AD-A064 019 AERODYNE RESEARCH INC BEDFORD MASS F/G 9/2

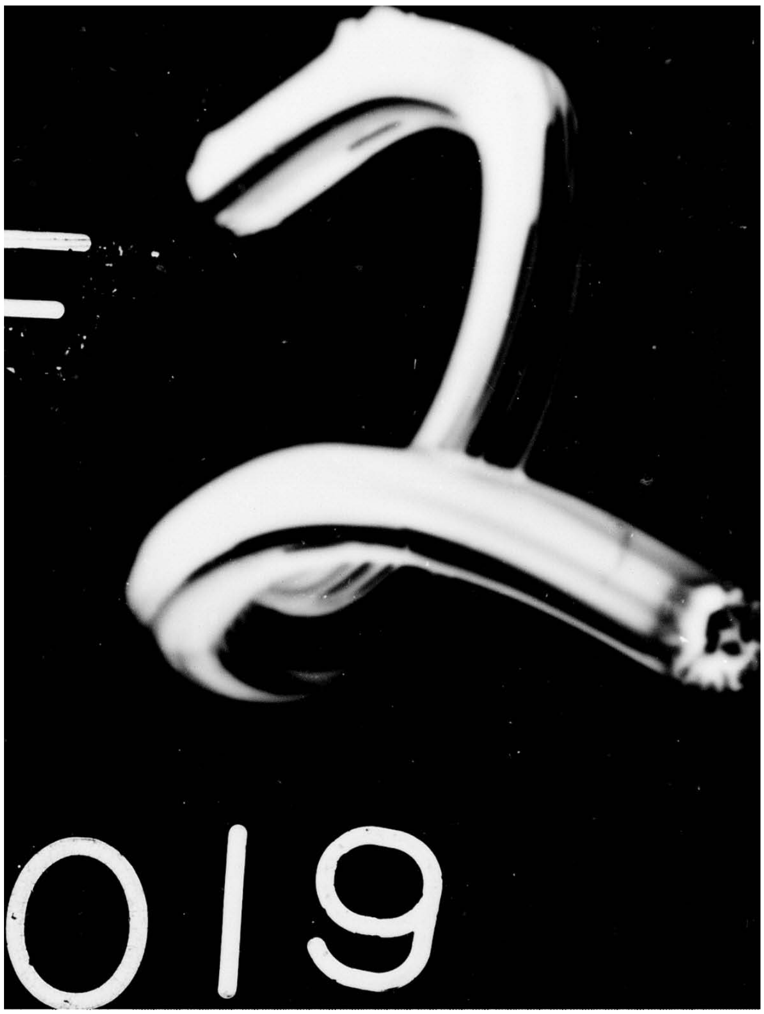
A USER'S GUIDE TO MIDTRAN - A COMBINATION OF LOWTRAN AND HITRAN--ETC(U)

JUN 78 D ROBERTSON, R SPECHT F19628-77-C-0198

UNCLASSIFIED ARI-RR-124 AFGL-TR-78-0184 NL

1 OF 2

AD A064 019


2
019

LEVEL III

AFGL-TR-78-0184

A USER'S GUIDE TO MIDTRAN - A COMBINATION OF LOWTRAN AND HITRAN TECHNOLOGIES

D. Robertson
R. Specht

Aerodyne Research, Inc.
Bedford Research Park
Crosby Drive
Bedford, Massachusetts 01730

Jun[redacted]78

Scientific Report No. 2

Approved for public release; distribution unlimited.

This research was supported by the Navy Optical Signatures Program, NWC, the Air Force Avionics Laboratory, and the Defense Advanced Research Projects Agency.

AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
HANSCOM AFG, MASSACHUSETTS 01730

Contractor: Aerodyne Research, Inc.

Principal Investigator and Phone No.: Dr. David Robertson 617-275-9400

AFGL/AFAL Project Scientist and Phone No.
Dr. Brian P. Sandford 617-861-4281

Contract Expiration Date: 1 July 1980

Optical Signatures Program (OSP)
NWC Project Scientist and Phone No.
Mr. Ted Smith 714-939-3697

Contract Expiration Date: 2 August 1978

Qualified requestors may obtain additional copies from the Defense Documentation Center. All others should apply to the National Technical Information Service.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER AFGL-TR-78-0184	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A USER'S GUIDE TO MIDTRAN - A COMBINATION OF LOWTRAN AND HITRAN TECHNOLOGIES		5. TYPE OF REPORT & PERIOD COVERED Scientific Report No. 2 3/24/78 - 7/1/78 6. PERFORMING ORG. REPORT NUMBER ARI-RR-124
7. AUTHOR(s) D. Robertson R. Specht		8. CONTRACT OR GRANT NUMBER(s) F19628-77-C-0198
9. PERFORMING ORGANIZATION NAME AND ADDRESS Aerodyne Research, Inc. Crosby Drive, Bedford Research Park Bedford, Massachusetts 01730		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61102F 2310G1AH
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Geophysics Laboratory Hanscom AFB, Massachusetts Monitor - B. Sandford/OPR		12. REPORT DATE June 1978 13. NUMBER OF PAGES 120
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Optical Signatures Program Naval Weapons Center China Lake, Calif. Monitor - T. Smith		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This research was supported by Optical Signatures Program, Naval Weapons Center, China Lake, Calif., under Contract No. N60530-77-C-0181, 3/24/78 - 8/2/78.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Atmospheric Transmittance and Radiation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes how to use the MIDTRAN computer code for calculation of atmospheric transmission and radiation in the 2 - 5 μm spectral region. The code contains the flexibility of the LOWTRAN code and the high resolution technology of the HITRAN compilation of spectral lines to yield a flexible code with a spectral resolution of approximately 0.1 cm^{-1}. The code can be used for a variety of paths (horizontal, vertical, slant, etc.) and for the six different model atmospheres (as contained in LOWTRAN). The spectral absorption coefficients which are calculated

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Abstract (Continued)

from the HITRAN data tape are stored in a tape library. This tape library is used by MIDTRAN to calculate the spectral absorption coefficients. For radiation calculations, the user has the option of including a background blackbody source of arbitrary temperature.

18. (Continued)

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Defense Advanced Research Projects Agency or the U.S. Government.

TABLE OF CONTENTS

Table of Contents (Continued)

1. INTRODUCTION

MIDTRAN is a computer code which calculates transmittance and radiation for paths through the earth's atmosphere in the 2 - 5 μm spectral region. The code is based on a marriage of the AFGL codes LOWTRAN3[1] and HITRAN.[2] The overall structure and formats of LOWTRAN3 have been retained for the input parameters, path geometry and continuum transmittance components. The HITRAN data tape is used to precalculate the spectral absorption properties of atmospheric molecules, which are stored on tape and then used as input data by MIDTRAN. The use of these data stored on external library tapes allows MIDTRAN to perform calculations for multilayered atmospheres at reasonable speeds and with a spectral resolution of 0.05 cm^{-1} or better. Because of the library tape's present structure, MIDTRAN is best suited for paths which fall below 15 km altitude at some point. The code is written in FORTRAN and is compatible with CDC and IBM formats. For radiation calculations, the user has the option of specifying a background blackbody source of arbitrary temperature and emissivity and then calculating the radiation as seen through an atmosphere. In following the LOWTRAN3 structure, the user has the choice of six model atmospheres or radiosonde data and of different atmospheric paths, horizontal, vertical, or downward. Thus, MIDTRAN has flexibility for those systems studies which require atmospheric transmittance at lower altitudes while maintaining good spectral resolution.

Section 2 gives a description of the MIDTRAN software and describes the MIDTRAN library tapes. Instructions for using MIDTRAN are in Section 3 and

---

[1] J. Selby and R. McClatchy, "Atmospheric Transmittance From 0.35 to 28.5 μm; Computer Code LOWTRAN3," Report No. AFCRL-TR-75-0255, AFGL/OPI, Hanscom AFB, Mass., May 1975.

[2] R. McClatchy, et al., "AFCRL Atmospheric Absorption Line Parameters Compilation," AFCRL-TR-73-0096, AFGL/OPI, Hansom AFB, Mass., January 1973.

comparisons to transmittance data are in Section 4. The appendices contain listings of MIDTRAN, a sample run, a list of variables, a MIDTRAN flowchart, and a listing of MRDAT, the program which generates the library tapes.

The support furnished by the Naval Weapons Center and the Air Force Avionics Laboratory via the Air Force Geophysics Laboratories is greatfully acknowledged. The contract monitors are Mr. S. Ted Smith (NWC), Dr. R. Sanderson (AFAL), and Mr. B. Sandford (AFGL). Previous support of the Defense Advanced Research Projects Agency for the development of a preliminary version (MRDA) of MIDTRAN for use on an HP-2100 minicomputer(3) is acknowledged. The present code supersedes the earlier MRDA code.

The MIDTRAN code can be directly used on either a CDC6600 computer or a minicomputer with virtual memory capability. Execution times on a CDC6600 for both transmittance and radiation is approximately 1.8 sec/wavenumber for a path transversing 11 model atmosphere layers and in steps of 0.01 cm^{-1} (100 calculations/ wavenumber). Calculational times on the PRIME 400 minicomputer are about 4 times slower. Total times for a calculation depend on the machine's tape read speed; considerable time can be spent by the PRIME in skipping over files to get to a spectral region near the end of a library tape. The code is still in the developmental stage. Qualified requestors may obtain copies of the code and library tapes from Aerodyne Research, Inc.; a charge will be made for tape duplication.

---

[3] D. Kryger and D. Robertson, "MRDA - A Medium Resolution Data Analysis Code for the HP2100 Minicomputer," AFGL-TR-77-0044, AFGL/OPR Hanscom AFB, Massachusetts 01731.

2. DESCRIPTION OF MIDTRAN SOFTWARE

2.1 The MIDTRAN Code

MIDTRAN is designed to make medium resolution atmospheric transmission and radiation calculations in the range of 1800 to 6000 cm^{-1} over a wide variety of geometrical paths. The first part of the calculation consists of predicting the continuum transmissions (H_2O, N_2, molecular scattering) along with aerosol absorption for the chosen path and wavenumber interval. These calculations are carried out by what is essentially LOWTRAN3[1] with all the spectral calculations removed. In the second part of MIDTRAN, the medium resolution spectral calculations are performed. Magnetic tapes which contain a complete library of extinction coefficients are used to provide the data for computing the spectral contributions. After having calculated the total transmission due to the spectral structure, the program then combines the continuum and medium resolution results; if desired, the radiation is also calculated at each frequency. The frequencies, radiances, and transmittances are then written to a disk file, associated with FORTRAN logic unit 9. In the third part of MIDTRAN, this disk file is rewound, and the transmittances and radiances are then degraded to the desired spectral resolution using the available slit function before being printed out and/or plotted.

In the process of computing the continuum results, intermediate values are saved for later use in the spectral calculations. For example, the pressure, temperature, and altitude of each layer traversed by the geometric path are stored. In addition, the transmission through each layer is also stored in an array TRAN1 for use in calculating the radiation. Finally, the atmospheric concentration of H_2O and O_3 in each layer along with the molecular density (of all gases) for the particular path through each layer is saved. Using this information from the continuum part of the calculation and data from the library tape, MIDTRAN calculates the spectral transmission and radiation over the geometric path at frequencies defined by the input. The spectral absorption coefficients are read from the library tape. They are tabulated for the six important infrared atmospheric molecules:

H_2O, CO_2, O_3, N_2O, CO, and CH_4.

The tapes are organized in 2 cm^{-1} blocks over the 1800 to 6000 cm^{-1} range that MIDTRAN operates. In each wavenumber block, the extinction coefficients for the six molecular species are tabulated at 9 pressure-temperature points, the wavenumbers being chosen to represent the structure of the absorption spectra for the particular species in that wavenumber block. For each species, the wavenumbers were selected so as to define the spectra by identifying the most important lines in the region. In combining the separate contributions from far and near spectral lines, the extinction coefficients were calculated near the line center at 10 points, spaced 0.01 cm^{-1} apart, and at 0.1 cm^{-1} intervals between adjacent strong lines. In order to obtain the extinction coefficient at a particular pressure, temperature and frequency, the program performs linear interpolations over the pressure/temperature matrix and then over frequency.

Presently, the slit function library in MIDTRAN contains the option for no slit function at all and for a generalized slit function which requires the user to input two arrays for its definition, the slit width and the shift. The plotting option requires that the user input certain titles, initial axis values, and scaling parameters for use by the plotting software. The plotting software now in the program is designed for a PRIME 400 system with a Versatec printer/plotter. The user must examine this part of the code to determine its compatability with his system. Printed output is columnar and is blocked in sections which contain a maximum of 240 pairs of output data.

2.2 The MIDTRAN Library Tapes

The MIDTRAN Library tapes contain the spectral absorption coefficients for the six atmospheric species which have significant absorption in the 1800 - 6000 cm^{-1} region. The species are: H_2O, CO_2, O_3, N_2O, CO, and CH_4. The absorption coefficients are calculated at selected (P, T, ν) points and then written onto a tape that is accessed by MIDTRAN. The CDC6600 computer at AFGL was used to generate these tapes.

2.2.1 Choice of Spectral Absorption Coefficients

The data in the MRDA library tape are organized so as to define the absorption spectra for the species in as compact a form as possible. Thus, nine pressure-temperature (P, T) points are used to describe the atmosphere, and the total number of wavenumber points within each block is limited to 250.

The choice of the (P, T) points is based on the expected range of atmospheric pressures and temperatures. Figure 1 shows the (P, T) variability, along with illustrative radiosonde data, taken from several AFGL Mission.(4) The heavy dots within the circles show the nine (P, T) points at which the spectral absorption coefficients are calculated. Pressure/temperature points for pressures below 100 mb are not included in the tape at this time, since the dominant part of the atmosphere is at lower altitudes. The tape program contains Doppler line-shapes, so the user can generate his own high altitude tape to use with MIDTRAN.

A considerable savings in the total number of wavenumber points at which the spectral absorption coefficients must be stored is obtained by identifying the stronger spectral lines within each wavenumber block. When one or more of the species have strong lines within a block, the absorption coefficients are calculated at the peak, at 10 points about line center 0.01 cm^{-1} apart, and at intervals of 0.1 cm^{-1} between adjacent peaks. Spectral absorption coefficients for intermediate values are obtained by linear interpolation.

---

[4] B. Sandford, et al., "Aircraft Signatures in the Infrared 1.2 to 5.5 Micron Region," AFGL-TR-76-0133, Air Force Geophysics Laboratory (OPR), Hanscom AFB, Mass., 01731, (June 1976).

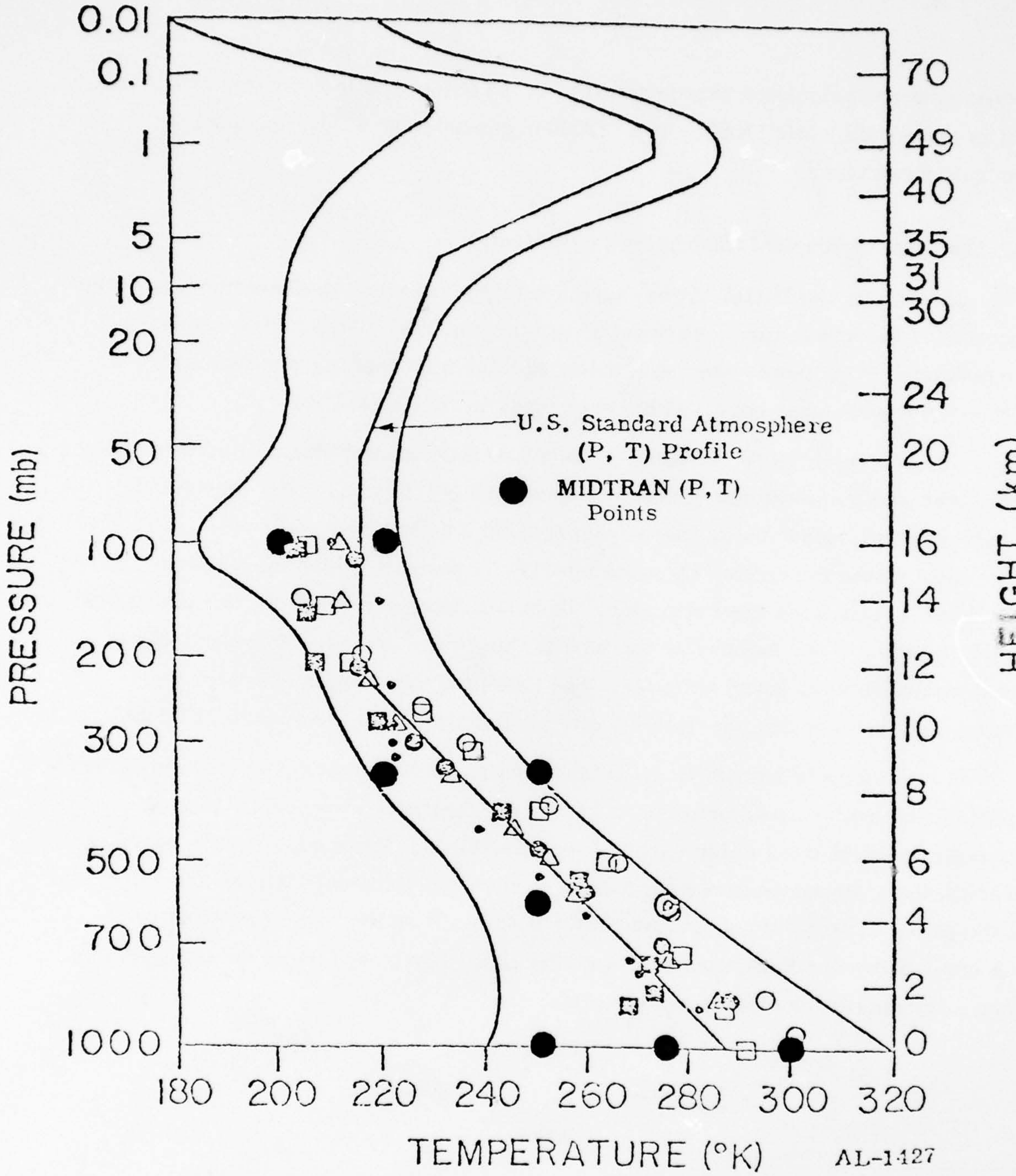


Figure 1 - Temperature and Pressure Variations of the Atmosphere. Radiosonde Data from Several AFGL Measurements are Indicated. The Outer Lines Indicate the Approximate Range of Atmospheric Temperature Fluctuations. The Center Line is the U.S. Standard Atmosphere.

2.2.2 The MRDAT Code

The MRDAT code is operational on the AFGL CDC6600 computer. It calculates the spectral absorption coefficients from line parameters contained on the HITRAN data tape[2] and writes them to an external tape. These tapes comprise the MIDTRAN tape library. The Lorentz lineshape function is used to describe the contribution of overlapping line tails. In the 2360 - 2500 cm^{-1} spectral region, the CO_2 lineshape includes the Burch form factor[5] as modeled by Kaplan, et al.[6] A Voigt lineshape is included in the program; internal logic selects this lineshape when the Doppler width becomes comparable to the Lorentz width.

The absorption coefficients are calculated in two steps. The contribution of lines external to each wavenumber block are calculated at two points (the edges of the block); linear interpolation is used to determine their contribution at intermediate frequencies. The contribution of the nearby lines is calculated at each wavenumber point within the block. The two results are combined and then written onto the library tape.

The spectral absorption coefficients for each molecule are calculated for 1 cc of pure gas at STP (i.e., 2.69×10^{19} molecules). MIDTRAN includes the concentration when calculating the transmittance. The codes are written for 9 (P, T) points and 6 atmospheric molecules. They are specified in the MRDAT input cards. So long as these parameters maintain the structure shown in Fig. 1, new tapes which are tailored to specific problems (like high altitude) are easily generated.

2.2.3 MRDAT Input Parameters

The spectral absorption coefficients are calculated from the molecular line parameters on the AFGL HITRAN data tape. A listing of the program (MRDAT) is

---

[5] D.E. Burch, D.A. Gryvnak, R.R. Patty, and C.E. Bartky, Journal, Optical Society of America, 59, 267, 1969.

[6] L.D. Kaplan, M.T. Chahine, J. Susskind, J.E. Searl, Applied Optics, 16, 322, 1977.

given in Appendix B. The data for the input parameters are given by the following sequence of read input lists:

1.	NPTPTS, MSPEC	Format (8I2)
2.	P (I), I = 1, NPTPTS	Format (8E10.0)
3.	T (I), I = 1, NPTPTS	Format (8E10.0)
4.	W (M), M = 1, 7	Format (7E10.3)
5.	V1, V2, DV, VLWST, VHGHST, DELTV, BOUND	Format (7E10.3)
6.	SSTR, VBLOCK, DV2	Format (3E10.3)

The input quantities are:

NPTPTS	=	number of (P, T) points
P	=	pressure values
T	=	temperature values
W	=	species column density = 0.269E20 molecules/cm^2 for (H_2O, CO_2, O_3, N_2O, CO, CH_4, O_2)*
V1	=	lower frequency limit (cm^{-1}) of the library tape
V2	=	upper frequency limit (cm^{-1}) of the library tape
DV	=	frequency increment for calculating between strong lines
VLWST	=	lower frequency bound, cm^{-1}, for consideration of distant lines. (presently, overidden internally)
VHGHST	=	upper frequency bound, cm^{-1}, for consideration of distant lines. (presently, overidden internally)
DELTV	=	frequency increment for distinguishing between near and far lines.
BOUND	=	distance (cm^{-1}) from line center beyond which a line is not included, presently fixed at 20.0 cm^{-1}.
SSTR	=	lower line intensity limit used for accepting lines.
MSPEC	=	identification of the six molecules (Set = 123456).(2)

*Since oxygen does not have any important absorption bands below 6000 cm^{-1}, it is not included as one of the six species in MIDTRAN, but could be used in place of a molecule on a new tape library.

VBLOCK = frequency interval length (cm^{-1}) into which the range $[V1, V2]$ is divided for blocking.

DV2 = frequency increment (usually 0.1 cm^{-1}) for calculations between strong lines.

Figure 2 is a schematic which illustrates the choice of these wavenumber parameters.

AL-78-303

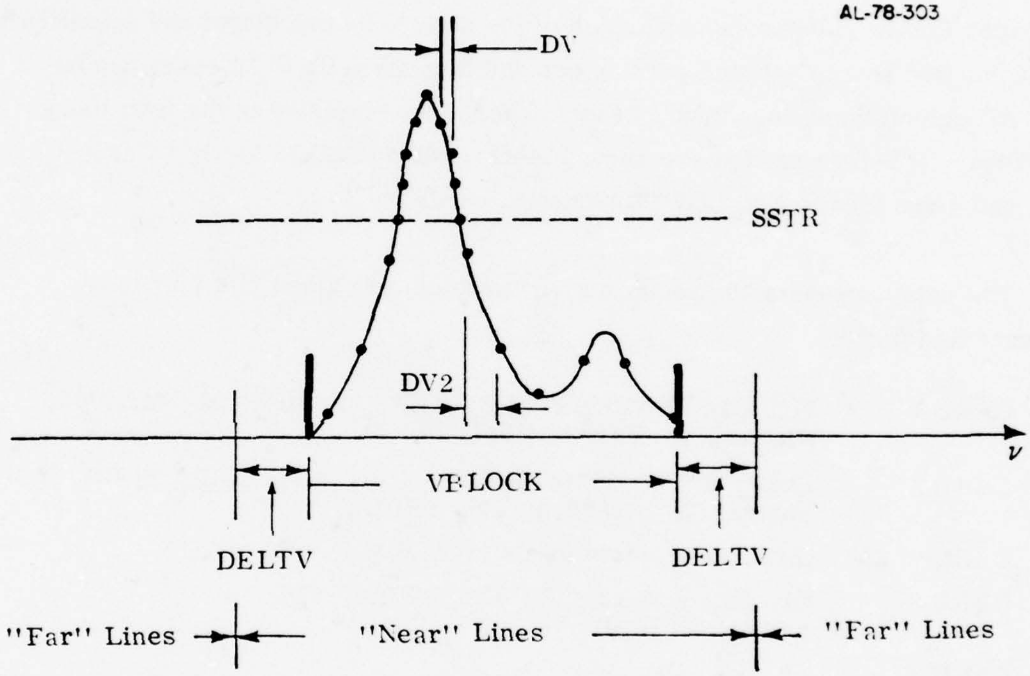


Figure 2. Schematic Showing the Definition of Wavenumber Parameters for MRDAT. Note that the Second Line is Weaker Than SSTR

3. OPERATING INSTRUCTIONS

3.1 Input Data and Formats

Many of the input cards and operations are very similar to those of LOWTRAN. In particular, the card input sequence is nearly identical. The input cards can be divided into two blocks, specification of the case to be calculated and specification of slit function and/or plotting parameters and formats. Up to 10 cases can be run. All calculations (including multiple cases) are completed in the first block (CARDS 1 - 4) before reading the second block of data (CARDS 5 - 7). Cards 1, 3, and 4 are identical to LOWTRAN3 input cards.[1]

The data necessary to specify a given problem are given in a four card sequence as follows:

CARD 1	MODEL, IHAZE, ITYPE, LEN, JP, IM, M1, M2, M3, NLDAT, R Format (10I3, F10.3)
CARD 2	IRAD, EMIS, TBACK, NTS, NTP, NRS, NRP, XORG, YORG Format (I10, 2F10.3, 4I5, 2F10.3)
CARD(s) 2A	(Atmosphere data cards when M = 0 or M = 7)
CARD 3	H1, H2, ANGLE, RANGE, BETA, VIS Format (6F10.3)
CARD 4	V1, V2, DV Format (3F10.3)
CARD 1	(Model = -1 to indicate last calculation)
CARD 5	TITLE Format (20A4)

(Slit Function Parameters)

CARD 6A	WIDTH, SHIFT, NS Format (2F10.5, I10)
CARD 6B	XSS (I), I = 1, NS Format (8F10.5)
CARD 6C	SS (I) I = 1, NS Format (8F10.5)

(Plotting Parameters)

CARD 7A	XTITLE Format (20A4)
CARD 7B	YTITLE Format (20A4)
CARD 7C	XAXIS, XINIT, XSCALE, DXT, NMINX Format (4E10.4, I10)
CARD 7D	YAXIS, YINIT, YSCALE, DYT, NMINY Format (4E10.4, I10)

If MODEL = 0 or 7, meteorological data used to describe the atmosphere are inputted on CARD(s) 2A. Transmittance and radiation calculations for all the various cases are completed with results written to an external file, before either the slit function is used or the plotting routine is employed. The external file is associated with FORTRAN logical unit 9. CARDS 1 - 4 can be repeated to perform up to ten calculations, ending with a MODEL = -1 on CARD 1. Another cyclical sequence of input data follows this card to specify the title, slit function parameters, and plotting parameters for each of the cases. Up to two plots (radiation and transmittance) can be made for each case and card set. The first block (CARDS 1 - 4) is described in Subsection 3.2 and the second block in Subsection 3.3.

3.2 Input Parameters

3.2.1 CARD1: MODEL, IHAZE, ITYPE, LEN, JP, IM, M1, M2, M3, NLDAT, R

The parameter, MODEL, selects one of the six geographical model atmospheres,[1] specifies that meteorological data are to be used in place of the standard models, or indicates the end of the first blocks of data (the second block being the output parameters).

IHAZE specifies whether aerosol attenuation is to be included in the calculation or not. For any problem, the atmospheric path must be specified as one of three types according to ITYPE and LEN. The rest of the quantities given on CARD 1 (which can be left blank if not required) provide the user with options to suppress printing (JP), to intermix the six standard model atmospheres (M1, M2, M3), to input a new model atmosphere (IM, NLDAT), and to specify the earth radius (R). The options for the above parameters and their use are described below:

MODEL	=	-1	indicates end of first data blocks
	=	0	indicates meteorological data are specified for a horizontal (constant pressure) path.
	=	1	selects TROPICAL MODEL ATMOSPHERE
	=	2	selects MIDLATITUDE SUMMER
	=	3	selects MIDLATITUDE WINTER
	=	4	selects SUBARCTIC SUMMER
	=	5	selects SUBARCTIC WINTER
	=	6	selects 1962 US STANDARD
	=	7	indicates a new model atmosphere (or radiosonde data) is to be inserted
IHAZE	=	0	means no aerosol attenuation included in the calculations.
	=	1	or 2 if aerosol attenuation is required (see also, CARD 2).

If IHAZE is set equal to 1 or 2 and visual range (VIS) is not specified on CARD 2, the program will then automatically select visual ranges of 23 or 5 km, respectively.

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

The TYPE 1 path should not be confused with a 90° path where the local height at the end of the trajectory is significantly different from that at the beginning. In such a case, specify the path according to ITYPE = 2.

LEN	=	0	for normal operation of program.
	=	1	selects the downward TYPE 2 path shown in Figure 3(e).

The parameter LEN, can be ignored (that is, left blank) for the majority of cases. It need only be used for a downward looking path ($H2 < H1$) when two paths are possible for the same input parameters. In such a case, a computer printout

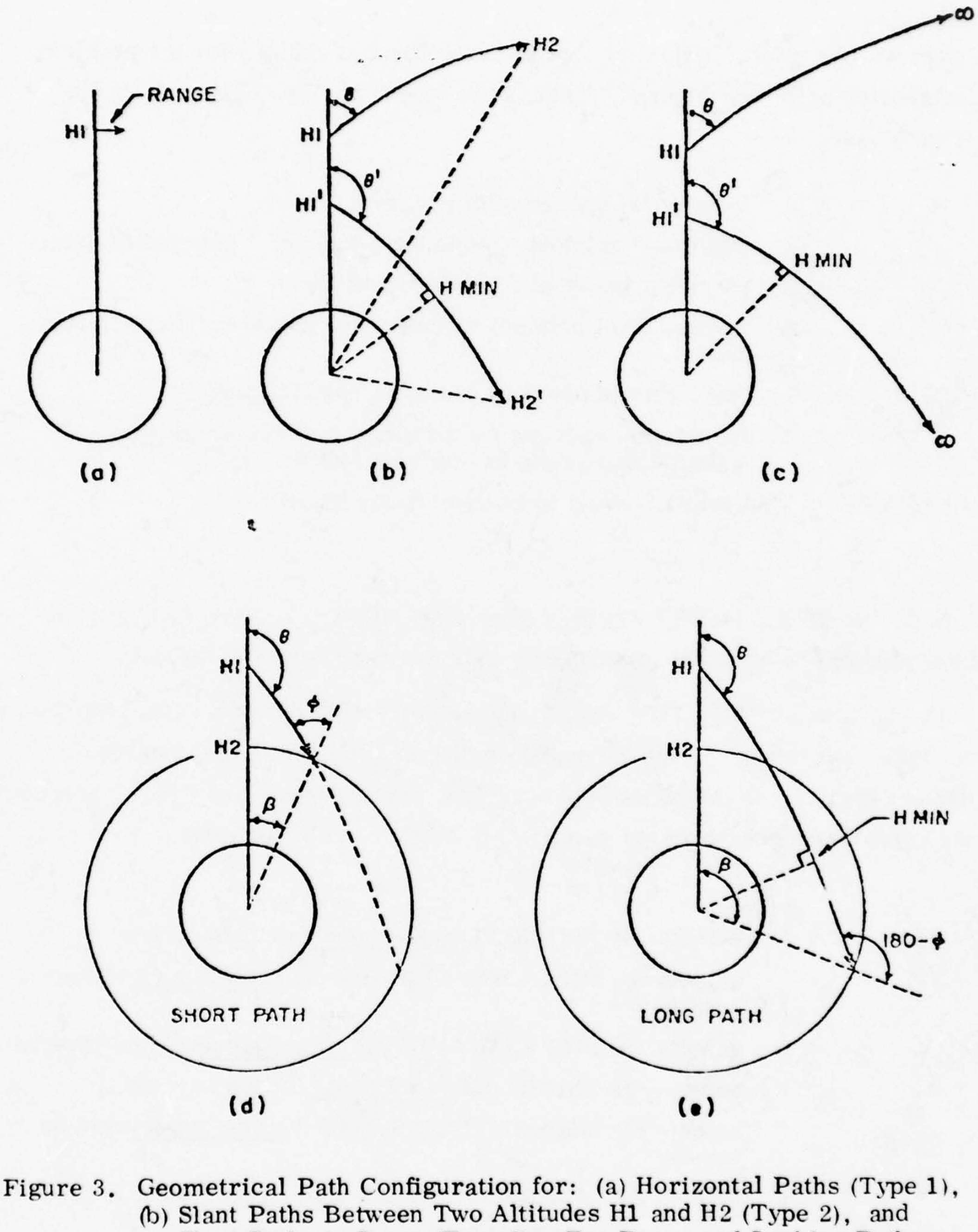


Figure 3. Geometrical Path Configuration for: (a) Horizontal Paths (Type 1), (b) Slant Paths Between Two Altitudes H1 and H2 (Type 2), and (c) Slant Paths to Space (Type 3). For Downward Looking Paths Where HMIN < H2 < H1, Two Trajectors Are Possible As Indicated in (d) and (e). The Angle θ Corresponds to ANGLE on CARD 3. From Ref. (1).

statement will be given, indicating that the user has two choices for the problem and the shorter path (see Figure 3(d)) has been executed. Set LEN = 1 for the longer path case.

JP	= 0	for normal operation of program.
	= 1	additional printout, including a 0.1 cm^{-1} printout of data.
	= 2	partial printout at a resolution of DV.
	= 3	highest level printout includes absorption coefficients from tape.
IM	= 1	when radiosonde data are to be read in initially.
	= 0	for normal operation of program or when subsequent calculations are to be run with MODEL = 7.
NLDAT	=	number of levels to be read in for MODEL = 7.

Note that IM and NLDAT are only used when MODEL = 7 and then only on the first calculation when the atmospheric data are read from Card(s) 2A.

The parameters M1, M2, and M3 can each take any integral value between 0 and 6. Set M1 = M2 = M3 = 0 for normal operation of program. They modify or supplement the altitude profiles of temperature, water vapor, and ozone, respectively, for any given atmospheric model specified by MODEL. For example:

M1	= 1	selects the TROPICAL temperature altitude profile
	= 2	selects the MIDLATITUDE SUMMER temperature altitude profile
	= 6	selects the 1962 US STANDARD temperature altitude profile
M2	= 1	selects the TROPICAL water vapor altitude profile
	= 2	selects the MIDLATITUDE SUMMER water vapor altitude profile
	= 6	selects the 1962 US STANDARD water vapor altitude profile
M3	= 1	selects the TROPICAL ozone altitude profile
	= 2	selects the MIDLATITUDE SUMMER ozone altitude profile

R	=	radius of the earch (km) at the particular geographical location at which the calculation is to be performed.

