinction coefficients. IHAZE specifies the aerosol model used for the boundary-layer (0 to 2 km) and a default-surface meteorological range. The relative humidity dependence of the boundary-layer aerosol extinction coefficients is based on the water vapor content of the model atmosphere selected by MODEL. ISEASN selects the seasonal dependence of the profiles for both the tropospheric (2 to 10 km) and stratospheric (10 to 30 km) aerosols. IVULCN is used to select both the profile and extinction type for the stratospheric aerosols and to determine transition profiles above the stratosphere to 100 km. VIS, the meteorological range, when specified, will supersede the default meteorological range in the boundary-layer aerosol profile set by IHAZE.

IHAZE selects the type of extinction and a default meteorological range for the boundary-layer aerosol models only. If VIS is also specified, it will override the default IHAZE value. Interpolation of the extinction coefficients based on relative humidity is performed only for the RURAL, MARITIME, URBAN, and TROPOSPHERIC coefficients used in the boundary layer (0 to 2 km altitude).

IHAZE=0	no aerosol attenuation included in the calculation
=1	RURAL extinction, default VIS = 23 km
=2	RURAL extinction, default VIS = 5 km
=3	NAVY MARITIME extinction, sets own VIS (wind and relative humidity dependent)
=4	MARITIME extinction, default VIS = 23 km (LOWTRAN model)
=5	URBAN extinction, default VIS = 5 km
=6	TROPOSPHERIC extinction, default VIS = 50 km
=7	User defined aerosol extinction coefficients. Triggers reading cards 2D, 2D1 and 2D2 for up to 4 altitude regions of user defined extinction, absorption and asymmetry parameters
=8	FOG1 (Advective Fog) extinction, 0.2-km VIS
=9	FOG2 (Radiative Fog) extinction, 0.5-km VIS
=10	DESERT extinction sets own visibility from wind speed (WSS)

ISEASN selects the appropriate seasonal aerosol profile for both the tropospheric and stratospheric aerosols. Only the tropospheric aerosol extinction coefficients are used with the 2 to 10 km profiles.

ISEASN=0	season determined by the value of MODEL; SPRING-SUMMER for MODEL = 0, 1, 2, 4, 6, 7 FALL-WINTER for MODEL = 3, 5
=1	SPRING-SUMMER
=2	FALL-WINTER

The parameter IVULCN controls both the selection of the aerosol profile as well as the type of extinction for the stratospheric aerosols. It also selects appropriate transition profiles above the stratosphere to 100 km. Meteoric dust extinction coefficients are always used for altitudes from 30 to 100 km.

IVULCN=0,1	BACKGROUND STRATOSPHERIC profile and extinction
=2	MODERATE VOLCANIC profile and AGED VOLCANIC extinction
=3	HIGH VOLCANIC profile and FRESH VOLCANIC extinction
=4	HIGH VOLCANIC profile and AGED VOLCANIC extinction
=5	MODERATE VOLCANIC profile and FRESH VOLCANIC extinction
=6	MODERATE VOLCANIC profile and BACKGROUND STRATOSPHERIC extinction
=7	HIGH VOLCANIC profile and BACKGROUND STRATOSPHERIC extinction
=8	EXTREME VOLCANIC profile and FRESH VOLCANIC extinction

Table 8 shows the value of IVULCN corresponding to the different choices of extinction coefficient model and the vertical distribution profile.

Table 8. LOWTRAN CARD 2 Input Parameter: IVULCN

EXTINCTION MODEL	VERTICAL DISTRIBUTION: BACKGROUND STRATOSPHERIC	MODERATE VOLCANIC	HIGH VOLCANIC	EXTREME VOLCANIC
BACKGROUND STRATOSPHERIC	0,1	6	7	–
AGED VOLCANIC	–	2	4	–
FRESH VOLCANIC	–	5	3	8

ICSTL is the air mass character (1 to 10), only used with the Navy maritime model (IHAZE = 3). Default value is 3.

ICSTL=1 open ocean

.

.

.

10 strong continental influence

ICLD specifies the cloud models and rain models used.

The rain profiles decrease linearly from the ground to the top of the associated cloud model. The program cuts off the rain at the cloud top.

ICLD=0 No clouds or rain

=1 Cumulus cloud; base 0.66 km, top 3.0 km

=2 Altostratus cloud; base 2.4 km, top 3.0 km

=3 Stratus cloud; base 0.33 km, top 1.0 km

=4 Stratus/Strato Cu; base 0.66 km, top 2.0 km

=5 Nimbostratus cloud; base 0.16 km, top 0.66 km

=6	2.0 mm/hr Drizzle (modeled with cloud 3) rain 2.0 mm/hr at 0 km to 0.22 mm/hr at 1.5 km
=7	5.0 mm/hr Light rain (modeled with cloud 5) rain 5.0 mm/hr at 0 km to 0.2 mm/hr at 2.0 km
=8	12.5 mm/hr Moderate rain (modeled with cloud 5) rain 12.5 mm/hr at 0 km to 0.2 mm/hr at 2.0 km
=9	25.0 mm/hr Heavy rain (modeled with cloud 1) rain 25.0 mm/hr at 0 km to 0.2 mm/hr at 3.0 km
=10	75.0 mm/hr Extreme rain (modeled with cloud 1) rain 75.0 mm/hr at 0 km to 0.2 mm/hr at 3.5 km
=11	Read in user defined cloud extinction and absorption. Triggers reading Cards 2D, 2D1 and 2D2 for up to 4 altitude regions of user defined extinction, absorption, and asymmetry parameters
=18	Standard Cirrus model
=19	Sub-visual Cirrus model
=20	NOAA Cirrus model (LOWTRAN 6 Model)

IVSA selects the use of the Army Vertical Structure Algorithm (VSA) for aerosols in the boundary layer.

IVSA=0	not used
=1	Vertical structure algorithm

VIS specifies the surface meteorological range* [36,37,38] (km) overriding the default value associated with the boundary layer chosen by IHAZE. If set to zero uses default value specified by IHAZE.

---

* The terms "meteorological range" and "visibility" are not always used correctly in the literature. Correctly,[36,37] visibility is the greatest distance at which it is just possible to see and identify with the unaided eye: (a) in the daytime, a dark object against the horizon sky; and (b) at night, a known moderately intense light source. Meteorological range is defined quantitatively, eliminating the subjective nature of the observer and the distinction between day and night. Meteorological range V is defined by the Koschmieder formula

$$V = \frac{1}{\beta} \ln \frac{1}{\varepsilon} = \frac{3.912}{\beta}$$

where β is the total extinction coefficient which is the sum of the molecular and aerosol extinction, and ε is the threshold contrast, set equal to 0.02. As used in the LOWTRAN computer code, the inputs are in terms of meteorological range with β, the extinction coefficient, evaluated at 0.55 μm. If only an observer visibility V_{obs} is available, the meteorological range can be estimated as $V = (1.3 \pm 0.3) \cdot V_{obs}$. (See Gordon[38])

36. Huschke, R.E. (1959) *Glossary of Meteorology*, American Meteorological Society, Boston, MA, p. 638
37. Middleton, W.E.K. (1952) *Vision Through the Atmosphere*, University of Toronto Press, p. 250.
38. Gordon, J.I. (1970) *Daytime Visibility, A Conceptual Review*, AFGL-TR-79-0257, AD A085451.

VIS > 0, user specified surface meteorological range (km)

= 0, uses the default meteorological range set by IHAZE (See Table 10).

WSS specifies the current wind speed for use with the Navy maritime and desert aerosol models.

WSS= current wind speed (m/s). Used with the Navy maritime model (IHAZE=3) or the DESERT model (IHAZE=10).

WHH specifies the 24 hour average wind speed for use with the Navy maritime model.

WHH= 24-h average wind speed (m/s). Only used with the Navy maritime model (IHAZE=3)

For the Navy Maritime model if WSS=WHH=0, default wind speeds are set according to the value of MODEL, see Table 9. For the Desert aerosol model (IHAZE=10), if WSS<0, the default wind speed is 10 m/s.

Table 9. Default Wind Speeds for Different Model Atmospheres Used with the Navy Maritime Model (IHAZE=3)

MODEL	Model Atmosphere	WSS and WHH Default Wind Speed (m/s)
0	User-defined (Horizontal Path)	6.9
1	Tropical	4.1
2	Midlatitude summer	4.1
3	Midlatitude winter	10.29
4	Subarctic summer	6.69
5	Subarctic winter	12.35
6	U. S. Standard	7.2
7	User-defined	6.9

RAINRT Specifies the rain rate

RAINRT = Rain rate (mm/hr) default value is zero.
Used to top of cloud when cloud is present,
when no clouds rain rate used to 6km

GNDALT specifies the altitude of the surface relative to sea level

GNDALT = Altitude of surface relative to sea level (km)
Used to modify aerosol profiles below 6 km altitudes

Table 10 summarizes the use of the control parameters IHAZE, ISEASN and IVULCN on card 2 and Table 11 summarizes the use of the parameter ICLD.

Table 10. LOWTRAN CARD 2 Input Parameters: IHAZE, ISEASN, IVULCN, VIS

CARD 2	IHAZE, ISEASN, IVULCN, ICSTL, ICLD, IVSA, VIS, WSS, WHH, RAINRT, GNDALT FORMAT (6I5, 5F10.3)								
IHAZE			ISEASN		IVULCN				
COL 5	VIS* (KM)	EXTINCTION	COL 10	SEASON	COL 15	SEASON	PROFILE	EXTINCTION	PROFILE/ EXTINCTION
0	NO AEROSOLS								
1	23	Rural	0	Set by model		Set by model			Meteoric dust extinction
2	5		1	Spring-summer		Spring-summer			
3	**	Navy maritime	2	Fall-winter		Fall-winter			
4	23	LOWTRAN maritime	Tropospheric profile/ tropospheric extinction		0		Background strato-spheric	Background strato-spheric	Normal atmospheric profile
					1				
5	5	Urban			2		Moderate volcanic	Aged volcanic	Transition profiles - volcanic to normal
6	50	Tropospheric			3		High volcanic	Fresh volcanic	
7	23	User-defined			4		High volcanic	Aged volcanic	
8	0.2	Fog 1			5		Moderate volcanic	Fresh volcanic	
9	0.5	Fog 2			6		Moderate volcanic	Background strato-spheric	
10	**	Desert			7		High volcanic	Background strato-spheric	
					8		Extreme volcanic	Fresh volcanic	
0 to 2 km			2 to 10 km		10 to 30 km				30 to 100 km

* Default VIS, can be overridden by VIS > 0 on CARD 2
** Sets own default VIS

Table 11. LOWTRAN CARD 2 Input Parameter: ICLD

CARD 2	IHAZE, ISEASN, IVULCN, ICSTL, ICLD, IVSA, VIS, WSS, WHH, RAINRT, GNDALT FORMAT (6I5, 5F10.3)
ICLD	FOR CLOUD AND OR RAIN OPTION
0	NO CLOUDS OR RAIN
1	CUMULUS CLOUD
2	ALTOSTRATUS CLOUD
3	STRATUS CLOUD
4	STRATUS/STRATO CUMULUS
5	NIMBOSTRATUS CLOUD
6	2.0 MM/HR DRIZZLE (MODELED WITH CLOUD 3)
7	5.0 MM/HR LIGHT RAIN (MODELED WITH CLOUD 5)
8	12.5 MM/HR MODERATE RAIN (MODELED WITH CLOUD 5)
9	25.0 MM/HR HEAVY RAIN (MODELED WITH CLOUD 1)
10	75.0 MM/HR EXTREME RAIN (MODELED WITH CLOUD 1)
11	USER DEFINED CLOUD EXTINCTION AND ABSORPTION
18	STANDARD CIRRUS MODEL
19	SUB VISUAL CIRRUS MODEL
20	NOAA CIRRUS MODEL (LOWTRAN 6 MODEL)

3.2.2.1 Optional Cards Following CARD 2

Optional input cards after CARD 2 selected by the parameters ICLD, IVSA, MODEL, and IHAZE on CARDS 1 and 2.

CARD 2A CTHIK, CALT, CEXT, ISEED (If ICLD=18, 19 or 20)
FORMAT (3F10.3, I10)

Input card for cirrus altitude profile subroutine when ICLD = 18, 19, or 20

CTHIK is the cirrus thickness (km)

If CTHIK=0 use thickness statistics
>0 user defined thickness

CALT is the cirrus base altitude (km)
CALT=0 use calculated value
>0 user defined base altitude

CEXT is the extinction coefficient (km^{-1}) at 0.55 μm

CEXT=0 use 0.14* CTHIK
>0 user defined extinction coefficient

ISEED is the random number initializing flag.

ISEED=0, use default mean values for cirrus.

> 0, initial value of seed for random number generator, function RANF (SEED). (different values of SEED produce different random number sequences). This provides for statistical determination of cirrus base altitude (CALT) and thickness (CTHIK).

NOTE: Random number generator is system dependent.

CARD 2B ZCVSA, ZTVSA, ZINVSA (If IVSA = 1)
FORMAT (3F10.3)

Input card for Army VSA subroutine when IVSA = 1. The case is determined by the parameters VIS, ZCVSA, ZTVSA, and ZINVSA.

CASE 1: cloud/fog at the surface; increasing extinction with height from cloud/fog base to cloud/fog top. Selected by VIS $\leq$ 0.5 km and ZCVSA $\geq$ 0.

Use case 2 or 2' below cloud and case 1 inside it.

CASE 2: hazy/light fog; increasing extinction with height up to the cloudbase. Selected by 0.5 < VIS $\leq$10 km, ZCVSA $\geq$ 0.

CASE 2': clear/hazy; increasing extinction with height, but less so than case 2, up to the cloudbase. Selected by VIS > 10 km, ZCVSA $\geq$ 0.

CASE 3: no cloud ceiling but a radiation fog or an inversion or boundary layer present; decreasing extinction with height up to the height of the fog or layer. Selected by ZCVSA < 0, ZINVSA $\geq$ 0.

CASE 4: no cloud ceiling or inversion layer; constant extinction with height. Selected by ZCVSA < 0 and ZINVSA < 0.

ZCVSA is the cloud ceiling height (km):

If ZCVSA > 0.0 the known cloud ceiling height;

= 0.0 height unknown: the program will calculate one for case 2, and default is 1.8 km for case 2'; or

< 0.0 no cloud ceiling (cases 3 and 4).

ZTVSA is the thickness of the cloud (case 2) or the thickness of the fog at the surface (case 1) (km):

If ZTVSA > 0.0 the known value of the cloud thickness;

= 0.0 thickness unknown: default is 0.2 km.

ZINVSA is the height of the inversion or boundary layer (km):

If ZINVSA > 0.0 the known height of the inversion layer;

= 0.0 height unknown: default is 2 km, 0.2 km for fog;

< 0.0 no inversion layer (case 4, if ZCVSA < 0.0 also).

OPTIONAL USER INPUT CARDS 2C, 2C1, 2C2 and 2C3

The following cards handle user input data.
Cards 2C and 2C1 are always read for MODEL 0 or 7.

CARD 2C   ML, IRD1, IRD2, TITLE   (MODEL=0/7, IM=1)
FORMAT (3I5, 18A4)

Additional atmospheric model   (MODEL 0/7)

New model atmospheric data can be inserted provided the parameters 'MODEL' and 'IM' are set equal to 0/7 and 1 respectively on card 1.

ML = Number of atmospheric levels to be inserted (Maximum of 34)

IRD1 Controls reading WN2O, WCO... and WNH3, WHNO3 (CARD 2C2)

IRD1=0   No read
IRD1=1   Read CARD 2C2

IRD2 Controls reading AHAZE, EQLWCZ, ... (CARD 2C3)

IRD2=0   No read
IRD2=1   Read CARD 2C3

TITLE = Identification of new model atmosphere

CARD 2C1   ZMDL,P,T, WMOL(1), WMOL(2), WMOL(3), (JCHAR(J), J=1, 14)
FORMAT (F10.3, 5E10.3, 15A1)

CARD 2C2   (WMOL(J), J=4, 12)
FORMAT (8E10.3)

ZMDL	=	Altitude of layer boundary (km)
P	=	Pressure of layer boundary
T	=	Temperature of layer boundary
WMOL (1-12)	=	Individual molecular species (see Table 11A. for species)
JCHAR(1-14)	=	Control variable on units selection for profile input (P,T and molecular constituents, see Table 11A.)

By utilizing a choice of values for the JCHAR(J) control variable (where J = 1,14) the user can designate specific units or accept defaults for the various molecular species and for the temperature and pressure. If JCHAR(J) is left blank the program will default to the values chosen by M1, M2, M3, M4, M5, M6 and MDEF when the given amount is zero.

For JCHAR(1)

A   indicates Pressure in (mb)
B   indicates Pressure in (atm)
C   indicates Pressure in (torr)
1-6   will default to specified atmospheric value

Table 11A. The Association of the JCHAR (J) Subscript (J=1,14) with the Variables P,T and WMOL

J	VARIABLE	SPECIES
1	P	pressure
2	T	temperature
3	WMOL(1)	water vapor (H_2O)
4	WMOL(2)	carbon dioxide (CO_2)
5	WMOL(3)	ozone (O_3)
6	WMOL(4)	nitrous oxide (N_2O)
7	WMOL(5)	carbon monoxide (CO)
8	WMOL(6)	methane (CH_4)
9	WMOL(7)	oxygen (O_2)
10	WMOL(8)	nitric oxide (NO)
11	WMOL(9)	sulphur dioxide (SO_2)
12	WMOL(10)	nitrogen dioxide (NO_2)
13	WMOL(11)	ammonia (NH_3)
14	WMOL(12)	nitric acid (HNO_3)

For JCHAR(2)

A	indicates Ambient temperature in deg (K)
B	indicates Ambient temperature in deg (C)
1-6	will default to specified atmospheric value

For JCHAR(3-14)

A	indicates Volume mixing ratio (ppmv)
B	indicates Number density (cm^{-3})
C	indicates Mass mixing ratio (gm/kg)
D	indicates Mass density (gm/m^3)
E	indicates Partial pressure (mb)
F	indicates Dew point temp (TD in T (K)) - H_2O only
G	indicates Dew point temp (TD in T (C)) - H_2O only
H	indicates Relative humidity (RH in percent) - H_2O only
I	is available for user definition
1-6	will default to specified model atmosphere

CARD 2C3 is read when IRD2 is set to 1 on CARD 2C.

CARD 2C3 AHAZE, EQLWCZ, RRATZ, IHA1, ICLD1, IVUL1, ISEA1, ICHR1
FORMAT (10X, 3F10.3, 5I5)

AHAZE Aerosol or cloud scaling factor (equal to the visible [wavelength of 0.55 μm] extinction coefficient [km^{-1}] at altitude ZMDL)
[NOTE: only one of AHAZE or EQLWCZ is allowed]

EQLWCZ Equivalent liquid water content (gm/m^3) at altitude ZMDL for the aerosol, cloud or fog models

RRATZ Rain rate (mm/hr) at altitude ZMDL

Only one of IHA1, ICLD1 or IVUL1 is allowed

IHA1 Aerosol model extinction and meteorological range control for the altitude, ZMDL, See IHAZE (CARD 2) for options

ICLD1 Cloud extinction control for the altitude, ZMDL, See ICLD (Card 2) for options. When using ICLD1 it is necessary to set ICLD (CARD 2) to the same value as the initial input of ICLD1.

IVUL1 Stratospheric aerosol profile and extinction control for the altitude ZMDL, see IVULCN (CARD 2) for options

The precedent order of these parameters (IHA1, ICLD1 and IVUL1) is as follows:

If (IHA1>0) then others ignored
If (IHA1=0) and (ICLD1>0) then use ICLD1
If (IHA1=0) and (ICLD1=0) then use IVUL1

If AHAZE and EQLWCZ are both zero, default profile loaded from IHA1, ICLD1, IVUL1

ISEA1 Aerosol season control for the altitude, ZMDL, see ISEASN (CARD 2) for options.

ICHR1 Used to indicate a boundary change between 2 or more adjacent user defined aerosol or cloud regions at altitude ZMDL (required for IHAZE=7 or ICLD=11).

ICHR1=0, no boundary change in user defined aerosol or cloud regions (regions are not adjacent).

=1, signifies the boundary change in adjacent user defined aerosol or cloud regions.

NOTE: ICHR1 internally defaults to 0 if (IHA1≠7) or (ICLD1≠11).

OPTIONAL CARDS 2D, 2D1, 2D2

The following cards allow the user to specify their own attenuation coefficients for any or all four of the aerosol regions. They are only read if IHAZE=7 or ICLD=11 are specified on card 2 (pages 24 and 26).

CARD 2D (IREG (II), II=1,4) (IHAZE=7 or ICLD=11 input)
FORMAT (4I5)

IREG Specifies which of the four altitude regions a user defined aerosol or cloud model is used (IHAZE=7/ICLD=11)

(NOTE: Regions default to 0-2, 3-10, 11-30, 35-100 km and can be overridden with 'IHA1' settings in MODEL 7)

IREG (II) = 0 Use default values for region II
IREG (II) = 1 Read extinction, absorption, and asymmetry for a region

CARD 2D1 AWCCON, TITLE
FORMAT (E10.3, 18A4)

AWCCON is a conversion factor from equivalent liquid water content (gm/m^3) to extinction coefficient (km^{-1}). It is numerically equal to the equivalent liquid water content corresponding to an extinction coefficient of 1.0 km^{-1}, at a wavelength of 0.55 μm. AWCCON has units of ($km \cdot gm \cdot m^{-3}$).

TITLE for an aerosol or cloud region (up to 72 characters)

CARD 2D2 (VX(I), EXTC(N, I), ABSC(N, I), ASYM(N, I), I=1,47)
FORMAT (3(F6.2, 2F7.5, F6.4))

Where N=II when IREG(II)=1 for up to 4 altitude regions. User defined aerosol or cloud extinction and absorption coefficients when IHAZE=7 or ICLD=11

VX(I) = Wavelengths for the aerosol or cloud coefficients (not used by program but should be the same as the wavelengths defined in array VX2 in subroutine EXTDTA, see Table 12)

EXTC(N, I) = Aerosol or cloud extinction coefficients, normalized so that EXTC for a wavelength of 0.55 μm (I=4) is 1.0 km^{-1}.

ABSC(N, I) = Aerosol or cloud absorption coefficient, normalized so that EXTC for a wavelength of 0.55 μm (I=4) is 1.0 km^{-1}.

ASYM(N, I) = Aerosol or cloud asymmetry parameter

3.2.3 CARD 3: H1, H2, ANGLE, RANGE, BETA, RO, LEN FORMAT (6F10.3, I5)

CARD 3 is used to define the geometrical path parameters for a given problem.

H1 = initial altitude (km)
H2 = final altitude (km) (for ITYPE = 2)
H2 = tangent height (km) (for ITYPE = 3)

It is important to emphasize here that in the radiance mode of program execution (IEMSCT = 1 or 2), H1, the initial altitude, always defines the position of the observer (or sensor). H1 and H2 cannot be used interchangeably as in the transmittance mode.

ANGLE = initial zenith angle (degrees) as measured from H1
RANGE = path length (km)
BETA = earth center angle subtended by H1 and H2 (degrees)
RO = radius of the earth (km) at the particular latitude at which the calculation is to be performed.
If RO is left blank, the program will use the midlatitude value of 6371.23 km if MODEL is set equal to 7. Otherwise, the earth radius for the appropriate standard model atmosphere (specified by MODEL) will be used as shown in Table 13.

For an ITYPE = 2 path for which H1 > H2 (and by necessity, ANGLE > 90°), two paths are possible: the long path from H1 through a tangent height to H2 and the short path from H1 to H2. LEN selects the type of path in these cases.

Table 12. The VX Array with the Required Wavelengths for the Multiply Read Card 2D2

INDEX	WAVELENGTH	INDEX	WAVELENGTH
1	.2000	25	9.0000
2	.3000	26	9.2000
3	.3371	27	10.0000
4	.5500	28	10.5910
5	.6943	29	11.0000
6	1.0600	30	11.5000
7	1.5360	31	12.5000
8	2.0000	32	14.8000
9	2.2500	33	15.0000
10	2.5000	34	16.4000
11	2.7000	35	17.2000
12	3.0000	36	18.5000
13	3.3923	37	21.3000
14	3.7500	38	25.0000
15	4.5000	39	30.0000
16	5.0000	40	40.0000
17	5.5000	41	50.0000
18	6.0000	42	60.0000
19	6.2000	43	80.0000
20	6.5000	44	100.0000
21	7.2000	45	150.0000
22	7.9000	46	200.0000
23	8.2000	47	300.0000
24	8.7000		

Table 13. Default Values of the Earth Radius for Different Model Atmospheres

MODEL	Model Atmosphere	Earth Radius, RO (km)
0	User-defined (Horizontal Path)	Not used
1	Tropical	6,378.39
2	Midlatitude summer	6,371.23
3	Midlatitude winter	6,371.23
4	Subarctic summer	6,356.91
5	Subarctic winter	6,356.91
6	U. S. Standard	6,371.23
7	User-defined	6,371.23

LEN = 0 short path (default).
= 1 long path through the tangent height.

It is not necessary to specify every variable on CARD 3; only those that adequately describe the problem according to the parameter ITYPE (as described below). (See Table 14).

(1) Horizontal Paths (ITYPE = 1)
   (a) Specify H1, RANGE
   (b) if non-standard meteorological data are to be used, that is, if MODEL = 0 on CARD 1, then refer to Section 3.3 for a detailed explanation.

(2) Slant Paths Between Two Altitudes (ITYPE = 2)
   (a) specify H1, H2, and ANGLE
   (b) specify H1, ANGLE, and RANGE
   (c) specify H1, H2, and RANGE
   (d) specify H1, H2, and BETA

(3) Slant Paths to Space (ITYPE = 3)
   (a) specify H1 and ANGLE
   (b) specify H1 and H2 (for limb-viewing problem where H2 is the tangent height or minimum altitude of the path trajectory).

For case 2(b), the program will calculate H2, assuming no refraction; then proceed as for case 2(a). The actual slant path range will differ from the input value. This method of defining the problem should be used when refraction effects are not important; for example, for ranges of a few tens of km at zenith angles less than 80°. For case 2(c), the program will calculate BETA and then proceed as for case 2(d). For case 2(d), the program will determine the proper value of ANGLE (including the effects of refraction) through an iterative procedure. This method can be used when the geometrical configuration of the source and receiver is known accurately, but the initial zenith angle is not known precisely due to atmospheric refraction effects. Beta is most frequently determined by the user from ground range information.

Table 14 lists the options on CARD 3 provided to the user for the different types of atmospheric paths.

3.2.3.1 Alternate CARD 3 for Transmitted Solar or Lunar Irradiance (IEMSCT = 3)

For calculating directly transmitted solar or lunar irradiance, an ITYPE = 3 path is assumed and CARD 3 has the following form:

ALTERNATE CARD 3
H1, H2, ANGLE, IDAY, RO, ISOURC, ANGLEM
FORMAT (3F10.3, I5, 5X, F10.3, I5, F10.3)

H1	=	altitude of the observer
H2	=	tangent height of path to sun or moon
ANGLE	=	apparent solar or lunar zenith angle at H1

Table 14. Allowable Combinations of Slant Path Parameters

Case	ITYPE	H1	H2	ANGLE	RANGE	BETA	LEN (Optional)
2a (1)	2	*	*	*			(*)
2b (2)	2	*		*	*		
2c (3)	2	*	*		*		
2d (4)	2	*	*			*	
3a	3	*		*			
3b (5)	3	*	*				

(1) LEN option is available only when H1 > H2 and ANGLE > 90°. Otherwise, LEN is set in the program.

(2) H2 calculated assuming no refraction. Calculated RANGE will differ from the input value.

(3) BETA calculated assuming no refraction.

(4) Exact ANGLE is calculated by iteration of the path calculation.

(5) H2 is interpreted as the tangent height. If H2 and ANGLE are both zero, Case 3a is assumed with ANGLE = 0 (that is vertical path). For a path tangent at the earth's surface, read in a small number for H2, for example, 0.001 km.

IDAY = day of the year, used to correct for variation in the earth-to-sun distance

RO = radius of earth (default according to MODEL)

ISOURC = 0 extraterrestrial source is the sun
= 1 extraterrestrial source is the moon

ANGLEM = phase angle of the moon, that is, the angle formed by the sun, moon, and earth (required if ISOURC = 1)

Either H2 or ANGLE should be specified. If both are given as zero, then a vertical path (ANGLE = 0°) is assumed. If IDAY is not specified, then the mean earth to sun distance is assumed.

If the apparent solar zenith angle is not known for a particular case, then the solar scattering option (IEMSCT = 2) may be used along with, for instance, the observers location, day of the year, and time of day to determine the solar zenith angle (see section 3.2.3.2 of the user instructions). Note that the apparent solar zenith angle is zenith angle at H1 of the refracted path to the sun and is less than the astronomical solar zenith angle. The difference between the two angles is negligible for angles less than 80°.

3.2.3.2 Optional Cards Following CARD 3

Optional input cards after CARD 3 are selected by parameters IEMSCT on CARD 1 and IPH on CARD 3A1.

CARD3A1 IPARM, IPH, IDAY, ISOURC (if IEMSCT = 2)
FORMAT (4I5)

Input card for solar/lunar scattered radiation when IEMSCT = 2.

IPARM = 0,1,2 controls the method of specifying the solar/lunar geometry on CARD 3A2.

IPH = 0 Henyey-Greenstein aerosol phase function (see CARD 3A2)

= 1 user-supplied aerosol phase function (see CARD 3B)

= 2 MIE-generated internal database of aerosol phase functions for the LOWTRAN models

IDAY = day of the year, that is, from 1 to 365 used to specify the earth to sun distance and (if IPARM = 1) to specify the sun's location in the sky. (Default value is the mean earth to sun distance, IDAY=93).

ISOURC = 0 extraterrestrial source is the sun

= 1 extraterrestrial source is the moon

CARD 3A2 PARM1, PARM2, PARM3, PARM4, TIME, PSIPO, ANGLEM, G
(IEMSCT = 2)
FORMAT (8F10.3)

Input card for solar/lunar scattered radiation when IEMSCT = 2. Definitions of PARM1, PARM2, PARM3, PARM4 determined by value of IPARM on CARD 3A1, (See Table 14A.).

For IPARM = 0

PARM1 = observer latitude (-90° to +90°)

(Note that if ABS(PARM1) is greater than 89.5° the observer is assumed to be at either the north or south pole. In this case the path azimuth is undefined. The direction of line-of-sight must be specified as the longitude along which the path lies. This quantity rather than the usual azimuth is read in.)

PARM2 = observer longitude (0° to 360°, west of Greenwich)

PARM3 = source (sun or moon) latitude

PARM4 = source (sun or moon) longitude

For IPARM = 1

NOTE: The parameters IDAY and TIME must be specified. This option cannot be used with ISOURC = 1.

PARM1 = observer latitude (-90° to +90°)

PARM2 = observer longitude (0° to 360°, west of Greenwich)

PARM3, PARM4 are not required

(Note that the calculated apparent solar zenith angle is the zenith angle at H1 of the refracted path to the sun and is less than the astronomical solar zenith angle. The difference between the two angles is negligible for angles less than 80 degrees.)

Table 14A. Card 3A2; Options for Different Choices of IPARM

IPARM=	0	1	2
PARM1	Observer Latitude (-90 to +90°)	Observer Latitude (-90 to +90°)	Azimuth Angle Between Observer LOS & Observer to Sun Path
PARM2	Observer Longitude (0 to 360° West of Greenwich)	Observer Longitude (0 to 360° West of Greenwich)	Solar Zenith Angle
PARM3	Source Latitude	—	—
PARM4	Source Longitude	—	—
TIME	—	Greenwich Time (Decimal Hours)	—
PSIPO	Path Azimuth Angle (degrees East of Due North)	Path Azimuth Angle (degrees East of Due North)	—
ANGLEM (only if ISOURC=1)	Lunar Phase Angle	—	Lunar Phase Angle
G (only if IPH=0)	Asymmetry Parameter (-1 to +1) for use with Henyey-Greenstein Phase Function	Asymmetry Parameter (-1 to +1) for use with Henyey-Greenstein Phase Function	Asymmetry Parameter (-1 to +1) for use with Henyey-Greenstein Phase Function

For IPARM = 2

PARM1 = azimuthal angle between the observers line-of-sight and the observer-to-sun path, measured from the line of sight, positive east of north, between -180° and 180°

PARM2 = the sun's zenith angle

PARM3, PARM4 are not required

REMAINING CONTROL PARAMETERS

TIME = Greenwich time in decimal hours, that is, 8:45 am is 8.75, 5:20 pm is 17.33 etc. (used with IPARM = 1)

PSIPO = path azimuth (degrees east of north, that is, due north is 0.0°, due east is 90.0° etc. (used with IPARM = 0 or 1)

ANGLEM = phase angle of the moon, that is, the angle formed by the sun, moon, and earth (required only if ISOURC = 1)

G = asymmetry factor for use with Henyey-Greenstein phase function (only used with IPH = 0), e.g., +1 for complete forward scattering, 0 for isotropic or symmetric scattering, and −1 for complete backscattering.

CARD 3B1 NANGLS (Only if IPH = 1 on card 3A1)
FORMAT (I5)

Input card for user-defined phase functions when IPH = 1.

NANGLS = number of angles for the user-defined phase functions (maximum of 50)

CARD 3B2 (1 to NANGLS)
(ANGF(I), F(1,I), F(2,I), F(3,I), F(4,I), I = 1, NANGLS)
FORMAT (5E10.3)

Input card for user-defined phase functions when IPH = 1.

ANGF(I) = scattering angle in decimal degrees (0.0° to 180.0°)

F(1,I) = user-defined phase function at ANGF(I), boundary layer (0 to 2 km default altitude region)

F(2,I) = user-defined phase function at ANGF(I), troposphere (2 to 10 km default altitude region)

F(3,I) = user-defined phase function at ANGF(I), stratosphere (10 to 30 km default altitude region)

F(4,I) = User-defined phase function at ANGF(I), mesosphere (30 to 100 km default altitude region)

The default altitude regions may be overriden by the parameters IHA1, ICLD1 or IVUL1.

3.2.4 CARD 4: V1, V2, DV
FORMAT (3F10.3)

The spectral range and increment of the calculation.

V1 = initial frequency in wavenumber (cm^{-1})

V2 = final frequency in wavenumber (cm^{-1}), where V2 > V1

DV = frequency increment (or step size) (cm^{-1})
(Note that $\nu = 10^4/\lambda$, where ν is the frequency in cm^{-1} and λ is the wavelength in μm, and that DV can only take values that are a multiple of 5 cm^{-1} and that V1 and V2 are reset to the next lowest or highest integer multiple of 5 cm^{-1}.)

3.2.5 CARD 5: IRPT
FORMAT (I5)

The control parameter IRPT causes the program to recycle, so that a series of problems can be run with one submission of LOWTRAN.

IRPT = 0 to end program
= 1 to read all new data cards (1, 2, 3, 4, 5)
= 2 not used
= 3 read new CARD 3 (the geometry card) and CARD 5
= 4 read new CARD 4 (frequency) and CARD 5
> 4 or IRPT = 2 will cause program to STOP

Thus, if for the same model atmosphere and type of atmospheric path the reader wishes to make further transmittance calculations in different spectral intervals V1' to V2' etc., and for a different step size (DV etc.), then IRPT is set equal to 4. In this case, the card sequence is as follows and can be repeated as many times as required.

CARD 5 IRPT = 4
CARD 6 V1' V2' DV'
CARD 7 IRPT = 4
CARD 8 V1" V2" DV"
CARD 9 IRPT = 0

The final IRPT card should always be a blank or zero. When using the IRPT option, the wavelength dependence of the refractive index is not changed (use the IRPT = 1 option if this is required).

Table 15 summarizes the user-control parameters on CARD 4 and CARD 5.

Table 15. LOWTRAN CARD 4 and CARD 5 Input Parameters: V1, V2, DV, IRPT

CARD 4	V1, V2, DV Format (3F10.3)			
	V1 (cm^{-1})	V2 (cm^{-1})	DV (cm^{-1})	Multiple of 5 cm^{-1}
CARD 5	IRPT Format (I5)			
COL 5	IRPT			
0	End of program.			
1	Read new CARDS 1, 2, 3, 4, and 5.			
2	Not used (stops program).			
3	Read new CARDS 3 and 5.			
4	Read new CARDS 4 and 5.			

NOTE: IRPT=3 cannot be used when running multiple scattering cases or solar single scattering. Use IRPT=1.

3.3 Non-Standard Conditions

Several options and combination of choices are available if atmospheric transmittance/ radiance calculations are required for non-standard conditions. Here non-standard refers to conditions other than those specified by the parameters MODEL, IHAZE, and ICLD on CARDS 1 and 2. These options enable the user to insert:

(1) An additional atmospheric model (MODEL = 7), which can be in the form of radiosonde or other source data. It is not necessary to duplicate the altitudes used in LOWTRAN 7.

(2) Meteorological conditions for a given horizontal path calculation (MODEL = 0)

(3) A combination of any or all of the 12 gases can be input for each layer boundary with default choices interleaved with user supplied data.

(4) Aerosol vertical distributions can be input at specified altitudes by the use of AHAZE, EQLWCZ, and/or IHA1 on CARD 2C3 when IRD2 is set to 1 on CARD 2C.

(5) Cloud liquid water contents and or rain rates can be input at specified altitudes by the use of EQLWCZ, RRATZ and/or ICLD1 on CARD 2C3 when IRD2 is set to 1 on CARD 2C.

(6) Any combination of the one to four Aerosol altitude regions can be replaced by reading in specific values of extinction and absorption coefficients and asymmetry parameters for specific regions by utilizing CARDS 2D, 2D1 and 2D2. The parameters can be for aerosols and for clouds.

3.3.1 ADDITIONAL ATMOSPHERIC MODEL (MODEL = 7)

A new model atmosphere can be inserted by the use of CARD 2C and the required multiples of card 2C1, provided the parameters MODEL and IM are set to 7 and 1 respectively on CARD 1. The number of atmospheric levels to be inserted (ML) must also be specified on CARD 2C.

The appropriate meteorological parameters and the format are given below:

CARD 2C   ML, IRD1, IRD2, TITLE
           FORMAT (3I5, 18A4)

CARD 2C1   ZMDL, P, T, WMOL(1), WMOL(2), WMOL(3), (JCHAR(J), J = 1,14)
           FORMAT (F10.3, 5E10.3, 15A1)

See section 3.2.2.1 above for a detailed description of each variable.

3.3.2 HORIZONTAL PATHS (MODEL = 0)

If known meteorological data are to be used for horizontal path atmospheric transmittance/ radiance calculations, then set MODEL = 0 and IM = 1 on CARD 1. Proceed to read the meteorological conditions utilizing CARDS 2C and 2C1 as described above. In this instance the parameter ML must be set to 1.

3.3.3 USER INSERTED VALUES FOR ATMOSPHERIC GASES (MODEL = 0 OR 7)

The user may wish to enter specific values of any or all of the atmospheric gases. This can be accomplished by utilizing CARDS 2C, 2C1 and 2C2. On CARD 2C set IRD1 = 1. The specific gas amounts for individual gases can be entered on CARDS 2C1 and 2C2 and by utilizing the parameter JCHAR on CARD 2C1, the user has a choice of entering data in several different sets of units (eg.

volume mixing ratio, number density, . . . etc), or defaulting to one of the model atmospheric gases at the specified altitude.

3.3.4 USER INSERTED VALUES FOR AEROSOL VERTICAL DISTRIBUTION (MODEL = 0 OR 7)

The capability exists for the user to be able to replace aerosol distributions at specific altitudes. In order to accomplish this the user must set IRD2 to 1 on CARD 2C. Then specify the altitudes on CARDS 2C1 along with the variables, defaults and or units by utilizing the parameters as explained in section 3.2.2.1

On CARD 2C3 the aerosol scaling factor for a given altitude can be entered by using the variable AHAZE, or an appropriate value for EQLWCZ, or defaulted by using the variable IHA1.

3.3.5 USER INSERTED VALUES FOR CLOUD AND OR RAIN RATES (MODEL = 0 OR 7)

The same capability exists permitting the user to replace cloud liquid water contents and or rain rates at specific altitudes as described in the above section. This is accomplished by setting IRD2 to 1 on CARD 2C. Then the specific altitudes may be entered on CARDS 2C1 along with the variables, defaults and or unit selection by using the remaining parameters of CARD 2C1 as described earlier.

On CARD 2C3 the variables EQLWCZ and/or RRATZ can be used to enter the intended value of equivalent liquid water content of a cloud and/or the rain rate at the specified altitude, or the cloud attenuation can be specified by using AHAZE. The user may default at the specified altitude to one of the built-in cloud and/or rain model values by using ICLD1.

3.3.6 REPLACEMENT OF AEROSOL OR CLOUD ATTENUATION MODELS (IHAZE = 7 AND/OR ICLD = 11)

The aerosols or cloud model utilized in any or all of the four altitude regions may be replaced by a user input model. The built-in regions are 0-2 km, > 2-10 km, > 10-30 km and > 30-100 km. These regions may be modified by the use of the parameters IHA1, ICLD1 or IVUL1. This option is initialized by setting IHAZE = 7 or ICLD = 11.

On CARD 2D the variable IREG (1, 4) determines which of the altitude regions will have replacement values read in. The user is required to enter a conversion factor, AWCCON ($km \cdot gm \cdot m^{-3}$), on card 2D1, which converts aerosol or cloud profiles specified in terms of equivalent liquid water content, EQLWCZ ($gm \cdot m^{-3}$), to an extinction coefficient (km^{-1}). This conversion factor (AWCCON), is only used if the aerosol or cloud concentration are specified by EQLWCZ instead of by the visible extinction, AHAZE. The LOWTRAN values for this variable are stored as DATA statements in subroutine EXABIN. (See DATA statements ELWCR, ELWCM, ELWCU, ELWCT, AFLWC, RFLWC, CULWC, ASLWC, STLWC, SCLWC, SNLWC, BSLWC, FVLWC, AVLWC, and MDLWC.)

The multiply read CARDS 2D2 (13 cards) consist of four variables, VX, EXTC, ABSC and ASYM. The first variable VX is the wavelength of the data points which should correspond to the wavelengths used in the program (defined in array VX2 in Subroutine EXTDTA, see table 12). The next three variables EXTC, ABSC, and ASYM are the aerosol or cloud extinction, absorption coefficients and the asymmetry parameters respectively. As stated previously the variable IREG (1-4) will determine if the user is reading in 1, 2, 3, or 4 sets of CARDS 2D1-2D2. Additionally, by utilizing the variables IVUL1 and ISEA1 the user can substitute for stratospheric aerosol profiles and can change the seasonal profile values.

The values of EXTC(N,I) and ABSC(N,I) should be normalized so that EXTC(N,4) = 1.0 (i.e., the extinction for wavelength 0.55 μm is normalized to 1.0).

4. EXAMPLES OF PROGRAM OUTPUT

Four test cases are explained in this section. The input cards for the four cases are listed in Table 16 and the listings of the file OUTPUT (TAPE 6) are in Tables 17 through 20. The next four subsections contain detailed explanations for the specific test cases. The output of case 1 is discussed in detail while the discussion of the next three cases is limited to a description of the physically important details of the input. The LOWTRAN 7 tape as distributed by the National Climatic Data Center (see Section 2.4) contains additional test cases.

4.1 Case 1: Single and Multiple Scattered Solar Radiance

The program will compute atmospheric radiance using the single scattered solar radiance calculation combined with the multiple scattered solar radiance calculation. The parameters selected for this case are as follows: the atmospheric profile is the 1976 US Standard and the boundary layer aerosol model is RURAL with 5 km meteorological range. Since M1 through M6 are left blank along with MDEF being set to 0, the atmospheric profile values (pressure and temperature) along with all of the molecular species amounts are retained as initially chosen by MODEL. The surface albedo is set to 0.4. The path for this case is from 20 km to 0 km looking straight down. The solar zenith angle is 60 degrees and the relative azimuth angle is 0. The earth to sun distance is chosen for day 1 (January 1). The aerosol phase functions are from the Mie-generated database stored in the program. The spectral range of the calculation is from 14000 to 34000 cm^{-1} in steps of 100 cm^{-1}. (This test case is admittedly under sampled and is for illustration only. If more spectral detail exists in a given region, a smaller DV is recommended).

