GCSOLAR User's Manual

User's Guide

INTRODUCTION

THE SOLAR COMPUTER PACKAGE CONTAINS A SET OF ROUTINES THAT COMPUTES DIRECT PHOTOLYSIS RATES AND HALF-LIVES OF POLLUTANTS IN THE AQUATIC ENVIRONMENT. THE HALF-LIVES ARE CALCULATED AS A FUNCTION OF SEASON, LATITUDE, TIME-OF-DAY, DEPTH IN WATER BODIES, AND OZONE LAYER THICKNESS.

AN ADDITIONAL SUBROUTINE, INPUT, WAS DEVELOPED TO FACILITATE DATA ENTRY BY THE USER AND TO MAKE THE PACKAGE INTERACTIVE. INPUTS TO THE ROUTINE, WITH FEW RESTRICTIONS, ARE FORMAT FREE AND THE USER CONTROLS PROGRAM FLOW BY ENTERING COMMANDS THAT ARE DEEMED
NECESSARY.

FOR A MORE COMPLETE DISCUSSION OF THE CHEMISTRY ASSOCIATED WITH THIS COMPUTER PACKAGE, THE USER MAY REFER TO THE FOLLOWING PUBLICATION:

"RATES OF DIRECT PHOTOLYSIS IN AQUATIC ENVIRONMENT", R. G. ZEPP AND D. M. CLINE, ENVIRONMENTAL SCIENCE AND TECHNOLOGY,11:4, PP 359-366.(1977)

GUIDE TO USAGE

WHEN EXECUTION OF THE PROGRAM COMMENCES, ALL USER MODIFIABLE VARIABLES ARE INITIALIZED WITH DEFAULT VALUES. THE INPUT ROUTINE PROMPTS THE USER WITH THE FOLLOWING IMPERATIVE:

ENTER COMMAND >

AND WAITS FOR THE USER TO RESPOND WITH ONE OF THE FOLLOWING COMMANDS:

ABSORPTION
ATMOSPHERE
BLUE BOOK
CORRECT
DEPTH
DEPTH POINT
EPSILON
EXIT

FILE
HELP ***THIS COMMAND***
KA LAMBDA
LATITUDE
LIST
LONGITUDE
MAX WAVE
MIN WAVE
MID-DAY
MODE
NAME
OZONE
PLOT
QUANTUM
QUIT
REFRACTIVE
RUN
SEASON
SUN ABS
TIME-OF-DAY
VISIBLE
WATER BODY
W-LAMBDA
Z-LAMBDA

COMMAND DESCRIPTION

(ALL USER RESPONSES ARE UNDERSCORED WITH "-----".)

ABSORPTION

THIS COMMAND ALLOWS ATTENTUATION COEFFICIENTS OF THE SOLVENT, E.G. WATER COLUMN OR SURFACE SLICK, AS A FUNCTION OF WAVELENGTH, TO BE ENTERED INTO THE SYSTEM. ENGINEERING UNITS OF THE ABSORPTION DATA ARE /CM. NOTE! THE MAXIMUM ABSORBING WAVELENGTH FOR THE WATER BODY SHOULD BE SET BEFORE ENTERING THIS COMMAND OR MORE DATA THAN IS AVAILABLE MAY BE REQUESTED BY THE INPUT ROUTINE. THE MAXIMUM ABSORBING WAVELENGTH CAN BE SET VIA THE MAX WAVE COMMAND.

ENTER COMMAND >MAX WAVE

ENTER MAXIMUM WAVELENGTH IN NANOMETERS: 305

ENTER COMMAND >ABSORPTION

ABSORPTION DATA:
ENTER PURE FOR PURE WATER
ENTER NEW TO INPUT NEW WATER DATA
NEW

ENTER WATER ABSORPTION FOR 297.50 NANOMETERS >.0030

ENTER WATER ABSORPTION FOR 300.00 NANOMETERS >.0029

ENTER WATER ABSORPTION FOR 302.50 NANOMETERS >.0028

ENTER WATER ABSORPTION FOR 305.00 NANOMETERS >.0027

ENTER WATER IDENTIFICATION >OCONEE RIVER

ATMOSPHERE

TWO DIFFERENT TYPES OF ATMOSPHERES MAY BE SELECTED USING THIS COMMAND. THE 'TERRESTRIAL' ATMOSPHERE USES EQUATIONS AND PARAMETERS DESCRIBED BY GREEN, CROSS, AND SMITH TO COMPUTE THE SOLAR UV INTENSITY VALUES (280 - 380 NM) CHARACT[CERISTIC OF ATMOSPHERES OVER LAND. THE 'MARINE' ATMOSPHERE USES DATA FROM BAKER, SMITH, AND GREEN TO GENERATE THE SOLAR UV IRRADIANCE AT SEA. THIS COMMAND IS USED ONLY WHEN EXECUTING 'TIME-OF-DAY' SIMULATIONS OF PHOTOLYSIS RATE CONSTANTS. IN EITHER MODE SOLAR VISIBLE IRRADIANCE (390 - 800 NM) IS COMPUTED USING EQUATIONS AND DATA DESCRIBED BY LEIGHTON AND SEA LEVEL ELEVATION IS ASSUMED. (SEE ALSO 'BLUE BOOK' AND 'VISIBLE' COMMANDS)

ENTER COMMAND >ATMOSPHERE

ENTER MARINE OR TERRESTRIAL >MARINE

GREEN, A.E.S.; CROSS, K.; SMITH, L.A. PHOTOCHEM PHOTOBIOL. 1980,31,59-65.
BAKER, K.; SMITH, R.; GREEN, A.E.S. PHOTOCHEM PHOTOBIOL. 1980,32,367-374.
LEIGHTON, P., "PHOTOCHEMISTRY OF AIR POLLUTION" ACADEMIC

PRESS, N.Y., 1961.