If R is left blank, the program will use the midlatitude value of 6371.23 km when MODEL is set equal to 0 to 7. Otherwise, the earth radius for the appropriate standard model atmosphere (specified by MODEL) will be used.

When MODEL = 0 or 7, the new atmosphere (model or radiosonde data) is inserted between CARDS 2 and 3.

3.2.2 CARD 2: IRAD, EMIS, TBACK, NTS, NTP, NRS, NRP, XOR, YOR

This card is in addition to the LOWTRAN input cards. It determines whether atmospheric radiation is calculated and specifies the slit function and plot parameters.

IRAD	=	1/0	if radiation calculations are/are not to be made.
EMIS	=		emissivity of a background radiation source located at the beginning of the path. (Include, if IRAD = 1.)
TBACK	=		temperature (in degrees Kelvin) of the background radiation source. (Include, if IRAD = 1.)
NTS	=	0	when using a previously specified value.
	=	+/-1	use variable slit function on transmittance and plot/don't plot.
	=	+/-3	don't use any slit function (leave points as they are) for transmittance and plot/don't plot.
NTP	=	+1	plot transmittance vs cm^{-1}.
	=	-1	plot transmittance vs microns.
NRS	=	0	±1, ±3 (same as NTS, for radiation).
NRP	=	±1	(same as NTP, for radiation).
XOR YOR	=		coordinates (in inches) for the lower left corner of the plot.

The background radiation source is calculated using the temperature dependence of the blackbody function and a surface emissivity given by EMIS. Radiation from this gray body source is then propagated through the atmosphere from H1 to H2.

It should be noted that all transmittance and radiation calculations for all of the various cases are made and written to an output file, before any slit functions are used or plotting software is employed. The external file is associated with FORTRAN logical unit 9. After the transmittance and radiation calculations for all of the cases have been written to unit 9, it is rewound and used as input for the slit function and plotting subroutines. For degrading and plotting, the order of processing then proceeds as follows: CASE 1 transmittance, CASE 2 transmittance, ..., CASE N transmittance, CASE 1 radiation, CASE 2 radiation, ..., Case N radiation. This is illustrated in the following matrix:

NTS (CASE 1),	NTP (CASE 1)
NTS (CASE 2),	NTP (CASE 2)
.	.
.	.
.	.
.	.
NTS (CASE N),	NTP (CASE N)
NRS (CASE 1),	NRP (CASE 1)
NRS (CASE 2),	NRP (CASE 2)
.	.
.	.
.	.
.	.
NRS (CASE N),	NRP (CASE N)

Briefly, Column 1 monitors the present slit function being used and whether or not to plot. Column 2 determines the units if the user has chosen to plot.

Once a particular slit function has been specified in Column 1; under the NTS or NRS parameter, the NTS/NRS column can be left blank until a new slit function is to be used (with the exception that in going from plotting to no-plotting or vice versa the NTS/NRS parameter has be to explicitly entered).

Likewise, the NTP/NRP parameter can be left blank after being specified, until a new set of plotting units is desired. However, the NTP/NRP parameter need not be respecified following a series of no-plot options under the NTS/NRS parameter.

3.2.3 CARD 2A: (For MODEL = 0 or 7)

If MODEL = 0 and ITYPE = 1, then meteorological data for a horizontal (constant pressure) path are to be inserted between CARD 2 and CARD 3 as follows:[1]

H1, P, T, DP, RH, WH, WO, VIS, RANGE
Format (3F10.3, 2F5.1, 2E10.3, 2F10.3),

where the above parameters refer to altitude (km), pressure (mb), ambient temperature (^{o}C), dew point temperature (^{o}C), relative humidity (%), water vapor density (gm m^{-3}), ozone density (gm m^{-3}), visual range (km), and path length (km), respectively. It is only necessary to specify the quantities underlined with the solid line and one of the quantities underlined with the dashed line. The ozone density WO can be specified using the parameter M3 on CARD 1, if data are not available. In the latter case, a value will be calculated at altitude H1, based on the appropriate model atmosphere selected by M3.

If MODEL = 7 and IM = 1, then a new model atmosphere must be inserted at this point, between CARD 2 and CARD 3.[1] The number of atmospheric levels to be inserted is given by NLDAT on CARD 1. The format for atmospheric data at each of the levels is:

Z, P, T, DP, RH, WH, WO, AHAZE
Format (3F10.3, 2F5.1, 2E10.3, F10.3)

The first level should be at Z = 0.0. These parameters are the same as defined above in this subsection, excepting AHAZE, the aerosol number density (cm^{-1}). It is only necessary to specify those quantities underlined with a full line and one of the quantities underlined with the dashed line. If the aerosol number density was not measured as a function of altitude and the user wishes to include aerosol attenuation in the calculation, set IHAZE = 1 on CARD 1. In this case, MIDTRAN will use the aerosol models already contained in the program and interpolate to give aerosol number density values at the same altitudes as the radiosonde (or new model atmosphere) data. The program will then look for a sea level visual range (VIS) to be specified on CARD 3. If VIS is not specified, a 23 km sea level visual range will be assumed. If aerosol attenuation is not required, set IHAZE = 0 on Card 1 as before.

3.2.4 CARD 3: H1, H2, ANGLE, RANGE, BETA, VIS

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

H1	=	initial altitude (km)
H2	=	final altitude (km)
ANGLE	=	initial zenith angle (degrees) as measured from H1
RANGE	=	path length (km)
BETA	=	earth center angle subtended by H1 and H2 (degrees)
VIS	=	sea level visual range (km)

It is not necessary to specify every quantity given above, only those that adequately describe the problem according to the parameter ITYPE (as described below).

(1) Horizontal Paths (ITYPE = 1)
  - (a) specify H1, RANGE, and VIS only
  - (b) if nonstandard meteorological data are to be used (that is, is MODEL = 0 on CARD 1), then the radiosonde data must be specified on CARD 2A and CARD 3 is omitted.

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

(3) Slant Paths Between Two Altitudes (ITYPE = 2)

(a) specify H1, H2, ANGLE, and VIS

(b) specify H1, ANGLE, RANGE, and VIS

(c) specify H1, H2, RANGE, and VIS

(d) specify H1, H2, BETA, and VIS

For cases (b) and (c), the program will calculate H2 and ANGLE assuming no refraction and then proceed as for case (a). This method of defining the problem should be used when refraction effects are not important; for example, consider ranges of a few tens of km at zenith angles less than 80^{o}. It can also be used for larger angles (including 90^{o}) provided that the path lies within one atmospheric layer.

Leave ANGLE and RANGE blank in case 3(d). 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.

In the cases of 2(b) and 3(d) above, the subroutine, ANGLE, is called in the program to determine the appropriate input zenith angle by the LOWTRAN3 iterative technique(1) that takes atmospheric refraction into account.

3.2.5 CARD4: V1, V2, DV Format (3F10.3)

The spectral range over which transmittance data are required and the spectral increments at which the results are calculated is determined by this card.

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

V2 = final frequency in wavenumbers (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 microns.

For lower altitude paths, values of DV around 0.05 cm^{-1} give sufficient accuracy; for high altitudes, 0.02 or even 0.01 cm^{-1} is necessary.

This completes the set of cards necessary to specify one transmittance/radiation calculation. If more cases are desired, repeat the sequence. If no more cases are desired, CARD 1 with MODEL = -1 is inserted after CARD 4 and before the slit function/plot cards that are described in the next section.

3.3 Output Parameters

In the same way that the input data blocks are given in sequence, another sequence of data specifying the output format and parameters must be given. The MODEL = -1 card separates the two groups of cards. In the second sequence, the title, slit function, and plotting cards for each transmission or radiation calculation must be specified. Generally, one complete cycle in the sequence from this second section of input data is structured as follows:

CARD 5	TITLE
CARDS 6A - 6C	SLIT FUNCTION PARAMETERS
CARDS 7A - 7D	PLOTTING PARAMETERS

All of these calculations are executed in one call to subroutine LIB, which is made just prior to stopping above statement #27.

3.3.1 CARD 5: TITLE (20A4)

The title is used on the plot and is printed with no change.

3.3.2 CARDS 6:

WIDTH, SHIFT, NS	Format (2F10.5, I10)
XSS(I), I = 1, NS	Format (8F10.5)
SS(I), I = 1, NS	Format (8F10.5)

WIDTH = width of slit function in cm^{-1}

SHIFT = distance (cm^{-1}) between points at which the slit function is calculated

NS = number of (XSS, SS) points to define the slit function (max. 8)

XSS = wavenumber coordinate of slit function points

SS = weighting function values for slit function

When no slit function is desired (i.e., print the results directly), Cards 6 are omitted. This is determined by setting NTS or NRS equal to ± 3 in Card 2. An illustrative example for the generalized slit function is given in Figure 4. The results are degraded to the desired resolution by integrating over the slit function. If the same slit function is used for subsequent calculations, Cards 6 are omitted. This omission must be reflected by zeros for the NTS and NRS parameters in Card 2. Arbitrary values of SS and XSS can be used, because the slit function is normalized.

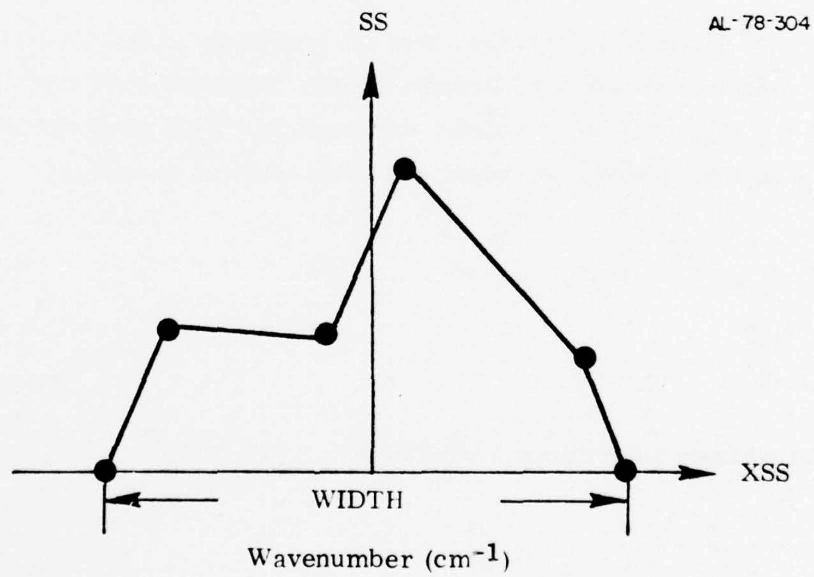


Figure 4. Example of a Generalized Slit Function Specified By Six Values of XSS and SS

3.3.3 CARDS 7:

XTITLE	Format (20A4)
YTITLE	Format (20A4)
XAXIS, XINIT, XSCALE, DXT, NMINX	Format (4E10.4, I10)
YAXIS, YINIT, YSCALE, DYT, NMINY	Format (4E10.4, I10)

XTITLE	=	Title for abscissa units
YTITLE	=	Title for ordinate units
XAXIS	=	Length of x-axis in inches
XINIT	=	Value of x at the origin
SCALE	=	Change in value of x per inch of plot
DXT	=	x-units between major tic marks
NMINX	=	Number of minor tic marks between the major ones.

(Same definitions for y-axis.)

These plot parameters are those that are necessary to specify a plot on the PRIME 400 computer at Aerodyne Research, Inc. The user must modify these parameters and their definition in order to be compatible with his plotting software. The external plotting subroutines which MIDTRAN expects to find are:

AXIS,
PLOT,
INIT, and
ENDPLT.

They are called from subroutines LIB, FRAME, and PROUT.

4. COMPARISON TO DATA

Comparison of atmospheric transmittance calculated using MIDTRAN is made to data taken by NRL.[7] The comparisons show that the code is able to calculate the data's spectral structure. Figure 5 shows NRL data taken for a 5.12 km sea level horizontal path at a spectral resolution of 0.08 cm^{-1} and a MIDTRAN calculation performed at a resolution of 0.01 cm^{-1} and degraded to 0.08 cm^{-1} using a triangular slit function. The calculations combine the molecular spectral structure of a HITRAN calculation and the H_2O and N_2 continuum components from LOWTRAN. This yields a calculated spectra that compares favorably with the data.

Figure 6 shows a comparison to the same data but on an expanded scale in the 2385 - 2450 cm^{-1} spectral region. This illustrates the fall-off in the transmittance as one moves in towards the 4.3 μm CO_2 band. The CO_2 spectral absorption coefficients in this region include the tail contribution from all lines in the CO_2 band. The form factor of Kaplan, et al.[6] was used to modify the Lorentz lineshape. The calculations have the correct roll-off as exhibited by the data but underestimate the strength of this effect. Since the difference between the calculated and measured spectra decreases as one moves away from the CO_2 band, the difference is most likely due to the modeling of the CO_2 form factor. The parameterization used by Kaplan, et al. is already larger than the form factor calculated by Burch, et al.[5] from their data, so no further changes were made to fit these data. Further theoretical studies and measurements at different atmospheric temperatures are required to better parameterize the lineshape in this region (and to verify that the strength is really due to CO_2 and not to unexpected spectral structure in the N_2 and/or H_2O continuum components).

---

[7] K. Haught and J. Dowling, "Long Path High Resolution Field Measurements of Absolute Transmission in the 3.5 to 4.0 μm Atmospheric Window," Optics Letters, **1**, 121 (1977).

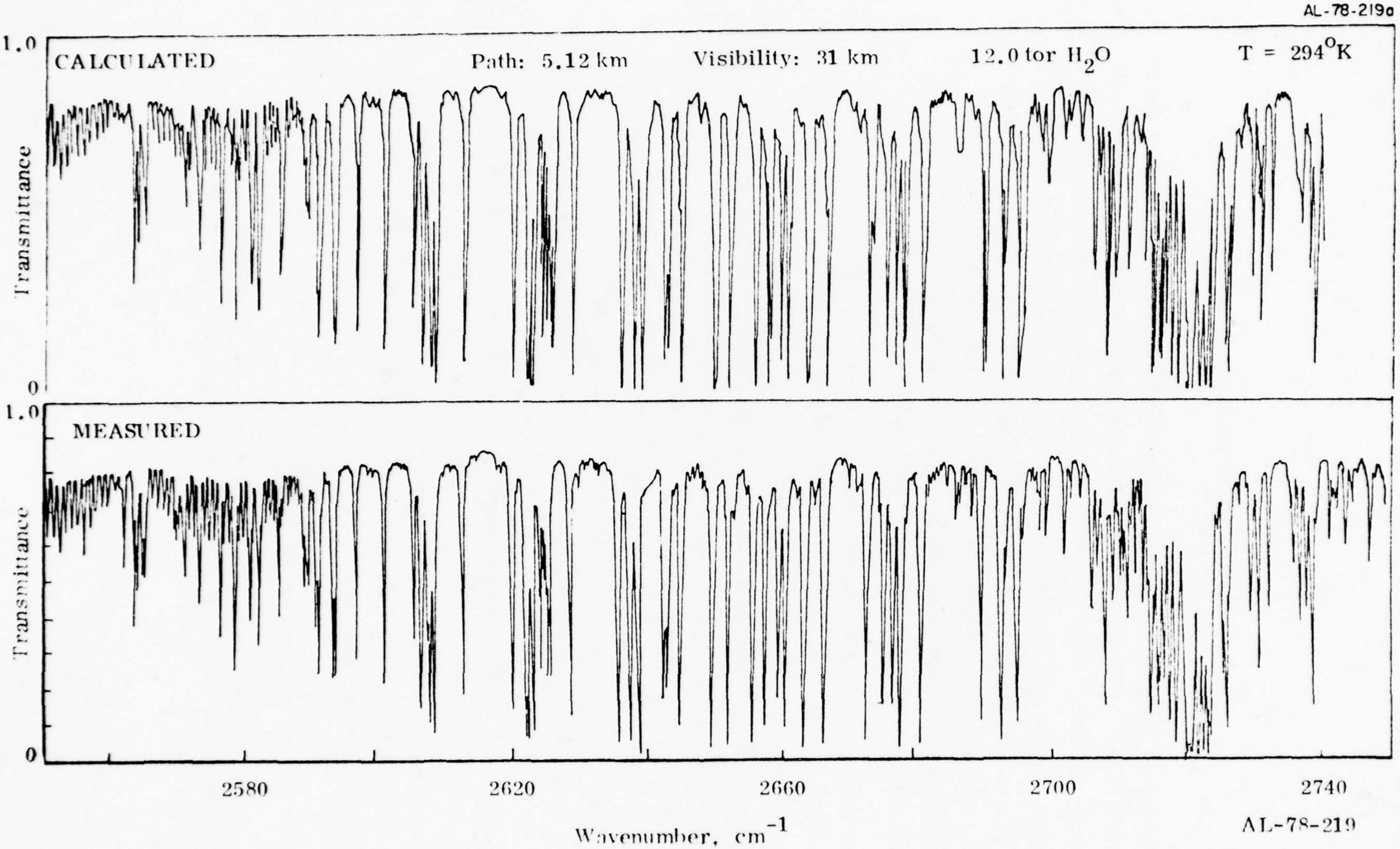


Figure 5. Comparison of NRL Data and a MIDTRAN Calculation for a 5.12 km Horizontal Sea Level Path in the 2550 - 2750 cm^{-1} Spectral Region

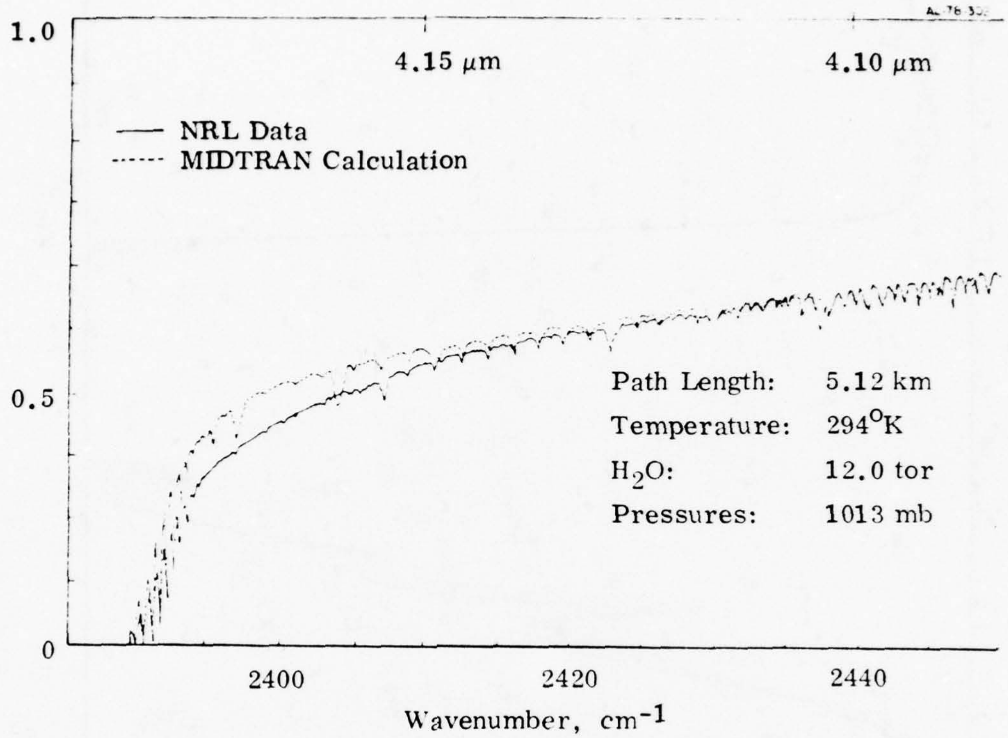


Figure 6. Comparison of NRL Data and MIDTRAN Calculation for a 5.12 km Path at Sea Level From 2385 to 2450 cm^{-1}

Figure 7 shows a comparison of AFGL data and MIDTRAN calculations for the transmittance to space from an altitude of 8.5 km. The transmittance data, which were taken from the AFGL KC135A flying laboratory, are obtained by measuring the solar spectrum and then dividing out the solar irradiance to obtain the atmospheric transmittance. The data were taken in the vicinity of Johnston Island in the Pacific. Local radiosonde data were obtained. The spectral resolution of the AFGL interferometer is 3.8 cm^{-1}.[4]

The MIDTRAN calculation was done at a spectral resolution of 0.01 cm^{-1} and then degraded to 3.8 cm^{-1} using the actual slit function of the AFGL interfereometer. The calculation used local radiosonde data for the lower altitudes and the Tropical

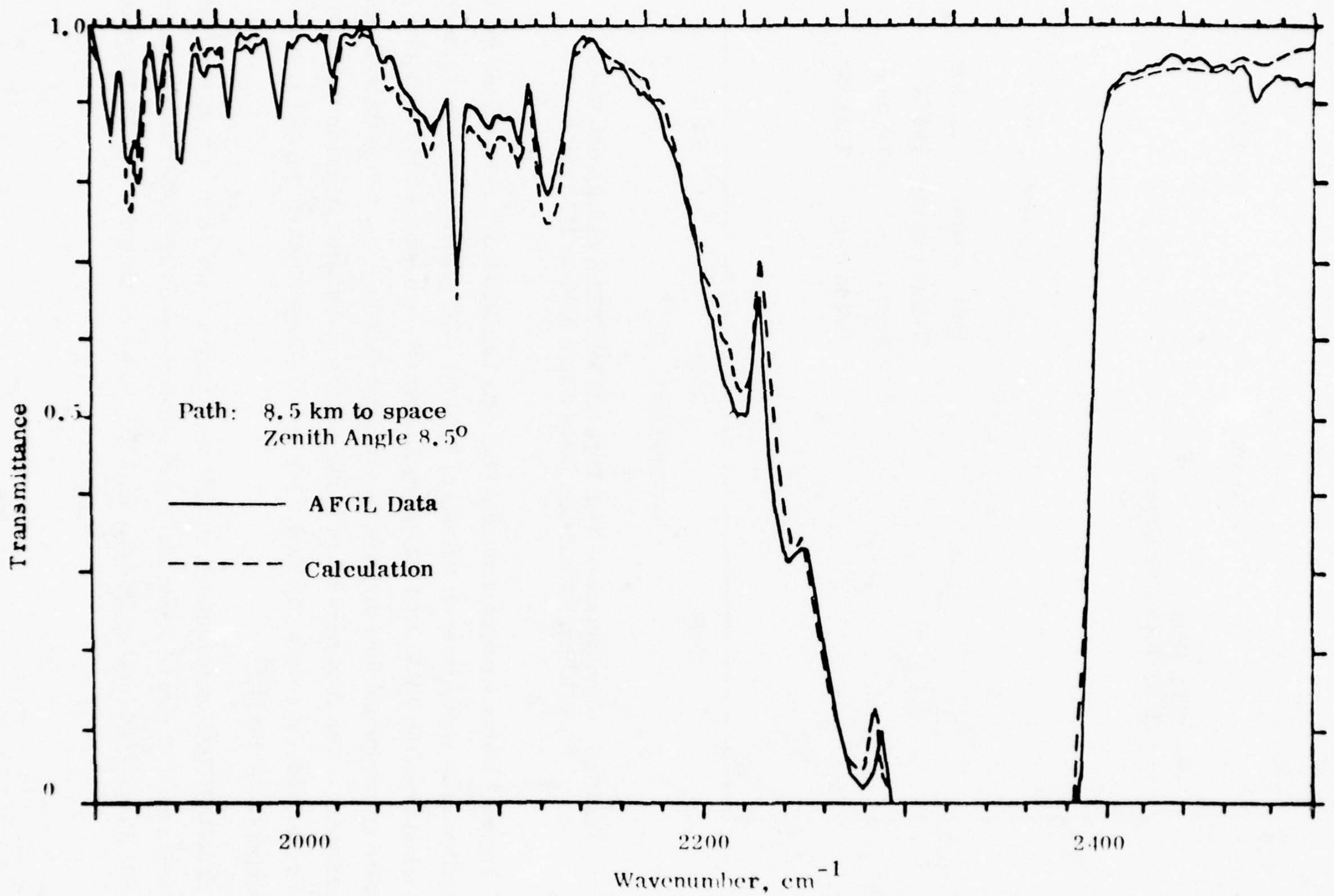


Figure 7. Atmospheric Transmittance Spectra From 8.0 km to Space. The Data Were Taken From the AFGL Flying Laboratory.

model atmosphere[1] for the high altitudes. Table I shows the layers which were used in the calculation. The radiosonde is not able to measure atmospheric water vapor concentrations when the dew point depression temperature becomes less than -30°. Thus, the radiosonde inputs resulted in too much H_2O absorption around 2000 cm^{-1}; the much lower H_2O concentrations listed in Table I bring the calculations and data into better agreement. The ozone profile is that of the Tropical Atmospheric model.

TABLE I - Model Atmosphere Used for the MIDTRAN Calculation Shown in Figure 7. It is Based on Local Radiosonde Data Supplemented by the Tropical Model Atmosphere.

Altitude (km)	Pressure (mb)	Temperature (°C)	H_2O_3 gm/m^3	O_3 gm/m^3
0.	1013.	15.	0.29 (+02)	0.560 (-04)
4.658	581.	0.5	0.74 (-01)	0.457 (-04)
4.968	559.	0.1	0.61 (-01)	0.451 (-04)
5.850	500.	-5.6	0.46 (-01)	0.433 (-04)
6.530	453.	-11.6	0.39 (-01)	0.419 (-04)
6.854	439.	-12.6	0.36 (-01)	0.413 (-04)
7.560	400.	-18.4	0.31 (-01)	0.399 (-04)
9.640	300.	-35.2	0.17 (-01)	0.390 (-04)
10.548	263.	-40.0	0.12 (-01)	0.401 (-04)
10.890	250.	-42.0	0.93 (-02)	0.408 (-04)
12.360	200.	-52.6	0.25 (-02)	0.437 (-04)
14.160	150.	-66.6	0.80 (-03)	0.453 (-04)
14.617	139.	-70.2	0.70 (-03)	0.462 (-04)
16.550	100.	-75.8	0.52 (-03)	0.581 (-04)
16.846	95.	-76.4	0.52 (-03)	0.605 (-04)
18.307	74.	-70.4	0.52 (-03)	0.103 (-03)
18.630	70.	-72.0	0.51 (-03)	0.119 (-03)
20.650	50.	-64.6	0.49 (-03)	0.221 (-03)
22.694	36.	-56.8	0.53 (-03)	0.307 (-03)
23.054	34.	-59.0	0.54 (-03)	0.321 (-03)
23.643	31.	-51.8	0.58 (-03)	0.333 (-03)
23.850	30.	--51.8	0.59 (-03)	0.337 (-03)
26.510	20.	-46.6	0.58 (-03)	0.306 (-03)
28.453	15.	-38.4	0.45 (-03)	0.267 (-03)
29.431	13.	-41.2	0.40 (-03)	0.250 (-03)
31.218	10.	-39.8	0.30 (-03)	0.190 (-03)
40.000	3.05	-19.2	0.43 (-04)	0.410 (-04)
50.000	0.85	-3.2	0.63 (-05)	0.430 (-05)
70.000	0.06	-54.2	0.14 (-06)	0.860 (-07)
100.000	0.00	-63.2	0.10 (-8)	0.430 (-10)
99999.000	0.00	-63.2	0.10 (-10)	0.

5. REFERENCES

1. J. Selby and R. McClatchy, "Atmospheric Transmittance From 0.35 to 28.5 μm; Computer Code LOWTRAN3," Rept. No. AFCRL-TR-75-0255, AFGL/OPI, Hanscom AFB, Mass., May 1975.

2. R. McClatchy, et al., "AFCRL Atmospheric Absorption Line Parameters Compilation," AFCRL-TR-73-0096, AFGL/OPI, Hanscom AFB, Mass., January 1973.

3. D. Kryger and D. Robertson, "MRDA - A Medium Resolution Data Analysis Code for the HP2100 Minicomputer," AFGL-TR-77-0044, AFGL/OPR Hanscom AFB, Massachusetts 01731.

4. B. Sandford, et al., "Aircraft Signatures in the Infrared 1.2 to 5.5 Micron Region," AFGL-TR-76-0133, Air Force Geophysics Laboratory (OPR), Hanscom AFB, Mass., June 1976).

5. D.E. Burch, D.A. Gryvnak, R.R. Patty, and C.E. Bartky, Journal, Optical Society of America, 59, 267, 1969.

6. L.D. Kaplan, M.T. Chahine, J. Susskind, J.E. Searl, Applied Optics, 16, 322, 1977.

7. K. Haught and J. Dowling, "Long Path High Resolution Field Measurements of Absolute Transmission in the 3.5 to 4.0 μm Atmospheric Window," Optics Letters, 1, 121 1977.