The output for this case shown in Table 17 will now be described in detail. On the first page the output echoes the input cards exactly as they are read in. CARD 1 selects the US Standard Atmosphere (MODEL = 6), type of slant path (ITYPE = 2), single scattering option (IEMSCT = 2), multiple scattering option (IMULT = 1), and the surface albedo (SALB = 0.4). CARD 2 selects the RURAL aerosol profile with the default meteorological range of 5 km (IHAZE = 2). CARD 3 describes the slant path in terms of the observer altitude (H1 = 20.0), endpoint at the ground (H2 = 0.0) and zenith angle (ANGLE = 180). On CARD 3A1 IPARM = 2 determines that the sun position will be described on CARD 3A2 in terms of the relative azimuth at H1 of 0° (PARM1) and the solar zenith angle at H1 of 60° (PARM2). IPH = 2 specifies that the Mie-generated phase function will be used while IDAY = 1 specifies that the earth-to-sun distance used to calculate the incident solar intensity will be that for January 1. ISOURC = 0 specifies the sun as the source. On CARD 3A2, only PARM1 and PARM2, as described earlier, are used for this case. The remaining parameters are left blank. CARD 4 selects the spectral range of 14000 to 34000 cm^{-1} in steps of 100 cm^{-1}. Following CARD 4 the program interprets the input cards in a more

(Text continued on page 63)

Table 16. Input Cards for Test Cases

```
    6    2    2    1    0    0    0    0    0    0    0    0    0  0.        0.4
    2    0    0    0    0    0     0.000     0.000     0.000     0.000
     20.0      00.0    180.
    2    2    1    0
  000.0     60.0      00.0      00.0      00.0      00.0      00.0      30.0
  14000.0   34000.0     100.0
  0

    2    3    1
    2    0    0    0    0
 0.0       0.        80.        0.
  740.      1250.     5.
    1
    2    3    1    1
    2    0    0    0    0
 0.0       0.        80.        0.
  740.      1250.     5.
    0

    6    2
    1    0    0    0    0                                               1.5
 1.5       6.        0.        0.
  990.      1090.     5.
    0

    6    3    3
    1
       0.0                 60.0   74
    6000.0    7500.0       20.0
    0
```

Table 17. Program Output for Case 1

```
                 ***** LOWTRAN 7 *****

CARD 1   *****    6    2    2    1    0    0    0    0    0    0    0    0    0    .000    .40

CARD 2   *****    2    0    0    0    0    0       .000       .000       .000       .000       .000

CARD 3   *****   20.000       .000   180.000       .000       .000       .000    0

CARD 3A1*****     2    2    1    0

CARD 3A2*****       .000    60.000       .000       .000       .000       .000       .000       .000

CARD 4   ***** 14000.000 34000.000    100.000

PROGRAM WILL COMPUTE RADIANCE+SOLAR SCATTERNG

CALCULATIONS WILL BE DONE USING MULTIPLE SCATTERINC

ATMOSPHERIC MODEL
        TEMPERATURE =     6       1976 U S STANDARD
        WATER VAPOR =     6       1976 U S STANDARD
        OZONE       =     6       1976 U S STANDARD
                   M4 =      6 M5 =      6 M6 =      6 MDEF =      1

AEROSOL MODEL
        REGIME                      AEROSOL TYPE              PROFILE                    SEASON

        BOUNDARY LAYER (0-2 KM)  RURAL                       5.0 KM VIS AT SEA LEVEL
        TROPOSPHERE  (2-10KM)    TROPOSPHERIC               TROPOSPHERIC               SPRING-SUMMER
        STRATOSPHERE (10-30KM)   BACKGROUND STRATO          BACKGROUND STRATO          SPRING-SUMMER
        UPPER ATMOS (30-100KM)   METEORIC DUST              NORMAL

SLANT PATH, H1 TO H2
        H1     =     20.000 KM
        H2     =       .000 KM
        ANGLE  =    180.000 DEG
        RANGE  =       .000 KM
        BETA   =       .000 DEG
        LEN    =       0

SINGLE SCATTERING CONTROL PARAMETERS SUMMARY

        RELATIVE AZIMUTH =            .000 DEG EAST OF NORTH
        SOLAR ZENITH =              60.000 DEG
        TIME (<0 UNDEF) =             .000 GREENWICH TIME
        PATH AZIMUTH =                .000 DEG EAST OF NORTH
        DAY OF THE YEAR =            1

EXTRATERRESTIAL SOURCE IS THE SUN

PHASE FUNCTION FROM MIE DATA BASE

FREQUENCY RANGE
         V1 =      14000.0 CM-1  (        .71 MICROMETERS)
         V2 =      34000.0 CM-1  (        .29 MICROMETERS)
         DV =        100.0 CM-1
```

Table 17. Program Output for Case 1 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	N2	CNTMSLF (MOL/CM2 KM)	MOL SCAT (-)	N-1 (-)	O3 (UV) (ATM CM/KM)	O2 (UV) (ATM CM/KM)
1	.00	1013.000	288.2	7.203E-01	1.566E+20	9.475E-01	2.815E-04	2.519E-03	3.348E+04
2	1.00	898.800	281.7	5.868E-01	7.926E+19	8.601E-01	2.556E-04	2.519E-03	2.924E+04
3	2.00	795.000	275.2	4.754E-01	3.781E+19	7.788E-01	2.314E-04	2.519E-03	2.551E+04
4	3.00	701.200	268.7	3.834E-01	1.457E+19	7.035E-01	2.091E-04	2.333E-03	2.224E+04
5	4.00	616.600	262.2	3.075E-01	5.440E+18	6.340E-01	1.885E-04	2.146E-03	1.937E+04
6	5.00	540.500	255.7	2.454E-01	1.842E+18	5.698E-01	1.694E-04	2.146E-03	1.685E+04
7	6.00	472.200	249.2	1.946E-01	6.495E+17	5.108E-01	1.519E-04	2.099E-03	1.465E+04
8	7.00	411.100	242.7	1.535E-01	1.983E+17	4.566E-01	1.358E-04	2.286E-03	1.272E+04
9	8.00	356.500	236.2	1.202E-01	6.471E+16	4.069E-01	1.210E-04	2.426E-03	1.102E+04
10	9.00	308.000	229.7	9.358E-02	9.518E+15	3.615E-01	1.075E-04	3.312E-03	9.542E+03
11	10.00	265.000	223.3	7.227E-02	1.456E+15	3.199E-01	9.514E-05	4.198E-03	8.242E+03
12	11.00	227.000	218.8	5.543E-02	3.023E+14	2.823E-01	8.394E-05	6.062E-03	7.110E+03
13	12.00	194.000	216.7	4.052E-02	6.151E+13	2.413E-01	7.177E-05	7.464E-03	5.929E+03
14	13.00	165.800	216.7	2.959E-02	1.456E+13	2.063E-01	6.134E-05	7.927E-03	4.957E+03
15	14.00	141.700	216.7	2.162E-02	3.173E+12	1.763E-01	5.242E-05	8.861E-03	4.155E+03
16	15.00	121.100	216.7	1.579E-02	1.649E+12	1.507E-01	4.480E-05	9.793E-03	3.493E+03
17	16.00	103.500	216.7	1.153E-02	7.519E+11	1.288E-01	3.829E-05	1.120E-02	2.942E+03
18	17.00	88.500	216.7	8.432E-03	5.223E+11	1.101E-01	3.274E-05	1.306E-02	2.484E+03
19	18.00	75.650	216.7	6.161E-03	3.767E+11	9.411E-02	2.799E-05	1.493E-02	2.101E+03
20	19.00	64.670	216.7	4.502E-03	2.789E+11	8.045E-02	2.392E-05	1.632E-02	1.779E+03
21	20.00	55.290	216.7	3.291E-03	2.092E+11	6.878E-02	2.045E-05	1.773E-02	1.509E+03
22	21.00	47.290	217.6	2.393E-03	1.576E+11	5.859E-02	1.742E-05	1.773E-02	1.276E+03
23	22.00	40.470	218.6	1.740E-03	1.196E+11	4.991E-02	1.484E-05	1.819E-02	1.080E+03
24	23.00	34.670	219.6	1.268E-03	9.286E+10	4.256E-02	1.256E-05	1.773E-02	9.165E+02
25	24.00	29.720	220.6	9.258E-04	7.090E+10	3.632E-02	1.080E-05	1.679E-02	7.787E+02
26	25.00	25.490	221.6	6.764E-04	5.473E+10	3.101E-02	9.222E-06	1.586E-02	6.623E+02
27	30.00	11.970	226.5	1.443E-04	1.317E+10	1.425E-02	4.237E-06	9.330E-03	3.006E+02
28	35.00	5.746	236.5	3.117E-05	2.994E+09	6.550E-03	1.948E-06	5.130E-03	1.375E+02
29	40.00	2.871	250.4	7.144E-06	7.012E+08	3.091E-03	9.192E-07	2.255E-03	6.470E+01
30	45.00	1.491	264.2	1.778E-06	1.837E+08	1.521E-03	4.524E-07	7.982E-04	3.181E+01
31	50.00	.798	270.7	4.908E-07	5.009E+07	7.945E-04	2.363E-07	2.461E-04	1.[illegible]E+01
32	70.00	.052	219.6	2.875E-09	1.462E+05	6.438E-05	1.906E-08	1.921E-06	1.338E+00
33	100.00	.000	195.1	1.290E-13	9.093E-02	4.422E-07	1.315E-10	1.767E-08	7.070E-03

Table 17. Program Output for Case 1 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1 (-)	AEROSOL 2 (-)	AEROSOL 3 (-)	AEROSOL 4 (-)	AER1*RH (-)	CIRRUS (-)	RH (PERCNT)
1	.00	1013.000	288.2	2.007E+22	4.738E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	3.074E+00	0.000E+00	4.584E+01
2	1.00	898.800	281.7	1.299E+22	5.126E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	3.028E+00	0.000E+00	4.898E+01
3	2.00	795.000	275.2	8.133E+21	5.397E-06	6.210E-02	0.000E+00	0.000E+00	0.000E+00	2.405E-01	0.000E+00	5.194E+01
4	3.00	701.200	268.7	4.567E+21	5.565E-06	0.000E+00	3.460E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.071E+01
5	4.00	616.600	262.2	2.518E+21	5.623E-06	0.000E+00	1.850E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.004E+01
6	5.00	540.500	255.7	1.318E+21	5.556E-06	0.000E+00	9.310E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.836E+01
7	6.00	472.200	249.2	7.018E+20	5.670E-06	0.000E+00	7.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.916E+01
8	7.00	411.100	242.7	3.468E+20	5.754E-06	0.000E+00	6.230E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.814E+01
9	8.00	356.500	236.2	1.765E+20	5.656E-06	0.000E+00	3.370E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.054E+01
10	9.00	308.000	229.7	6.016E+19	5.531E-06	0.000E+00	1.820E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.708E+01
11	10.00	265.000	223.3	2.083E+19	5.567E-06	0.000E+00	1.140E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.869E+01
12	11.00	227.000	216.8	8.374E+18	5.702E-06	0.000E+00	0.000E+00	7.990E-04	0.000E+00	0.000E+00	0.000E+00	2.743E+01
13	12.00	194.000	216.7	3.230E+18	5.816E-06	0.000E+00	0.000E+00	6.410E-04	0.000E+00	0.000E+00	0.000E+00	1.252E+01
14	13.00	165.800	216.7	1.343E+18	5.693E-06	0.000E+00	0.000E+00	5.170E-04	0.000E+00	0.000E+00	0.000E+00	6.092E+00
15	14.00	141.700	216.7	5.358E+17	5.870E-06	0.000E+00	0.000E+00	4.420E-04	0.000E+00	0.000E+00	0.000E+00	2.844E+00
16	15.00	121.100	216.7	3.301E+17	6.809E-06	0.000E+00	0.000E+00	3.950E-04	0.000E+00	0.000E+00	0.000E+00	2.050E+00
17	16.00	103.500	216.7	1.905E+17	9.489E-06	0.000E+00	0.000E+00	3.820E-04	0.000E+00	0.000E+00	0.000E+00	1.384E+00
18	17.00	88.500	216.7	1.358E+17	1.442E-05	0.000E+00	0.000E+00	4.250E-04	0.000E+00	0.000E+00	0.000E+00	1.154E+00
19	18.00	75.650	216.7	9.855E+16	1.986E-05	0.000E+00	0.000E+00	5.200E-04	0.000E+00	0.000E+00	0.000E+00	9.798E-01
20	19.00	64.670	216.7	7.249E+16	2.550E-05	0.000E+00	0.000E+00	5.810E-04	0.000E+00	0.000E+00	0.000E+00	8.431E-01
21	20.00	55.290	216.7	5.368E+16	2.889E-05	0.000E+00	0.000E+00	5.890E-04	0.000E+00	0.000E+00	0.000E+00	7.302E-01
22	21.00	47.290	217.6	3.969E+16	2.894E-05	0.000E+00	0.000E+00	5.020E-04	0.000E+00	0.000E+00	0.000E+00	5.702E-01
23	22.00	40.470	218.6	2.946E+16	2.725E-05	0.000E+00	0.000E+00	4.200E-04	0.000E+00	0.000E+00	0.000E+00	4.422E-01
24	23.00	34.670	219.6	2.213E+16	2.443E-05	0.000E+00	0.000E+00	3.000E-04	0.000E+00	0.000E+00	0.000E+00	3.472E-01
25	24.00	29.720	220.6	1.650E+16	2.121E-05	0.000E+00	0.000E+00	1.980E-04	0.000E+00	0.000E+00	0.000E+00	2.707E-01
26	25.00	25.490	221.6	1.238E+16	1.740E-05	0.000E+00	0.000E+00	1.310E-04	0.000E+00	0.000E+00	0.000E+00	2.125E-01
27	30.00	11.970	226.5	2.790E+15	5.328E-06	0.000E+00	0.000E+00	3.320E-05	0.000E+00	0.000E+00	0.000E+00	6.101E-02
28	35.00	5.746	236.5	6.115E+14	1.074E-06	0.000E+00	0.000E+00	0.000E+00	1.640E-05	0.000E+00	0.000E+00	1.056E-02
29	40.00	2.871	250.4	1.397E+14	1.647E-07	0.000E+00	0.000E+00	0.000E+00	7.990E-06	0.000E+00	0.000E+00	1.460E-03
30	45.00	1.491	264.2	3.518E+13	1.841E-08	0.000E+00	0.000E+00	0.000E+00	4.010E-06	0.000E+00	0.000E+00	2.502E-04
31	50.00	.798	270.7	9.595E+12	4.409E-09	0.000E+00	0.000E+00	0.000E+00	2.100E-06	0.000E+00	0.000E+00	6.159E-05
32	70.00	.052	219.6	4.181E+10	2.095E-10	0.000E+00	0.000E+00	0.000E+00	1.600E-07	0.000E+00	0.000E+00	4.357E-04
33	100.00	.000	195.1	2.275E+05	1.207E-12	0.000E+00	0.000E+00	0.000E+00	9.310E-10	0.000E+00	0.000E+00	8.646E-06

Table 17. Program Output for Case 1 (Cont.)

ATMOSPHERIC PROFILES

(IF A MOLECULE HAS MORE THAN ONE BAND, THEN THE DATA FOR THE FIRST BAND ARE SHOWN.)

I	Z (KM)	P (MB)	T (K)	H2O G/CM**2/KM	O3 (	CO2	CO	CH4 ATM CM/KM	N2O	O2	NH3	NO	NO2	SO2)
1	.00	1013.000	288.2	5.79E-01	2.34E-03	3.53E+01	1.37E-02	1.65E-01	2.88E-02	1.69E+04	4.97E-05	2.91E-05	2.18E-06	2.66E-05
2	1.00	898.800	281.7	3.69E-01	2.30E-03	2.81E+01	1.11E-02	1.36E-01	2.55E-02	1.42E+04	4.01E-05	2.46E-05	1.89E-06	2.19E-05
3	2.00	795.000	275.2	2.28E-01	2.25E-03	2.22E+01	9.01E-03	1.12E-01	2.26E-02	1.19E+04	2.99E-05	2.06E-05	1.63E-06	1.69E-05
4	3.00	701.200	268.7	1.26E-01	2.04E-03	1.75E+01	7.25E-03	9.13E-02	1.99E-02	9.96E+03	1.96E-05	1.72E-05	1.40E-06	1.22E-05
5	4.00	616.600	262.2	6.84E-02	1.84E-03	1.37E+01	5.87E-03	7.43E-02	1.75E-02	8.29E+03	1.18E-05	1.44E-05	1.19E-06	8.40E-06
6	5.00	540.500	255.7	3.53E-02	1.81E-03	1.06E+01	4.82E-03	6.01E-02	1.53E-02	6.87E+03	6.61E-06	1.19E-05	1.02E-06	6.06E-06
7	6.00	472.200	249.2	1.85E-02	1.73E-03	8.21E+00	3.92E-03	4.84E-02	1.33E-02	5.66E+03	3.72E-06	9.81E-06	8.64E-07	4.43E-06
8	7.00	411.100	242.7	9.00E-03	1.84E-03	6.30E+00	3.11E-03	3.68E-02	1.16E-02	4.64E+03	1.96E-06	8.05E-06	7.30E-07	3.36E-06
9	8.00	356.500	236.2	4.51E-03	1.91E-03	4.80E+00	2.41E-03	3.08E-02	1.00E-02	3.79E+03	9.98E-07	6.57E-06	6.14E-07	2.58E-06
10	9.00	308.000	229.7	1.51E-03	2.56E-03	3.63E+00	1.80E-03	2.43E-02	8.66E-03	3.07E+03	4.47E-07	5.34E-06	5.18E-07	2.07E-06
11	10.00	265.000	223.3	5.16E-04	3.16E-03	2.72E+00	1.32E-03	1.90E-02	7.40E-03	2.47E+03	1.84E-07	4.31E-06	4.43E-07	1.68E-06
12	11.00	227.000	216.8	2.04E-04	4.46E-03	2.03E+00	9.53E-04	1.47E-02	6.25E-03	1.98E+03	7.50E-08	3.45E-06	4.04E-07	1.40E-06
13	12.00	194.000	216.7	7.88E-05	5.14E-03	1.56E+00	6.31E-04	1.12E-02	4.96E-03	1.41E+03	3.27E-08	2.72E-06	3.90E-07	1.10E-06
14	13.00	165.800	216.7	3.29E-05	5.11E-03	1.20E+00	3.90E-04	8.45E-03	3.94E-03	9.99E+02	1.22E-08	2.13E-06	4.43E-07	8.99E-07
15	14.00	141.700	216.7	1.32E-05	5.35E-03	9.22E-01	2.33E-04	6.38E-03	3.12E-03	7.08E+02	3.27E-09	1.65E-06	5.98E-07	7.41E-07
16	15.00	121.100	216.7	8.13E-06	5.54E-03	7.09E-01	1.39E-04	4.81E-03	2.47E-03	5.02E+02	9.91E-10	1.25E-06	1.10E-06	6.16E-07
17	16.00	103.500	216.7	4.71E-06	5.93E-03	5.46E-01	8.20E-05	3.62E-03	1.94E-03	3.56E+02	3.53E-10	9.30E-07	1.64E-06	5.03E-07
18	17.00	88.500	216.7	3.36E-06	6.47E-03	4.20E-01	5.05E-05	2.72E-03	1.51E-03	2.53E+02	1.39E-10	6.89E-07	2.15E-06	3.83E-07
19	18.00	75.650	216.7	2.45E-06	6.93E-03	3.23E-01	3.03E-05	2.04E-03	1.17E-03	1.79E+02	6.36E-11	5.16E-07	2.57E-06	2.79E-07
20	19.00	64.670	216.7	1.81E-06	7.09E-03	2.49E-01	1.81E-05	1.51E-03	8.92E-04	1.27E+02	2.84E-11	4.13E-07	2.83E-06	1.89E-07
21	20.00	55.290	216.7	1.34E-06	7.21E-03	1.91E-01	1.18E-05	1.11E-03	6.72E-04	9.03E+01	1.30E-11	3.40E-07	2.99E-06	1.24E-07
22	21.00	47.290	217.6	9.98E-07	6.71E-03	1.48E-01	8.25E-06	8.09E-04	4.99E-04	6.31E+01	7.82E-12	2.90E-07	3.03E-06	8.39E-08
23	22.00	40.470	218.6	7.45E-07	6.41E-03	1.15E-01	6.22E-06	5.80E-04	3.73E-04	4.41E+01	5.29E-12	2.53E-07	2.98E-06	5.80E-08
24	23.00	34.670	219.6	5.63E-07	5.82E-03	8.93E-02	4.99E-06	4.15E-04	2.86E-04	3.09E+01	3.70E-12	2.34E-07	2.85E-06	4.27E-08
25	24.00	29.720	220.6	4.22E-07	5.13E-03	6.94E-02	4.05E-06	2.99E-04	2.19E-04	2.16E+01	2.54E-12	2.31E-07	2.72E-06	3.18E-08
26	25.00	25.490	221.6	3.19E-07	4.52E-03	5.40E-02	3.28E-06	2.16E-04	1.64E-04	1.52E+01	1.64E-12	2.77E-07	2.67E-06	2.37E-08
27	30.00	11.970	226.5	7.39E-08	1.88E-03	1.57E-02	9.54E-07	5.06E-05	4.48E-05	2.66E+00	2.17E-13	3.09E-07	1.50E-06	6.51E-09
28	35.00	5.746	236.5	1.69E-08	7.14E-04	4.87E-03	2.87E-07	1.15E-05	9.82E-06	4.51E-01	1.65E-14	2.87E-07	6.11E-07	1.98E-09
29	40.00	2.871	250.4	4.07E-09	2.17E-04	1.64E-03	9.55E-08	2.55E-06	1.64E-06	7.87E-02	7.58E-16	1.51E-07	1.22E-07	8.32E-10
30	45.00	1.491	264.2	1.08E-09	5.40E-05	5.87E-04	3.57E-08	5.18E-07	2.12E-07	1.52E-02	2.35E-17	5.65E-08	1.32E-08	4.88E-10
31	50.00	.798	270.7	3.02E-10	1.24E-05	2.13E-04	1.62E-08	1.01E-07	2.55E-08	3.50E-03	1.82E-18	1.89E-08	2.08E-09	3.49E-10
32	70.00	.052	219.6	1.20E-12	4.12E-08	1.72E-06	1.27E-09	7.61E-10	2.15E-10	2.06E-05	4.89E-21	3.67E-10	2.94E-11	1.98E-11
33	100.00	.000	195.1	6.67E-18	5.25E-11	1.77E-10	1.10E-11	1.05E-13	7.00E-14	3.65E-10	2.93E-25	2.97E-11	1.98E-14	2.92E-16

CASE 2A: GIVEN H1, H2, ANGLE

SLANT PATH PARAMETERS IN STANDARD FORM

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H1     =      .000 KM
H2     =   100.000 KM
ANGLE  =      .000 DEG
PHI    =   180.000 DEG
HMIN   =      .000 KM
LEN    =         0
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Table 17. Program Output for Case 1 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	.000	1.000	.000	1.000	1.000	.000	.000	180.000	.000	.000	955.683	284.99	1.17E-03
2	1.000	2.000	.000	1.000	2.000	.000	.000	180.000	.000	.000	846.698	278.49	1.06E-03
3	2.000	3.000	.000	1.000	3.000	.000	.000	180.000	.000	.000	747.913	271.99	9.57E-04
4	3.000	4.000	.000	1.000	4.000	.000	.000	180.000	.000	.000	658.727	265.49	8.63E-04
5	4.000	5.000	.000	1.000	5.000	.000	.000	180.000	.000	.000	578.391	258.99	7.77E-04
6	5.000	6.000	.000	1.000	6.000	.000	.000	180.000	.000	.000	506.204	252.50	6.98E-04
7	6.000	7.000	.000	1.000	7.000	.000	.000	180.000	.000	.000	441.516	246.00	6.24E-04
8	7.000	8.000	.000	1.000	8.000	.000	.000	180.000	.000	.000	383.677	239.50	5.57E-04
9	8.000	9.000	.000	1.000	9.000	.000	.000	180.000	.000	.000	332.137	233.00	4.96E-04
10	9.000	10.000	.000	1.000	10.000	.000	.000	180.000	.000	.000	286.399	226.55	4.40E-04
11	10.000	11.000	.000	1.000	11.000	.000	.000	180.000	.000	.000	245.907	220.10	3.89E-04
12	11.000	12.000	.000	1.000	12.000	.000	.000	180.000	.000	.000	210.499	216.75	3.38E-04
13	12.000	13.000	.000	1.000	13.000	.000	.000	180.000	.000	.000	179.900	216.70	2.89E-04
14	13.000	14.000	.000	1.000	14.000	.000	.000	180.000	.000	.000	153.750	216.70	2.47E-04
15	14.000	15.000	.000	1.000	15.000	.000	.000	180.000	.000	.000	131.400	216.70	2.11E-04
16	15.000	16.000	.000	1.000	16.000	.000	.000	180.000	.000	.000	112.300	216.70	1.80E-04
17	16.000	17.000	.000	1.000	17.000	.000	.000	180.000	.000	.000	96.000	216.70	1.54E-04
18	17.000	18.000	.000	1.000	18.000	.000	.000	180.000	.000	.000	82.075	216.70	1.32E-04
19	18.000	19.000	.000	1.000	19.000	.000	.000	180.000	.000	.000	70.160	216.70	1.13E-04
20	19.000	20.000	.000	1.000	20.000	.000	.000	180.000	.000	.000	59.980	216.70	9.62E-05
21	20.000	21.000	.000	1.000	21.000	.000	.000	180.000	.000	.000	51.293	217.14	8.21E-05
22	21.000	22.000	.000	1.000	22.000	.000	.000	180.000	.000	.000	43.883	218.09	7.00E-05
23	22.000	23.000	.000	1.000	23.000	.000	.000	180.000	.000	.000	37.572	219.09	5.96E-05
24	23.000	24.000	.000	1.000	24.000	.000	.000	180.000	.000	.000	32.197	220.09	5.09E-05
25	24.000	25.000	.000	1.000	25.000	.000	.000	180.000	.000	.000	27.607	221.09	4.34E-05
26	25.000	30.000	.000	5.000	30.000	.000	.000	180.000	.000	.000	18.754	223.73	2.79E-05
27	30.000	35.000	.000	5.000	35.000	.000	.000	180.000	.000	.000	8.880	230.82	1.28E-05
28	35.000	40.000	.000	5.000	40.000	.000	.000	180.000	.000	.000	4.322	242.52	5.95E-06
29	40.000	45.000	.000	5.000	45.000	.000	.000	180.000	.000	.000	2.187	256.43	2.86E-06
30	45.000	50.000	.000	5.000	50.000	.000	.000	180.000	.000	.000	1.146	267.09	1.45E-06
31	50.000	70.000	.000	20.000	70.000	.000	.000	180.000	.000	.000	.414	254.07	3.75E-07
32	70.000	100.000	.000	30.000	100.000	.000	.000	180.000	.000	.000	.026	214.67	1.65E-08

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	1.000	284.99	4.932E-06	2.519E-03	1.136E+20	3.473E+19	1.627E+22	3.131E+04
2	2.000	278.49	1.019E-05	5.038E-03	1.696E+20	6.197E+19	2.665E+22	5.865E+04
3	3.000	271.99	1.567E-05	7.463E-03	1.939E+20	7.822E+19	3.282E+22	8.249E+04
4	4.000	265.49	2.127E-05	9.701E-03	2.032E+20	8.607E+19	3.627E+22	1.033E+05
5	5.000	258.99	2.686E-05	1.185E-02	2.065E+20	8.939E+19	3.812E+22	1.213E+05
6	6.000	252.50	3.247E-05	1.397E-02	2.077E+20	9.054E+19	3.910E+22	1.371E+05
7	7.000	246.00	3.818E-05	1.616E-02	2.080E+20	9.092E+19	3.960E+22	1.507E+05
8	8.000	239.50	4.389E-05	1.852E-02	2.082E+20	9.103E+19	3.985E+22	1.626E+05
9	9.000	233.00	4.948E-05	2.139E-02	2.082E+20	9.106E+19	3.996E+22	1.728E+05
10	10.000	226.55	5.503E-05	2.514E-02	2.082E+20	9.107E+19	4.000E+22	1.817E+05
11	11.000	220.10	6.066E-05	3.027E-02	2.082E+20	9.107E+19	4.001E+22	1.894E+05
12	12.000	216.75	6.642E-05	3.703E-02	2.082E+20	9.107E+19	4.002E+22	1.959E+05
13	13.000	216.70	7.218E-05	4.473E-02	2.082E+20	9.107E+19	4.002E+22	2.013E+05

Table 17. Program Output for Case 1 (Cont.)

14	14.000	216.70	7.796E-05	5.312E-02	2.082E+20	9.107E+19	4.002E+22	2.058E+05
15	15.000	216.70	8.430E-05	6.245E-02	2.082E+20	9.107E+19	4.002E+22	2.097E+05
16	16.000	215.70	9.245E-05	7.294E-02	2.082E+20	9.107E+19	4.002E+22	2.129E+05
17	17.000	216.70	1.044E-04	8.507E-02	2.082E+20	9.107E+19	4.002E+22	2.156E+05
18	18.000	216.70	1.215E-04	9.906E-02	2.082E+20	9.107E+19	4.002E+22	2.179E+05
19	19.000	216.70	1.442E-04	1.147E-01	2.082E+20	9.107E+19	4.002E+22	2.198E+05
20	20.000	216.70	1.714E-04	1.31[illegible]E-01	2.082E+20	9.107E+19	4.002E+22	2.214E+05
21	21.000	217.14	2.003E-04	1.494E-01	2.082E+20	9.107E+19	4.002E+22	2.228E+05
22	22.000	218.09	2.284E-04	1.674E-01	2.082E+20	9.107E+19	4.002E+22	2.240E+05
23	23.000	219.09	2.542E-04	1.854E-01	2.082E+20	9.107E+19	4.002E+22	2.250E+05
24	24.000	220.09	2.770E-04	2.026E-01	2.082E+20	9.107E+19	4.002E+22	2.258E+05
25	25.000	221.09	2.963E-04	2.189E-01	2.082E+20	9.107E+19	4.002E+22	2.266E+05
26	30.000	223.73	3.473E-04	2.805E-01	2.082E+20	9.107E+19	4.002E+22	2.289E+05
27	35.000	230.82	3.605E-04	3.156E-01	2.082E+20	9.107E+19	4.002E+22	2.299E+05
28	40.000	242.52	3.630E-04	3.331E-01	2.082E+20	9.107E+19	4.002E+22	2.304E+05
29	45.000	256.43	3.633E-04	3.401E-01	2.082E+20	9.107E+19	4.002E+22	2.306E+05
30	50.000	267.09	3.633E-04	3.424E-01	2.082E+20	9.107E+19	4.002E+22	2.307E+05
31	70.000	254.07	3.634E-04	3.434E-01	2.082E+20	9.107E+19	4.002E+22	2.309E+05
32	100.000	214.67	3.634E-04	3.434E-01	2.082E+20	9.107E+19	4.002E+22	2.309E+05

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	1.000	6.512E-01	9.031E-01	7.700E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	2.000	1.180E+00	1.722E+00	1.051E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.000	1.608E+00	2.462E+00	1.082E+00	1.730E-02	0.000E+00	0.000E+00	0.000E+00
4	4.000	1.952E+00	3.131E+00	1.082E+00	4.302E-02	0.000E+00	0.000E+00	0.000E+00
5	5.000	2.227E+00	3.732E+00	1.082E+00	5.640E-02	0.000E+00	0.000E+00	0.000E+00
6	6.000	2.446E+00	4.272E+00	1.082E+00	6.488E-02	0.000E+00	0.000E+00	0.000E+00
7	7.000	2.620E+00	4.755E+00	1.082E+00	7.183E-02	0.000E+00	0.000E+00	0.000E+00
8	8.000	2.756E+00	5.186E+00	1.082E+00	7.648E-02	0.000E+00	0.000E+00	0.000E+00
9	9.000	2.862E+00	5.570E+00	1.082E+00	7.900E-02	0.000E+00	0.000E+00	0.000E+00
10	10.000	2.945E+00	5.910E+00	1.082E+00	8.045E-02	0.000E+00	0.000E+00	0.000E+00
11	11.000	3.008E+00	6.211E+00	1.082E+00	8.102E-02	3.995E-04	0.000E+00	0.000E+00
12	12.000	3.056E+00	6.472E+00	1.082E+00	8.102E-02	1.117E-03	0.000E+00	0.000E+00
13	13.000	3.091E+00	6.695E+00	1.082E+00	8.102E-02	1.693E-03	0.000E+00	0.000E+00
14	14.000	3.116E+00	6.886E+00	1.082E+00	8.102E-02	2.172E-03	0.000E+00	0.000E+00
15	15.000	3.135E+00	7.049E+00	1.082E+00	8.102E-02	2.590E-03	0.000E+00	0.000E+00
16	16.000	3.148E+00	7.189E+00	1.082E+00	8.102E-02	2.978E-03	0.000E+00	0.000E+00
17	17.000	3.158E+00	7.308E+00	1.082E+00	8.102E-02	3.382E-03	0.000E+00	0.000E+00
18	18.000	3.165E+00	7.410E+00	1.082E+00	8.102E-02	3.854E-03	0.000E+00	0.000E+00
19	19.000	3.171E+00	7.497E+00	1.082E+00	8.102E-02	4.405E-03	0.000E+00	0.000E+00
20	20.000	3.174E+00	7.571E+00	1.082E+00	8.102E-02	4.990E-03	0.000E+00	0.000E+00
21	21.000	3.177E+00	7.635E+00	1.082E+00	8.102E-02	5.534E-03	0.000E+00	0.000E+00
22	22.000	3.179E+00	7.689E+00	1.082E+00	8.102E-02	5.994E-03	0.000E+00	0.000E+00
23	23.000	3.181E+00	7.735E+00	1.082E+00	8.102E-02	6.351E-03	0.000E+00	0.000E+00
24	24.000	3.182E+00	7.775E+00	1.082E+00	8.102E-02	6.596E-03	0.000E+00	0.000E+00
25	25.000	3.183E+00	7.808E+00	1.082E+00	8.102E-02	6.758E-03	0.000E+00	0.000E+00
26	30.000	3.184E+00	7.916E+00	1.082E+00	8.102E-02	7.115E-03	0.000E+00	0.000E+00
27	35.000	3.185E+00	7.966E+00	1.082E+00	8.102E-02	7.198E-03	4.100E-05	0.000E+00
28	40.000	3.185E+00	7.989E+00	1.082E+00	8.102E-02	7.198E-03	9.948E-05	0.000E+00
29	45.000	3.163E+00	8.000E+00	1.082E+00	8.102E-02	7.198E-03	1.283E-04	0.000E+00
30	50.000	3.185E+00	8.005E+00	1.082E+00	8.102E-02	7.198E-03	1.431E-04	0.000E+00
31	70.000	3.185E+00	8.011E+00	1.082E+00	8.102E-02	7.198E-03	1.582E-04	0.000E+00
32	100.000	3.185E+00	8.011E+00	1.082E+00	8.102E-02	7.198E-03	1.591E-04	0.000E+00

J	Z (KM)	H2O (G/CM**2)	(O3	CO2	CO	CH4	N2O	O2	NH3	NO	NO2	SO2)
			ATM CM									

Table 17. Program Output for Case 1 (Cont.)

1	1.00	4.66E-01	2.32E-03	3.15E+01	1.24E-02	1.50E-01	2.71E-02	1.55E+04	4.48E-05	2.68E-05	2.03E-06	2.42E-05
2	2.00	7.59E-01	4.59E-03	5.65E+01	2.24E-02	2.73E-01	5.12E-02	2.85E+04	7.95E-05	4.93E-05	3.79E-06	4.35E-05
3	3.00	9.31E-01	6.74E-03	7.63E+01	3.05E-02	3.74E-01	7.23E-02	3.95E+04	1.04E-04	6.82E-05	5.30E-06	5.79E-05
4	4.00	1.02E+00	8.68E-03	9.18E+01	3.70E-02	4.57E-01	9.10E-02	4.86E+04	1.19E-04	8.39E-05	6.59E-06	6.81E-05
5	5.00	1.07E+00	1.05E-02	1.04E+02	4.24E-02	5.24E-01	1.07E-01	5.61E+04	1.28E-04	9.70E-05	7.69E-06	7.53E-05
6	6.00	1.10E+00	1.23E-02	1.13E+02	4.67E-02	5.78E-01	1.22E-01	6.24E+04	1.33E-04	1.08E-04	8.63E-06	8.05E-05
7	7.00	1.11E+00	1.41E-02	1.20E+02	5.02E-02	6.21E-01	1.34E-01	6.75E+04	1.36E-04	1.17E-04	9.43E-06	8.44E-05
8	8.00	1.12E+00	1.59E-02	1.26E+02	5.30E-02	6.56E-01	1.45E-01	7.17E+04	1.37E-04	1.24E-04	1.01E-05	8.73E-05
9	9.00	1.12E+00	1.82E-02	1.30E+02	5.51E-02	6.83E-01	1.54E-01	7.51E+04	1.38E-04	1.30E-04	1.07E-05	8.96E-05
10	10.00	1.12E+00	2.10E-02	1.33E+02	5.66E-02	7.05E-01	1.62E-01	7.79E+04	1.38E-04	1.35E-04	1.11E-05	9.15E-05
11	11.00	1.12E+00	2.48E-02	1.36E+02	5.77E-02	7.21E-01	1.69E-01	8.01E+04	1.38E-04	1.39E-04	1.16E-05	9.30E-05
12	12.00	1.12E+00	2.96E-02	1.37E+02	5.85E-02	7.34E-01	1.75E-01	8.18E+04	1.39E-04	1.42E-04	1.20E-05	9.43E-05
13	13.00	1.12E+00	3.48E-02	1.39E+02	5.90E-02	7.44E-01	1.79E-01	8.30E+04	1.39E-04	1.44E-04	1.24E-05	9.53E-05
14	14.00	1.12E+00	4.00E-02	1.40E+02	5.93E-02	7.51E-01	1.83E-01	8.38E+04	1.39E-04	1.46E-04	1.29E-05	9.61E-05
15	15.00	1.12E+00	4.55E-02	1.41E+02	5.95E-02	7.57E-01	1.85E-01	8.44E+04	1.39E-04	1.47E-04	1.37E-05	9.68E-05
16	16.00	1.12E+00	5.12E-02	1.41E+02	5.96E-02	7.61E-01	1.88E-01	8.48E+04	1.39E-04	1.49E-04	1.51E-05	9.73E-05
17	17.00	1.12E+00	5.74E-02	1.42E+02	5.97E-02	7.64E-01	1.89E-01	8.51E+04	1.39E-04	1.49E-04	1.70E-05	9.78E-05
18	18.00	1.12E+00	6.41E-02	1.42E+02	5.97E-02	7.67E-01	1.91E-01	8.53E+04	1.39E-04	1.50E-04	1.94E-05	9.81E-05
19	19.00	1.12E+00	7.11E-02	1.42E+02	5.98E-02	7.69E-01	1.92E-01	8.55E+04	1.39E-04	1.50E-04	2.21E-05	9.83E-05
20	20.00	1.12E+00	7.82E-02	1.43E+02	5.98E-02	7.70E-01	1.92E-01	8.56E+04	1.39E-04	1.51E-04	2.50E-05	9.85E-05
21	21.00	1.12E+00	8.52E-02	1.43E+02	5.98E-02	7.71E-01	1.93E-01	8.57E+04	1.39E-04	1.51E-04	2.80E-05	9.86E-05
22	22.00	1.12E+00	9.18E-02	1.43E+02	5.98E-02	7.71E-01	1.93E-01	8.57E+04	1.39E-04	1.51E-04	3.10E-05	9.87E-05
23	23.00	1.12E+00	9.79E-02	1.43E+02	5.98E-02	7.72E-01	1.94E-01	8.58E+04	1.39E-04	1.52E-04	3.39E-05	9.87E-05
24	24.00	1.12E+00	1.03E-01	1.43E+02	5.98E-02	7.72E-01	1.94E-01	8.58E+04	1.39E-04	1.52E-04	3.67E-05	9.87E-05
25	25.00	1.12E+00	1.08E-01	1.43E+02	5.98E-02	7.73E-01	1.94E-01	8.58E+04	1.39E-04	1.52E-04	3.94E-05	9.88E-05
26	30.00	1.12E+00	1.23E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.58E+04	1.39E-04	1.54E-04	4.95E-05	9.88E-05
27	35.00	1.12E+00	1.29E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.55E-04	5.45E-05	9.89E-05
28	40.00	1.12E+00	1.31E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.56E-04	5.60E-05	9.89E-05
29	45.00	1.12E+00	1.32E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.57E-04	5.62E-05	9.89E-05
30	50.00	1.12E+00	1.32E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.57E-04	5.63E-05	9.89E-05
31	70.00	1.12E+00	1.32E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.57E-04	5.63E-05	9.89E-05
32	100.00	1.12E+00	1.32E-01	1.43E+02	5.98E-02	7.73E-01	1.95E-01	8.59E+04	1.39E-04	1.57E-04	5.63E-05	9.89E-05

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =      .000 KM
H2      =   100.000 KM
ANGLE   =      .000 DEG
RANGE   =   100.000 KM
BETA    =      .000 DEG
PHI     =   180.000 DEG
HMIN    =      .000 KM
BENDING =      .000 DEG
LEN     =         0
```

EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
3.634E-04	3.434E-01	2.082E+20	9 107E+19	4.002E+22	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
3.185E+00	8.011E+00	1.082E+00	8.102E-02	7.198E-03	1.591E-04	0.000E+00	48.23

Table 17. Program Output for Case 1 (Cont.)

H2O (G/CM**2)	O3 (	CO2	CO ATM CM	CH4	N2O	O2)
1.125E+00	1.321E-01	1.434E+02	5.981E-02	7.733E-01	1.948E-01	8.585E+04

NH3 (	NO ATM CM	NO2	SO2)
1.386E-04	1.563E-04	5.627E-05	9.887E-05

SINGLE SCATTERING POINT TO SOURCE PATHS

SCTTR POINT	SCTTR ALT	SUBTENDED ANGLE	SOLAR ZENITH	PATH ZENITH	RELATIVE AZIMUTH	SCTTR ANGLE	MOLECULAR PHASE F
1	.00	.00	60.00	.00	I	60.00	.748E-01
2	1.00	.00	60.00	.00	I	60.00	.748E-01
3	2.00	.00	60.00	.00	I	60.00	.748E-01
4	3.00	.00	60.00	.00	I	60.00	.748E-01
5	4.00	.00	60.00	.00	I	60.00	.748E-01
6	5.00	.00	60.00	.00	I	60.00	.748E-01
7	6.00	.00	60.00	.00	I	60.00	.748E-01
8	7.00	.00	60.00	.00	I	60.00	.748E-01
9	8.00	.00	60.00	.00	I	60.00	.748E-01
10	9.00	.00	60.00	.00	I	60.00	.748E-01
11	10.00	.00	60.00	.00	I	60.00	.748E-01
12	11.00	.00	60.00	.00	I	60.00	.748E-01
13	12.00	.00	60.00	.00	I	60.00	.748E-01
14	13.00	.00	60.00	.00	I	60.00	.748E-01
15	14.00	.00	60.00	.00	I	60.00	.748E-01
16	15.00	.00	60.00	.00	I	60.00	.748E-01
17	16.00	.00	60.00	.00	I	60.00	.748E-01
18	17.00	.00	60.00	.00	I	60.00	.748E-01
19	18.00	.00	60.00	.00	I	60.00	.748E-01
20	19.00	.00	60.00	.00	I	60.00	.748E-01
21	20.00	.00	60.00	.00	I	60.00	.748E-01
22	21.00	.00	60.00	.00	I	60.00	.748E-01
23	22.00	.00	60.00	.00	I	60.00	.748E-01
24	23.00	.00	60.00	.00	I	60.00	.748E-01
25	24.00	.00	60.00	.00	I	60.00	.748E-01
26	25.00	.00	60.00	.00	I	60.00	.748E-01
27	30.00	.00	60.00	.00	I	60.00	.748E-01
28	35.00	.00	60.00	.00	I	60.00	.748E-01
29	40.00	.00	60.00	.00	I	60.00	.748E-01
30	45.00	.00	60.00	.00	I	60.00	.748E-01
31	50.00	.00	60.00	.00	I	60.00	.748E-01
32	70.00	.00	60.00	.00	I	60.00	.748E-01
33	100.00	.00	60.00	.00	I	60.00	.748E-01

CASE 2A: GIVEN H1, H2, ANGLE

EITHER A SHORT PATH (LEN=0) OR A LONG PATH THROUGH A TANGENT HEIGHT (LEN=1) IS POSSIBLE: LEN = 0

SLANT PATH PARAMETERS IN STANDARD FORM

H1	=	20.000 KM
H2	=	.000 KM
ANGLE	=	180.000 DEG

Table 17. Program Output for Case 1 (Cont.)