APPENDIX A

MIDTRAN PROGRAM LISTING

```
C      PROGRAM MIDTRAN(INPUT,OUTPUT,TAPE5=INPUT,TAPE7,TAPE6=OUTPUT,
C     &TAPE9,TAPE21=12Ø)
C
C
C
       IMPLICIT DOUBLE PRECISION (A-H,O-Z)
       REAL*4 XORG,YORG
       REAL*4 RAD,FNU,TRAN1,TRANS
       REAL*4 SPY1,SPY2
       COMMON Z(34),P(7,34),T(7,34),EH(1Ø,34),WH(7,34),M,NL,RE,CW,CO,PI
       COMMON/BLOCK1/VTAU,TAU1
       COMMON/BLOCK2/RAD,FNU,TRAN1,TRANS
       COMMON/BLOCK3/C1,FRAD
       DIMENSION WO(7,34),HZ1(34),HZ2(6),AHAZE(34),AHZ2(2Ø)
       DIMENSION TR(67),FW(67),FO(67),HZ(2,2),TX(12),VH(1Ø),W(1Ø),E(1Ø)
       DIMENSION C1(258Ø), C2(1575), C3(54Ø), C4(133), C5(15), C8(1Ø2)
       DIMENSION VX(45),C7(45),C7A(45)
       DIMENSION TEMP(66),PRES(66),ALT(66),LYR(66),KPTS(3,66),NUM(6)
       DIMENSION CON(6),SPEC(6,2),PP(9),TTT(9),WW(64,1Ø),WGAS(64)
       DIMENSION WO3(64),WH2Ø(64)
       DIMENSION AK(9,65Ø),FAC5(2)
       DIMENSION TAU(2ØØ),VV(65Ø),FAC6(6),TAU1(4ØØØ),VTAU(4ØØØ)
       DIMENSION FNU(5ØØ),TRANS(5ØØ)
       DIMENSION FAC2(66),HZZ(6)
       DIMENSION RAD(4ØØØ),FRAD(5ØØ),TRAN1(4ØØØ)
       DIMENSION MAX(2),NEWS(2,1Ø),NEWP(2,1Ø)
       DATA ENDF/-1.Ø/,NFILES/Ø/,MAX/Ø,Ø/,XORG/Ø.Ø/,YORG/Ø.Ø/
       DATA CON/Ø.Ø,.33E-3,Ø.Ø,.28E-6,.75E-7,1.6E-6/
       DATA HZ(1,1)/2H23/,HZ(1,2)/2HKM/,HZ(2,1)/2H 5/,HZ(2,2)/2HKM/
       BLAM(T,V)=1.1989E-12*V**3/(DEXP(1.4388*V/T)-1.Ø)
       F(A)=DEXP(18.9766-14.9595*A-2.43832*A*A)*A
       F1(Y1,Y2,X1,X2,X)=Y1+(Y2-Y1)*(X-X1)/(X2-X1)
       SPF1(SPY1,SPY2,X1,X2,X)=SPY1+(SPY2-SPY1)*(X-X1)/(X2-X1)
C*************************************************************************
C      PROGRAM  MIDTRAN  CALCULATES THE TRANSMITTANCE OF THE ATMOSPHERE
C      FROM 18ØØ CM-1 TO 6ØØØ CM-1 (1.67 TO 6.5Ø MICRONS) AT A VARIABLE
C      SPECTRAL RESOLUTION ON A LINEAR WAVENUMBER SCALE.
C      REFRACTION AND EARTH CURVATURE EFFECTS ARE INCLUDED.    ATMOSPHERE
C      IS LAYERED IN ONE KM. INTERVALS BETWEEN Ø AND 25 KM., 5 KM. INTER-
C      VALS TO 5Ø KM., A TWENTY KM. INTERVAL TO 7Ø KM., AND A THIRTY KM.
C      INTERVAL TO 1ØØ KM.
C*************************************************************************
C      PROGRAM ACTIVATED BY SUBMISSION OF TWO SEPARATE SECTIONS OF INPUT.
C
C      FIRST SECTION OF INPUT DATA USES A REPEATING FOUR CARD SEQUENCE
C    CARD 1 MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO FORMAT(1ØI3,F1Ø
C    CARD 2 IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR  FORMAT(I1Ø,2F1Ø.3,
C           4I5,2F1Ø.3)
C    CARD 3 H1,H2,ANGLE,RANGE,BETA,VIS                    FORMAT(7F1Ø.3)
C    CARD 4 V1, V2, DV                                    FORMAT(7F1Ø.3)
C
```

```
C     MODEL=1,2,3,4,5 OR 6 SELECTS ONE OF THE FOLLOWING MODEL ATMOSPHEREMA 00520
C     TROPICAL,MIDLATITUDE SUMMER,MIDLATITUDE WINTER,SUBARCTIC SUMMER,  MA 00530
C     SUBARCTIC WINTER,OR THE 1962 U.S.  STANDARD RESPECTIVELY          MA 00540
C     MODEL=-1 TO END FIRST SECTION OF INPUT DATA                       MA 00550
C     MODEL=0 FOR HORIZ. PATH WHEN METEOROL. DATA USED\INSTEAD OF CARD 3MA 00560
C     READ H1,P(MB),T(DEG C),DEW PT.TEMP(DEG C),%REL HUMIDITY,H2O DENSITMA 00570
C     (GM.M-3),O3 DENSITY(GM.M-3), VIS(KM),RANGE(KM) WITH FORMAT 429.   MA 00580
C     MODEL=7 WHEN NEW MODEL ATMOSPHERE(E.G. RADIOSONDE DATA) USED.     MA 00590
C     DATA CARDS ARE READ IN BETWEEN CARDS 2 AND 3, AND SHOULD CONTAIN\ MA 00600
C     ALTITUDE(KM.),PRESSURE,TEMP,DEW PT.TEMP,REL. HUMIDITY,H2O DENSITY,MA 00610
C     O3 DENSITY,AEROSOL NO. DENSITY(CM-3) ACCORDING TO FORMAT 9110     MA 00620
C     NOTE THAT EITHER DEW PT. TEMP.OR REL. HUMIDITY CAN BE USED.       MA 00630
C                                                                       MA 00640
C     M1,M2,M3, ARE USED TO CHANGE TEMP,H2O, AND O3 ALTITUDE PROFILES.  MA 00650
C                                                                       MA 00660
C     IF IHAZE=0 NO AEROSOL SCATTERING IS COMPUTED                      MA 00670
C     IHAZE =1 IF AEROSOL ATTENUATION REQUIRED (THIS IS USED IN         MA 00680
C     CONJUNCTION WITH VISUAL RANGE(SEE CARD 3))                        MA 00690
C     IHAZE = 1 OR 2 ALSO GIVE AEROSOL ATTENUATION FOR 23KM AND 5KM VIS.MA 00700
C     HAZE MODELS RESPECTIVELY IF VIS =0 ON CARD 3                      MA 00710
C                                                                       MA 00720
C     ITYPE=1,2  OR 3 INDICATES THE TYPE OF ATMOSPHERIC PATH            MA 00730
C     ITYPE=3,VERTICAL OR SLANT PATH TO SPACE                           MA 00740
C     ITYPE=2,VERTICAL OR SLANT PATH BETWEEN TWO ALTITUDES              MA 00750
C     ITYPE=1, CORRESPONDS TO A HORIZONTAL (CONSTANT PRESSURE) PATH     MA 00760
                                                                        MA 00770
C     IRAD=1/0, CALCULATE/DONT CALCULATE RADIATION                      MA 00780
C     EMIS=EMISSIVITY OF A BACKGROUND RADIATION SOURCE LOCATED AT THE   MA 00790
C           BEGINNING OF THE ATMOSPHERIC PATH.                          MA 00800
C     TBACK=TEMPERATURE(KELVIN) OF A BACKGROUND RADIATION SOURCE        MA 00810
C            LOCATED AT THE BEGINNING OF THE ATMOSPHERIC PATH.          MA 00820
C     NTS=1/-1, USE GENERAL SLIT FUNCTION AND PLOT/DONT PLOT TRANS.     MA 00830
C        -2/-2, USE SPECIAL AFGL SLIT FUNCTION AND PLOT/DONT PLOT TRANS.MA 00840
C        =3/-3, USE NO SLIT FUNCTION AND PLOT/DONT PLOT TRANS.          MA 00850
C        =0, USE LAST SLIT FUNCTION USED, USE LAST PLOTTING STATUS.     MA 00860
C     NTP=1, PLOT USING CM-1 VS TRANSMITTANCE                           MA 00870
C        =-1, PLOT USING MICRONS VS. TRANSMITTANCE                      MA 00880
C        =0, CONTINUE PLOTTING IN THE LAST UNITS USED.                  MA 00890
C     NRS(SAME AS NTS, BUT FOR RADIATION)                               MA 00900
C     NRP=1, PLOT USING CM-1 VS RADIATION/CM-1                          MA 00910
C        =-1, PLOT USING MICRONS VS RADIATION/MICRONS                   MA 00920
C        =0, CONTINUE PLOTTING IN THE LAST UNITS USED.                  MA 00930
C     XOR= INITIAL HORIZONTAL SETTING IN INCHES FOR PLOT.               MA 00940
C     YOR= INITIAL VERTICAL SETTING IN INCHES FOR PLOT.                 MA 00950
C                                                                       MA 00960
C     H1=OBSERVER ALTITUDE (KM)                                         MA 00970
C     H2=SOURCE  ALTITUDE (KM)                                          MA 00980
C     ANGLE= ZENITH ANGLE AT H1 (DEGREES)                               MA 00990
C     RANGE=PATH LENGTH (KM)                                            MA 01000
C     BETA=EARTH CENTRE ANGLE                                           MA 01010
C     VIS = VISUAL RANGE AT SEA LEVEL (KM)                              MA 01020
C     (IF ITYPE=1 READ H1 AND RANGE;IF ITYPE=3 READ H1 AND ANGLE.       MA 01030
C     IF ITYPE=2 READ H1 AND TWO OTHER PARAMETERS E.G. H2 AND ANGLE)    MA 01040
C                                                                       MA 01050
```

```
C     V1=INITIAL FREQUENCY (WAVENUMBER CM-1 ) INTEGER VALUE               MA 01060
C     V2=FINAL FREQUENCY(WAVENUMBER CM-1 ) INTEGER VALUE                  MA 01070
C     DV= FREQUENCY INTERVALS AT WHICH TRANSMITTANCE IS CALCULATED        MA 01080
C                                                                         MA 01090
C     SECOND SECTION OF INPUT DATA USES A REPEATING FORMAT AS FOLLOWS:    MA 01100
C   CARD 1 TITLE                                         FORMAT(20A4)     MA 01110
C   CARD 2(A,B,C) SLIT FUNCTION DATA CARDS (VARIES WITH SLIT FUNCTION)    MA 01120
C     GENERAL SLIT FUNCTION                                               MA 01130
C   CARD 2A WIDTH,SHIFT,NS                          FORMAT(2F10.5,2I10)   MA 01140
C   CARD 2B XSS(I),I=1,NS                           FORMAT(8F10.5)        MA 01150
C   CARD 2C SS(I),I=1,NS                            FORMAT(8F10.5)        MA 01160
C     SPECIAL AFGL SLIT FUNCTION                                          MA 01170
C   CARD 2 DELNU,RES,JLO,JHI                        FORMAT(2F10.5,2I10)   MA 01180
C     NO SLIT FUNCTION                                                    MA 01190
C   (NO CARD)                                                             MA 01200
C     PLOTTING DATA CARDS                                                 MA 01210
C   CARD 3A XTITLE                                  FORMAT(20A4)          MA 01220
C   CARD 3B YTITLE                                  FORMAT(20A4)          MA 01230
C   CARD 3C XAXIS,XINIT,XSCALE,DXT,NMINX            FORMAT(4E10.4,I10)    MA 01240
C   CARD 3D YAXIS,YINIT,YSCALE,DYT,NMINY            FORMAT(4E10.4,I10)    MA 01250
                                                                          MA 01260
                                                                          MA 01270
C     TITLE= HEADER FOR PRINTOUT AND TOP TITLE FOR PLOT IF THERE IS ONE MA 01280
                                                                          MA 01290
C     WIDTH= SLIT WIDTH TO BE USED ON DATA                                MA 01300
C     SHIFT= DISTANCE IN CM-1 BETWEEN SLIT FUNCTION CALCULATION POINTS    MA 01310
C     NS= NUMBER OF (XSS,SS) PAIRS DEFINING SLIT FUNCTION                 MA 01320
C     XSS= X CO-ORDINATES OF POINTS DEFINING SLIT FUNCTION                MA 01330
C     SS= Y CO-ORDINATES OF POINTS DEFINING SLIT FUNCTION                 MA 01340
                                                                          MA 01350
C     DELNU= SAMPLING INTERVAL(CM-1)                                      MA 01360
C     RES= RESOLUTION(CM-1) OF DATA TO BE PROCESSED                       MA 01370
C     JLO= BEGINNING CHANNEL(VLOW/DELNU)                                  MA 01380
C     JHI= ENDING CHANNEL(VHIGH/DELNU)                                    MA 01390
                                                                          MA 01400
C     XTITLE= LABEL FOR HORIZONTAL PLOT UNITS                             MA 01410
C     YTITLE= LABEL FOR VERTICAL PLOT UNITS                               MA 01420
C     XAXIS,YAXIS= LENGTH IN INCHES OF THE HORZ., VERT. AXES              MA 01430
C     XINIT,YINIT= VALUES IN HORZ., VERT. UNITS AT ORIGIN                 MA 01440
C     XSCALE,YSCALE= HORZ., VERT. UNITS/INCH.                             MA 01450
C     DXT,DYT= HORIZ., VERT. UNITS BETWEEN MAJOR(LABELED) TIC MARKS       MA 01460
C     NMINX,NMINY= NUMBER OF MINOR TIC MARKS BETWEEN MAJOR TICS           MA 01470
                                                                          MA 01480
C     THE SECOND SECTION OF INPUT DATA IS TO BE SET UP IN ACCORDANCE      MA 01490
C     WITH THE FOLLOWING MATRIX:                                          MA 01500
                                                                          MA 01510
C     NTS(CASE1),NTP(CASE1)  (IE. TRANSMITTANCE,CASE1)                    MA 01520
C     NTS(CASE2),NTP(CASE2)  (IE. TRANSMITTANCE,CASE2)                    MA 01530
C                                                                         MA 01540
C     NTS(CASEN),NTP(CASEN)  (IE. TRANSMITTANCE,CASEN)                    MA 01550
C     NRS(CASE1),NRP(CASE1)  (IE. RADIATION,CASE1)                        MA 01560
C     NRS(CASE2),NRP(CASE2)  (IE. RADIATION,CASE2)                        MA 01570
C                                                                         MA 01580
C     NRS(CASEN),NRP(CASEN)  (IE. RADIATION,CASEN)                        MA 01590
                                                                          MA 01600
                                                                          MA 01610
```

```
C      TRANSMITTANCE AND RADIATION CASES ARE DEGRADED AND PLOTTED IN
C      THE ORDER OF THE ABOVE MATRIX, WITH EACH ROW CORRESPONDING TO A
C      CARD 1-3 SEQUENCE OF INPUT DATA WHICH MUST BE INCLUDED. THE
C      FOLLOWING RULES ARE HELPFUL IN DETERMINING THE VALUES WHICH
C      NTS,NTP,NRS,NRP SHOULD INITIALLY HAVE ON CARD 2 IN THE FIRST
C      SECTION OF INPUT DATA:

C      CARD 1  TITLE, MUST BE INCLUDED IN EVERY CARD 1-3 SEQUENCE.
C      CARD 2  MUST BE OMITTED, IF HAVE A ZERO IN THE NTS/NRS
C              COLUMN(IE. USE SAME SLIT FUNCTION)
C      CARD 2  MUST BE OMITTED, IF THE NEW NTS/NRS VALUE IS EQUAL TO
C              MINUS THE OLD NTS/NRS VALUE(IE. USE SAME SLIT FUNCTION,
C              BUT CHANGE PLOTTING STATUS)
C      CARD 3  MUST BE OMITTED, IF HAVE A ZERO IN THE NTP/NRP COLUMN(IE.
C              USE THE LAST PLOT PARAMETERS READ IN)
C*********************************************************************
C
C
C
      READ (7,9Ø1Ø) IATM,NL
      READ (7,9Ø2Ø) (HZ1(I),I=1,NL)
      READ (7,9Ø2Ø) (HZ2(I),I=1,5)
      HZ2(6)=HZ1(6)

      DO 15 J=1,3
      K2=2*J
      K1=K2-1
      DO 1Ø L=1,NL
      READ (7,9Ø3Ø) Z(L),(P(K,L),T(K,L),WH(K,L),WO(K,L),K=K1,K2)
   1Ø CONTINUE
   15 CONTINUE

      READ (7,9Ø4Ø) (VX(L),C7(L),C7A(L),L=1,44)
      READ (7,9Ø5Ø) (TR(L),FW(L),FO(L),L=1,67)
      READ (7,9Ø6Ø) (C1(L),L=1,258Ø)
      READ (7,9Ø6Ø) (C2(L),L=1,1575)
      READ (7,9Ø6Ø) (C3(L),L=1,54Ø)
      READ (7,9Ø7Ø) (C4(L),L=1,133)
      READ (7,9Ø6Ø) (C5(L),L=1,15)
      READ (7,9Ø7Ø) (C8(L),L=1,1Ø2)
      PI=2.Ø*DASIN(1.Ø)
      CA=PI/18Ø.
      IP=Ø
   2Ø CONTINUE

C **********      PROGRAM STOPS HERE    ************
```

```
      RE=6371.23                                                        MA Ø2Ø9Ø
      IFIND=Ø                                                           MA Ø21ØØ
      READ(5,9Ø1Ø) MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO        MA Ø211Ø
      IF(MODEL.GE.Ø) GO TO 27                                           MA Ø212Ø
      CALL LIB(NEWS,NEWP,MAX,NFILES,XORG,YORG)                          MA Ø213Ø
      STOP22                                                            MA Ø214Ø
                                                                        MA Ø215Ø
   27 IF(JP.LT.1) GO TO 28                                              MA Ø216Ø
      WRITE(6,9Ø1Ø) MODEL,IHAZE,ITYPE,LEN,JP,IM,M1,M2,M3,NLDAT,RO       MA Ø217Ø
   28 READ(5,9Ø75) IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR              MA Ø218Ø
      IF(JP.LT.1) GO TO 29                                              MA Ø219Ø
      WRITE(6,9Ø75) IRAD,EMIS,TBACK,NTS,NTP,NRS,NRP,XOR,YOR             MA Ø22ØØ
   29 IF(NFILES.NE.Ø) GO TO 3Ø                                          MA Ø221Ø
      XORG=XOR                                                          MA Ø222Ø
      YORG=YOR                                                          MA Ø223Ø
   3Ø M=MODEL                                                           MA Ø224Ø
      IF (M.EQ.1) RE=6378.39                                            MA Ø225Ø
      IF (M.EQ.4) RE=6356.91                                            MA Ø226Ø
      IF (M.EQ.5) RE=6356.91                                            MA Ø227Ø
      NFS1=NFILES+1                                                     MA Ø228Ø
      MAX(1)=NFS1                                                       MA Ø229Ø
      IF(IRAD.EQ.Ø) GO TO 35                                            MA Ø23ØØ
      WRITE(6,9Ø85) EMIS,TBACK                                          MA Ø231Ø
      MAX(2)=NFS1                                                       MA Ø232Ø
      GO TO 45                                                          MA Ø233Ø
   35 XRAD=Ø.Ø                                                          MA Ø234Ø
                                                                        MA Ø235Ø
      DO 4Ø I=1,4ØØØ                                                    MA Ø236Ø
      RAD(I)=Ø.Ø                                                        MA Ø237Ø
   4Ø CONTINUE                                                          MA Ø238Ø
                                                                        MA Ø239Ø
      NRS=-11                                                           MA Ø24ØØ
   45 NEWS(1,NFS1)=NTS                                                  MA Ø241Ø
      NEWS(2,NFS1)=NRS                                                  MA Ø242Ø
      NEWP(1,NFS1)=NTP                                                  MA Ø243Ø
      NEWP(2,NFS1)=NRP                                                  MA Ø244Ø
      IF(RO.NE.Ø.Ø) RE=RO                                               MA Ø245Ø
      IF(M.EQ.7.AND.IM.NE.Ø)GO TO 7Ø                                    MA Ø246Ø
      IF (MODEL.EQ.Ø) GO TO 7Ø                                          MA Ø247Ø
   5Ø READ(5,9Ø8Ø)  H1,H2,ANGLE,RANGE,BETA,VIS                          MA Ø248Ø
      WRITE(6,9Ø9Ø) H1,H2,ANGLE,RANGE,BETA,VIS                          MA Ø249Ø
      X1=RE+H1                                                          MA Ø25ØØ
      IF (ITYPE.EQ.3) GO TO 11Ø                                         MA Ø251Ø
      IF (ITYPE.EQ.1) GO TO 16Ø                                         MA Ø252Ø
      X2=RE+H2                                                          MA Ø253Ø
      IF (RANGE.EQ.Ø.) GO TO 13Ø                                        MA Ø254Ø
      WRITE(6,91ØØ)  H1,H2,ANGLE,RANGE,BETA,VIS                         MA Ø255Ø
      IF (H2.EQ.Ø.AND.ANGLE.NE.Ø) GO TO 6Ø                              MA Ø256Ø
      ANGLE=DACOS(Ø.5*((H2-H1)*(1.+X2/X1)/RANGE-RANGE/X1))/CA           MA Ø257Ø
      GO TO 15Ø                                                         MA Ø258Ø
   6Ø X2=DSQRT((X1/RANGE+RANGE/X1+2.Ø*DCOS(ANGLE*CA))*X1*RANGE)         MA Ø259Ø
      H2=X2-RE                                                          MA Ø26ØØ
      GO TO 15Ø                                                         MA Ø261Ø
   7Ø CONTINUE                                                          MA Ø262Ø
      IF(NLDAT.LE.Ø)NLDAT=1                                             MA Ø263Ø
                                                                        MA Ø264Ø
                                                                        MA Ø265Ø
```

```
      DO 100 L=1,NLDAT                                                  MA 02660
      AHAZE(L)=0.0                                                      MA 02670
      IF(M.EQ.0) READ(5,9110) H1,P(7,1),TMP,DP,RH,WH(7,L),WO(7,L),VIS,  MA 02680
     X RANGE                                                            MA 02690
      IF(M.EQ.0) WRITE(6,9115) H1,P(7,1),TMP,DP,RH,WH(7,L),WO(7,L),VIS, MA 02700
     X RANGE                                                            MA 02710
      IF(M.GT.0) READ(5,9110) Z(L),P(7,L),TMP,DP,RH,WH(7,L),WO(7,L),    MA 02720
     X AHAZE(L)                                                         MA 02730
      IF(M.EQ.0)Z(L)=H1                                                 MA 02740
      J=IFIX(Z(L)+1.0E-6)+1.                                            MA 02750
      IF(Z(L).GE.25.0) J=(Z(L)-25.0)/5.0+26.                            MA 02760
      IF(Z(L).GE.50.0) J=(Z(L)-50.0)/20.0+31.                           MA 02770
      IF(Z(L).GE.70.0) J=(Z(L)-70.0)/30.0+32.                           MA 02780
      IF(J.GT.33)J=33                                                   MA 02790
      FAC=Z(L)-FLOAT(J-1)                                               MA 02800
      IF(J.LT.26) GO TO 80                                              MA 02810
      FAC=(Z(L)-5.0*FLOAT(J-26)-25.)/5.                                 MA 02820
      IF(J.GE.31) FAC=(Z(L)-50.0)/20.                                   MA 02830
      IF(J.GE.32) FAC=(Z(L)-70.0)/30.                                   MA 02840
      IF(FAC.GT.1.0) FAC=1.0                                            MA 02850
   80 K=J+1                                                             MA 02860
      T(7,L)=TMP+273.15                                                 MA 02870
      IF(M1.GT.0)T(7,L)=T(M1,J)*(T(M1,K)/T(M1,J))**FAC                  MA 02880
      TT=273.15/T(7,L)                                                  MA 02890
      IF(RH.LE.0.0) TT=273.15/(273.15+DP)                               MA 02900
      IF(WH(7,L).LE.0.0) WH(7,L)=F(TT)                                  MA 02910
      IF(M2.GT.0)WH(7,L)=WH(M2,J)*(WH(M2,K)/WH(M2,J))**FAC              MA 02920
      IF(RH.GT.0.0) WH(7,L)=0.01*RH*WH(7,L)                             MA 02930
      IF(M3.GT.0)WO(7,L)=WO(M3,J)*(WO(M3,K)/WO(M3,J))**FAC              MA 02940
      IF(Z(L).GE.5.0)GO TO 90                                           MA 02950
      IF(AHAZE(L).EQ.0.0)AHZ2(L)=HZ2(J)*(HZ2(K)/HZ2(J))**FAC            MA 02960
   90 IF(AHAZE(L).EQ.0.0)AHAZE(L)=HZ1(J)*(HZ1(K)/HZ1(J))**FAC           MA 02970
      IF(MODEL.EQ.0)GO TO 160                                           MA 02980
      IF(L.EQ.1) WRITE(6,9120)                                          MA 02990
      WRITE(6,9113) Z(L),P(7,L),TMP,DP,RH,WH(7,L),WO(7,L),AHAZE(L)      MA 03000
  100 CONTINUE                                                          MA 03010
                                                                        MA 03020
                                                                        MA 03030
      IM=0                                                              MA 03040
      NL=NLDAT                                                          MA 03050
      M1=0                                                              MA 03060
      M2=0                                                              MA 03070
      M3=0                                                              MA 03080
                                                                        MA 03090
C     NOTE THAT Z(I) MAY NOT CORRESPOND TO THE VALUES GIVEN FOR STANDARDMA 03100
C     MODEL ATMOSPHERES                                                 MA 03110
                                                                        MA 03120
      GO TO 50                                                          MA 03130
  110 IF (RANGE.GT.0.0) GO TO 120                                       MA 03140
      IF (H2.GT.0.0.AND.H2.LT.H1) IFIND=1                               MA 03150
      GO TO 160                                                         MA 03160
  120 ITYPE=2                                                           MA 03170
      BETA=DACOS(0.5*(RANGE*RANGE/(X1*X2)-X2/X1-X1/X2))/CA              MA 03180
  130 IF (BETA.EQ.0.) GO TO 140                                         MA 03190
      IFIND=1                                                           MA 03200
```

```
      BET=CA*BETA                                                       MA 03210
      X2=RE+H2                                                          MA 03220
      ANGLE=DATAN(X2*DSIN(BET)/(X2*DCOS(BET)-X1))/CA                    MA 03230
      RANGE=X2*DSIN(BET)/DSIN(ANGLE*CA)                                 MA 03240
      BET=BETA                                                          MA 03250
      GO TO 160                                                         MA 03260
  140 RANGE=(X2/X1)**2-(DSIN(ANGLE*CA))**2                              MA 03270
      IF (RANGE.GE.0.0) RANGE=X1*(DSQRT(RANGE)-DABS(DCOS(ANGLE*CA)))    MA 03280
  150 IF (ANGLE.NE.0..OR.ANGLE.NE.180.) BET=DASIN(RANGE*DSIN(ANGLE*CA)/ MA 03290
     &X2)                                                               MA 03300
      IF (ANGLE.LT.0.) ANGLE=ANGLE+PI                                   MA 03310
      IF (RANGE.LT.0.0) RANGE=-RANGE                                    MA 03320
      BET=BET/CA                                                        MA 03330
      WRITE(6,9100)  H1,H2,ANGLE,RANGE,BET,VIS                          MA 03340
  160 CONTINUE                                                          MA 03350
      SUMA=0.                                                           MA 03360
                                                                        MA 03370
C***   DV FOR LOWTRAN --- DVM FOR MIDTRAN                               MA 03380
                                                                        MA 03390
      DV=5.0                                                            MA 03400
      READ(5,9080) V1,V2,DVM                                            MA 03410
      IF(JP.GE.1) WRITE(6,9080) V1,V2,DV,DVM                            MA 03420
      IF (ITYPE.EQ.1) WRITE(6,9130)  H1,RANGE                           MA 03430
      IF (ITYPE.EQ.2) WRITE(6,9140) H1,H2,ANGLE                         MA 03440
      IF (ITYPE.EQ.3) WRITE(6,9150) H1,ANGLE                            MA 03450
      IF (MODEL.EQ.0) M=7                                               MA 03460
      IF(VIS.GT.0.0) WRITE(6,9160)VIS                                   MA 03470
      IF(VIS.LT.2.0.AND.VIS.GT.0.0) WRITE(6,9165)                       MA 03480
      IF (M.EQ.1) WRITE(6,9170) M                                       MA 03490
      IF (M.EQ.2) WRITE(6,9180) M                                       MA 03500
      IF (M.EQ.3) WRITE(6,9190) M                                       MA 03510
      IF (M.EQ.4) WRITE(6,9200) M                                       MA 03520
      IF (M.EQ.5) WRITE(6,9210) M                                       MA 03530
      IF (M.EQ.6) WRITE(6,9220) M                                       MA 03540
      IF (IHAZE.EQ.0.) WRITE(6,9230)                                    MA 03550
      IF(VIS.LE.0.0.AND.IHAZE.GT.0) WRITE(6,9235) IHAZE,(HZ(IHAZE,L),   MA 03560
     X L=1,2)                                                           MA 03570
      AVW=10000./V1                                                     MA 03580
      ALAM=10000./V2                                                    MA 03590