```
PHI     =        .000 DEG
HMIN    =        .000 KM
LEN     =           0
```

Table 17. Program Output for Case 1 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H2 TO H1												
1	.000	1.000	.000	1.000	1.000	.000	.000	180.000	.000	.000	955.683	284.99	1.17E-03
2	1.000	2.000	.000	1.000	2.000	.000	.000	180.000	.000	.000	846.698	278.49	1.06E-03
3	2.000	3.000	.000	1.000	3.000	.000	.000	180.000	.000	.000	747.913	271.99	9.57E-04
4	3.000	4.000	.000	1.000	4.000	.000	.000	180.000	.000	.000	658.727	265.49	8.63E-04
5	4.000	5.000	.000	1.000	5.000	.000	.000	180.000	.000	.000	578.391	258.99	7.77E-04
6	5.000	6.000	.000	1.000	6.000	.000	.000	180.000	.000	.000	506.204	252.50	6.98E-04
7	6.000	7.000	.000	1.000	7.000	.000	.000	180.000	.000	.000	441.516	246.00	6.24E-04
8	7.000	8.000	.000	1.000	8.000	.000	.000	180.000	.000	.000	383.677	239.50	5.57E-04
9	8.000	9.000	.000	1.000	9.000	.000	.000	180.000	.000	.000	332.137	233.00	4.96E-04
10	9.000	10.000	.000	1.000	10.000	.000	.000	180.000	.000	.000	286.399	226.55	4.40E-04
11	10.000	11.000	.000	1.000	11.000	.000	.000	180.000	.000	.000	245.907	220.10	3.89E-04
12	11.000	12.000	.000	1.000	12.000	.000	.000	180.000	.000	.000	210.499	216.75	3.38E-04
13	12.000	13.000	.000	1.000	13.000	.000	.000	180.000	.000	.000	179.900	216.70	2.89E-04
14	13.000	14.000	.000	1.000	14.000	.000	.000	180.000	.000	.000	153.750	216.70	2.47E-04
15	14.000	15.000	.000	1.000	15.000	.000	.000	180.000	.000	.000	131.400	216.70	2.11E-04
16	15.000	16.000	.000	1.000	16.000	.000	.000	180.000	.000	.000	112.300	216.70	1.80E-04
17	16.000	17.000	.000	1.000	17.000	.000	.000	180.000	.000	.000	96.000	216.70	1.54E-04
18	17.000	18.000	.000	1.000	18.000	.000	.000	180.000	.000	.000	82.075	216.70	1.32E-04
19	18.000	19.000	.000	1.000	19.000	.000	.000	180.000	.000	.000	70.160	216.70	1.13E-04
20	19.000	20.000	.000	1.000	20.000	.000	.000	180.000	.000	.000	59.980	216.70	9.62E-05

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	19.000	216.70	2.720E-05	1.702E-02	2.424E+11	2.424E+11	6.261E+16	1.640E+03
2	18.000	216.70	4.988E-05	3.265E-02	5.677E+11	5.677E+11	1.475E+17	3.575E+03
3	17.000	216.70	6.702E-05	4.664E-02	1.013E+12	1.013E+12	2.636E+17	5.863E+03
4	16.000	216.70	7.897E-05	5.877E-02	1.643E+12	1.643E+12	4.252E+17	8.569E+03
5	15.000	216.70	8.712E-05	6.926E-02	2.786E+12	2.786E+12	6.792E+17	1.178E+04
6	14.000	216.70	9.346E-05	7.859E-02	5.114E+12	5.114E+12	1.104E+18	1.559E+04
7	13.000	216.70	9.924E-05	8.698E-02	1.259E+13	1.259E+13	1.982E+18	2.014E+04
8	12.000	216.70	1.050E-04	9.468E-02	4.517E+13	4.517E+13	4.132E+18	2.557E+04
9	11.000	216.75	1.108E-04	1.014E-01	1.964E+14	1.964E+14	9.532E+18	3.207E+04
10	10.000	220.10	1.164E-04	1.066E-01	9.304E+14	9.304E+14	2.320E+19	3.973E+04
11	9.000	226.55	1.219E-04	1.103E-01	5.224E+15	5.224E+15	6.028E+19	4.861E+04
12	8.000	233.00	1.275E-04	1.132E-01	3.402E+16	3.402E+16	1.684E+20	5.887E+04
13	7.000	239.50	1.332E-04	1.155E-01	1.533E+17	1.533E+17	4.205E+20	7.072E+04
14	6.000	246.00	1.389E-04	1.177E-01	5.336E+17	5.336E+17	9.242E+20	8.438E+04
15	5.000	252.50	1.446E-04	1.199E-01	1.678E+18	1.678E+18	1.902E+21	1.001E+05
16	4.000	258.99	1.501E-04	1.220E-01	5.000E+18	5.000E+18	3.755E+21	1.182E+05
17	3.000	265.49	1.557E-04	1.242E-01	1.427E+19	1.285E+19	7.196E+21	1.390E+05
18	2.000	271.99	1.612E-04	1.267E-01	3.863E+19	2.910E+19	1.338E+22	1.628E+05
19	1.000	278.49	1.665E-04	1.292E-01	9.463E+19	5.634E+19	2.375E+22	1.901E+05
20	.000	284.99	1.714E-04	1.317E-01	2.082E+20	9.107E+19	4.002E+22	2.214E+05

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS

Table 17. Program Output for Case 1 (Cont.)

1	19.000	3.865E-03	7.446E-02	0.000E+00	0.000E+00	5.850E-04	0.000E+00	0.000E+00
2	18.000	9.153E-03	1.616E-01	0.000E+00	0.000E+00	1.136E-03	0.000E+00	0.000E+00
3	17.000	1.639E-02	2.635E-01	0.000E+00	0.000E+00	1.608E-03	0.000E+00	0.000E+00
4	16.000	2.629E-02	3.826E-01	0.000E+00	0.000E+00	2.012E-03	0.000E+00	0.000E+00
5	15.000	3.984E-02	5.221E-01	0.000E+00	0.000E+00	2.400E-03	0.000E+00	0.000E+00
6	14.000	5.839E-02	6.852E-01	0.000E+00	0.000E+00	2.818E-03	0.000E+00	0.000E+00
7	13.000	8.379E-02	8.761E-01	0.000E+00	0.000E+00	3.297E-03	0.000E+00	0.000E+00
8	12.000	1.186E-01	1.099E+00	0.000E+00	0.000E+00	3.873E-03	0.000E+00	0.000E+00
9	11.000	1.661E-01	1.361E+00	0.000E+00	0.000E+00	4.590E-03	0.000E+00	0.000E+00
10	10.000	2.296E-01	1.661E+00	0.000E+00	5.700E-04	4.990E-03	0.000E+00	0.000E+00
11	9.000	3.121E-01	2.002E+00	0.000E+00	2.024E-03	4.990E-03	0.000E+00	0.000E+00
12	8.000	4.184E-01	2.365E+00	0.000E+00	4.540E-03	4.990E-03	0.000E+00	0.000E+00
13	7.000	5.546E-01	2.817E+00	0.000E+00	9.194E-03	4.990E-03	0.000E+00	0.000E+00
14	6.000	7.279E-01	3.300E+00	0.000E+00	1.614E-02	4.990E-03	0.000E+00	0.000E+00
15	5.000	9.469E-01	3.840E+00	0.000E+00	2.462E-02	4.990E-03	0.000E+00	0.000E+00
16	4.000	1.222E+00	4.441E+00	0.000E+00	3.801E-02	4.990E-03	0.000E+00	0.000E+00
17	3.000	1.566E+00	5.109E+00	0.000E+00	6.372E-02	4.990E-03	0.000E+00	0.000E+00
18	2.000	1.994E+00	5.850E+00	3.105E-02	8.102E-02	4.990E-03	0.000E+00	0.000E+00
19	1.000	2.523E+00	6.668E+00	3.122E-01	8.102E-02	4.990E-03	0.000E+00	0.000E+00
20	.000	3.174E+00	7.571E+00	1.082E+00	8.102E-02	4.990E-03	0.000E+00	0.000E+00

J	Z (KM)	H2O (G/CM**2)	O3 (	CO2	CO	CH4	N2O	O2 ATM CM	NH3	NO	NO2	SO2)
1	19.00	1.56E-06	7.15E-03	2.19E-01	1.47E-05	1.30E-03	7.77E-04	1.08E+02	1.97E-11	3.75E-07	2.91E-06	1.54E-07
2	18.00	3.67E-06	1.42E-02	5.03E-01	3.84E-05	3.07E-03	1.80E-03	2.60E+02	6.34E-11	8.38E-07	5.61E-06	3.85E-07
3	17.00	6.56E-06	2.09E-02	8.73E-01	7.80E-05	5.43E-03	3.14E-03	4.74E+02	1.60E-10	1.44E-06	7.97E-06	7.13E-07
4	16.00	1.06E-05	2.71E-02	1.35E+00	1.43E-04	8.58E-03	4.85E-03	7.75E+02	3.89E-10	2.24E-06	9.86E-06	1.15E-06
5	15.00	1.68E-05	3.28E-02	1.98E+00	2.51E-04	1.28E-02	7.05E-03	1.20E+03	1.01E-09	3.32E-06	1.12E-05	1.71E-06
6	14.00	2.73E-05	3.82E-02	2.79E+00	4.33E-04	1.83E-02	9.83E-03	1.80E+03	2.92E-09	4.76E-06	1.21E-05	2.39E-06
7	13.00	4.88E-05	4.35E-02	3.84E+00	7.38E-04	2.57E-02	1.33E-02	2.64E+03	9.69E-09	6.65E-06	1.26E-05	3.21E-06
8	12.00	1.01E-04	4.86E-02	5.21E+00	1.24E-03	3.55E-02	1.78E-02	3.84E+03	3.05E-08	9.06E-06	1.30E-05	4.20E-06
9	11.00	2.33E-04	5.34E-02	6.99E+00	2.02E-03	4.83E-02	2.34E-02	5.52E+03	8.14E-08	1.21E-05	1.34E-05	5.45E-06
10	10.00	5.69E-04	5.72E-02	9.35E+00	3.15E-03	6.51E-02	3.02E-02	7.73E+03	2.03E-07	1.60E-05	1.38E-05	6.98E-06
11	9.00	1.50E-03	6.01E-02	1.25E+01	4.70E-03	8.67E-02	3.82E-02	1.05E+04	4.99E-07	2.08E-05	1.43E-05	8.85E-06
12	8.00	4.24E-03	6.23E-02	1.67E+01	6.79E-03	1.14E-01	4.75E-02	1.39E+04	1.19E-06	2.67E-05	1.49E-05	1.12E-05
13	7.00	1.07E-02	6.42E-02	2.22E+01	9.54E-03	1.49E-01	5.83E-02	1.81E+04	2.61E-06	3.40E-05	1.56E-05	1.41E-05
14	6.00	2.39E-02	6.60E-02	2.94E+01	1.30E-02	1.92E-01	7.08E-02	2.32E+04	5.36E-06	4.29E-05	1.63E-05	1.80E-05
15	5.00	4.99E-02	6.77E-02	3.88E+01	1.74E-02	2.46E-01	8.51E-02	2.95E+04	1.04E-05	5.37E-05	1.73E-05	2.32E-05
16	4.00	1.00E-01	6.96E-02	5.09E+01	2.27E-02	3.13E-01	1.01E-01	3.70E+04	1.93E-05	6.68E-05	1.84E-05	3.04E-05
17	3.00	1.94E-01	7.15E-02	6.64E+01	2.93E-02	3.96E-01	1.20E-01	4.61E+04	3.47E-05	8.26E-05	1.97E-05	4.06E-05
18	2.00	3.66E-01	7.37E-02	8.61E+01	3.74E-02	4.97E-01	1.41E-01	5.71E+04	5.91E-05	1.01E-04	2.12E-05	5.50E-05
19	1.00	6.59E-01	7.59E-02	1.11E+02	4.74E-02	6.20E-01	1.65E-01	7.01E+04	9.38E-05	1.24E-04	2.29E-05	7.43E-05
20	.00	1.12E+00	7.82E-02	1.43E+02	5.98E-02	7.70E-01	1.92E-01	8.56E+04	1.39E-04	1.51E-04	2.50E-05	9.85E-05

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =   20.000 KM
H2      =     .000 KM
ANGLE   =  180.000 DEG
RANGE   =   20.000 KM
BETA    =     .000 DEG
PHI     =     .000 DEG
HMIN    =     .000 KM
BENDING =     .000 DEG
LEN     =        0
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Table 17. Program Output for Case 1 (Cont.)

EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
1.714E-04	1.317E-01	2.082E+20	9.107E+19	4.002E+22	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
3.174E+00	7.571E+00	1.082E+00	8.102E-02	4.990E-03	0.000E+00	0.000E+00	48.23

H2O (G/CM**2)	O3 (	CO2	CO ATM CM	CH4	N2O	O2)
1.125E+00	7.824E-02	1.426E-02	5.977E-02	7.698E-01	1.924E-01	8.560E+04

NH3 (	NO ATM CM	NO2	SO2)
1.386E-04	1.508E-04	2.498E-05	9.849E-05

SINGLE SCATTERING POINT TO SOURCE PATHS

SCTTR POINT	SCTTR ALT	SUBTENDED ANGLE	SOLAR ZENITH	PATH ZENITH	RELATIVE AZIMUTH	SCTTR ANGLE	MOLECULAR PHASE F
1	20.00	.00	60.00	180.00	I	120.00	.748E-01
2	19.00	.00	60.00	180.00	I	120.00	.748E-01
3	18.00	.00	60.00	180.00	I	120.00	.748E-01
4	17.00	.00	60.00	180.00	I	120.00	.748E-01
5	16.00	.00	60.00	180.00	I	120.00	.748E-01
6	15.00	.00	60.00	180.00	I	120.00	.748E-01
7	14.00	.00	60.00	180.00	I	120.00	.748E-01
8	13.00	.00	60.00	180.00	I	120.00	.748E-01
9	12.00	.00	60.00	180.00	I	120.00	.748E-01
10	11.00	.00	60.00	180.00	I	120.00	.748E-01
11	10.00	.00	60.00	180.00	I	120.00	.748E-01
12	9.00	.00	60.00	180.00	I	120.00	.748E-01
13	8.00	.00	60.00	180.00	I	120.00	.748E-01
14	7.00	.00	60.00	180.00	I	120.00	.748E-01
15	6.00	.00	60.00	180.00	I	120.00	.748E-01
16	5.00	.00	60.00	180.00	I	120.00	.748E-01
17	4.00	.00	60.00	180.00	I	120.00	.748E-01
18	3.00	.00	60.00	180.00	I	120.00	.748E-01
19	2.00	.00	60.00	180.00	I	120.00	.748E-01
20	1.00	.00	60.00	180.00	I	120.00	.748E-01
21	.00	.00	60.00	180.00	I	120.00	.748E-01

Table 17. Program Output for Case 1 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ (CM-1)	WAVLEN (MICRN)	ATMOS RADIANCE (CM-1)	ATMOS RADIANCE (MICRN)	PATH SCATTERED RADIANCE TOTAL (CM-1)	PATH SCATTERED RADIANCE TOTAL (MICRN)	PATH SCATTERED RADIANCE S SCAT (CM-1)	GROUND REFLECTED RADIANCE TOTAL (CM-1)	GROUND REFLECTED RADIANCE TOTAL (MICRN)	GROUND REFLECTED RADIANCE DIRECT (CM-1)	TOTAL RADIANCE (CM-1)	TOTAL RADIANCE (MICRN)	INTEGRAL (CM-1)	TOTAL TRANS
14000.	.714	8.00E-31	1.57E-26	2.08E-07	4.07E-03	4.03E-08	1.18E-07	2.31E-03	2.92E-08	3.26E-07	6.38E-03	1.63E-05	.3962
14100.	.709	4.97E-31	9.87E-27	2.10E-07	4.18E-03	4.06E-08	1.18E-07	2.34E-03	2.88E-08	3.28E-07	6.53E-03	4.91E-05	.3953
14200.	.704	3.06E-31	6.18E-27	2.08E-07	4.20E-03	4.08E-08	1.15E-07	2.32E-03	2.80E-08	3.23E-07	6.52E-03	8.15E-05	.3902
14300.	.699	1.85E-31	3.78E-27	1.88E-07	3.85E-03	3.97E-08	1.03E-07	2.10E-03	2.55E-08	2.91E-07	5.95E-03	1.11E-04	.3750
14400.	.694	1.14E-31	2.36E-27	1.85E-07	3.83E-03	3.96E-08	9.89E-08	2.05E-03	2.45E-08	2.84E-07	5.88E-03	1.39E-04	.3682
14500.	.690	6.57E-32	1.38E-27	1.58E-07	3.33E-03	3.65E-08	8.57E-08	1.80E-03	2.17E-08	2.44E-07	5.13E-03	1.53E-04	.3467
14600.	.685	4.56E-32	9.71E-28	2.21E-07	4.70E-03	4.22E-08	1.16E-07	2.47E-03	2.61E-08	3.36E-07	7.17E-03	1.97E-04	.3888
14700.	.680	2.82E-32	6.09E-28	2.25E-07	4.85E-03	4.30E-08	1.16E-07	2.50E-03	2.56E-08	3.40E-07	7.35E-03	2.31E-04	.3856
14800.	.676	1.74E-32	3.82E-28	2.25E-07	4.92E-03	4.32E-08	1.14E-07	2.49E-03	2.47E-08	3.38E-07	7.41E-03	2.65E-04	.3818
14900.	.671	1.08E-32	2.39E-28	2.24E-07	4.97E-03	4.31E-08	1.11E-07	2.46E-03	2.37E-08	3.34E-07	7.42E-03	2.98E-04	.3777
15000.	.667	6.65E-33	1.50E-28	2.24E-07	5.05E-03	4.33E-08	1.09E-07	2.44E-03	2.28E-08	3.33E-07	7.49E-03	3.32E-04	.3732
15100.	.662	4.11E-33	9.37E-29	2.25E-07	5.13E-03	4.35E-08	1.06E-07	2.43E-03	2.20E-08	3.31E-07	7.55E-03	3.65E-04	.3689
15200.	.658	2.53E-33	5.84E-29	2.03E-07	4.68E-03	3.96E-08	9.32E-08	2.15E-03	1.90E-08	2.96E-07	6.83E-03	3.94E-04	.3610
15300.	.654	1.56E-33	3.65E-29	2.19E-07	5.12E-03	4.32E-08	9.85E-08	2.31E-03	1.99E-08	3.17E-07	7.43E-03	4.26E-04	.3558
15400.	.649	9.54E-34	2.26E-29	2.06E-07	4.89E-03	4.17E-08	9.05E-08	2.15E-03	1.81E-08	2.97E-07	7.03E-03	4.56E-04	.3475
15500.	.645	5.97E-34	1.43E-29	2.23E-07	5.37E-03	4.36E-08	9.73E-08	2.34E-03	1.89E-08	3.21E-07	7.71E-03	4.88E-04	.3518
15600.	.641	3.69E-34	8.99E-30	2.21E-07	5.38E-03	4.34E-08	9.51E-08	2.31E-03	1.81E-08	3.16E-07	7.70E-03	5.19E-04	.3502
15700.	.637	2.28E-34	5.62E-30	2.23E-07	5.50E-03	4.39E-08	9.39E-08	2.31E-03	1.76E-08	3.17E-07	7.81E-03	5.51E-04	.3458
15800.	.633	1.41E-34	3.51E-30	2.20E-07	5.50E-03	4.33E-08	9.07E-08	2.26E-03	1.67E-08	3.11E-07	7.76E-03	5.82E-04	.3418
15900.	.629	8.62E-35	2.18E-30	2.19E-07	5.54E-03	4.34E-08	8.73E-08	2.21E-03	1.60E-08	3.06E-07	7.75E-03	6.13E-04	.3334
16000.	.625	5.37E-35	1.38E-30	2.16E-07	5.54E-03	4.28E-08	8.68E-08	2.22E-03	1.55E-08	3.03E-07	7.76E-03	6.43E-04	.3379
16100.	.621	3.31E-35	8.59E-31	2.23E-07	5.78E-03	4.43E-08	8.78E-08	2.27E-03	1.54E-08	3.11E-07	8.05E-03	6.74E-04	.3346
16200.	.617	2.05E-35	5.37E-31	2.17E-07	5.69E-03	4.37E-08	8.39E-08	2.20E-03	1.45E-08	3.01E-07	7.90E-03	7.04E-04	.3313
16300.	.613	1.26E-35	3.35E-31	2.15E-07	5.72E-03	4.31E-08	8.18E-08	2.17E-03	1.40E-08	2.97E-07	7.89E-03	7.34E-04	.3281
16400.	.610	7.78E-36	2.09E-31	2.19E-07	5.88E-03	4.39E-08	8.16E-08	2.20E-03	1.37E-08	3.00E-07	8.07E-03	7.64E-04	.3249
16500.	.606	4.80E-36	1.31E-31	2.20E-07	5.99E-03	4.44E-08	8.08E-08	2.20E-03	1.34E-08	3.01E-07	8.19E-03	7.94E-04	.3217
16600.	.602	2.96E-36	8.16E-32	2.13E-07	5.87E-03	4.32E-08	7.67E-08	2.11E-03	1.25E-08	2.90E-07	7.99E-03	8.23E-04	.3181
16700.	.599	1.81E-36	5.06E-32	2.12E-07	5.92E-03	4.38E-08	7.41E-08	2.07E-03	1.20E-08	2.86E-07	7.98E-03	8.52E-04	.3109
16800.	.595	1.10E-36	3.11E-32	2.02E-07	5.72E-03	4.37E-08	6.91E-08	1.95E-03	1.12E-08	2.72E-07	7.66E-03	8.79E-04	.3022
16900.	.592	6.73E-37	1.94E-32	2.01E-07	5.74E-03	4.38E-08	6.74E-08	1.93E-03	1.08E-08	2.69E-07	7.67E-03	9.06E-04	.2988
17000.	.588	4.2[illegible]E-37	1.22E-32	2.05E-07	5.92E-03	4.39E-08	6.77E-08	1.96E-03	1.06E-08	2.73E-07	7.88E-03	9.33E-04	.2992
17100.	.585	2.62E-37	7.67E-33	2.22E-07	6.48E-03	4.58E-08	7.33E-08	2.14E-03	1.11E-08	2.95E-07	8.62E-03	9.63E-04	.3047
17200.	.581	1.62E-37	4.79E-33	2.22E-07	6.57E-03	4.60E-08	7.24E-08	2.14E-03	1.08E-08	2.94E-07	8.71E-03	9.92E-04	.3026
17300.	.576	9.83E-38	2.94E-33	2.15E-07	6.45E-03	4.49E-08	6.89E-08	2.06E-03	1.01E-08	2.84E-07	8.51E-03	1.02E-03	.2993
17400.	.575	6.03E-38	1.83E-33	2.16E-07	6.54E-03	4.56E-08	6.75E-08	2.04E-03	9.82E-09	2.84E-07	8.59E-03	1.05E-03	.2944
17500.	.571	0.00E+00	0.00E+00	2.12E-07	6.49E-03	4.47E-08	6.55E-08	2.01E-03	9.36E-09	2.78E-07	8.50E-03	1.08E-03	.2934
17600.	.568	0.00E+00	0.00E+00	2.12E-07	6.58E-03	4.50E-08	6.45E-08	2.00E-03	9.10E-09	2.77E-07	8.58E-03	1.10E-03	.2906
17700.	.565	0.00E+00	0.00E+00	2.13E-07	6.68E-03	4.52E-08	6.42E-08	2.01E-03	8.91E-09	2.77E-07	8.69E-03	1.13E-03	.2905
17800.	.562	0.00E+00	0.00E+00	2.13E-07	6.75E-03	4.53E-08	6.32E-08	2.00E-03	8.65E-09	2.76E-07	8.75E-03	1.16E-03	.2884
17900.	.559	0.00E+00	0.00E+00	2.08E-07	6.66E-03	4.44E-08	6.07E-08	1.94E-03	8.19E-09	2.68E-07	8.60E-03	1.19E-03	.2863
18000.	.556	0.00E+00	0.00E+00	2.19E-07	7.10E-03	4.70E-08	6.30E-08	2.04E-03	8.38E-09	2.82E-07	9.14E-03	1.21E-03	.2841
18100.	.552	0.00E+00	0.00E+00	2.14E-07	7.00E-03	4.61E-08	6.05E-08	1.98E-03	7.95E-09	2.74E-07	8.99E-03	1.24E-03	.2820
18200.	.549	0.00E+00	0.00E+00	2.18E-07	7.23E-03	4.72E-08	6.08E-08	2.01E-03	7.86E-09	2.79E-07	9.24E-03	1.27E-03	.2797
18300.	.546	0.00E+00	0.00E+00	2.16E-07	7.24E-03	4.69E-08	5.89E-08	1.97E-03	7.47E-09	2.75E-07	9.21E-03	1.30E-03	.2764
18400.	.543	0.00E+00	0.00E+00	2.15E-07	7.27E-03	4.67E-08	5.74E-08	1.94E-03	7.12E-09	2.72E-07	9.22E-03	1.32E-03	.2732
18500.	.541	0.00E+00	0.00E+00	2.03E-07	6.96E-03	4.43E-08	5.32E-08	1.82E-03	6.47E-09	2.57E-07	8.78E-03	1.35E-03	.2701
18600.	.538	0.00E+00	0.00E+00	2.15E-07	7.43E-03	4.70E-08	5.50E-08	1.90E-03	6.56E-09	2.70E-07	9.33E-03	1.38E-03	.2670
18700.	.535	0.00E+00	0.00E+00	2.14E-07	7.50E-03	4.70E-08	5.37E-08	1.88E-03	6.28E-09	2.68E-07	9.37E-03	1.40E-03	.2639
18800.	.532	0.00E+00	0.00E+00	2.11E-07	7.47E-03	4.64E-08	5.19E-08	1.83E-03	5.94E-09	2.63E-07	9.30E-03	1.43E-03	.2609
18900.	.529	0.00E+00	0.00E+00	2.15E-07	7.69E-03	4.75E-08	5.18E-08	1.85E-03	5.82E-09	2.67E-07	9.54E-03	1.46E-03	.2581

Table 17. Program Output for Case 1 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ	WAVLEN	ATMOS RADIANCE		PATH SCATTERED RADIANCE TOTAL		PATH SCATTERED RADIANCE S SCAT	GROUND REFLECTED RADIANCE TOTAL		GROUND REFLECTED RADIANCE DIRECT	TOTAL RADIANCE		INTEGRAL	TOTAL
(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	TRANS
19000.	.526	0.00E+00	0.00E+00	1.93E-07	6.96E-03	4.26E-08	4.55E-08	1.64E-03	5.01E-09	2.38E-07	8.60E-03	1.48E-03	.2552
19100.	.524	0.00E+00	0.00E+00	2.13E-07	7.77E-03	4.72E-08	4.92E-08	1.80E-03	5.32E-09	2.62E-07	9.57E-03	1.51E-03	.2524
19200.	.521	0.00E+00	0.00E+00	2.08E-07	7.67E-03	4.63E-08	4.71E-08	1.74E-03	4.99E-09	2.55E-07	9.41E-03	1.53E-03	.2497
19300.	.518	0.00E+00	0.00E+00	1.87E-07	6.96E-03	4.17E-08	4.15E-08	1.55E-03	4.31E-09	2.28E-07	8.50E-03	1.56E-03	.2469
19400.	.515	0.00E+00	0.00E+00	2.11E-07	7.93E-03	4.72E-08	4.59E-08	1.73E-03	4.67E-09	2.57E-07	9.66E-03	1.58E-03	.2442
19500.	.513	0.00E+00	0.00E+00	2.06E-07	7.82E-03	4.62E-08	4.39E-08	1.67E-03	4.38E-09	2.49E-07	9.48E-03	1.61E-03	.2415
19600.	.510	0.00E+00	0.00E+00	2.13E-07	8.18E-03	4.80E-08	4.46E-08	1.71E-03	4.37E-09	2.57E-07	9.89E-03	1.63E-03	.2338
19700.	.508	0.00E+00	0.00E+00	2.09E-07	8.11E-03	4.73E-08	4.29E-08	1.67E-03	4.13E-09	2.52E-07	9.78E-03	1.66E-03	.2361
19800.	.505	0.00E+00	0.00E+00	2.11E-07	8.26E-03	4.79E-08	4.25E-08	1.66E-03	4.00E-09	2.53E-07	9.93E-03	1.68E-03	.2335
19900.	.503	0.00E+00	0.00E+00	2.06E-07	8.16E-03	4.69E-08	4.07E-08	1.61E-03	3.77E-09	2.47E-07	9.77E-03	1.71E-03	.2310
20000.	.500	0.00E+00	0.00E+00	2.10E-07	8.38E-03	4.79E-08	4.06E-08	1.62E-03	3.69E-09	2.50E-07	1.00E-02	1.73E-03	.2286
20100.	.498	0.00E+00	0.00E+00	2.18E-07	8.80E-03	5.00E-08	4.14E-08	1.67E-03	3.69E-09	2.59E-07	1.05E-02	1.76E-03	.2262
20200.	.495	0.00E+00	0.00E+00	2.15E-07	8.78E-03	4.96E-08	4.02E-08	1.64E-03	3.51E-09	2.55E-07	1.04E-02	1.78E-03	.2233
20300.	.493	0.00E+00	0.00E+00	2.03E-07	8.38E-03	4.70E-08	3.72E-08	1.53E-03	3.19E-09	2.41E-07	9.91E-03	1.81E-03	.2214
20400.	.490	0.00E+00	0.00E+00	2.15E-07	8.94E-03	4.98E-08	3.86E-08	1.61E-03	3.25E-09	2.53E-07	1.05E-02	1.83E-03	.2190
20500.	.488	0.00E+00	0.00E+00	1.99E-07	8.38E-03	4.64E-08	3.51E-08	1.48E-03	2.91E-09	2.35E-07	9.86E-03	1.86E-03	.2166
20600.	.485	0.00E+00	0.00E+00	1.95E-07	8.26E-03	4.55E-08	3.37E-08	1.43E-03	2.73E-09	2.28E-07	9.69E-03	1.88E-03	.2143
20700.	.483	0.00E+00	0.00E+00	2.12E-07	9.10E-03	4.99E-08	3.61E-08	1.55E-03	2.87E-09	2.48E-07	1.06E-02	1.90E-03	.2120
20800.	.481	0.00E+00	0.00E+00	2.15E-07	9.29E-03	5.06E-08	3.58E-08	1.55E-03	2.80E-09	2.50E-07	1.08E-02	1.93E-03	.2097
20900.	.478	0.00E+00	0.00E+00	2.11E-07	9.20E-03	4.98E-08	3.44E-08	1.50E-03	2.64E-09	2.45E-07	1.07E-02	1.95E-03	.2075
21000.	.476	0.00E+00	0.00E+00	2.04E-07	8.99E-03	4.84E-08	3.27E-08	1.44E-03	2.47E-09	2.37E-07	1.04E-02	1.98E-03	.2053
21100.	.474	0.00E+00	0.00E+00	2.09E-07	9.30E-03	4.98E-08	3.29E-08	1.47E-03	2.44E-09	2.42E-07	1.08E-02	2.00E-03	.2032
21200.	.472	0.00E+00	0.00E+00	2.10E-07	9.45E-03	5.04E-08	3.25E-08	1.46E-03	2.36E-09	2.43E-07	1.09E-02	2.03E-03	.2011
21300.	.469	0.00E+00	0.00E+00	2.04E-07	9.27E-03	4.91E-08	3.10E-08	1.41E-03	2.21E-09	2.35E-07	1.07E-02	2.05E-03	.1989
21400.	.467	0.00E+00	0.00E+00	2.04E-07	9.34E-03	4.92E-08	3.04E-08	1.39E-03	2.13E-09	2.34E-07	1.07E-02	2.07E-03	.1968
21500.	.465	0.00E+00	0.00E+00	2.06E-07	9.53E-03	5.00E-08	3.02E-08	1.40E-03	2.08E-09	2.36E-07	1.09E-02	2.10E-03	.1947
21600.	.463	0.00E+00	0.00E+00	2.11E-07	9.83E-03	5.13E-08	3.03E-08	1.41E-03	2.05E-09	2.41E-07	1.12E-02	2.12E-03	.1926
21700.	.461	0.00E+00	0.00E+00	2.05E-07	9.67E-03	5.02E-08	2.90E-08	1.37E-03	1.92E-09	2.34E-07	1.10E-02	2.14E-03	.1906
21800.	.459	0.00E+00	0.00E+00	1.97E-07	9.37E-03	4.84E-08	2.73E-08	1.30E-03	1.78E-09	2.24E-07	1.07E-02	2.17E-03	.1886
21900.	.457	0.00E+00	0.00E+00	2.08E-07	9.97E-03	5.12E-08	2.83E-08	1.36E-03	1.81E-09	2.36E-07	1.13E-02	2.19E-03	.1866
22000.	.455	0.00E+00	0.00E+00	1.97E-07	9.52E-03	4.87E-08	2.63E-08	1.27E-03	1.65E-09	2.23E-07	1.08E-02	2.21E-03	.1846
22100.	.452	0.00E+00	0.00E+00	1.92E-07	9.39E-03	4.78E-08	2.53E-08	1.23E-03	1.56E-09	2.18E-07	1.06E-02	2.23E-03	.1827
22200.	.450	0.00E+00	0.00E+00	2.10E-07	1.04E-02	5.25E-08	2.71E-08	1.34E-03	1.64E-09	2.37E-07	1.17E-02	2.26E-03	.1807
22300.	.448	0.00E+00	0.00E+00	1.94E-07	9.64E-03	4.86E-08	2.46E-08	1.22E-03	1.46E-09	2.18E-07	1.09E-02	2.28E-03	.1788
22400.	.446	0.00E+00	0.00E+00	1.83E-07	9.18E-03	4.60E-08	2.28E-08	1.14E-03	1.33E-09	2.06E-07	1.03E-02	2.30E-03	.1769
22500.	.444	0.00E+00	0.00E+00	1.91E-07	9.65E-03	4.82E-08	2.33E-08	1.18E-03	1.34E-09	2.14E-07	1.08E-02	2.32E-03	.1751
22600.	.442	0.00E+00	0.00E+00	1.91E-07	9.74E-03	4.84E-08	2.29E-08	1.17E-03	1.29E-09	2.14E-07	1.09E-02	2.34E-03	.1732
22700.	.441	0.00E+00	0.00E+00	1.65E-07	8.51E-03	4.21E-08	1.95E-08	1.00E-03	1.08E-09	1.85E-07	9.51E-03	2.36E-03	.1714
22800.	.439	0.00E+00	0.00E+00	1.52E-07	7.88E-03	3.88E-08	1.75E-08	9.12E-04	9.53E-10	1.69E-07	8.80E-03	2.38E-03	.1696
22900.	.437	0.00E+00	0.00E+00	1.81E-07	9.63E-03	4.71E-08	2.09E-08	1.09E-03	1.11E-09	2.04E-07	1.07E-02	2.40E-03	.1678
23000.	.435	0.00E+00	0.00E+00	1.57E-07	8.31E-03	4.05E-08	1.75E-08	9.28E-04	9.19E-10	1.75E-07	9.24E-03	2.42E-03	.1660
23100.	.433	0.00E+00	0.00E+00	1.57E-07	8.35E-03	4.05E-08	1.72E-08	9.16E-04	8.83E-10	1.74E-07	9.27E-03	2.43E-03	.1642
23200.	.431	0.00E+00	0.00E+00	1.32E-07	7.12E-03	3.44E-08	1.42E-08	7.66E-04	7.19E-10	1.46E-07	7.88E-03	2.45E-03	.1625
23300.	.429	0.00E+00	0.00E+00	1.45E-07	7.87E-03	3.78E-08	1.53E-08	8.33E-04	7.61E-10	1.60E-07	8.71E-03	2.46E-03	.1608
23400.	.427	0.00E+00	0.00E+00	1.47E-07	8.06E-03	3.85E-08	1.53E-08	8.37E-04	7.44E-10	1.62E-07	8.89E-03	2.48E-03	.1591
23500.	.426	0.00E+00	0.00E+00	1.57E-07	8.65E-03	4.12E-08	1.60E-08	8.82E-04	7.64E-10	1.73E-07	9.53E-03	2.50E-03	.1574
23600.	.424	0.00E+00	0.00E+00	1.60E-07	8.91E-03	4.22E-08	1.60E-08	8.92E-04	7.52E-10	1.76E-07	9.80E-03	2.52E-03	.1557
23700.	.422	0.00E+00	0.00E+00	1.55E-07	8.72E-03	4.11E-08	1.53E-08	8.57E-04	7.04E-10	1.70E-07	9.57E-03	2.53E-03	.1541
23800.	.420	0.00E+00	0.00E+00	1.57E-07	8.92E-03	4.18E-08	1.52E-08	8.61E-04	6.88E-10	1.73E-07	9.78E-03	2.55E-03	.1524
23900.	.418	0.00E+00	0.00E+00	1.52E-07	8.68E-03	4.05E-08	1.44E-08	8.23E-04	6.41E-10	1.66E-07	9.50E-03	2.57E-03	.1508

Table 17. Program Output for Case 1 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ	WAVLEN	ATMOS RADIANCE		PATH SCATTERED RADIANCE TOTAL		PATH SCATTERED RADIANCE S SCAT	GROUND REFLECTED RADIANCE TOTAL		GROUND REFLECTED RADIANCE DIRECT	TOTAL RADIANCE		INTEGRAL	TOTAL
(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	TRANS
24000.	.417	0.00E+00	0.00E+00	1.64E-07	9.46E-03	4.40E-08	1.53E-08	8.81E-04	6.67E-10	1.80E-07	1.03E-02	2.58E-03	.1492
24100.	.415	0.00E+00	0.00E+00	1.54E-07	8.96E-03	4.15E-08	1.41E-08	8.20E-04	6.04E-10	1.68E-07	9.78E-03	2.60E-03	.1475
24200.	.413	0.00E+00	0.00E+00	1.57E-07	9.19E-03	4.23E-08	1.41E-08	8.25E-04	5.93E-10	1.71E-07	1.00E-02	2.62E-03	.1460
24300.	.412	0.00E+00	0.00E+00	1.61E-07	9.53E-03	4.37E-08	1.42E-08	8.40E-04	5.87E-10	1.76E-07	1.04E-02	2.64E-03	.1444
24400.	.410	0.00E+00	0.00E+00	1.41E-07	8.42E-03	3.84E-08	1.22E-08	7.29E-04	4.96E-10	1.54E-07	9.15E-03	2.65E-03	.1428
24500.	.408	0.00E+00	0.00E+00	1.53E-07	9.17E-03	4.16E-08	1.30E-08	7.79E-04	5.16E-10	1.66E-07	9.95E-03	2.67E-03	.1413
24600.	.407	0.00E+00	0.00E+00	1.42E-07	8.60E-03	3.88E-08	1.19E-08	7.17E-04	4.63E-10	1.54E-07	9.31E-03	2.68E-03	.1397
24700.	.405	0.00E+00	0.00E+00	1.42E-07	8.64E-03	3.89E-08	1.16E-08	7.08E-04	4.45E-10	1.53E-07	9.35E-03	2.70E-03	.1382
24800.	.403	0.00E+00	0.00E+00	1.47E-07	9.07E-03	4.06E-08	1.19E-08	7.30E-04	4.46E-10	1.59E-07	9.80E-03	2.71E-03	.1367
24900.	.402	0.00E+00	0.00E+00	1.56E-07	9.68E-03	4.31E-08	1.23E-08	7.64E-04	4.55E-10	1.68E-07	1.04E-02	2.73E-03	.1352
25000.	.400	0.00E+00	0.00E+00	1.41E-07	8.82E-03	3.91E-08	1.09E-08	6.84E-04	3.97E-10	1.52E-07	9.51E-03	2.75E-03	.1337
25100.	.398	0.00E+00	0.00E+00	1.29E-07	8.12E-03	3.58E-08	9.81E-09	6.18E-04	3.49E-10	1.39E-07	8.74E-03	2.76E-03	.1323
25200.	.397	0.00E+00	0.00E+00	5.68E-08	3.61E-03	1.59E-08	4.24E-09	2.69E-04	1.48E-10	6.10E-08	3.88E-03	2.77E-03	.1308
25300.	.395	0.00E+00	0.00E+00	1.21E-07	7.72E-03	3.37E-08	8.85E-09	5.67E-04	3.03E-10	1.30E-07	8.29E-03	2.78E-03	.1294
25400.	.394	0.00E+00	0.00E+00	4.65E-08	3.00E-03	1.31E-08	3.35E-09	2.16E-04	1.12E-10	4.99E-08	3.22E-03	2.78E-03	.1279
25500.	.392	0.00E+00	0.00E+00	9.67E-08	6.29E-03	2.72E-08	6.83E-09	4.44E-04	2.25E-10	1.04E-07	6.73E-03	2.79E-03	.1265
25600.	.391	0.00E+00	0.00E+00	1.23E-07	8.06E-03	3.47E-08	8.52E-09	5.59E-04	2.75E-10	1.31E-07	8.61E-03	2.81E-03	.1251
25700.	.389	0.00E+00	0.00E+00	9.05E-08	5.97E-03	2.56E-08	6.16E-09	4.07E-04	1.95E-10	9.66E-08	6.38E-03	2.82E-03	.1237
25800.	.388	0.00E+00	0.00E+00	7.90E-08	5.26E-03	2.24E-08	5.28E-09	3.51E-04	1.64E-10	8.42E-08	5.61E-03	2.83E-03	.1223
25900.	.386	0.00E+00	0.00E+00	8.44E-08	5.66E-03	2.40E-08	5.53E-09	3.71E-04	1.69E-10	8.99E-08	6.03E-03	2.83E-03	.1209
26000.	.385	0.00E+00	0.00E+00	8.50E-08	5.74E-03	2.42E-08	5.47E-09	3.70E-04	1.63E-10	9.05E-08	6.11E-03	2.84E-03	.1195
26100.	.383	0.00E+00	0.00E+00	5.27E-08	3.59E-03	1.51E-08	3.33E-09	2.27E-04	9.75E-11	5.61E-08	3.82E-03	2.85E-03	.1182
26200.	.382	0.00E+00	0.00E+00	8.38E-08	5.75E-03	2.40E-08	5.19E-09	3.56E-04	1.49E-10	8.90E-08	6.11E-03	2.86E-03	.1168
26300.	.380	0.00E+00	0.00E+00	9.84E-08	6.81E-03	2.83E-08	5.98E-09	4.13E-04	1.68E-10	1.04E-07	7.22E-03	2.87E-03	.1155
26400.	.379	0.00E+00	0.00E+00	9.98E-08	6.95E-03	2.87E-08	5.95E-09	4.15E-04	1.64E-10	1.06E-07	7.37E-03	2.88E-03	.1142
26500	.377	0.00E+00	0.00E+00	1.01E-07	7.12E-03	2.93E-08	5.93E-09	4.16E-04	1.60E-10	1.07E-07	7.54E-03	2.89E-03	.1128
26600.	.376	0.00E+00	0.00E+00	9.13E-08	6.46E-03	2.64E-08	5.24E-09	3.70E-04	1.39E-10	9.65E-08	6.83E-03	2.90E-03	.1115
26700.	.375	0.00E+00	0.00E+00	7.11E-08	5.07E-03	2.06E-08	4.00E-09	2.85E-04	1.04E-10	7.51E-08	5.36E-03	2.91E-03	.1102
26800.	.373	0.00E+00	0.00E+00	7.14E-08	5.13E-03	2.07E-08	3.94E-09	2.83E-04	1.00E-10	7.54E-08	5.41E-03	2.91E-03	.1089
26900.	.372	0.00E+00	0.00E+00	1.03E-07	7.43E-03	2.99E-08	5.56E-09	4.02E-04	1.39E-10	1.08E-07	7.83E-03	2.93E-03	.1077
27000.	.370	0.00E+00	0.00E+00	8.67E-08	6.32E-03	2.53E-08	4.60E-09	3.35E-04	1.13E-10	9.13E-08	6.66E-03	2.93E-03	.1064
27100.	.369	0.00E+00	0.00E+00	9.71E-08	7.13E-03	2.84E-08	5.05E-09	3.71E-04	1.21E-10	1.02E-07	7.50E-03	2.95E-03	.1051
27200.	.368	0.00E+00	0.00E+00	9.32E-08	6.90E-03	2.73E-08	4.76E-09	3.52E-04	1.12E-10	9.80E-08	7.25E-03	2.95E-03	.1039
27300.	.366	0.00E+00	0.00E+00	9.85E-08	7.34E-03	2.89E-08	4.93E-09	3.67E-04	1.13E-10	1.03E-07	7.71E-03	2.97E-03	.1026
27400.	.365	0.00E+00	0.00E+00	8.91E-08	6.69E-03	2.62E-08	4.37E-09	3.28E-04	9.84E-11	9.35E-08	7.02E-03	2.97E-03	.1014
27500.	.364	0.00E+00	0.00E+00	7.30E-08	5.52E-03	2.15E-08	3.51E-09	2.65E-04	7.74E-11	7.65E-08	5.78E-03	2.98E-03	.1002
27600.	.362	0.00E+00	0.00E+00	8.87E-08	6.76E-03	2.61E-08	4.18E-09	3.19E-04	9.03E-11	9.29E-08	7.07E-03	2.99E-03	.0989
27700.	.361	0.00E+00	0.00E+00	6.72E-08	5.15E-03	1.98E-08	3.10E-09	2.38E-04	6.56E-11	7.03E-08	5.39E-03	3.00E-03	.0977
27800.	.360	0.00E+00	0.00E+00	8.90E-08	6.88E-03	2.63E-08	4.03E-09	3.12E-04	8.34E-11	9.31E-08	7.19E-03	3.01E-03	.0965
27900.	.358	0.00E+00	0.00E+00	4.79E-08	3.73E-03	1.42E-08	2.12E-09	1.65E-04	4.30E-11	5.00E-08	3.89E-03	3.01E-03	.0953
28000.	.357	0.00E+00	0.00E+00	7.15E-08	5.61E-03	2.12E-08	3.11E-09	2.44E-04	6.16E-11	7.46E-08	5.85E-03	3.02E-03	.0941
28100.	.356	0.00E+00	0.00E+00	7.61E-08	6.01E-03	2.26E-08	3.24E-09	2.56E-04	6.29E-11	7.93E-08	6.26E-03	3.03E-03	.0930
28200.	.355	0.00E+00	0.00E+00	8.51E-08	6.77E-03	2.53E-08	3.56E-09	2.83E-04	6.74E-11	8.87E-08	7.05E-03	3.04E-03	.0918
28300.	.353	0.00E+00	0.00E+00	8.13E-08	6.51E-03	2.42E-08	3.33E-09	2.66E-04	6.17E-11	8.46E-08	6.78E-03	3.05E-03	.0906
28400.	.352	0.00E+00	0.00E+00	6.54E-08	5.28E-03	1.95E-08	2.62E-09	2.11E-04	4.76E-11	6.80E-08	5.49E-03	3.05E-03	.0894
28500.	.351	0.00E+00	0.00E+00	8.32E-08	6.76E-03	2.48E-08	3.27E-09	2.65E-04	5.80E-11	8.64E-08	7.02E-03	3.06E-03	.0883
28600.	.350	0.00E+00	0.00E+00	6.30E-08	5.15E-03	1.88E-08	2.42E-09	1.98E-04	4.21E-11	6.54E-08	5.35E-03	3.07E-03	.0871
28700.	.348	0.00E+00	0.00E+00	6.74E-08	5.55E-03	2.01E-08	2.54E-09	2.09E-04	4.31E-11	7.00E-08	5.76E-03	3.07E-03	.0860
28800.	.347	0.00E+00	0.00E+00	7.52E-08	6.23E-03	2.24E-08	2.77E-09	2.30E-04	4.60E-11	7.79E-08	6.46E-03	3.08E-03	.0849
28900.	.346	0.00E+00	0.00E+00	6.19E-08	5.17E-03	1.85E-08	2.24E-09	1.87E-04	3.63E-11	6.42E-08	5.36E-03	3.09E-03	.0837

Table 17. Program Output for Case 1 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ	WAVLEN	ATMOS RADIANCE		PATH SCATTERED RADIANCE			GROUND REFLECTED RADIANCE			TOTAL RADIANCE		INTEGRAL	TOTAL
				TOTAL		S SCAT	TOTAL		DIRECT				
(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	TRANS
29000.	.345	0.00E+00	0.00E+00	7.14E-08	6.00E-03	2.14E-08	2.52E-09	2.12E-04	4.00E-11	7.39E-08	6.22E-03	3.10E-03	.0826
29100.	.344	0.00E+00	0.00E+00	7.77E-08	6.58E-03	2.33E-08	2.69E-09	2.28E-04	4.17E-11	8.04E-08	6.81E-03	3.10E-03	.0815
29200.	.342	0.00E+00	0.00E+00	7.23E-08	6.16E-03	2.16E-08	2.45E-09	2.09E-04	3.71E-11	7.47E-08	6.37E-03	3.11E-03	.0804
29300.	.341	0.00E+00	0.00E+00	6.48E-08	5.56E-03	1.94E-08	2.15E-09	1.84E-04	3.18E-11	6.69E-08	5.74E-03	3.12E-03	.0793
29400.	.340	0.00E+00	0.00E+00	8.39E-08	7.25E-03	2.52E-08	2.72E-09	2.35E-04	3.93E-11	8.66E-08	7.48E-03	3.13E-03	.0779
29500.	.339	0.00E+00	0.00E+00	7.59E-08	6.61E-03	2.28E-08	2.41E-09	2.10E-04	3.40E-11	7.83E-08	6.82E-03	3.13E-03	.0771
29600.	.338	0.00E+00	0.00E+00	6.48E-08	5.68E-03	1.95E-08	2.01E-09	1.76E-04	2.77E-11	6.68E-08	5.85E-03	3.14E-03	.0757
29700.	.337	0.00E+00	0.00E+00	5.90E-08	5.21E-03	1.77E-08	1.79E-09	1.58E-04	2.41E-11	6.08E-08	5.36E-03	3.15E-03	.0747
29800.	.336	0.00E+00	0.00E+00	7.98E-08	7.08E-03	2.40E-08	2.36E-09	2.10E-04	3.10E-11	8.21E-08	7.29E-03	3.16E-03	.0737
29900.	.334	0.00E+00	0.00E+00	7.41E-08	6.62E-03	2.24E-08	2.13E-09	1.91E-04	2.74E-11	7.62E-08	6.81E-03	3.16E-03	.0721
30000.	.333	0.00E+00	0.00E+00	6.71E-08	6.04E-03	2.03E-08	1.88E-09	1.70E-04	2.36E-11	6.90E-08	6.21E-03	3.17E-03	.0711
30100.	.332	0.00E+00	0.00E+00	5.98E-08	5.42E-03	1.81E-08	1.64E-09	1.49E-04	2.00E-11	6.15E-08	5.57E-03	3.18E-03	.0700
30200.	.331	0.00E+00	0.00E+00	6.20E-08	5.66E-03	1.90E-08	1.64E-09	1.50E-04	1.97E-11	6.37E-08	5.81E-03	3.18E-03	.0677
30300.	.330	0.00E+00	0.00E+00	8.28E-08	7.60E-03	2.51E-08	2.15E-09	1.98E-04	2.51E-11	8.50E-08	7.80E-03	3.19E-03	.0677
30400.	.329	0.00E+00	0.00E+00	6.73E-08	6.22E-03	2.05E-08	1.70E-09	1.57E-04	1.93E-11	6.90E-08	6.38E-03	3.20E-03	.0662
30500.	.328	0.00E+00	0.00E+00	5.29E-08	4.92E-03	1.64E-08	1.29E-09	1.20E-04	1.44E-11	5.42E-08	5.04E-03	3.20E-03	.0639
30600.	.327	0.00E+00	0.00E+00	6.70E-08	6.27E-03	2.05E-08	1.61E-09	1.50E-04	1.74E-11	6.86E-08	6.42E-03	3.21E-03	.0639
30700.	.326	0.00E+00	0.00E+00	5.67E-08	5.35E-03	1.76E-08	1.31E-09	1.23E-04	1.39E-11	5.80E-08	5.47E-03	3.22E-03	.0616
30800.	.325	0.00E+00	0.00E+00	4.72E-08	4.48E-03	1.46E-08	1.06E-09	1.01E-04	1.10E-11	4.83E-08	4.58E-03	3.22E-03	.0607
30900.	.324	0.00E+00	0.00E+00	3.79E-08	3.62E-03	1.17E-08	8.31E-10	7.94E-05	8.38E-12	3.87E-08	3.70E-03	3.22E-03	.0598
31000.	.323	0.00E+00	0.00E+00	3.28E-08	3.15E-03	1.04E-08	6.89E-10	6.62E-05	6.85E-12	3.35E-08	3.22E-03	3.23E-03	.0570
31100.	.322	0.00E+00	0.00E+00	3.41E-08	3.30E-03	1.07E-08	7.03E-10	6.80E-05	6.77E-12	3.48E-08	3.37E-03	3.23E-03	.0569
31200.	.321	0.00E+00	0.00E+00	4.06E-08	3.95E-03	1.29E-08	8.04E-10	7.83E-05	7.61E-12	4.14E-08	4.03E-03	3.24E-03	.0547
31300.	.319	0.00E+00	0.00E+00	2.56E-08	2.50E-03	8.27E-09	4.86E-10	4.76E-05	4.51E-12	2.61E-08	2.55E-03	3.24E-03	.0524
31400.	.318	0.00E+00	0.00E+00	2.64E-08	2.60E-03	8.50E-09	4.90E-10	4.83E-05	4.43E-12	2.69E-08	2.65E-03	3.24E-03	.0520
31500.	.317	0.00E+00	0.00E+00	2.88E-08	2.85E-03	9.44E-09	5.11E-10	5.07E-05	4.54E-12	2.93E-08	2.91E-03	3.24E-03	.0497
31600.	.316	0.00E+00	0.00E+00	2.09E-08	2.09E-03	6.91E-09	3.59E-10	3.59E-05	3.11E-12	2.13E-08	2.13E-03	3.25E-03	.0483
31700.	.315	0.00E+00	0.00E+00	1.79E-08	1.80E-03	6.08E-09	2.93E-10	2.94E-05	2.50E-12	1.82E-08	1.83E-03	3.25E-03	.0457
31800.	.314	0.00E+00	0.00E+00	1.07E-08	1.08E-03	3.63E-09	1.70E-10	1.72E-05	1.41E-12	1.09E-08	1.10E-03	3.25E-03	.0448
31900.	.313	0.00E+00	0.00E+00	1.22E-08	1.24E-03	4.29E-09	1.82E-10	1.86E-05	1.50E-12	1.24E-08	1.26E-03	3.25E-03	.0418
32000.	.313	0.00E+00	0.00E+00	1.19E-08	1.22E-03	4.20E-09	1.72E-10	1.76E-05	1.38E-12	1.21E-08	1.24E-03	3.25E-03	.0408
32100.	.312	0.00E+00	0.00E+00	9.87E-09	1.02E-03	3.61E-09	1.33E-10	1.37E-05	1.05E-12	1.00E-08	1.03E-03	3.25E-03	.0378
32200.	.311	0.00E+00	0.00E+00	8.32E-09	8.63E-04	3.09E-09	1.08E-10	1.12E-05	8.31E-13	8.43E-09	8.74E-04	3.25E-03	.0364
32300.	.310	0.00E+00	0.00E+00	5.08E-09	5.30E-04	1.93E-09	6.22E-11	6.49E-06	4.71E-13	5.14E-09	5.37E-04	3.25E-03	.0345
32400.	.309	0.00E+00	0.00E+00	4.12E-09	4.33E-04	1.64E-09	4.65E-11	4.88E-06	3.48E-13	4.17E-09	4.38E-04	3.25E-03	.0315
32500.	.308	0.00E+00	0.00E+00	3.20E-09	3.38E-04	1.30E-09	3.41E-11	3.61E-06	2.50E-13	3.24E-09	3.42E-04	3.25E-03	.0299
32600.	.307	0.00E+00	0.00E+00	1.44E-09	1.53E-04	6.19E-10	1.39E-11	1.48E-06	1.01E-13	1.46E-09	1.55E-04	3.25E-03	.0268
32700.	.306	0.00E+00	0.00E+00	7.60E-10	8.13E-05	3.39E-10	6.74E-12	7.20E-07	4.80E-14	7.67E-10	8.20E-05	3.25E-03	.0248
32800.	.305	0.00E+00	0.00E+00	7.21E-10	7.76E-05	3.39E-10	5.73E-12	6.16E-07	4.02E-14	7.27E-10	7.82E-05	3.26E-03	.0223
32900.	.304	0.00E+00	0.00E+00	4.39E-10	4.76E-05	2.19E-10	3.06E-12	3.31E-07	2.13E-14	4.42E-10	4.79E-05	3.26E-03	.0198
33000.	.303	0.00E+00	0.00E+00	2.99E-10	3.26E-05	1.56E-10	1.86E-12	2.03E-07	1.27E-14	3.01E-10	3.28E-05	3.26E-03	.0180
33100.	.302	0.00E+00	0.00E+00	6.18E-11	6.77E-06	3.50E-11	3.13E-13	3.43E-08	2.12E-15	6.21E-11	6.80E-06	3.26E-03	.0152
33200.	.301	0.00E+00	0.00E+00	7.10E-11	7.83E-06	4.24E-11	3.04E-13	3.35E-08	2.03E-15	7.13E-11	7.86E-06	3.26E-03	.0135
33300.	.300	0.00E+00	0.00E+00	1.91E-11	2.12E-06	1.24E-11	6.22E-14	6.89E-09	4.12E-16	1.92E-11	2.13E-06	3.26E-03	.0112
33400.	.299	0.00E+00	0.00E+00	1.22E-11	1.36E-06	8.41E-12	2.95E-14	3.30E-09	1.95E-16	1.22E-11	1.36E-06	3.26E-03	.0094
33500.	.299	0.00E+00	0.00E+00	3.93E-12	4.41E-07	2.90E-12	6.58E-15	7.38E-10	4.35E-17	3.93E-12	4.41E-07	3.26E-03	.0077
33600.	.298	0.00E+00	0.00E+00	3.40E-12	3.84E-07	2.65E-12	3.67E-15	4.14E-10	8.30E-17	3.40E-12	3.84E-07	3.26E-03	.0061
33700.	.297	0.00E+00	0.00E+00	6.35E-13	7.21E-08	5.22E-13	4.07E-16	4.62E-11	4.49E-17	6.35E-13	7.21E-08	3.26E-03	.0046
33800.	.296	0.00E+00	0.00E+00	4.32E-13	4.94E-08	3.67E-13	2.11E-16	2.42E-11	7.91E-17	4.32E-13	4.94E-08	3.26E-03	.0036
33900.	.295	0.00E+00	0.00E+00	8.95E-14	1.03E-08	7.81E-14	6.67E-17	7.66E-12	5.50E-17	8.96E-14	1.03E-08	3.26E-03	.0025

Table 17. Program Output for Case 1 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ	WAVLEN	ATMOS RADIANCE		PATH SCATTERED RADIANCE			GROUND REFLECTED RADIANCE			TOTAL RADIANCE		INTEGRAL	TOTAL
				TOTAL		S SCAT	TOTAL		DIRECT				
(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	(CM-1)	(MICRN)	(CM-1)	TRANS
34000.	.294	0.00E+00	0.00E+00	3.71E-14	4.29E-09	3.29E-14	6.58E-17	7.61E-12	6.36E-17	3.72E-14	4.30E-09	3.26E-03	.0019

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INTEGRATED ABSORPTION FROM14000 TO34000 CM-1 =   16602.47 CM-1
AVERAGE TRANSMITTANCE = .1699

INTEGRATED RADIANCE =  3.255E-03 WATTS CM-2 STER-1
MINIMUM RADIANCE    =  3.721E-14 WATTS CM-2 STER-1 (CM-1)-1 AT    34000.0 CM-1
MAXIMUM RADIANCE    =  3.403E-07 WATTS CM-2 STER-1 (CM-1)-1 AT    14700.0 CM-1
BOUNDARY TEMPERATURE =     288.20 K
BOUNDARY EMISSIVITY =        .600

 CARD 5 *****    0
```

readable fashion.

The next three pages labeled Atmospheric Profiles, list the profiles of pressure, temperature, and absorber densities at the indicated altitudes Z for the selected atmospheric model. The units of the densities are as indicated or are in relative units (-). The densities of the nitrogen continuum (N_2) are in scaled LOWTRAN units. The self-broadened water vapor continuum density factor 'CNTMSLF' is listed next. The column labeled 'MOL SCAT' is the total air density relative to 1013.25 mb and 273.15K which is used to calculate molecular scattering. 'N-1' is the refractivity or the index of refraction −1.0. The ultra-violet ozone and oxygen [O_3 (UV), O_2 (UV)] densities are the actual densities.

The second of these three pages contains the following information: the foreign-broadened water vapor continuum density factor 'CNTMFRN' and the nitric acid 'HNO_3' density factor. AEROSOL 1 to 4 refer to the aerosol scaling factors for the 4 aerosol altitude regimes. "AER1*RH' is the log weighted relative humidity weighted by the boundary layer aerosol. 'CIRRUS' is the cirrus cloud density profile in km^{-1}. Since the cirrus cloud option was not selected, the cirrus density is zero everywhere. The last column labeled 'RH' is the path averaged relative humidity.

The third page of these profiles contains the densities for each molecular species in the following order: H_2O, O_3, CO_2, CO, CH_4, N_2O, O_2, NH_3, NO, NO_2, and SO_2. The next six tables labelled: Slant Path Parameters in Standard Form, Calculation of the Refracted Path Through the Atmosphere, Cumulative Absorber Amounts for the Path from H1 to Z, Summary of the Geometry Calculation, Equivalent Sea Level Total Absorber Amounts and Single Scattering Point to Source Paths are repeated twice in the output. The first set of tables result from the calculations taken for a vertical path through the entire atmosphere (0 to 100 km). This calculation is needed to obtain the up and down fluxes necessary to perform multiple scattering calculations. The second set of tables are for the line of sight path, in this case 20 to 0 km.

The first table contains pertinent information concerning the slant path parameters. All possible combinations of slant path parameters are reduced to the standard set of H1, H2, ANGLE, PHI, HMIN and LEN, where PHI is the arrival angle at H2, HMIN is the altitude of the lowest point along the path and LEN has a value of unity if the path goes through a tangent height and a value of zero otherwise.

A layer-by-layer description of the ray trace through the atmosphere appears next. The ray tract always begins at the lowest point along the path HMIN and proceeds upwards. The various quantities presented are: layer boundaries; zenith angle at the bottom of the layer THETA; curved path length through the layer DRANGE; cumulative path length RANGE from HMIN; earth-centered angle subtended by the layer DBETA and by the cumulative path BETA; arrival angle at the top of the layer PHI; path bending within the layer DBEND and cumulative BENDING; density-weighted path averaged pressure and temperature PBAR and TBAR for the layer; and average total air density RHOBAR.

The next table lists the cumulative absorber amounts for the species described in the atmospheric profile table from the observer to the different layer boundaries. 'CNTMSLF1' and 'CNTMSLF2' refer to the self-broadened water vapor amount and the temperature correction factor. A summary of the geometry calculation appears next, followed by "Equivalent Sea Level Total Absorber Amounts" that are the total amounts for the whole path for each of the aforementioned variables. "Mean RH" refers to the mean relative humidity in the boundary layer only.

Next is the output of the single solar scattering geometry routines: this includes a summary of the path from each scattering point to the sun. 'SUBTENDED ANGLE' is the earth-centered angle between the observer at H1 and the scattering point. The 'SOLAR ZENITH' angle is the astronomical or unrefracted zenith angle to the sun. However, if the refractive bending for the path to the sun is calculated to be greater than 0.1°, then the solar zenith angle is corrected by the bending and that path is calculated again (up to four times) until the correction for refraction is less than 0.1°.

The 'RELATIVE AZIMUTH' is negative because internally the azimuth angles are measured positive counterclockwise, while for the input cards, azimuth angles are specified positive clockwise. 'SCTTR ANGLE' is the scattering angle at that point. A message will be printed if any scattering point is in the shade. The last column contains the molecular phase function used for the calculation.

As previously noted the same six tables are now repeated, only this time the calculations are performed for the chosen path, in this case 20.0 to 0.0 km.