      WRITE(6,9240) V1,V2,DV,ALAM,AVW                                   MA 03600
      AVW=0.5E-4*(V1+V2)                                                MA 03610
      AVW=AVW*AVW                                                       MA 03620
      CO=77.46+.459*AVW                                                 MA 03630
      CW=43.487-0.3473*AVW                                              MA 03640
      IF (IFIND.EQ.1) GO TO 210                                         MA 03650
  170 IF (IFIND.EQ.1) CALL ANGL (H1,H2,ANGLE,BETA,LEN,NLDAT)            MA 03660
      IFIND=0                                                           MA 03670
      IF(MODEL.NE.0.OR.ITYPE.NE.1) WRITE(6,9250)                        MA 03680
      IF (ITYPE.EQ.1) GO TO 210                                         MA 03690
                                                                        MA 03700
```

```
      DO 18Ø K=1,1Ø
      VH(K)=Ø.Ø
  18Ø CONTINUE

      BETA=Ø.Ø
      SR=Ø Ø
      IP=Ø

C****  NOW DEFINE CONSTANT PRESSURE PATH QUANTITES  EH(1-8)

      Y=CA*ANGLE
      SPHI=DSIN(Y)
      R1=(RE+H1)*SPHI
      IF (H1.GT.Z(NL)) GO TO 19Ø
      GO TO 21Ø
  19Ø X=(RE+Z(NL))/(RE+H1)
      IF (SPHI.GT.X) GO TO 2ØØ
      H1=Z(NL)
      L1=NL
      SPHI=SPHI/X
      ANGLE=18Ø.Ø-DASIN(SPHI)/CA
      R1=(RE+H1)*SPHI
      GO TO 21Ø
  2ØØ HMIN=R1-RE
      WRITE(6,926Ø)  HMIN

C     ****    TEMPORARY STOP    ****

      STOP 5


  21Ø DO 24Ø L=1,NL
      PS=P(M,L)/1Ø13.Ø
      TS=273.15/T(M,L)
      IF(M1.GT.Ø.AND.M.LT.7)TS=273.15/T(M1,L)
      X=PS*TS
      PT=PS*DSQRT(TS)
      D=Ø.1*WH(M,L)
      IF(M2.GT.Ø.AND.M.LT.7) D=Ø.1*WH(M2,L)
      EH(1,L) = .Ø125*D
      EH(2,L)=X*PT**Ø.75
      EH(4,L)=Ø.8*PT*X
      PPW=4.56E-5*D*273.15/TS
      EH(5,L)=D*PPW*DEXP(6.Ø8*(296.Ø/T(M,L)-1.Ø))
     &+.ØØ2*D*(PS-PPW)
      EH(1Ø,L)=D*(PPW+Ø.12*(PS-PPW))*DEXP(4.56*(296.Ø/T(M,L)-1.Ø))
      EH(6,L)=X
      HAZE=HZ1(L)
      IF(M.EQ.7) HAZE=AHAZE(L)
      IF(Z(L).GE.5.Ø) GO TO 22Ø
       IF(M.EQ.7.AND.IHAZE.EQ.2) HAZE=HZ2(L)
      IF(IHAZE.EQ.2.AND.M.EQ.7)HAZE=AHZ2(L)
      IF(VIS.LE.Ø.Ø) GO TO 22Ø
      IF(M.EQ.7)HAZE= 6.389*((HZ2(L)-HZ1(L))/VIS+HZ1(L)/5.Ø-HZ2(L)/23.Ø)
      IF (M.NE.7) GO TO 22Ø
```

```
      HAZE=6.389*((AHZ2(L)-AHAZE(L))/VIS+AHAZE(L)/5.ØDØ-AHZ2(L)/23.Ø)   MA Ø426Ø
  22Ø IF(HAZE.LT.Ø.Ø) HAZE=Ø.Ø                                          MA Ø427Ø
      EH(7,L)=3.5336E-4*HAZE                                            MA Ø428Ø
      IF(MODEL.EQ.7) EH(7,L)=HAZE/AHAZE(1)                              MA Ø429Ø
      EH(8,L)=.467E-3*WO(M,L)                                           MA Ø43ØØ
      IF(M3.GT.Ø.AND.M.LT.7) EH(8,L)=.467E-3*WO(M3,L)                   MA Ø431Ø
      EH(3,L)=EH(8,L)                                                   MA Ø432Ø
      EH(9,L)=1.Ø                                                       MA Ø433Ø
      REF=1.ØE-6*(CO*X*1Ø13.Ø/273.15-PPW*CW)                            MA Ø434Ø
      L1=1                                                              MA Ø435Ø
      IF (L.EQ.NL) GO TO 23Ø                                            MA Ø436Ø
      IF (MODEL.EQ.Ø.AND.L.GE.1) GO TO 35Ø                              MA Ø437Ø
      T2=T(M,L+1)                                                       MA Ø438Ø
      W2=WH(M,L+1)                                                      MA Ø439Ø
      IF(M1.GT.Ø)T2=T(M1,L+1)                                           MA Ø44ØØ
      IF(M2.GT.Ø)W2=WH(M2,L+1)                                          MA Ø441Ø
      PPW=4.56E-6*W2*T2                                                 MA Ø442Ø
      EH(9,L)=Ø.5*(REF+1.ØE-6*(CO*P(M,L+1)/T2-PPW*CW))                  MA Ø443Ø
  23Ø IF (L.EQ.NL) EH(9,L)=Ø.Ø                                          MA Ø444Ø
      IF (H1.GE.Z(L)) L1=L                                              MA Ø445Ø
      IF(IFIND.EQ.Ø)  WRITE(6,927Ø)L,Z(L),(EH(K,L),K=1,1Ø),REF          MA Ø446Ø
      EH(9,L)=EH(9,L)+1.Ø                                               MA Ø447Ø
  24Ø CONTINUE                                                          MA Ø448Ø
                                                                        MA Ø449Ø
                                                                        MA Ø45ØØ
  25Ø IF (IFIND.EQ.1) GO TO 17Ø                                         MA Ø451Ø
      IP=-1                                                             MA Ø452Ø
      IK=Ø                                                              MA Ø453Ø
      X1=H1                                                             MA Ø454Ø
      CALL POINT (H1,YN,L,NP1,TX,IP)                                    MA Ø455Ø
      T1=TX(11)                                                         MA Ø456Ø
      P1=TX(12)                                                         MA Ø457Ø
      L1=L                                                              MA Ø458Ø
      TX1=TX(9)                                                         MA Ø459Ø
                                                                        MA Ø46ØØ
      DO 26Ø K=1,1Ø                                                     MA Ø461Ø
      E(K)=TX(K)                                                        MA Ø462Ø
  26Ø CONTINUE                                                          MA Ø463Ø
                                                                        MA Ø464Ø
      LBR=Ø                                                             MA Ø465Ø
      IF (ITYPE.EQ.1) GO TO 35Ø                                         MA Ø466Ø
      IF (ITYPE.EQ.3) H2=Z(NL)                                          MA Ø467Ø
      IF (ANGLE.GT.9Ø.Ø) GO TO 38Ø                                      MA Ø468Ø
  27Ø IF (ANGLE.GT.9Ø.Ø.AND.NP1.GT.Ø) L1=L1+1                           MA Ø469Ø
      L2=NL                                                             MA Ø47ØØ
      IF (ITYPE.EQ.3) GO TO 28Ø                                         MA Ø471Ø
      CALL POINT (H2,YN,L,NP,TX,IP)                                     MA Ø472Ø
      T2=TX(11)                                                         MA Ø473Ø
      P2=TX(12)                                                         MA Ø474Ø
      L2=L                                                              MA Ø475Ø
      IF (NP.GT.Ø) L2=L2-1                                              MA Ø476Ø
      EH(1Ø,L1)=E(1Ø)                                                   MA Ø477Ø
                                                                        MA Ø478Ø
```

```
  28Ø DO 29Ø K=1,8
      EH(K,L1)=E(K)
      IF (ITYPE.EQ.3) GO TO 29Ø
      EH(K,L2+1)=TX(K)
  29Ø CONTINUE

      IF(ITYPE.NE.3)EH(1Ø,L2+1)=TX(1Ø)
      IF (L1.EQ.L2) TX1=TX1+YN-EH(9,L1)

C****  NOW DEFINE VERTICAL PATH QUANTITIES VH(1-8)

      WRITE(6,928Ø)


      DO 34Ø L=L1,L2
      X1=Z(L)
      X2=Z(L+1)
      IF (L.EQ.L1) X1=H1
      IF (L.EQ.L2) X2=H2
      DZ=X2-X1
      IF (L.EQ.NL) DZ=Z(L)-Z(L-1)
      DS=DZ

C*****  UPWARD TRAJECTORY

      RX=(RE+X1)/(RE+X2)
      THETA=DASIN(SPHI)/CA
      PHI=DASIN(SPHI*RX)/CA
      BET=THETA-PHI
      SALP=RX*SPHI
      IF (SPHI.GT.1.E-1Ø) DS=(RE+X2)*DSIN(BET*CA)/SPHI
      BETA=BETA+BET
      PSI=BETA+PHI-ANGLE
      PHI=18Ø.-PHI
      SR=SR+DS
      LL=L-L1+LBR+1

      DO 33Ø K=1,1Ø
      EV=DS*EH(K,L)
      IF (L.EQ.NL) GO TO 3ØØ
      IF (EH(K,L).EQ.Ø.Ø.OR.EH(K,L+1).EQ.Ø.Ø) GO TO 31Ø
      IF (EH(K,L).EQ.EH(K,L+1)) GO TO 32Ø
      A1=EH(K,L)
      B1=EH(K,L+1)
      EV=DS*(EH(K,L)-EH(K,L+1))/DLOG(EH(K,L)/EH(K,L+1))
      GO TO 32Ø
  3ØØ IF (EH(K,L).EQ.Ø.Ø) GO TO 31Ø
      IF (EH(K,L-1).EQ.Ø.Ø) GO TO 31Ø
      IF (EH(K,L).EQ.EH(K,L-1)) GO TO 32Ø
      A2=EH(K,L)
      B2=EH(K,L-1)
      EV=EV/DLOG(EH(K,L-1)/EH(K,L))
      GO TO 32Ø
```

```
310 EV=Ø.
320 VH(K)=VH(K)+EV
    WW(LL,K)=EV
330 CONTINUE

    LYR(LL)=L
    ALT(LL)=X1
    TEMP(LL)=DSQRT(T(M,L)*T(M,L+1))
    PRES(LL)=DSQRT(P(M,L)*P(M,L+1))
    WRITE(6,929Ø)L,X1,(VH(K),K=1,8),PSI,PHI,BETA,THETA,SR
    IF (L.GE.NL) GO TO 34Ø
    IF (L+1.EQ.L2) EH(9,L+1)=YN
    IF (L.EQ.L1) EH(9,L)=TX1
    RN=EH(9,L+1)/EH(9,L)
    SPHI=SPHI*RX/RN
    IF (SALP.GE.RN) SPHI=SALP
34Ø CONTINUE


    LBR=L2-L1+LBR+1
    GO TO 66Ø

C**** HORIZONTAL PATH

35Ø DO 36Ø K=1,1Ø
    W(K)=RANGE*EH(K,1)
    VH(K)=W(K)
    IF (MODEL.GT.Ø) W(K)=RANGE*TX(K)
    WW(1,K)=W(K)
36Ø CONTINUE

    LMAX=1
    LYR(1)=L1
    TEMP(1)=T(M,1)
    PRES(1)=P(M,1)
    ALT(1)=Z(1)
    IF(MODEL.EQ.Ø) GO TO 37Ø
    TEMP(1)=T1
    PRES(1)=P1
    ALT(1)=H1
37Ø LBR=1
    GO TO 68Ø
38Ø CONTINUE

C****   DOWNWARD TRAJECTORY

    K2=Ø
    IF (NP1.EQ.1) L1=L1-1
    L2=L1+1
    YN1=YN
    LØ=L1+1
    IF (H2.GT.Z(L1+1).OR.H1.EQ.H2) GO TO 4ØØ
    IF (NP1.EQ.1.AND.H2.GE.Z(L1+1)) GO TO 4ØØ
    CALL POINT (H2,YN,L,NP2,TX,IP)
```

```
      T2=TX(11)
      P2=TX(12)

      DO 39Ø K=1,1Ø
      W(K)=TX(K)
39Ø   CONTINUE

      TX2=TX(9)
      YN2=YN
      IF (H2.LT.H1) H=H2
      L2=L
      IF (L1.EQ.L2) TX2=TX1+YN2-EH(9,L)
      IF (H2.GT.H1) TX1=TX2
      IF (L1.EQ.L2.AND.H2.LT.H1) YN1=TX2
4ØØ   AØ=(RE+H1)*SPHI*YN1
      IF (H2.GE.H1) YN2=YN1

      DO 41Ø L=1,L1
      HMIN=AØ/EH(9,L)-RE
      IF (L.EQ.L1) HMIN=AØ/YN1-RE
      LMIN=L
      IF (HMIN.LE.Z(L+1)) GO TO 42Ø
41Ø   CONTINUE

42Ø   X=HMIN
      IF (HMIN.LE.Ø) GO TO 44Ø
      CALL POINT (X,YN,L,NP,TX,IP)
      TMIN=TX(11)
      PMIN=TX(12)
      LMIN=N
      TX3=TX(9)
      IF (L2.EQ.L.OR.L1.EQ.L) TX3=YN2+TX(9)-EH(9,L)
      IF(TX3.LT.Ø.Ø)TX3=TX(9)
      IF (L1.EQ.L.AND.H2.GE.H1) GO TO 43Ø
      HMIN=AØ/TX3-RE
      IF (DABS(X-HMIN).GT.Ø.ØØØ1) GO TO 42Ø
43Ø   IF (L1.EQ.L.AND.H2.GE.H1) YN1=TX3

      IF (L2.EQ.L.AND.L1.LE.L2) YN2=TX3
      IF (H2.GE.H1) TX2=TX3
      IF (H2.GE.H1) L2=L
      IF (H2.GE.H1.OR.H2.LT.HMIN) H=HMIN
      WRITE(6,93ØØ)  HMIN
      IF(H2.LT.HMIN)L2=L
      IF (H2.LT.HMIN) WRITE(6,93Ø5) HMIN
      GO TO 45Ø
44Ø   WRITE(6,93ØØ) HMIN
      IF (H2.LT.H1) GO TO 45Ø
      IF (ITYPE.EQ.3.OR.H2.GE.H1) WRITE(6,931Ø)
      ITYPE=2
      TX2=EH(9,1)
      LMIN=Ø
      L2=1
      H2=Ø.Ø
      H=Ø.3
```

```
C****  NOW DEFINE VERTICAL PATH QUANTITIES VH(1-8)

  45Ø WRITE(6,928Ø)
      L=LØ
      LL=LBR


      DO 51Ø I=1,NL
      LL=LL+1
      L=L-1
      REF=EH(9,L)
      IF (I.EQ.1) REF=YN1
      IF (I.EQ.1.AND.K2.EQ.1) REF=YN2
      IF (L.EQ.L2.AND.K2.EQ.Ø) REF=TX2
      IF (I.NE.1) X1=Z(L+1)
      X2=Z(L)
      IF (L.EQ.L2.AND.K2.EQ.Ø) X2=H
      IF (L.EQ.LMIN.AND.K2.EQ.1) X2=HMIN
      HM=(RE+X1)*SPHI-RE
      IF (HM.GT.Z(L).AND.HM.GT.X2) X2=HM
      RX=(RE+X1)/(RE+X2)
      DS=X1-X2
      ALP=9Ø.Ø
      THET=DASIN(SPHI)/CA
      SALP=RX*SPHI
      IF (DABS(X2-HM).GT.1.ØE-5) ALP=DASIN(SALP)/CA
      BET=ALP-THET
      IF (SPHI.GT.1.ØE-1Ø) DS=(RE+X2)*DSIN(BET*CA)/SPHI
      THETA=18Ø.Ø-THET
      BETA=BETA+BET
      PSI=BETA-ALP-ANGLE+18Ø.Ø
      SR=SR+DS

      DO 5ØØ K=1,1Ø
      AL=EH(K,L)
      BL=EH(K,L+1)
      IF (L.EQ.L1) BL=E(K)
      IF (L.EQ.L2.AND.H2.LT.H1.AND.H2.GT.Ø.Ø) AL=W(K)
      IF (L.EQ.LMIN.AND.H2.GE.H1) AL=TX(K)
      IF (L.EQ.LMIN.AND.DABS(H2-HM).LT.1.ØE-5) AL=TX(K)
      IF (K2.EQ.Ø) GO TO 46Ø
      IF (L.EQ.L2) BL=W(K)
      IF (L.EQ.LMIN) AL=TX(K)
  46Ø IF (AL.EQ.Ø.Ø.OR.BL.EQ.Ø.Ø) GO TO 48Ø
      IF (AL.EQ.BL) GO TO 47Ø
      EV=DS*(AL-BL)/DLOG(AL/BL)
      GO TO 49Ø
  47Ø EV=DS*AL
      GO TO 49Ø
  48Ø EV=Ø.Ø
  49Ø VH(K)=VH(K)+EV
      WW(LL,K)=EV
  5ØØ CONTINUE
```

```
      LBR=LL
      LYR(LL)=L
      ALT(LL)=X1
      TEMP(LL)=DSQRT(T(M,L)*T(M,L+1))
      PRES(LL)=DSQRT(P(M,L)*P(M,L+1))
      WRITE(6,929Ø) L,X1,(VH(K),K=1,8),PSI,ALP,BETA,THETA,SR
      IF (L.EQ.L2.AND.H2.GE.H1) GO TO 6ØØ
      IF (L.EQ.LMIN.AND.K2.EQ.1) GO TO 54Ø
      IF (L.NE.1) RN=REF/EH(9,L-1)
      IF (L.EQ.L2+1) RN=REF/TX2
      IF (L.EQ.L2.AND.K2.EQ.Ø) RN=REF/YN2
      IF (L.EQ.(LMIN+1).AND.K2.EQ.1) RN=REF/TX3
      IF (SALP.GE.RN) RN=1.Ø
      SPHI=SALP*RN
      IF (L.EQ.L2.AND.K2.EQ.Ø) GO TO 52Ø
  51Ø CONTINUE


  52Ø TEMP(LL)=DSQRT(T2*T(M,L))
      PRES(LL)=DSQRT(P2*P(M,L))
      IF (HMIN.LE.Ø) GO TO 66Ø
      IF (LEN.EQ.Ø) WRITE(6,932Ø)
      IF (LEN.EQ.Ø) GO TO 66Ø
      IF (LEN.EQ.1) WRITE(6,933Ø)
      K2=1
      X1=X2
      IF (DABS(X1-HMIN).LE.Ø.ØØ1) GO TO 66Ø
      H=HMIN
      L=L2+1
      IF (NP2.EQ.1) L=L-1
      B=BETA
      PH=18Ø.Ø-DASIN(SPHI)/CA
      TS=SR
      PS=PSI

      DO 53Ø K=1,1Ø
      E(K)=VH(K)
  53Ø CONTINUE

      LSTORE=LBR
      GO TO 45Ø

  54Ø TEMP(LL)=DSQRT(TMIN*T(M,L+1))
      PRES(LL)=DSQRT(PMIN*P(M,L+1))
      BETA=2.*BETA-B
      PSI=2.*PSI-PS
      SR=2.*SR-TS

C      LONG PATH  TAKEN

      PHI=PH

      DO 55Ø K=1,1Ø
      VH(K)=2.*VH(K)-E(K)
  55Ø CONTINUE
```

```
C***DOWNWARD H2.GT.H1--LONG PATH STORAGE

      LLMIN=LBR+1
      LBR=2*LBR-LSTORE

      DO 59Ø LL=LLMIN,LBR
      LMAP=LBR-LL+LSTORE
      ALT(LL)=ALT(LMAP+2)
      IF (LL.EQ.LLMIN) GO TO 56Ø
      TEMP(LL)=DSQRT(T(M,LMAP+1)*T(M,LMAP+2))
      PRES(LL)=DSQRT(P(M,LMAP+1)*P(M,LMAP+2))
      GO TO 57Ø
  56Ø ALT(LL)=HMIN
      PRES(LL)=DSQRT(PMIN*P(M,LMAP+2))
      TEMP(LL)=DSQRT(TMIN*T(M,LMAP+2))
  57Ø CONTINUE

      DO 58Ø K=1,1Ø
      WW(LL,K)=WW(LMAP+1,K)
  58Ø CONTINUE

  59Ø CONTINUE

      GO TO 66Ø
  6ØØ TEMP(LL)=DSQRT(T1*T(M,L))
      PRES(LL)=DSQRT(P1*P(M,L))

      DO 61Ø K=1,1Ø
      VH(K)=2.Ø*VH(K)
  61Ø CONTINUE

C***DOWNWARD H1.LT.H2---H1.NE.HMIN

      LLMIN=LBR+1
      LBR=2*LBR

      DO 65Ø LL=LLMIN,LBR
      LMAP=LBR-LL
      ALT(LL)=ALT(LMAP+2)
      IF (LL.EQ.LLMIN) GO TO 62Ø
      TEMP(LL)=DSQRT(T(M,LMAP+1)*T(M,LMAP+2))
      PRES(LL)=DSQRT(P(M,LMAP+1)*P(M,LMAP+2))
      GO TO 63Ø
  62Ø ALT(LL)=HMIN
      TEMP(LL)=DSQRT(TMIN*T(M,LMAP+2))
      PRES(LL)=DSQRT(PMIN*P(M,LMAP+2))
  63Ø LYR(LL)=LYR(LMAP+1)

      DO 64Ø K=1,1Ø
      WW(LL,K)=WW(LMAP+1,K)
  64Ø CONTINUE

  65Ø CONTINUE
```

```
      BETA=2.Ø*BETA
      SR=2.Ø*SR
      IF (H2.EQ.H1) GO TO 66Ø
      RN=TX1/YN1
      SPHI=DSIN(ANGLE*CA)
      IF (SPHI.LT.RN) SPHI=SPHI/RN
      GO TO 27Ø
  66Ø CONTINUE
      WRITE(6,9Ø8Ø) HM

      DO 67Ø K=1,1Ø
      W(K)=VH(K)
  67Ø CONTINUE

  68Ø WRITE (6,934Ø)
      WRITE(6,935Ø) (W(K),K=4,8),W(1Ø)
      I=1
      L=1
      IV1=V1/5.Ø
      IV2=V2/5.+.998
      IV1=5*IV1
      IV2=5*IV2
      IF (IV1.LT.35Ø) IV1=35Ø
      IF (IV2.GT.5ØØØØ) IV2=5ØØØØ
      IF (DV.LT.5.) DV=5.
      IDV=DV
      IV=IV1-IDV
      IC=Ø
      ICOUNT=Ø
      ICNT=Ø
      LMAX=LBR
      LOOP=1
      IF (IRAD.EQ.1) LOOP=LBR

C****  BEGINING OF TRANSMITTANCE CALCULATIONS

  69Ø IV=IV+IDV
      ICNT=ICNT+1
      IF (ICOUNT.EQ.Ø) GO TO 7ØØ
      IF (ICOUNT.EQ.5Ø) GO TO 7ØØ
      GO TO 71Ø
  7ØØ ICOUNT=Ø
      WRITE(6,936Ø)
  71Ø CONTINUE



      DO 83Ø LL=1,LOOP
```

```
      DO 720 K=1,10
      TX(K)=0.0
      IF (K.LT.4) TX(K)=1.0
      W(K)=VH(K)
      IF (LL.GT.1) W(K)=W(K)-WW(LL-1,K)
  720 CONTINUE

      TX(1)=1.0
      ICOUNT=ICOUNT+1
      IC=IC+1
      SUM=0.0
      V=IV
      I=(IV-350)/5+1
      IF(IV.LT.670) GO TO 800
      IF(IV.LE.3000) GO TO 730

C********   MOLECULAR SCATTERING

      C6=9.807E-20*(V**4.0117)
      TX(6)=C6*W(6)
      SUM=SUM+TX(6)
      IF (IV.LT.9200) GO TO 800
      IF (IV.LT.13000) GO TO 800

C********  WATER VAPOR CONTINUUM 10 MICRON REGION

  730 IF(IV.GT.1350) GO TO 740
      TX(5)=(4.18+5578.0*DEXP(-7.87E-3*V))*W(5)
      GO TO 780
  740 IF(IV.LT.2350) GO TO 790

C********  WATER VAPOR CONTINUUM 4 MICRON REGION

      XI=(V-2350.0)/50.0+1.0

      DO 750 NH=1,15
      XH=XI-FLOAT(NH)
      TX(5)=C5(NH)
      IF(XH) 760,770,750
  750 CONTINUE

  760 TX(5)=TX(5)+XH*(C5(NH)-C5(NH-1))
  770 TX(5)=TX(5)*W(10)
  780 SUM=SUM+TX(5)
      IF(IV.LE.1350.OR.IV.GT.2740) GO TO 800

C********   NITROGEN CONTINUUM

  790 IF (IV.LT.2080) GO TO 800
      K4=I-346
      TX(4)=C4(K4)*W(4)
      SUM=SUM+TX(4)

C********   AEROSOL EXTINCTION
```

```
800 ALAM=1.0E+4/V
    XX=0.0
    YY=0.0
    IF (IHAZE.EQ.0.) GO TO 830

    DO 810 N=1,44
    XD=ALAM-VX(N)
    IF(XD)820,810,810
810 CONTINUE

820 XX=(C7(N)-C7(N-1))*XD/(VX(N)-VX(N-1))+C7(N)
    YY=(C7A(N)-C7A(N-1))*XD/(VX(N)-VX(N-1))+C7A(N)
830 TX(10)=YY*W(7)
    TX(7)=XX*W(7)
    SUM=SUM+TX(7)
    TX(9)=SUM

    DO 870 K=4,10
    IF (TX(K).EQ.0.0) GO TO 850
    IF (TX(K).LE.0.1) GO TO 840
    IF (TX(K).GT.20.) GO TO 860
    TX(K)=DEXP(-TX(K))
    GO TO 870
840 TX(K)=1.0-TX(K)+0.5*TX(K)*TX(K)
    GO TO 870
850 TX(K)=1.0
    GO TO 870
860 TX(K)=0.
870 CONTINUE

    TX(10)=1.0-TX(10)
    TX(9)=TX(1)*TX(2)*TX(3)*TX(9)
    IF (IV.GE.13000) TX(3)=TX(8)
    AB=1.-TX(9)
    IF(IV.EQ.IV1.OR.IV.EQ.IV2) AB=0.5*AB
    SUMA=SUMA+AB*DV
    IF(LL.EQ.1) WRITE(6,9370) IV,ALAM,TX(9),(TX(K),K=1,7),TX(10),SUMA
    IF(IRAD.NE.0) TRAN1(IC)=TX(9)
880 CONTINUE



C**********ICNT IS INDEXING VARIABLE USED TO FOLD IN CONTINUUM TAU?S

    TAU(ICNT)=TX(9)
    IF (IV.GE.IV2) GO TO 890
    GO TO 690
890 WRITE(6,9380)
    NUMV=ICNT
    ICNT=1

    DO 920 LL=1,LMAX
    FAC=WW(LL,6)
    IF(FAC.NE.0.0) GO TO 900
    WH20(LL)=0.0
```

```
      WO3(LL)=0.0
      GO TO 910
  900 WH20(LL)=WW(LL,1)/FAC
      WO3(LL)=WW(LL,3)/FAC
  910 WGAS(LL)=FAC

C******TEMPORARY PRINT OUT

      IF(TEMP(LL).LT.100.0) TEMP(LL)=100.0
      WRITE(6,9390) LL,LYR(LL),ALT(LL),TEMP(LL),PRES(LL),WH20(LL)
     1,WO3(LL),WGAS(LL)
  920 CONTINUE

      AB=1.0-SUMA/(V2-V1)
      WRITE(6,9400) IV1,IV2,SUMA,AB
C
C*******START OF MIDTRAN CALCULATION  ***********
C
      NPRNT=1
  930   NTAU=0
      IF (DVM.LT.0.005) DVM =.005
      WRITE(6,9410) DVM
      KSPEC = 6

C*****READ TAPE BLOCK INTO DISK FILE

C

      REWIND 21
      READ(21,9420) VMIN,VMAX,NPT
      IF (V2.GT.VMIN) GO TO 950
  940 WRITE(6,9422) V1,V2,VMIN,VMAX
      STOP
  950 IF (V1.GE.VMAX) GO TO 940
  960 IF (V1.GE.VMIN) GO TO 970
      WRITE(6,9424) V1,VMIN
      V1 = VMIN
  970 IF (V2.LE.VMAX) GO TO 980
      WRITE(6,9426) V2,VMAX
      V2 = VMAX
  980 CONTINUE

C******READ (P,T) VALUES FROM DISK FILE

      READ(21,9427)(PP(K),K=1,NPT)
      READ(21,9427)(TTT(K),K=1,NPT)

C*****DETERMINE INTERPOLATION POINTS FOR EACH LAYER

      CALL PTPTS(PP,TTT,LMAX,KPTS,TEMP,PRES)
      IF(JP.LT.1) GO TO 985
      WRITE(6,9429) (LL,TEMP(LL),PRES(LL),(KPTS(J,LL),J=1,3),LL=1,LMAX)

C*****READ IN WAVENUMBER BLOCKS
```

```
  985 VCHK1 = V1-10.
      VCHK2 = V2+10.
      ILP = 1
  990 NUM1 = 1
      READ (21,9420) VA,VB


      DO 1010 K=1,KSPEC
      READ(21,9430) SPEC(K,1),SPEC(K,2),NUM2
C     WRITE(6,9440) SPEC(K,1),SPEC(K,2),NUM2
      NUM(K) = NUM1
      NUM1 =NUM1 + NUM2
      NMIN = NUM(K)
      NMAX = NUM1 - 1

      DO 1000 N=NMIN,NMAX
      READ(21,9450) VV(N),(AK(L,N),L=1,NPT)
      IF(VB.LE.VCHK1) GO TO 1000
      IF(JP.GE.3) WRITE(6,9450) VV(N),(AK(L,N),L=1,NPT)
 1000 CONTINUE

 1010 CONTINUE


      IF(VA.GT.VCHK1.AND.VB.GE.V1) GO TO 1020
      IF(JP.LT.1) GO TO 990
      WRITE(6,9460) VA,(NUM(N),N=1,6),NMAX
      GO TO 990
 1020 IF (VA.GE.VCHK2) GO TO 1200
C*****CALCULATE TRANSMISSION

C     WRITE(6,9465) NUM(1),NUM(6)
      ILP =ILP +1
      IF (ILP.GT.60) ILP=1
      V = VV(NMIN) + DVM
      V0 = V
      N = 0
 1030 IF (V.GE.V1) GO TO 1040
      N = N + 1
      V = V0 + FLOAT(N)*DVM
      GO TO 1030
 1040 N = 0
      V0 = V
 1050 N = N+1
      RDD = 0.0
      RAD1 = 1.0
      FAC1 = 0.0

      DO 1060 K=1,KSPEC
      FAC6(K)=0.0
 1060 CONTINUE
```

```
      DO 114Ø LL=1,LMAX
      DIST = WGAS(LL)
      CON(1) = WH2Ø(LL)
      CON(3) = WO3(LL)
      FAC2(LL)=Ø.Ø
      PBAR = PRES(LL)


      DO 112Ø K=1,KSPEC
      NDUM=NUM(K)
      IF (AK(1,NDUM   ).EQ.Ø.Ø) GO TO 112Ø
      M1 = NUM(K)
1Ø7Ø  VV1 =  VV(M1)
      VV2 =  VV(M1+1)
      IF (V.LE.VV2) GO TO 1Ø9Ø
      M1 = M1+1
      GO TO 1Ø7Ø

1Ø9Ø  DO 11ØØ I=1,2
      N1 = M1+I-1
      LDUM=KPTS(1,LL)
      MDUM=KPTS(2,LL)
      NDUM=KPTS(3,LL)
      YØ = AK(MDUM       ,N1)
      FT = F1(YØ,AK(LDUM       ,N1),TTT(MDUM       ),TTT(LDUM       )
     1   ,TEMP(LL))
      FP = F1(YØ,AK(NDUM       ,N1),PP(MDUM       ),PP(NDUM       )
     1   ,PBAR)
      AKK = FT+FP-YØ
      IF (AKK.LT.Ø) AKK=Ø
      IF (VV(N1).EQ.V) GO TO 111Ø
      FAC5(I) = AKK
11ØØ  CONTINUE

      AKK = F1(FAC5(1),FAC5(2),VV1,VV2,V)
111Ø  FAC=AKK*CON(K)*DIST
      FAC6(K)=FAC6(K)+FAC
      FAC2(LL)=FAC2(LL)+FAC
112Ø  CONTINUE

114Ø  CONTINUE



      TRAN=1.Ø

      DO 115Ø K=1,KSPEC
      FAC6(K)=FAC6(K)*1.ØE5
      HZZ(K)=Ø.Ø
      IF(FAC6(K).LT.5Ø.) HZZ(K)=DEXP(-FAC6(K))
      TRAN=TRAN*HZZ(K)
115Ø  CONTINUE
```

```
C********** FOLD IN CONTINUUM

 116Ø V3=V1 + DV
      IF (V3.GT.V) GO TO 117Ø
      V1=V1 + DV
      ICNT=ICNT + 1
      IF (V3.GT.V2) STOP
      GO TO 116Ø
 117Ø RDD=F1(TAU(ICNT),TAU(ICNT+1),V1,V3,V)
      TOTAL=TRAN*RDD
      IF(IRAD.EQ.Ø) GO TO 1195
C
C*******RADIATION CALCULATION*****

      AUX=Ø.Ø

      DO 118Ø LL=1,LMAX
      FAC2(LL)=FAC2(LL)*1.ØE5
      AUX=AUX+FAC2(LL)
 118Ø CONTINUE

      JØ=(ICNT-1)*LMAX+1
      J1=JØ+LMAX
      T1=SPF1(TRAN1(JØ),TRAN1(J1),V1,V3,V)
      BUX=Ø.Ø
      IF(-AUX.GT.-673.Ø) BUX=DEXP(-AUX)
      XTAU=T1*BUX
      B1=BLAM(TEMP(1),V)
      XRAD=(EMIS*BLAM(TBACK,V)-B1)*XTAU+BLAM(TEMP(LMAX),V)
      IF(LMAX.EQ.1) GO TO 1195

      DO 119Ø LL=2,LMAX
      JØ=JØ+1
      J1=J1+1
      T1=SPF1(TRAN1(JØ),TRAN1(J1),V1,V3,V)
      AUX=AUX-FAC2(LL-1)
      BUX=Ø.Ø
      IF(-AUX.GT.-673.Ø) BUX=DEXP(-AUX)
      XTAU=T1*BUX
      B2=BLAM(TEMP(LL),V)
      XRAD=XRAD+XTAU*(B1-B2)
      B1=B2
 119Ø CONTINUE

C     ***   SPECIES PRINT OUT   ***

 1195 IF(JP.LT.2) GO TO 1197
      IF(NPRNT.GT.1ØØ) NPRNT=1
      IF(NPRNT.EQ.1) WRITE(6,947Ø) ((SPEC(K,J),J=1,2),K=1,KSPEC)
      IF(NPRNT.LE.11) WRITE(6,948Ø) V,XRAD,TOTAL,RDD,TRAN,HZZ
 1197 NTAU=NTAU+1
      NPRNT=NPRNT+1
      RAD(NTAU)=XRAD
      TAU1(NTAU)=TOTAL
      VTAU(NTAU)=V
```

```
      V = VØ + FLOAT(N)*DVM                                              MA 1185Ø
      IF (V.GE.V2) GO TO 12ØØ                                            MA 1186Ø
      IF(NTAU.EQ.4ØØØ) GO TO 12ØØ                                        MA 1187Ø
      IF (V.LE.VB) GO TO 1Ø5Ø                                            MA 1188Ø
      N = N - 1                                                          MA 1189Ø
      GO TO 99Ø                                                          MA 119ØØ
C                                                                        MA 1191Ø
C***   STORE RESULTS ON OUTPUT FILE 9    ***                             MA 1192Ø
C                                                                        MA 1193Ø
 12ØØ CONTINUE                                                           MA 1194Ø
      WRITE (9,949Ø) H1,H2                                               MA 1195Ø
      WRITE (9,95ØØ) NTAU,VTAU(1),VTAU(NTAU),DVM                         MA 1196Ø
      WRITE (9,951Ø) (VTAU(J),RAD(J),TAU1(J),J=1,NTAU)                   MA 1197Ø
      IF(JP.GE.1) GO TO 12Ø5                                             MA 1198Ø
      IF(V.GE.V2) GO TO 127Ø                                             MA 1199Ø
      GO TO 126Ø                                                         MA 12ØØØ
C                                                                        MA 12Ø1Ø
C     ***   SLIT FUNCTION WITH FIXED WIDTH OF Ø.1 CM-1    ***            MA 12Ø2Ø
C                                                                        MA 12Ø3Ø
C                                                                        MA 12Ø4Ø
 12Ø5 A=.1                                                               MA 12Ø5Ø
      DELV=A                                                             MA 12Ø6Ø
      DVT=DVM                                                            MA 12Ø7Ø
      V2T=VTAU(NTAU)-A                                                   MA 12Ø8Ø
      FREQT=VTAU(1)+A                                                    MA 12Ø9Ø
      VT=VTAU(1)                                                         MA 121ØØ
      JFNU=1                                                             MA 1211Ø
      L=DELV/DVT+Ø.Ø1                                                    MA 1212Ø
      IA=1                                                               MA 1213Ø
 121Ø SUM=Ø.Ø                                                            MA 1214Ø
      RSUM=Ø.Ø                                                           MA 1215Ø
                                                                         MA 1216Ø
      DO 122Ø I=IA,NTAU                                                  MA 1217Ø
      VT=VTAU(I)                                                         MA 1218Ø
      AA=A-DABS(VT-FREQT)                                                MA 1219Ø
      SUM=SUM+AA*TAU1(I)                                                 MA 122ØØ
      RSUM=RSUM+AA*RAD(I)                                                MA 1221Ø
      IF(VT-(FREQT+A)) 122Ø,123Ø,123Ø                                    MA 1222Ø
 122Ø CONTINUE                                                           MA 1223Ø
                                                                         MA 1224Ø
 123Ø TRANS(JFNU)=SUM*DVT/(A*A)                                          MA 1225Ø
      FRAD(JFNU)=RSUM*DVT/(A*A)                                          MA 1226Ø
      FNU(JFNU)=FREQT                                                    MA 1227Ø
      IF(FREQT.GT.V2T) GO TO 124Ø                                        MA 1228Ø
      FREQT=FREQT+DELV                                                   MA 1229Ø
      IF(JFNU.GE.5ØØ) GO TO 124Ø                                         MA 123ØØ
      JFNU=JFNU+1                                                        MA 1231Ø
      IA=IA+L                                                            MA 1232Ø
      GO TO 121Ø                                                         MA 1233Ø
 124Ø WRITE(6,952Ø) JFNU                                                 MA 1234Ø