Finally the results of the calculation are printed. In this case, it is the radiance and the total transmittance for the path. The first two columns are the frequency and wavelength in wavenumbers (cm^{-1}) and micrometers (μm) respectively. The "Total Radiance" is broken down into three types: "Atmospheric Radiance", which includes all thermal radiation emitted by the atmosphere or by the boundary (and thermal radiation scattered by the atmosphere or reflected by the ground); "Path Scattered Radiance", which includes the solar radiation scattered by the atmosphere (the single scattered component of the solar radiation, "S Scat", is also shown separately); "Ground Reflected Radiance", which includes the solar radiation reflected by the ground (both the directly transmitted solar reaching the ground, "Direct", which is shown separately, or the solar radiation scattered within the atmosphere before reaching the ground). The "Total Radiance" is the sum of the three types of radiances reaching the observer. The four major components: atmospheric radiance, path scattered radiance, ground reflected radiance and total radiance are listed per cm^{-1} and μm. The next column 'INTEGRAL' is the integrated radiance from the initial frequency. The last column lists the total transmittance from H1 to H2. A short summary is printed at the end of the table, including the actual boundary temperature and emissivity used (if any), the integrated absorption, average transmittance, integrated radiance and the minimum and maximum values of the total radiance, which are useful in determining the limits for plotting.

The last item printed is the value of IRPT on CARD 5. In this case IRPT = 0 indicates there are no further input cards following. Figure 6 is a depiction of this case, the solid line is the total multiple scattered radiance and the dotted line shows the contribution due to single scattered solar radiance.

4.2 Case 2: Thermal Radiance

This case which is shown in Figure 7 consists of two separate runs of LOWTRAN. The solid line is the result using the multiple scattering calculations and the dotted line is the result of a standard radiance calculation. The output is depicted in Table 18.

In both runs MODEL has been set to 2 choosing the midlatitude summer model atmosphere, ITYPE = 3 is a slant path to space, IEMSCT = 1 is the thermal radiance option and M1 through M6 are left blank and MDEF set to 0 retains the amounts for each gas as chosen by MODEL. The only change on CARD 1 is the IMULT parameter which is on for one run and off for the second. On CARD 2 IHAZE has been set to 2 thereby choosing the rural aerosol profile with a meteorological range of 5 km. In defining the geometrical path H1 and H2 have been set to 0, while angle has been set to 80°. Since this is a slant path to space the program will perform calculations between 0 to 100 km, HMIN will be set to

(Text continued on page 93)

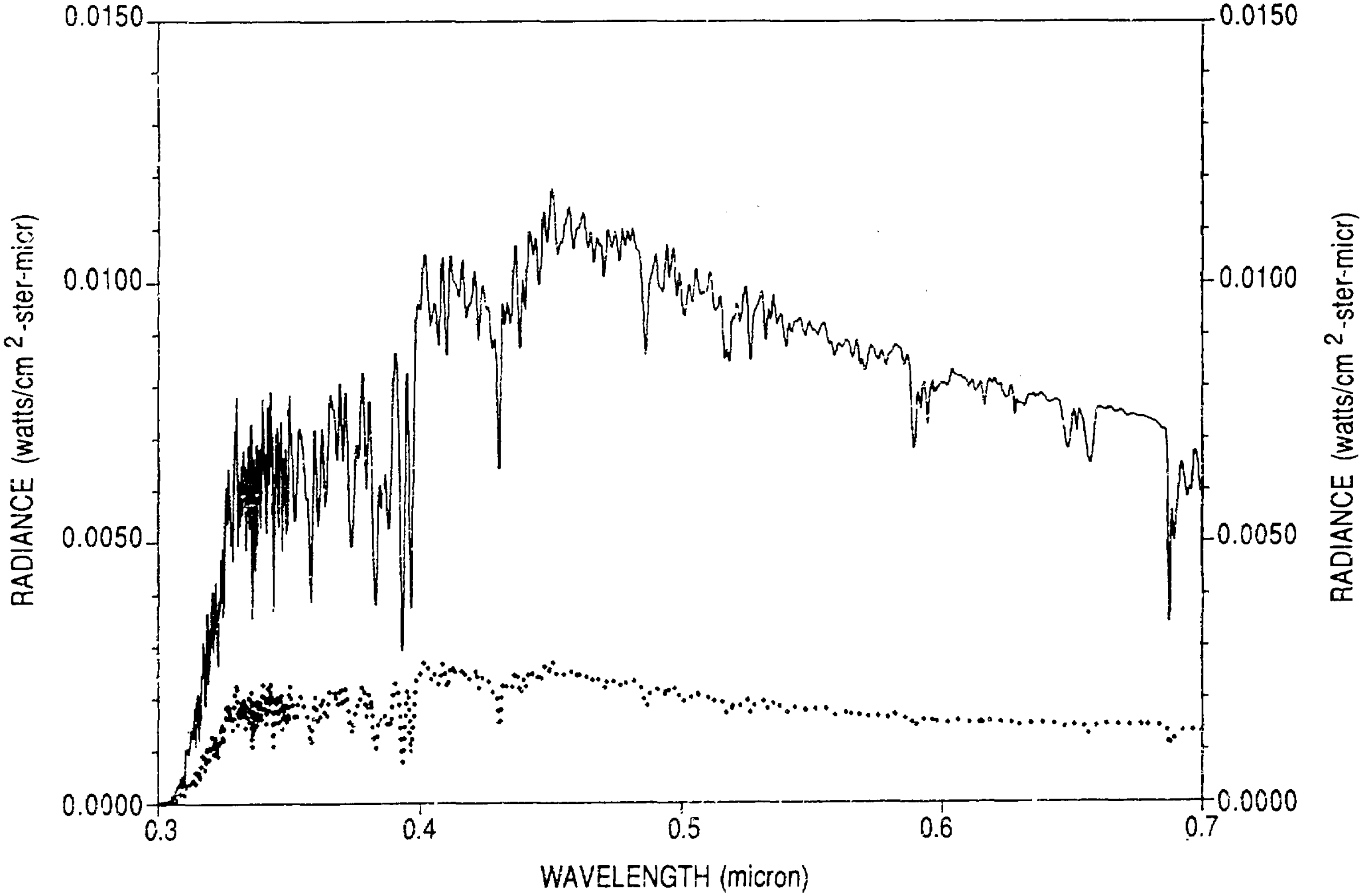

Figure 6. Single and Multiple Scattered, Solar Radiance (Case 1). The path for this case is 20 km to 0 km, the surface albedo is 0.4 and the solar zenith angle is 60°. The solid line is the total multiple scattered radiance and the dotted line shows the contribution due to single scatttered solar radiance.

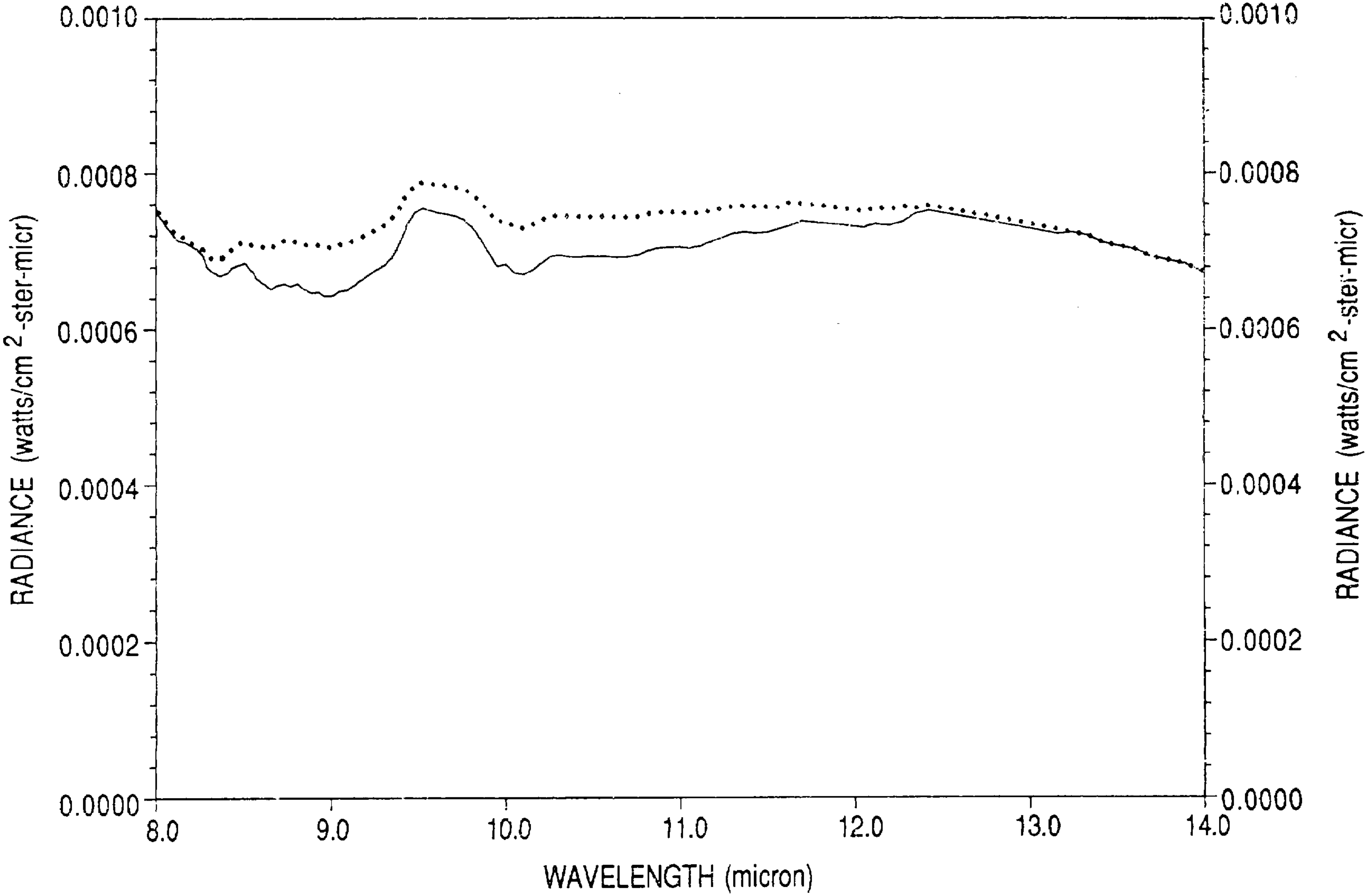

Figure 7. Multiple Scattered Thermal Radiance and a Standard Thermal Radiance Calculation, Conservative Scattering (Case 2). This is a slant path to space (0 to 100 km). The solid line is the result due to multiple scattering and the dotted line is the result of a radiance calculation.

Table 18. Program Output for Case 2

```
            ***** LOWTRAN 7 *****

CARD 1  *****    2    3    1    0    0    0    0    0    0    0    0    0    0   .000    .00

CARD 2  *****    2    0    0    0    0    0       .000      .000      .000      .000      .000

CARD 3  *****      .000      .000    80.000       .000      .000      .000    0

CARD 4  *****   740.000  1250.000     5.000

PROGRAM WILL COMPUTE RADIANCE

ATMOSPHERIC MODEL
        TEMPERATURE =     2     MIDLATITUDE SUMMER
        WATER VAPOR =     2     MIDLATITUDE SUMMER
        OZONE       =     2     MIDLATITUDE SUMMER
                   M4 =      2 M5 =      2 M6 =      2 MDEF =      1

AEROSOL MODEL
        REGIME                  AEROSOL TYPE              PROFILE                   SEASON

        BOUNDARY LAYER (0-2 KM) RURAL                       5.0 KM VIS AT SEA LEVEL
        TROPOSPHERE  (2-10KM)   TROPOSPHERIC              TROPOSPHERIC              SPRING-SUMMER
        STRATOSPHERE (10-30KM)  BACKGROUND STRATO         BACKGROUND STRATO         SPRING-SUMMER
        UPPER ATMOS (30-100KM)  METEORIC DUST             NORMAL

SLANT PATH TO SPACE
        H1    =        .000 KM
        HMIN  =        .000 KM
        ANGLE =      80.000 DEG

FREQUENCY RANGE
         V1 =         740.0 CM-1  (      13.51 MICROMETERS)
         V2 =        1250.0 CM-1  (       8.00 MICROMETERS)
         DV =           5.0 CM-1
```

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	N2	CNTMSLF (MOL/CM2 KM)	MOL SCAT (-)	N-1 (-)	O3 (UV) (ATM CM/KM)	O2 (UV) (ATM CM/KM)
1	.00	1013.000	294.2	6.984E-01	8.814E+20	9.282E-01	2.661E-04	2.799E-03	3.252E+04
2	1.00	902.000	289.7	5.666E-01	3.889E+20	8.393E-01	2.409E-04	2.799E-03	2.827E+04
3	2.00	802.000	285.2	4.586E-01	1.565E+20	7.581E-01	2.177E-04	2.798E-03	2.459E+04
4	3.00	710.000	279.2	3.711E-01	4.892E+19	6.855E-01	1.970E-04	2.892E-03	2.148E+04
5	4.00	628.000	273.2	2.999E-01	1.623E+19	6.197E-01	1.781E-04	2.985E-03	1.880E+04
6	5.00	554.000	267.2	2.413E-01	4.496E+18	5.589E-01	1.607E-04	3.079E-03	1.644E+04
7	6.00	487.000	261.2	1.929E-01	1.674E+18	5.026E-01	1.445E-04	3.219E-03	1.435E+04
8	7.00	426.000	254.7	1.533E-01	6.148E+17	4.509E-01	1.297E-04	3.498E-03	1.252E+04
9	8.00	372.000	248.2	1.215E-01	1.983E+17	4.040E-01	1.162E-04	3.685E-03	1.093E+04
10	9.00	324.000	241.7	9.594E-02	6.472E+16	3.614E-01	1.039E-04	4.012E-03	9.539E+03
11	10.00	281.000	235.3	7.513E-02	1.841E+16	3.219E-01	9.258E-05	4.195E-03	8.304E+03
12	11.00	243.000	228.8	5.859E-02	2.176E+15	2.863E-01	8.234E-05	5.130E-03	7.230E+03
13	12.00	209.000	222.3	4.526E-02	1.618E+14	2.534E-01	7.289E-05	5.648E-03	6.273E+03
14	13.00	179.000	215.8	3.471E-02	9.302E+12	2.236E-01	6.431E-05	6.704E-03	5.433E+03
15	14.00	153.000	215.7	2.538E-02	2.657E+12	1.912E-01	5.499E-05	8.408E-03	4.551E+03
16	15.00	130.000	215.7	1.832E-02	8.870E+11	1.625E-01	4.673E-05	8.118E-03	3.796E+03
17	16.00	111.000	215.7	1.336E-02	6.092E+11	1.387E-01	3.990E-05	8.318E-03	3.191E+03
18	17.00	95.000	215.7	9.783E-03	4.196E+11	1.187E-01	3.415E-05	8.305E-03	2.695E+03
19	18.00	81.200	216.8	7.093E-03	2.940E+11	1.010E-01	2.904E-05	1.009E-02	2.254E+03
20	19.00	69.500	217.9	5.157E-03	2.201E+11	8.598E-02	2.473E-05	1.289E-02	1.909E+03
21	20.00	59.500	219.2	3.746E-03	1.695E+11	7.317E-02	2.104E-05	1.463E-02	1.610E+03
22	21.00	51.000	220.4	2.730E-03	1.346E+11	6.238E-02	1.794E-05	1.496E-02	1.362E+03
23	22.00	43.700	221.6	1.988E-03	1.065E+11	5.31[illegible]E-02	1.529E-05	1.541E-02	1.153E+03
24	23.00	37.600	222.8	1.460E-03	8.918E+10	4.549E-02	1.308E-05	1.546E-02	9.817E+02
25	24.00	32.200	223.9	1.063E-03	6.991E+10	3.877E-02	1.115E-05	1.550E-02	8.326E+02
26	25.00	27.700	225.1	7.802E-04	5.643E+10	3.317E-02	9.541E-06	1.591E-02	7.096E+02
27	30.00	13.200	233.7	1.575E-04	1.489E+10	1.523E-02	4.379E-06	1.065E-02	3.216E+02
28	35.00	6.520	245.2	3.802E-05	3.660E+09	7.168E-03	2.062E-06	6.375E-03	1.505E+02
29	40.00	3.330	257.5	9.216E-06	9.189E+08	3.486E-03	1.003E-06	2.630E-03	7.300E+01
30	45.00	1.760	269.9	2.399E-06	2.668E+08	1.758E-03	5.056E-07	7.905E-04	3.676E+01
31	50.00	.951	275.7	6.785E-07	7.603E+07	9.299E-04	2.674E-07	2.602E-04	1.943E+01
32	70.00	.067	218.1	4.786E-09	2.729E+05	8.281E-05	2.382E-08	3.310E-06	1.730E+00
33	100.00	.000	190.5	8.694E-14	6.200E-02	3.651E-07	1.050E-10	1.459E-08	5.838E-03

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1 (-)	AEROSOL 2 (-)	AEROSOL 3 (-)	AEROSOL 4 (-)	AER1*RH (-)	CIRRUS (-)	RH (PERCNT)
1	.00	1013.000	294.2	4.614E+22	4.641E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	2.443E+00	0.000E+00	7.611E+01
2	1.00	902.000	289.7	2.785E+22	5.003E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	2.716E+00	0.000E+00	6.597E+01
3	2.00	802.000	285.2	1.603E+22	5.253E-06	6.210E-02	0.000E+00	0.000E+00	0.000E+00	2.362E-01	0.000E+00	5.515E+01
4	3.00	710.000	279.2	8.132E+21	5.423E-06	0.000E+00	3.460E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.526E+01
5	4.00	628.000	273.2	4.243E+21	5.497E-06	0.000E+00	1.850E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.902E+01
6	5.00	554.000	267.2	2.018E+21	5.450E-06	0.000E+00	9.310E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.139E+01
7	6.00	487.000	261.2	1.108E+21	5.579E-06	0.000E+00	7.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.996E+01
8	7.00	426.000	254.7	6.026E+20	5.681E-06	0.000E+00	6.230E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.029E+01
9	8.00	372.000	248.2	3.068E+20	5.616E-06	0.000E+00	3.370E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.961E+01
10	9.00	324.000	241.7	1.568E+20	5.529E-06	0.000E+00	1.820E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.013E+01
11	10.00	281.000	235.3	7.452E+19	5.602E-06	0.000E+00	1.140E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.942E+01
12	11.00	243.000	228.8	2.279E+19	5.783E-06	0.000E+00	0.000E+00	7.990E-04	0.000E+00	0.000E+00	0.000E+00	1.946E+01
13	12.00	209.000	222.3	5.502E+18	6.108E-06	0.000E+00	0.000E+00	6.410E-04	0.000E+00	0.000E+00	0.000E+00	1.069E+01
14	13.00	179.000	215.8	1.164E+18	6.172E-06	0.000E+00	0.000E+00	5.170E-04	0.000E+00	0.000E+00	0.000E+00	5.418E+00
15	14.00	153.000	215.7	5.319E+17	6.368E-06	0.000E+00	0.000E+00	4.420E-04	0.000E+00	0.000E+00	0.000E+00	2.931E+00
16	15.00	130.000	215.7	2.611E+17	7.344E-06	0.000E+00	0.000E+00	3.950E-04	0.000E+00	0.000E+00	0.000E+00	1.693E+00
17	16.00	111.000	215.7	1.848E+17	1.022E-05	0.000E+00	0.000E+00	3.820E-04	0.000E+00	0.000E+00	0.000E+00	1.403E+00
18	17.00	[illegible]	215.7	1.312E+17	1.555E-05	0.000E+00	0.000E+00	4.250E-04	0.000E+00	0.000E+00	0.000E+00	1.165E+00
19	18.00	[illegible]	216.8	9.342E+16	2.130E-05	0.000E+00	0.000E+00	5.200E-04	0.000E+00	0.000E+00	0.000E+00	8.556E-01
20	19.00	[illegible]	217.9	6.883E+16	2.726E-05	0.000E+00	0.000E+00	5.810E-04	0.000E+00	0.000E+00	0.000E+00	6.505E-01
21	20.00	59.500	219.2	5.141E+16	3.073E-05	0.000E+00	0.000E+00	5.890E-04	0.000E+00	0.000E+00	0.000E+00	4.911E-01
22	21.00	51.000	220.4	3.906E+16	3.082E-05	0.000E+00	0.000E+00	5.020E-04	0.000E+00	0.000E+00	0.000E+00	3.816E-01
23	22.00	43.700	221.6	2.960E+16	2.903E-05	0.000E+00	0.000E+00	4.200E-04	0.000E+00	0.000E+00	0.000E+00	2.964E-01
24	23.00	37.600	222.8	2.318E+16	2.611E-05	0.000E+00	0.000E+00	3.000E-04	0.000E+00	0.000E+00	0.000E+00	2.373E-01
25	24.00	32.200	223.9	1.749E+16	2.264E-05	0.000E+00	0.000E+00	1.980E-04	0.000E+00	0.000E+00	0.000E+00	1.861E-01
26	25.00	27.700	225.1	1.345E+16	1.861E-05	0.000E+00	0.000E+00	1.310E-04	0.000E+00	0.000E+00	0.000E+00	1.468E-01
27	30.00	13.200	233.7	3.170E+15	5.695E-06	0.000E+00	0.000E+00	3.320E-05	0.000E+00	0.000E+00	0.000E+00	3.096E-02
28	35.00	6.520	245.2	7.399E+14	1.176E-06	0.000E+00	0.000E+00	0.000E+00	1.640E-05	0.000E+00	0.000E+00	5.227E-03
29	40.00	3.330	257.5	1.803E+14	1.858E-07	0.000E+00	0.000E+00	0.000E+00	7.990E-06	0.000E+00	0.000E+00	9.357E-04
30	45.00	1.760	269.9	4.900E+13	2.127E-08	0.000E+00	0.000E+00	0.000E+00	4.010E-06	0.000E+00	0.000E+00	1.993E-04
31	50.00	.951	275.7	1.384E+13	5.161E-09	0.000E+00	0.000E+00	0.000E+00	2.100E-06	0.000E+00	0.000E+00	7.121E-05
32	70.00	.067	218.1	7.382E+10	2.708E-10	0.000E+00	0.000E+00	0.000E+00	1.600E-07	0.000E+00	0.000E+00	7.078E-04
33	100.00	.000	190.5	1.551E+05	9.967E-13	0.000E+00	0.000E+00	0.000E+00	9.310E-10	0.000E+00	0.000E+00	1.460E-05

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

(IF A MOLECULE HAS MORE THAN ONE BAND, THEN THE DATA FOR THE FIRST BAND ARE SHOWN.)

I	Z (KM)	P (MB)	T (K)	H2O G/CM**2/KM	O3 (	CO2	CO	CH4 ATM CM/KM	N2O	O2	NH3	NO	NO2	SO2)
1	.0	1013.000	294.2	1.36E+00	2.52E-03	3.62E+01	1.32E-02	1.63E-01	2.77E-02	1.55E+04	4.96E-05	2.88E-05	2.14E-06	2.54E-05
2	1.00	902.000	289.7	8.13E-01	2.46E-03	2.92E+01	1.07E-02	1.35E-01	2.43E-02	1.28E+04	4.03E-05	2.43E-05	1.85E-06	2.07E-05
3	2.00	802.000	285.2	4.62E-01	2.39E-03	2.36E+01	8.61E-03	1.11E-01	2.13E-02	1.05E+04	3.02E-05	2.05E-05	1.59E-06	1.58E-05
4	3.00	710.000	279.2	2.31E-01	2.42E-03	1.87E+01	6.95E-03	9.12E-02	1.88E-02	8.79E+03	2.00E-05	1.72E-05	1.37E-06	1.14E-05
5	4.00	628.000	273.2	1.19E-01	2.44E-03	1.48E+01	5.65E-03	7.47E-02	1.65E-02	7.33E+03	1.22E-05	1.44E-05	1.18E-06	7.85E-06
6	5.00	554.000	267.2	5.56E-02	2.46E-03	1.17E+01	4.67E-03	6.07E-02	1.45E-02	6.08E+03	6.88E-06	1.21E-05	1.01E-06	5.67E-06
7	6.00	487.000	261.2	3.02E-02	2.52E-03	9.17E+00	3.83E-03	4.89E-02	1.27E-02	5.02E+03	3.91E-06	1.00E-05	8.52E-07	4.15E-06
8	7.00	426.000	254.7	1.62E-02	2.68E-03	7.10E+00	3.06E-03	3.89E-02	1.11E-02	4.14E+03	2.08E-06	8.29E-06	7.33E-07	3.16E-06
9	8.00	372.000	248.2	8.10E-03	2.76E-03	5.48E+00	2.39E-03	3.09E-02	9.66E-03	3.41E+03	1.07E-06	6.83E-06	6.21E-07	2.44E-06
10	9.00	324.000	241.7	4.08E-03	2.95E-03	4.21E+00	1.81E-03	2.46E-02	8.32E-03	2.80E+03	4.88E-07	5.61E-06	5.30E-07	1.97E-06
11	10.00	281.000	235.3	1.91E-03	3.01E-03	3.21E+00	1.34E-03	1.91E-02	7.05E-03	2.28E+03	2.04E-07	4.58E-06	4.57E-07	1.61E-06
12	11.00	243.000	228.8	5.74E-04	3.60E-03	2.43E+00	9.81E-04	1.48E-02	5.89E-03	1.86E+03	8.44E-08	3.72E-06	4.22E-07	1.35E-06
13	12.00	209.000	222.3	1.36E-04	3.88E-03	1.82E+00	6.89E-04	1.14E-02	4.97E-03	1.50E+03	3.73E-08	3.00E-06	4.22E-07	1.15E-06
14	13.00	179.000	215.8	2.64E-05	4.49E-03	1.36E+00	4.50E-04	8.69E-03	4.14E-03	1.20E+03	1.40E-08	2.40E-06	4.94E-07	1.00E-06
15	14.00	153.000	215.7	1.30E-05	5.28E-03	1.04E+00	2.69E-04	6.51E-03	3.27E-03	8.53E+02	3.75E-09	1.86E-06	6.68E-07	8.26E-07
16	15.00	130.000	215.7	6.40E-06	4.76E-03	7.94E-01	1.59E-04	4.83E-03	2.54E-03	5.97E+02	1.13E-09	1.39E-06	1.22E-06	6.82E-07
17	16.00	111.000	215.7	4.54E-06	4.56E-03	6.10E-01	9.35E-05	3.60E-03	1.96E-03	4.23E+02	4.00E-10	1.04E-06	1.82E-06	5.56E-07
18	17.00	95.000	215.7	3.24E-06	4.27E-03	4.70E-01	5.77E-05	2.69E-03	1.46E-03	3.01E+02	1.58E-10	7.70E-07	2.38E-06	4.25E-07
19	18.00	81.200	216.8	2.32E-06	4.82E-03	3.64E-01	3.43E-05	2.00E-03	1.05E-03	2.09E+02	7.23E-11	5.75E-07	2.83E-06	3.05E-07
20	19.00	69.500	217.9	1.72E-06	5.73E-03	2.82E-01	2.04E-05	1.48E-03	7.11E-04	1.46E+02	3.23E-11	4.60E-07	3.12E-06	2.05E-07
21	20.00	59.500	219.2	1.29E-06	6.04E-03	2.20E-01	1.32E-05	1.08E-03	4.94E-04	1.01E+02	1.48E-11	3.78E-07	3.27E-06	1.33E-07
22	21.00	51.000	220.4	9.89E-07	5.75E-03	1.71E-01	9.27E-06	7.78E-04	3.26E-04	7.08E+01	8.95E-12	3.24E-07	3.32E-06	8.99E-08
23	22.00	43.700	221.6	7.54E-07	5.50E-03	1.33E-01	6.96E-06	5.50E-04	2.26E-04	4.94E+01	6.06E-12	2.82E-07	3.27E-06	6.21E-08
24	23.00	37.600	222.8	5.95E-07	5.15E-03	1.04E-01	5.62E-06	3.87E-04	1.64E-04	3.48E+01	4.27E-12	2.63E-07	3.15E-06	4.59E-08
25	24.00	32.200	223.9	4.51E-07	4.80E-03	8.08E-02	4.54E-06	2.67E-04	1.22E-04	2.43E+01	2.93E-12	2.59E-07	3.00E-06	3.41E-08
26	25.00	27.700	225.1	3.49E-07	4.59E-03	6.33E-02	3.75E-06	1.85E-04	9.13E-05	1.71E+01	1.90E-12	3.12E-07	2.95E-06	2.55E-08
27	30.00	13.200	233.7	8.56E-08	2.14E-03	1.92E-02	1.25E-06	4.06E-05	2.28E-05	2.91E+00	2.58E-13	3.52E-07	1.67E-06	6.89E-09
28	35.00	6.520	245.2	2.09E-08	8.90E-04	6.29E-03	4.17E-07	9.35E-06	4.34E-06	5.15E-01	2.06E-14	3.41E-07	7.04E-07	2.15E-09
29	40.00	3.330	257.5	5.33E-09	2.59E-04	2.18E-03	1.40E-07	2.25E-06	7.35E-07	9.74E-02	9.88E-16	1.87E-07	1.46E-07	9.47E-10
30	45.00	1.760	269.9	1.51E-09	5.57E-05	7.96E-04	4.71E-08	5.37E-07	1.23E-07	2.00E-02	3.16E-17	7.20E-08	1.63E-08	5.77E-10
31	50.00	.951	275.7	4.39E-10	1.37E-05	2.92E-04	1.70E-08	1.25E-07	2.12E-08	4.78E-03	2.49E-18	2.45E-08	2.61E-09	4.20E-10
32	70.00	.067	218.1	2.11E-12	7.95E-08	2.59E-06	7.66E-10	1.17E-09	2.08E-10	3.66E-05	7.68E-21	5.39E-10	4.19E-11	2.78E-11
33	100.00	.000	190.5	4.49E-18	4.10E-11	1.20E-10	4.67E-12	7.38E-14	4.66E-14	2.50E-10	1.99E-25	2.16E-11	1.50E-14	2.33E-16

CASE 3A: GIVEN H1,H2=SPACE,ANGLE

SLANT PATH PARAMETERS IN STANDARD FORM

H1	=	.000	KM
H2	=	100.000	KM
ANGLE	=	80.000	DEG
PHI	=	104.106	DEG
HMIN	=	.000	KM
LEN	=	0	

Table 18. Program Output for Case 2 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	.000	1.000	80.000	5.747	5.747	.051	.051	100.043	.008	.008	957.370	291.98	1.14E-03
2	1.000	2.000	79.957	5.722	11.469	.051	.102	100.086	.007	.016	851.881	287.48	1.03E-03
3	2.000	3.000	79.914	5.698	17.167	.050	.152	100.130	.007	.022	755.847	282.24	9.32E-04
4	3.000	4.000	79.870	5.674	22.841	.050	.202	100.174	.006	.028	668.861	276.24	8.43E-04
5	4.000	5.000	79.826	5.649	28.490	.050	.252	100.218	.006	.034	590.871	270.24	7.61E-04
6	5.000	6.000	79.782	5.625	34.115	.050	.302	100.263	.005	.039	520.380	264.24	6.85E-04
7	6.000	7.000	79.737	5.601	39.716	.050	.351	100.308	.005	.044	456.378	258.00	6.15E-04
8	7.000	8.000	79.692	5.577	45.292	.049	.401	100.353	.004	.048	398.889	251.50	5.52E-04
9	8.000	9.000	79.647	5.553	50.845	.049	.450	100.398	.004	.052	347.898	245.00	4.94E-04
10	9.000	10.000	79.602	5.529	56.374	.049	.499	100.443	.004	.055	302.406	238.55	4.41E-04
11	10.000	11.000	79.557	5.505	61.879	.049	.547	100.489	.003	.059	261.915	232.10	3.93E-04
12	11.000	12.000	79.511	5.482	67.360	.048	.596	100.534	.003	.061	225.921	225.60	3.48E-04
13	12.000	13.000	79.466	5.458	72.819	.048	.644	100.580	.003	.064	193.928	219.10	3.08E-04
14	13.000	14.000	79.420	5.435	78.254	.048	.692	100.625	.003	.067	166.001	215.75	2.67E-04
15	14.000	15.000	79.375	5.412	83.666	.048	.739	100.670	.003	.069	141.502	215.70	2.28E-04
16	15.000	16.000	79.330	5.390	89.056	.048	.787	100.715	.002	.072	120.501	215.70	1.94E-04
17	16.000	17.000	79.285	5.367	94.423	.047	.834	100.761	.002	.073	103.001	215.70	1.66E-04
18	17.000	18.000	79.239	5.345	99.768	.047	.881	100.806	.002	.075	88.107	216.23	1.42E-04
19	18.000	19.000	79.194	5.322	105.090	.047	.928	100.852	.001	.076	75.356	217.33	1.21E-04
20	19.000	20.000	79.148	5.300	110.390	.047	.975	100.898	.001	.077	64.505	218.53	1.03E-04
21	20.000	21.000	79.102	5.279	115.669	.046	1.021	100.943	.001	.078	55.254	219.76	8.74E-05
22	21.000	22.000	79.057	5.257	120.926	.046	1.068	100.989	.001	.079	47.354	220.98	7.45E-05
23	22.000	23.000	79.011	5.236	126.162	.046	1.114	101.034	.001	.080	40.653	222.18	6.36E-05
24	23.000	24.000	78.966	5.214	131.376	.046	1.159	101.079	.001	.080	34.902	223.33	5.43E-05
25	24.000	25.000	78.921	5.193	136.569	.046	1.205	101.124	.000	.081	29.952	224.48	4.64E-05
26	25.000	30.000	78.876	25.660	162.229	.225	1.430	101.348	.001	.082	20.517	228.81	2.98E-05
27	30.000	35.000	78.652	25.169	187.398	.221	1.651	101.568	.001	.083	9.896	238.67	1.38E-05
28	35.000	40.000	78.432	24.705	212.104	.216	1.867	101.784	.000	.083	4.942	250.55	6.61E-06
29	40.000	45.000	78.216	24.267	236.371	.212	2.080	101.996	.000	.083	2.553	262.93	3.27E-06
30	45.000	50.000	78.004	23.852	260.223	.208	2.288	102.205	.000	.083	1.358	272.48	1.68E-06
31	50.000	70.000	77.795	91.660	351.882	.797	3.085	103.001	.000	.083	.499	256.71	4.58E-07
32	70.000	100.000	76.999	128.005	479.887	1.104	4.189	104.106	.000	.083	.033	212.98	2.02E-08

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	1.000	291.98	2.771E-05	1.608E-02	3.459E+21	3.861E+20	2.082E+23	1.744E+05
2	2.000	287.48	5.705E-05	3.210E-02	4.921E+21	7.318E+20	3.307E+23	3.254E+05
3	3.000	282.24	8.747E-05	4.831E-02	5.448E+21	9.333E+20	3.970E+23	4.565E+05
4	4.000	276.24	1.184E-04	6.499E-02	5.616E+21	1.026E+21	4.309E+23	5.706E+05
5	5.000	270.24	1.494E-04	8.212E-02	5.660E+21	1.063E+21	4.478E+23	6.700E+05
6	6.000	264.24	1.804E-04	9.983E-02	5.684E+21	1.077E+21	4.564E+23	7.564E+05
7	7.000	258.00	2.119E-04	1.186E-01	5.690E+21	1.083E+21	4.610E+23	8.316E+05
8	8.000	251.50	2.434E-04	1.387E-01	5.692E+21	1.085E+21	4.635E+23	8.968E+05
9	9.000	245.00	2.744E-04	1.600E-01	5.692E+21	1.085E+21	4.647E+23	9.536E+05
10	10.000	238.55	3.051E-04	1.827E-01	5.693E+21	1.086E+21	4.653E+23	1.003E+06
11	11.000	232.10	3.365E-04	2.084E-01	5.693E+21	1.086E+21	4.656E+23	1.045E+06
12	12.000	225.60	3.691E-04	2.379E-01	5.693E+21	1.086E+21	4.656E+23	1.082E+06
13	13.000	219.10	4.026E-04	2.716E-01	5.693E+21	1.086E+21	4.656E+23	1.114E+06

Table 18. Program Output for Case 2 (Cont.)

14	14.000	215.75	4.366E-04	3.127E-01	5.693E+21	1.086E+21	4.656E+23	1.141E+06
15	15.000	215.70	4.737E-04	3.574E-01	5.693E+21	1.086E+21	4.656E+23	1.164E+06
16	16.000	215.70	5.211E-04	4.017E-01	5.693E+21	1.086E+21	4.656E+23	1.183E+06
17	17.000	215.70	5.903E-04	4.463E-01	5.693E+21	1.086E+21	4.656E+23	1.198E+06
18	18.000	216.23	6.888E-04	4.955E-01	5.693E+21	1.086E+21	4.656E+23	1.212E+06
19	19.000	217.33	8.180E-04	5.566E-01	5.693E+21	1.086E+21	4.656E+23	1.223E+06
20	20.000	218.53	9.717E-04	6.295E-01	5.693E+21	1.086E+21	4.656E+23	1.232E+06
21	21.000	219.78	1.134E-03	7.076E-01	5.693E+21	1.086E+21	4.656E+23	1.240E+06
22	22.000	220.98	1.291E-03	7.875E-01	5.693E+21	1.086E+21	4.656E+23	1.246E+06
23	23.000	222.18	1.436E-03	8.683E-01	5.693E+21	1.086E+21	4.656E+23	1.252E+06
24	24.000	223.33	1.562E-03	9.490E-01	5.693E+21	1.086E+21	4.656E+23	1.257E+06
25	25.000	224.48	1.669E-03	1.031E+00	5.693E+21	1.086E+21	4.656E+23	1.261E+06
26	30.000	228.81	1.950E-03	1.367E+00	5.693E+21	1.086E+21	4.656E+23	1.273E+06
27	35.000	238.67	2.022E-03	1.577E+00	5.693E+21	1.086E+21	4.656E+23	1.279E+06
28	40.000	250.55	2.035E-03	1.682E+00	5.693E+21	1.086E+21	4.656E+23	1.282E+06
29	45.000	262.93	2.037E-03	1.719E+00	5.693E+21	1.086E+21	4.656E+23	1.283E+06
30	50.000	272.48	2.037E-03	1.730E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06
31	70.000	256.71	2.037E-03	1.736E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06
32	100.000	212.98	2.037E-03	1.736E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	1.000	3.622E+00	5.075E+00	4.425E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	2.000	6.544E+00	9.641E+00	6.034E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.000	8.899E+00	1.375E+01	6.211E+00	9.855E-02	0.000E+00	0.000E+00	0.000E+00
4	4.000	1.080E+01	1.745E+01	6.211E+00	2.445E-01	0.000E+00	0.000E+00	0.000E+00
5	5.000	1.232E+01	2.078E+01	6.211E+00	3.201E-01	0.000E+00	0.000E+00	0.000E+00
6	6.000	1.353E+01	2.376E+01	6.211E+00	3.678E-01	0.000E+00	0.000E+00	0.000E+00
7	7.000	1.450E+01	2.643E+01	6.211E+00	4.067E-01	0.000E+00	0.000E+00	0.000E+00
8	8.000	1.526E+01	2.881E+01	6.211E+00	4.326E-01	0.000E+00	0.000E+00	0.000E+00
9	9.000	1.586E+01	3.093E+01	6.211E+00	4.466E-01	0.000E+00	0.000E+00	0.000E+00
10	10.000	1.633E+01	3.282E+01	6.211E+00	4.547E-01	0.000E+00	0.000E+00	0.000E+00
11	11.000	1.670E+01	3.449E+01	6.211E+00	4.578E-01	2.199E-03	0.000E+00	0.000E+00
12	12.000	1.698E+01	3.597E+01	6.211E+00	4.578E-01	6.130E-03	0.000E+00	0.000E+00
13	13.000	1.720E+01	3.727E+01	6.211E+00	4.578E-01	9.278E-03	0.000E+00	0.000E+00
14	14.000	1.736E+01	3.839E+01	6.211E+00	4.578E-01	1.188E-02	0.000E+00	0.000E+00
15	15.000	1.748E+01	3.935E+01	6.211E+00	4.578E-01	1.414E-02	0.000E+00	0.000E+00
16	16.000	1.756E+01	4.016E+01	6.211E+00	4.578E-01	1.624E-02	0.000E+00	0.000E+00
17	17.000	1.763E+01	4.085E+01	6.211E+00	4.578E-01	1.840E-02	0.000E+00	0.000E+00
18	18.000	1.767E+01	4.143E+01	6.211E+00	4.578E-01	2.093E-02	0.000E+00	0.000E+00
19	19.000	1.770E+01	4.193E+01	6.211E+00	4.578E-01	2.386E-02	0.000E+00	0.000E+00
20	20.000	1.773E+01	4.235E+01	6.211E+00	4.578E-01	2.696E-02	0.000E+00	0.000E+00
21	21.000	1.774E+01	4.271E+01	6.211E+00	4.578E-01	2.983E-02	0.000E+00	0.000E+00
22	22.000	1.776E+01	4.301E+01	6.211E+00	4.578E-01	3.225E-02	0.000E+00	0.000E+00
23	23.000	1.777E+01	4.327E+01	6.211E+00	4.578E-01	3.411E-02	0.000E+00	0.000E+00
24	24.000	1.777E+01	4.349E+01	6.211E+00	4.578E-01	3.539E-02	0.000E+00	0.000E+00
25	25.000	1.778E+01	4.367E+01	6.211E+00	4.578E-01	3.624E-02	0.000E+00	0.000E+00
26	30.000	1.779E+01	4.427E+01	6.211E+00	4.578E-01	3.807E-02	0.000E+00	0.000E+00
27	35.000	1.779E+01	4.454E+01	6.211E+00	4.578E-01	3.849E-02	2.058E-04	0.000E+00
28	40.000	1.779E+01	4.466E+01	6.211E+00	4.578E-01	3.849E-02	4.950E-04	0.000E+00
29	45.000	1.779E+01	4.472E+01	6.211E+00	4.578E-01	3.849E-02	6.352E-04	0.000E+00
30	50.000	1.779E+01	4.475E+01	6.211E+00	4.578E-01	3.849E-02	7.057E-04	0.000E+00
31	70.000	1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.756E-04	0.000E+00
32	100.000	1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.797E-04	0.000E+00

J	Z (KM)	H2O (G/CM**2)	O3 (	CO2	CO	CH4	N2O	O2 ATM CM	NH3	NO	NO2	SO2)

Table 18. Program Output for Case 2 (Cont.)

1	1.00	6.12E+00	1.43E-02	1.87E+02	6.84E-02	8.51E-01	1.49E-01	8.12E+04	2.57E-04	1.52E-04	1.14E-05	1.32E-04
2	2.00	9.67E+00	2.82E-02	3.38E+02	1.23E-01	1.55E+00	2.79E-01	1.48E+05	4.58E-04	2.80E-04	2.13E-05	2.36E-04
3	3.00	1.16E+01	4.19E-02	4.58E+02	1.68E-01	2.13E+00	3.94E-01	2.03E+05	5.99E-04	3.88E-04	2.97E-05	3.13E-04
4	4.00	1.25E+01	5.56E-02	5.52E+02	2.03E-01	2.59E+00	4.94E-01	2.48E+05	6.88E-04	4.77E-04	3.69E-05	3.67E-04
5	5.00	1.30E+01	6.95E-02	6.27E+02	2.32E-01	2.98E+00	5.81E-01	2.86E+05	7.41E-04	5.52E-04	4.31E-05	4.04E-04
6	6.00	1.32E+01	8.35E-02	6.85E+02	2.56E-01	3.28E+00	6.58E-01	3.17E+05	7.70E-04	6.14E-04	4.83E-05	4.32E-04
7	7.00	1.34E+01	9.81E-02	7.31E+02	2.75E-01	3.53E+00	7.24E-01	3.43E+05	7.86E-04	6.65E-04	5.28E-05	4.52E-04
8	8.00	1.34E+01	1.13E-01	7.66E+02	2.90E-01	3.72E+00	7.82E-01	3.64E+05	7.95E-04	7.07E-04	5.66E-05	4.68E-04
9	9.00	1.35E+01	1.29E-01	7.92E+02	3.02E-01	3.87E+00	8.32E-01	3.81E+05	7.99E-04	7.41E-04	5.98E-05	4.80E-04
10	10.00	1.35E+01	1.46E-01	8.13E+02	3.11E-01	3.99E+00	8.74E-01	3.95E+05	8.01E-04	7.69E-04	6.25E-05	4.90E-04
11	11.00	1.35E+01	1.64E-01	8.28E+02	3.17E-01	4.09E+00	9.10E-01	4.07E+05	8.02E-04	7.92E-04	6.49E-05	4.98E-04
12	12.00	1.35E+01	1.84E-01	8.40E+02	3.22E-01	4.16E+00	9.39E-01	4.16E+05	8.02E-04	8.11E-04	6.72E-05	5.05E-04
13	13.00	1.35E+01	2.07E-01	8.48E+02	3.25E-01	4.21E+00	9.64E-01	4.23E+05	8.02E-04	8.25E-04	6.97E-05	5.11E-04
14	14.00	1.35E+01	2.34E-01	8.55E+02	3.27E-01	4.25E+00	9.84E-01	4.29E+05	8.02E-04	8.37E-04	7.29E-05	5.16E-04
15	15.00	1.35E+01	2.61E-01	8.60E+02	3.28E-01	4.28E+00	1.00E+00	4.32E+05	8.02E-04	8.46E-04	7.80E-05	5.20E-04
16	16.00	1.35E+01	2.86E-01	8.64E+02	3.28E-01	4.31E+00	1.01E+00	4.35E+05	8.02E-04	8.52E-04	8.62E-05	5.23E-04
17	17.00	1.35E+01	3.10E-01	8.66E+02	3.29E-01	4.32E+00	1.02E+00	4.37E+05	8.02E-04	8.57E-04	9.74E-05	5.26E-04
18	18.00	1.35E+01	3.34E-01	8.69E+02	3.29E-01	4.34E+00	1.03E+00	4.38E+05	8.02E-04	8.61E-04	1.11E-04	5.28E-04
19	19.00	1.35E+01	3.62E-01	8.70E+02	3.29E-01	4.34E+00	1.03E+00	4.39E+05	8.02E-04	8.63E-04	1.27E-04	5.29E-04
20	20.00	1.35E+01	3.93E-01	8.72E+02	3.29E-01	4.35E+00	1.04E+00	4.40E+05	8.02E-04	8.65E-04	1.44E-04	5.30E-04
21	21.00	1.35E+01	4.24E-01	8.73E+02	3.29E-01	4.36E+00	1.04E+00	4.40E+05	8.02E-04	8.67E-04	1.62E-04	5.30E-04
22	22.00	1.35E+01	4.54E-01	8.74E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.69E-04	1.79E-04	5.31E-04
23	23.00	1.35E+01	4.82E-01	8.74E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.70E-04	1.96E-04	5.31E-04
24	24.00	1.35E+01	5.08E-01	8.75E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.72E-04	2.12E-04	5.31E-04
25	25.00	1.35E+01	5.32E-01	8.75E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.73E-04	2.27E-04	5.31E-04
26	30.00	1.35E+01	6.14E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.82E-04	2.85E-04	5.32E-04
27	35.00	1.35E+01	6.50E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.50E-04	3.13E-04	5.32E-04
28	40.00	1.35E+01	6.63E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.97E-04	3.22E-04	5.32E-04
29	45.00	1.35E+01	6.66E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.00E-04	3.23E-04	5.32E-04
30	50.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04
31	70.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04
32	100.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =    .000 KM
H2      = 100.000 KM
ANGLE   =  80.000 DEG
RANGE   = 479.887 KM
BETA    =   4.189 DEG
PHI     = 104.106 DEG
HMIN    =    .000 KM
BENDING =    .083 DEG
LEN     =       0
```

EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
2.037E-03	1.736E+00	5.693E+21	1.086E+21	4.656E+23	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.7[illegible]E-04	0.000E+00	69.10

Table 18. Program Output for Case 2 (Cont.)

H2O (G/CM**2)	O3	CO2	CO	CH4	N2O	O2
	(		ATM CM			)
1.348E+01	6.671E-01	8.764E+02	3.295E-01	4.368E+00	1.043E+00	4.415E+05

NH3	NO	NO2	SO2
(	ATM CM		)
8.021E-04	9.013E-04	3.236E-04	5.319E-04

Table 18. Program Output for Case 2 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ (CM-1)	WAVLEN (MICRN)	ATMOS RADIANCE (CM-1)	ATMOS RADIANCE (MICRN)	INTEGRAL (CM-1)	TOTAL TRANS
740.	13.514	1.29E-05	7.07E-04	3.23E-05	.0001
745.	13.423	1.28E-05	7.13E-04	9.65E-05	.0001
750.	13.333	1.28E-05	7.18E-04	1.60E-04	.0004
755.	13.245	1.27E-05	7.23E-04	2.24E-04	.0010
760.	13.158	1.26E-05	7.27E-04	2.87E-04	.0023
765.	13.072	1.25E-05	7.30E-04	3.49E-04	.0043
770.	12.987	1.24E-05	7.34E-04	4.11E-04	.0063
775.	12.903	1.23E-05	7.37E-04	4.72E-04	.0083
780.	12.821	1.22E-05	7.41E-04	5.33E-04	.0095
785.	12.739	1.21E-05	7.46E-04	5.94E-04	.0103
790.	12.656	1.20E-05	7.50E-04	6.54E-04	.0112
795.	12.579	1.19E-05	7.54E-04	7.14E-04	.0117
800.	12.500	1.18E-05	7.57E-04	7.73E-04	.0138
805.	12.422	1.17E-05	7.58E-04	8.31E-04	.0176
810.	12.346	1.15E-05	7.57E-04	8.89E-04	.0232
815.	12.270	1.14E-05	7.55E-04	9.46E-04	.0297
820.	12.195	1.12E-05	7.54E-04	1.00E-03	.0363
825.	12.121	1.11E-05	7.54E-04	1.06E-03	.0408
830.	12.048	1.09E-05	7.53E-04	1.11E-03	.0457
835.	11.976	1.08E-05	7.54E-04	1.17E-03	.0488
840.	11.905	1.07E-05	7.57E-04	1.22E-03	.0497
845.	11.834	1.06E-05	7.59E-04	1.27E-03	.0518
850.	11.765	1.05E-05	7.62E-04	1.33E-03	.0525
855.	11.696	1.04E-05	7.62E-04	1.38E-03	.0555
860.	11.628	1.03E-05	7.59E-04	1.43E-03	.0620
865.	11.561	1.01E-05	7.58E-04	1.48E-03	.0667
870.	11.494	9.99E-06	7.56E-04	1.53E-03	.0717
875.	11.429	9.88E-06	7.56E-04	1.58E-03	.0747
880.	11.364	9.78E-06	7.58E-04	1.63E-03	.0759
885.	11.299	9.66E-06	7.57E-04	1.68E-03	.0794
890.	11.236	9.52E-06	7.54E-04	1.72E-03	.0847
895.	11.173	9.38E-06	7.51E-04	1.77E-03	.0901
900.	11.111	9.24E-06	7.49E-04	1.82E-03	.0958
905.	11.050	9.13E-06	7.48E-04	1.86E-03	.0991
910.	10.989	9.05E-06	7.49E-04	1.91E-03	.1001
915.	10.929	8.95E-06	7.49E-04	1.95E-03	.1020
920.	10.870	8.85E-06	7.49E-04	2.00E-03	.1043
925.	10.811	8.73E-06	7.47E-04	2.04E-03	.1085
930.	10.753	8.60E-06	7.44E-04	2.08E-03	.1134
935.	10.695	8.50E-06	7.43E-04	2.13E-03	.1159
940.	10.638	8.41E-06	7.43E-04	2.17E-03	.1170
945.	10.582	8.33E-06	7.44E-04	2.21E-03	.1174
950.	10.526	8.24E-06	7.44E-04	2.25E-03	.1183
955.	10.471	8.15E-06	7.44E-04	2.29E-03	.1196
960.	10.417	8.07E-06	7.43E-04	2.33E-03	.1206
965.	10.363	7.99E-06	7.44E-04	2.37E-03	.1200
970.	10.309	7.92E-06	7.45E-04	2.41E-03	.1183
975.	10.256	7.83E-06	7.44E-04	2.45E-03	.1183
980.	10.204	7.70E-06	7.39E-04	2.49E-03	.1216
985.	10.152	7.56E-06	7.33E-04	2.53E-03	.1238

Table 18. Program Output for Case 2 (Cont.)

FREQ (CM-1)	WAVLEN (MICRN)	RADIANCE(WATTS/CM2-STER-XXX) ATMOS RADIANCE (CM-1)	(MICRN)	INTEGRAL (CM-1)	TOTAL TRANS
990.	10.101	7.44E-06	7.29E-04	2.56E-03	.1219
995.	10.050	7.38E-06	7.31E-04	2.60E-03	.1113
1000.	10.000	7.39E-06	7.39E-04	2.64E-03	.0911
1005.	9.950	7.44E-06	7.51E-04	2.68E-03	.0667
1010.	9.901	7.49E-06	7.64E-04	2.71E-03	.0441
1015.	9.852	7.53E-06	7.76E-04	2.75E-03	.0271
1020.	9.804	7.54E-06	7.84E-04	2.79E-03	.0170
1025.	9.756	7.52E-06	7.90E-04	2.83E-03	.0119
1030.	9.709	7.47E-06	7.92E-04	2.86E-03	.0104
1035.	9.662	7.40E-06	7.93E-04	2.90E-03	.0100
1040.	9.615	7.34E-06	7.94E-04	2.94E-03	.0095
1045.	9.569	7.28E-06	7.95E-04	2.97E-03	.0087
1050.	9.524	7.24E-06	7.98E-04	3.01E-03	.0074
1055.	9.479	7.15E-06	7.95E-04	3.04E-03	.0097
1060.	9.434	7.00E-06	7.86E-04	3.08E-03	.0197
1065.	9.390	6.79E-06	7.70E-04	3.11E-03	.0459
1070.	9.346	6.60E-06	7.56E-04	3.15E-03	.0779
1075.	9.302	6.49E-06	7.50E-04	3.18E-03	.0927
1080.	9.259	6.38E-06	7.44E-04	3.21E-03	.1019
1085.	9.217	6.29E-06	7.40E-04	3.24E-03	.1069
1090.	9.174	6.21E-06	7.37E-04	3.27E-03	.1101
1095.	9.132	6.14E-06	7.36E-04	3.30E-03	.1115
1100.	9.091	6.10E-06	7.38E-04	3.33E-03	.1089
1105.	9.050	6.05E-06	7.39E-04	3.37E-03	.1065
1110.	9.009	5.99E-06	7.38E-04	3.40E-03	.1054
1115.	8.969	5.90E-06	7.34E-04	3.42E-03	.1072
1120.	8.929	5.84E-06	7.33E-04	3.45E-03	.1055
1125.	8.889	5.78E-06	7.32E-04	3.48E-03	.1036
1130.	8.850	5.74E-06	7.32E-04	3.51E-03	.1008
1135.	8.811	5.73E-06	7.39E-04	3.54E-03	.0923
1140.	8.772	5.68E-06	7.39E-04	3.57E-03	.0904
1145.	8.734	5.63E-06	7.38E-04	3.60E-03	.0888
1150.	8.696	5.60E-06	7.40E-04	3.62E-03	.0846
1155.	8.658	5.51E-06	7.35E-04	3.65E-03	.0878
1160.	8.621	5.47E-06	7.36E-04	3.68E-03	.0850
1165.	8.584	5.45E-06	7.40E-04	3.71E-03	.0787
1170.	8.547	5.41E-06	7.41E-04	3.73E-03	.0753
1175.	8.511	5.39E-06	7.45E-04	3.76E-03	.0686
1180.	8.475	5.33E-06	7.42E-04	3.79E-03	.0684
1185.	8.439	5.26E-06	7.39E-04	3.81E-03	.0690
1190.	8.403	5.18E-06	7.33E-04	3.84E-03	.0723
1195.	8.368	5.10E-06	7.28E-04	3.87E-03	.0749
1200.	8.333	5.06E-06	7.29E-04	3.89E-03	.0716
1205.	8.299	5.04E-06	7.32E-04	3.92E-03	.0650
1210.	8.264	5.07E-06	7.42E-04	3.94E-03	.0507
1215.	8.230	5.07E-06	7.48E-04	3.97E-03	.0408
1220.	8.197	5.03E-06	7.49E-04	3.99E-03	.0364
1225.	8.163	4.99E-06	7.49E-04	4.02E-03	.0321
1230.	8.130	4.94E-06	7.47E-04	4.04E-03	.0304
1235.	8.097	4.92E-06	7.50E-04	4.07E-03	.0234

Table 18. Program Output for Case 2 (Cont.)

```
                    RADIANCE(WATTS/CM2-STER-XXX)

  FREQ WAVLEN   ATMOS RADIANCE        INTEGRAL TOTAL
 (CM-1) (MICRN)  (CM-1)     (MICRN)   (CM-1)    TRANS

  1240.   8.065  4.91E-06  7.55E-04  4.09E-03    .0150
  1245.   8.032  4.90E-06  7.59E-04  4.11E-03    .0082
  1250.   8.000  4.88E-06  7.62E-04  4.13E-03    .0038

INTEGRATED ABSORPTION FROM  740 TO 1250 CM-1 =     477.33 CM-1
AVERAGE TRANSMITTANCE = .0640


INTEGRATED RADIANCE =  4.127E-03 WATTS CM-2 STER-1
MINIMUM RADIANCE    =  4.876E-06 WATTS CM-2 STER-1 (CM-1)-1 AT      1250.0 CM-1
MAXIMUM RADIANCE    =  1.292E-05 WATTS CM-2 STER-1 (CM-1)-1 AT       740.0 CM-1
BOUNDARY TEMPERATURE =        .00 K
BOUNDARY EMISSIVITY =       1.000

 CARD 5 *****      1
```

Table 18. Program Output for Case 2 (Cont.)

```
                    ***** LOWTRAN 7 *****

CARD 1 *****    2    3    1    1    0    0    0    0    0    0    0    0    0   .000   .00

CARD 2 *****    2    0    0    0    0    0    .000     .000     .000     .000     .000

CARD 3 *****     .000      .000     80.000     .000     .000     .000    0

CARD 4 *****   740.000  1250.000     5.000

PROGRAM WILL COMPUTE RADIANCE

CALCULATIONS WILL BE DONE USING MULTIPLE SCATTERING

ATMOSPHERIC MODEL
        TEMPERATURE =     2     MIDLATITUDE SUMMER
        WATER VAPOR =     2     MIDLATITUDE SUMMER
        OZONE       =     2     MIDLATITUDE SUMMER
                    M4 =     2 M5 =     2 M6 =     2 MDEF =     1

AEROSOL MODEL
        REGIME                     AEROSOL TYPE            PROFILE                  SEASON

        BOUNDARY LAYER (0-2 KM)   RURAL                    5.0 KM VIS AT SEA LEVEL
        TROPOSPHERE  (2-10KM)     TROPOSPHERIC            TROPOSPHERIC             SPRING-SUMMER
        STRATOSPHERE (10-30KM)    BACKGROUND STRATO       BACKGROUND STRATO        SPRING-SUMMER
        UPPER ATMOS (30-100KM)    METEORIC DUST           NORMAL

SLANT PATH TO SPACE
        H1    =       .000 KM
        HMIN  =       .000 KM
        ANGLE =     80.000 DEG

FREQUENCY RANGE
         V1 =        740.0 CM-1  (      13.51 MICROMETERS)
         V2 =       1250.0 CM-1  (       8.00 MICROMETERS)
         DV =          5.0 CM-1
```

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	N2	CNTMSLF (MOL/CM2 KM)	MOL SCAT (-)	N-1 (-)	O3 (UV) (ATM CM/KM)	O2 (UV) (ATM CM/KM)
1	.00	1013.000	294.2	6.984E-01	8.814E+20	9.282E-01	2.661E-04	2.799E-03	3.252E+04
2	1.00	902.000	289.7	5.666E-01	3.889E+20	8.393E-01	2.409E-04	2.799E-03	2.827E+04
3	2.00	802.000	285.2	4.586E-01	1.565E+20	7.581E-01	2.177E-04	2.798E-03	2.459E+04
4	3.00	710.000	279.2	3.711E-01	4.892E+19	6.855E-01	1.970E-04	2.892E-03	2.148E+04
5	4.00	628.000	273.2	2.999E-01	1.623E+19	6.197E-01	1.781E-04	2.985E-03	1.880E+04
6	5.00	554.000	267.2	2.413E-01	4.496E+18	5.589E-01	1.607E-04	3.079E-03	1.644E+04
7	6.00	487.000	261.2	1.929E-01	1.674E+18	5.036E-01	1.445E-04	3.219E-03	1.435E+04
8	7.00	426.000	254.7	1.533E-01	6.146E+17	4.509E-01	1.297E-04	3.498E-03	1.252E+04
9	8.00	372.000	248.2	1.215E-01	1.983E+17	4.040E-01	1.162E-04	3.685E-03	1.093E+04
10	9.00	324.000	241.7	9.594E-02	6.472E+16	3.614E-01	1.039E-04	4.012E-03	9.539E+03
11	10.00	281.000	235.3	7.513E-02	1.841E+16	3.219E-01	9.253E-05	4.195E-03	8.304E+03
12	11.00	243.000	228.8	5.859E-02	2.176E+15	2.863E-01	8.234E-05	5.130E-03	7.230E+03
13	12.00	209.000	222.3	4.526E-02	1.618E+14	2.534E-01	7.289E-05	5.648E-03	6.273E+03
14	13.00	179.000	215.8	3.471E-02	9.302E+12	2.236E-01	6.431E-05	6.704E-03	5.433E+03
15	14.00	153.000	215.7	2.538E-02	2.657E+12	1.912E-01	5.499E-05	8.408E-03	4.551E+03
16	15.00	130.000	215.7	1.832E-02	8.870E+11	1.625E-01	4.673E-05	8.118E-03	3.796E+03
17	16.00	111.000	215.7	1.336E-02	6.092E+11	1.387E-01	3.990E-05	8.318E-03	3.191E+03
18	17.00	95.000	215.7	9.783E-03	4.196E+11	1.187E-01	3.415E-05	8.305E-03	2.695E+03
19	18.00	81.200	216.8	7.093E-03	2.940E+11	1.010E-01	2.904E-05	1.009E-02	2.264E+03
20	19.00	69.500	217.9	5.157E-03	2.201E+11	8.598E-02	2.473E-05	1.289E-02	1.909E+03
21	20.00	59.500	219.2	3.746E-03	1.695E+11	7.317E-02	2.104E-05	1.463E-02	1.610E+03
22	21.00	51.000	220.4	2.730E-03	1.346E+11	6.238E-02	1.794E-05	1.496E-02	1.362E+03
23	22.00	43.700	221.6	1.988E-03	1.065E+11	5.316E-02	1.529E-05	1.541E-02	1.153E+03
24	23.00	37.600	222.8	1.460E-03	8.918E+10	4.549E-02	1.308E-05	1.546E-02	9.817E+02
25	24.00	32.200	223.9	1.063E-03	6.991E+10	3.877E-02	1.115E-05	1.550E-02	8.326E+02
26	25.00	27.700	225.1	7.802E-04	5.643E+10	3.317E-02	9.541E-06	1.591E-02	7.096E+02
27	30.00	13.200	233.7	1.675E-04	1.469E+10	1.523E-02	4.379E-06	1.065E-02	3.216E+02
28	35.00	6.520	245.2	3.807E-05	3.660E+09	7.168E-03	2.062E-06	6.375E-03	1.505E+02
29	40.00	3.330	257.5	9.216E-06	9.189E+08	3.486E-03	1.003E-06	2.630E-03	7.300E+01
30	45.00	1.760	269.9	2.399E-06	2.666E+08	1.755E-03	5.056E-07	7.905E-04	3.676E+01
31	50.00	.951	275.7	6.765E-07	7.603E+07	9.299E-04	2.674E-07	2.602E-04	1.943E+01
32	70.00	.067	218.1	4.786E-09	2.729E+05	8.281E-05	2.382E-08	3.310E-06	1.730E+00
33	100.00	.000	190.5	8.694E-14	6.200E-02	3.651E-07	1.050E-10	1.459E-08	5.838E-03

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1 (-)	AEROSOL 2 (-)	AEROSOL 3 (-)	AEROSOL 4 (-)	AER1*RH (-)	CIRRUS (-)	RH (PERCNT)
1	.00	1013.000	294.2	4.614E+22	4.641E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	2.443E+00	0.000E+00	7.611E+01
2	1.00	902.000	289.7	2.785E+22	5.003E-06	7.700E-01	0.000E+00	0.000E+00	0.000E+00	2.716E+00	0.000E+00	6.597E+01
3	2.00	802.000	285.2	1.603E+22	5.253E-06	6.210E-02	0.000E+00	0.000E+00	0.000E+00	2.362E-01	0.000E+00	5.515E+01
4	3.00	710.000	279.2	8.132E+21	5.423E-06	0.000E+00	3.460E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.526E+01
5	4.00	628.000	273.2	4.243E+21	5.497E-06	0.000E+00	1.850E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.902E+01
6	5.00	554.000	267.2	2.018E+21	5.450E-06	0.000E+00	9.310E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.139E+01
7	6.00	487.000	261.2	1.108E+21	5.579E-06	0.000E+00	7.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.996E+01
8	7.00	426.000	254.7	6.026E+20	5.681E-06	0.000E+00	6.230E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.029E+01
9	8.00	372.000	248.2	3.068E+20	5.616E-06	0.000E+00	3.370E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.961E+01
10	9.00	324.000	241.7	1.568E+20	5.529E-06	0.000E+00	1.820E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.013E+01
11	10.00	281.000	235.3	7.452E+19	5.602E-06	0.000E+00	1.140E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.942E+01
12	11.00	243.000	228.8	2.279E+19	5.783E-06	0.000E+00	0.000E+00	7.990E-04	0.000E+00	0.000E+00	0.000E+00	1.946E+01
13	12.00	209.000	222.3	5.502E+18	6.109E-06	0.000E+00	0.000E+00	6.410E-04	0.000E+00	0.000E+00	0.000E+00	1.069E+01
14	13.00	179.000	215.8	1.164E+18	6.172E-06	0.000E+00	0.000E+00	5.170E-04	0.000E+00	0.000E+00	0.000E+00	5.413E+00
15	14.00	153.000	215.7	5.319E+17	6.368E-06	0.000E+00	0.000E+00	4.420E-04	0.000E+00	0.000E+00	0.000E+00	2.931E+00
16	15.00	130.000	215.7	2.611E+17	7.344E-06	0.000E+00	0.000E+00	3.950E-04	0.000E+00	0.000E+00	0.000E+00	1.693E+00
17	16.00	111.000	215.7	1.848E+17	1.022E-05	0.000E+00	0.000E+00	3.820E-04	0.000E+00	0.000E+00	0.000E+00	1.403E+00
18	17.00	95.000	215.7	1.312E+17	1.555E-05	0.000E+00	0.000E+00	4.250E-04	0.000E+00	0.000E+00	0.000E+00	1.165E+00
19	18.00	81.200	216.8	9.342E+16	2.130E-05	0.000E+00	0.000E+00	5.200E-04	0.000E+00	0.000E+00	0.000E+00	8.556E-01
20	19.00	69.500	217.9	6.883E+16	2.726E-05	0.000E+00	0.000E+00	5.810E-04	0.000E+00	0.000E+00	0.000E+00	6.505E-01
21	20.00	59.500	219.2	5.141E+16	3.073E-05	0.000E+00	0.000E+00	5.890E-04	0.000E+00	0.000E+00	0.000E+00	4.911E-01
22	21.00	51.000	220.4	3.906E+16	3.082E-05	0.000E+00	0.000E+00	5.020E-04	0.000E+00	0.000E+00	0.000E+00	3.816E-01
23	22.00	43.700	221.6	2.960E+16	2.903E-05	0.000E+00	0.000E+00	4.200E-04	0.000E+00	0.000E+00	0.000E+00	2.964E-01
24	23.00	37.600	222.8	2.318E+16	2.611E-05	0.000E+00	0.000E+00	3.000E-04	0.000E+00	0.000E+00	0.000E+00	2.373E-01
25	24.00	32.200	223.9	1.749E+16	2.264E-05	0.000E+00	0.000E+00	1.980E-04	0.000E+00	0.000E+00	0.000E+00	1.861E-01
26	25.00	27.700	225.1	1.345E+16	1.861E-05	0.000E+00	0.000E+00	1.310E-04	0.000E+00	0.000E+00	0.000E+00	1.468E-01
27	30.00	13.200	233.7	3.170E+15	5.695E-06	0.000E+00	0.000E+00	3.320E-05	0.000E+00	0.000E+00	0.000E+00	3.096E-02
28	35.00	6.520	245.2	7.399E+14	1.176E-06	0.000E+00	0.000E+00	0.000E+00	1.640E-05	0.000E+00	0.000E+00	5.227E-03
29	40.00	3.330	257.5	1.803E+14	1.856E-07	0.000E+00	0.000E+00	0.000E+00	7.990E-06	0.000E+00	0.000E+00	9.357E-04
30	45.00	1.760	269.9	4.900E+13	2.127E-08	0.000E+00	0.000E+00	0.000E+00	4.010E-06	0.000E+00	0.000E+00	1.993E-04
31	50.00	.951	275.7	1.384E+13	5.161E-09	0.000E+00	0.000E+00	0.000E+00	2.100E-06	0.000E+00	0.000E+00	7.121E-05
32	70.00	.067	218.1	7.382E+10	2.708E-10	0.000E+00	0.000E+00	0.000E+00	1.600E-07	0.000E+00	0.000E+00	7.078E-04
33	100.00	.000	190.5	1.551E+05	9.967E-13	0.000E+00	0.000E+00	0.000E+00	9.310E-10	0.000E+00	0.000E+00	1.460E-05

Table 18. Program Output for Case 2 (Cont.)

ATMOSPHERIC PROFILES

(IF A MOLECULE HAS MORE THAN ONE BAND, THEN THE DATA FOR THE FIRST BAND ARE SHOWN.)

I	Z (KM)	P (MB	T (K)	H2C G/CM**2/KM	O3 (	CO2	CO	CH4 ATM CM/KM	N2O	O2	NH3	NO	NO2	SO2)
1	.00	1013.00	294.2	1.36E+00	2.52E-03	3.62E+01	1.32E-02	1.63E-01	2.77E-02	1.55E+04	4.96E-05	2.88E-05	2.14E-06	2.54E-05
2	1.00	902.000	289.7	8.13E-01	2.46E-03	2.92E+01	1.07E-02	1.35E-01	2.43E-02	1.28E+04	4.03E-05	2.43E-05	1.65E-06	2.07E-05
3	2.00	802.000	285.2	4.62E-01	2.39E-03	2.36E+01	8.61E-03	1.11E-01	2.13E-02	1.05E+04	3.02E-05	2.05E-05	1.59E-06	1.58E-05
4	3.00	710.000	279.2	2.31E-01	2.42E-03	1.87E+01	6.95E-03	9.12E-02	1.88E-02	8.79E+03	2.00E-05	1.72E-05	1.37E-06	1.14E-05
5	4.00	628.000	273.2	1.19E-01	2.44E-03	1.48E+01	5.65E-03	7.47E-02	1.65E-02	7.33E+03	1.22E-05	1.44E-05	1.18E-06	7.85E-06
6	5.00	554.000	267.2	5.56E-02	2.46E-03	1.17E+01	4.67E-03	6.07E-02	1.45E-02	6.08E+03	6.88E-06	1.21E-05	1.01E-06	5.67E-06
7	6.00	487.000	261.2	3.02E-02	2.52E-03	9.17E+00	3.83E-03	4.89E-02	1.27E-02	5.02E+03	3.91E-06	1.00E-05	8.62E-07	4.15E-06
8	7.00	426.000	254.7	1.62E-02	2.68E-03	7.10E+00	3.06E-03	3.89E-02	1.11E-02	4.14E+03	2.08E-06	8.29E-06	7.33E-07	3.16E-06
9	8.00	372.000	248.2	8.10E-03	2.76E-03	5.48E+00	2.39E-03	3.09E-02	9.66E-03	3.41E+03	1.07E-06	6.83E-06	6.21E-07	2.44E-06
10	9.00	324.000	241.7	4.08E-03	2.95E-03	4.21E+00	1.81E-03	2.46E-02	8.32E-03	2.80E+03	4.88E-07	5.61E-06	5.30E-07	1.97E-06
11	10.00	281.000	235.3	1.91E-03	3.01E-03	3.21E+00	1.34E-03	1.91E-02	7.05E-03	2.28E+03	2.04E-07	4.58E-06	4.57E-07	1.61E-06
12	11.00	243.000	228.8	5.74E-04	3.60E-03	2.43E+00	9.81E-04	1.48E-02	5.89E-03	1.86E+03	8.44E-08	3.72E-06	4.22E-07	1.35E-06
13	12.00	209.000	222.3	1.36E-04	3.88E-03	1.82E+00	6.89E-04	1.14E-02	4.97E-03	1.50E+03	3.73E-08	3.00E-06	4.22E-07	1.15E-06
14	13.00	179.000	215.8	2.84E-05	4.49E-03	1.36E+00	4.50E-04	8.65E-03	4.14E-03	1.20E+03	1.40E-08	2.40E-06	4.94E-07	1.00E-06
15	14.00	153.000	215.7	1.30E-05	5.28E-03	1.04E+00	2.69E-04	6.51E-03	3.27E-03	8.53E+02	3.75E-09	1.86E-06	6.68E-07	8.26E-07
16	15.00	130.000	215.7	6.40E-06	4.76E-03	7.94E-01	1.59E-04	4.83E-03	2.54E-03	5.97E+02	1.13E-09	1.39E-06	1.22E-06	6.82E-07
17	16.00	111.000	215.7	4.54E-06	4.56E-03	6.10E-01	9.35E-05	3.60E-03	1.96E-03	4.20E+02	4.00E-10	1.04E-06	1.82E-06	5.56E-07
18	17.00	95.000	215.7	3.24E-06	4.27E-03	4.70E-01	5.77E-05	2.69E-03	1.46E-03	3.01E+02	1.58E-10	7.70E-07	2.38E-06	4.25E-07
19	18.00	81.200	216.8	2.32E-06	4.82E-03	3.64E-01	3.43E-05	2.00E-03	1.05E-03	2.09E+02	7.23E-11	5.75E-07	2.83E-06	3.05E-07
20	19.00	69.500	217.9	1.72E-06	5.73E-03	2.82E-01	2.04E-05	1.48E-03	7.11E-04	1.46E+02	3.23E-11	4.60E-07	3.12E-06	2.05E-07
21	20.00	59.500	219.2	1.29E-06	6.04E-03	2.20E-01	1.32E-05	1.08E-03	4.94E-04	1.01E+02	1.48E-11	3.78E-07	3.27E-06	1.33E-07
22	21.00	51.000	220.4	9.69E-07	5.75E-03	1.71E-01	9.22E-06	7.78E-04	3.26E-04	7.05E+01	8.95E-12	3.24E-07	3.32E-06	8.99E-08
23	22.00	43.700	221.6	7.54E-07	5.50E-03	1.33E-01	6.96E-06	5.50E-04	2.25E-04	4.94E+01	6.06E-12	2.82E-07	3.27E-06	6.21E-08
24	23.00	37.600	222.8	5.95E-07	5.15E-03	1.04E-01	5.62E-06	3.87E-04	1.64E-04	3.48E+01	4.27E-12	2.63E-07	3.15E-06	4.59E-08
25	24.00	32.200	223.9	4.51E-07	4.80E-03	8.03E-02	4.54E-06	2.67E-04	1.22E-04	2.43E+01	2.93E-12	2.59E-07	3.00E-06	3.41E-08
26	25.00	27.700	225.1	3.49E-07	4.59E-03	6.33E-02	3.75E-06	1.85E-04	9.13E-05	1.71E+01	1.90E-12	3.12E-07	2.95E-06	2.55E-08
27	30.00	13.200	233.7	8.56E-08	2.14E-03	1.92E-02	1.25E-06	4.06E-05	2.28E-05	2.91E+00	2.58E-13	3.52E-07	1.67E-06	6.89E-09
28	35.00	6.520	245.2	2.09E-08	8.90E-04	6.29E-03	4.17E-07	9.35E-06	4.34E-06	5.15E-01	2.06E-14	3.41E-07	7.04E-07	2.15E-09
29	40.00	3.330	257.5	5.33E-09	2.59E-04	2.18E-03	1.40E-07	2.25E-06	7.35E-07	9.74E-02	9.88E-16	1.87E-07	1.46E-07	9.47E-10
30	45.00	1.760	259.9	1.51E-09	5.57E-05	7.96E-04	4.71E-08	5.37E-07	1.23E-07	2.00E-02	3.16E-17	7.20E-08	1.63E-08	5.77E-10
31	50.00	.951	275.7	4.39E-10	1.37E-05	2.92E-04	1.70E-08	1.25E-07	2.12E-08	4.78E-03	2.49E-18	2.45E-08	2.61E-09	4.20E-10
32	70.00	.067	218.1	2.11E-12	7.95E-08	2.59E-06	7.66E-10	1.17E-09	2.08E-10	3.66E-05	7.68E-21	5.39E-10	4.19E-11	2.78E-11
33	100.00	.000	190.5	4.49E-18	4.10E-11	1.20E-10	4.67E-12	7.38E-14	4.66E-14	2.50E-10	1.99E-25	2.16E-11	1.50E-14	2.33E-16

CASE 2A. GIVEN H1, H2, ANGLE

SLANT PATH PARAMETERS IN STANDARD FORM

H1	=	.000	KM
H2	=	100.000	KM
ANGLE	=	.000	DEG
PHI	=	180.000	DEG
HMIN	=	.000	KM
LEN	=	0	

Table 18. Program Output for Case 2 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	.000	1.000	.000	1.000	1.000	.000	.000	180.000	.000	.000	957.357	291.98	1.14E-03
2	1.000	2.000	.000	1.000	2.000	.000	.000	180.000	.000	.000	851.870	287.48	1.03E-03
3	2.000	3.000	.000	1.000	3.000	.000	.000	180.000	.000	.000	755.837	282.24	9.32E-04
4	3.000	4.000	.000	1.000	4.000	.000	.000	180.000	.000	.000	668.852	276.24	8.43E-04
5	4.000	5.000	.000	1.000	5.000	.000	.000	180.000	.000	.000	590.863	270.24	7.61E-04
6	5.000	6.000	.000	1.000	6.000	.000	.000	180.000	.000	.000	520.373	264.24	6.85E-04
7	6.000	7.000	.000	1.000	7.000	.000	.000	180.000	.000	.000	456.372	258.00	6.15E-04
8	7.000	8.000	.000	1.000	8.000	.000	.000	180.000	.000	.000	398.884	251.50	5.52E-04
9	8.000	9.000	.000	1.000	9.000	.000	.000	180.000	.000	.000	347.894	245.00	4.94E-04
10	9.000	10.000	.000	1.000	10.000	.000	.000	180.000	.000	.000	302.404	238.55	4.41E-04
11	10.000	11.000	.000	1.000	11.000	.000	.000	180.000	.000	.000	261.911	232.10	3.93E-04
12	11.000	12.000	.000	1.000	12.000	.000	.000	180.000	.000	.000	225.918	225.60	3.48E-04
13	12.000	13.000	.000	1.000	13.000	.000	.000	180.000	.000	.000	193.926	219.10	3.08E-04
14	13.000	14.000	.000	1.000	14.000	.000	.000	180.000	.000	.000	165.999	215.75	2.67E-04
15	14.000	15.000	.000	1.000	15.000	.000	.000	180.000	.000	.000	141.500	215.70	2.28E-04
16	15.000	16.000	.000	1.000	16.000	.000	.000	180.000	.000	.000	120.500	215.70	1.94E-04
17	16.000	17.000	.000	1.000	17.000	.000	.000	180.000	.000	.000	103.000	215.70	1.66E-04
18	17.000	18.000	.000	1.000	18.000	.000	.000	180.000	.000	.000	88.106	216.23	1.42E-04
19	18.000	19.000	.000	1.000	19.000	.000	.000	180.000	.000	.000	75.355	217.33	1.21E-04
20	19.000	20.000	.000	1.000	20.000	.000	.000	180.000	.000	.000	64.505	218.53	1.03E-04
21	20.000	21.000	.000	1.000	21.000	.000	.000	180.000	.000	.000	55.254	219.78	8.74E-05
22	21.000	22.000	.000	1.000	22.000	.000	.000	180.000	.000	.000	47.353	220.98	7.45E-05
23	22.000	23.000	.000	1.000	23.000	.000	.000	180.000	.000	.000	40.653	222.18	6.36E-05
24	23.000	24.000	.000	1.000	24.000	.000	.000	180.000	.000	.000	34.902	223.33	5.43E-05
25	24.000	25.000	.000	1.000	25.000	.000	.000	180.000	.000	.000	29.952	224.48	4.64E-05
26	25.000	30.000	.000	5.000	30.000	.000	.000	180.000	.000	.000	20.494	228.82	2.98E-05
27	30.000	35.000	.000	5.000	35.000	.000	.000	180.000	.000	.000	9.886	238.69	1.38E-05
28	35.000	40.000	.000	5.000	40.000	.000	.000	180.000	.000	.000	4.938	250.57	6.60E-06
29	40.000	45.000	.000	5.000	45.000	.000	.000	180.000	.000	.000	2.551	262.95	3.26E-06
30	45.000	50.000	.000	5.000	50.000	.000	.000	180.000	.000	.000	1.357	272.48	1.68E-06
31	50.000	70.000	.000	20.000	70.000	.000	.000	180.000	.000	.000	.495	256.48	4.53E-07
32	70.000	100.000	.000	30.000	100.000	.000	.000	180.000	.000	.000	.033	212.91	1.96E-08

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	1.000	291.98	4.822E-06	2.799E-03	6.019E+20	6.718E+19	3.623E+22	3.035E+04
2	2.000	287.48	9.950E-06	5.598E-03	8.573E+20	1.276E+20	5.763E+22	5.674E+04
3	3.000	282.24	1.529E-05	8.443E-03	9.498E+20	1.630E+20	6.927E+22	7.974E+04
4	4.000	276.24	2.075E-05	1.138E-02	9.794E+20	1.792E+20	7.525E+22	9.985E+04
5	5.000	270.24	2.622E-05	1.441E-02	9.885E+20	1.858E+20	7.824E+22	1.174E+05
6	6.000	264.24	3.173E-05	1.756E-02	9.914E+20	1.883E+20	7.976E+22	1.328E+05
7	7.000	258.00	3.736E-05	2.092E-02	9.925E+20	1.893E+20	8.059E+22	1.462E+05
8	8.000	251.50	4.301E-05	2.451E-02	9.928E+20	1.897E+20	8.103E+22	1.579E+05
9	9.000	245.00	4.859E-05	2.836E-02	9.929E+20	1.898E+20	8.125E+22	1.681E+05
10	10.000	238.55	5.415E-05	3.246E-02	9.930E+20	1.899E+20	8.136E+22	1.771E+05
11	11.000	232.10	5.984E-05	3.713E-02	9.930E+20	1.899E+20	8.140E+22	1.848E+05
12	12.000	225.60	6.579E-05	4.252E-02	9.930E+20	1.899E+20	8.142E+22	1.915E+05
13	13.000	219.10	7.193E-05	4.869E-02	9.930E+20	1.899E+20	8.142E+22	1.974E+05

Table 18. Program Output for Case 2 (Cont.)

14	14.000	215.75	7.820E-05	5.625E-02	9.930E+20	1.899E+20	8.142E+22	2.024E+05
15	15.000	215.70	8.505E-05	6.451E-02	9.930E+20	1.899E+20	8.142E+22	2.065E+05
16	16.000	215.70	9.384E-05	7.273E-02	9.930E+20	1.899E+20	8.142E+22	2.100E+05
17	17.000	215.70	1.067E-04	8.104E-02	9.930E+20	1.899E+20	8.142E+22	2.130E+05
18	18.000	216.23	1.252E-04	9.024E-02	9.930E+20	1.899E+20	8.142E+22	2.154E+05
19	19.000	217.33	1.494E-04	1.017E-01	9.930E+20	1.899E+20	8.142E+22	2.175E+05
20	20.000	218.53	1.784E-04	1.155E-01	9.930E+20	1.899E+20	8.142E+22	2.193E+05
21	21.000	219.78	2.092E-04	1.303E-01	9.930E+20	1.899E+20	8.142E+22	2.207E+05
22	22.000	220.98	2.391E-04	1.455E-01	[illegible]30E+20	1.899E+20	8.142E+22	2.220E+05
23	23.000	222.18	2.657E-04	1.609E-01	[illegible]0E+20	1.899E+20	8.142E+22	2.231E+05
24	24.000	223.33	2.910E-04	1.764E-01	[illegible]30E+20	1.899E+20	8.142E+22	2.240E+05
25	25.000	224.48	3.116E-04	1.921E-01	9.930E+20	1.899E+20	8.142E+22	2.247E+05
26	30.000	228.82	3.661E-04	2.576E-01	9.930E+20	1.899E+20	8.142E+22	2.272E+05
27	35.000	238.69	3.804E-04	2.993E-01	9.930E+20	1.899E+20	8.142E+22	2.283E+05
28	40.000	250.57	3.831E-04	3.204E-01	9.930E+20	1.899E+20	8.142E+22	2.289E+05
29	45.000	262.95	3.835E-04	3.281E-01	9.930E+20	1.899E+20	8.142E+22	2.291E+05
30	50.000	272.48	3.835E-04	3.305E-01	9.930E+20	1.899E+20	8.142E+22	2.293E+05
31	70.000	256.48	3.836E-04	3.316E-01	9.930E+20	1.899E+20	8.142E+22	2.294E+05
32	100.000	[illegible]	3.836E-04	3.316E-01	9.930E+20	1.899E+20	8.142E+22	2.294E+05

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	1.000	6.302E-01	8.830E-01	7.700E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	2.000	1.141E+00	1.681E+00	1.051E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.000	1.554E+00	2.402E+00	1.082E+00	1.730E-02	0.000E+00	0.000E+00	0.000E+00
4	4.000	1.888E+00	3.054E+00	1.082E+00	4.302E-02	0.000E+00	0.000E+00	0.000E+00
5	5.000	2.158E+00	3.643E+00	1.082E+00	5.640E-02	0.000E+00	0.000E+00	0.000E+00
6	6.000	2.374E+00	4.173E+00	1.082E+00	6.488E-02	0.000E+00	0.000E+00	0.000E+00
7	7.000	2.547E+00	4.650E+00	1.082E+00	7.183E-02	0.000E+00	0.000E+00	0.000E+00
8	8.000	2.683E+00	5.077E+00	1.082E+00	7.648E-02	0.000E+00	0.000E+00	0.000E+00
9	9.000	2.792E+00	5.459E+00	1.082E+00	7.900E-02	0.000E+00	0.000E+00	0.000E+00
10	10.000	2.877E+00	5.800E+00	1.082E+00	8.045E-02	0.000E+00	0.000E+00	0.000E+00
11	11.000	2.942E+00	6.104E+00	1.082E+00	8.102E-02	3.995E-04	0.000E+00	0.000E+00
12	12.000	2.995E+00	6.374E+00	1.082E+00	8.102E-02	1.117E-03	0.000E+00	0.000E+00
13	13.000	3.035E+00	6.612E+00	1.082E+00	8.102E-02	1.693E-03	0.000E+00	0.000E+00
14	14.000	3.064E+00	6.819E+00	1.082E+00	8.102E-02	2.172E-03	0.000E+00	0.000E+00
15	15.000	3.086E+00	6.995E+00	1.082E+00	8.102E-02	2.590E-03	0.000E+00	0.000E+00
16	16.000	3.102E+00	7.146E+00	1.082E+00	8.102E-02	2.978E-03	0.000E+00	0.000E+00
17	17.000	3.113E+00	7.274E+00	1.082E+00	8.102E-02	3.382E-03	0.000E+00	0.000E+00
18	18.000	3.122E+00	7.384E+00	1.082E+00	8.102E-02	3.854E-03	0.000E+00	0.000E+00
19	19.000	3.128E+00	7.477E+00	1.082E+00	8.102E-02	4.405E-03	0.000E+00	0.000E+00
20	20.000	3.132E+00	7.556E+00	1.082E+00	8.102E-02	4.990E-03	0.000E+00	0.000E+00
21	21.000	3.135E+00	7.624E+00	1.082E+00	8.102E-02	5.534E-03	0.000E+00	0.000E+00
22	22.000	3.138E+00	7.682E+00	1.082E+00	8.102E-02	5.994E-03	0.000E+00	0.000E+00
23	23.000	3.139E+00	7.731E+00	1.082E+00	8.102E-02	6.351E-03	0.000E+00	0.000E+00
24	24.000	3.141E+00	7.773E+00	1.082E+00	8.102E-02	6.596E-03	0.000E+00	0.000E+00
25	25.000	3.142E+00	7.809E+00	1.082E+00	8.102E-02	6.758E-03	0.000E+00	0.000E+00
26	30.000	3.144E+00	7.924E+00	1.082E+00	8.102E-02	7.115E-03	0.000E+00	0.000E+00
27	35.000	3.144E+00	7.977E+00	1.082E+00	8.102E-02	7.198E-03	4.100E-05	0.000E+00
28	40.000	3.144E+00	8.003E+00	1.082E+00	8.102E-02	7.198E-03	9.948E-05	0.000E+00
29	45.000	3.144E+00	8.016E+00	1.082E+00	8.102E-02	7.198E-03	1.283E-04	0.000E+00
30	50.000	3.144E+00	8.022E+00	1.082E+00	8.102E-02	7.198E-03	1.431E-04	0.000E+00
31	70.000	3.144E+00	8.029E+00	1.082E+00	8.102E-02	7.198E-03	1.582E-04	0.000E+00
32	100.000	3.144E+00	8.030E+00	1.082E+00	8.102E-02	7.198E-03	1.591E-04	0.000E+00

J	Z (KM)	H2O (G/CM**2)	(O3	CO2	CO	CH4	N2O	O2 ATM CM	NH3	NO	NO2	SO2)

Table 18. Program Output for Case 2 (Cont.)

1	1.00	1.06E+00	2.49E-03	3.26E+01	1.19E-02	1.48E-01	2.60E-02	1.41E+04	4.48E-05	2.65E-05	1.99E-06	2.29E-05
2	2.00	1.69E+00	4.91E-03	5.89E+01	2.15E-02	2.70E-01	4.87E-02	2.58E+04	7.98E-05	4.89E-05	3.71E-06	4.11E-05
3	3.00	2.02E+00	7.31E-03	7.99E+01	2.93E-02	3.71E-01	6.87E-02	3.54E+04	1.05E-04	6.77E-05	5.19E-06	5.46E-05
4	4.00	2.19E+00	9.74E-03	9.66E+01	3.56E-02	4.54E-01	8.64E-02	4.35E+04	1.20E-04	8.35E-05	6.46E-06	6.41E-05
5	5.00	2.27E+00	1.22E-02	1.10E+02	4.07E-02	5.21E-01	1.02E-01	5.02E+04	1.30E-04	9.67E-05	7.55E-06	7.08E-05
6	6.00	2.31E+00	1.47E-02	1.20E+02	4.49E-02	5.76E-01	1.15E-01	5.57E+04	1.35E-04	1.08E-04	8.49E-06	7.57E-05
7	7.00	2.33E+00	1.73E-02	1.28E+02	4.84E-02	6.20E-01	1.27E-01	6.03E+04	1.38E-04	1.17E-04	9.28E-06	7.93E-05
8	8.00	2.35E+00	2.00E-02	1.35E+02	5.11E-02	6.54E-01	1.38E-01	6.40E+04	1.39E-04	1.24E-04	9.96E-06	8.21E-05
9	9.00	2.35E+00	2.29E-02	1.39E+02	5.32E-02	6.82E-01	1.47E-01	6.71E+04	1.40E-04	1.31E-04	1.05E-05	8.40E-05
10	10.00	2.35E+00	2.58E-02	1.43E+02	5.47E-02	7.04E-01	1.54E-01	6.97E+04	1.40E-04	1.36E-04	1.10E-05	8.61E-05
11	11.00	2.36E+00	2.91E-02	1.46E+02	5.59E-02	7.20E-01	1.61E-01	7.17E+04	1.40E-04	1.40E-04	1.15E-05	8.75E-05
12	12.00	2.36E+00	3.29E-02	1.48E+02	5.67E-02	7.33E-01	1.66E-01	7.34E+04	1.41E-04	1.43E-04	1.19E-05	8.86E-05
13	13.00	2.36E+00	3.71E-02	1.50E+02	5.73E-02	7.43E-01	1.71E-01	7.47E+04	1.41E-04	1.46E-04	1.23E-05	8.99E-05
14	14.00	2.36E+00	4.20E-02	1.51E+02	5.76E-02	7.51E-01	1.74E-01	7.57E+04	1.41E-04	1.48E-04	1.29E-05	9.08E-05
15	15.00	2.36E+00	4.70E-02	1.52E+02	5.78E-02	7.57E-01	1.77E-01	7.65E+04	1.41E-04	1.50E-04	1.39E-05	9.15E-05
16	16.00	2.36E+00	5.16E-02	1.52E+02	5.79E-02	7.61E-01	1.80E-01	7.70E+04	1.41E-04	1.51E-04	1.54E-05	9.22E-05
17	17.00	2.36E+00	5.60E-02	1.53E+02	5.80E-02	7.64E-01	1.81E-01	7.73E+04	1.41E-04	1.52E-04	1.75E-05	9.26E-05
18	18.00	2.36E+00	6.06E-02	1.53E+02	5.81E-02	7.66E-01	1.83E-01	7.76E+04	1.41E-04	1.52E-04	2.01E-05	9.30E-05
19	19.00	2.36E+00	6.59E-02	1.54E+02	5.81E-02	7.68E-01	1.83E-01	7.78E+04	1.41E-04	1.53E-04	2.31E-05	9.33E-05
20	20.00	2.36E+00	7.17E-02	1.54E+02	5.81E-02	7.69E-01	1.84E-01	7.79E+04	1.41E-04	1.53E-04	2.63E-05	9.34E-05
21	21.00	2.36E+00	7.76E-02	1.54E+02	5.81E-02	7.70E-01	1.84E-01	7.80E+04	1.41E-04	1.54E-04	2.96E-05	9.35E-05
22	22.00	2.36E+00	8.33E-02	1.54E+02	5.81E-02	7.71E-01	1.85E-01	7.80E+04	1.41E-04	1.54E-04	3.29E-05	9.36E-05
23	23.00	2.36E+00	8.86E-02	1.54E+02	5.81E-02	7.71E-01	1.85E-01	7.81E+04	1.41E-04	1.54E-04	3.61E-05	9.37E-05
24	24.00	2.36E+00	9.36E-02	1.54E+02	5.81E-02	7.72E-01	1.85E-01	7.81E+04	1.41E-04	1.54E-04	3.91E-05	9.37E-05
25	25.00	2.36E+00	9.80E-02	1.55E+02	5.81E-02	7.72E-01	1.85E-01	7.81E+04	1.41E-04	1.55E-04	4.21E-05	9.37E-05
26	30.00	2.36E+00	1.14E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.56E-04	5.34E-05	9.38E-05
27	35.00	2.36E+00	1.21E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.58E-04	5.90E-05	9.38E-05
28	40.00	2.36E+00	1.24E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.59E-04	6.07E-05	9.38E-05
29	45.00	2.36E+00	1.25E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.60E-04	6.10E-05	9.38E-05
30	50.00	2.36E+00	1.25E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.60E-04	6.11E-05	9.38E-05
31	70.00	2.36E+00	1.25E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.60E-04	6.11E-05	9.38E-05
32	100.00	2.36E+00	1.25E-01	1.55E+02	5.82E-02	7.72E-01	1.85E-01	7.82E+04	1.41E-04	1.60E-04	6.11E-05	9.38E-05

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =      .000 KM
H2      =   100.000 KM
ANGLE   =      .000 DEG
RANGE   =   100.000 KM
BETA    =      .000 DEG
PHI     =   180.000 DEG
HMIN    =      .000 KM
BENDING =      .000 DEG
LEN     =         0
```

EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
3.836E-04	3.316E-01	9.930E+20	1.899E+20	8.142E+22	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
3.144E+00	8.030E+00	1.082E+00	8.102E-02	7.198E-03	1.591E-04	0.000E+00	69.09

Table 18. Program Output for Case 2 (Cont.)

```
       H2O          O3           CO2          CO            CH4          N2O          O2
   (G/CM**2)        (                                ATM CM                            )

   2.356E+00    1.248E-01    1.548E+02    5.816E-02    7.724E-01    1.854E-01    7.816E+04

       NH3          NO           NO2          SO2
       (                  ATM CM               )

   1.406E-04    1.604E-04    6.108E-05    9.383E-05

CASE 3A: GIVEN H1,H2=SPACE,ANGLE


SLANT PATH PARAMETERS IN STANDARD FORM

        H1       =        .000 KM
        H2       =     100.000 KM
        ANGLE    =      80.000 DEG
        PHI      =     104.106 DEG
        HMIN     =        .000 KM
        LEN      =           0
```

Table 18. Program Output for Case 2 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	.000	1.000	80.000	5.747	5.747	.051	.051	100.043	.008	.008	957.370	291.98	1.14E-03
2	1.000	2.000	79.957	5.722	11.469	.051	.102	100.086	.007	.016	851.881	287.48	1.03E-03
3	2.000	3.000	79.914	5.698	17.167	.050	.152	100.130	.007	.022	755.847	282.24	9.32E-04
4	3.000	4.000	79.870	5.674	22.841	.050	.202	100.174	.006	.028	668.861	276.24	8.43E-04
5	4.000	5.000	79.826	5.649	28.490	.050	.252	100.218	.006	.034	590.871	270.24	7.61E-04
6	5.000	6.000	79.782	5.625	34.115	.050	.302	100.263	.005	.039	520.380	264.24	6.85E-04
7	6.000	7.000	79.737	5.601	39.716	.050	.351	100.308	.005	.044	456.378	258.00	6.15E-04
8	7.000	8.000	79.692	5.577	45.292	.049	.401	100.353	.004	.048	398.889	251.50	5.52E-04
9	8.000	9.000	79.647	5.553	50.845	.049	.450	100.398	.004	.052	347.898	245.00	4.94E-04
10	9.000	10.000	79.602	5.529	56.374	.049	.499	100.443	.004	.055	302.408	238.55	4.41E-04
11	10.000	11.000	79.557	5.505	61.879	.049	.547	100.489	.003	.059	261.915	232.10	3.93E-04
12	11.000	12.000	79.511	5.482	67.360	.048	.596	100.534	.003	.061	225.921	225.60	3.48E-04
13	12.000	13.000	79.466	5.458	72.819	.048	.644	100.580	.003	.064	193.928	219.10	3.08E-04
14	13.000	14.000	79.420	5.435	78.254	.048	.692	100.625	.003	.067	166.001	215.75	2.67E-04
15	14.000	15.000	79.375	5.412	83.666	.048	.739	100.670	.003	.069	141.502	215.70	2.28E-04
16	15.000	16.000	79.330	5.390	89.056	.048	.787	100.715	.002	.072	120.501	215.70	1.94E-04
17	16.000	17.000	79.285	5.367	94.423	.047	.834	100.761	.002	.073	103.001	215.70	1.66E-04
18	17.000	18.000	79.239	5.345	99.768	.047	.881	100.806	.002	.075	88.107	216.23	1.42E-04
19	18.000	19.000	79.194	5.322	105.090	.047	.928	100.852	.001	.076	75.356	217.33	1.21E-04
20	19.000	20.000	79.148	5.300	110.390	.047	.975	100.898	.001	.077	64.505	218.53	1.03E-04
21	20.000	21.000	79.102	5.279	115.669	.046	1.021	100.943	.001	.078	55.254	219.78	8.74E-05
22	21.000	22.000	79.057	5.257	120.926	.046	1.066	100.989	.001	.079	47.354	220.93	7.45E-05
23	22.000	23.000	79.011	5.236	126.162	.046	1.114	101.034	.001	.080	40.653	222.18	6.36E-05
24	23.000	24.000	78.966	5.214	131.376	.046	1.159	101.079	.001	.080	34.902	223.33	5.43E-05
25	24.000	25.000	78.921	5.193	136.569	.046	1.205	101.124	.000	.081	29.952	224.48	4.64E-05
26	25.000	30.000	78.876	25.660	162.229	.225	1.430	101.348	.001	.082	20.517	228.81	2.98E-05
27	30.000	35.000	78.652	25.169	187.398	.221	1.651	101.568	.001	.083	9.896	238.67	1.38E-05
28	35.000	40.000	78.432	24.705	212.104	.216	1.867	101.784	.000	.083	4.942	250.55	6.61E-06
29	40.000	45.000	78.216	24.267	236.371	.212	2.080	101.996	.000	.083	2.553	262.93	3.27E-06
30	45.000	50.000	78.004	23.852	260.223	.208	2.288	102.205	.000	.083	1.358	272.48	1.68E-06
31	50.000	70.000	77.795	91.660	351.882	.797	3.085	103.001	.000	.083	.499	256.71	4.58E-07
32	70.000	100.000	76.999	128.005	479.887	1.104	4.189	104.106	.000	.083	.033	212.98	2.02E-08

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	1.000	291.98	2.771E-05	1.608E-02	3.459E+21	3.861E+20	2.082E+23	1.744E+05
2	2.000	287.48	5.705E-05	3.210E-02	4.921E+21	7.318E+20	3.307E+23	3.254E+05
3	3.000	282.24	8.747E-05	4.831E-02	5.448E+21	9.333E+20	3.970E+23	4.565E+05
4	4.000	276.24	1.184E-04	6.499E-02	5.616E+21	1.026E+21	4.309E+23	5.706E+05
5	5.000	270.24	1.494E-04	8.212E-02	5.668E+21	1.063E+21	4.478E+23	6.700E+05
6	6.000	264.24	1.804E-04	9.983E-02	5.684E+21	1.077E+21	4.564E+23	7.564E+05
7	7.000	258.00	2.119E-04	1.186E-01	5.690E+21	1.083E+21	4.610E+23	8.316E+05
8	8.000	251.50	2.434E-04	1.387E-01	5.692E+21	1.085E+21	4.635E+23	8.968E+05
9	9.000	245.00	2.744E-04	1.600E-01	5.692E+21	1.085E+21	4.647E+23	9.536E+05
10	10.000	238.55	3.051E-04	1.827E-01	5.693E+21	1.086E+21	4.653E+23	1.003E+06
11	11.000	232.10	3.365E-04	2.064E-01	5.693E+21	1.086E+21	4.656E+23	1.045E+06
12	12.000	225.60	3.691E-04	2.379E-01	5.693E+21	1.086E+21	4.656E+23	1.082E+06
13	13.000	219.10	4.026E-04	2.716E-01	5.693E+21	1.086E+21	4.656E+23	1.114E+06

Table 18. Program Output for Case 2 (Cont.)