      WRITE(6,953Ø)                                                      MA 1235Ø
      JFAC=JFNU/4                                                        MA 1236Ø
      J1=JFAC                                                            MA 1237Ø
      J2=2*JFAC                                                          MA 1238Ø
      J3=3*JFAC                                                          MA 1239Ø
                                                                         MA 124ØØ
```

```
      DO 1245 J=1,JFAC
      J1DUM=J1+J
      J2DUM=J2+J
      J3DUM=J3+J
      WRITE(6,954Ø)  FNU(J),FRAD(J),TRANS(J),FNU(J1DUM),FRAD(J1DUM),
     X TRANS(J1DUM),FNU(J2DUM),FRAD(J2DUM),TRANS(J2DUM),FNU(J3DUM),
     X FRAD(J3DUM),TRANS(J3DUM)
 1245 CONTINUE

      J2=JFAC*4
      JDELT=JFNU-J2
      IF(JDELT.GT.Ø) WRITE(6,955Ø) (FNU(J),FRAD(J),TRANS(J),J=J2,JFNU)
      IF(FREQT.GE.V2-DVM-A) GO TO 127Ø
      IF(FREQT.GE.V2T) GO TO 126Ø
      IF(JFNU.GE.5ØØ) GO TO 125Ø
      GO TO 126Ø
 125Ø JFNU=1
      GO TO 121Ø
 126Ø NTAU=Ø
      IF(V.LT.VB) GO TO 1Ø5Ø
      N=N-1
      GO TO 99Ø
 127Ø WRITE(9,949Ø) ENDF
      NFILES=NFILES+1

      GO TO 2Ø

 9Ø1Ø FORMAT(1ØI3,F1Ø.3)
 9Ø2Ø FORMAT(8E1Ø.3)
 9Ø3Ø FORMAT(F6.1,2(E1Ø.3,F6.1,2E1Ø.3))
 9Ø4Ø FORMAT(4(F6.2,2F7.5))
 9Ø5Ø FORMAT(4(F6.3,2F7.4))
 9Ø6Ø FORMAT(15F5.2)
 9Ø7Ø FORMAT(8E9.2)
 9Ø75 FORMAT(I1Ø,2F1Ø.3,4I5,2F1Ø.3)
 9Ø8Ø FORMAT(7F1Ø.3)
 9Ø85 FORMAT(12H EMISSIVITY=,F5.3,1ØX,14HT(BACKGROUND)=,F1Ø.1,9HDEGREES
     XK)
 9Ø9Ø FORMAT(1ØX,7F1Ø.3)
 91ØØ FORMAT(1ØX,4H H1=,F7.3,6HKM,H2=,F7.3,9HKM,ANGLE=,F8.4,13HGEOM. RAN
     XGE =,F7.2,8HKM,BETA=,F8.5,5H,VIS=,F6.1)
 911Ø FORMAT(3F1Ø.3,2F5.1,2E1Ø.3,2F1Ø.3)
 9115 FORMAT(1ØX,26HINPUT METEOROLOGICAL DATA:/1ØX,2HZ=,F7.2,7H KM, P=,
     XF7.2,6H MB,T=,F5.1,15H C, DEW PT.TEMP,F5.1,17H REL HUMIDITY=,
     XF5.1,16H %, H2O DENSITY=,1PE9.2,7H GM M-3/1ØX,15H OZONE DENSITY=,
     XE9.2,2ØH GM-3, VISUAL RANGE=,ØPF6.1,1ØH KM,RANGE=,F1Ø.3,4H KM )
 912Ø FORMAT(25H  MODEL ATMOSPHERE NO. 7,/4X,6HZ (KM),3X,6HP (MB),4X,
     X49HT (C) DEW PT %RH  H2O(GM.M-3) O3(GM.M-3) NO. DEN.)
 913Ø FORMAT(//1ØX,28H HORIZONTAL PATH, ALTITUDE =,F7.3,11H KM,RANGE =,
     XF7.3,3H KM)
 914Ø FORMAT(//1ØX,51H SLANT PATH BETWEEN ALTITUDES H1 AND H2 WHERE H1
     X=,F7.3,8H KM H2 =,F7.3,18H KM,ZENITH ANGLE =,F7.3,8H DEGREES)
 915Ø FORMAT(//1ØX,39H SLANT PATH TO SPACE FROM ALTITUDE H1 =,F7.3,2ØH
     XKM, ZENITH ANGLE =,F7.3,8H DEGREES)
 916Ø FORMAT(/25X,13HHAZE MODEL  =,F5.1,29H KM VISUAL RANGE AT SEA LEVEL
     X)
```

```
9165 FORMAT(61H  FOG CONDITIONS MAY EXIST AT LEA LEVEL FOR THIS VISUAL MA 12970
    XRANGE,/,94H  IF SO THEN ASSUME THE TRANSMITTANCE DUE TO FOG IS GIVMA 12980
    XEN BY THE TRANSMITTANCE AT 0.55 MICRONS)                         MA 12990
9170 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,11H = TROPICAL)             MA 13000
9180 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,21H = MIDLATITUDE SUMMER)   MA 13010
9190 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,21H = MIDLATITUDE WINTER)   MA 13020
9200 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,21H = SUB-ARCTIC SUMMER )   MA 13030
9210 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,21H = SUB-ARCTIC WINTER )   MA 13040
9220 FORMAT(/20X,18H MODEL ATMOSPHERE ,I1,21H = 1962 US STANDARD  )   MA 13050
9230 FORMAT(/20X,39HAEROSOL SCATTERING NOT COMPUTED,IHAZE=0)          MA 13060
9235 FORMAT(/20X,18H       HAZE MODEL ,I1,3H = ,2A2,13H VISUAL RANGE) MA 13070
9240 FORMAT(/10X,21H FREQUENCY RANGE V1= ,F7.1,13H CM-1 TO V2= ,F7.1, MA 13080
    X14H CM-1 FOR DV =,F6.1,9H CM-1   (,F6.2,3H - ,F5.2,10H MICRONS )) MA 13090
9250 FORMAT(1H1,///10X,20H HORIZONTAL PROFILES/)                      MA 13100
9260 FORMAT(69H TRAJECTORY MISSES EARTHS ATMOSPHERE. CLOSEST DISTANCE OMA 13110
    XF APPROACH IS,F10.2,1X,/,1X,18HEND OF CALCULATION)               MA 13120
9270 FORMAT(10X,I4,F6.1,11(E10.3))                                    MA 13130
9280 FORMAT(1H1,///10X,21H  VERTICAL PROFILES  ,64X,3HPSI,6X,3HPHI,6X, MA 13140
    X4HBETA,4X,14HTHETA    RANGE)                                     MA 13150
9290 FORMAT(I5,F7.1,8E10.3,4F9.4,F7.1)                                MA 13160
9300 FORMAT(8H HMIN = ,F10.3)                                         MA 13170
9305 FORMAT(75H H2 WAS SET LESS THAN HMIN AND HAS BEEN RESET EQUAL TO MA 13180
    X    HMIN I.E. H2 = ,F10.3)                                       MA 13190
9310 FORMAT(65H PATH INTERSECTS EARTH - PATH CHANGED TO TYPE 2 WITH H2 MA 13200
    X=  0.0 KM)                                                       MA 13210
9320 FORMAT(85H CHOICE OF TWO PATHS FOR THIS CASE -SHORTEST PATH TAKEN.MA 13220
    X   FOR LONGER PATH SET LEN=1.)                                   MA 13230
9330 FORMAT(85H CHOICE OF TWO PATHS FOR THIS CASE -LONGEST PATH TAKEN. MA 13240
    X   FOR SHORT PATH SET LEN = 0 )                                  MA 13250
9340 FORMAT(/11X,37HEQUIVALENT SEA LEVEL ABSORBER AMOUNTS//21X,110HWATEMA 13260
    XR VAPOUR     CO2 ETC.       OZONE    NITROGEN (CONT)  H2O (CONT)  MA 13270
    X   MOL  SCAT      AEROSOL     OZONE(U-V)/24X,7X       ,10X,2X  ,10MA 13280
    XX,6X       ,10X,2HKM,9X,7HGM CM-2,10X,2HKM,13X,2HKM,10X,6HATM CM) MA 13290
9350 FORMAT(/10X,8H W(1-8)=42X,5(E14.3)/ 74X,E14.3/)                  MA 13300
9360 FORMAT(1H1,/10X,32H FREQ WAVELENGTH  TOTAL     H2O,5X4HCO2+,5X,64HMA 13310
    XOZONE  N2 CONT  H2O CONT MOL SCAT  AEROSOL  AEROSOL   INTEGRATED /MA 13320
    X11X,14H CM-1  MICRONS,8(4X5HTRANS),4X,20H ABS     ABSORPTION )   MA 13330
9370 FORMAT(10X,I6,10F9.4,F12.2)                                      MA 13340
9380 FORMAT(///1X,2HLL,3X,5HLEVEL,2X,8HALTITUDE,3X,4HTEMP,6X,4HPRES,7X,MA 13350
    X4HWH2O,7X,3HWO3,8X,4HWGAS/)                                      MA 13360
9390 FORMAT(I3,I6,3F10.2,2X,3E11.3)                                   MA 13370
9400 FORMAT(26H INTEGRATED ASORPTION FROM,I5,3H TO,I5,7H CM-1 =,F10.2, MA 13380
    X24H,AVERAGE TRANSMITTANCE =,F6.4)                                MA 13390
9410 FORMAT(/26H MEDIUM  RESOLUTION   DVM=,F5.3,12H WAVENUMBERS/)     MA 13400
9420 FORMAT(2F10.2,I5)                                                MA 13410
9422 FORMAT(26H TAPE OUT OF RANGE OF DATA/5H V1 =,F7.1,6H, V2 =,F7.1, MA 13420
    X8H, VMIN =,F7.1,8H, VMAX =,F7.1)                                 MA 13430
9424 FORMAT(//5H V1 =,F10.2,5X,19HTOO SMALL, RESET TO,F10.2,4HCM-1)   MA 13440
9426 FORMAT(//5H V2 =,F10.2,5X,18HTOO LARGE,RESET TO,F10.2,4HCM-1)    MA 13450
9427 FORMAT(9F10.2)                                                   MA 13460
9429 FORMAT(41H INTERPOLATION POINTS RETURNED FROM PTPTS/             MA 13470
    X66(I5,2F10.3,3I6/))                                              MA 13480
```

```
9430 FORMAT(2A2,I5)                                                        MA 13490
9440 FORMAT(1X,2A2,I10,21H CALCULATIONAL POINTS)                           MA 13500
9450 FORMAT(F12.2,9E12.6)                                                  MA 13510
9460 FORMAT(19H BLOCK SKIPPED, V =,F10.2,12H WAVENUMBERS,7I6)              MA 13520
9465 FORMAT(13H NMIN,NMAX = ,2I10)                                         MA 13530
9470 FORMAT(1X,3X,5HFREQ.,5X,4HRAD.,3X,13HTRANSMITTANCE,3X,5HCONT.,6X,     MA 13540
    X6HH1 RES,6(8X,2A2))                                                   MA 13550
9480 FORMAT(F9.2,E10.3,F11.4,3F12.4)                                       MA 13560
9490 FORMAT(2F10.2)                                                        MA 13570
9500 FORMAT(I10,3F10.4)                                                    MA 13580
9510 FORMAT(F12.4,2E12.4)                                                  MA 13590
9520 FORMAT(7H JFNU =,I5)                                                  MA 13600
9530 FORMAT(4(3X,7H FREQ. ,2X,10H   RAD.    ,2X,8H TRANS. ))               MA 13610
9540 FORMAT(4(3X,F7.2,2X,E10.3,2X,F8.6))                                   MA 13620
9550 FORMAT(96X,3X,F7.2,2X,E10.3,2X,F8.6)                                  MA 13630
     END                                                                   MA 13640
```

```
      SUBROUTINE POINT (X,YN,N,NP,TX,IP)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      COMMON Z(34),P(7,34),T(7,34),EH(1Ø,34),WH(7,34),M,NL,RE,CW,CO,PI
      DIMENSION TX(12)
C***********************************************************************
C     SUBROUTINE POINT COMPUTES THE MEAN REFRATIVE INDEX ABOVE AND BELOW
C     A GIVEN ALTITUDE AND INTERPOLATES EXPONENTIALLY TO DETERMINE THE
C     EQUIVALENT ABSORBER AMOUNTS AT THAT ALTITUDE.
C
C***********************************************************************
C
C      X IS THE HEIGHT IN QUESTION
C      TX(9) AND YN ARE THE MEAN REFRACTIVE INDICES ABOVE AND BELOW X
C      N IS THE LEVEL INTEGER CORRESPONDING TO X OR THE LEVEL BELOW X
C      NP =1 IF X COINCIDES WITH MODEL ATMOSPHERE LEVEL ,IF NOT NP = Ø
C      TX(1-8) ARE ABSORBER  AMOUNTS PER KM AT HEIGHT X
C***********************************************************************
      N=NL
      NP=Ø
      IF (X.LT.Ø.Ø) X=Ø.
      IF (X.GT.Z(NL)) GO TO 4
      DO 1 I=1,NL
      N=I
      IF (X-Z(I)) 2,4,1
1     CONTINUE
2     J2=N
      N=N-1
      FAC=(X-Z(N))/(Z(J2)-Z(N))
      PX1=P(M,N)*(P(M,J2)/P(M,N))**FAC
      TX1=T(M,N)*(T(M,J2)/T(M,N))**FAC
      TX(11)=TX1
      TX(12)=PX1
      WX1=WH(M,N)*(WH(M,J2)/WH(M,N))**FAC
      TX(3)=CO*PX1/TX1-4.56E-6*WX1*TX1*CW
      TX(2)=CO*P(M,J2)/T(M,J2)-4.56E-6*WH(M,J2)*T(M,J2)*CW
      TX(1)=CO*P(M,N)/T(M,N)-4.56E-6*WH(M,N)*T(M,N)*CW
      TX(9)=Ø.5E-6*(TX(2)+TX(3))
      YN=Ø.5E-6*(TX(1)+TX(3))
      IF (IP.EQ.Ø) GO TO 9
      DO 3 L=1,9
      K=L
      IF(L.EQ.9) K=1Ø
      IF (EH(K,N).EQ.Ø.Ø) GO TO 3
      IF (EH(K,N).GT.1ØØØ.Ø) GO TO 3
      TX(K)=EH(K,N)*(EH(K,J2)/EH(K,N))**FAC
3     CONTINUE
      GO TO 9
4     NP=1
      IF (IP.EQ.Ø) GO TO 6
      DO 5 K=1,1Ø
5     TX(K)=EH(K,N)
      TX(11)=T(M,N)
      TX(12)=P(M,N)
6     TX(9)=EH(9,N)-1.
```

```
      YN=0.0                                                            PO 00500
      IF (N.GT.1) YN=XN(9,N-1)-1.0                                      PO 00510
9     CONTINUE                                                          PO 00520
      IF (IP.EQ.1) WRITE(6,400) X,N,NP,TX(9),YN,IP,(TX(K),K=1,8)        PO 00530
      TX(9)=TX(9)+1.                                                    PO 00540
      YN=YN+1.                                                          PO 00550
      RETURN                                                            PO 00560
C                                                                       PO 00570
400   FORMAT(/,20H FROM POINT: HEIGHT=,F10.4,6H KM,N=,I3,4H,NP=,I2,     PO 00580
     X29H,REF . INDEX ABOVE & BELOW X=,2E11.4,4H,IP=,I3,/,12X,37HEQUIV. PO 00590
     XABSORBER  AMOUNTS PER KM AT X=,8E10.3)                            PO 00600
      END                                                               PO 00610
      SUBROUTINE PTPTS (PP,TT,IMAX,KPTS,TEMP,PRES)                      PT 00010
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                               PT 00020
      DIMENSION PP(9),TT(9),KPTS(3,40),TEMP(1),PRES(1)                  PT 00030
C**********SUBROUTINE WRITTEN FOR 9 P,T POINTS                          PT 00040
      DO 60 J=1,IMAX                                                    PT 00050
      P0=PRES(J)                                                        PT 00060
      T0=TEMP(J)                                                        PT 00070
C*****IF (ICALC2.GT.0) GO TO 50                                         PT 00080
C*****ICALC2=1                                                          PT 00090
C**********FIRST CALL AT GIVEN P,T---LOCATE INTERPOLATION POINTS        PT 00100
      IF (P0.GT.PP(5).AND.T0.GT.TT(5)) GO TO 15                         PT 00110
      IF (P0.GT.PP(3)) GO TO 5                                          PT 00120
      K1=1                                                              PT 00130
      K2=2                                                              PT 00140
      K3=3                                                              PT 00150
      IF (T0.LE.TT(2)) GO TO 50                                         PT 00160
      K1=4                                                              PT 00170
      K2=3                                                              PT 00180
      K3=2                                                              PT 00190
      GO TO 50                                                          PT 00200
5     IF (P0.GT.PP(5)) GO TO 10                                         PT 00210
      K1=3                                                              PT 00220
      K2=4                                                              PT 00230
      K3=5                                                              PT 00240
      IF (T0.LE.TT(5)) GO TO 50                                         PT 00250
      K1=6                                                              PT 00260
      K2=5                                                              PT 00270
      K3=4                                                              PT 00280
      GO TO 50                                                          PT 00290
10    K1=6                                                              PT 00300
      K2=5                                                              PT 00310
      K3=7                                                              PT 00320
      PMID=0.5*(PP(5)+PP(7))                                            PT 00330
      IF (P0.LT.PMID) GO TO 50                                          PT 00340
      K1=8                                                              PT 00350
      K2=7                                                              PT 00360
      K3=5                                                              PT 00370
      GO TO 50                                                          PT 00380
```

```
15     IF (PØ.GT.PP(7)) GO TO 25                                     PT ØØ39Ø
       K1=9                                                          PT ØØ4ØØ
       K2=8                                                          PT ØØ41Ø
       K3=6                                                          PT ØØ42Ø
       IF (TØ.GT.TT(6)) GO TO 5Ø                                     PT ØØ43Ø
       A6=(TØ - TT(6))**2 + (PØ - PP(6))**2                          PT ØØ44Ø
       A7=(TØ - TT(7))**2 + (PØ - PP(7))**2                          PT ØØ45Ø
       IF (A6.GT.A7) GO TO 2Ø                                        PT ØØ46Ø
       K1=5                                                          PT ØØ47Ø
       K2=6                                                          PT ØØ48Ø
       K3=8                                                          PT ØØ49Ø
       GO TO 5Ø                                                      PT ØØ5ØØ
2Ø     IF (TØ.GT.TT(8)) GO TO 3Ø                                     PT ØØ51Ø
       K1=8                                                          PT ØØ52Ø
       K2=7                                                          PT ØØ53Ø
       K3=5                                                          PT ØØ54Ø
       GO TO 5Ø                                                      PT ØØ55Ø
25     TMID=Ø.5*(TT(7) + TT(8))                                      PT ØØ56Ø
       K1=8                                                          PT ØØ57Ø
       K2=7                                                          PT ØØ58Ø
       K3=5                                                          PT ØØ59Ø
       IF (TØ.LE.TMID) GO TO 5Ø                                      PT ØØ6ØØ
       K1=7                                                          PT ØØ61Ø
       K2=8                                                          PT ØØ62Ø
       K3=6                                                          PT ØØ63Ø
       GO TO 5Ø                                                      PT ØØ64Ø
3Ø     K1=9                                                          PT ØØ65Ø
       K2=8                                                          PT ØØ66Ø
       K3=6                                                          PT ØØ67Ø
5Ø     CONTINUE                                                      PT ØØ68Ø
       KPTS(1,J)=K1                                                  PT ØØ69Ø
       KPTS(2,J)=K2                                                  PT ØØ7ØØ
       KPTS(3,J)=K3                                                  PT ØØ71Ø
6Ø     CONTINUE                                                      PT ØØ72Ø
       RETURN                                                        PT ØØ73Ø
       END                                                           PT ØØ74Ø
```

```
      SUBROUTINE ANGL (H1,H2,ANGLE,B1,LEN,ML)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      COMMON Z(34),P(7,34),T(7,34),EH(1Ø,34),WH(7,34),M,ML,RE,CW,CO,PI
      DIMENSION TX(1Ø)
C***********************************************************************
C
C     THIS SUBROUTINE CALCULATES THE INITIAL ZENITH ANGLE (ANGLE)
C     TAKING INTO ACCOUNT REFRACTION EFFECTS GIVEN H1,H2, AND BETA
C     (WHERE BETA IS THE EARTH CENTRE ANGLE SUBTENDED BY H1 AND H2 ),
C     ASSUMING THE REFRACTIVE INDEX TO BE CONSTANT IN A GIVEN LAYER.
C     FOR GREATER ACCURACY INCREASE THE NUMBER OF LEVELS IN THE MODEL
C     ATMOSPHERE.
C
C     THIS SUBROUTINE CAN BE REMOVED FROM THE PROGRAM IF NOT REQUIRED.
C***********************************************************************
      IP=99
      CA=PI/18Ø.
      X1=RE+H1
      X2=RE+H2
      LEN=Ø.
      IT=Ø
      B1=B1*CA
      IF(B1.EQ.Ø.Ø) B1=DACOS(X2/X1)
      TANG=X2*DSIN(B1)/(X2*DCOS(B1)-X1)
      THET=DATAN(TANG)
      IF (THET.LT.Ø.Ø) THET=THET+PI
      SPHI=DSIN(THET)
      ANG=THET/CA
C     WRITE(6,4Ø4) B1,ANG,TANG
      TN=THET
      TM=TN-Ø.5*CA
1     ANGLE=THET
      FBT=Ø.
      BETA=Ø.
      BET1=Ø
      BET2=Ø
      FBT1=Ø
      FBT2=Ø
      FBT3=Ø.Ø
      IF(B1.LE.Ø.Ø) GO TO 2
C     WRITE(6,4ØØ) IT
      Y=2.*THET
      IF (Y-PI.GT.1.ØE-8) GO TO 9
      IF (IP.EQ.1ØØ) GO TO 6
      XMIN=X2*DCOS(B1)-RE
      IF (XMIN-H1) 8,4,4
    2 HMIN=H2
      H2=H1
      H1=HMIN
3     ANGLE=Ø.5*PI
      THET=ANGLE
      SPHI=1.Ø
      ANG=ANGLE/CA
C     WRITE(6,4Ø4) B1,ANG,SPHI
4     IP=1ØØ
      CALL POINT (H1,YM,M,MP,TX,IP)
```

```
      J1=N
      TX1=TX(9)
    5 CALL POINT (H2,YN,N,NP,TX,IP)
      IF (NP.EQ.1) N=N-1
      J2=N
      IF (J1.EQ.J2) TX1=TX1+YN-EH(9,J1)
    6 DO 7 J=J1,J2
      X1=RE+Z(J)
      X2=RE+Z(J+1)
      IF (J.EQ.J1) X1=RE+H1
      IF (J.EQ.J2) X2=RE+H2
      SALP=X1*SPHI/X2
      ALP=DASIN(SALP)
      RN=EH(9,J+1)/EH(9,J)
      IF ((J+1).EQ.J2) RN=YN/EH(9,J)
      IF (J.EQ.J1) RN=EH(9,J+1)/TX1
      IF ((J+1).EQ.J2.AND.J.EQ.J1) RN=YN/TX1
      BET=THET-ALP
      FB=-DTAN(ALP)
      IF (J.NE.J1) FB=FB+DTAN(THET)
      FBT=FBT+FB
      BETA=BETA+BET
      TH1=THET/CA
      BE=BET/CA
      C=ALP/CA
C     WRITE(6,4Ø2) J,Z(J),THET,ALP,BET,BETA,FBT,FB,TH1,BE,C
      IF (X2.EQ.RE+H2) C=PI-ALP
      IF (SALP.GE.RN) RN=1.
      SPHI=SALP/RN
      THET=DASIN(SPHI)
    7 CONTINUE
      IF(B1.LE.Ø.Ø) GO TO 29
      GO TO 26
    8 CONTINUE
      TANG=-TANG
      ANGLE=PI-ANGLE
      TN=ANGLE
      ANG=ANGLE/CA
C     WRITE(6,4Ø4) B1,ANG,TANG
      IF (H1.LE.Ø.Ø) GO TO 3
    9 CONTINUE
      IP=1Ø1
      CALL POINT (H1,YN,N,NP1,TX,IP)
      TX1=TX(9)
      YN1=YN
      IF (NP1.EQ.1) N=N-1
      J2=NL
      IF (M.EQ.7) J2=ML
      J1=N
      J=J1+1
      IF (H2.GE.H1) GO TO 13
      CALL POINT (H2,YN,N,NP,TX,IP)
      TX2=TX(9)
      YN2=YN
      J2=N
      IF (J1.EQ.J2) TX2=YN1+TX(9)-EH(9,J1)
```

```
10     J=J-1                                                              AN Ø113Ø
       X1=RE+Z(J+1)                                                       AN Ø114Ø
       X2=RE+Z(J)                                                         AN Ø115Ø
       IF (J.EQ.J1) X1=RE+H1                                              AN Ø116Ø
       IF (J.EQ.J2) X2=RE+H2                                              AN Ø117Ø
       SALP=X1*SPHI/X2                                                    AN Ø118Ø
       HMIN=X1*SPHI-RE                                                    AN Ø119Ø
C      WRITE(6,4Ø2) J,X1,Z(J),SPHI,SALP,HMIN,RE                           AN Ø12ØØ
       IF (SALP.LE.1.Ø) GO TO 11                                          AN Ø121Ø
       SALP=SPHI                                                          AN Ø122Ø
       IF (HMIN.GT.H2) GO TO 18                                           AN Ø123Ø
11     ALP=DASIN(SALP)                                                    AN Ø124Ø
       THET=DASIN(SPHI)                                                   AN Ø125Ø
       BET=ALP-THET                                                       AN Ø126Ø
       BET1=BET1+BET                                                      AN Ø127Ø
       FB=DTAN(ALP)                                                       AN Ø128Ø
       IF (J.NE.J1) FB=FB-DTAN(THET)                                      AN Ø129Ø
       FBT1=FBT1+FB                                                       AN Ø13ØØ
       TH1=THET/CA                                                        AN Ø131Ø
       EE=BET/CA                                                          AN Ø132Ø
       AL=ALP/CA                                                          AN Ø133Ø
C      WRITE(6,4Ø2) J,X2,THET,ALP,BET1,BET,BMIN,HMIN,FBT1,TH1,BE,AL       AN Ø134Ø
       IF (X2.EQ.RE+H2) C=PI-ALP                                          AN Ø135Ø
       REF=EH(9,J)                                                        AN Ø136Ø
       IF (J.EQ.J1) REF=YN1                                               AN Ø137Ø
       IF (J.EQ.J2) REF=TX2                                               AN Ø138Ø
       IF (J.EQ.1) CO TO 12                                               AN Ø139Ø
       RN=EH(9,J)/EH(9,J-1)                                               AN Ø14ØØ
       IF (J.EQ.J1) RN=YN1/EH(9,J-1)                                      AN Ø141Ø
       IF(J.EQ.J2+1) RN=REF/TX2                                           AN Ø142Ø
       IF(J.EQ.J2) RN=REF/YN2                                             AN Ø143Ø
       IF (SALP.GE.RN) RN=1.                                              AN Ø144Ø
       SPHI=SALP*RN                                                       AN Ø145Ø
       IF (Z(J).LE.H2) GO TO 12                                           AN Ø146Ø
       GO TO 1Ø                                                           AN Ø147Ø
12     X1=X2                                                              AN Ø148Ø
       IF (DABS(Z(J)-H2).LT.1.ØE-1Ø.AND.J.NE.1) GO TO 13                  AN Ø149Ø
       GO TO 14                                                           AN Ø15ØØ
13     J=J-1                                                              AN Ø151Ø
       X1=RE+Z(J+1)                                                       AN Ø152Ø
       IF (J.EQ.J1) X1=RE+H1                                              AN Ø153Ø
       IF (J.EQ.J2.AND.J.NE.J1) X1=RE+H2                                  AN Ø154Ø
14     X2=RE+Z(J)                                                         AN Ø155Ø
       HMIN=X1*SPHI-RE                                                    AN Ø156Ø
       IF (HMIN.LE.Ø.Ø) GO TO 25                                          AN Ø157Ø
       IF (Z(J).LT.HMIN) GO TO 18                                         AN Ø158Ø
       REF=EH(9,J)                                                        AN Ø159Ø
       IF (J.EQ.J2) REF=YN                                                AN Ø16ØØ
       SALP=X1*SPHI/X2                                                    AN Ø161Ø
       ALP=DASIN(SALP)                                                    AN Ø162Ø
       THET=DASIN(SPHI)                                                   AN Ø163Ø
       BET=ALP-THET                                                       AN Ø164Ø
       FB=DTAN(ALP)-DTAN(THET)                                            AN Ø165Ø
       FBT2=FBT2+FB                                                       AN Ø166Ø
       BET2=BET2+BET                                                      AN Ø167Ø
       BMIN=BET1+BET2                                                     AN Ø168Ø
```

```
      AL=ALP/CA
      TH1=THET/CA
C     WRITE(6,4Ø2) J,X2,THET,ALP,BET2,BET,BMIN,HMIN,FBT2,TH1,BE,AL
      RN=REF/EH(9,J-1)
      IF (SALP.GE.RN) RN=1.Ø
      SPHI=SALP*RN
      GO TO 13
17    TX3=YN1+TX(9)-EH(9,J1)
      YN1=TX3
      IF (DABS(H2-Z(J+1)).LE.1.ØE-5) YN1=TX(9)
      IF (DABS(H1-Z(J+1)).LE.1.ØE-5) YN1=TX(9)
      RN=1.Ø
      GO TO 19
18    CALL POINT (HMIN,YN,N,NP,TX,IP)
      IP=1Ø2
      TX3=TX(9)
      IF (J.EQ.J1.AND.H2.GE.H1) GO TO 17
      IF (J.EQ.J1.OR.J.EQ.J2) TX3=YN2+TX(9)-EH(9,J)
      IF (HMIN.GT.H2) TX3=TX(9)
      IF (J.EQ.J1.AND.HMIN.GT.H2) GO TO 17
      RN=REF/TX3
      IF (SALP.GE.RN) RN=1.
      SPHI=SALP*RN
      X=X1*SPHI-RE
      DIF=DABS(HMIN-X)
      HMIN=X
      IF (DIF-1.ØE-5) 19,19,18
19    X2=RE+HMIN
C     WRITE(6,4Ø3) HMIN,DIF,RN
      THET=DASIN(SPHI)
      IF(RN.EQ.1.Ø) FBT3=-DTAN(THET)
      IF (RN.EQ.1) GO TO 2Ø
      DNX=(TX3-1.Ø)*DLOG((TX3-1.Ø)/(REF-1.Ø))/(X2-X1)
      FBT3=-DTAN(THET)*(1.Ø-1.Ø/(1.Ø+TX3/(X2*DNX)))
2Ø    BET=Ø.5*PI-THET

      BET2=BET2+BET
      BMIN=BET1+BET2
      IF (H2.GE.H1) GO TO 23
      BET=BET1+2.*BET2
      DB1=B1-BET1
      DB2=BET-B1
  21    DB3=DABS(BMIN-B1)