14	14.000	215.75	4.366E-04	3.127E-01	5.693E+21	1.086E+21	4.656E+23	1.141E+06
15	15.000	215.70	4.737E-04	3.574E-01	5.693E+21	1.086E+21	4.656E+23	1.164E+06
16	16.000	215.70	5.211E-04	4.017E-01	5.693E+21	1.086E+21	4.656E+23	1.183E+06
17	17.000	215.70	5.903E-04	4.463E-01	5.693E+21	1.086E+21	4.656E+23	1.198E+06
18	18.000	216.23	6.888E-04	4.955E-01	5.693E+21	1.086E+21	4.656E+23	1.212E+06
19	19.000	217.33	8.160E-04	5.566E-01	5.693E+21	1.086E+21	4.656E+23	1.223E+06
20	20.000	218.53	9.717E-04	6.296E-01	5.693E+21	1.086E+21	4.656E+23	1.232E+06
21	21.000	219.78	1.134E-03	7.076E-01	5.693E+21	1.086E+21	4.656E+23	1.240E+06
22	22.000	220.98	1.291E-03	7.875E-01	5.693E+21	1.086E+21	4.656E+23	1.246E+06
23	23.000	222.18	1.436E-03	8.683E-01	5.693E+21	1.086E+21	4.656E+23	1.252E+06
24	24.000	223.33	1.562E-03	9.490E-01	5.693E+21	1.086E+21	4.656E+23	1.257E+06
25	25.000	224.48	1.669E-03	1.031E+00	5.693E+21	1.086E+21	4.656E+23	1.261E+06
26	30.000	228.81	1.950E-03	1.367E+00	5.693E+21	1.086E+21	4.656E+23	1.273E+06
27	35.000	238.67	2.022E-03	1.577E+00	5.693E+21	1.086E+21	4.656E+23	1.279E+06
28	40.000	250.55	2.035E-03	1.682E+00	5.693E+21	1.086E+21	4.656E+23	1.282E+06
29	45.000	262.93	2.037E-03	1.719E+00	5.693E+21	1.086E+21	4.656E+23	1.283E+06
30	50.000	272.48	2.037E-03	1.730E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06
31	70.000	256.71	2.037E-03	1.736E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06
32	100.000	212.98	2.037E-03	1.736E+00	5.693E+21	1.086E+21	4.656E+23	1.284E+06

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	1.000	3.622E+00	5.075E+00	4.425E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	2.000	6.544E+00	9.641E+00	6.034E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.000	8.899E+00	1.375E+01	6.211E+00	9.855E-02	0.000E+00	0.000E+00	0.000E+00
4	4.000	1.080E+01	1.745E+01	6.211E+00	2.445E-01	0.000E+00	0.000E+00	0.000E+00
5	5.000	1.232E+01	2.078E+01	6.211E+00	3.201E-01	0.000E+00	0.000E+00	0.000E+00
6	6.000	1.353E+01	2.376E+01	6.211E+00	3.678E-01	0.000E+00	0.000E+00	0.000E+00
7	7.000	1.450E+01	2.643E+01	6.211E+00	4.067E-01	0.000E+00	0.000E+00	0.000E+00
8	8.000	1.526E+01	2.881E+01	6.211E+00	4.326E-01	0.000E+00	0.000E+00	0.000E+00
9	9.000	1.586E+01	3.093E+01	6.211E+00	4.466E-01	0.000E+00	0.000E+00	0.000E+00
10	10.000	1.633E+01	3.282E+01	6.211E+00	4.547E-01	0.000E+00	0.000E+00	0.000E+00
11	11.000	1.670E+01	3.449E+01	6.211E+00	4.578E-01	2.199E-03	0.000E+00	0.000E+00
12	12.000	1.698E+01	3.597E+01	6.211E+00	4.578E-01	6.130E-03	0.000E+00	0.000E+00
13	13.000	1.720E+01	3.727E+01	6.211E+00	4.578E-01	9.278E-03	0.000E+00	0.000E+00
14	14.000	1.736E+01	3.839E+01	6.211E+00	4.578E-01	1.188E-02	0.000E+00	0.000E+00
15	15.000	1.748E+01	3.935E+01	6.211E+00	4.578E-01	1.414E-02	0.000E+00	0.000E+00
16	16.000	1.756E+01	4.016E+01	6.211E+00	4.578E-01	1.624E-02	0.000E+00	0.000E+00
17	17.000	1.763E+01	4.085E+01	6.211E+00	4.578E-01	1.840E-02	0.000E+00	0.000E+00
18	18.000	1.767E+01	4.143E+01	6.211E+00	4.578E-01	2.093E-02	0.000E+00	0.000E+00
19	19.000	1.770E+01	4.193E+01	6.211E+00	4.578E-01	2.386E-02	0.000E+00	0.000E+00
20	20.000	1.773E+01	4.235E+01	6.211E+00	4.578E-01	2.696E-02	0.000E+00	0.000E+00
21	21.000	1.774E+01	4.271E+01	6.211E+00	4.578E-01	2.983E-02	0.000E+00	0.000E+00
22	22.000	1.776E+01	4.301E+01	6.211E+00	4.578E-01	3.225E-02	0.000E+00	0.000E+00
23	23.000	1.777E+01	4.327E+01	6.211E+00	4.578E-01	3.411E-02	0.000E+00	0.000E+00
24	24.000	1.777E+01	4.349E+01	6.211E+00	4.578E-01	3.539E-02	0.000E+00	0.000E+00
25	25.000	1.778E+01	4.367E+01	6.211E+00	4.578E-01	3.624E-02	0.000E+00	0.000E+00
26	30.000	1.779E+01	4.427E+01	6.211E+00	4.578E-01	3.807E-02	0.000E+00	0.000E+00
27	35.000	1.779E+01	4.454E+01	6.211E+00	4.578E-01	3.849E-02	2.058E-04	0.000E+00
28	40.000	1.779E+01	4.466E+01	6.211E+00	4.578E-01	3.849E-02	4.950E-04	0.000E+00
29	45.000	1.779E+01	4.472E+01	6.211E+00	4.578E-01	3.849E-02	6.352E-04	0.000E+00
30	50.000	1.779E+01	4.475E+01	6.211E+00	4.578E-01	3.849E-02	7.057E-04	0.000E+00
31	70.000	1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.756E-04	0.000E+00
32	100.000	1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.797E-04	0.000E+00

J	Z (KM)	H2O (G/CM**2)	(O3	CO2	CO	CH4	N2O	O2 ATM CM	NH3	NO	NO2	SO2)

Table 18. Program Output for Case 2 (Cont.)

1	1.00	6.12E+00	1.43E-02	1.87E+02	6.84E-02	8.51E-01	1.49E-01	8.12E+04	2.57E-04	1.52E-04	1.14E-05	1.32E-04
2	2.00	9.67E+00	2.82E-02	3.38E+02	1.23E-01	1.55E+00	2.79E-01	1.48E+05	4.58E-04	2.80E-04	2.13E-05	2.36E-04
3	3.00	1.16E+01	4.19E-02	4.58E+02	1.68E-01	2.13E+00	3.94E-01	2.03E+05	5.99E-04	3.88E-04	2.97E-05	3.13E-04
4	4.00	1.25E+01	5.56E-02	5.52E+02	2.03E-01	2.59E+00	4.94E-01	2.48E+05	6.88E-04	4.77E-04	3.69E-05	3.67E-04
5	5.00	1.30E+01	6.95E-02	6.27E+02	2.32E-01	2.98E+00	5.81E-01	2.86E+05	7.41E-04	5.52E-04	4.31E-05	4.04E-04
6	6.00	1.32E+01	8.35E-02	6.85E+02	2.56E-01	3.28E+00	6.58E-01	3.17E+05	7.70E-04	6.14E-04	4.83E-05	4.32E-04
7	7.00	1.34E+01	9.81E-02	7.31E+02	2.75E-01	3.53E+00	7.24E-01	3.43E+05	7.86E-04	6.65E-04	5.28E-05	4.52E-04
8	8.00	1.34E+01	1.13E-01	7.66E+02	2.90E-01	3.72E+00	7.82E-01	3.64E+05	7.95E-04	7.07E-04	5.66E-05	4.68E-04
9	9.00	1.35E+01	1.29E-01	7.92E+02	3.02E-01	3.87E+00	8.32E-01	3.81E+05	7.99E-04	7.41E-04	5.98E-05	4.80E-04
10	10.00	1.35E+01	1.46E-01	8.13E+02	3.11E-01	3.99E+00	8.74E-01	3.95E+05	8.01E-04	7.69E-04	6.25E-05	4.90E-04
11	11.00	1.35E+01	1.64E-01	8.28E+02	3.17E-01	4.09E+00	9.10E-01	4.07E+05	8.02E-04	7.92E-04	6.49E-05	4.98E-04
12	12.00	1.35E+01	1.84E-01	8.40E+02	3.22E-01	4.16E+00	9.39E-01	4.16E+05	8.02E-04	8.11E-04	6.72E-05	5.05E-04
13	13.00	1.35E+01	2.07E-01	8.48E+02	3.25E-01	4.21E+00	9.64E-01	4.23E+05	8.02E-04	8.25E-04	6.97E-05	5.11E-04
14	14.00	1.35E+01	2.34E-01	8.55E+02	3.27E-01	4.25E+00	9.84E-01	4.29E+05	8.02E-04	8.37E-04	7.29E-05	5.16E-04
15	15.00	1.35E+01	2.61E-01	8.60E+02	3.28E-01	4.28E+00	1.00E+00	4.32E+05	8.02E-04	8.46E-04	7.80E-05	5.20E-04
16	16.00	1.35E+01	2.86E-01	8.64E+02	3.28E-01	4.31E+00	1.01E+00	4.35E+05	8.02E-04	8.52E-04	8.62E-05	5.23E-04
17	17.00	1.35E+01	3.10E-01	8.66E+02	3.29E-01	4.32E+00	1.02E+00	4.37E+05	8.02E-04	8.57E-04	9.74E-05	5.26E-04
18	18.00	1.35E+01	3.34E-01	8.69E+02	3.29E-01	4.34E+00	1.03E+00	4.38E+05	8.02E-04	8.61E-04	1.11E-04	5.28E-04
19	19.00	1.35E+01	3.62E-01	8.70E+02	3.29E-01	4.34E+00	1.03E+00	4.39E+05	8.02E-04	8.63E-04	1.27E-04	5.29E-04
20	20.00	1.35E+01	3.93E-01	8.72E+02	3.29E-01	4.35E+00	1.04E+00	4.40E+05	8.02E-04	8.65E-04	1.44E-04	5.30E-04
21	21.00	1.35E+01	4.24E-01	8.73E+02	3.29E-01	4.36E+00	1.04E+00	4.40E+05	8.02E-04	8.67E-04	1.62E-04	5.30E-04
22	22.00	1.35E+01	4.54E-01	8.74E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.69E-04	1.79E-04	5.31E-04
23	23.00	1.35E+01	4.82E-01	8.74E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.70E-04	1.96E-04	5.31E-04
24	24.00	1.35E+01	5.08E-01	8.75E+02	3.29E-01	4.36E+00	1.04E+00	4.41E+05	8.02E-04	8.72E-04	2.17E-04	5.31E-04
25	25.00	1.35E+01	5.32E-01	8.75E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.73E-04	2.27E-04	5.31E-04
26	30.00	1.35E+01	6.14E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.82E-04	2.85E-04	5.32E-04
27	35.00	1.35E+01	6.50E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.90E-04	3.13E-04	5.32E-04
28	40.00	1.35E+01	6.63E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	8.97E-04	3.22E-04	5.32E-04
29	45.00	1.35E+01	6.66E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.00E-04	3.23E-04	5.32E-04
30	50.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04
31	70.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04
32	100.00	1.35E+01	6.67E-01	8.76E+02	3.29E-01	4.37E+00	1.04E+00	4.41E+05	8.02E-04	9.01E-04	3.24E-04	5.32E-04

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =      .000 KM
H2      =   100.000 KM
ANGLE   =    80.000 DEG
RANGE   =   479.887 KM
BETA    =     4.189 DEG
PHI     =   104.106 DEG
HMIN    =      .000 KM
BENDING =      .083 DEG
LEN     =         0
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EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
2.037E-03	1.736E+00	5.593E+21	1.086E+21	4.656E+23	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
1.779E+01	4.479E+01	6.211E+00	4.578E-01	3.849E-02	7.797E-04	0.000E+00	69.10

Table 18. Program Output for Case 2 (Cont.)

H2O (G/CM**2)	O? (	CO2	CO ATM CM	CH4	N2O	O2)
1.348E+01	6.671E-01	8.764E+02	3.295E-01	4.368E+00	1.043E+00	4.415E+05

NH3 (	NO ATM CM	NO2	SO2)
8.021E 04	9.013E-04	3.236E-04	5.319E-04

Table 18. Program Output for Case 2 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ (CM-1)	WAVLEN (MICRN)	ATMOS RADIANCE (CM-1)	ATMOS RADIANCE (MICRN)	INTEGRAL (CM-1)	TOTAL TRANS
740.	13.514	1.29E-05	7.07E-04	3.23E-05	.0001
745.	13.423	1.28E-05	7.13E-04	9.65E-05	.0001
750.	13.333	1.28E-05	7.18E-04	1.60E-04	.0004
755.	13.245	1.27E-05	7.22E-04	2.24E-04	.0010
760.	13.158	1.25E-05	7.24E-04	2.86E-04	.0023
765.	13.072	1.24E-05	7.26E-04	3.48E-04	.0043
770.	12.987	1.23E-05	7.28E-04	4.10E-04	.0063
775.	12.903	1.22E-05	7.31E-04	4.70E-04	.0083
780.	12.821	1.21E-05	7.35E-04	5.31E-04	.0095
785.	12.739	1.20E-05	7.40E-04	5.91E-04	.0103
790.	12.658	1.19E-05	7.44E-04	6.50E-04	.0112
795.	12.579	1.18E-05	7.48E-04	7.10E-04	.0117
800.	12.500	1.17E-05	7.50E-04	7.63E-04	.0138
805.	12.422	1.16E-05	7.49E-04	8.23E-04	.0178
810.	12.346	1.14E-05	7.46E-04	8.83E-04	.0232
815.	12.270	1.11E-05	7.40E-04	9.39E-04	.0297
820.	12.195	1.09E-05	7.34E-04	9.93E-04	.0363
825.	12.121	1.08E-05	7.33E-04	1.05E-03	.0408
830.	12.048	1.06E-05	7.30E-04	1.10E-03	.0457
835.	11.976	1.05E-05	7.30E-04	1.15E-03	.0488
840.	11.905	1.04E-05	7.34E-04	1.20E-03	.0497
845.	11.834	1.03E-05	7.36E-04	1.25E-03	.0518
850.	11.765	1.02E-05	7.39E-04	1.31E-03	.0525
855.	11.696	1.01E-05	7.38E-04	1.35E-03	.0555
860.	11.628	9.90E-06	7.32E-04	1.41E-03	.0620
865.	11.561	9.73E-06	7.28E-04	1.46E-03	.0667
870.	11.494	9.56E-06	7.24E-04	1.50E-03	.0717
875.	11.429	9.44E-06	7.23E-04	1.55E-03	.0747
880.	11.364	9.35E-06	7.24E-04	1.60E-03	.0759
885.	11.299	9.22E-06	7.22E-04	1.64E-03	.0794
890.	11.236	9.05E-06	7.17E-04	1.69E-03	.0847
895.	11.173	8.88E-06	7.11E-04	1.73E-03	.0901
900.	11.111	8.71E-06	7.05E-04	1.78E-03	.0958
905.	11.050	8.59E-06	7.04E-04	1.82E-03	.0991
910.	10.989	8.51E-06	7.05E-04	1.86E-03	.1001
915.	10.929	8.41E-06	7.04E-04	1.90E-03	.1020
920.	10.870	8.31E-06	7.03E-04	1.95E-03	.1043
925.	10.811	8.18E-06	7.00E-04	1.99E-03	.1085
930.	10.753	8.03E-06	6.94E-04	2.03E-03	.1134
935.	10.695	7.92E-06	6.92E-04	2.07E-03	.1158
940.	10.638	7.83E-06	6.92E-04	2.11E-03	.1170
945.	10.582	7.76E-06	6.93E-04	2.14E-03	.1174
950.	10.526	7.68E-06	6.93E-04	2.18E-03	.1183
955.	10.471	7.60E-06	6.93E-04	2.22E-03	.1196
960.	10.417	7.51E-06	6.92E-04	2.26E-03	.1206
965.	10.363	7.44E-06	6.93E-04	2.30E-03	.1200
970.	10.309	7.38E-06	6.95E-04	2.33E-03	.1183
975.	10.256	7.29E-06	6.93E-04	2.37E-03	.1183
980.	10.204	7.13E-06	6.85E-04	2.40E-03	.1216
985.	10.152	6.97E-06	6.76E-04	2.44E-03	.1238

Table 18. Program Output for Case 2 (Cont.)

RADIANCE(WATTS/CM2-STER-XXX)

FREQ (CM-1)	WAVLEN (MICRN)	ATMOS RADIANCE (CM-1)	(MICRN)	INTEGRAL (CM-1)	TOTAL TRANS
990.	10.101	6.84E-06	6.70E-04	2.47E-03	.1219
995.	10.050	6.79E-06	6.72E-04	2.51E-03	.1113
1000.	10.000	6.83E-06	6.83E-04	2.54E-03	.0911
1005.	9.950	6.93E-06	7.00E-04	2.58E-03	.0667
1010.	9.901	7.03E-06	7.18E-04	2.61E-03	.0441
1015.	9.852	7.13E-06	7.35E-04	2.65E-03	.0271
1020.	9.804	7.17E-06	7.46E-04	2.68E-03	.0170
1025.	9.756	7.18E-06	7.55E-04	2.72E-03	.0119
1030.	9.709	7.15E-06	7.58E-04	2.75E-03	.0104
1035.	9.662	7.08E-06	7.58E-04	2.79E-03	.0100
1040.	9.615	7.03E-06	7.60E-04	2.83E-03	.0095
1045.	9.569	6.99E-06	7.63E-04	2.86E-03	.0087
1050.	9.524	6.96E-06	7.67E-04	2.90E-03	.0074
1055.	9.479	6.85E-06	7.64E-04	2.93E-03	.0097
1060.	9.434	6.69E-06	7.52E-04	2.96E-03	.0197
1065.	9.390	6.46E-06	7.32E-04	3.00E-03	.0459
1070.	9.346	6.24E-06	7.14E-04	3.03E-03	.0779
1075.	9.302	6.12E-06	7.07E-04	3.06E-03	.0927
1080.	9.259	5.99E-06	6.99E-04	3.09E-03	.1019
1085.	9.217	5.90E-06	6.95E-04	3.12E-03	.1069
1090.	9.174	5.82E-06	6.92E-04	3.15E-03	.1101
1095.	9.132	5.76E-06	6.91E-04	3.17E-03	.1115
1100.	9.091	5.76E-06	6.97E-04	3.20E-03	.1089
1105.	9.050	5.73E-06	7.00E-04	3.23E-03	.1065
1110.	9.009	5.68E-06	6.99E-04	3.26E-03	.1054
1115.	8.969	5.57E-06	6.93E-04	3.29E-03	.1072
1120.	8.929	5.52E-06	6.92E-04	3.32E-03	.1055
1125.	8.889	5.45E-06	6.91E-04	3.34E-03	.1036
1130.	8.850	5.42E-06	6.92E-04	3.37E-03	.1008
1135.	8.811	5.46E-06	7.04E-04	3.40E-03	.0923
1140.	8.772	5.42E-06	7.04E-04	3.42E-03	.0904
1145.	8.734	5.36E-06	7.03E-04	3.45E-03	.0888
1150.	8.696	5.35E-06	7.08E-04	3.48E-03	.0846
1155.	8.658	5.28E-06	7.04E-04	3.50E-03	.0878
1160.	8.621	5.27E-06	7.10E-04	3.53E-03	.0850
1165.	8.584	5.31E-06	7.20E-04	3.56E-03	.0737
1170.	8.547	5.29E-06	7.25E-04	3.58E-03	.0753
1175.	8.511	5.31E-06	7.33E-04	3.61E-03	.0686
1180.	8.475	5.25E-06	7.31E-04	3.64E-03	.0684
1185.	8.439	5.19E-06	7.29E-04	3.66E-03	.0690
1190.	8.403	5.11E-06	7.24E-04	3.69E-03	.0723
1195.	8.368	5.04E-06	7.20E-04	3.71E-03	.0749
1200.	8.333	5.01E-06	7.22E-04	3.74E-03	.0716
1205.	8.299	5.01E-06	7.27E-04	3.76E-03	.0650
1210.	8.264	5.05E-06	7.40E-04	3.79E-03	.0507
1215.	8.230	5.06E-06	7.47E-04	3.81E-03	.0408
1220.	8.197	5.03E-06	7.48E-04	3.84E-03	.0364
1225.	8.163	4.99E-06	7.48E-04	3.86E-03	.0321
1230.	8.130	4.92E-06	7.45E-04	3.89E-03	.0304
1235.	8.097	4.90E-06	7.48E-04	3.91E-03	.0234

Table 18. Program Output for Case 2 (Cont.)

```
                 RADIANCE(WATTS/CM2-STER-XXX)

  FREQ  WAVLEN   ATMOS RADIANCE        INTEGRAL  TOTAL
(CM-1) (MICRN)  (CM-1)     (MICRN)    (CM-1)     TRANS

 1240.   8.065  4.90E-06  7.54E-04  3.94E-03     .0150
 1245.   8.032  4.89E-06  7.58E-04  3.96E-03     .0082
 1250.   8.000  4.87E-06  7.61E-04  3.97E-03     .0038

INTEGRATED ABSORPTION FROM  740 TO 1250 CM-1 =     477.33 CM-1
AVERAGE TRANSMITTANCE = .0640

INTEGRATED RADIANCE =  3.974E-03 WATTS CM-2 STER-1
MINIMUM RADIANCE    =  4.870E-06 WATTS CM-2 STER-1 (CM-1)-1 AT      1250.0 CM-1
MAXIMUM RADIANCE    =  1.291E-05 WATTS CM-2 STER-1 (CM-1)-1 AT       740.0 CM-1
BOUNDARY TEMPERATURE =          .00 K
BOUNDARY EMISSIVITY =         1.000

 CARD 5 *****    0
```

0 and the RANGE will be calculated (for this case 479.887 km). The spectral range for these calculations have been chosen as 740 to 1250 cm^{-1} with steps of 5 cm^{-1}.

4.3 Case 3: Atmospheric Transmittance

This case represents a standard atmospheric transmittance run with the added feature of having an elevated surface of 1.5 km. The parameters selected for this case are as follows: the atmospheric profile is the 1976 US Standard and the boundary layer aerosol model is RURAL with 23 km meteorological range. Since M1 through M6 are left blank along with MDEF being set to 0, the atmospheric profile (pressure and temperature), along with all of the remaining molecular species are retained as initially chosen by MODEL. By setting the variable GNDALT to 1.5 an elevated surface is chosen. The path is a vertical path from the ground to 6 km. The spectral range of the calculation is from 990 to 1090 cm^{-1} in steps of 5 cm^{-1}. Figure 8 is a plot from 750 - 1250 cm^{-1}, containing the results from this case. The TAPE 6 output appears in Table 19.

4.4 Case 4: Directly Transmitted Solar Irradiance

Case 4 calculates the directly transmitted solar irradiance from 6000 to 7500 cm^{-1} for an observer at the ground and a solar zenith angle of 60°. This case is selected by IEMSCT = 3 on CARD 1. An ITYPE = 3 slant path is required: CARD 3 specifies the observer altitude H1 = 0.0, the apparent solar zenith angle at H1, ANGLE = 60°, and the day of the year IDAY = 74 (the Ides of March). The TAPE 6 output appears on Table 20.

The spectral output consists of the transmitted solar irradiance and the incident solar irradiance, corrected for variations in the earth-to-sun distance according to the day of the year. Also given are the cumulative integrals of these two quantities and the total transmittance for the path from H1 to the sun. The directly transmitted solar irradiance (solid line) and the solar radiance (dashed line) is depicted graphically in Figure 9.

4.5 Description of TAPE7 and TAPE8

Two files are opened for the storage of pertinent output, UNIT = 7 and UNIT = 8. The next section will describe the various types of output included on TAPE 7.

4.5.1 TAPE7 OUTPUT

The spectral results from each successful case run are written to a file on UNIT = 7, along with a 11-line header identifying the parameters for the case. This file can then be used to further process the results. For example, the plot, filter, and scanning function programs described in Appendices A, B, and C work from this file.

The data on the file consists of an 11-line header followed by the spectral data. The header consists for the most part of images of the input control cards, with the default values supplied for parameters that have defaults, for example VIS on CARD 2. The first four lines of the header are CARD 1, CARD 2, CARD 2A, and CARD 2B. When the cirrus, VSA, and single scattering options are not

(Text continued on page 114)

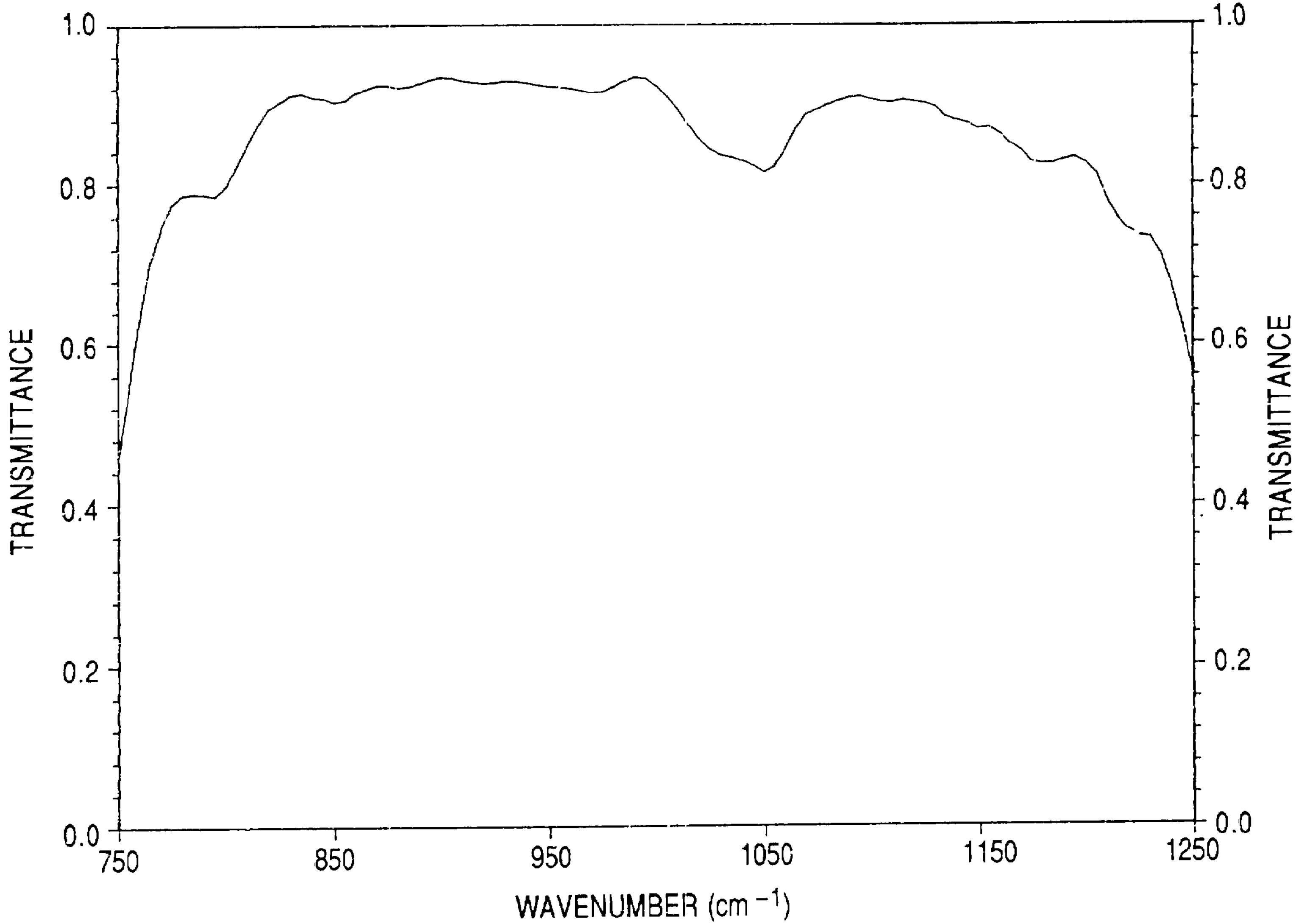

Figure 8. Atmospheric Transmittance with an Elevated Surface of 1.5 km (Case 3). The path is 1.5 to 6 km.

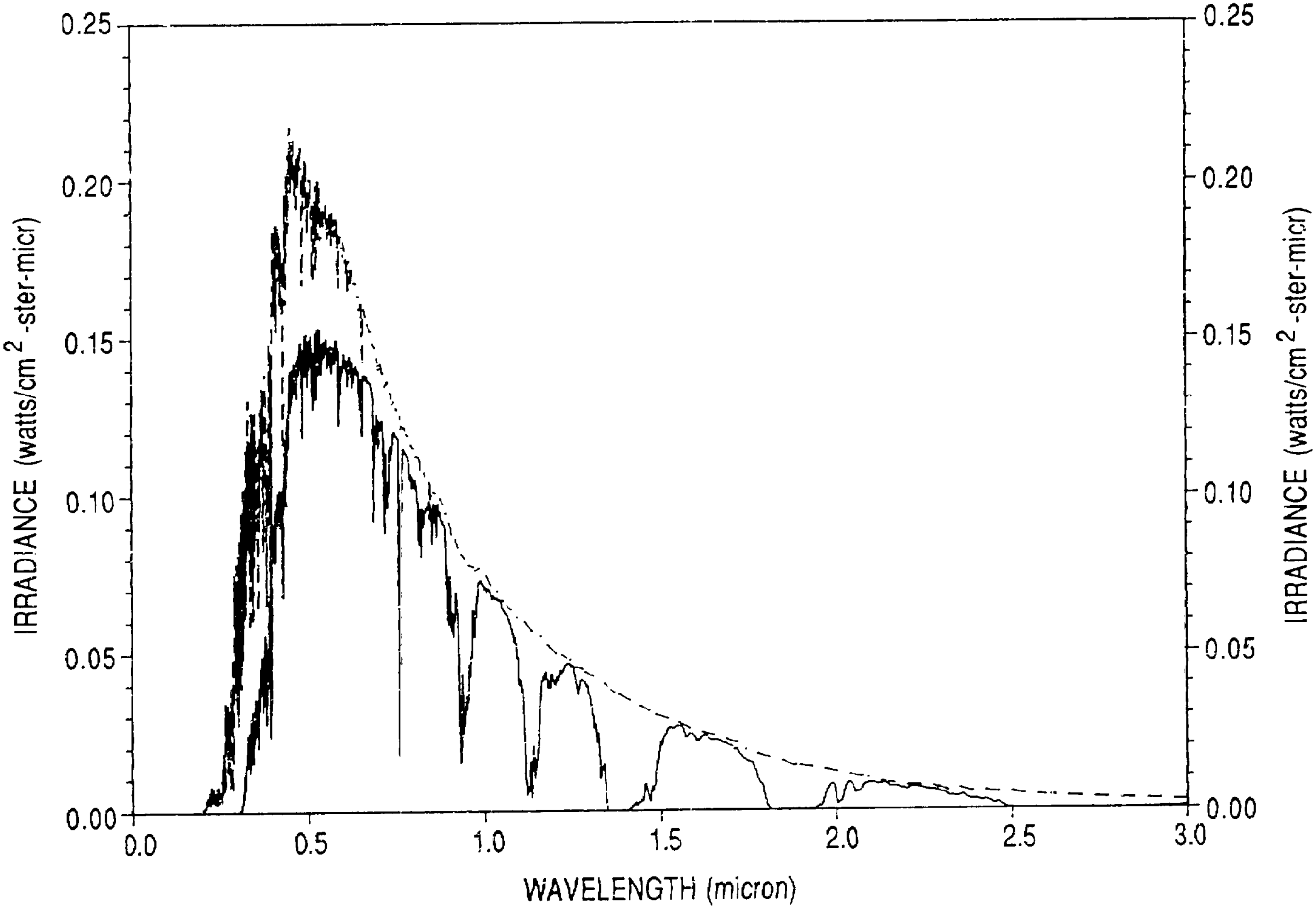

Figure 9. Directly Transmitted Solar Irradiance (Case 4). The path is from the ground to space with an angle 60°. The solid line is the directly transmitted solar irradiance and the dashed line is the extra-terrestrial solar radiance.

Table 19. Program Output for Case 3

```
***** LOWTRAN 7 *****

CARD 1 *****    6    2    0    0    0    0    0    0    0    0    0    0    0   .000   .00

CARD 2 *****    1    0    0    0    0    0     .000     .000     .000     .000    1.500

 GNDALT =      1.50

MODEL ATMOSPHERE NO.     6 ICLD =     0
```

Z (KM)	P (MB)	T (K)	REL H (%)	H2O (GM M-3)	CLD AMT (GM M-3)	RAIN RATE (MM HR-1)	TYPE	AEROSOL PROFILE	
1.500	845.622	278.45	50.64	3.509E+00	0.000E+00	0.000E+00	RURAL	RURAL	
2.250	770.645	273.56	51.97	2.593E+00	0.000E+00	0.000E+00	RURAL	RURAL	
3.000	701.200	268.70	50.71	1.798E+00	0.000E+00	0.000E+00	RURAL	RURAL	
3.750	636.926	263.83	50.19	1.246E+00	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
4.500	577.533	258.95	49.21	8.416E-01	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
5.250	522.718	254.08	48.37	5.606E-01	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
6.000	472.200	249.20	49.18	3.796E-01	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
7.000	411.100	242.70	48.14	2.098E-01	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
8.000	356.500	236.20	50.54	1.198E-01	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
9.000	308.000	229.70	37.08	4.595E-02	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
10.000	265.000	223.30	28.69	1.797E-02	0.000E+00	0.000E+00	TROPOSPHERIC	TROPOSPHERIC	SPRING-SUMMER
11.000	227.000	216.80	27.43	8.190E-03	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
12.000	194.000	216.70	12.52	3.694E-03	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
13.000	165.800	216.70	6.09	1.797E-03	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
14.000	141.700	216.70	2.84	8.391E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
15.000	121.100	216.70	2.05	6.049E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
16.000	103.500	216.70	1.38	4.084E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
17.000	88.500	216.70	1.15	3.404E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
18.000	75.650	216.70	.98	2.891E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
19.000	64.670	216.70	.84	2.487E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
20.000	55.290	216.70	.73	2.154E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
21.000	47.290	217.60	.57	1.870E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
22.000	40.470	218.60	.44	1.629E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
23.000	34.670	219.60	.35	1.436E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
24.000	29.720	220.60	.27	1.254E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
25.000	25.490	221.60	.21	1.102E-04	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
30.000	11.970	226.50	.06	5.406E-05	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
35.000	5.746	236.50	.01	2.577E-05	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
40.000	2.871	250.40	.00	1.247E-05	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
45.000	1.491	264.20	.00	6.384E-06	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
50.000	.798	270.70	.00	3.334E-06	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
70.000	.052	219.60	.00	1.801E-07	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER
100.000	.000	195.10	.00	1.420E-10	0.000E+00	0.000E+00	BACKGROUND STRATO	BACKGROUND STRATO	SPRING-SUMMER

```
CARD 3 *****     1.500     6.000     .000     .000     .000     .000    0

CARD 4 *****   990.000  1090.000     5.000

PROGRAM WILL COMPUTE TRANSMITTANCE

ATMOSPHERIC MODEL
        TEMPERATURE =    6      1976 U S STANDARD
        WATER VAPOR =    6      1976 U S STANDARD
        OZONE       =    6      1976 U S STANDARD
                    M4 =     6 M5 =     6 M6 =     6 MDEF =     1

SLANT PATH, H1 TO H2
        H1    =      1.500 KM
        H2    =      6.000 KM
```

Table 19. Program Output for Case 3 (Cont.)

```
    ANGLE  =          .000 DEG
    RANGE  =          .000 KM
    BETA   =          .000 DEG
    LEN    =         0

FREQUENCY RANGE
      V1 =          990.0 CM-1   (      10.10 MICROMETERS)
      V2 =         1090.0 CM-1   (       9.17 MICROMETERS)
      DV =            5.0 CM-1
```

Table 19. Program Output for Case 3 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	N2	CNTMSLF (MOL/CM2 KM)	MOL SCAT (-)	N-1 (-)	O3 (UV) (ATM CM/KM)	O2 (UV) (ATM CM/KM)
1	1.50	845.622	278.5	5.285E-01	5.549E+19	8.187E-01	2.353E-04	2.533E-03	2.732E+04
2	2.25	770.645	273.6	4.507E-01	3.032E+19	7.594E-01	2.183E-04	2.482E-03	2.465E+04
3	3.00	701.200	268.7	3.834E-01	1.457E+19	7.035E-01	2.022E-04	2.333E-03	2.224E+04
4	3.75	636.926	263.8	3.251E-01	6.992E+18	6.508E-01	1.871E-04	2.181E-03	2.005E+04
5	4.50	577.533	259.0	2.749E-01	3.192E+18	6.012E-01	1.729E-04	2.139E-03	1.807E+04
6	5.25	522.718	254.1	2.317E-01	1.417E+18	5.546E-01	1.595E-04	2.125E-03	1.627E+04
7	6.00	472.200	249.2	1.946E-01	6.495E+17	5.108E-01	1.469E-04	2.099E-03	1.465E+04
8	7.00	411.100	242.7	1.535E-01	1.983E+17	4.566E-01	1.313E-04	2.286E-03	1.272E+04
9	8.00	356.500	236.2	1.202E-01	6.471E+16	4.069E-01	1.170E-04	2.426E-03	1.102E+04
10	9.00	308.000	229.7	9.358E-02	9.518E+15	3.615E-01	1.040E-04	3.312E-03	9.542E+03
11	10.00	265.000	223.3	7.227E-02	1.456E+15	3.199E-01	9.201E-05	4.198E-03	8.242E+03
12	11.00	227.000	216.8	5.543E-02	3.023E+14	2.823E-01	8.118E-05	6.062E-03	7.110E+03
13	12.00	194.000	216.7	4.052E-02	6.151E+13	2.413E-01	6.941E-05	7.464E-03	5.929E+03
14	13.00	165.800	216.7	2.959E-02	1.456E+13	2.063E-01	5.932E-05	7.927E-03	4.957E+03
15	14.00	141.700	216.7	2.162E-02	3.173E+12	1.763E-01	5.070E-05	8.861E-03	4.155E+03
16	15.00	121.100	216.7	1.579E-02	1.649E+12	1.507E-01	4.333E-05	9.793E-03	3.493E+03
17	16.00	103.500	216.7	1.153E-02	7.519E+11	1.288E-01	3.703E-05	1.120E-02	2.942E+03
18	17.00	88.500	216.7	8.432E-03	5.223E+11	1.101E-01	3.166E-05	1.306E-02	2.484E+03
19	18.00	75.650	216.7	6.161E-03	3.767E+11	9.411E-02	2.707E-05	1.493E-02	2.101E+03
20	19.00	64.670	216.7	4.502E-03	2.789E+11	8.045E-02	2.314E-05	1.632E-02	1.779E+03
21	20.00	55.290	216.7	3.291E-03	2.092E+11	6.878E-02	1.978E-05	1.773E-02	1.509E+03
22	21.00	47.290	217.6	2.393E-03	1.576E+11	5.859E-02	1.685E-05	1.773E-02	[illegible]
23	22.00	40.470	218.6	1.740E-03	1.196E+11	4.991E-02	1.435E-05	1.819E-02	[illegible]
24	23.00	34.670	219.6	1.268E-03	9.288E+10	4.256E-02	1.224E-05	1.773E-02	9.165E+02
25	24.00	29.720	220.6	9.258E-04	7.090E+10	3.632E-02	1.045E-05	1.679E-02	7.787E+02
26	25.00	25.490	221.6	6.764E-04	5.473E+10	3.101E-02	8.918E-06	1.586E-02	6.623E+02
27	30.00	11.970	226.5	1.440E-04	1.317E+10	1.425E-02	4.097E-06	9.330E-03	3.006E+02
28	35.00	5.746	236.5	3.117E-05	2.994E+09	6.550E-03	1.884E-06	5.130E-03	1.375E+02
29	40.00	2.871	250.4	7.144E-06	7.012E+08	3.091E-03	8.889E-07	2.255E-03	6.470E+01
30	45.00	1.491	264.2	1.778E-06	1.837E+08	1.521E-03	4.375E-07	[illegible]	3.181E+01
31	50.00	.798	270.7	4.805E-07	5.009E+07	7.945E-04	2.285E-07	[illegible]	1.650E+01
32	70.00	.052	219.6	2.875E-09	1.452E+05	6.408E-05	1.843E-08	[illegible]	1.338E+00
33	100.00	.000	195.1	1.290E-13	9.093E-02	4.422E-07	[illegible]	[illegible]	7.070E-03

Table 19. Program Output for Case 3 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1 (-)	AEROSOL 2 (-)	AEROSOL 3 (-)	AEROSOL 4 (-)	AER1*RH (-)	CIRRUS (-)	RH (PERCNT)
1	1.50	845.622	278.5	1.035E+22	5.275E-06	1.580E-01	0.000E+00	0.000E+00	0.000E+00	6.161E-01	0.000E+00	5.064E+01
2	2.25	770.645	273.6	7.104E+21	5.449E-06	9.910E-02	0.000E+00	0.000E+00	0.000E+00	3.837E-01	0.000E+00	5.197E+01
3	3.00	701.200	268.7	4.567E+21	5.565E-06	6.210E-02	0.000E+00	0.000E+00	0.000E+00	2.420E-01	0.000E+00	5.071E+01
4	3.75	636.925	263.8	2.929E+21	5.620E-06	0.000E+00	3.460E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.019E+01
5	4.50	577.533	259.0	1.830E+21	5.583E-06	0.000E+00	1.850E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.921E+01
6	5.25	522.718	254.1	1.125E+21	5.577E-06	0.000E+00	9.310E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.337E+01
7	6.00	472.200	249.2	7.018E+20	5.670E-06	0.000E+00	7.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.918E+01
8	7.00	411.100	242.7	3.468E+20	5.754E-06	0.000E+00	6.230E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.814E+01
9	8.00	356.500	236.2	1.765E+20	5.656E-06	0.000E+00	3.370E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.054E+01
10	9.00	308.000	229.7	6.016E+19	5.531E-06	0.000E+00	1.820E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.708E+01
11	10.00	265.000	223.3	2.083E+19	5.567E-06	0.000E+00	1.140E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.869E+01
12	11.00	227.000	216.8	8.374E+18	5.702E-06	0.000E+00	0.000E+00	7.990E-04	0.000E+00	0.000E+00	0.000E+00	2.743E+01
13	12.00	194.000	216.7	3.230E+18	5.816E-06	0.000E+00	0.000E+00	6.410E-04	0.000E+00	0.000E+00	0.000E+00	1.252E+01
14	13.00	165.800	216.7	1.343E+18	5.693E-06	0.000E+00	0.000E+00	5.170E-04	0.000E+00	0.000E+00	0.000E+00	6.092E+00
15	14.00	141.700	216.7	5.358E+17	5.870E-06	0.000E+00	0.000E+00	4.420E-04	0.000E+00	0.000E+00	0.000E+00	2.844E+00
16	15.00	121.100	216.7	3.301E+17	6.809E-06	0.000E+00	0.000E+00	3.950E-04	0.000E+00	0.000E+00	0.000E+00	2.050E+00
17	16.00	103.500	216.7	1.905E+17	9.489E-06	0.000E+00	0.000E+00	3.620E-04	0.000E+00	0.000E+00	0.000E+00	1.384E+00
18	17.00	88.500	216.7	1.358E+17	1.442E-05	0.000E+00	0.000E+00	4.250E-04	0.000E+00	0.000E+00	0.000E+00	1.154E+00
19	18.00	75.650	216.7	9.855E+16	1.986E-05	0.000E+00	0.000E+00	5.200E-04	0.000E+00	0.000E+00	0.000E+00	9.798E-01
20	19.00	64.670	216.7	7.249E+16	2.550E-05	0.000E+00	0.000E+00	5.810E-04	0.000E+00	0.000E+00	0.000E+00	8.431E-01
21	20.00	55.290	216.7	5.368E+16	2.889E-05	0.000E+00	0.000E+00	5.890E-04	0.000E+00	0.000E+00	0.000E+00	7.302E-01
22	21.00	47.290	217.6	3.969E+16	2.894E-05	0.000E+00	0.000E+00	5.020E-04	0.000E+00	0.000E+00	0.000E+00	5.702E-01
23	22.00	40.470	218.6	2.946E+16	2.725E-05	0.000E+00	0.000E+00	4.200E-04	0.000E+00	0.000E+00	0.000E+00	4.422E-01
24	23.00	34.670	219.6	2.213E+16	2.443E-05	0.000E+00	0.000E+00	3.000E-04	0.000E+00	0.000E+00	0.000E+00	3.472E-01
25	24.00	29.720	220.6	1.650E+16	2.121E-05	0.000E+00	0.000E+00	1.980E-04	0.000E+00	0.000E+00	0.000E+00	2.707E-01
26	25.00	25.490	221.6	1.238E+16	1.740E-05	0.000E+00	0.000E+00	1.310E-04	0.000E+00	0.000E+00	0.000E+00	2.125E-01
27	30.00	11.970	226.5	2.790E+15	5.328E-06	0.000E+00	0.000E+00	3.320E-05	0.000E+00	0.000E+00	0.000E+00	6.101E-02
28	35.00	5.746	236.5	6.115E+14	1.074E-06	0.000E+00	0.000E+00	0.000E+00	1.640E-05	0.000E+00	0.000E+00	1.056E-02
29	40.00	2.871	250.4	1.397E+14	1.647E-07	0.000E+00	0.000E+00	0.000E+00	7.990E-06	0.000E+00	0.000E+00	1.460E-03
30	45.00	1.491	264.2	3.518E+13	1.841E-08	0.000E+00	0.000E+00	0.000E+00	4.010E-06	0.000E+00	0.000E+00	2.502E-04
31	50.00	.798	270.7	9.595E+12	4.409E-09	0.000E+00	0.000E+00	0.000E+00	2.100E-06	0.000E+00	0.000E+00	8.159E-05
32	70.00	.052	219.6	4.181E+10	2.095E-10	0.000E+00	0.000E+00	0.000E+00	1.600E-07	0.000E+00	0.000E+00	4.357E-04
33	100.00	.000	195.1	2.275E+05	1.207E-12	0.000E+00	0.000E+00	0.000E+00	9.310E-10	0.000E+00	0.000E+00	8.646E-06

Table 19. Program Output for Case 3 (Cont.)

ATMOSPHERIC PROFILES

(IF A MOLECULE HAS MORE THAN ONE BAND, THEN THE DATA FOR THE FIRST BAND ARE SHOWN.)