      IF(DB3.GT.DB1.AND.DB2.GT.DB1) GO TO 25
      IF(DB2.GT.DB3) GO TO 22
      IF(DB2.GT.DB1)  GO TO 25
      BETA=BET
      FBT=FBT1+2.Ø*(FBT2+FBT3)
      LEN=1.
      GO TO 26
22    BETA=BET1+BET2
      FBT=FBT1+FBT2+FBT3
C     WRITE(6,4Ø1) J,BETA,FBT,FBT1,FBT2,FBT3,TX1,YN1
      GO TO 26
23    BETA=2.Ø*(BET1+BET2)
      LEN=1.
```

```
      FBT=2.Ø*(FBT1+FBT2+FBT3)                                          AN Ø225Ø
      WRITE(6,4Ø1) J,BETA,FBT,FBT1,FBT2,FBT3,TX1,YN1                    AN Ø226Ø
      IF (H2.EQ.H1) GO TO 26                                            AN Ø227Ø
      IP=1Ø3                                                            AN Ø228Ø
      IF (NP1.EQ.1) J1=J1+1                                             AN Ø229Ø
      SPHI=DSIN(ANGLE)                                                  AN Ø23ØØ
      IF (Z(J1+1).LE.H2) GO TO 24                                       AN Ø231Ø
      RN=TX1/YN1                                                        AN Ø232Ø
      IF (SPHI.GE.RN) RN=1.                                             AN Ø233Ø
      SPHI=SPHI/RN                                                      AN Ø234Ø
      THET=DASIN(SPHI)                                                  AN Ø235Ø
      GO TO 5                                                           AN Ø236Ø
 24   CALL POINT (H2,YN,N,NP,TX,IP)                                     AN Ø237Ø
      TX1=TX1+YN-EH(9,J1)                                               AN Ø238Ø
      RN=TX1/YN1                                                        AN Ø239Ø
      J2=J1                                                             AN Ø24ØØ
      IF (SPHI.GE.RN) RN=1.                                             AN Ø241Ø
      SPHI=SPHI/RN                                                      AN Ø242Ø
      THET=DASIN(SPHI)                                                  AN Ø243Ø
      GO TO 5                                                           AN Ø244Ø
 25   BETA=BET1                                                         AN Ø245Ø
      LEN=Ø.                                                            AN Ø246Ø
      FBT=FBT1                                                          AN Ø247Ø
 26   THET=ANGLE+(B1-BETA)/(1.+FBT/TANG)                                AN Ø248Ø
      DBETA=BETA/CA                                                     AN Ø249Ø
      B=BET1/CA                                                         AN Ø25ØØ
      TH1=THET/CA                                                       AN Ø251Ø
      WRITE(6,4Ø4) BETA,DBETA,FBT,TH1,TANG                              AN Ø252Ø
      IF (THET.GT.TN.OR.THET.LT.TM) THET=(TN+TM)/2.                     AN Ø253Ø
      TH1=THET/CA                                                       AN Ø254Ø
      WRITE(6,4Ø4) BET1,B,FBT,TH1                                       AN Ø255Ø
      TN1=TN/CA                                                         AN Ø256Ø
```

```
      TM1=TM/CA
      WRITE(6,405) TN,TM,TN1,TM1
      SPHI=DSIN(THET)
      TANG=DTAN(THET)
      IT=IT+1
      DBE=DABS(B1-BETA)
      DTH=DABS(ANGLE-THET)
      IF (IT.EQ.10)  THET=0.5*(ANGLE+THET)
      IF (IT.EQ.10) GO TO 28
      IF (DBE.GT.1.0E-7.AND.DTH.GT.1.0E-7) GO TO 1
28    ANGLE=THET/CA
      WRITE(6,406) ANGLE,IT
      RETURN
   29 H1=H2
      ANGLE=C/CA
      WRITE(6,406) ANGLE,IT
      RETURN
C
400   FORMAT(//18H ITERATION NUMBER ,I3,//)
401   FORMAT(I6,E16.7,8F13.8)
402   FORMAT(I4,F10.4,6E13.4,4F10.4/)
403   FORMAT(7H  HMIN=,F14.6,6H  DIF=,E14.6,5H  PR=,E16.8)
404   FORMAT(14H TOTAL BETA = ,E14.6,F15.6,7H,FBT = ,E14.6,7H THET =,
     XF10.6,5HTANG=,F10.6)
405   FORMAT(5F12.6)
406   FORMAT(8X,/1X,14HZENITH ANGLE =,F7.3,60H DEGREES :  RECOMPUTED
     X   FROM SUBROUTINE ANGL (ITERATION,I3,1H))
      END
```

```
      SUBROUTINE LIB(NEWS,NEWP,MAX,NFILES,XORG,YORG)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XORG,YORG
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      DIMENSION ARRAY(3ØØ1),V(4ØØØ),T(4ØØØ),Y(45ØØ),X(45ØØ)
      DIMENSION XSS(8),SS(8),NEWS(2,1Ø),NEWP(2,1Ø),MAX(2)
      COMMON/BLOCK1/V,T
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
C     DOUBLE PRECISION WIDTH,SHIFT
      DATA IPLOT/Ø/,ISLOT/Ø/

      DO 2ØØ ITYPE=1,2
      REWIND 9
      IF(MAX(ITYPE).EQ.Ø) GO TO 2ØØ
      NMAX=MAX(ITYPE)

      DO 15Ø IFILE=1,NMAX
      KSLOT=NEWS(ITYPE,IFILE)
      IF(KSLOT.NE.-11) GO TO 2Ø
      CALL SPACE
      GO TO 15Ø
   2Ø READ(5,9ØØ) TITLE
      WRITE(6,9Ø1) TITLE
      CALL CRAM(TITLE,KCHAR)
      IF(KSLOT.EQ.Ø) GO TO 4Ø
      LAST=ISLOT
      ISLOT=KSLOT
      JSLOT=IABS(ISLOT)
      IF(-ISLOT.EQ.LAST) GO TO 4Ø
      GO TO (25,3Ø,35),JSLOT
   25 READ(5,91Ø) WIDTH,SHIFT,NS
      READ(5,92Ø) (XSS(I),I=1,NS)
      READ(5,92Ø) (SS(I),I=1,NS)
      GO TO 4Ø
   3Ø READ(5,91Ø) DELNU,RES,JLO,JHI
      GO TO 4Ø
   35 CONTINUE
   4Ø IF(ISLOT.GT.Ø) GO TO 43
      NEWT=1
      GO TO 55
   43 IF(NEWP(ITYPE,IFILE).NE.Ø) LNEW=NEWP(ITYPE,IFILE)
      NEWT=LNEW
      IPLOT=IPLOT+1
      IF(IPLOT.NE.1) GO TO 45
      CALL INITP$(4,2)
      CALL PLOT(XORG,YORG,-3)
   45 IF(NEWP(ITYPE,IFILE).EQ.Ø) GO TO 5Ø
```

```
      READ(5,900) XTITLE
      READ(5,900) YTITLE
      READ(5,930) XAXIS,XINIT,XSCALE,DXT,NMINX
      READ(5,930) YAXIS,YINIT,YSCALE,DYT,NMINY
      CALL CRAM(XTITLE,ICHAR)
      CALL CRAM(YTITLE,JCHAR)
C  50 IF(ISLOT.GT.0) CALL FRAME
   50 CONTINUE
   55 GO TO (60,70,80),JSLOT
   60 WRITE(6,940) WIDTH,SHIFT,NS
      WRITE(6,942) (SS(I),I=1,NS)
      WRITE(6,945) (XSS(I),I=1,NS)
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL GEN(WIDTH,SHIFT,XSS,SS,NS)
      GO TO 150
   70 WRITE(6,950) DELNU,RES,JLO,JHI
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL AFGL(DELNU,RES,JLO,JHI)
      GO TO 150
   80 WRITE(6,960)
      IF(ITYPE.EQ.1) WRITE(6,935)
      IF(ITYPE.EQ.2) WRITE(6,937)
      CALL ALL
  150 CONTINUE

  200 CONTINUE

      IF(IPLOT.EQ.0) RETURN
      CALL PLOT(XAXIS+5.0,0.0,-3)
      CALL ENDPLT
      RETURN
  900 FORMAT(20A4)
  901 FORMAT(/////30X,20A4)
  910 FORMAT(2F10.5,2I10)
  920 FORMAT(8F10.5)
  930 FORMAT(4E10.4,I10)
  935 FORMAT(////1X,53X,25HATMOSPHERIC TRANSMITTANCE)
  937 FORMAT(////1X,50X,31HRADIATION(WATTS/SR/CM**2/UNITS))
  940 FORMAT(//1X,22HVARIABLE SLIT FUNCTION/1X,6HWIDTH=,F10.5,4X,
     X 6HSHIFT=,F10.5,4X,20HNO. OF DEFINING PTS=,I2)
  942 FORMAT(1X,8HYS ARE  ,8F10.3)
  945 FORMAT(1X,8HXS ARE  ,8F10.3)
  950 FORMAT(//1X,6HDELNU=,F10.5,4X,4HRES=,F10.5,4X,4HJLO=,
     X I5,4X,4HJHI=,I5///)
  960 FORMAT(//1X,25HNO SLIT FUNCTION USED           ///)
      END
```

```
      SUBROUTINE CRAM(TITLE,NCHAR)
C
C***   REMOVES TRAILING BLANKS IN TITLE   ***
C
      DIMENSION TITLE(1)
      NCHAR=8Ø
      DO 5Ø I=1,2Ø
      IWORD=21-I
      IF(TITLE(IWORD).NE.4H    ) RETURN
      NCHAR=NCHAR-4
   5Ø CONTINUE
      NCHAR=1
      RETURN
      END







      SUBROUTINE AFGL(DELNU,RES,JLO,JHI)
C PART1 - CALCULATES THE FOURIER ANALYZER INSTRUMENT FUNCTION (WINDOW +
C HANNING) FOR EVERY .Ø1 CHANNEL FROM Ø TO 3Ø CHANNELS.
C PART2 - CONVOLVES A DATA SPECTRUM (TAPE1) AT HIGH RESOLUTION (.1 CM-1)
C WITH THE F.A. INSTRUMENT FUNCTION.
C INSTR.FUNCT= .25*(SINC(PI*(X-1))+SINC(PI*(X+1)))+.5*SINC(PI*X)
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      INTEGER*4 N,JJ
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 A,VV
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      DIMENSION ARRAY(3ØØ1),V(4ØØØ),T(4ØØØ),A(45ØØ),VV(45ØØ)
      COMMON/BLOCK1/V,T
      COMMON/BLOCK2/A,VV
      COMMON/BLOCK3/KKK,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,JWT

      NN=Ø
C BEGINNING PART1
      PI=3.14159265358979
      ARRAY(1)=Ø.5
      DO 2ØØ I=2,1ØØ
      X=(I-1)/1ØØ.
      X1=PI*(X-1.)
      X2=PI*X
      X3=PI*(X+1.)
      ARRAY(I)=.25*(DSIN(X1)/X1+DSIN(X3)/X3)+.5*DSIN(X2)/X2
  2ØØ CONTINUE
      ARRAY(1Ø1)=Ø.25
      DO 21Ø I=1Ø2,3ØØ1
```

```
      X=(I-1)/100.                                                      AF 00360
      X1=PI*(X-1.)                                                      AF 00370
      X2=PI*X                                                           AF 00380
      X3=PI*(X+1.)                                                      AF 00390
      ARRAY(I)=.25*(DSIN(X1)/X1+DSIN(X3)/X3)+.5*DSIN(X2)/X2             AF 00400
  210 CONTINUE                                                          AF 00410
C BEGINNING PART2                                                       AF 00420
C CONVOLVE OVER 30 CHANNEL RANGE ONLY                                   AF 00430
C CALCULATE INSTR FUNCT. TO NEAREST .01 CHANNEL BY USING ARRAY LIBRARY  AF 00440
C READ SPECTRUM                                                         AF 00450
C DELNU(CM-1) BETWEEN CHANNELS, LASER SAMPLING INTERVAL IN WAVENUMBERS  AF 00460
C JLO LOWEST OUTPUT CHANNEL, JLO*DELNU WAVENUMBER                       AF 00470
C JHI HIGHEST OUTPUT CHANNEL, JHI*DELNU WAVENUMBER                      AF 00480
      DO 50 J=1,500                                                     AF 00490
   50 A(J)=0.                                                           AF 00500
   52 READ(9,54) H1,H2                                                  AF 00510
   54 FORMAT(2F10.2)                                                    AF 00520
      IF(H1.EQ.-1.0) GO TO 120                                          AF 00530
   55 READ(9,58) JWT,V(1),V(JWT),DVM                                    AF 00540
   58 FORMAT(I10,3F10.4)                                                AF 00550
      IF(ITYPE.EQ.1) READ(9,56)(V(J),DUM,T(J),J=1,JWT)                  AF 00560
      IF(ITYPE.EQ.2) READ(9,56)(V(J),T(J),DUM,J=1,JWT)                  AF 00570
   56 FORMAT(F12.4,2E12.4)                                              AF 00580
      DO 100 J=1,JWT                                                    AF 00590
      X1=V(J)/DELNU                                                     AF 00600
      N=X1                                                              AF 00610
      N1=N-29                                                           AF 00620
      IF(N1.LT.JLO) N1=JLO                                              AF 00630
      N2=N+30                                                           AF 00640
      IF(N2.GT.JHI) N2=JHI                                              AF 00650
      DO 110 I=N1,N2                                                    AF 00660
      X=DABS((X1-FLOAT(I))*100.)+1                                      AF 00670
      JJ=X                                                              AF 00680
      K=I-JLO+1                                                         AF 00690
  110 A(K)=A(K)+T(J)*((ARRAY(JJ+1)-ARRAY(JJ))*(X-JJ)+ARRAY(JJ))         AF 00700
  100 CONTINUE                                                          AF 00710
      GO TO 52                                                          AF 00720
  120 KK=JHI-JLO+1                                                      AF 00730
      KKK=0                                                             AF 00740
      DO 400 K=1,KK                                                     AF 00750
      KKK=KKK+1                                                         AF 00760
      A(KKK)=A(K)*RES/DELNU                                             AF 00770
      I=JLO+K-1                                                         AF 00780
      VV(KKK)=I*DELNU+DELNU/2.0                                         AF 00790
      IF(KKK.EQ.240) CALL PROUT                                         AF 00800
  400 CONTINUE                                                          AF 00810
      CALL PROUT                                                        AF 00820
      RETURN                                                            AF 00830
      END                                                               AF 00840
                                                                        AF 00850
                                                                        AF 00860
                                                                        AF 00870
                                                                        AF 00880
```

```
      SUBROUTINE GEN(WIDTH,SHIFT,XSS,SS,NS)
C
C***   SLIT FUNCTION   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION ARRAY(3001),XF(4000),F(4000),Y(4500),X(4500)
      DIMENSION XTITLE(20),YTITLE(20),TITLE(20)
      DIMENSION XS(8),S(8),XSS(1),SS(1)
      COMMON/BLOCK1/XF,F
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NF
C     DOUBLE PRECISION A,B,C,D,AA,BB,CC,DELX,DELF,DELS,DEL3,DEL2,DEL1
C     DOUBLE PRECISION X1,S1,F1,X2,S2,F2,XNEXT,XMID,XSTOP,XTOP,WIDTH
C     DOUBLE PRECISION SUM,XSF,SHIFT,XS,XFS,XFIF,XSF1,XSEND,XSTRT
C     DOUBLE PRECISION XDEL,AREA,PART,SF


      FAC=WIDTH/(XSS(NS)-XSS(1))
      DO 5 IS=1,NS
      XS(IS)=FAC*XSS(IS)
      S(IS)=FAC*SS(IS)
    5 CONTINUE

      AREA=0.0
      DO 10 IS=2,NS
      IS1=IS-1
      AREA=AREA+(S(IS)+S(IS1))*(XS(IS)-XS(IS1))/2.0
   10 CONTINUE

      NN=0
      N=0


   32 READ(9,33) H1,H2
   33 FORMAT(2F10.2)
      IF(H1.NE.-1.0) GC TO 34
      CALL PROUT
      RETURN
   34 READ(9,35) NF,XF(1),XF(NF),DVM
   35 FORMAT(I10,3F10.4)
      IF(ITYPE.EQ.1) READ(9,36)(XF(J),DUM,F(J),J=1,NF)
      IF(ITYPE.EQ.2) READ(9,36)(XF(J),F(J),DUM,J=1,NF)
   36 FORMAT(F12.4,2E12.4)


   39 XTOP=XF(NF)
      XDEL=SHIFT+XS(1)
```

```
      XSTRT=XS(1)
      XSEND=XS(NS)
      XMID=XF(1)-XS(1)-SHIFT
      MF=1

   4Ø IF=MF

      XMID=XMID+SHIFT
      XNEXT=XMID+XDEL
      XSTOP=XMID+XSEND

      SUM=Ø.Ø
      X2=XMID+XSTRT
      S2=S(1)

      IF1=IF+1
      F2=F(IF)+(F(IF1)-F(IF))*(X2-XF(IF))/(XF(IF1)-XF(IF))


      IS=1
      XSF=XMID+XSTRT

   5Ø X1=X2
      S1=S2
      F1=F2

      IF(XF(IF).GT.X1) GO TO 7Ø
      IF=IF+1

   7Ø IF(XF(IF).LE.XNEXT) MF=IF
      XSF1=XSF-X1
      IF(XSF1.GT.Ø.Ø) GO TO 8Ø
      IS=IS+1
      XSF=XMID+XS(IS)

   8Ø XFIF=XF(IF)
      X2=DMIN1(XFIF,XSF)
      XFS=X2-XMID

      IS1=IS-1
      IF1=IF-1
      S2=S(IS1)+(S(IS)-S(IS1))*(XFS-XS(IS1))/(XS(IS)-XS(IS1))
      F2=F(IF1)+(F(IF)-F(IF1))*(X2-XF(IF1))/(XF(IF)-XF(IF1))

      DELX=X2-X1
      DELF=F2-F1
      DELS=S2-S1

      A=DELS/DELX
      B=S1
      C=DELF/DELX
      D=F1

      AA=A*C/3.Ø
      BB=(A*D+B*C)/2.Ø
      CC=B*D
```

```
      DEL3=DELX**3
      DEL2=DELX**2
      DEL1=DELX



      SUM=SUM+AA*DEL3+BB*DEL2+CC*DEL1

      IF(X2.LT.XTOP) GO TO 85
      IF(XSTOP.GT.XTOP) GO TO 1ØØ
      N=N+1
      X(N)=XMID
      Y(N)=SUM/AREA
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 32



   85 IF(X2.LT.XSTOP) GO TO 5Ø
      N=N+1
      X(N)=XMID
      Y(N)=SUM/AREA
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 4Ø


  1ØØ XFS=X2-XMID
      PART=Ø.Ø
      IS=1

  1Ø5 IS1=IS+1
      IF(XS(IS1).LT.XFS) GO TO 11Ø
      SF=S(IS)+(S(IS1)-S(IS))*(XFS-XS(IS))/(XS(IS1)-XS(IS))
      PART=PART+(SF+S(IS))*(XFS-XS(IS))/2.Ø
      GO TO 115

  11Ø PART=PART+(S(IS1)+S(IS))*(XS(IS1)-XS(IS))/2.Ø
      IS=IS+1
      GO TO 1Ø5

  115 N=N+1
      X(N)=XMID
      Y(N)=SUM/PART
      IF(N.EQ.24Ø) CALL PROUT
      GO TO 32


      END
```

```
      SUBROUTINE FRAME
C
C***   SETS UP FRAME FOR PLOT   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
      IF(IPLOT.GT.1) CALL PLOT(XAXIS+5.Ø,Ø.Ø,-3)
      CALL AXIS(Ø.Ø,Ø.Ø,XTITLE,-ICHAR,XAXIS,Ø.Ø,XINIT,XSCALE,DXT,NMINX)
      CALL AXIS(Ø.Ø,YAXIS,TITLE,+KCHAR,XAXIS,Ø.Ø,XINIT,XSCALE,DXT,NMINX)
      CALL AXIS(Ø.Ø,Ø.Ø,YTITLE,+JCHAR,YAXIS,9Ø.Ø,YINIT,YSCALE,DYT,NMINY)
      CALL AXIS(XAXIS,Ø.Ø,4H    ,-4,YAXIS,9Ø.Ø,YINIT,YSCALE,DYT,NMINY)
      RETURN
      END




      SUBROUTINE PROUT
C
C***   PRINT OUTPUT AND PLOT CURVES   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XPT,YPT
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE,TNORM1,TNORM2,TEXP
      REAL*4 Y,X,YMAX,YCHECK
      DIMENSION XTITLE(2Ø),YTITLE(2Ø),TITLE(2Ø),TNORM1(5)
      DIMENSION V(6ØØ),W(6ØØ),T(6ØØ),RV(6ØØ),RW(6ØØ)
      DIMENSION XX(4ØØØ),YY(4ØØØ),Y(45ØØ),X(45ØØ)
      COMMON/BLOCK1/XX,YY
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,V,W,T,RV,RW,DUMMY(79)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NX
      DATA TNORM1/4H  NO,4HRMAL,4HIZED,4H TO ,4H1Ø.(/
      DATA TNORM2/4H)   /

      IF(N.EQ.Ø) RETURN
      IF(ISLOT.LT.Ø) GO TO 5
      IF(NEWT.GT.Ø) GO TO 3
      IF(ITYPE.EQ.2) GO TO 75Ø
      DO 72Ø I=1,N
      X(I)=1.ØE+Ø4/X(I)
  72Ø CONTINUE
      GO TO 3
  75Ø DO 8ØØ I=1,N
```

```
      Y(I)=1.ØE-Ø4*Y(I)*X(I)**2
      X(I)=1.ØE+Ø4/X(I)
  8ØØ CONTINUE
    3 CONTINUE
      YMAX=Y(1)
      DO 4 I=2,N
    4 YMAX=AMAX1(Y(I),YMAX)
      YCHECK=YINIT+YAXIS*YSCALE
      IF(YMAX.LE.YCHECK) IEXP=INT(ALOG1Ø(YCHECK))-1
      IF(YMAX.GT.YCHECK) IEXP=INT(ALOG1Ø(YMAX))-1
      IF(IEXP.EQ.-1) IEXP=Ø
      YINIT=YINIT/1Ø.**IEXP
      IF(YMAX.GT.YCHECK) YMAX=INT(YMAX/1Ø.**IEXP+.9999)
      IF(YMAX.GT.YCHECK) YSCALE=(YMAX-YINIT)/YAXIS
      IF(YMAX.LE.YCHECK) YSCALE=YSCALE/1Ø.**IEXP
      IF(YMAX.GT.YCHECK) DYT=YSCALE
      IF(YMAX.LE.YCHECK) DYT=DYT/1Ø.**IEXP
      DO 6 I=1,N
    6 Y(I)=Y(I)/1Ø.**IEXP
      X(N+1)=XINIT
      X(N+2)=XSCALE
      Y(N+1)=YINIT
      Y(N+2)=YSCALE
      IF(ISLOT.LE.Ø) GO TO 8
      CALL FRAME
      IF(IEXP.EQ.Ø) GO TO 8
      CALL SYMBOL(XAXIS+1.,3.*YAXIS/4Ø.,YAXIS/4Ø.,TNORM1,9Ø.Ø,2Ø)
      CALL WHERE(XNORM,YNORM)
      TEXP=IEXP
      CALL NUMBER(XNORM,YNORM,YAXIS/4Ø.,TEXP,9Ø.Ø,-1)
      CALL WHERE(XNORM,YNORM)
      CALL SYMBOL(XNORM,YNORM,YAXIS/4Ø.,TNORM2,9Ø.Ø,4)
    8 CALL LINE(X,Y,N,1,Ø,Ø)
      DO 7 I=1,N
    7 Y(I)=Y(I)*1Ø.**IEXP
    5 IF(ITYPE.EQ.2) GO TO 5ØØ
      WRITE(6,9Ø3)
  9Ø3 FORMAT(////1X,6HLAMBDA,7X,1HV,9X,13HTRANSMITTANCE,11X,
     X 6HLAMBDA,7X,1HV,9X,13HTRANSMITTANCE,11X,6HLAMBDA,7X,1HV,
     X 9X,13HTRANSMITTANCE)
      WRITE(6,9Ø4)
  9Ø4 FORMAT(1X,7HMICRONS,4X,4HCM-1,32X,7HMICRONS,4X,
     X 4HCM-1,32X,7HMICRONS,4X,4HCM-1)
      K=N/3
      NK=3*K
      IF(NEWT.GT.Ø) GO TO 3Ø
      DO 2Ø I=1,N
      IF(I.LE.NK) GO TO 1Ø
      L=I
      GO TO 15
   1Ø I1=I-1
      IROW=MOD(I1,K )+1
      JCOL=I1/K+1
      L=3*IROW+JCOL-3
   15 V(L)=1.ØE+Ø4/X(I)
```

```
      W(L)=X(I)                                                          PR ØØ88Ø
      T(L)=Y(I)                                                          PR ØØ89Ø
   2Ø CONTINUE                                                           PR ØØ9ØØ
      GO TO 8Ø                                                           PR ØØ91Ø
   3Ø DO 4Ø I=1,N                                                        PR ØØ92Ø
      IF(I.LE.NK) GO TO 33                                               PR ØØ93Ø
      L=I                                                                PR ØØ94Ø
      GO TO 37                                                           PR ØØ95Ø
   33 I1=I-1                                                             PR ØØ96Ø
      IROW=MOD(I1,K )+1                                                  PR ØØ97Ø
      JCOL=I1/K+1                                                        PR ØØ98Ø
      L=3*IROW+JCOL-3                                                    PR ØØ99Ø
   37 V(L)=X(I)                                                          PR Ø1ØØØ
      W(L)=1.ØE+Ø4/X(I)                                                  PR Ø1Ø1Ø
      T(L)=Y(I)                                                          PR Ø1Ø2Ø
   4Ø CONTINUE                                                           PR Ø1Ø3Ø
   8Ø WRITE(6,9Ø8)(W(L),V(L),T(L),T(L),L=1,NK)                           PR Ø1Ø4Ø
  9Ø8 FORMAT(1X,F7.4,3X,F7.2,5X,F4.2,5X,F7.5,9X,                         PR Ø1Ø5Ø
     X F7.4,3X,F7.2,5X,F4.2,5X,F7.5,9X,F7.4,3X,                          PR Ø1Ø6Ø
     X F7.2,5X,F4.2,5X,F7.5)                                             PR Ø1Ø7Ø
      IF(NK.EQ.N) GO TO 85                                               PR Ø1Ø8Ø
      N1=NK+1                                                            PR Ø1Ø9Ø
      WRITE(6,9Ø9)(W(L),V(L),T(L),T(L),L=N1,N)                           PR Ø11ØØ
  9Ø9 FORMAT(95X,F7.4,3X,F7.2,5X,F4.2,5X,F7.5)                           PR Ø111Ø
   85 N=Ø                                                                PR Ø112Ø
      RETURN                                                             PR Ø113Ø
  5ØØ WRITE(6,912)                                                       PR Ø114Ø
  912 FORMAT(////4X,1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION,8X,    PR Ø115Ø
     X 1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION,8X,                 PR Ø116Ø
     X 1HV,6X,9HRADIATION,4X,6HLAMBDA,2X,9HRADIATION)                    PR Ø117Ø
      WRITE(6,914)                                                       PR Ø118Ø
  914 FORMAT(3X,4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM,9X,        PR Ø119Ø
     X 4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM,9X                  PR Ø12ØØ
     X 4HCM-1,4X,8HPER CM-1,4X,7HMICRONS,3X,6HPER UM)                    PR Ø121Ø
      K=N/3                                                              PR Ø122Ø
      NK=3*K                                                             PR Ø123Ø
      IF(NEWT.GT.Ø) GO TO 53Ø                                            PR Ø124Ø
      DO 52Ø I=1,N                                                       PR Ø125Ø
      IF(I.LE.NK) GO TO 51Ø                                              PR Ø126Ø
      L=I                                                                PR Ø127Ø
      GO TO 515                                                          PR Ø128Ø
  51Ø I1=I-1                                                             PR Ø129Ø
      IROW=MOD(I1,K )+1                                                  PR Ø13ØØ
      JCOL=I1/K+1                                                        PR Ø131Ø
      L=3*IROW+JCOL-3                                                    PR Ø132Ø
  515 V(L)=1.ØE+Ø4/X(I)                                                  PR Ø133Ø
      RV(L)=Y(I)*X(I)/V(L)                                               PR Ø134Ø
      W(L)=X(I)                                                          PR Ø135Ø
      RW(L)=Y(I)                                                         PR Ø136Ø
  52Ø CONTINUE                                                           PR Ø137Ø
      GO TO 58Ø                                                          PR Ø138Ø
  53Ø DO 54Ø I=1,N                                                       PR Ø139Ø
      IF(I.LE.NK) GO TO 533                                              PR Ø14ØØ
      L=I                                                                PR Ø141Ø
```

```
      GO TO 537
  533 I1=I-1
      IROW=MOD(I1,K )+1
      JCOL=I1/K+1
      L=3*IROW+JCOL-3
  537 V(L)=X(I)
      RV(L)=Y(I)
      W(L)=1.ØE+Ø4/X(I)
      RW(L)=Y(I)*X(I)/W(L)
  54Ø CONTINUE
  58Ø WRITE(6,985) (V(L),RV(L),W(L),RW(L),L=1,NK)
  985 FORMAT(1X,ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3,5X
     X ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3,5X,
     X ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3)
      IF(NK.EQ.N) GO TO 545
      N1=NK+1
      WRITE(6,988) (V(L),RV(L),W(L),RW(L),L=N1,N)
  988 FORMAT(91X,ØPF7.2,2X,PE1Ø.4,3X,ØPF7.4,2X,PE9.3)
  545 N=Ø
      RETURN
      END
```

```
      SUBROUTINE SPACE                                                  SP ØØØ1Ø
C                                                                       SP ØØØ2Ø
C***   SKIPS OVER DATA SETS ON FILE 9    ***                            SP ØØØ3Ø
C                                                                       SP ØØØ4Ø
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)                               SP ØØØ5Ø
   52 READ(9,54) DUM1,DUM2                                              SP ØØØ6Ø
   54 FORMAT(2F1Ø.2)                                                    SP ØØØ7Ø
      IF(DUM1.EQ.-1.Ø) RETURN                                           SP ØØØ8Ø
      READ(9,58) N,DUM,DUM,DUM                                          SP ØØØ9Ø
   58 FORMAT(I1Ø,3F1Ø.4)                                                SP ØØ1ØØ
      READ(9,59) (DUM,DUM,DUM,I=1,N)                                    SP ØØ11Ø
   59 FORMAT(F12.4,2E12.4)                                              SP ØØ12Ø
      GO TO 52                                                          SP ØØ13Ø
      END                                                               SP ØØ14Ø
                                                                        SP ØØ15Ø
                                                                        SP ØØ16Ø
```

```
      SUBROUTINE ALL
C
C***   PRINTS/PLOTS UNDEGRADED SPECTRUM   ***
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
      REAL*4 XTITLE,XAXIS,XINIT,XSCALE,DXT
      REAL*4 YTITLE,YAXIS,YINIT,YSCALE,DYT
      REAL*4 TITLE
      REAL*4 Y,X
      DIMENSION ARRAY(3001),XF(4000),F(4000),Y(4500),X(4500)
      DIMENSION XTITLE(20),YTITLE(20),TITLE(20)
      COMMON/BLOCK1/XF,F
      COMMON/BLOCK2/Y,X
      COMMON/BLOCK3/N,ARRAY,DUMMY(78)
      COMMON/XBLOCK/XTITLE,XAXIS,XINIT,XSCALE,DXT,NMINX
      COMMON/YBLOCK/YTITLE,YAXIS,YINIT,YSCALE,DYT,NMINY
      COMMON/PBLOCK/TITLE,ICHAR,JCHAR,KCHAR,NN
      COMMON/SETUP/ITYPE,ISLOT,NEWT,IPLOT,NF

      NN=0
      N=0
   32 READ(9,33) H1,H2
   33 FORMAT(2F10.2)
      IF(H1.NE.-1.0) GO TO 34
      CALL PROUT
      RETURN
   34 READ(9,35) NF,XF(1),XF(NF),DVM
   35 FORMAT(I10,3F10.4)
      IF(ITYPE.EQ.1) READ(9,36)(XF(J),DUM,F(J),J=1,NF)
      IF(ITYPE.EQ.2) READ(9,36)(XF(J),F(J),DUM,J=1,NF)
   36 FORMAT(F12.4,2E12.4)
   39 DO 100 J=1,NF
      N=N+1
      X(N)=XF(J)
      Y(N)=F(J)
      IF(N.EQ.240) CALL PROUT
  100 CONTINUE
      GO TO 32
      END
```