I	Z	P	T	H2O	O3	CO2	CO	CH4	N2O	O2	NH3	NO	NO2	SO2
	(KM)	(MB)	(K)	G/CM**2/KM	(		ATM	CM/KM						)
1	1.50	645.622	278.5	2.92E-01	2.29E-03	2.50E+01	1.00E-02	1.23E-01	2.40E-02	1.30E+04	3.50E-05	2.25E-05	1.75E-06	1.94E-05
2	2.25	770.645	273.6	1.98E-01	2.21E-03	2.09E+01	8.54E-03	1.06E-01	2.19E-02	1.14E+04	2.72E-05	1.97E-05	1.57E-06	1.57E-05
3	3.00	701.200	268.7	1.26E-01	2.04E-03	1.75E+01	7.25E-03	9.13E-02	1.99E-02	9.96E+03	1.96E-05	1.72E-05	1.40E-06	1.22E-05
4	3.75	636.925	263.8	7.99E-02	1.88E-03	1.45E+01	6.18E-03	7.82E-02	1.80E-02	8.68E+03	1.35E-05	1.50E-05	1.24E-06	9.24E-06
5	4.50	577.533	259.0	4.94E-02	1.82E-03	1.21E+01	5.31E-03	6.69E-02	1.63E-02	7.55E+03	8.89E-06	1.31E-05	1.10E-06	7.10E-06
6	5.25	522.718	254.1	3.00E-02	1.78E-03	9.97E+00	4.59E-03	5.70E-02	1.48E-02	6.54E+03	5.73E-06	1.13E-05	9.77E-07	5.59E-06
7	6.00	472.200	249.2	1.85E-02	1.73E-03	8.21E+00	3.92E-03	4.84E-02	1.33E-02	5.66E+03	3.72E-06	9.81E-06	8.64E-07	4.43E-06
8	7.00	411.100	242.7	9.00E-03	1.84E-03	6.30E+00	3.11E-03	3.88E-02	1.16E-02	4.64E+03	1.96E-06	8.05E-06	7.30E-07	3.36E-06
9	8.00	356.500	236.2	4.51E-03	1.91E-03	4.80E+00	2.41E-03	3.08E-02	1.00E-02	3.79E+03	9.98E-07	6.57E-06	6.14E-07	2.58E-06
10	9.00	308.000	229.7	1.51E-03	2.56E-03	3.63E+00	1.80E-03	2.43E-02	8.66E-03	3.07E+03	4.47E-07	5.34E-06	5.18E-07	2.07E-06
11	10.00	265.000	223.3	5.16E-04	3.16E-03	2.72E+00	1.32E-03	1.90E-02	7.40E-03	2.47E+03	1.84E-07	4.31E-06	4.43E-07	1.68E-06
12	11.00	227.000	216.8	2.04E-04	4.46E-03	2.03E+00	9.53E-04	1.47E-02	6.25E-03	1.98E+03	7.50E-08	3.45E-06	4.04E-07	1.40E-06
13	12.00	194.000	216.7	7.88E-05	5.14E-03	1.56E+00	6.31E-04	1.12E-02	4.96E-03	1.41E+03	3.27E-08	2.72E-06	3.90E-07	1.10E-06
14	13.00	165.800	216.7	3.29E-05	5.11E-03	1.20E+00	3.90E-04	8.45E-03	3.94E-03	9.99E+02	1.22E-08	2.13E-06	4.43E-07	8.99E-07
15	14.00	141.700	216.7	1.32E-05	5.35E-03	9.22E-01	2.33E-04	6.38E-03	3.12E-03	7.08E+02	3.27E-09	1.65E-06	5.98E-07	7.41E-07
16	15.00	121.100	216.7	8.13E-06	5.54E-03	7.09E-01	1.39E-04	4.81E-03	2.47E-03	5.02E+02	9.91E-10	1.25E-06	1.10E-06	6.16E-07
17	16.00	103.500	216.7	4.71E-06	5.93E-03	5.46E-01	8.20E-05	3.62E-03	1.94E-03	3.56E+02	3.53E-10	9.30E-07	1.64E-06	5.03E-07
18	17.00	88.500	216.7	3.36E-06	6.47E-03	4.20E-01	5.05E-05	2.72E-03	1.51E-03	2.53E+02	1.39E-10	6.89E-07	2.15E-06	3.83E-07
19	18.00	75.650	216.7	2.45E-06	6.93E-03	3.23E-01	3.03E-05	2.04E-03	1.17E-03	1.79E+02	6.36E-11	5.16E-07	2.57E-06	2.79E-07
20	19.00	64.670	216.7	1.81E-06	7.09E-03	2.49E-01	1.81E-05	1.51E-03	8.92E-04	1.27E+02	2.84E-11	4.13E-07	2.83E-06	1.89E-07
21	20.00	55.290	216.7	1.34E-06	7.71E-03	1.91E-01	1.18E-05	1.11E-03	6.72E-04	9.03E+01	1.30E-11	3.40E-07	2.99E-06	1.24E-07
22	21.00	47.290	217.6	9.96E-07	6.71E-03	1.48E-01	8.25E-06	8.09E-04	4.99E-04	6.31E+01	7.82E-12	2.90E-07	3.03E-06	8.39E-08
23	22.00	40.470	218.6	7.45E-07	6.41E-03	1.15E-01	6.22E-06	5.80E-04	3.73E-04	4.41E+01	5.29E-12	2.53E-07	2.98E-06	5.80E-08
24	23.00	34.670	219.6	5.63E-07	5.82E-03	8.93E-02	4.99E-06	4.15E-04	2.86E-04	3.09E+01	3.70E-12	2.34E-07	2.85E-06	4.27E-08
25	24.00	29.720	220.6	4.22E-07	5.13E-03	6.94E-02	4.05E-06	2.99E-04	2.19E-04	2.16E+01	2.54E-12	2.31E-07	2.72E-06	3.18E-08
26	25.00	25.490	221.6	3.19E-07	4.52E-03	5.40E-02	3.28E-06	2.16E-04	1.64E-04	1.52E+01	1.64E-12	2.77E-07	2.67E-06	2.37E-08
27	30.00	11.970	226.5	7.39E-08	1.88E-03	1.57E-02	9.54E-07	5.06E-05	4.48E-05	2.66E+00	2.17E-13	3.09E-07	1.50E-06	6.51E-09
28	35.00	5.746	236.5	1.69E-08	7.14E-04	4.87E-03	2.87E-07	1.15E-05	9.82E-06	4.51E-01	1.65E-14	2.87E-07	6.11E-07	1.98E-09
29	40.00	2.871	250.4	4.07E-09	2.17E-04	1.64E-03	9.55E-08	2.55E-06	1.64E-06	7.87E-02	7.58E-16	1.51E-07	1.22E-07	6.32E-10
30	45.00	1.491	264.2	1.08E-09	5.40E-05	5.87E-04	3.57E-08	5.18E-07	2.12E-07	1.52E-02	2.35E-17	5.65E-08	1.32E-08	4.88E-10
31	50.00	.798	270.7	3.02E-10	1.24E-05	2.13E-04	1.67E-08	1.01E-07	2.55E-08	3.50E-03	1.82E-18	1.89E-08	2.08E-09	3.49E-10
32	70.00	.052	219.6	1.20E-12	4.12E-08	1.72E-06	1.27E-09	7.61E-10	2.16E-10	2.06E-05	4.89E-21	3.67E-10	2.94E-11	1.98E-11
33	100.00	.000	195.1	6.67E-18	5.25E-11	1.77E-10	1.10E-11	1.05E-13	7.00E-14	3.65E-10	2.93E-25	2.97E-11	1.98E-14	2.92E-16

CASE 2A: GIVEN H1, H2, ANGLE

SLANT PATH PARAMETERS IN STANDARD FORM

H1	=	1.500 KM
H2	=	6.000 KM
ANGLE	=	.000 DEG
PHI	=	180.000 DEG
HMIN	=	1.500 KM
LEN	=	0

Table 19. Program Output for Case 3 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	1.500	2.250	.000	.750	.750	.000	.000	180.000	.000	.000	808.023	276.04	1.02E-03
2	2.250	3.000	.000	.750	1.500	.000	.000	180.000	.000	.000	735.818	271.16	9.45E-04
3	3.000	3.750	.000	.750	2.250	.000	.000	180.000	.000	.000	668.965	266.29	8.75E-04
4	3.750	4.500	.000	.750	3.000	.000	.000	180.000	.000	.000	607.137	261.41	8.09E-04
5	4.500	5.250	.000	.750	3.750	.000	.000	180.000	.000	.000	550.038	256.54	7.46E-04
6	5.250	6.000	.000	.750	4.500	.000	.000	180.000	.000	.000	497.377	251.66	6.88E-04

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	2.250	276.04	4.022E-06	1.880E-03	3.123E+19	1.732E+19	6.469E+21	1.947E+04
2	3.000	271.16	8.152E-06	3.685E-03	4.735E+19	2.844E+19	1.078E+22	3.704E+04
3	3.750	266.29	1.235E-05	5.377E-03	5.509E+19	3.483E+19	1.354E+22	5.289E+04
4	4.500	261.41	1.655E-05	6.997E-03	5.872E+19	3.832E+19	1.529E+22	6.717E+04
5	5.250	256.54	2.073E-05	8.596E-03	6.036E+19	3.996E+19	1.638E+22	8.003E+04
6	6.000	251.66	2.495E-05	1.018E-02	6.110E+19	4.070E+19	1.705E+22	9.162E+04

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	2.250	3.664E-01	5.915E-01	9.470E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	3.000	6.785E-01	1.140E+00	1.541E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.750	9.436E-01	1.647E+00	1.774E-01	1.298E-02	0.000E+00	0.000E+00	0.000E+00
4	4.500	1.168E+00	2.117E+00	1.774E-01	3.226E-02	0.000E+00	0.000E+00	0.000E+00
5	5.250	1.358E+00	2.550E+00	1.774E-01	4.230E-02	0.000E+00	0.000E+00	0.000E+00
6	6.000	1.517E+00	2.949E+00	1.774E-01	4.866E-02	0.000E+00	0.000E+00	0.000E+00

J	Z (KM)	H2O (G/CM**2)	O3 (	CO2	CO	CH4	N2O ATM	O2 CM	NH3	NO	NO2	SO2)
1	2.25	1.82E-01	1.68E-03	1.72E+01	6.95E-03	8.59E-02	1.72E-02	9.15E+03	2.32E-05	1.58E-05	1.24E-06	1.31E-05
2	3.00	3.01E-01	3.28E-03	3.15E+01	1.29E-02	1.60E-01	3.28E-02	1.71E+04	4.06E-05	2.97E-05	2.35E-06	2.35E-05
3	3.75	3.77E-01	4.75E-03	4.35E+01	1.79E-02	2.23E-01	4.70E-02	2.41E+04	5.28E-05	4.17E-05	3.34E-06	3.15E-05
4	4.50	4.25E-01	6.14E-03	5.34E+01	2.22E-02	2.78E-01	5.99E-02	3.02E+04	6.11E-05	5.23E-05	4.22E-06	3.76E-05
5	5.25	4.54E-01	7.49E-03	6.17E+01	2.59E-02	3.24E-01	7.16E-02	3.55E+04	6.65E-05	6.14E-05	5.00E-06	4.24E-05
6	6.00	4.72E-01	8.81E-03	6.85E+01	2.91E-02	3.63E-01	8.21E-02	4.01E+04	7.00E-05	6.93E-05	5.69E-06	4.61E-05

SUMMARY OF THE GEOMETRY CALCULATION

H1	=	1.500 KM
H2	=	6.000 KM
ANGLE	=	.000 DEG
RANGE	=	4.500 KM

Table 19. Program Output for Case 3 (Cont.)

```
BETA      =       .000 DEG
PHI       =    180.000 DEG
HMIN      =      1.500 KM
BENDING   =       .000 DEG
LEN       =          0


EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

            HNO3       O3 UV      CNTMSLF1    CNTMSLF2   CNTMFRN
          (ATM CM)   (ATM CM)   (MOL CM-2)  (MOL CM-2)  (MOL CM-2)  (MOL CM-2)

         2.495F-05   1.016E-02   6.110E+19   4.070E+19   1.705E+22

          N2 CONT    MOL SCAT     AER 1       AER 2       AER 3       AER 4      CIRRUS     MEAN RH
                                                                                            (PRCNT)

         1.517E+00   2.949E+00   1.774E-01   4.866E-02   0.000E+00   0.000E+00   0.000E+00    51.23

            H2O        O3          CO2         CO          CH4         N2O         O2
         (G/CM**2)   (                            ATM CM                           )

         4.715E-01   8.605E-03   6.846E+01   2.907E-02   3.633E-01   8.212E-02   4.005E+04

            NH3        NO          NO2         SO2
            (              ATM CM               )

         7.000E-05   6.933E-05   5.689E-06   4.612E-05
```

Table 19. Program Output for Case 3 (Cont.)

FREQ	WAVELENGTH	TOTAL	H2O	CO2+	OZONE	TRACE	N2 CONT	H2O CONT	MOL SCAT	AER-HYD	HNO3	AER-HYD	INTEGRATED
1/CM	MICRONS	TRANS	TRANS	TRANS	TRANS	TRANS	TRANS	TRANS	TRANS	TRANS	TRANS	ABS	ABSORPTION
990.	10.101	.9325	.9865	.9903	.9908	.9995	1.0000	.9799	1.0000	.9836	1.0000	.0076	.169
995.	10.050	.9316	.9867	.9943	.9858	.9993	1.0000	.9802	1.0000	.9834	1.0000	.0077	.511
1000.	10.000	.9226	.9827	.9966	.9779	.9992	1.0000	.9805	1.0000	.9832	1.0000	.0078	.898
1005.	9.950	.9098	.9799	.9977	.9664	.9991	1.0000	.9808	1.0000	.9828	1.0000	.0083	1.349
1010.	9.901	.8929	.9775	.9977	.9511	.9991	1.0000	.9810	1.0000	.9823	1.0000	.0089	1.884
1015.	9.852	.8733	.9751	.9968	.9336	.9990	1.0000	.9812	1.0000	.9818	1.0000	.0094	2.517
1020.	9.804	.8562	.9755	.9951	.9167	.9990	1.0000	.9815	1.0000	.9813	1.0000	.0099	3.236
1025.	9.756	.8424	.9756	.9928	.9043	.9989	1.0000	.9817	1.0000	.9809	1.0000	.0104	4.025
1030.	9.709	.8358	.9757	.9896	.9003	.9988	1.0000	.9818	1.0000	.9804	1.0000	.0109	4.845
1035.	9.662	.8331	.9780	.9858	.8991	.9987	1.0000	.9820	1.0000	.9800	1.0000	.0114	5.680
1040.	9.615	.8288	.9784	.9816	.8963	.9986	1.0000	.9821	1.0000	.9795	1.0000	.0118	6.536
1045.	9.569	.8230	.9781	.9778	.8961	.9986	1.0000	.9823	1.0000	.9791	1.0000	.0123	7.421
1050.	9.524	.8146	.9752	.9754	.8919	.9986	1.0000	.9824	1.0000	.9786	1.0000	.0128	8.346
1055.	9.479	.8205	.9722	.9743	.9026	.9986	1.0000	.9825	1.0000	.9782	1.0000	.0133	9.245
1060.	9.434	.8414	.9687	.9736	.9297	.9987	1.0000	.9826	1.0000	.9778	1.0000	.0137	10.038
1065.	9.390	.8684	.9673	.9724	.9627	.9986	1.0000	.9827	1.0000	.9773	1.0000	.0142	10.696
1070.	9.346	.8866	.9697	.9697	.9835	.9986	1.0000	.9828	1.0000	.9769	1.0000	.0146	11.263
1075.	9.302	.8922	.9707	.9679	.9909	.9986	1.0000	.9828	1.0000	.9765	1.0000	.0151	11.802
1080.	9.259	.8988	.9744	.9690	.9937	.9986	1.0000	.9828	1.0000	.9761	1.0000	.0155	12.308
1085.	9.217	.9036	.9737	.9741	.9949	.9986	1.0000	.9828	1.0000	.9757	1.0000	.0160	12.790
1090.	9.174	.9073	.9696	.9818	.9954	.9987	1.0000	.9827	1.0000	.9756	1.0000	.0159	13.022

INTEGRATED ABSORPTION FROM 990 TO 1090 CM-1 = 13.02 CM-1
AVERAGE TRANSMITTANCE = .8698

CARD 5 ***** 0

Table 20. Program Output for Case 4

```
                   ***** LOWTRAN 7 *****

CARD 1  *****    6   3   3   0   0   0   0   0   0   0   0   0   0   .000    .00

CARD 2  *****    1   0   0   0   0   0      .000      .000      .000      .000      .000

CARD 3   *****     .000      .000     60.000   74           .000    0      .000

CARD 4  *****  6000.000  7500.000    20.000

PROGRAM WILL COMPUTE TRANSMITTED SOLAR IRRAD.

ATMOSPHERIC MODEL
        TEMPERATURE =    6      1976 U S STANDARD
        WATER VAPOR =    6      1976 U S STANDARD
        OZONE       =    6      1976 U S STANDARD
                   M4 =      6 M5 =      6 M6 =      6 MDEF =      1

AEROSOL MODEL
        REGIME                      AEROSOL TYPE            PROFILE                   SEASON

        BOUNDARY LAYER (0-2 KM)  RURAL                       23.0 KM VIS AT SEA LEVEL
        TROPOSPHERE  (2-10KM)    TROPOSPHERIC               TROPOSPHERIC              SPRING-SUMMER
        STRATOSPHERE (10-30KM)   BACKGROUND STRATO          BACKGROUND STRATO         SPRING-SUMMER
        UPPER ATMOS (30-100KM)   METEORIC DUST              NORMAL

SLANT PATH TO SPACE
        H1    =       .000 KM
        HMIN  =       .000 KM
        ANGLE =     60.000 DEG

FREQUENCY RANGE
         V1 =       6000.0 CM-1  (       1.67 MICROMETERS)
         V2 =       7500.0 CM-1  (       1.33 MICROMETERS)
         DV =         20.0 CM-1
```

Table 20. Program Output for Case 4 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	N2	CNTMSLF (MOL/CM2 KM)	MOL SCAT (-)	N-1 (-)	O3 (UV) (ATM CM/KM)	O2 (UV) (ATM CM/KM)
1	.00	1013.000	288.2	7.203E-01	1.566E+20	9.475E-01	2.729E-04	2.519E-03	3.348E+04
2	1.00	898.600	281.7	5.868E-01	7.926E+19	8.601E-01	2.478E-04	2.519E-03	2.924E+04
3	2.00	795.000	275.2	4.754E-01	3.781E+19	7.788E-01	2.244E-04	2.519E-03	2.551E+04
4	3.00	701.200	268.7	3.834E-01	1.457E+19	7.035E-01	2.027E-04	2.333E-03	2.224E+04
5	4.00	616.600	262.2	3.075E-01	5.440E+18	6.340E-01	1.827E-04	2.146E-03	1.937E+04
6	5.00	540.500	255.7	2.454E-01	1.842E+18	5.698E-01	1.643E-04	2.146E-03	1.685E+04
7	6.00	472.200	249.2	1.946E-01	6.495E+17	5.108E-01	1.473E-04	2.099E-03	1.465E+04
8	7.00	411.100	242.7	1.535E-01	1.983E+17	4.566E-01	1.316E-04	2.286E-03	1.272E+04
9	8.00	356.500	236.2	1.202E-01	6.471E+16	4.069E-01	1.173E-04	2.426E-03	1.102E+04
10	9.00	308.000	229.7	9.358E-02	9.518E+15	3.615E-01	1.042E-04	3.312E-03	9.542E+03
11	10.00	265.000	223.3	7.227E-02	1.456E+15	3.199E-01	9.224E-05	4.198E-03	8.242E+03
12	11.00	227.000	216.8	5.543E-02	3.023E+14	2.823E-01	8.138E-05	6.062E-03	7.110E+03
13	12.00	194.000	216.7	4.052E-02	6.151E+13	2.413E-01	6.958E-05	7.464E-03	5.929E+03
14	13.00	165.800	216.7	2.959E-02	1.456E+13	2.063E-01	5.947E-05	7.927E-03	4.957E+03
15	14.00	141.700	216.7	2.162E-02	3.173E+12	1.763E-01	5.082E-05	8.861E-03	4.155E+03
16	15.00	121.100	216.7	1.579E-02	1.649E+12	1.507E-01	4.344E-05	9.793E-03	3.493E+03
17	16.00	103.500	216.7	1.153E-02	7.519E+11	1.288E-01	3.712E-05	1.120E-02	2.942E+03
18	17.00	88.500	216.7	8.432E-03	5.223E+11	1.101E-01	3.174E-05	1.306E-02	2.484E+03
19	18.00	75.650	216.7	6.161E-03	3.767E+11	9.411E-02	2.713E-05	1.493E-02	2.101E+03
20	19.00	64.670	216.7	4.502E-03	2.789E+11	8.045E-02	2.320E-05	1.632E-02	1.779E+03
21	20.00	55.290	216.7	3.291E-03	2.092E+11	6.878E-02	1.983E-05	1.773E-02	1.509E+03
22	21.00	47.290	217.6	2.393E-03	1.576E+11	5.859E-02	1.689E-05	1.773E-02	1.276E+03
23	22.00	40.470	218.6	1.740E-03	1.196E+11	4.991E-02	1.439E-05	1.819E-02	1.080E+03
24	23.00	34.670	219.6	1.268E-03	9.288E+10	4.256E-02	1.227E-05	1.773E-02	9.165E+02
25	24.00	29.720	220.6	9.258E-04	7.090E+10	3.632E-02	1.047E-05	1.679E-02	7.787E+02
26	25.00	25.490	221.6	6.764E-04	5.473E+10	3.101E-02	8.940E-06	1.586E-02	6.623E+02
27	30.00	11.970	226.5	1.443E-04	1.317E+10	1.425E-02	4.108E-06	9.330E-03	3.006E+02
28	35.00	5.746	236.5	3.117E-05	2.994E+09	6.550E-03	1.888E-06	5.130E-03	1.375E+02
29	40.00	2.871	250.4	7.144E-06	7.012E+08	3.091E-03	8.912E-07	2.255E-03	6.470E+01
30	45.00	1.491	264.2	1.778E-06	1.837E+08	1.521E-03	4.386E-07	7.982E-04	3.181E+01
31	50.00	.798	270.7	4.908E-07	5.009E+07	7.945E-04	2.291E-07	2.461E-04	1.660E+01
32	70.00	.052	219.6	2.675E-09	1.462E+05	6.408E-05	1.848E-08	1.921E-06	1.338E+00
33	100.00	.000	195.1	1.290E-13	9.093E-02	4.422E-07	1.275E-10	1.767E-08	7.070E-03

Table 20. Program Output for Case 4 (Cont.)

ATMOSPHERIC PROFILES

I	Z (KM)	P (MB)	T (K)	CNTMFRN MOL/CM2 KM	HNO3 ATM CM/KM	AEROSOL 1 (-)	AEROSOL 2 (-)	AEROSOL 3 (-)	AEROSOL 4 (-)	AER1*RH (-)	CIRRUS (-)	RH (PERCNT)
1	.00	1013.000	288.2	2.007E+22	4.738E-06	1.580E-01	0.000E+00	0.000E+00	0.000E+00	6.307E-01	0.000E+00	4.584E+01
2	1.00	898.800	281.7	1.299E+22	5.126E-06	9.910E-02	0.000E+00	0.000E+00	0.000E+00	3.897E-01	0.000E+00	4.898E+01
3	2.00	795.000	275.2	8.133E+21	5.397E-06	6.210E-02	0.000E+00	0.000E+00	0.000E+00	2.405E-01	0.000E+00	5.194E+01
4	3.00	701.200	268.7	4.567E+21	5.565E-06	0.000E+00	3.460E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.071E+01
5	4.00	616.600	262.2	2.518E+21	5.623E-06	0.000E+00	1.850E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.004E+01
6	5.00	540.500	255.7	1.318E+21	5.556E-06	0.000E+00	9.310E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.836E+01
7	6.00	472.200	249.2	7.018E+20	5.670E-06	0.000E+00	7.710E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.918E+01
8	7.00	411.100	242.7	3.468E+20	5.754E-06	0.000E+00	6.230E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.814E+01
9	8.00	356.500	236.2	1.765E+20	5.656E-06	0.000E+00	3.370E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.054E+01
10	9.00	308.000	229.7	6.016E+19	5.531E-06	0.000E+00	1.820E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.708E+01
11	10.00	265.000	223.3	2.083E+19	5.567E-06	0.000E+00	1.140E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.869E+01
12	11.00	227.000	216.8	8.374E+18	5.702E-06	0.000E+00	0.000E+00	7.990E-04	0.000E+00	0.000E+00	0.000E+00	2.743E+01
13	12.00	194.000	216.7	3.230E+18	5.816E-06	0.000E+00	0.000E+00	6.410E-04	0.000E+00	0.000E+00	0.000E+00	1.252E+01
14	13.00	165.800	216.7	1.343E+18	5.693E-06	0.000E+00	0.000E+00	5.170E-04	0.000E+00	0.000E+00	0.000E+00	6.092E+00
15	14.00	141.700	216.7	5.356E+17	5.870E-06	0.000E+00	0.000E+00	4.420E-04	0.000E+00	0.000E+00	0.000E+00	2.844E+00
16	15.00	121.100	216.7	3.301E+17	6.809E-06	0.000E+00	0.000E+00	3.950E-04	0.000E+00	0.000E+00	0.000E+00	2.050E+00
17	16.00	103.500	216.7	1.905E+17	9.489E-06	0.000E+00	0.000E+00	3.820E-04	0.000E+00	0.000E+00	0.000E+00	1.384E+00
18	17.00	88.500	216.7	1.358E+17	1.442E-05	0.000E+00	0.000E+00	4.250E-04	0.000E+00	0.000E+00	0.000E+00	1.154E+00
19	18.00	75.650	216.7	9.855E+16	1.986E-05	0.000E+00	0.000E+00	5.200E-04	0.000E+00	0.000E+00	0.000E+00	9.798E-01
20	19.00	64.670	216.7	7.249E+16	2.550E-05	0.000E+00	0.000E+00	5.810E-04	0.000E+00	0.000E+00	0.000E+00	8.431E-01
21	20.00	55.290	216.7	5.358E+16	2.889E-05	0.000E+00	0.000E+00	5.890E-04	0.000E+00	0.000E+00	0.000E+00	7.302E-01
22	21.00	47.290	217.6	3.969E+16	2.894E-05	0.000E+00	0.000E+00	5.020E-04	0.000E+00	0.000E+00	0.000E+00	5.702E-01
23	22.00	40.470	218.6	2.946E+16	2.725E-05	0.000E+00	0.000E+00	4.200E-04	0.000E+00	0.000E+00	0.000E+00	4.422E-01
24	23.00	34.670	219.6	2.213E+16	2.443E-05	0.000E+00	0.000E+00	3.000E-04	0.000E+00	0.000E+00	0.000E+00	3.472E-01
25	24.00	29.720	220.6	1.650E+16	2.121E-05	0.000E+00	0.000E+00	1.980E-04	0.000E+00	0.000E+00	0.000E+00	2.707E-01
26	25.00	25.490	221.6	1.238E+16	1.740E-05	0.000E+00	0.000E+00	1.310E-04	0.000E+00	0.000E+00	0.000E+00	2.125E-01
27	30.00	11.970	226.5	2.790E+15	5.328E-06	0.000E+00	0.000E+00	3.320E-05	0.000E+00	0.000E+00	0.000E+00	6.101E-02
28	35.00	5.746	236.5	6.115E+14	1.074E-06	0.000E+00	0.000E+00	0.000E+00	1.640E-05	0.000E+00	0.000E+00	1.056E-02
29	40.00	2.871	250.4	1.397E+14	1.647E-07	0.000E+00	0.000E+00	0.000E+00	7.990E-06	0.000E+00	0.000E+00	1.460E-03
30	45.00	1.491	264.2	3.518E+13	1.841E-08	0.000E+00	0.000E+00	0.000E+00	4.010E-06	0.000E+00	0.000E+00	2.502E-04
31	50.00	.798	270.7	9.595E+12	4.409E-09	0.000E+00	0.000E+00	0.000E+00	2.100E-06	0.000E+00	0.000E+00	8.159E-05
32	70.00	.052	219.6	4.181E+10	2.095E-10	0.000E+00	0.000E+00	0.000E+00	1.600E-07	0.000E+00	0.000E+00	4.357E-04
33	100.00	.000	195.1	2.275E+05	1.207E-12	0.000E+00	0.000E+00	0.000E+00	9.310E-10	0.000E+00	0.000E+00	8.646E-06

Table 20. Program Output for Case 4 (Cont.)

ATMOSPHERIC PROFILES

(IF A MOLECULE HAS MORE THAN ONE BAND, THEN THE DATA FOR THE FIRST BAND ARE SHOWN.)

I	Z (KM)	P (MB)	T (K)	H2O G/CM**2/KM	O3 (	CO2	CO	CH4 ATM CM/KM	N2O	O2	NH3	NO	NO2	SO2)
1	.00	1013.000	283.2	5.79E-01	2.34E-03	3.53E+01	1.37E-02	1.65E-01	2.88E-02	1.69E+04	4.97E-05	2.91E-05	2.18E-06	2.66E-05
2	1.00	898.800	281.7	3.69E-01	2.30E-03	2.81E+01	1.11E-02	1.36E-01	2.55E-02	1.42E+04	4.01E-05	2.46E-05	1.89E-06	2.19E-05
3	2.00	795.000	275.2	2.28E-01	2.25E-03	2.22E+01	9.01E-03	1.12E-01	2.26E-02	1.19E+04	2.99E-05	2.06E-05	1.63E-06	1.69E-05
4	3.00	701.200	268.7	1.26E-01	2.04E-03	1.75E+01	7.25E-03	9.13E-02	1.99E-02	9.96E+03	1.96E-05	1.72E-05	1.40E-06	1.22E-05
5	4.00	616.600	262.2	6.84E-02	1.84E-03	1.37E+01	5.87E-03	7.43E-02	1.75E-02	8.29E+03	1.13E-05	1.44E-05	1.19E-06	8.40E-06
6	5.00	540.500	255.7	3.53E-02	1.81E-03	1.06E+01	4.82E-03	6.01E-02	1.53E-02	6.87E+03	6.61E-06	1.19E-05	1.02E-06	6.06E-06
7	6.00	472.200	249.2	1.85E-02	1.73E-03	8.21E+00	3.92E-03	4.84E-02	1.33E-02	5.66E+03	3.72E-06	9.81E-06	8.64E-07	4.43E-06
8	7.00	411.100	242.7	9.00E-03	1.84E-03	6.30E+00	3.11E-03	3.88E-02	1.16E-02	4.64E+03	1.96E-06	8.05E-06	7.30E-07	3.36E-06
9	8.00	356.500	236.2	4.51E-03	1.91E-03	4.80E+00	2.41E-03	3.08E-02	1.00E-02	3.79E+03	9.96E-07	6.57E-06	6.14E-07	2.58E-06
10	9.00	308.000	229.7	1.51E-03	2.56E-03	3.63E+00	1.80E-03	2.43E-02	8.66E-03	3.07E+03	4.47E-07	5.34E-06	5.18E-07	2.07E-06
11	10.00	265.000	223.3	5.16E-04	3.16E-03	2.72E+00	1.32E-03	1.90E-02	7.40E-03	2.47E+03	1.84E-07	4.31E-06	4.43E-07	1.68E-06
12	11.00	227.000	216.8	2.04E-04	4.46E-03	2.03E+00	9.53E-04	1.47E-02	6.25E-03	1.98E+03	7.50E-08	3.45E-06	4.04E-07	1.40E-06
13	12.00	194.000	216.7	7.88E-05	5.14E-03	1.56E+00	6.31E-04	1.12E-02	4.96E-03	1.41E+03	3.27E-08	2.72E-06	3.90E-07	1.10E-06
14	13.00	165.800	216.7	3.29E-05	5.11E-03	1.20E+00	3.90E-04	8.45E-03	3.94E-03	9.99E+02	1.22E-08	2.13E-06	4.43E-07	8.99E-07
15	14.00	141.700	216.7	1.32E-05	5.35E-03	9.22E-01	2.33E-04	6.38E-03	3.12E-03	7.08E+02	3.27E-09	1.65E-06	5.98E-07	7.41E-07
16	15.00	121.100	216.7	8.13E-06	5.54E-03	7.09E-01	1.39E-04	4.81E-03	2.47E-03	5.02E+02	9.91E-10	1.25E-06	1.10E-06	6.16E-07
17	16.00	103.500	216.7	4.71E-06	5.93E-03	5.46E-01	8.20E-05	3.62E-03	1.94E-03	3.56E+02	3.53E-10	9.30E-07	1.64E-06	5.03E-07
18	17.00	88.500	216.7	3.36E-06	6.47E-03	4.20E-01	5.05E-05	2.72E-03	1.51E-03	2.53E+02	1.39E-10	6.89E-07	2.15E-06	3.83E-07
19	18.00	75.650	216.7	2.45E-06	6.93E-03	3.23E-01	3.03E-05	2.04E-03	1.17E-03	1.79E+02	6.36E-11	5.16E-07	2.57E-06	2.79E-07
20	19.00	64.670	216.7	1.81E-06	7.09E-03	2.49E-01	1.81E-05	1.51E-03	8.92E-04	1.27E+02	2.84E-11	4.13E-07	2.83E-06	1.89E-07
21	20.00	55.290	216.7	1.34E-06	7.21E-03	1.91E-01	1.18E-05	1.11E-03	6.72E-04	9.03E+01	1.30E-11	3.40E-07	2.99E-06	1.24E-07
22	21.00	47.290	217.6	9.98E-07	6.71E-03	1.48E-01	8.25E-06	8.09E-04	4.99E-04	6.31E+01	7.82E-12	2.90E-07	3.03E-06	8.39E-08
23	22.00	40.470	218.6	7.45E-07	6.41E-03	1.15E-01	6.22E-06	5.80E-04	3.73E-04	4.41E+01	5.29E-12	2.53E-07	2.98E-06	5.80E-08
24	23.00	34.670	219.6	5.63E-07	5.82E-03	8.93E-02	4.99E-06	4.15E-04	2.86E-04	3.09E+01	3.70E-12	2.34E-07	2.85E-06	4.27E-08
25	24.00	29.720	220.6	4.22E-07	5.13E-03	6.94E-02	4.05E-06	2.99E-04	2.19E-04	2.16E+01	2.54E-12	2.31E-07	2.72E-06	3.18E-08
26	25.00	25.490	221.6	3.19E-07	4.52E-03	5.40E-02	3.28E-06	2.16E-04	1.64E-04	1.52E+01	1.64E-12	2.77E-07	2.67E-06	2.37E-08
27	30.00	11.970	226.5	7.39E-08	1.88E-03	1.57E-02	9.54E-07	5.06E-05	4.48E-05	2.66E+00	2.17E-13	3.09E-07	1.50E-06	6.51E-09
28	35.00	5.746	236.5	1.69E-08	7.14E-04	4.87E-03	2.87E-07	1.15E-05	9.82E-06	4.51E-01	1.65E-14	2.87E-07	6.11E-07	1.98E-09
29	40.00	2.871	250.4	4.07E-09	2.17E-04	1.64E-03	9.55E-08	2.55E-06	1.64E-06	7.87E-02	7.58E-16	1.51E-07	1.22E-07	8.32E-10
30	45.00	1.491	264.2	1.08E-09	5.40E-05	5.87E-04	3.57E-08	5.18E-07	2.12E-07	1.52E-02	2.35E-17	5.65E-08	1.32E-08	4.88E-10
31	50.00	.798	270.7	3.02E-10	1.24E-05	2.13E-04	1.62E-08	1.01E-07	2.55E-08	3.50E-03	1.82E-18	1.89E-08	2.03E-09	3.49E-10
32	70.00	.052	219.6	1.20E-12	4.12E-08	1.72E-06	1.27E-09	7.61E-10	2.16E-10	2.06E-05	4.89E-21	3.67E-10	2.94E-11	1.98E-11
33	100.00	.000	195.1	6.67E-18	5.25E-11	1.77E-10	1.10E-11	1.05E-13	7.00E-14	3.65E-10	2.93E-25	2.97E-11	1.98E-14	2.92E-16

CASE 3A: GIVEN H1,H2=SPACE,ANGLE

SLANT PATH PARAMETERS IN STANDARD FORM

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H1     =      .000 KM
H2     =   100.000 KM
ANGLE  =    60.000 DEG
PHI    =   121.474 DEG
HMIN   =      .000 KM
LEN    =         0
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Table 20. Program Output for Case 4 (Cont.)

CALCULATION OF THE REFRACTED PATH THROUGH THE ATMOSPHERE

I	ALTITUDE FROM (KM)	ALTITUDE TO (KM)	THETA (DEG)	DRANGE (KM)	RANGE (KM)	DBETA (DEG)	BETA (DEG)	PHI (DEG)	DBEND (DEG)	BENDING (DEG)	PBAR (MB)	TBAR (K)	RHOBAR (GM CM-3)
	H1 TO H2												
1	.000	1.000	60.000	2.000	2.000	.016	.016	120.013	.002	.002	955.683	284.99	1.17E-03
2	1.000	2.000	59.987	1.999	3.998	.016	.031	120.026	.002	.005	846.698	278.49	1.06E-03
3	2.000	3.000	59.974	1.998	5.996	.016	.047	120.040	.002	.007	747.913	271.99	9.57E-04
4	3.000	4.000	59.960	1.997	7.994	.016	.062	120.053	.002	.009	658.727	265.49	8.63E-04
5	4.000	5.000	59.947	1.996	9.990	.016	.078	120.067	.002	.011	578.391	258.99	7.77E-04
6	5.000	6.000	59.933	1.996	11.986	.016	.093	120.081	.002	.012	506.204	252.50	6.98E-04
7	6.000	7.000	59.919	1.995	13.980	.016	.109	120.095	.002	.014	441.516	246.00	6.24E-04
8	7.000	8.000	59.905	1.994	15.974	.015	.124	120.109	.001	.015	383.677	239.50	5.57E-04
9	8.000	9.000	59.891	1.993	17.967	.015	.140	120.123	.001	.017	332.137	233.00	4.96E-04
10	9.000	10.000	59.877	1.992	19.959	.015	.155	120.137	.001	.018	286.399	226.55	4.40E-04
11	10.000	11.000	59.863	1.991	21.951	.015	.171	120.152	.001	.019	245.907	220.10	3.89E-04
12	11.000	12.000	59.848	1.990	23.941	.015	.186	120.166	.001	.020	210.499	216.75	3.38E-04
13	12.000	13.000	59.834	1.990	25.931	.015	.202	120.180	.001	.021	179.900	216.70	2.89E-04
14	13.000	14.000	59.820	1.989	27.919	.015	.217	120.195	.001	.022	153.750	216.70	2.47E-04
15	14.000	15.000	59.805	1.988	29.907	.015	.232	120.210	.001	.023	131.400	216.70	2.11E-04
16	15.000	16.000	59.790	1.987	31.894	.015	.248	120.224	.001	.023	112.300	216.70	1.80E-04
17	16.000	17.000	59.776	1.986	33.880	.015	.263	120.239	.001	.024	96.000	216.70	1.54E-04
18	17.000	18.000	59.761	1.985	35.865	.015	.279	120.254	.000	.024	82.075	216.70	1.32E-04
19	18.000	19.000	59.746	1.984	37.850	.015	.294	120.269	.000	.025	70.160	216.70	1.13E-04
20	19.000	20.000	59.731	1.983	39.833	.015	.309	120.284	.000	.025	59.980	216.70	9.62E-05
21	20.000	21.000	59.716	1.983	41.816	.015	.325	120.299	.000	.025	51.293	217.14	8.21E-05
22	21.000	22.000	59.701	1.982	43.797	.015	.340	120.314	.000	.026	43.883	218.09	7.00E-05
23	22.000	23.000	59.686	1.981	45.778	.015	.355	120.330	.000	.026	37.572	219.09	5.96E-05
24	23.000	24.000	59.670	1.980	47.758	.015	.371	120.345	.000	.026	32.197	220.09	5.09E-05
25	24.000	25.000	59.655	1.979	49.737	.015	.386	120.360	.000	.026	27.607	221.09	4.34E-05
26	25.000	30.000	59.640	9.881	59.618	.076	.462	120.436	.000	.027	13.756	223.73	2.79E-05
27	30.000	35.000	59.564	9.859	69.478	.076	.538	120.511	.000	.027	8.881	230.82	1.28E-05
28	35.000	40.000	59.489	9.837	79.315	.076	.614	120.587	.000	.027	4.322	242.52	5.95E-06
29	40.000	45.000	59.413	9.815	89.130	.075	.689	120.663	.000	.027	2.187	256.43	2.86E-06
30	45.000	50.000	59.337	9.793	98.923	.075	.765	120.738	.000	.027	1.146	267.09	1.45E-06
31	50.000	70.000	59.262	38.960	137.884	.298	1.062	121.036	.000	.027	.415	254.10	3.76E-07
32	70.000	100.000	58.964	57.820	195.704	.439	1.501	121.474	.000	.027	.026	214.68	1.66E-08

CUMULATIVE ABSORBER AMOUNTS FOR THE PATH FROM H1 TO Z

J	Z (KM)	TBAR (K)	HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	O2 (MOL CM-2)
1	1.000	284.99	9.862E-06	5.037E-03	2.271E+20	6.945E+19	3.254E+22	6.262E+04
2	2.000	278.49	2.038E-05	1.007E-02	3.390E+20	1.239E+20	5.327E+22	1.173E+05
3	3.000	271.99	3.133E-05	1.492E-02	3.877E+20	1.564E+20	6.562E+22	1.649E+05
4	4.000	265.49	4.250E-05	1.939E-02	4.062E+20	1.720E+20	7.249E+22	2.064E+05
5	5.000	258.99	5.366E-05	2.367E-02	4.128E+20	1.787E+20	7.619E+22	2.425E+05
6	6.000	252.50	6.486E-05	2.791E-02	4.151E+20	1.810E+20	7.814E+22	2.738E+05
7	7.000	246.00	7.625E-05	3.223E-02	4.159E+20	1.817E+20	7.915E+22	3.011E+05
8	8.000	239.50	8.763E-05	3.699E-02	4.161E+20	1.819E+20	7.965E+22	3.247E+05
9	9.000	233.00	9.877E-05	4.269E-02	4.162E+20	1.820E+20	7.986E+22	3.452E+05
10	10.000	226.55	1.098E-04	5.017E-02	4.162E+20	1.820E+20	7.994E+22	3.629E+05
11	11.000	220.10	1.210E-04	6.039E-02	4.162E+20	1.820E+20	7.997E+22	3.781E+05
12	12.000	216.75	1.325E-04	7.385E-02	4.162E+20	1.820E+20	7.998E+22	3.910E+05
13	13.000	216.70	1.440E-04	8.916E-02	4.162E+20	1.820E+20	7.998E+22	4.018E+05

Table 20. Program Output for Case 4 (Cont.)

14	14.000	216.70	1.555E-04	1.059E-01	4.162E+20	1.820E+20	7.998E+22	4.109E+05
15	15.000	216.70	1.681E-04	1.244E-01	4.162E+20	1.820E+20	7.998E+22	4.185E+05
16	16.000	216.70	1.843E-04	1.452E-01	4.162E+20	1.820E+20	7.998E+22	4.248E+05
17	17.000	216.70	2.080E-04	1.693E-01	4.162E+20	1.820E+20	7.998E+22	4.302E+05
18	18.000	216.70	2.420E-04	1.971E-01	4.162E+20	1.820E+20	7.998E+22	4.348E+05
19	19.000	216.70	2.870E-04	2.281E-01	4.162E+20	1.820E+20	7.998E+22	4.386E+05
20	20.000	216.70	3.410E-04	2.619E-01	4.162E+20	1.820E+20	7.998E+22	4.419E+05
21	21.000	217.14	3.983E-04	2.970E-01	4.162E+20	1.820E+20	7.999E+22	4.446E+05
22	22.000	218.09	4.540E-04	3.326E-01	4.162E+20	1.820E+20	7.999E+22	4.469E+05
23	23.000	219.09	5.051E-04	3.682E-01	4.162E+20	1.820E+20	7.999E+22	4.489E+05
24	24.000	220.09	5.502E-04	4.023E-01	4.162E+20	1.820E+20	7.999E+22	4.506E+05
25	25.000	221.09	5.883E-04	4.346E-01	4.162E+20	1.820E+20	7.999E+22	4.520E+05
26	30.000	223.73	6.891E-04	5.563E-01	4.162E+20	1.820E+20	7.999E+22	4.565E+05
27	35.000	230.82	7.153E-04	6.255E-01	4.162E+20	1.820E+20	7.999E+22	4.586E+05
28	40.000	242.52	7.200E-04	6.599E-01	4.162E+20	1.820E+20	7.999E+22	4.595E+05
29	45.000	256.43	7.207E-04	6.737E-01	4.162E+20	1.820E+20	7.999E+22	4.600E+05
30	50.000	267.09	7.208E-04	6.783E-01	4.162E+20	1.820E+20	7.999E+22	4.602E+05
31	70.000	254.10	7.208E-04	6.802E-01	4.162E+20	1.820E+20	7.999E+22	4.605E+05
32	100.000	214.68	7.208E-04	6.803E-01	4.162E+20	1.820E+20	7.999E+22	4.605E+05

J	Z (KM)	N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS
1	1.000	1.302E+00	1.806E+00	2.525E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	2.000	2.360E+00	3.442E+00	4.107E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3	3.000	3.215E+00	4.922E+00	4.728E-01	3.457E-02	0.000E+00	0.000E+00	0.000E+00
4	4.000	3.902E+00	6.256E+00	4.728E-01	8.592E-02	0.000E+00	0.000E+00	0.000E+00
5	5.000	4.451E+00	7.457E+00	4.728E-01	1.126E-01	0.000E+00	0.000E+00	0.000E+00
6	6.000	4.888E+00	8.534E+00	4.728E-01	1.296E-01	0.000E+00	0.000E+00	0.000E+00
7	7.000	5.234E+00	9.498E+00	4.728E-01	1.434E-01	0.000E+00	0.000E+00	0.000E+00
8	8.000	5.505E+00	1.036E+01	4.728E-01	1.527E-01	0.000E+00	0.000E+00	0.000E+00
9	9.000	5.717E+00	1.112E+01	4.728E-01	1.577E-01	0.000E+00	0.000E+00	0.000E+00
10	10.000	5.882E+00	1.180E+01	4.728E-01	1.606E-01	0.000E+00	0.000E+00	0.000E+00
11	11.000	6.008E+00	1.240E+01	4.728E-01	1.618E-01	7.955E-04	0.000E+00	0.000E+00
12	12.000	6.103E+00	1.292E+01	4.728E-01	1.618E-01	2.223E-03	0.000E+00	0.000E+00
13	13.000	6.172E+00	1.336E+01	4.728E-01	1.618E-01	3.370E-03	0.000E+00	0.000E+00
14	14.000	6.222E+00	1.374E+01	4.728E-01	1.618E-01	4.322E-03	0.000E+00	0.000E+00
15	15.000	6.259E+00	1.407E+01	4.728E-01	1.618E-01	5.153E-03	0.000E+00	0.000E+00
16	16.000	6.286E+00	1.434E+01	4.728E-01	1.618E-01	5.925E-03	0.000E+00	0.000E+00
17	17.000	6.306E+00	1.458E+01	4.728E-01	1.618E-01	6.726E-03	0.000E+00	0.000E+00
18	18.000	6.320E+00	1.478E+01	4.728E-01	1.618E-01	7.664E-03	0.000E+00	0.000E+00
19	19.000	6.331E+00	1.495E+01	4.728E-01	1.618E-01	8.757E-03	0.000E+00	0.000E+00
20	20.000	6.338E+00	1.510E+01	4.728E-01	1.618E-01	9.917E-03	0.000E+00	0.000E+00
21	21.000	6.344E+00	1.523E+01	4.728E-01	1.618E-01	1.100E-02	0.000E+00	0.000E+00
22	22.000	6.348E+00	1.534E+01	4.728E-01	1.618E-01	1.191E-02	0.000E+00	0.000E+00
23	23.000	6.351E+00	1.543E+01	4.728E-01	1.618E-01	1.261E-02	0.000E+00	0.000E+00
24	24.000	6.353E+00	1.551E+01	4.728E-01	1.618E-01	1.310E-02	0.000E+00	0.000E+00
25	25.000	6.355E+00	1.557E+01	4.728E-01	1.618E-01	1.342E-02	0.000E+00	0.000E+00
26	30.000	6.358E+00	1.579E+01	4.728E-01	1.618E-01	1.412E-02	0.000E+00	0.000E+00
27	35.000	6.359E+00	1.588E+01	4.728E-01	1.618E-01	1.429E-02	8.082E-05	0.000E+00
28	40.000	6.359E+00	1.593E+01	4.728E-01	1.618E-01	1.429E-02	1.959E-04	0.000E+00
29	45.000	6.359E+00	1.595E+01	4.728E-01	1.618E-01	1.429E-02	2.526E-04	0.000E+00
30	50.000	6.359E+00	1.596E+01	4.728E-01	1.618E-01	1.429E-02	2.815E-04	0.000E+00
31	70.000	6.359E+00	1.597E+01	4.728E-01	1.618E-01	1.429E-02	3.109E-04	0.000E+00
32	100.000	6.359E+00	1.597E+01	4.728E-01	1.618E-01	1.429E-02	3.127E-04	0.000E+00

J	Z (KM)	H2O (G/CM**2)	O3 (	CO2	CO	CH4	N2O ATM CM	O2	NH3	NO	NO2	SO2)

Table 20. Program Output for Case 4 (Cont.)

1	1.00	9.32E-01	4.63E-03	6.30E+01	2.47E-02	3.00E-01	5.43E-02	3.10E+04	8.95E-05	5.36E-05	4.06E-06	4.83E-05
2	2.00	1.52E+00	9.18E-03	1.13E+02	4.48E-02	5.46E-01	1.02E-01	5.71E+04	1.59E-04	9.86E-05	7.57E-06	8.69E-05
3	3.00	1.86E+00	1.35E-02	1.52E+02	6.10E-02	7.48E-01	1.45E-01	7.69E+04	2.08E-04	1.36E-04	1.06E-05	1.16E-04
4	4.00	2.05E+00	1.73E-02	1.83E+02	7.40E-02	9.13E-01	1.82E-01	9.70E+04	2.38E-04	1.68E-04	1.32E-05	1.36E-04
5	5.00	2.15E+00	2.10E-02	2.08E+02	8.47E-02	1.05E+00	2.14E-01	1.12E+05	2.56E-04	1.94E-04	1.54E-05	1.50E-04
6	6.00	2.20E+00	2.45E-02	2.26E+02	9.34E-02	1.15E+00	2.43E-01	1.25E+05	2.66E-04	2.15E-04	1.72E-05	1.61E-04
7	7.00	2.23E+00	2.81E-02	2.41E+02	1.00E-01	1.24E+00	2.68E-01	1.35E+05	2.72E-04	2.33E-04	1.88E-05	1.69E-04
8	8.00	2.24E+00	3.18E-02	2.52E+02	1.06E-01	1.31E+00	2.89E-01	1.43E+05	2.75E-04	2.48E-04	2.02E-05	1.74E-04
9	9.00	2.25E+00	3.63E-02	2.60E+02	1.10E-01	1.36E+00	3.08E-01	1.50E+05	2.76E-04	2.60E-04	2.13E-05	1.79E-04
10	10.00	2.25E+00	4.20E-02	2.66E+02	1.13E-01	1.41E+00	3.24E-01	1.56E+05	2.77E-04	2.69E-04	2.22E-05	1.83E-04
11	11.00	2.25E+00	4.96E-02	2.71E+02	1.15E-01	1.44E+00	3.37E-01	1.60E+05	2.77E-04	2.77E-04	2.31E-05	1.86E-04
12	12.00	2.25E+00	5.91E-02	2.74E+02	1.17E-01	1.47E+00	3.49E-01	1.63E+05	2.77E-04	2.83E-04	2.39E-05	1.88E-04
13	13.00	2.25E+00	6.93E-02	2.77E+02	1.18E-01	1.49E+00	3.57E-01	1.66E+05	2.77E-04	2.88E-04	2.47E-05	1.90E-04
14	14.00	2.25E+00	7.97E-02	2.79E+02	1.18E-01	1.50E+00	3.64E-01	1.67E+05	2.77E-04	2.92E-04	2.57E-05	1.92E-04
15	15.00	2.25E+00	9.06E-02	2.81E+02	1.19E-01	1.51E+00	3.70E-01	1.69E+05	2.77E-04	2.94E-04	2.74E-05	1.93E-04
16	16.00	2.25E+00	1.02E-01	2.82E+02	1.19E-01	1.52E+00	3.74E-01	1.69E+05	2.77E-04	2.97E-04	3.01E-05	1.94E-04
17	17.00	2.25E+00	1.14E-01	2.83E+02	1.19E-01	1.53E+00	3.76E-01	1.70E+05	2.77E-04	2.98E-04	3.39E-05	1.95E-04
18	18.00	2.25E+00	1.28E-01	2.84E+02	1.19E-01	1.53E+00	3.80E-01	1.70E+05	2.77E-04	2.99E-04	3.86E-05	1.96E-04
19	19.00	2.25E+00	1.41E-01	2.84E+02	1.19E-01	1.53E+00	3.82E-01	1.71E+05	2.77E-04	3.00E-04	4.40E-05	1.96E-04
20	20.00	2.25E+00	1.56E-01	2.85E+02	1.19E-01	1.54E+00	3.84E-01	1.71E+05	2.77E-04	3.01E-04	4.97E-05	1.97E-04
21	21.00	2.25E+00	1.69E-01	2.85E+02	1.19E-01	1.54E+00	3.85E-01	1.71E+05	2.77E-04	3.02E-04	5.57E-05	1.97E-04
22	22.00	2.25E+00	1.82E-01	2.85E+02	1.19E-01	1.54E+00	3.86E-01	1.71E+05	2.77E-04	3.02E-04	6.16E-05	1.97E-04
23	23.00	2.25E+00	1.95E-01	2.86E+02	1.19E-01	1.54E+00	3.87E-01	1.71E+05	2.77E-04	3.03E-04	6.74E-05	1.97E-04
24	24.00	2.25E+00	2.05E-01	2.86E+02	1.19E-01	1.54E+00	3.87E-01	1.71E+05	2.77E-04	3.03E-04	7.29E-05	1.97E-04
25	25.00	2.25E+00	2.15E-01	2.86E+02	1.19E-01	1.54E+00	3.87E-01	1.71E+05	2.77E-04	3.04E-04	7.82E-05	1.97E-04
26	30.00	2.25E+00	2.45E-01	2.86E+02	1.19E-01	1.54E+00	3.88E-01	1.71E+05	2.77E-04	3.06E-04	9.83E-05	1.97E-04
27	35.00	2.25E+00	2.56E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.09E-04	1.08E-04	1.97E-04
28	40.00	2.25E+00	2.61E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.12E-04	1.11E-04	1.97E-04
29	45.00	2.25E+00	2.62E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.12E-04	1.12E-04	1.97E-04
30	50.00	2.25E+00	2.62E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.13E-04	1.12E-04	1.97E-04
31	70.00	2.25E+00	2.62E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.13E-04	1.12E-04	1.97E-04
32	100.00	2.25E+00	2.62E-01	2.86E+02	1.19E-01	1.54E+00	3.89E-01	1.71E+05	2.77E-04	3.13E-04	1.12E-04	1.97E-04

SUMMARY OF THE GEOMETRY CALCULATION

```
H1      =      .000 KM
H2      =   100.000 KM
ANGLE   =    60.000 DEG
RANGE   =   195.704 KM
BETA    =     1.501 DEG
PHI     =   121.474 DEG
HMIN    =      .000 KM
BENDING =      .027 DEG
LEN     =         0
```

EQUIVALENT SEA LEVEL TOTAL ABSORBER AMOUNTS

HNO3 (ATM CM)	O3 UV (ATM CM)	CNTMSLF1 (MOL CM-2)	CNTMSLF2 (MOL CM-2)	CNTMFRN (MOL CM-2)	(MOL CM-2)
7.208E-04	6.803E-01	4.162E+20	1.820E+20	7.999E+22	

N2 CONT	MOL SCAT	AER 1	AER 2	AER 3	AER 4	CIRRUS	MEAN RH (PRCNT)
6.359E+00	1.597E+01	4.728E-01	1.618E-01	1.429E-02	3.127E-04	0.000E+00	48.98

Table 20. Program Output for Case 4 (Cont.)

H2O (G/CM**2)	O3 (	CO2	CO ATM CM	CH4	N2O	O2)
2.246E+00	2.621E-01	2.863E+02	1.194E-01	1.544E+00	3.886E-01	1.714E+05

NH3 (	NO ATM CM	NO2	SO2)
2.769E-04	3.130E-04	1.116E-04	1.975E-04

Table 20. Program Output for Case 4 (Cont.)

IRRADIANCE (WATTS/CM2-XXXX)

FREQ	WAVLEN	TRANSMITTED		SOLAR		INTEGRATED		TOTAL
(CM-1)	(MICRN)	(CM-1)	(MICRN)	(CM-1)	(MICRN)	TRANS.	SOLAR	TRANS
6000.	1.667	5.33E-06	1.92E-02	6.46E-06	2.32E-02	5.33E-05	6.46E-05	.8248
6020.	1.661	5.38E-06	1.95E-02	6.51E-06	2.36E-02	1.61E-04	1.95E-04	.8273
6040.	1.656	5.34E-06	1.95E-02	6.48E-06	2.36E-02	2.68E-04	3.24E-04	.8232
6060.	1.650	5.27E-06	1.94E-02	6.46E-06	2.37E-02	3.73E-04	4.53E-04	.8164
6080.	1.645	5.25E-06	1.94E-02	6.41E-06	2.37E-02	4.78E-04	5.82E-04	.8191
6100.	1.639	5.28E-06	1.97E-02	6.41E-06	2.38E-02	5.84E-04	7.10E-04	.8249
6120.	1.634	5.43E-06	2.03E-02	6.47E-06	2.42E-02	6.92E-04	8.39E-04	.8388
6140.	1.629	5.51E-06	2.08E-02	6.52E-06	2.46E-02	8.02E-04	9.70E-04	.8448
6160.	1.623	5.42E-06	2.06E-02	6.43E-06	2.44E-02	9.11E-04	1.10E-03	.8433
6180.	1.618	5.30E-06	2.02E-02	6.41E-06	2.45E-02	1.02E-03	1.23E 03	.8260
6200.	1.613	5.11E-06	1.97E-02	6.41E-06	2.46E-02	1.12E-03	1.35E-03	.7980
6220.	1.608	4.95E-06	1.91E-02	6.35E-06	2.45E-02	1.22E-03	1.48E-03	.7796
6240.	1.603	4.91E-06	1.91E-02	6.39E-06	2.49E-02	1.32E-03	1.61E-03	.7685
6260.	1.597	5.15E-06	2.02E-02	6.35E-06	2.49E-02	1.42E-03	1.74E-03	.8117
6280.	1.592	5.27E-06	2.08E-02	6.32E-06	2.49E-02	1.52E-03	1.86E-03	.8329
6300.	1.587	5.32E-06	2.11E-02	6.41E-06	2.54E-02	1.63E-03	1.99E-03	.8298
6320.	1.582	5.18E-06	2.07E-02	6.46E-06	2.58E-02	1.73E-03	2.12E-03	.8010
6340.	1.577	5.04E-06	2.03E-02	6.51E-06	2.62E-02	1.84E-03	2.25E-03	.7746
6360.	1.572	4.92E-06	1.99E-02	6.50E-06	2.63E-02	1.93E-03	2.38E-03	.7568
6380.	1.567	5.29E-06	2.15E-02	6.54E-06	2.66E-02	2.04E-03	2.51E-03	.8091
6400.	1.563	5.53E-06	2.26E-02	6.63E-06	2.72E-02	2.15E-03	2.64E-03	.8332
6420.	1.558	5.58E-06	2.30E-02	6.67E-06	2.75E-02	2.26E-03	2.78E-03	.8371
6440.	1.553	5.54E-06	2.30E-02	6.65E-06	2.76E-02	2.37E-03	2.91E-03	.8327
6460.	1.548	5.51E-06	2.30E-02	6.64E-06	2.77E-02	2.48E-03	3.04E-03	.8301
6480.	1.543	5.38E-06	2.26E 02	6.61E-06	2.78E-02	2.59E-03	3.18E-03	.8129
6500.	1.538	5.28E-06	2.23E-02	6.57E-06	2.77E-02	2.70E-03	3.31E-03	.8046
6520.	1.534	5.25E-06	2.23E-02	6.65E-06	2.83E-02	2.80E-03	3.44E-03	.7898
6540.	1.529	5.28E-06	2.26E-02	6.80E-06	2.91E-02	2.91E-03	3.58E-03	.7765
6560.	1.524	5.20E-06	2.24E-02	6.76E-06	2.91E-02	3.01E-03	3.71E-03	.7690
6580.	1.520	4.97E-06	2.15E-02	6.72E-06	2.91E-02	3.11E-03	3.85E-03	.7393
6600.	1.515	4.72E-06	2.06E-02	6.73E-06	2.93E-02	3.20E-03	3.98E-03	.7019
6620.	1.511	4.55E-06	2.00E-02	6.73E-06	2.95E-02	3.30E-03	4.11E-03	.6763
6640.	1.506	4.21E-06	1.86E-02	6.77E-06	2.98E-02	3.38E-03	4.25E-03	.6221
6660.	1.502	4.11E-06	1.83E-02	6.76E-06	3.00E-02	3.46E-03	4.39E-03	.6084
6680.	1.497	3.55E-06	1.58E-02	6.81E-06	3.04E-02	3.53E-03	4.52E-03	.5212
6700.	1.493	2.97E-06	1.33E-02	6.80E-06	3.05E-02	3.59E-03	4.66E-03	.4365
6720.	1.488	1.89E-06	8.52E-03	6.70E-06	3.02E-02	3.63E-03	4.79E-03	.2817
6740.	1.484	1.49E-06	6.76E-03	6.71E-06	3.05E-02	3.66E-03	4.93E-03	.2217
6760.	1.479	1.14E-06	5.23E-03	6.76E-06	3.09E-02	3.68E-03	5.06E-03	.1692
6780.	1 475	1.39E-06	6.41E-03	6.80E-06	3.13E-02	3.71E-03	5.20E-03	.2049
6800.	1.471	5.30E-07	2 45E-03	6.79E-06	3.14E-02	3.72E-03	5.33E-03	.0780
6820.	1.466	8.16E-07	3.79E-03	6.81E-06	3.17E-02	3.74E-03	[illegible]	.1198
6840.	1.462	1.22E-06	5.71E-03	6.80E-06	3.18E-02	3.76E-03	5.60E-03	.1794
6860.	1.458	1.46E-06	6.89E-03	6.65E-06	3.13E-02	3.79E-03	5.74E-03	.2198
6880.	1.453	8.94E-07	4.23E-03	6.81E-06	3.22E-02	3.81E-03	5.87E-03	.1313
6900.	1.449	6.08E-07	2.89E-03	6.81E-06	3.24E-02	3.82E-03	6 01E-03	.0893
6920.	1.445	5.07E-07	2.43E-03	6.79E-06	3.25E-02	3.83E-03	6.15E-03	.0746
6940.	1.441	4.80E-07	2.31E-03	6.90E-06	3.32E-02	3.84E-03	6.28E-03	.0697
6960.	1.437	3.60E-07	1.74E-03	6.92E-06	3.35E-02	3.85E-03	6.42E-03	.0520
6980.	1.433	3.12E-07	1.52E-03	7.00E-06	3.41E-02	3.85E-03	6.56E-03	.0446

Table 20. Program Output for Case 4 (Cont.)

IRRADIANCE (WATTS/CM2-XXXX)

FREQ (CM-1)	WAVLEN (MICRN)	TRANSMITTED (CM-1)	TRANSMITTED (MICRN)	SOLAR (CM-1)	SOLAR (MICRN)	INTEGRATED TRANS.	INTEGRATED SOLAR	TOTAL TRANS
7000.	1.429	3.36E-07	1.94E-03	7.13E-06	3.49E-02	3.86E-03	6.70E-03	.0556
7020.	1.425	3.36E-07	1.66E-03	7.09E-06	3.49E-02	3.87E-03	6.85E-03	.0474
7040.	1.420	2.01E-07	9.98E-04	7.00E-06	3.47E-02	3.87E-03	6.99E-03	.0288
7060.	1.416	1.52E-07	7.57E-04	6.98E-06	3.48E-02	3.88E-03	7.13E-03	.0217
7080.	1.412	6.52E-08	3.27E-04	6.98E-06	3.50E-02	3.88E-03	7.27E-03	.0093
7100.	1.408	1.23E-08	6.20E-05	7.00E-06	3.53E-02	3.88E-03	7.41E-03	.0018
7120.	1.404	5.22E-09	2.65E-05	7.01E-06	3.55E-02	3.88E-03	7.55E-03	.0007
7140.	1.401	1.52E-09	7.75E-06	7.03E-06	3.59E-02	3.88E-03	7.69E-03	.0002
7160.	1.397	7.91E-10	4.06E-06	7.04E-06	3.61E-02	3.88E-03	7.83E-03	.0001
7180.	1.393	9.96E-10	5.13E-06	7.03E-06	3.62E-02	3.88E-03	7.97E-03	.0001
7200.	1.389	1.55E-09	8.02E-06	7.06E-06	3.66E-02	3.88E-03	8.11E-03	.0002
7220.	1.385	3.67E-11	1.91E-07	7.06E-06	3.68E-02	3.88E-03	8.25E-03	.0000
7240.	1.381	1.14E-11	5.96E-08	7.04E-06	3.69E-02	3.88E-03	8.39E-03	.0000
7260.	1.377	1.34E-09	7.07E-06	7.05E-06	3.72E-02	3.88E-03	8.53E-03	.0002
7280.	1.374	1.16E-09	6.17E-06	7.04E-06	3.73E-02	3.88E-03	8.67E-03	.0002
7300.	1.370	4.23E-12	2.25E-08	7.00E-06	3.73E-02	3.88E-03	8.81E-03	.0000
7320.	1.366	4.45E-12	2.38E-08	7.02E-06	3.76E-02	3.88E-03	8.95E-03	.0000
7340.	1.362	7.91E-13	4.26E-09	7.09E-06	3.82E-02	3.88E-03	9.10E-03	.0000
7360.	1.359	4.70E-11	2.55E-07	7.11E-06	3.85E-02	3.88E-03	9.24E-03	.0000
7380.	1.355	1.37E-09	7.47E-06	7.13E-06	3.88E-02	3.88E-03	9.38E-03	.0002
7400.	1.351	3.76E-08	2.06E-04	7.17E-06	3.93E-02	3.88E-03	9.52E-03	.0052
7420.	1.348	3.39E-07	1.87E-03	7.23E-06	3.98E-02	3.89E-03	9.67E-03	.0470
7440.	1.344	1.53E-06	8.45E-03	7.25E-06	4.01E-02	3.92E-03	9.81E-03	.2107
7460.	1.340	2.15E-06	1.20E-02	7.24E-06	4.03E-02	3.96E-03	9.96E-03	.2975
7480.	1.337	2.00E-06	1.12E-02	7.24E-06	4.05E-02	4.00E-03	1.01E-02	.2768
7500.	1.333	1.62E-06	9.11E-03	7.26E-06	4.08E-02	4.02E-03	1.02E-02	.2230

INTEGRATED ABSORPTION FROM 6000 TO 7500 CM-1 = 890.37 CM-1
AVERAGE TRANSMITTANCE = .4064

INTEGRATED RADIANCE = 4.0156-03 WATTS CM-2 STER-1
MINIMUM RADIANCE = 7.913E-13 WATTS CM-2 STER-1 (CM-1)-1 AT 7340.0 CM-1
MAXIMUM RADIANCE = 5.581E-06 WATTS CM-2 STER-1 (CM-1)-1 AT 6420.0 CM-1

CARD 5 ***** 0

selected, the images of their respective control cards are supplied with the parameters set equal to -99. The fifth line of the header is the image of CARD 2C and gives the number of atmospheric layers and title of the atmospheric profile. This information is given for all values of MODEL (0 to 7) even though it is read in only for MODEL = 0 or 7. CARDS 2C1, 2C2, 2C3, 2D1 and 2D2 are not included in the header. Line 6 contains the values of the path parameters on CARD 3 after they have been evaluated. CARDS 3B1 and 3B2 are not included. Lines 7 and 8 are the images of CARDS 3A1 and 3A2, with all the parameters set equal to -99 if the single scattering option is not selected. Line 9 is the image of CARD 4, the frequency card, and line 10 gives the value of IRPT from CARD 5. Line 11 consists of headers for the columns of data to follow.

The following lines contain the spectral output and differ depending on the type of calculation: transmittance, radiance, radiance with single scattering, or directly transmitted solar irradiance. For a transmittance calculation (IEMSCT = 0) each line of spectral data has the following format:

1. frequency (cm^{-1})	F7.0
2. transmittance, total	11F8.4
3. transmittance, water vapor (band type)	
4. transmittance, uniformly mixed gases	
5. transmittance, ozone	
6. transmittance, trace gases	
7. transmittance, nitrogen continuum	
8. transmittance, water vapor continuum	
9. transmittance, molecular scattering	
10. transmittance, aerosol and hydrometeor	
11. transmittance, nitric acid	
12. aerosol and hydrometeor absorptance	
13. Log of the total transmittance	1PE10.3

For a thermal radiance run (IEMSCT = 1) the format is:

1. frequency (cm^{-1})	F7.0
2. transmittance, total	F8.4
3. atmospheric radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	1PE9.2
4. Log of the total transmittance	T96, E10.3

For a radiance case with single scattering or multiple scattering (IEMSCT = 2) the format is:

1. frequency (cm^{-1})	F7.0
2. transmittance, total	F8.4
3. atmospheric radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	1P6E9.2
4. path scattered radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	
5. single scattered radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	
6. total ground reflected radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	
7. direct reflected radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	
8. total radiance (W cm^{-2} $ster^{-1}(cm^{-1})^{-1}$)	
9. TEB1	0P2F8.4
10. TEB2SV	
11. Log of the total transmittance	T96, 1PE10.3

TEB1 is the total transmittance for the L-shaped path from H1 to H2 to the sun. TEB2SV is the total transmittance for the path from H1 to the last boundary before H2 to the sun.
For directly transmitted solar irradiance (IEMSCT = 3) the format is:

1.	frequency (cm^{-1})	F7.0
2.	transmittance, total	F8.4
3.	transmitted solar irradiance (W cm^{-2} $(cm^{-1})^{-1}$)	1PE9.2
4.	incident solar irradiance (W cm^{-2} $(cm^{-1})^{-1}$)	E9.2
5.	Log of the total transmittance	T96, E10.3

The end of the spectral data is marked by a frequency of -9999.

4.5.2 TAPE8 OUTPUT

There are three different types of spectral data sent to UNIT=8, depending on cases run. The first type, printing of the separate transmittances of the molecular absorbers, only occurs with IEMSCT = 0. In this instance the spectral results will be printed as follows: the same 10 line header printed to UNIT = 7 will be sent to UNIT = 8 as well. Two lines of descriptive headers follow. Then the spectral data will have the following format:

1.	frequency (cm^{-1})	F7.0
2.	transmittance, water vapor (band type)	11F8.4
3.	transmittance, ozone	
4.	transmittance, carbon dioxide	
5.	transmittance, carbon monoxide	
6.	transmittance, methane	
7.	transmittance, nitrous oxide	
8.	transmittance, oxygen	
9.	transmittance, ammonia	
10.	transmittance, nitric oxide	
11.	transmittance, nitrogen dioxide	
12.	transmittance, sulphur dioxide	

The end of the spectral data is marked by a frequency of -9999.

The second type, printing of the black body function and differential transmittance for each layer along the line of sight and each frequency, occurs when NOPRT = -1, IEMSCT = 1 or 2, and IMULT = 0. The spectral results are stored as follows: the same 10 line header sent to UNIT = 7 will be sent to UNIT = 8 also. Line 11 is a line of descriptive headers for the data following. The output consists of a line of data for each boundary and repeats this procedure for each spectral frequency. The spectral results have the following format:

1.	frequency (cm^{-1})	F10.0
2.	first altitude of boundary (km)	F7.2
3.	second altitude of boundary (km)	F7.2
4.	black body function (W cm^{-2} $ster^{-1}(\mu m)^{-1}$)	1PE12.5
5.	differential transmittance	E12.5
6.	transmittance, total	F12.9

The third type, printing of the upward and downward, solar and thermal vertical fluxes, and solar irradiances for each layer and each frequency occurs when NOPRT = -1, IEMSCT = 1 or 2 and IMULT = 1. Again the same ten line header sent to UNIT = 7 will be sent to UNIT = 8. The next line consists of descriptive headers for the data to follow. The output consists of a line of data for each layer and repeats this procedure for each spectral frequency. The spectral results have the following format:

1.	frequency (cm^{-1})	F10.0
2.	altitude of layer (km)	F7.2
3.	upward total flux (W cm^{-2} $(\mu m)^{-1}$)	1P5E12.5
4.	upward solar flux (W cm^{-2} $(\mu m)^{-1}$)	1P5E12.5
5.	downward total flux (W cm^{-2} $(\mu m)^{-1}$)	1P5E12.5
6.	downward solar flux (W cm^{-2} $(\mu m)^{-1}$)	1P5E12.5
7.	direct solar irradiance (W cm^{-2} $(\mu m)^{-1}$)	1P5E12.5
8.	transmittance, total	F10.5

The end of the spectral data is marked by a frequency of -9999.

When using this method to output data to UNIT = 8, it is necessary to follow a specific procedure. The position of the sun should be placed directly behind the viewer's back. This is accomplished by choosing the IPARM = 2 option on CARD 3A1 and then setting PARM1 = 180.0 on CARD 3A2. The second requirement is that the sum of the two variables, ANGLE of line of sight (CARD 3) and the solar zenith angle (PARM2 on CARD 3A2), must be equal to 180.0. These procedures are necessary in order to obtain the correct direct solar irradiance.

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Appendix A

LOWTRAN 7 Plot Program

The LOWTRAN 7 plot program, LOWPLT, is an independent program designed to plot the transmittance and/or radiance output of a LOWTRAN 7 run. The program will plot one file of data, several files of data, or the same file of data as many times as desired. Another feature of the plot program is the ability to choose any of the many variables produced by a transmittance run, radiance run, or a radiance with scattering run. Finally, the user is given the option of plotting these variables on individual plots or on the same plot. When plotting different variables on the same plot, it is important to define the proper scale for the Y-axis. The LOWTRAN 7 plot program uses Tape 7 or Tape 8 as generated by a LOWTRAN 7 transmittance run.

This plot program utilizes plot routines unique to the CDC-Cyber CALCOMP plotter. Therefore, some minor changes may be necessary to accommodate a different computer plotting system. (See Section A3 for more details on CALCOMP system differences).

A1. INSTRUCTIONS FOR USING THE LOWTRAN 7 PLOT PROGRAM

The plot program extracts the data to be plotted from Tape 7 or Tape 8. To initiate the progrm five input cards are required.

A1.1 Input Data and Formats

The data necessary to specify a given plot are given by the following five cards:

CARD 1	PROGID, SCALE (FORMAT (3A10, F10.4))
CARD 2	XSIZE, PFRBEG, PFREND, DELTAX, ITYP, IXAXIS, NUMFIL (FORMAT (4F10.4, 3I5))
CARD 3	YSIZE, YRMIN, YRMAX, DELTAY, ICRV, IYAXIS, NMYDEC (FORMAT (F10.4, 3E10.2, 3I5))
CARD 4	IPOS (FORMAT (5I5))
CARD 5	ISAMFL, ISAMPT (FORMAT (2I5))

A1.2 Utilizing Input Cards

To produce multiple plots; input cards 2 through 5 must be repeated. To end plotting; the first value on the following input card 2 should be negative.

Definitions of the input card variables will be discussed in Section A2.

A2. BASIC INSTRUCTIONS

The various quantities to be specified on each of the five control cards are defined in this section. If plotting the variables from Tape 8, see section A4.

A2.1 CARD 1 PROGID, SCALE

The variable PROGID is a 30 Hollerith character identification header that is printed as a banner at the start of the plot.

SCALE = Multiplicative factor to increase or decrease the plot size (usually = 1.0)

A2.2 CARD 2 XSIZE, PFRBEG, PFREND, DELTAX, ITYP, IXAXIS, NUMFIL

XSIZE	=	Length of X-axis in inches
PFRBEG	=	Beginning wavenumber on plot in cm^{-1} or wavelength in μm
PFREND	=	Ending wavenumber on plot in cm^{-1} or wavelength in μm
DELTAX	=	The interval between the numbered values on the X-axis
ITYP	= 0	Radiance per μm vs μm
	= 1	Radiance per cm^{-1} vs cm^{-1}
	= 2	Transmittance vs μm
	= 3	Transmittance vs cm^{-1}
IXAXIS	= 0	X-axis will be linear
	= 1	X-axis will be logarithmic

NUMFIL	= 0	Uses next available file of data
	> 0	Uses file of data specified by NUMFIL

A2.3 CARD 3 YSIZE, YRMIN, YRMAX, DELTAY, ICRV, IYAXIS, NMYDEC

YSIXE	=	Length of Y-axis in inches
YRMIN	=	Minimum transmittance or radiance value to be plotted
YRMAX	=	Maximum transmittance or radiance value to be plotted

In a log plot YRMIN and YRMAX are input as the values of the respective exponents. In a linear plot they are entered as the actual minimum and maximum value.

DELTAY	=	The interval between the numbered values on the Y-axis
ICRV	= 0	Normal plot of line
	> 0	Calls special plotting routine to plot dashed and dotted lines
	= 1	Solid line without symbols
	= 2	Dashed line without symbols
	= 3	Dotted line without symbols
	= 4	Alternating dashes and dots without symbols
	= 5	Alternating dashes and 2 dots without symbols
	= 6-10	Same as ICRV = 1 to 5 with symbols at every point
	> 10	Alternating dashes of different lengths
	< 0	Data points only using symbol number = | ICRV |, where symbol number refers to the computer-system plotting table
IYAXIS	=0	Y-axis will be linear
	=1	Y-axis will be logarithmic
NMYDEC	=	Number of digits to the right of the decimal point on the Y-axis

A2.4 CARD 4 IPOS

If IEMSCT = 0,

IPOS	= 0	Plot of total transmittance
	= 1	Plot of H_2O transmittance
	= 2	Plot of uniformly mixed gases transmittance
	= 3	Plot of O_3 transmittance
	= 4	Plot of trace gases transmittance
	= 5	Plot of N_2 continuum transmittance
	= 6	Plot of H_2O continuum transmittance
	= 7	Plot of molecular scattering transmittance
	= 8	Plot of aerosol/hydrometeor transmittance
	= 9	Plot of HNO_3 transmittance
	= 10	Plot of aerosol/hydrometeor absorptance

If IEMSCT	= 1,	
IPOS	= 0	Plot of total transmittance
	= 1	Plot of atmospheric radiance (units chosen by variable ITYP on Card 2)
If IEMSCT	= 2,	
IPOS	= 0	Plot of total transmittance
	= 1	Plot of atmospheric radiance
	= 2	Plot of path scattered radiance
	= 3	Plot of single scattered radiance
	= 4	Plot of ground reflected radiance
	= 5	Plot of direct reflected radiance
	= 6	Plot of total radiance
for IPOS	= 1-6	The units are chosen by ITYP.

NOTE: When running without multiple scattering (IMULT = 0) the path scattered radiance is equal to the single scattered radiance and the ground reflected radiance is equal to the direct radiance.

If IEMSCT	= 3,	
IPOS	= 0	Plot of total transmittance
	= 1	Plot of transmitted solar irradiance
	= 2	Plot of incident solar irradiance

for IPOS 1 and 2 the units are chosen by ITYP.

A2.5 CARD 5 ISAMFL, ISAMPT

ISAMFL and ISAMPT are set to handle the next set of data to be plotted. ISAMFL is used when the user wishes to plot a second, third, or ...., variable from the same file of LOWTRAN 7 Tape 7 data. The user should be sure that the range of the variable falls within the range as specified on the plot axis by CARD 2 and CARD 3.

ISAMFL	= 0	Normal advance to next file of data
	= 1	Rewind and stay on same file
ISAMPT	= 0	Normal advance to new plot
	= 1	Plot data on same physical plot

A3. THE AFGL COMPUTER SYSTEM CALCOMP PLOT ROUTINES

The program LOWPLT uses several AFGL computer-system CALCOMP plot calls that may differ from the system plotting routines available to the user. It is anticipated that with suitable adaptation of the CALCOMP plot calls including the calls to PLTID3, PLOT, ENDPLT, NUMBER, SYMBOL, and LINE plotting can be accomplished with minimal difficulty.

The general functions of the AFGL system CALCOMP plot routines are as follows:

1. CALL PLTID 3 (PROGID, XMAX, YMAX, FACTOR)

This subroutine must be the first routine called as it initializes the plot.

PROGID = A 30-character hollerith array used as an identifier on the plot header
XMAX = Max dimension in X inches (X limit for entire plot) (real)
YMAX = Max dimension in Y inches (Y limit for entire plot) (real)
FACTOR = A multiplicative factor to change size of plotting (usually 1.0) in both the X and Y directions

2. CALL ENDPLT - PHYSICAL END OF PROGRAM

Subroutine ENDPLT must be the last plotting subroutine called in all levels. ENDPLT will empty plotting buffers and write identifying information at the end of the page. A call to ENDPLT causes termination of the job.

3. CALL LINE (X, Y, N, K, J, L, XMIN, DX, YMIN, DY, SYMSZE)

Subroutine LINE produces a single line by connecting the points defined in the dimensioned variables X and Y.

X = Array of X values (real)
Y = Array of Y values (real)
N = Number of points to be plotted (integer)
K = Repeat cycle (usually K = 1) (integer)
When K = 2 the first, third, fifth, etc., points will be plotted
When K = 3 the first, fourth, seventh, etc., points will be plotted, etc.
Example CALL LINE (X(1), X(2), N2 . . .) This is usually used when X and Y arrays are one mixed array.
J = Control for using symbols (integer)
J = 0 will produce a line plot without symbols
J = 1 will produce a line plot with a symbol at every point
J = 2 will produce a line plot with a symbol at every second point, etc., a negative J will suppress the lines between the points.
L = A number describing the symbol to be used. Only symbols whose integer equivalent is 0 to 13 are centered around the point (X,Y). For all others the point (X,Y) is at the lower left corner of the symbol.
XMIN = Starting value of X-axis, in units of X (real)
DX = The difference between the final value on X-axis and the starting value of X-axis divided by the length of X-axis in inches (real).
YMIN = Starting value of Y-axis, in units of Y (real)
DY = The difference between the final value on Y-axis and the starting value of Y-axis divided by the length of Y-axis in inches.

SYMSZE = A number defining the size of the symbol to be used at the point (X,Y) (real). (Default size is 0.08 in.)

4. CALL PLOT (X, Y, IC)

Subroutine PLOT is used to move the pen and to redefine a new origin.

X = X Coordinate, in inches (real)

Y = Y Coordinate, in inches (real)

IC = If IC = 2, pen down as pen moves to (X, Y) (integer)
If IC = 3, pen up as pen moves to X, Y.
If IC = –2 or –3, a new origin is defined at X, Y.

NOTE: the pen will move to location X,Y on page in all cases. X and Y are defined with respect to the previously defined origin. Page frame limits should be considered in all cases. If IC $\neq \pm 2$ or 3, an error message is printed.

5. CALL NUMBER (X, Y, HGHT, FPN, THETA, N)

Subroutine NUMBER will interpret and plot a real (floating point) number.

X = X Coordinate of lower left-hand corner of first digit, in inches, relative to the current origin (real)

Y = Y Coordinate of lower left-hand corner of first digit, in inches, relative to the current origin (real)

HGHT = Height of numbers to be plotted, in inches (real)

FPN = Number to be plotted (real)

THETA = Orientation of the number with respect to the X-axis, counterclockwise in degrees (real)

N = Number of digits after the decimal point (integer), N = –1 will suppress the decimal point

6. CALL SYMBOL (X, Y, HGHT, BCD, THETA, N)

Subroutine SYMBOL will draw a series of symbols as defined in the symbol table in the CALCOMP instruction manual.

X = Coordinate of the lower-left corner of the first character, in inches, relative to the current defined origin (real)

Y = Coordinate of the lower-left corner of the first character, in inches, relative to the current origin (real)

HGHT = The height of the characters, in inches (real). For pen plots the width of each character will be equal to the height.

BCD = This parameter and the last parameter in CALL to SYMBOL (called N) determine the type of annotation the routine produces. If BCD is the text to be used as annotation, usually BCD or A type format, the characters must be left-justified and contiguous in a single variable, in an array, or in a Hollerith literal. Parameter N must contain the number of characters to be plotted. If BCD is a single character of text, the text must be right-justified and parameter N = 0.

THETA = The angular orientation with respect to the X axis counterclockwise, degrees (real).

N = This parameter plus parameter BCD determines type of lettering/symbols produced by routine SYMBOL.

N > 0 - defines character count in array BCD, left-justified.

N = 0 - defines single characters to be plotted, right-justified.

N < 0 (negative) - determines the condition of the pen in the move from its present position to the place where the symbol is to be produced.
If N = -1, the pen is up during the move, after which a symbol is produced. If N = -2 or less, the pen is down during the move, after which a suymbol is produced.

Three of the CALCOMP plot calls from the AFGL plotting library used in LOWPLT, are not consistent with the standard CALCOMP versions. These calls and their possible modifications are as follows:

1. CALL PLTID3 - should be replaced with CALL PLOTS (0, 0, LDEV) where LDEV is the plot device designation;

2. CALL ENDPLT - should be replaced with a plot completion call appropriate to the user's system; and

3. CALL LINE - a program modification must be made so that the starting value and the scaling factor immediately follow the data values in the X-array and the Y-array respectively.

A4. PLOTTING OF TAPE8 VARIABLES

When plotting any of the variables on a Tape 8 output created by a transmittance run, the card sequence as outlined above remain the same. The only change is in the definition of the control variable IPOS on CARD 4 as follows:

IPOS	= 0	Plot of H_2O transmittance
	= 1	Plot of O_3 transmittance
	= 2	Plot of CO_2 transmittance
	= 3	Plot of CO transmittance
	= 4	Plot of CH_4 transmittance
	= 5	Plot of N_2O transmittance
	= 6	Plot of O_2 transmittance
	= 7	Plot of NH_3 transmittance
	= 8	Plot of NO transmittance
	= 9	Plot of NO_2 transmittance
	= 10	Plot of SO_2 transmittance

NOTE: The plot program does not handle Tape 8 type output not created by a transmittance run.

A5. LOWTRAN PLOT: PROGRAM STRUCTURE

The plot program for LOWTRAN 7 is a separate program package available with LOWTRAN 7. The plot code structure is shown in Figure A1. Descriptions of each subroutine are shown in Table A1.

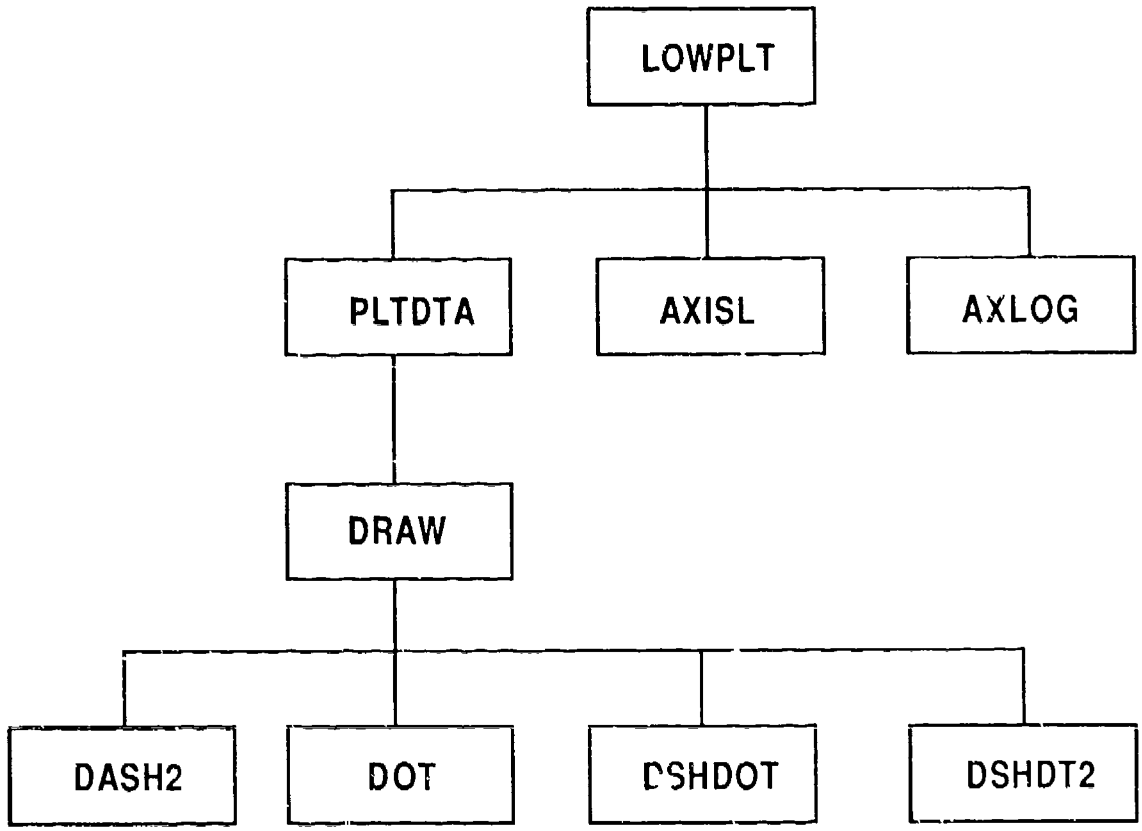

Figure A1. Plot Program Structure

Table A1. Descriptions of Plot Program Subroutines

LOWPLT	Main driver program. Reads 4 control cards.
AXISL	Plots a labeled linear axis.
AXLOG	Plots a labeled logarithmic axis.
PLTDTA	Reads LOWTRAN data from TAPE 7. Determines which variable to plot.
DRAW	Sets up data to be plotted. Determines which type of line to plot.
DASH2	Plots a dashed line.
DOT	Plots a dotted line.
DSHDOT	Plots a line with alternating dashes and dots.
DSHDT2	Plots line with alternating dash and two dots.

Appendix B

LOWTRAN 7 Filter Function Program, LOWFIL

B1. INTRODUCTION

The LOWTRAN 7 Filter Function Program, LOWFIL, is primarily designed to calculate the effective atmospheric transmittance that would be measured by a filtered transmissometer. It can also be used to calculate the effective radiance seen by a radiometer measuring the radiance emitted or scattered by the atmosphere.

This program is written as an independent program package for use with the LOWTRAN 7 code. It assumes that the basic mass storage file, TAPE7, written by LOWTRAN, is available. It was written to be fairly flexible in its use, although it is recognized that users may wish to modify the code to tailor it more specifically for their own applications.

The effective average atmospheric transmittance measured by a transmissometer looking at a blackbody source is given by:

$$\bar{\tau} = \frac{\int \tau(\upsilon) F(\upsilon)\, B(\upsilon, T_{BB})\, d\upsilon}{\int F(\upsilon)\, B(\upsilon, T_{BB})\, d\upsilon} \qquad \text{(B1)}$$

where

$\tau(\upsilon)$ is the spectral transmittance of the atmosphere,

$F(\upsilon)$ is the total combined response function of the sensor, including the transmittance of any filters, the effect of the optical components and the detector response,

$B(\upsilon, T_{BB})$ is the spectral emissivity of the blackbody source,

T_{BB} is the temperature of the blackbody, and

υ is the frequency and the range of integration includes all the non-zero values of $F(\upsilon)$.

The atmospheric or scattered solar radiance measured by a radiometer is proportional to:

$$R = \int I(\upsilon) F(\upsilon) d\upsilon, \tag{B2}$$

where $I(\upsilon)$ is the spectral radiance. In general, when using Eq. (B2) to determine the radiance measured by a radiometer it would be necessary to include in $F(\upsilon)$, the radiometer angular field-of-view, calibration constants, and all other frequency independent quantities that can be neglected for Eq. (B1), since they cancel out. The effective normalized radiance is given by:

$$I_{Eff} = \frac{R}{F_{max}} = \frac{\int I(\upsilon) F(\upsilon) d\upsilon}{F_{max}}, \tag{B3}$$

where F_{max} = the maximum value of $F(\upsilon)$. When used with radiance output, LOWFIL will calculate both R and I_{Eff}. The units of R will depend on the units of $F(\upsilon)$, the sensor response function; I_{Eff} will be in W/cm^2-ster.

The effective filter weighted average transmittances for the different atmospheric components used in LOWTRAN are also computed, (for example, the transmittance due to ozone, the water vapor continuum, aerosol, etc.). It should be recognized, that while:

$$\tau(\upsilon) = \tau_{H_2O}(\upsilon)\, \tau_{CO_2} \cdots \tau_{HNO_3}(\upsilon) \quad , \tag{B4}$$

in general:

$$\bar{\tau} \neq \bar{\tau}_{H_2O} \bar{\tau}_{CO_2} \cdot \cdots \cdot \bar{\tau}_{HNO_3} \quad . \tag{B5}$$

where the average transmittance for each of the atmospheric components is found by evaluating an expression analogous to Eq. (B1).

In addition to the eight average component transmittances, the water continuum and band-type absorption are combined into a total water transmittance.

$$\tau_{Water}(\upsilon) = \tau_{H_2O\ Band}(\upsilon)\, \tau_{H_2O\ cont.}(\upsilon) \tag{B6}$$

Also the other gaseous transmittances are combined:

$$\tau_{Gas}(\upsilon) = \tau_{CO_2}(\upsilon) \cdot \tau_{ozone}(\upsilon) \cdot \tau_{N_2}(\upsilon) \cdot \tau_{mol.\ scat}(\upsilon) \cdot \tau_{HNO_3}(\upsilon) \tag{B7}$$

These combined transmittance components have proved useful in developing simple analytic expressions for the effective transmittance measured by a system.

$$\bar{\tau} \approx \bar{\tau}_{Water} \cdot \bar{\tau}_{Gas} \cdot \bar{\tau}_{Aerosol} \quad . \tag{B8}$$

where analytic expressions are derived separately for τ_{Water}, τ_{Gas}, and $\tau_{Aerosol}$.

B2. COMPUTATIONAL DETAILS OF THE PROGRAM

The program starts by reading in a set of filter functions, or systems response functions. There can be up to 15 different filters each specified at up to 80 different wavelengths (these limits can be modified by adjusting the dimension statements) in each set.

The program is written so that the systems response functions or filter function F(υ), can be input either as a function of wavelength (μm) or as function of wavenumber (cm^{-1}). If they are input as a function of wavelength, the wavelengths are converted to wavenumbers and the order of the points is reversed to be in ascending order in wavenumber.

Next, a specified number of LOWTRAN cases are read in from TAPE7 one at a time. For each LOWTRAN case, the different filters are cycled over one-by-one. The subset of the LOWTRAN wavenumbers, which bracket the values for which the filter is defined, are found for each filter in turn. Then the values of the filter function are interpolated to this subset of the LOWTRAN wavenumbers.

Finally, the integrals in Eqs. (B1) through (B3) are evaluated using the trapezoidal rule. After a set of filters is used with the specified number of LOWTRAN cases, the next set of filter functions is read in, and repeated until the input is terminated.

B3. USE OF THE FILTER FUNCTION PROGRAM

B3.1 General Remarks

The filter function program LOWFIL utilizes TAPE7, the standard mass storage output file as written by the LOWTRAN 7 computer code. The control cards for the filter are read from TAPE 5, which in the listing that follows is equated to the INPUT file.

The program is written so that a set of up to 15 filter functions (system response functions) can be read in at once, and used with one or several consecutive LOWTRAN calculations. The filter functions can be input either as a function of wavelength (μm) or as a function of wavenumber (cm^{-1}). The wavelengths (wavenumbers) should be in ascending order, but can be at unequal intervals. An option is included to rewind the LOWTRAN TAPE 7 output file, so more than 15 filter functions (system response functions) can be used or the same filters can be re-used with a different blackbody source temperature. It should be emphasized that the spectral range of the LOWTRAN calculations should include the full sensitive range of the systems response functions to be used.

B3.2 Control Cards

There are three (3) basic control cards:

CARD 1 NF, NEW, IFT, TEMP, IPRINT, NLOW
(FORMAT (3I5, F10.2, 2I5))

Repeat CARD 2 and CARD 3 "NF" times, where NF is specified on CARD 1.

CARD 2 IDFIL, KODE, IFWV, NW
(FORMAT (2A10, 3I5))

CARD 3 (WAVE (I), FF (I), I = 1, NW)

CARD 3 is a free format with as many cards as needed for all the values of WAVE and FF.

B3.2.1 CARD 1 NF, NEW, IFT, TEMP, IPRINT, NLOW

NF indicates number of different filters

NF > 0 Read in NF filters (NF ≤ 15)
= 0 Use preceding filter for next LOWTRAN output
< 0 Stop filter program

NEW is an option to reuse the previous LOWTRAN data set for the next set of filters.

NEW = 0 No, Read next NLOW sets of LOWTRAN data
= 1 Yes, Rewind the LOWTRAN TAPE 7 output file

IFT is an option to enter blackbody temperature of source

IFT = 0 No blackbody
= 1 Fold in blackbody emmissivity

TEMP = blackbody source temperature in degrees Kelvin

IPRINT controls the information printed

IPRINT ≥10, Print LOWTRAN transmittances and results below
≥ 5, Print filter function with blackbody function folded in
≥ 0, Only print the filter weighted transmittances

NLOW indicates number of LOWTRAN data sets to use with this set of filters

B3.2.2 CARD 2 IDFIL, KODE, IFWV, NW

If NF is set to zero on CARD 1, a new input set of CARDS 2 and 3 are not read. If NF is > zero then "NF" input sets of CARD 2 and 3 are read.

IDFIL = 20 Hollerith character identification for the given filter
KODE = Filter identification number (5 digits)

IFWV is an option to input the filter function either vs wavelength or vs wavenumber.

IFWV = 0 Wavelength
= 1 Wavenumber
NW = Number of wavelengths or wavenumbers for the filter (NW ≤ 80)

B3.2.3 CARD 3 (WAVE (I), FF (I), I = 1, NW)

The variable NW on input card 2 gives the number of wavelength or (wavenumber) filter function pairs necessary to CARD 3 or multiples of CARD 3. These should be in ascending order by wavelength (or wavenumber).

WAVE = Wavelength or wavenumber, depending of IFWV

FF = Corresponding filter function

B4. STRUCTURE OF THE FILTER FUNCTION PROGRAM

The filter function program is an independent program package available for use on LOWTRAN 7 TAPE7 output. The filter function code structure is shown in Figure B1. Descriptions of each subroutine are listed in Table B1.

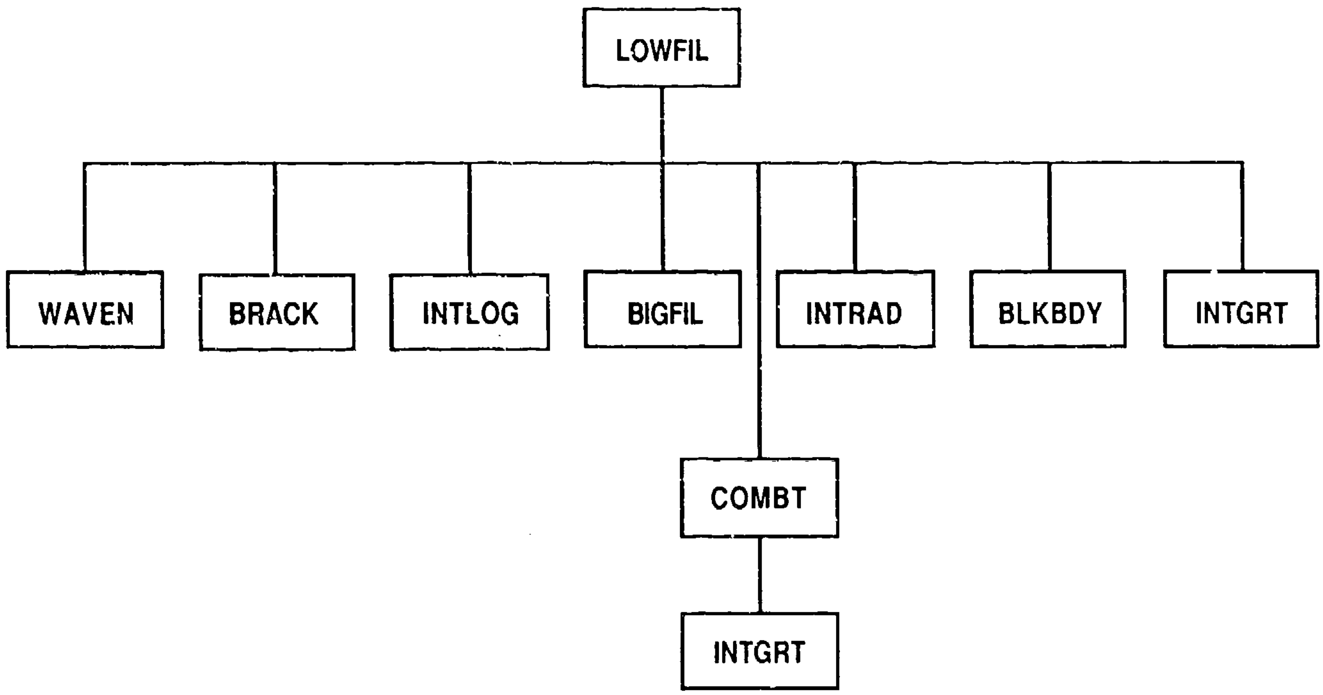

Figure B1. Filter Program Structure

Table B1. Description of LOWTRAN Filter Program Subroutines

LOWFIL –	Main driver program. Reads control cards and TAPE7 output from LOWTRAN
WAVEN –	Changes a system response function vs wavelength (μm) to a response function vs wavenumber (cm^{-1})
BRACK –	Finds the LOWTRAN wavenumbers, which bracket the system response function
INTLOG –	Interpolates a pair of vectors, F(I) = $f(x_i)$, and X(I) = X_i, i = 1, 2, . . . N, to a new set of coordinates; FNEW (J) = $f(x_j)$ and XNEW (J) = x_j, j = 1, 2, . . . M
BIGFIL –	Routine to find the maximum value of the system response function
INTRAD –	Integrates the emitted or scattered radiance from LOWTRAN times the systems response function
BLKBDY –	Weights the system response function by a blackbody radiance
INTGRT –	Finds the average value of the transmittance from LOWTRAN weighted by the systems response function
COMBT –	Finds the weighted average transmittance due to water vapor (both band-type and continuum combined) and all the other gases combined together

Appendix C

LOWTRAN 7 Scanning Function Program

C1. INTRODUCTION

The LOWTRAN 7 scanning function program is an independent program supplied with the LOWTRAN 7 package. The program is designed to convolve a triangular slit function with the transmittance, or radiance available on the TAPE7 output file created by a LOWTRAN 7 run. The fixed half width at half maximum can be input as either wavenumbers (cm^{-1}) or wavelength (μm). This program allows the user to generate spectra with a coarser resolution than the current LOWTRAN resolution of 20 cm^{-1}. Use of the scanning function preserves the correct integrated intensities or transmittances and avoids the errors of undersampling the spectra.

C2. INSTRUCTIONS FOR USING THE SCANNING FUNCTION

Four tape files are initially opened. The scanning function program extracts the data to be scanned from TAPE7. TAPE5 is needed to read the control card, TAPE6, is used for printed output from the program and TAPE9 is used to store the scanned variable and is available for plotting.

C2.1 Input Data and Format

The data necessary to pass a scanning function over the TAPE7 variable is given by the following card:

CARD 1 V10, V20, HWHM, IHW, NUMFIL, IVAR
FORMAT (3F10.5, 3I5)

C3. BASIC INSTRUCTIONS

The various quantities to be specified on the control card are defined in this section.

C3.1 CARD 1 V10, V20, HWHM, IHW, NUMFIL, IVAR

V10	=	First output frequency in cm^{-1}
V20	=	Last output frequency in cm^{-1}
HWHM	=	Fixed half width at half max (cm^{-1}) defined at V10 (if IHW = 0)
		Fixed half width at half max (μm) (if IHW = 1)
IHW	=	Flag for scanning function half width (0 or 1 as explained above)
NUMFIL	=	0 uses next file of data
	>	0 uses file of data specified by NUMFIL

IVAR: The use of the variable IVAR depends on the value of the variable IEMSCT as read from CARD 1 of TAPE7.

If IEMSCT = 0

IVAR	= 0	scans total transmittance
	= 1	scans H_2O transmittance
	= 2	scans uniformly mixed gases transmittance
	= 3	scans O_3 transmittance
	= 4	scans trace gases transmittance
	= 5	scans N_2 continuum transmittance
	= 6	scans H_2O continuum transmittance
	= 7	scans molecular scattering transmittance
	= 8	scans aerosol/hydrometeor transmittance
	= 9	scans HNO_3 transmittance
	= 10	scans aerosol/hydrometeor absorptance

If IEMSCT = 1

IVAR	= 0	scan of total transmittance
	= 1	scan of atmospheric radiance

If IEMSCT = 2

IVAR	=	0	scan of total transmittance
	=	1	scan of atmospheric radiance
	=	2	scan of path scattered radiance
	=	3	scan of single scattered radiance
	=	4	scan of total ground reflected radiance
	=	5	scan of direct reflected radiance
	=	6	scan of total radiance

NOTE: When running without multiple scattering (IMULT = 0), the path scattered radiance is equal to the single scattered radiance and the ground reflected radiance is equal to the direct radiance.

If IEMSCT = 3

IVAR	=	0	scan of total transmittance
	=	1	scan of transmitted solar irradiance
	=	2	scan of incident solar irradiance

C4. SCAN OF TAPE8 VARIABLES

If a scan of any of the TAPE8 variables as created by a transmittance run is required, the only variable treated differently is IVAR. The changes are as follows:

IVAR	=	0	scan of H_2O transmittance
	=	1	scan of O_3 transmittance
	=	2	scan of CO_2 transmittance
	=	3	scan of CO transmittance
	=	4	scan of CH_4 transmittance
	=	5	scan of N_2O transmittance
	=	6	scan of O_2 transmittance
	=	7	scan of NH_3 transmittance
	=	8	scan of NO transmittance
	=	9	scan of NO_2 transmittance
	=	10	scan of SO_2 transmittance

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