APPENDIX B

MRDAT PROGRAM LISTING

```
      PROGRAM MRDAT(INPUT,OUTPUT,TAPE2,TAPE4,TAPE6=OUTPUT,TAPE5=INPUT,
```

```
      PROGRAM MRDAT(INPUT,OUTPUT,TAPE2,TAPE4,TAPE6=OUTPUT,TAPE5=INPUT,
     X TAPE11,TAPE12,TAPE13)
C
C         MAY 9 77   HITRAN MODIFIED FOR BLUE CO2 ARC TABLES
C   JUNE 23 --  VOIGHT PROFILE AND FORM FACTOR
C  JULY 77 MODIFIED FOR RED CO2 REGION
C  AUG 77 REWRITTEN FO MRDA
      LOGICAL LCHK,LOGIC
      DIMENSION SUM1(6,9,1Ø1),SUM2(6,9,1Ø1),OMEGB(1Ø1),
     KSPECIE(7),AMASS(7),JCALC(7)
      DIMENSION CAY3(6,9),CS1(9),CS2(7,9),CA(9)
      COMMON/INPUT/ P(1Ø),T(1Ø),W(7),V1,V2,DV,VLWST,VHGHST,DELTV,
     KBOUND,NPTPTS,MSPEC(7),SSTR,VBLOCK,DV2
      COMMON/OMG/ OMEGA(2Ø1,6),STOR(6,9,3Ø4)
      COMMON/LINES/ GNU(25Ø),S(25Ø),ALPHA(25Ø),EDP(25Ø),MOL(25Ø),
     KLCHK(25Ø),TI(25Ø,9),ITI(25Ø),TMAX
      COMMON/BLOCK1/MAX,CS1,CS2,CA,SUM1,SUM2,OMEGB,JMAX,NFILES
      DATA AMASS/18.,44.,48.,44.,28.,16.,32./
      DATA SPECIE/4HH2O ,4HCO2 ,4HO3  ,4HN2O ,4HCO  ,4HCH4 ,4HO2  /
C
      PI=3.14159
      PØ=1Ø13.
      TØ=296.
C
      MAX=6
      VSTEP=5Ø.Ø
      SLOWER=1.ØE-27

C**   ROOT OF MOLECULAR WT FOR DOPPLER LINESHAPE
      DO 1 M=1,7
    1 AMASS(M)=SQRT(AMASS(M))
C
C ***  THESE DEFINTIONS ARE NOT ACCURATE
C     READ INPUT PARAMETERS (P=PRESSURE), (T=TEMPERATURE),
C     W(1)=H2Ø, W(2)=CØ2,W(3)=Ø3,W(4)=N2Ø,W(5)=CØ,W(6)=CH4,W(7)=Ø2.
C     V1 AND V2 ARE FREQUENCY LIMITS FOR WHICH OUTPUT RESULTS ARE REQUIR
C     DV IS MONOCHROMATIC FREQUENCY INCREMENT.
C     BOUND IS THE FREQUENCY FROM ANY LINE CENTER BEYOND WHICH THE LINE
C
C ***  DEFINE MOLECULAR SPECIES
C ***  READ INITIAL PARAMETERS
      CALL DATIN
      WRITE(4,3) V1,V2,NPTPTS
    3 FORMAT(2F1Ø.2,I5)
      WRITE(4,4)(P(I),I=1,NPTPTS)
      WRITE(4,4)(T(I),I=1,NPTPTS)
    4 FORMAT(9F1Ø.2)
C ***  CALCULATE CONTRIBUTION OF DISTANT LINES
C ****  FIRST DETERMINE OMEGBS (CALCULATIONAL POINTS)
    5 VBOT=FLOAT(INT(V1))
      VTOP=FLOAT(INT(V2) )
      IF(VTOP.GT.236Ø.Ø.AND.VBOT.LT.236Ø.Ø) VTOP=236Ø.Ø
      IF (VTOP.LT.V2) VTOP=VTOP+1.Ø
      JMAX = INT((VTOP-VBOT)/DELTV+1.ØØØØ1)
C ***  JMAX MUST BE .LE. 1Ø1
      IF (JMAX .LE. 1Ø1) GO TO 8
```

```
      JMAX = 1Ø1
      VTOP=VBOT + 1ØØ.*DELTV
8     VVTOP=VTOP
      VO= VBOT
      VLWST=VBOT-VSTEP
      IF(VO.GT.236Ø.Ø) VLWST=225Ø.Ø
      VHGHST=VTOP + VSTEP
      DO 1Ø J=1,JMAX
1Ø    OMEGB(J)=VO+ (J-1)*DELTV
C****  (SUM1,SUM2)=(LEFT,RIGHT) SIDE OF REGION
C ***ZERO SUM?S -- READ TAPE -- CALCULATE
      DO 12 MM=1,MAX
      DO 12 NPT=1,NPTPTS
      DO 12 J=1,JMAX
      SUM1(MM,NPT,J)=Ø.Ø
12    SUM2(MM,NPT,J)=Ø.Ø
C
      DO 3Ø MM=1,MAX
      M=MSPEC(MM)
      IF (M.LE.Ø) GO TO 3Ø
C ***  LOGIC IS FOR TEMP DEP OF LINESTRENGTH
      LOGIC=.FALSE.
      IF(M.EQ.1.OR.M.EQ.3.OR.M.EQ.6) LOGIC=.TRUE.
C*** PRESSURE, TEMPERATURE LOOP
      DO 28 NPT=1,NPTPTS
C*** (P,T) COMPUTE DEPENDENCE OF LINE PARAMETERS
      CS1(NPT)=(TØ-T(NPT))/(TØ*T(NPT)*Ø.6946)
      WT=SQRT(TØ/T(NPT))
      CS2(M,NPT)=TØ/T(NPT)
      IF(LOGIC) CS2(M,NPT)=CS2(M,NPT)*WT
      CA(NPT)=WT*P(NPT)/PØ
28    CONTINUE
3Ø    CONTINUE

      CALL REDLIN(VBOT,VTOP)
C
C ***   CALCULATION OF FAR LINES IS COMPLETED
      M=1
      DO 33 J=1,JMAX
      WRITE(6,34) SPECIE(M),OMEGB(J),(SUM1(M,NPT,J),SUM2(M,NPT,J),NPT=1
     * ,5)
34    FORMAT(A5,F1Ø.3,5(2X,2E9.3))
      M=M+1
      IF(M.GT.5) M=5
33    CONTINUE
C
C***  CALCULATE NEAR LINES
C ***  CALL STRONG FOR CALCULATIONAL POINTS (OMEGA?S)
      REWIND 13
      VTOP=V1+VBLOCK
      DO 365 IFILE=1,NFILES
      REWIND 11
      VBOT=V1-BOUND
      IF(VTOP.GT.VVTOP) VTOP=VVTOP
      IF(VTOP.GT.V2) VTOP=V2
      NREC=Ø
```

```
34Ø   CONTINUE
C*CDC READ(13) N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
      READ(13,END=35Ø) N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
C*CDC IF(EOF(13)) 35Ø,345
345   NREC=NREC+1
      WRITE(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      GO TO 34Ø
  35Ø WRITE(4,3Ø2) V1,VTOP
  3Ø2 FORMAT(2F1Ø.2)
      CALL STRONG(MSPEC,V1,VTOP,DV,DV2,JCALC,SSTR,MAX,NREC)
      VTOP = VTOP+BOUND
C***  ZERO STOR---READ TAPE --- CALCULATE
      DO 35 MM=1,MAX
      DO 35 NPT=1,NPTPTS
      JMAX=JCALC(MM)
      DO 35 J=1,JMAX
35    STOR(MM,NPT,J)=Ø.Ø
      REWIND 11
      DO 55 IREC=1,NREC
      READ(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      DO 48 NPT=1,NPTPTS
      DO 46 L=1,N
      M=MOL(L)
      DO 37 MM=1,MAX
      IF(M.EQ.MSPEC(MM)) GO TO 52
   37 CONTINUE
      GO TO 46
   52 SO=S(L)*CS2(M,NPT)*EXP(-EDP(L)*CS1(NPT))
      AL=ALPHA(L)*CA(NPT)
      AD=.3581E-6*GNU(L)*WT
      ARAT= .83255*AL/AD
C***  LOOP OVER CALCULATIONAL POINTS (OMEGA?S)
      K=1
      JMAX=JCALC(MM)
      DO 44 J=1,JMAX
      V=OMEGA(J,MM)
C ***    DETERMINE RANGE FOR ACCEPTING LINES
38    VLEFT=OMEGB(K)
      IF (VLEFT+DELTV-V) 39,4Ø,4Ø
39    K=K+1
      GO TO 38
4Ø    Z1=ABS(VLEFT-GNU(L))
      IF (Z1.LT.BOUND) GO TO 42
      Z2=ABS(VLEFT+DELTV-GNU(L))
      IF (Z2.GT.BOUND) GO TO 44
C*** IF LINE WITHIN "BOUND" OF INTERVAL, INCLUDE IT IN CALCULATION
42    Z=ABS(V-GNU(L))
      ETA=.83255*Z/AD
      CALL ABSORB(AL,AD,ETA,ARAT,Z,AK)
      FAC=SO*AK
C**  CO2 FORM FACTOR
      IF(M.EQ.2) FAC=FAC*FORM(Z,M)
      STOR(MM,NPT,J)=STOR(MM,NPT,J)+FAC
```

```
44     CONTINUE
46     CONTINUE
48     CONTINUE
C ***    MORE LINES ????
   55 CONTINUE
C
C *** , NEARBY REGIONS ARE NOW CALCULATED
C
C ***    COMBINE RESULTS
       DO 8Ø MM=1,MAX
       M = MSPEC(MM)
       K = 1
       JMAX = JCALC(MM)
       DO 68 J=1,JMAX
       V=OMEGA(J,MM)
62     VLEFT=OMEGB(K)
       IF (VLEFT+DELTV-V) 63,64,64
63     K=K+1
       GO TO 62
64     CONTINUE
       DO 66 NPT=1,NPTPTS
       FAC1=SUM1(MM,NPT,K)
       FAC2=SUM2(MM,NPT,K)
       STOR(MM,NPT,J)=STOR(MM,NPT,J)+FAC1+(FAC2-FAC1)*(V-VLEFT)/DELTV
66     STOR(MM,NPT,J) = STOR(MM,NPT,J)*W(M)
68     CONTINUE
C
C*******    WRITE TABLE FOR MRDA
C
       WRITE (4,22Ø) SPECIE(M),JMAX
C       WRITE(6,222) SPECIE(M),JMAX
C222    FORMAT (1X,A4,I5)
22Ø    FORMAT (A4,I5)
       DO 74 J=1,JMAX
C      WRITE(6,226) OMEGA(J,MM),(STOR(MM,NPT,J),NPT=1,NPTPTS)
       WRITE (4,226) OMEGA(J,MM),(STOR(MM,NPT,J),NPT=1,NPTPTS)
226    FORMAT (F12.3,9E12.6)
74     CONTINUE
8Ø     CONTINUE
       V1=V1+VBLOCK
       IF(IFILE.EQ.NFILES) V1=VVTOP
       IF(V1.GE.V2) STOP 23
       VTOP=V1 + VBLOCK
  365 CONTINUE
       GO TO 5
C
       END
       FUNCTION FORM(Z,M)
C
C       FORM FACTOR FOR SUB-LORENTZIAN TAILS
C
       FORM = 1.Ø
       IF (M.NE.2) RETURN
       IF (Z.LT.Ø.5) RETURN
       IF (Z.GT.23.) GO TO 1Ø
       FORM=1.Ø69*EXP(-.133*Z)
```

```
      RETURN
10    FORM = .05
      IF (Z.LE.50.) RETURN
      FORM = 0.0
      IF (Z.GE.250.) RETURN
      FORM=.005*(12.5-.05*Z)
      RETURN
      END
      SUBROUTINE ABSORB(AL,AD,ETA,ARAT,Z,AK)
      IF ((ETA.LE.5.).AND.(ARAT.LE.2.)) GO TO 10
      AK=(.31831)*AL/(Z**2 + AL*AL)
      GO TO 20
10    CONTINUE
      AK=0.0
      DO 15 K=1,51
      Y=-2. + (K-1)*.1
      FY=(ARAT/AD)*.14952*EXP(-Y*Y)/(ARAT**2 + (ETA-Y)**2)
      FY=FY*.1
      AK=AK + FY
15    CONTINUE
20    RETURN
      END
      SUBROUTINE DATIN
      COMMON/INPUT/ P(10),T(10),W(7),V1,V2,DV,VLWST,VHGHST,DELTV
     K,BOUND,NPTPTS,MSPEC(7),SSTR,VBLOCK,DV2
C*CDC READ(5,76) NPTPTS,MSPEC
      READ(5,76,END=345) NPTPTS,MSPEC
   76 FORMAT(8I2)
C*CDC READ(5,77) (P(I),I=1,NPTPTS)
      READ(5,77,END=345) (P(I),I=1,NPTPTS)
   77 FORMAT(8(E10.0))
      READ(5,77,END=345) (T(I),I=1,NPTPTS)
C*CDC READ(5,77) (T(I),I=1,NPTPTS)
      WRITE(6,82) (P(I),I=1,NPTPTS)
   82 FORMAT(* PRESSURE=*,5(2X,F7.2)/10X,5(2X,F7.2))
      WRITE(6,84) (T(I),I=1,NPTPTS)
   84 FORMAT(* TEMPERATURE=*,5(2X,F7.2)/13X,5(2X,F7.2))
C*CDC IF(EOF(5).NE.0) GO TO 345
      READ(5,81) (W(M),M=1,7)
   81 FORMAT(7E10.3)
      WRITE(6,83)
   83 FORMAT(3X,*WATER*,6X,*CO2*,6X,*OZONE*,7X,*N2O*,7X,*CO*,8X,*CH4*,
     17X,*O2*,4X)
      WRITE(6,81)  (W(M),M=1,7)
      READ(5,85) V1,V2,DV,VLWST,VHGHST,DELTV,BOUND
85    FORMAT (7E10.3)
      WRITE(6,87) V1,V2,DV,VLWST,VHGHST,DELTV,BOUND
87    FORMAT (* (V1,V2,DV) =*,3F10.3,5X,* (VLWST,VHGHST,DELTV) =*,
     K3F10.3,5X,*BOUND =*,F10.3)
      READ(5,889) SSTR,VBLOCK,DV2
889   FORMAT (E10.2,F10.3,3F10.2)
      WRITE(6,89) SSTR,VBLOCK,DV2
89    FORMAT (*  SMIN FOR STRONG = *,E10.3,5X,*VBLOCK =*,F10.1,5X,
     &*DV2 =*,F5.2)
      IF (V1.GE.V2) STOP 21
      RETURN
```

```
345    STOP 20
       END
       SUBROUTINE STRONG (MSPEC,V1,V2,DV,DV2,JCALC,SSTR,MAX,NREC)
C  DETERMINES CLACULATIONAL POINTS FOR STRONG LINES
       LOGICAL LCHK,LCHK0
       DIMENSION G0(201),S0(201),LCHK0(201),DENS(7),MSPEC(7)
       DIMENSION JCALC(7),SPECIE(7),M0(201),A0(201)
       COMMON/LINES/ GNU(250),S(250),ALPHA(250),EDP(250),MOL(250),
      KLCHK(250),TI(250,9),ITI(250),TMAX
       COMMON/OMG/ OMEGA(201,6),STOR(6,9,304)
       DATA DENS/1.0,1.0,.01,.001,.0005,.005,.001/
       DATA SPECIE/4HH2O ,4HCO2 ,4HO3  ,4HN2O ,4HCO  ,4HCH4 ,4HO2  /
C***   INITIALIZE CONTROL VARIABLES
       W10 = SQRT(10.0)
       NMAX = 200
C**   TOO MANY LINES----INCREASE SMIN AND READ TAPE AGAIN
5      NLINES=0
       REWIND 11
       DO 30 IREC=1,NREC
       READ(11)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
      X LCHK(I),I=1,N)
       IF(GNU(N).LT.V1) GO TO 30
C**   THROW OUT LINES THAT ARE WEAKER THAN SSTR
       DO 20 J=1,N
       IF(GNU(J).LT.V1) GO TO 20
       IF(GNU(J).GT.V2) GO TO 27
       IF (S(J).LT.SSTR .AND. (.NOT.LCHK(J))) GO TO 20
       NLINES = NLINES+1
       IF(NLINES.LE.NMAX) GO TO 15
       SSTR=W10*SSTR
       GO TO 5
   15  G0(NLINES)=GNU(J)
       S0(NLINES)=S(J)
       A0(NLINES)=ALPHA(J)
       M0(NLINES)=MOL(J)
       LCHK0(NLINES)=LCHK(J)
20     CONTINUE
   30  CONTINUE
C ***   SET UP PARAMETERS
   27  ID0=5
       DELT1 = ID0*DV
       ISPACE = 2*ID0 + 2
       LMAX=2000
       LMAX1=LMAX - ISPACE - 5
       LMIN= LMAX/2
C ***   PICK OUT STRONG LINES
       FAC=1.0E-20
       JLOOP=0
  309  JLOOP=JLOOP+1
       JPTS=0
       FAC=.3*FAC
       DO 370 M=1,MAX
       JMAX = LMAX-JPTS
       JCALC(M)=0
       IF (MSPEC(M).LE.0) GO TO 370
       OMEGA(1,M)=V1
```

```
      MM=MSPEC(M)
      SMIN=FAC*DENS(MM)
      JCNT=1
      DO 32Ø JC=1,NLINES
      IF(MØ(JC).NE.MM) GO TO 32Ø
C***  GNU.GT. 2388 --- ACCEPT ALL CO2 R BRANCH FUNDAMENTAL LINES
      IF (GØ(JC).GT.2388..AND.LCHKØ(JC))GO TO 3Ø8
      IF(SØ(JC).LT.SMIN) GO TO 32Ø
C*** ACCEPT LINE - DETERMINE CALCULATIONAL POINTS
  3Ø8 D1=(GØ(JC)-OMEGA(JCNT,M))/DV
      IF (D1.LT.(.5*DV)) GO TO 32Ø
      ID=IDØ
      IF (D1.GE.ISPACE) GO TO 313
      ID=(D1+Ø.5)
C*** ID IS NUMBER OF POINTS ON LINE WING---DV=SPACING BTWN PTS
      IF (ID.EQ.Ø) ID=1
      D2=(GØ(JC)-OMEGA(JCNT,M))/ID
      JCNT=JCNT+ID
      OMEGA(JCNT,M)=GØ(JC)
C***  IF (JCNT.GT.1ØØ) JLOOP=6Ø
      IF (ID.EQ.1) GO TO 32Ø
      ID=ID-1
      GO TO 316
C*** ID.GE.8---LINES WELL SEPARATED - L.H.S OF INTERVAL
  313 DO 314 II=1,ID
      JCNTII=JCNT+II
  314 OMEGA(JCNTII,M)=OMEGA(JCNT,M)+II*DV
C*** DETERMINE POINTS BETWEEN THE TWO LINES---INCREMENTS OF DV2
      JCNTID=JCNT+ID
      VA = DV2*(FLOAT(INT(OMEGA(JCNTID,M)/DV2)) + 1.Ø )
      VB = DV2*FLOAT(INT((GØ(JC)-DELT1-.ØØ1)/DV2))
      JCNT = JCNT+2*ID+1
      IF (VB.LT.VA) GO TO 316
      ID2 = 1+INT((VB-VA)/DV2+.ØØØ5)
      JCNT = JCNT-ID-1
      DO 315 II=1,ID2
      JCNTII=JCNT+II
315   OMEGA(JCNTII,M) = VA+(II-1)*DV2
      JCNT = JCNT+ID+ID2+1
316   OMEGA(JCNT,M)=GØ(JC)
C*** LINES CLOSE --- OR --- R.H.S. OF INTERVAL
      DO 317 II=1,ID
      JCNTII=JCNT-II
  317 OMEGA(JCNTII,M)=OMEGA(JCNT,M)-II*DV
C***        IF TOO MANY CALC.PTS., INCREASE SMIN
      IF (JCNT .GT. JMAX) GO TO 371
  32Ø CONTINUE
C*** JCALC = NO,. OF CALCULATIONAL POINTS
      JCALC(M)=JCNT
  37Ø JPTS=JPTS+JCALC(M)
C***      DECIDE WHETHER TO LOOP BACK AGAIN
      IF (JLOOP.GE.6Ø) GO TO 371
      IF ((JPTS.LT.LMIN).AND.(FAC.GE.SSTR)) GO TO 3Ø9
      IF (JPTS.LT.LMAX1) GO TO 321
  371 FAC=4.*FAC
      GO TO 3Ø9
```

```
C
C
  321 CONTINUE
      ICOUNT=Ø
      DO 24Ø M=1,MAX
      MM=MSPEC(M)
      IF (MM.LE.Ø) GO TO 24Ø
      JCNT=JCALC(M)
      IF(JCNT.GT.1) GO TO 33Ø
C
C
C     NO STRONG LINES IN THIS BLOCK
C
      JCALC(M)=5
      JCNT = 5
      DLT = .25*(V2-V1)
      DO 331 K=2,5
  331 OMEGA(K,M)=V1+(K-1)*DLT
      WRITE(6,339) JLOOP,FAC,SPECIE(MM),(OMEGA(JJ,M),JJ=1,JCNT)
339   FORMAT(/* NO INTENSE LINES*,1ØX,*JLOOP =*,I4,
     &1ØX,*SMIN=*,E1Ø.3,12X,*SPECIES\*,A1Ø/
     &* OMEGA=*,5F14.3)
      GO TO 24Ø
C
C     STRONG LINES IN THIS BLOCK
C*** DEFINE CALCULATIONAL POINTS NEAR V2
  33Ø D1=(V2-OMEGA(JCNT,M))/DV
C**  LAST LINE VERY CLOSE TO V2????
      IF (D1.GT.1.Ø) GO TO 341
      JCNT = JCNT+1
      OMEGA(JCNT,M) = V2
      GO TO 335
341   ID=IDØ
      IF (D1.GE.ISPACE) GO TO 343
      ID=(D1+Ø.5)
      IF (ID.EQ.Ø) ID=1
      D2=(V2-OMEGA(JCNT,M))/ID
      JCNT=JCNT+ID
      OMEGA(JCNT,M)=V2
      IF (ID.EQ.1) GO TO 335
      ID=ID-1
      GO TO 346
  343 DO 344 II=1,ID
      JCNTII=JCNT+II
  344 OMEGA(JCNTII,M)=OMEGA(JCNT,M)+II*DV
      JCNTID=JCNT+ID+1
      OMEGA(JCNTID,M)=(OMEGA(JCNT,M)+V2)/2.
      JCNT=JCNT+2*(ID+1)
      OMEGA(JCNT,M)=V2
  346 DO 347 II=1,ID
      JCNTII=JCNT-II
  347 OMEGA(JCNTII,M)=OMEGA(JCNT,M)-II*DV
C*** PRINT STRONG LIVES AND CALC.PTS.
335   JCALC(M)=JCNT
      WRITE(6,325) JLOOP,JCNT,FAC,SPECIE(MM)
325   FORMAT (/*  MOST INTESE LINES:*,1ØX,*JLOOP =*,I3,5X,
```

```
      *I5,*  CALCULATIONAL POINTS*,5X,
      **SMIN=*,E1Ø.3,1ØX,A1Ø/5X,*V*,1ØX,*S*,6X,*ALPHA*,3X,*M*,1ØX,
      **INTERMEDIATE POINTS*)
       JCMIN=1
       JMAX1=JCNT-1
       J2 = ISPACE-1
       WRITE(6,327) (OMEGA(J,M),J=1,ISPACE)
327    FORMAT (F1Ø.3,26X,11F9.3,(/35X,1ØF9.3))
       DO 36Ø JJ=2,JMAX1
       DO 328 JC=JCMIN,NLINES
       IF (OMEGA(JJ,M).NE.GØ(JC)) GO TO 328
       J1=JJ+J2-1
       WRITE(6,326) GØ(JC),SØ(JC),AØ(JC),MØ(JC),(OMEGA(J+1,M),J=JJ,J1)
       JCMIN = JC
       GO TO 329
328    CONTINUE
  329  CONTINUE
36Ø    CONTINUE
326    FORMAT (F1Ø.3,2E9.2,I3,5X,11F9.3,(/35X,1ØF9.3))
24Ø    CONTINUE
       RETURN
       END
       SUBROUTINE REDLIN(V1,V2)
       DIMENSION CS1(9),CS2(7,9),CA(9),SUM1(6,9,1Ø1),SUM2(6,9,1Ø1)
       DIMENSION OMEGB(1Ø1)
       DIMENSION TI(25Ø,9),ITI(25Ø)
       DIMENSION GNU(25Ø),S(25Ø),ALPHA(25Ø),MOL(25Ø),LCHK(25Ø)
       DIMENSION EDP(25Ø),DENS(7),CO2R(5),MSPEC(7),ALPHB(6)
       COMMON/LINES/GNU,S,ALPHA,EDP,MOL,LCHK,TI,ITI,TMAX
       COMMON/INPUT/P(1Ø),T(1Ø),W(7),VA,VB,DV,VLWST,VHGHST,DELTV,
      X BOUND,NPTPTS,MSPEC,SSTR,VBLOCK,DV2
       COMMON/BLOCK1/MAX,CS1,CS2,CA,SUM1,SUM2,OMEGB,JMAX,NFILES
       LOGICAL IOEND,IOND13,LCHK
       DATA DENS/1.Ø,1.Ø,Ø.Ø1,Ø.ØØ1,Ø.ØØØ5,Ø.ØØ5,Ø.ØØ1/
       DATA CO2R/6H   Ø Ø,6H Ø 1 1,6H      ,6HØ Ø Ø ,6HØ 1   /
       DATA ALPHB/Ø.Ø7,Ø.11,Ø.Ø8,Ø.Ø6,Ø.Ø55,Ø.Ø48/
       IFILE=Ø
       IOEND=.FALSE.
       IOND13=.FALSE.
       REWIND 11
       END FILE 11
       IN=11
       IOUT=12
       REWIND 2
       REWIND IN
       REWIND IOUT
       REWIND 13
       VLOW=V1-BOUND
       VHIGH=V2+BOUND
       VL=V1-VBLOCK
  1ØØ  VL=VL+VBLOCK
       IF(VL.GE.V2) GO TO 23Ø
       VR=VL+VBLOCK
       IF(VR.GT.V2) VR=V2
       VBOT=VL-BOUND
       VTOP=VR+BOUND
```

```
      VRB=VR-BOUND
      I=1
  125 IF(I.LE.25Ø) GO TO 13Ø
      N=25Ø
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
  999 FORMAT(1X,1ØF1Ø.3)
      WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I),I=1,N)
      I=1
13Ø   CONTINUE
C*CDC READ(IN)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I)
      READ(IN,END=21Ø)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I)
C*CDC IF(EOF(IN)) 21Ø,15Ø
  15Ø V=GNU(I)
      IF(VR.GE.V2) GO TO 16Ø
      IF(V.GE.VRB)WRITE(IOUT)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I)
  16Ø IF(V.LE.VTOP) GO TO 2ØØ
      IF(IOEND) GO TO 13Ø
      N=I-1
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
      IF(N.GT.Ø)WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      END FILE 13
      IFILE=IFILE+1
      IOEND=.TRUE.
      GO TO 13Ø
  2ØØ I=I+1
      GO TO 125
  21Ø IF(IOEND) GO TO 22Ø
      IF(.NOT.IOND13) GO TO 23Ø
  215 IF(VR.LT.V2) GO TO 23Ø
      N=I-1
      WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
      IF(N.GT.Ø)WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
     X LCHK(I),I=1,N)
      END FILE 13
      IFILE=IFILE+1
      GO TO 23Ø
  22Ø END FILE IOUT
      ISAVE=IOUT
      IOUT=IN
      IN=ISAVE
      REWIND IN
      REWIND IOUT
      IOEND=.FALSE.
      GO TO 1ØØ
23Ø   CONTINUE
C*CDC READ(2) TMIN,TMAX,NREC,((TI(I1,J1),J1=1,9),DUM,
      READ(2,END=28Ø,ERR=24Ø) TMIN,TMAX,NREC,((TI(I1,J1),J1=1,9),DUM,
     X DUM,DUM,ITI(I1),I1=1,NREC)
C*CDC JTO=IOCHEC(2)
C*CDC IF(JTO) 24Ø,27Ø
27Ø   CONTINUE
C*CDC IF(EOF(2)) 28Ø,29Ø
      GO TO 29Ø
  24Ø WRITE(6,245) GNU(I)
```

```
 245 FORMAT(* PARITY ERROR ENCOUNTERED AT*,F12.3)
     GO TO 23Ø
 28Ø IEOF=IEOF+1
     NEOF=NEOF+1
     IF(NEOF.GT.2) STOP 22
     GO TO 23Ø
 29Ø NEOF=Ø
     IF(TMAX.LT.VLWST) GO TO 23Ø
     IF(TMIN.GT.VHGHST) GO TO 15ØØ
     DO 11ØØ K=1,NREC
     DO 31Ø MM=1,MAX
     IF(ITI(K).EQ.MSPEC(MM)) GO TO 32Ø
 31Ø CONTINUE
     GO TO 11ØØ
 32Ø V=TI(K,1)
     IF(V.GT.VHGHST) GO TO 111Ø
     IF(V.LT.VLWST) GO TO 11ØØ
     M=ITI(K)
     SMIN=TI(K,2)*DENS(M)
     IF(SMIN.LE.1.ØE-27) GO TO 11ØØ
     IF(I.LE.25Ø) GO TO 38Ø
     IF(IOEND) GO TO 38Ø
     N=25Ø
     WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
     WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),LCHK(I),
    X I=1,N)
     I=1
 38Ø GNU(I)=V
     S(I)=TI(K,2)
     ALPHA(I)=TI(K,3)
     IF(M.EQ.1) GO TO 39Ø
     IF(ALPHA(I).GT.Ø.Ø) GO TO 385
     ALPHA(I)=ALPHB(M-1)
     GO TO 39Ø
 385 IF(ALPHA(I).LT.Ø.Ø1.OR.ALPHA(I).GT.1.Ø) ALPHA(I)=Ø.Ø6
 39Ø EDP(I)=TI(K,4)
     MOL(I)=M
     IF(M.NE.2) GO TO 1ØØØ
     LCHK(I)=.FALSE.
     DO 4ØØ J=1,5
     IF(CO2R(J).NE.TI(K,J+4)) GO TO 1ØØØ
 4ØØ CONTINUE
     LCHK(I)=.TRUE.
1ØØØ IF(V.LT.VLOW) GO TO 1Ø55
     IF(IOND13) GO TO 1Ø55
     IF(VR.GE.V2) GO TO 1Ø2Ø
     IF(V.GT.VHIGH) GO TO 1Ø2Ø
     IF(V.GE.VRB) WRITE(IOUT)GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
    X LCHK(I)
1Ø2Ø IF(V.LE.VTOP) GO TO 1Ø5Ø
     IF(V.GT.VHIGH) IOND13=.TRUE.
     IF(IOEND) GO TO 1Ø55
     WRITE(6,999) VL,VR,VBOT,VTOP,VRB,VLWST,VHGHST,VSTEP,VLOW,VHIGH
     N=I-1
     IF(N.GT.Ø) WRITE(13)N,(GNU(I),S(I),ALPHA(I),EDP(I),MOL(I),
    X LCHK(I),I=1,N)
```

```
      END FILE 13
      IFILE=IFILE+1
      IOEND=.TRUE.
      GO TO 1055
1050  L=I
      I=I+1
      GO TO 1057
1055  L=I
1057  DO 1080 NPT=1,NPTPTS
      SO=S(L)*CS2(M,NPT)*EXP(-EDP(L)*CS1(NPT))
      AL=ALPHA(L)*CA(NPT)
      DO 1070 J=1,JMAX
      VV=OMEGB(J)
      Z1=ABS(VV-V)
      IF(Z1.LT.BOUND) GO TO 1070
      Z2=ABS(VV+DELTV-V)
      IF(Z2.LT.BOUND) GO TO 1070
      FRM1=1.0
      FRM2=1.0
      IF(M.NE.2) GO TO 1060
      FRM1=FORM(Z1,M)
      FRM2=FORM(Z2,M)
1060  CONTINUE
      SUM1(MM,NPT,J)=SUM1(MM,NPT,J)+FRM1*.3183*SO*AL/(Z1**2+AL**2)
      SUM2(MM,NPT,J)=SUM2(MM,NPT,J)+FRM2*.3183*SO*AL/(Z2**2+AL**2)
1070  CONTINUE
1080  CONTINUE
1100  CONTINUE
1110  IF(.NOT.IOEND) GO TO 230
1125  END FILE IOUT
      ISAVE=IOUT
      IOUT=IN
      IN=ISAVE
      IOEND=.FALSE.
      REWIND IN
      REWIND IOUT
      GO TO 100
1500  NFILES=IFILE
      RETURN
      END
```

AD-A064 019 AERODYNE RESEARCH INC BEDFORD MASS F/G 9/2

A USER'S GUIDE TO MIDTRAN - A COMBINATION OF LOWTRAN AND HITRAN--ETC(U)

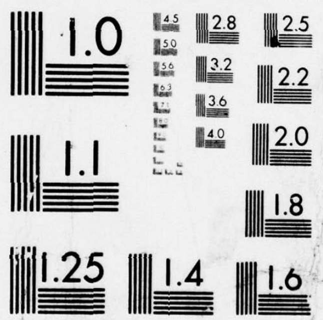
JUN 78 D ROBERTSON, R SPECHT F19628-77-C-0198

UNCLASSIFIED ARI-RR-124 AFGL-TR-78-0184 NL

2 OF 2

AD
A064 019

END
DATE
FILMED
4 -- 79
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX C
SAMPLE CASE

INPUT FILE

```
  6  1  2
          1          .9        3ØØ.    -1     Ø     Ø     Ø          1.          1.
         Ø.          2.         1Ø.
     19Ø5.       1915.         .Ø1
 -1
MIDTRAN TEST - TRANSMITTANCE
         .2          .1           3
        -1.          Ø.          1.
         Ø.          1.          Ø.
MIDTRAN TEST - RADIATION
```

OUTPUT FILE

```
EMISSIVITY=Ø.9ØØ          T(BACKGROUND)=     3ØØ.ØDEGREES K
           Ø.ØØØ      2.ØØØ     1Ø.ØØØ      Ø.ØØØ      Ø.ØØØ      Ø.ØØØ
     H1=  Ø.ØØØKM,H2=  2.ØØØKM,ANGLE= 1Ø.ØØØØGEOM. RANGE =   2.Ø3KM,BETA= Ø.ØØ317,VIS=   Ø.Ø

     SLANT PATH BETWEEN ALTITUDES H1 AND H2 WHERE H1  =  Ø.ØØØ KM H2 =  2.ØØØ KM,ZENITH ANGLE = 1Ø.ØØØ DEGREES

          MODEL ATMOSPHERE 6 = 1962 US STANDARD

             HAZE MODEL 1 = 23KM VISUAL RANGE

     FREQUENCY RANGE V1=  19Ø5.Ø CM-1 TO V2=  1915.Ø CM-1 FOR DV =   5.Ø CM-1   (  5.22 -  5.25 MICRONS )
```

```
HORIZONTAL PROFILES
 1    Ø.Ø Ø.737E-Ø2 Ø.929E ØØ Ø.252E-Ø7 Ø.739E ØØ Ø.54ØE-Ø2 Ø.948E ØØ Ø.1ØØE Ø1 Ø.252E-Ø7 Ø.26ØE-Ø3 Ø.848E-Ø1 Ø.272E-Ø3
 2    1.Ø Ø.525E-Ø2 Ø.778E ØØ Ø.252E-Ø7 Ø.6Ø1E ØØ Ø.3Ø9E-Ø2 Ø.86ØE ØØ Ø.44ØE ØØ Ø.252E-Ø7 Ø.235E-Ø3 Ø.59ØE-Ø1 Ø.247E-Ø3
 3    2.Ø Ø.362E-Ø2 Ø.648E ØØ Ø.252E-Ø7 Ø.487E ØØ Ø.167E-Ø2 Ø.779E ØØ Ø.19ØE ØØ Ø.252E-Ø7 Ø.213E-Ø3 Ø.399E-Ø1 Ø.224E-Ø3
 4    3.Ø Ø.225E-Ø2 Ø.537E ØØ Ø.233E-Ø7 Ø.393E ØØ Ø.736E-Ø3 Ø.7Ø4E ØØ Ø.798E-Ø1 Ø.233E-Ø7 Ø.192E-Ø3 Ø.243E-Ø1 Ø.2Ø2E-Ø3
 5    4.Ø Ø.137E-Ø2 Ø.444E ØØ Ø.215E-Ø7 Ø.315E ØØ Ø.317E-Ø3 Ø.634E ØØ Ø.422E-Ø1 Ø.215E-Ø7 Ø.173E-Ø3 Ø.147E-Ø1 Ø.182E-Ø3
 6    5.Ø Ø.8ØØE-Ø3 Ø.365E ØØ Ø.215E-Ø7 Ø.251E ØØ Ø.125E-Ø3 Ø.57ØE ØØ Ø.318E-Ø1 Ø.215E-Ø7 Ø.155E-Ø3 Ø.849E-Ø2 Ø.164E-Ø3
 7    6.Ø Ø.475E-Ø3 Ø.298E ØØ Ø.21ØE-Ø7 Ø.199E ØØ Ø.514E-Ø4 Ø.511E ØØ Ø.224E-Ø1 Ø.21ØE-Ø7 Ø.139E-Ø3 Ø.5Ø4E-Ø2 Ø.147E-Ø3
 8    7.Ø Ø.262E-Ø3 Ø.243E ØØ Ø.229E-Ø7 Ø.157E ØØ Ø.186E-Ø4 Ø.457E ØØ Ø.2ØØE-Ø1 Ø.229E-Ø7 Ø.124E-Ø3 Ø.28ØE-Ø2 Ø.131E-Ø3
 9    8.Ø Ø.15ØE-Ø3 Ø.196E ØØ Ø.243E-Ø7 Ø.123E ØØ Ø.723E-Ø5 Ø.4Ø7E ØØ Ø.215E-Ø1 Ø.243E-Ø7 Ø.11ØE-Ø3 Ø.161E-Ø2 Ø.117E-Ø3
1Ø    9.Ø Ø.575E-Ø4 Ø.158E ØØ Ø.332E-Ø7 Ø.959E-Ø1 Ø.128E-Ø5 Ø.362E ØØ Ø.2Ø6E-Ø1 Ø.332E-Ø7 Ø.979E-Ø4 Ø.627E-Ø3 Ø.1Ø4E-Ø3
11   1Ø.Ø Ø.225E-Ø4 Ø.126E ØØ Ø.42ØE-Ø7 Ø.741E-Ø1 Ø.24ØE-Ø6 Ø.32ØE ØØ Ø.2Ø1E-Ø1 Ø.42ØE-Ø7 Ø.866E-Ø4 Ø.25ØE-Ø3 Ø.92ØE-Ø4
12   11.Ø Ø.1Ø2E-Ø4 Ø.1ØØE ØØ Ø.6Ø7E-Ø7 Ø.568E-Ø1 Ø.613E-Ø7 Ø.282E ØØ Ø.188E-Ø1 Ø.6Ø7E-Ø7 Ø.753E-Ø4 Ø.117E-Ø3 Ø.811E-Ø4
13   12.Ø Ø.462E-Ø5 Ø.763E-Ø1 Ø.747E-Ø7 Ø.416E-Ø1 Ø.126E-Ø7 Ø.242E ØØ Ø.197E-Ø1 Ø.747E-Ø7 Ø.643E-Ø4 Ø.452E-Ø4 Ø.694E-Ø4
14   13.Ø Ø.225E-Ø5 Ø.579E-Ø1 Ø.794E-Ø7 Ø.3Ø3E-Ø1 Ø.297E-Ø8 Ø.2Ø6E ØØ Ø.182E-Ø1 Ø.794E-Ø7 Ø.55ØE-Ø4 Ø.188E-Ø4 Ø.593E-Ø4
15   14.Ø Ø.1Ø5E-Ø5 Ø.44ØE-Ø1 Ø.887E-Ø7 Ø.222E-Ø1 Ø.647E-Ø9 Ø.176E ØØ Ø.179E-Ø1 Ø.887E-Ø7 Ø.47ØE-Ø4 Ø.75ØE-Ø5 Ø.5Ø7E-Ø4
16   15.Ø Ø.9ØØE-Ø6 Ø.334E-Ø1 Ø.981E-Ø7 Ø.162E-Ø1 Ø.476E-Ø9 Ø.151E ØØ Ø.168E-Ø1 Ø.981E-Ø7 Ø.4Ø2E-Ø4 Ø.55ØE-Ø5 Ø.433E-Ø4
17   16.Ø Ø.762E-Ø6 Ø.254E-Ø1 Ø.112E-Ø6 Ø.118E-Ø1 Ø.341E-Ø9 Ø.129E ØØ Ø.16ØE-Ø1 Ø.112E-Ø6 Ø.343E-Ø4 Ø.398E-Ø5 Ø.37ØE-Ø4
18   17.Ø Ø.65ØE-Ø6 Ø.193E-Ø1 Ø.131E-Ø6 Ø.865E-Ø2 Ø.248E-Ø9 Ø.11ØE ØØ Ø.158E-Ø1 Ø.131E-Ø6 Ø.294E-Ø4 Ø.29ØE-Ø5 Ø.317E-Ø4
19   18.Ø Ø.55ØE-Ø6 Ø.147E-Ø1 Ø.149E-Ø6 Ø.632E-Ø2 Ø.178E-Ø9 Ø.942E-Ø1 Ø.153E-Ø1 Ø.149E-Ø6 Ø.251E-Ø4 Ø.21ØE-Ø5 Ø.271E-Ø4
2Ø   19.Ø Ø.55ØE-Ø6 Ø.112E-Ø1 Ø.163E-Ø6 Ø.462E-Ø2 Ø.178E-Ø9 Ø.8Ø5E-Ø1 Ø.128E-Ø1 Ø.163E-Ø6 Ø.215E-Ø4 Ø.179E-Ø5 Ø.231E-Ø4
21   2Ø.Ø Ø.55ØE-Ø6 Ø.848E-Ø2 Ø.177E-Ø6 Ø.338E-Ø2 Ø.178E-Ø9 Ø.688E-Ø1 Ø.943E-Ø2 Ø.177E-Ø6 Ø.183E-Ø4 Ø.153E-Ø5 Ø.198E-Ø4
22   21.Ø Ø.6ØØE-Ø6 Ø.641E-Ø2 Ø.177E-Ø6 Ø.245E-Ø2 Ø.2Ø4E-Ø9 Ø.586E-Ø1 Ø.684E-Ø2 Ø.177E-Ø6 Ø.156E-Ø4 Ø.139E-Ø5 Ø.168E-Ø4
23   22.Ø Ø.65ØE-Ø6 Ø.485E-Ø2 Ø.182E-Ø6 Ø.178E-Ø2 Ø.232E-Ø9 Ø.499E-Ø1 Ø.514E-Ø2 Ø.182E-Ø6 Ø.133E-Ø4 Ø.125E-Ø5 Ø.143E-Ø4
24   23.Ø Ø.712E-Ø6 Ø.368E-Ø2 Ø.177E-Ø6 Ø.13ØE-Ø2 Ø.27ØE-Ø9 Ø.426E-Ø1 Ø.394E-Ø2 Ø.177E-Ø6 Ø.113E-Ø4 Ø.114E-Ø5 Ø.122E-Ø4
25   24.Ø Ø.762E-Ø6 Ø.279E-Ø2 Ø.168E-Ø6 Ø.949E-Ø3 Ø.299E-Ø9 Ø.363E-Ø1 Ø.312E-Ø2 Ø.168E-Ø6 Ø.967E-Ø5 Ø.1Ø2E-Ø5 Ø.1Ø4E-Ø4
26   25.Ø Ø.825E-Ø6 Ø.212E-Ø2 Ø.159E-Ø6 Ø.693E-Ø3 Ø.339E-Ø9 Ø.31ØE-Ø1 Ø.263E-Ø2 Ø.159E-Ø6 Ø.65ØE-Ø5 Ø.921E-Ø6 Ø.891E-Ø5
27   3Ø.Ø Ø.475E-Ø6 Ø.548E-Ø3 Ø.934E-Ø7 Ø.148E-Ø3 Ø.96[illegible]E-1Ø Ø.143E-Ø1 Ø.7[illegible]1E-Ø3 Ø.934E-Ø7 Ø.299E-Ø5 Ø.218E-Ø6 Ø.4Ø9E-Ø5
28   35.Ø Ø.2ØØE-Ø6 Ø.143E-Ø3 Ø.514E-Ø7 Ø.319E-Ø4 Ø.127E-1Ø Ø.655E-Ø2 Ø.2Ø8E-Ø3 Ø.514E-Ø7 Ø.138E-Ø5 Ø.343E-Ø7 Ø.188E-Ø5
29   4Ø.Ø Ø.837E-Ø7 Ø.386E-Ø4 Ø.229E-Ø7 Ø.719E-Ø5 Ø.144E-11 Ø.3Ø6E-Ø2 Ø.548E-Ø4 Ø.229E-Ø7 Ø.658E-Ø6 Ø.491E-Ø8 Ø.878E-Ø6
3Ø   45.Ø Ø.4ØØE-Ø7 Ø.116E-Ø4 Ø.794E-Ø8 Ø.182E-Ø5 Ø.256E-12 Ø.152E-Ø2 Ø.144E-Ø4 Ø.794E-Ø8 Ø.333E-Ø6 Ø.979E-Ø9 Ø.437E-Ø6
31   5Ø.Ø Ø.15ØE-Ø7 Ø.375E-Ø5 Ø.187E-Ø8 Ø.5Ø3E-Ø6 Ø.314E-13 Ø.795E-Ø3 Ø.381E-Ø5 Ø.187E-Ø8 Ø.124E-Ø6 Ø.174E-Ø9 Ø.228E-Ø6
32   7Ø.Ø Ø.187E-Ø9 Ø.466E-Ø7 Ø.4Ø2E-1Ø Ø.329E-Ø8 Ø.186E-16 Ø.677E-Ø4 Ø.196E-Ø7 Ø.4Ø2E-1Ø Ø.979E-Ø8 Ø.478E-12 Ø.195E-Ø7
33  1ØØ.Ø Ø.125E-11 Ø.542E-11 Ø.2Ø1E-13 Ø.1Ø5E-12 Ø.115E-2Ø Ø.386E-Ø6 Ø.696E-11 Ø.2Ø1E-13 Ø.555E-1Ø Ø.231E-16 Ø.111E-Ø9
34$99999 Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ Ø.ØØØE ØØ
```

```
         VERTICAL PROFILES                                                                                   PSI       PHI       BETA     THETA     RA
1    Ø.Ø Ø.635E-Ø2 Ø.864E ØØ Ø.256E-Ø7 Ø.678E ØØ Ø.42ØE-Ø2 Ø.917E ØØ Ø.692E ØØ Ø.256E-Ø7  -Ø.ØØØØ 17Ø.ØØ16   Ø.ØØ16   1Ø.ØØØØ
2    1.Ø Ø.1Ø8E-Ø1 Ø.159E Ø1 Ø.512E-Ø7 Ø.123E Ø1 Ø.655E-Ø2 Ø.175E Ø1 Ø.995E ØØ Ø.512E-Ø7   Ø.ØØØ2 17Ø.ØØ29   Ø.ØØ32    9.9986
 Ø.ØØØ

        EQUIVALENT SEA LEVEL ABSORBER AMOUNTS

               WATER VAPOUR    .CO2 ETC.      OZONE    NITROGEN (CONT)   H2O (CONT)     MOL  SCAT      AEROSOL      OZONE(U-V)
                                                              KM           GM CM-2         KM            KM           ATM CM

        W(1-8)=                                           Ø.123E Ø1     Ø.655E-Ø2      Ø.175E Ø1     Ø.995E ØØ     Ø.512E-Ø7
                                                                        Ø.122E ØØ


               FREQ WAVELENGTH  TOTAL     H2O,      CO2+     OZONE   N2 CONT  H2O CONT MOL SCAT  AEROSOL  AEROSOL    INTEGRATED
               CM-1  MICRONS    TRANS     TRANS     TRANS    TRANS    TRANS    TRANS    TRANS    TRANS     ABS      ABSORPTION
               19Ø5   5.2493   Ø.9858    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   Ø.9858   Ø.ØØ28       Ø.Ø4
               191Ø   5.2356   Ø.9858    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   Ø.9858   Ø.ØØ28       Ø.12
               1915   5.2219   Ø.9857    1.ØØØØ    1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   1.ØØØØ   Ø.9857   Ø.ØØ28       Ø.17

        LL   LEVEL  ALTITUDE    TEMP      PRES       WH2O        WO3        WGAS
         1     1      Ø.ØØ     284.83    954.Ø9    Ø.692E-Ø2  Ø.279E-Ø7  Ø.917E ØØ
         2     2      1.ØØ     278.33    845.21    Ø.536E-Ø2  Ø.3Ø8E-Ø7  Ø.832E ØØ
        INTEGRATED ASORPTION FROM 19Ø5 TO 1915 CM-1 =      Ø.19,AVERAGE TRANSMITTANCE =Ø.9814

        MEDIUM  RESOLUTION   DVM=Ø.Ø1Ø WAVENUMBERS
```

VARIABLE SLIT FUNCTION
WIDTH= 0.20000 SHIFT= 0.10000 NO. OF DEFINING PTS= 3
YS ARE 0.000 1.000 0.000
XS ARE -1.000 0.000 1.000

ATMOSPHERIC TRANSMITTANCE

LAMBDA MICRONS	V CM-1	TRANSMITTANCE		LAMBDA MICRONS	V CM-1	TRANSMITTANCE		LAMBDA MICRONS	V CM-1	TRANSMITTANCE	
5.2490	1905.11	0.01	0.00960	5.2400	1908.41	0.00	0.00000	5.2309	1911.71	0.07	0.0673
5.2488	1905.21	0.03	0.02728	5.2397	1908.51	0.00	0.00003	5.2306	1911.81	0.06	0.0580
5.2485	1905.31	0.07	0.07438	5.2394	1908.61	0.00	0.00022	5.2304	1911.91	0.07	0.0700
5.2482	1905.41	0.15	0.15220	5.2391	1908.71	0.00	0.00064	5.2301	1912.01	0.12	0.1224
5.2479	1905.51	0.17	0.17165	5.2389	1908.81	0.00	0.00113	5.2298	1912.11	0.15	0.1534
5.2477	1905.61	0.18	0.17516	5.2386	1908.91	0.00	0.00132	5.2296	1912.21	0.16	0.1604
5.2474	1905.71	0.18	0.17833	5.2383	1909.01	0.00	0.00103	5.2293	1912.31	0.15	0.1537
5.2471	1905.81	0.18	0.18142	5.2380	1909.11	0.00	0.00049	5.2290	1912.41	0.13	0.1250
5.2468	1905.91	0.18	0.18360	5.2378	1909.21	0.00	0.00015	5.2287	1912.51	0.09	0.0886
5.2466	1906.01	0.17	0.17129	5.2375	1909.31	0.00	0.00002	5.2285	1912.61	0.10	0.0986
5.2463	1906.11	0.15	0.15128	5.2372	1909.41	0.00	0.00000	5.2282	1912.71	0.12	0.1176
5.2460	1906.21	0.15	0.14787	5.2369	1909.51	0.00	0.00000	5.2279	1912.81	0.15	0.1494
5.2457	1906.31	0.14	0.14351	5.2367	1909.61	0.00	0.00000	5.2276	1912.91	0.18	0.1798
5.2455	1906.41	0.12	0.12349	5.2364	1909.71	0.00	0.00000	5.2274	1913.01	0.20	0.2009
5.2452	1906.51	0.10	0.09915	5.2361	1909.81	0.00	0.00000	5.2271	1913.11	0.21	0.2105
5.2449	1906.61	0.08	0.08162	5.2358	1909.91	0.00	0.00000	5.2268	1913.21	0.22	0.2151
5.2446	1906.71	0.07	0.06530	5.2356	1910.01	0.00	0.00000	5.2265	1913.31	0.21	0.2127
5.2444	1906.81	0.05	0.04873	5.2353	1910.11	0.00	0.00000	5.2263	1913.41	0.20	0.2033
5.2441	1906.91	0.03	0.03305	5.2350	1910.21	0.00	0.00000	5.2260	1913.51	0.19	0.1912
5.2438	1907.01	0.02	0.01941	5.2348	1910.31	0.00	0.00000	5.2257	1913.61	0.17	0.1735
5.2435	1907.11	0.01	0.00902	5.2345	1910.41	0.00	0.00000	5.2255	1913.71	0.14	0.1408
5.2433	1907.21	0.00	0.00306	5.2342	1910.51	0.00	0.00001	5.2252	1913.81	0.08	0.0770
5.2430	1907.31	0.00	0.00063	5.2339	1910.61	0.00	0.00016	5.2249	1913.91	0.03	0.0341
5.2427	1907.41	0.00	0.00006	5.2337	1910.71	0.00	0.00098	5.2246	1914.01	0.05	0.0466
5.2424	1907.51	0.00	0.00000	5.2334	1910.81	0.00	0.00347	5.2244	1914.11	0.10	0.0968
5.2422	1907.61	0.00	0.00000	5.2331	1910.91	0.01	0.00810	5.2241	1914.21	0.12	0.1233
5.2419	1907.71	0.00	0.00000	5.2328	1911.01	0.01	0.01412	5.2238	1914.31	0.12	0.1193
5.2416	1907.81	0.00	0.00000	5.2326	1911.11	0.02	0.01869	5.2235	1914.41	0.09	0.0853
5.2413	1907.91	0.00	0.00000	5.2323	1911.21	0.02	0.02453	5.2233	1914.51	0.03	0.0252
5.2411	1908.01	0.00	0.00000	5.2320	1911.31	0.03	0.03211	5.2230	1914.61	0.00	0.0017
5.2408	1908.11	0.00	0.00000	5.2317	1911.41	0.04	0.04174	5.2227	1914.71	0.03	0.0300
5.2405	1908.21	0.00	0.00000	5.2315	1911.51	0.05	0.05331	5.2225	1914.81	0.07	0.0733
5.2402	1908.31	0.00	0.00000	5.2312	1911.61	0.06	0.06425	5.2222	1914.91	0.09	0.0866

VARIABLE-SLIT FUNCTION
WIDTH= Ø.2ØØØØ SHIFT= Ø.1ØØØØ NO. OF DEFINING PTS= 3
YS ARE Ø.ØØØ 1.ØØØ Ø.ØØØ
XS ARE -1.ØØØ Ø.ØØØ 1.ØØØ

RADIATION(WATTS/SR/CM**2/UNITS)

V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM	V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM	V CM-1	RADIATION PER CM-1	LAMBDA MICRONS	RADIATION PER UM
19Ø5.11	4.5799E-Ø7	5.249Ø	1.662E-Ø4	19Ø8.41	4.3338E-Ø7	5.24ØØ	1.578E-Ø4	1911.71	4.8292E-Ø7	5.23Ø9	1.765E-Ø4
19Ø5.21	4.7135E-Ø7	5.2488	1.711E-Ø4	19Ø8.51	4.3464E-Ø7	5.2397	1.583E-Ø4	1911.81	4.7765E-Ø7	5.23Ø6	1.746E-Ø4
19Ø5.31	4.9598E-Ø7	5.2485	1.8Ø1E-Ø4	19Ø8.61	4.3683E-Ø7	5.2394	1.591E-Ø4	1911.91	4.83Ø1E-Ø7	5.23Ø4	1.766E-Ø4
19Ø5.41	5.29Ø8E-Ø7	5.2482	1.921E-Ø4	19Ø8.71	4.391ØE-Ø7	5.2391	1.6ØØE-Ø4	1912.Ø1	5.Ø567E-Ø7	5.23Ø1	1.849E-Ø4
19Ø5.51	5.3663E-Ø7	5.2479	1.948E-Ø4	19Ø8.81	4.4Ø7ØE-Ø7	5.2389	1.6Ø6E-Ø4	1912.11	5.1777E-Ø7	5.2298	1.893E-Ø4
19Ø5.61	5.3777E-Ø7	5.2477	1.953E-Ø4	19Ø8.91	4.411ØE-Ø7	5.2386	1.6Ø7E-Ø4	1912.21	5.2Ø22E-Ø7	5.2296	1.9Ø2E-Ø4
19Ø5.71	5.388ØE-Ø7	5.2474	1.957E-Ø4	19Ø9.Ø1	4.4ØØ5E-Ø7	5.2383	1.6Ø4E-Ø4	1912.31	5.1743E-Ø7	5.2293	1.892E-Ø4
19Ø5.81	5.398ØE-Ø7	5.2471	1.961E-Ø4	19Ø9.11	4.3771E-Ø7	5.238Ø	1.595E-Ø4	1912.41	5.Ø562E-Ø7	5.229Ø	1.849E-Ø4
19Ø5.91	5.4Ø44E-Ø7	5.2468	1.963E-Ø4	19Ø9.21	4.3525E-Ø7	5.2378	1.587E-Ø4	1912.51	4.89Ø5E-Ø7	5.2287	1.789E-Ø4
19Ø6.Ø1	5.3529E-Ø7	5.2466	1.945E-Ø4	19Ø9.31	4.3319E-Ø7	5.2375	1.579E-Ø4	1912.61	4.9252E-Ø7	5.2285	1.8Ø2E-Ø4
19Ø6.11	5.2714E-Ø7	5.2463	1.915E-Ø4	19Ø9.41	4.3185E-Ø7	5.2372	1.574E-Ø4	1912.71	5.Ø159E-Ø7	5.2282	1.835E-Ø4
19Ø6.21	5.2625E-Ø7	5.246Ø	1.912E-Ø4	19Ø9.51	4.3125E-Ø7	5.2369	1.572E-Ø4	1912.81	5.1433E-Ø7	5.2279	1.882E-Ø4
19Ø6.31	5.2441E-Ø7	5.2457	1.9Ø6E-Ø4	19Ø9.61	4.31Ø2E-Ø7	5.2367	1.572E-Ø4	1912.91	5.2566E-Ø7	5.2276	1.924E-Ø4
19Ø6.41	5.16Ø8E-Ø7	5.2455	1.876E-Ø4	19Ø9.71	4.3Ø86E-Ø7	5.2364	1.571E-Ø4	1913.Ø1	5.3328E-Ø7	5.2274	1.952E-Ø4
19Ø6.51	5.Ø541E-Ø7	5.2452	1.837E-Ø4	19Ø9.81	4.3Ø71E-Ø7	5.2361	1.571E-Ø4	1913.11	5.3662E-Ø7	5.2271	1.964E-Ø4
19Ø6.61	4.9781E-Ø7	5.2449	1.81ØE-Ø4	19Ø9.91	4.3Ø55E-Ø7	5.2358	1.571E-Ø4	1913.21	5.3822E-Ø7	5.2268	1.97ØE-Ø4
19Ø6.71	4.9Ø25E-Ø7	5.2446	1.782E-Ø4	191Ø.Ø1	4.3Ø4ØE-Ø7	5.2356	1.57ØE-Ø4	1913.31	5.372ØE-Ø7	5.2265	1.967E-Ø4
19Ø6.81	4.8189E-Ø7	5.2444	1.752E-Ø4	191Ø.11	4.3Ø25E-Ø7	5.2353	1.57ØE-Ø4	1913.41	5.3362E-Ø7	5.2263	1.954E-Ø4
19Ø6.91	4.73Ø7E-Ø7	5.2441	1.72ØE-Ø4	191Ø.21	4.3ØØ9E-Ø7	5.235Ø	1.569E-Ø4	1913.51	5.29Ø1E-Ø7	5.226Ø	1.937E-Ø4
19Ø7.Ø1	4.6398E-Ø7	5.2438	1.687E-Ø4	191Ø.31	4.2995E-Ø7	5.2348	1.569E-Ø4	1913.61	5.2235E-Ø7	5.2257	1.913E-Ø4
19Ø7.11	4.5499E-Ø7	5.2435	1.655E-Ø4	191Ø.41	4.2996E-Ø7	5.2345	1.569E-Ø4	1913.71	5.Ø972E-Ø7	5.2255	1.867E-Ø4
19Ø7.21	4.4711E-Ø7	5.2433	1.626E-Ø4	191Ø.51	4.3Ø74E-Ø7	5.2342	1.572E-Ø4	1913.81	4.8223E-Ø7	5.2252	1.766E-Ø4
19Ø7.31	4.4Ø82E-Ø7	5.243Ø	1.6Ø4E-Ø4	191Ø.61	4.3298E-Ø7	5.2339	1.581E-Ø4	1913.91	4.5897E-Ø7	5.2249	1.681E-Ø4
19Ø7.41	4.3664E-Ø7	5.2427	1.589E-Ø4	191Ø.71	4.3686E-Ø7	5.2337	1.595E-Ø4	1914.Ø1	4.6646E-Ø7	5.2246	1.7Ø9E-Ø4
19Ø7.51	4.3469E-Ø7	5.2424	1.582E-Ø4	191Ø.81	4.4216E-Ø7	5.2334	1.614E-Ø4	1914.11	4.9113E-Ø7	5.2244	1.799E-Ø4
19Ø7.61	4.3415E-Ø7	5.2422	1.58ØE-Ø4	191Ø.91	4.4793E-Ø7	5.2331	1.636E-Ø4	1914.21	5.Ø233E-Ø7	5.2241	1.841E-Ø4
19Ø7.71	4.3398E-Ø7	5.2419	1.579E-Ø4	1911.Ø1	4.53Ø7E-Ø7	5.2328	1.655E-Ø4	1914.31	5.ØØ64E-Ø7	5.2238	1.835E-Ø4
19Ø7.81	4.3382E-Ø7	5.2416	1.579E-Ø4	1911.11	4.5663E-Ø7	5.2326	1.668E-Ø4	1914.41	4.8612E-Ø7	5.2235	1.782E-Ø4
19Ø7.91	4.3366E-Ø7	5.2413	1.579E-Ø4	1911.21	4.6Ø58E-Ø7	5.2323	1.682E-Ø4	1914.51	4.5154E-Ø7	5.2233	1.655E-Ø4
19Ø8.Ø1	4.3351E-Ø7	5.2411	1.578E-Ø4	1911.31	4.6518E-Ø7	5.232Ø	1.699E-Ø4	1914.61	4.2862E-Ø7	5.223Ø	1.571E-Ø4
19Ø8.11	4.3335E-Ø7	5.24Ø8	1.578E-Ø4	1911.41	4.7Ø56E-Ø7	5.2317	1.719E-Ø4	1914.71	4.564ØE-Ø7	5.2227	1.673E-Ø4
19Ø8.21	4.3319E-Ø7	5.24Ø5	1.577E-Ø4	1911.51	4.7649E-Ø7	5.2315	1.741E-Ø4	1914.81	4.8Ø39E-Ø7	5.2225	1.761E-Ø4
19Ø8.31	4.33Ø9E-Ø7	5.24Ø2	1.577E-Ø4	1911.61	4.8167E-Ø7	5.2312	1.76ØE-Ø4	1914.91	4.8616E-Ø7	5.2222	1.783E-Ø4

APPENDIX D
MIDTRAN FLOWCHART; SUBROUTINE LIST

Table D-1. Generalized MIDTRAN Flowchart

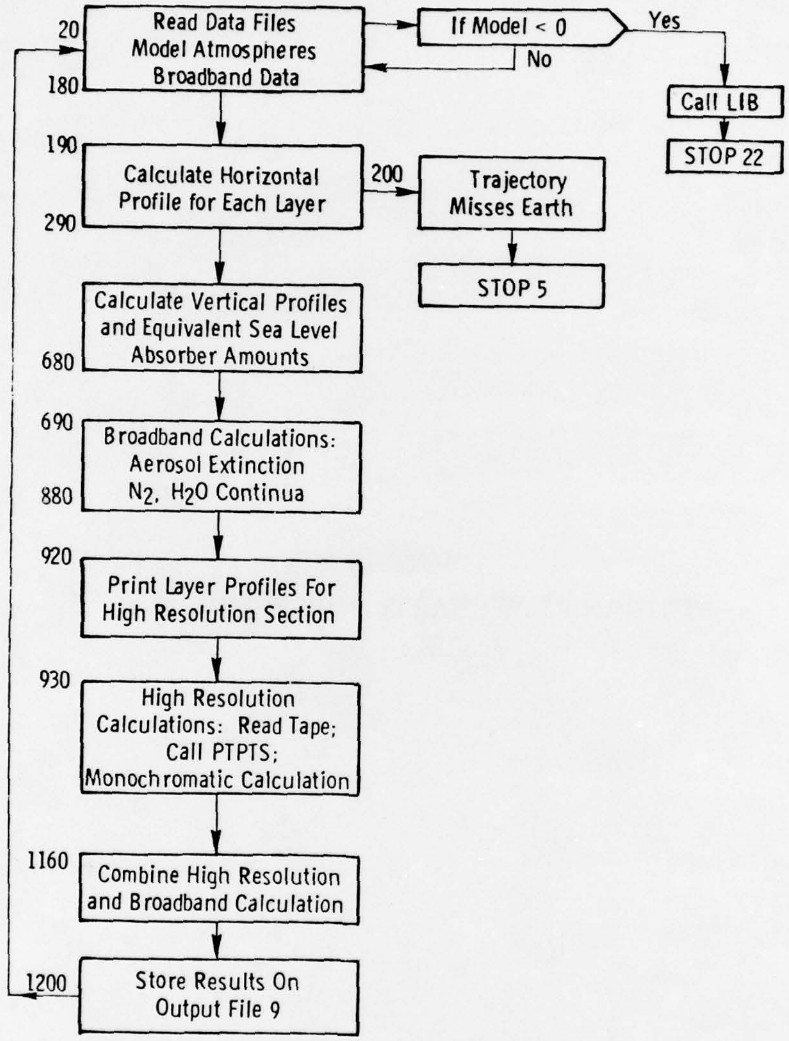


Table D-2. Listing of MIDTRAN Subroutines

Subroutine	Purpose
POINT	Computes the equivalent absorber amount at a given altitude (from LOWTRAN).
PTPTS	Determines the interpolation points from the data tape for each layer.
ANGL	Computes the zenith angle given H1, H2 and the earth center angle (from LOWTRAN).
LIB	Performs output functions Reads Cards 5, 6, 7.
CRAM	Removes trailing blanks in Card 5.
GEN	Degrades results to the desired resolution using the generalized slit function.
FRAME	Sets up frame for the plots
PROUT	Prints output and plots curves.
SPACE	Skips over data sets on File 9.

APPENDIX E

LIST OF MIDTRAN VARIABLES

A	Width of fixed triangular slit function (= 0.1 cm^{-1})
AHAZE	Aerosol number density for MODEL = 1
AHZ2	Aerosol number density for MODEL = 2
AK	Extinction coefficient read from tape for Kth pressure-temperature point at frequency VV
AKK	Interpolated extinction coefficient
AL	Equivalent absorber amount per km at level L
ALAM	Wavelength (μm)
ALT	Altitude at level Z (LYR)
ANGLE	Input zenith angle (degrees) (compare with θ_o in the text)
AVW	Average wavelength used in refractive index expression
AO	Constant A defined in Eq. (10) of LOWTRAN3 Manual
B	Blackbody function
BET	Angle subtended at the earth's center as path transverses adjacent levels
BETA	Total angle subtended by path at earth's center
CA	Conversion factor from degrees to radians
CO	Wavelength dependent coefficient used in refractive index expression
CON	Species concentrations
CW	Wavelength dependent coefficient used in refractive index expression
C4	Absorption coefficient for nitrogen (~ 4 μm)
C5	Absorption coefficient for water vapor continuum
C6	Extinction coefficient for molecular scattering
C7	Extinction coefficient for aerosol models
C7A	Aerosol absorption coefficient
D	Water vapor amount (pr. cm/km) at level L
DELV	Increment for fixed slit function
DIST	Optical depth of a species
DP	Dew point temperature (^oC)
DS	Path length from level L to Level L + 1
DV	Wavenumber increment

DVM	MRDA frequency interval
DZ	Height increment from level L to level L + 1
E	Equivalent absorber amounts per km at height H
EH	Equivalent absorber amounts
EMIS	Emissivity of background radiation source
ENDF	End-of-file control variable
EV	Integrated absorber amount from level L to level L + 1
FAC	Dummy variable
FAC2	Summing variable for transmittance
FAC5	Log transmittance for radiation
FAC6	Summing variable for transmittance
FNU	Frequency for print-out
FP	Intermediate result in interpolation of AK
FRAD	Degraded radiation
FREQT	Dummy frequency variable
FT	Intermediate result in interpolation of AK
H	Altitude
HAZE	Aerosol number density (no. cm^{-3})
HM	Estimated tangent height (km)
HMIN	Minimum altitude of path trajectory (km)
HZZ	Dummy variable for transmittance
HZ1	Aerosol number density (no. cm^{-3}) for 23 km visual range
HZ2	Aerosol number density (no. cm^{-3}) for 5 km visual range
H1	Initial altitude (km)
H2	Final altitude (km)
IC	Counting variable for low resolution calculations
ICNT	Index for low resolution calculations
ICOUNT	Index for low resolution printed output
IDV	Frequency increment
IFIND	Call parameter for subroutine ANGL

IHAZE	Aerosol model indicator
ILP	Integer variable for printing heading
IM	Parameter used when reading in a new atmospheric model
IP	Indicator for using subroutine POINT to calculate refractive index only (IP = 0) or equivalent absorber amounts also (IP $\neq$ 0)
IRAD	Radiation calculation flag
ITYPE	Indicator for type of atmospheric path
IV	Frequency of calculations
IV1	Starting frequency
IV2	Last frequency
J	Running integer for altitude identification
JP	Print option parameter
J1	Level indicator for altitude H1
J2	Level indicator for altitude H2
K	General loop variable
KPTS	Elements in P-T matrix used for AK interpolation
KSPEC	Number of species for high resolution calculation ($\leq$6)
K2	Cycling parameter for downward path
L	Running index for layers
LBR	Total number of levels transversed in the path
LEN	Parameter used for defining longer of two paths
LL	Running index for level s
LMAP	Counting variable for long path storage
LOOP	Number of layers for low resolution radiance calculations
LSTORE	Counting variable for layer index
LYR	Altitude of Lth layer in path
L1	Frequency identifier for transmittance calculation
L2	Frequency identifier for transmittance calculation

M	Index for model atmosphere
MAX	Number of radiation and transmission calculations
MODEL	Integer used to identify required model atmosphere
M1	Variable to select temperature profile and counting variable
M2	Variable to select water vapor profile
M3	Variable to select ozone profile
N	Loop variable
NEWP	Plot control parameter
NEWS	Plot control parameter
NH	Frequency indicator for water vapor continuum transmittance calculation
NL	Number of levels in model atmosphere data
NLDAT	Number of layers in model atmosphere data
NPT	Number of points in the pressure temperature matrix
NRP	Determines units for radiation output
NRS	Control variable for radiation slit function
NTP	Determines scale for transmittance
NTS	Control variable for transmittance slit function
NUM	Index for locating species on library tape
P	Pressure
PH	Angle of arrival at H2
PHI	Angle of arrival at H2
PI	3.141592654 that is (π)
PP	Pressure values on library tapes
PPW	Partial pressure H_2O
PRES	Pressure at level LL
PS	Total pressure in atmospheres
PSI	Angular deviation of path from initial direction
RAD	Radiance
Range	Path length (km)
RE	Earth radius (km)
REF	Refractive index of air at level L

RH	Relative humidity (%)
RN	Ratio of refractive indices of air above and below a given level
RX	Ratio of earth center distances between adjacent levels
SALP	Sine of angle of arrival at adjacent level (cf sin α)
SPEC	Number of species
SPHI	Sine of the local zenith angle at a given level (cf sin θ)
SR	Slant range (km)
SUM	Sum of optical thicknesses of absorbers 4 thru 8
SUMA	Accumulated integrated absorption
T	Temperature (^{o}K) at level L
TAU	Transmittance
TAU1	Transmittance
TBACK	Background radiation calculation temperature
TEMP	Temperature at level LL
THET	Zenith angle at a given level (in radians)
THETA	Zenith angle at a given level (in degrees)
TMP	Ambient temperature (^{o}C)
TRAN	Total transmission
TRANS	Transmittance from fixed slit function
TRAN1	Broadband transmittance of layer LL
TT	Ratio 273.15/(TMP + 273.15)
TX(K)	Temperature values on library tape
TX(9)	Total transmittance at frequency V
TX(10)	Absorption due to aerosol only at frequency V
TX1	Refractive index of layer above initial altitude H1
V	Frequency (cm^{-1})
VA	Initial frequency in tape data block
VB	Final frequency in tape data block
VCHK1	Used to compare lower frequency of tape data block with calculation frequency

VCHK2	Used to compare upper frequency of tape data block with calculated frequency
VH	Integral of the equivalent absorber amounts from H1 to level L
VIS	Visual range (km) at sea level
VMAX	Max frequency contained in tape
VMIN	Minimum frequency contained in tape
VT	Frequency for fixed slit function
VV	Frequency array read from tape
VV1	Used in interpolating tape input frequencies to calculation frequency
VV2	Used in interpolating tape input frequencies to calculation frequency
VX	Wavelength at which aerosol coefficients are read in (μm)
Vo	Initial calculation frequency
V1	Initial frequency for transmittance calculation, cm^{-1}
V2	Final frequency for transmittance calculation, cm^{-1}
W	Total equivalent absorber amount for entire path
WGAS	Gas concentration
WH	Water vapor density at level L (gm m^{-3})
WH20	Water vapor concentration
WO	Ozone density at level L (gm m^{-3})
WO3	Ozone concentration
WW	Equivalent absorber amount from observer to level L
W2	Water vapor density for atmospheric model M at level L + 1 (gm m^{-3})
X	Input height to POINT subroutine
XD	Wavenumber interpolation parameter
XH	Wavenumber interpolation parameter in H_2O continuum calculation
XI	Wavenumber interpolation parameter

XOR	X-coordinate for lower left corner of plot
XX	Aerosol extinction coefficient
X1	Earth center distance of level L
X2	Earth center distance of level L + 1
Y	Input zenith angle in radians
YN	Refractive index of layer below input height from POINT subroutine
YOR	Y-coordinate for lower left corner of plot
YY	Aerosol absorption coefficient of frequency V
Z	Altitude at level L in km

DISTRIBUTION LIST

ODDR + E
The Pentagon
Washington, D.C. 20301
Attn: D. Brockway
Dr. R. Yost

Defense Advanced Research Projects Agency
1400 Wilson Boulevard
Arlington, Virginia 22209
Attn: Dr. Peter O. Clark, STO
Mr. Eugene H. Kopf, STO
Dr. J. Jenney, STO
Dr. Stephen Zakanycz, STO

OSD-ASDI
The Pentagon
Washington, DC 20301
Attn: Mr. W. Henderson
Mr. A. Albrecht

U.S. Arms Control + Disarmament Agency
Department of State
Washington, D.C. 20451
Attn: Dr. F. Eimer

Commander
U.S. Army Missile R+D Command
Redstone Arsenal, Alabama 35809
Attn: DRDMI-MS/Mr. Drake

Missile Intelligence Agency
Redstone Arsenal
Huntsville, Alabama 35809
Attn: DRDMI-YDL

Office of Naval Research
495 Summer Street
Boston, Massachusetts 02210
Attn: Dr. F. Quelle

Naval Research Laboratory
Washington, D. C. 20375
Attn: Dr. A. F. Petty, Code 7930
Dr. James Dowling
Dr. J. McCallum, Code 1409

Hq. USAF
Washington, D.C. 20330
Attn: Col. E. D. Cohen, RDSD
Major H. Stears, RDSD
Lt. Col. George Watts, RDSD

Air Force Systems Command
Andrews Air Force Base
Washington, D.C. 20334
Attn: Capt. D. Beadner, DLCEA
Lt. Col. W. Castlen, XRTD

SAMSO
P.O. Box 92960
Worldway Posal Center
Los Angeles, California 90009
Attn: Col. James E. McCormick, SZ
Col. F. Stuart, YA
Capt. R. Weber, SZD
Major R. Baumgartner, YAD

Air Force Cambridge Research Laboratory
L.G. Hanscom Field
Bedford, Massachusetts 01731
Attn: Dr. J. Garing
Mr. B.P. Sandford/OPR (10 cys)
Dr. A.T. Stair/OPR
Dr. R. McClatchey/OPR

Rome Air Development Center, AFSO
Griffiss Air Force Base
Rome, New York 13440
Attn: Mr. D. D. Dylis, IRAD

Air Force Rocket Propulsion Laboratory
Edwards Air Force Base
California, 93523
Attn: Dr. J.D. Stewart
Dr. David Mann

Air Force Armament Laboratory
Eglin Air Force Base
Florida, 32542
Attn: Capt. W.J. Rothschild, ADTC/XRO

Foreign Technology Division
Wright-Patterson Air Force Base
Ohio, 45433
Attn: Mr. T. Larson
Mr. R. C. Frick

Air Force Avionics Laboratory
Air Force Systems Command
Wright-Patterson Air Force Base
Ohio, 45433
Attn: Mr. W. Edwards
Dr. R. Sanderson
Library (Mr. B. J. Sabo)WRA-1

Arnold Engineering Development Center
Tennessee, 37389
Attn: Dr. H. E. Scott
Dr. W. K. McGregor
Dr. C. Peters

Commander
Naval Intelligence Support Center
Code 452
4301 Suitland Road
Washington, D. C. 20390

Naval Weapons Center
China Lake, California 93555
Attn: Dr. M. Benton Code 394
Dr. L. Wilkins Code 39403
Mr. S. Smith Code 39403

Defense Documentation Center
Cameron Station
Alexandria, Virginia 22314
(2 copies)

Central Intelligence Agency
Washington, D. C. 20505
Attn: Mr. J. Murphy

Aerospace Corporation
El Segundo Operations
P.O. Box 95085
Los Angeles, California 90045
Attn: Dr. F. Simmons
Dr. R. Lee

Institute for Defense Analysis
400 Army-Navy Drive
Arlington, Virginia 22202
Attn: Dr. H. G. Wolfhard
Dr. L. Biberman
Dr. R. Roberts

Carson System, Inc.
4630 Campus Drive
Newport Beach, California 92660
Attn: Dr. John Carson

CALSPAN
4455 Genesee Street
Buffalo, New York 14221
Attn: Dr. C. Treanor
Dr. W. Wurster

Environmental Research Institute of Michigan
P.O. Box 618
Ann Arbor, Michigan 48107
Attn: Mr. R. Legault

Grumman Aerospace Corporation
Research Department - Plant 35
Bethpage, Long Island, New York 11714
Attn: Mr. J. Selby

Hughers Aircraft Company
Culver City, California 90230
Attn: Mr. J. Denney
Mr. J. Callis

Lockheed Missiles and Space Company
3251 Hanover Street
Palo Alto, California 94304
Attn: Dr. D. Pecka
Dr. N. Kulgein

Riverside Research Institute
1701 N. Fort Myer Dr.
Suite 711
Arlington, Virginia 22209
Attn: Mr. R. Pasent

Rockwell International Corporation
Space Division
12214 S. Lakewood Blvd.
Downey, CA 90241
Attn: Mr. R. Colman
Mr. D. Utley

Science Applications, Inc.
P.O. Box 7329
Ann Arbor, Michigan 48103
Attn: Dr. R. Meredith

Defense Intelligence Agency
Washington, D. C. 20301
Attn: Mr. S. Berler
DT-1A

Photon Research Associates
P.O. Box 1318
LaJolla, Cal. 92037
Attn: Mr. D. Anding

Analytical Decisions Inc.
1401 Wilson Blvd
Suite 200
Arlington, Virginia 22209
Attn: Mr. Gary Glaser

Charles S. Draper Labs
68 Albany Street
Cambridge, Massachusetts 02139
Attn: Dr. L. Matson

ARAP
50 Washington Road
Princeton, New Jersey 08540
Attn: Dr. E. Stokes Fishburn

Mr. Russ Moulton
DRSEL-NVI
Ft. Belvoir, Virginia 22060

Aerodyne Research, Inc. (50 cys)
Bedford Research Park
Crosby Drive
Bedford, Massachusetts 01730
Attn: D.C. Robertson