BLUE BOOK

THIS ROUTINE GENERATES TABULAR VALUES OF SOLAR UV INTENSITIES AS COMPUTED USING EQUATIONS OF GREEN, CROSS, AND SMITH (TERRESTRIAL ATMOSPHERES) OR OF BAKER, SMITH, AND GREEN (MARINE ATMOSPHERE). SKY INTENSITIES FROM THE WHOLE SKY ON A HORIZONTAL SURFACE (H) AND THE VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY (SN) ARE PRODUCED AS A FUNCTION OF SOLAR ALTITUDE, OZONE AMOUNT, AND WAVE LENGTH.

ENTER COMMAND >BLUE BOOK

THE UV INTENSITY VALUES WILL BE PRODUCED ON THE SELECTED LISTING DEVICE. (SEE ALSO 'ATMOSPHERE' COMMAND)

CORRECT

IN ORDER TO CHANGE A SINGLE ABSORPTION OR EPSILON DATUM, THE 'CORRECT' COMMAND WAS IMPLEMENTED. THE USER IS PROMPTED TO ENTER 'ABSORPTION' OR 'EPSILON'. AFTER THE SELECTION HAS BEEN MADE, THE WAVELENGTH IS REQUESTED, FOLLOWED BY A REQUEST FOR THE NEW DATUM.

ENTER COMMAND >CORRECT

ENTER ABSORPTION OR EPSILON >ABSORPTION

ENTER WAVELENGTH >297.5

ENTER NEW VALUE >12.7

DEPTH

THE 'DEPTH' COMMAND WAS IMPLEMENTED TO PROVIDE FOR THE COMPUTATION OF PHOTOLYSIS RATES AS A FUNCTION OF DEPTH IN THE WATER BODY. INITIAL, INCREMENTAL,AND FINAL DEPTHS ARE INPUT IN

UNITS OF CENTIMETERS. THE AVERAGE RATE CONSTANT IN A COMPLETELY MIXED WATER COLUMN IS CALCULATED.

ENTER COMMAND >DEPTH

ENTER INITIAL DEPTH >0.0

ENTER FINAL DEPTH >100.

ENTER DEPTH INCREMENT >10.

DEPTH POINT

THIS COMMAND RESULTS IN COMPUTATION OF THE RATE CONSTANT IN A LAYER OF THICKNESS 'DELTA DEPTH' (CM) AT A SPECIFIED DEPTH IN A WATER BODY.

ENTER COMMAND >DEPTH POINT

ENTER DELTA DEPTH >0.001

EPSILON

THIS COMMAND ALLOWS MOLAR EXTINCTION COEFFICIENTS OF THE POLLUTANT AT WAVELENGTHS >280.0 NM. TO BE ENTERED INTO THE SYSTEM. ENGINEERING UNITS OF THE EXTINCTION COEFFICIENTS ARE LITER/(MOLE CM). NOTE! THE MAXIMUM ABSORBING WAVELENGTH FOR THE WATER BODY SHOULD BE SET BEFORE ENTERING THIS COMMAND OR MORE DATA THAN IS AVAILABLE MAY BE REQUESTED BY THE INPUT ROUTINE. THE MAXIMUM ABSORBING WAVELENGTH CAN BE SET VIA THE MAX WAVE COMMAND. THE MINIMUM ABSORBING WAVELENGTH HAS A DEFAULT
VALUE OF 297.5 WHICH CAN BE SET LOWER TO 280.0 USING THE MIN WAVE COMMAND WHEN 'TIME-OF-DAY' SIMULATIONS ARE PERFORMED.

ENTER COMMAND >EPSILON

EPSILON DATA:
ENTER CURR TO USE CURRENT DATA
ENTER NEW TO ENTER NEW EPSILON DATA

NEW

ENTER EPSILON FOR 297.5 NANOMETERS >18.7

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.
.

EXIT

RETURNS CONTROL TO THE OPERATING SYSTEM.

FILE

THE 'FILE' COMMAND WAS IMPLEMENTED TO PROVIDE THE USER WITH A LIBRARY OF XENOBIOTIC INFORMATION. THE AVAILABILITY OF THE LIBRARY FUNCTION PROVIDES THE USER WITH A STORAGE AND RETRIEVAL
CAPABILITY. THIS MEANS THAT DATA FROM ONE SESSION CAN BE MADE AVAILABLE ON SUBSEQUENT SESSIONS WITHOUT THE USER HAVING TO REENTER REQUIRED DATA. THE FOLLOWING SUBCOMMANDS ARE AVAILABLE AFTER THE 'FILE' COMMAND IS ENTERED:

READ
WRITE
DELETE
DIRECTORY
HELP

FILE-READ

THE 'READ' SUBCOMMAND IS USED TO SELECT INFORMATION ABOUT A PARTICULAR XENOBIOTIC. AFTER THE READ SUB-COMMAND IS GIVEN, THE USER IS PROMPTED FOR A RECORD NUMBER IN THE RANGE OF 1-99. THE INFORMATION RETRIEVED FROM THE LIBRARY REPLACES ALL CURRENT INFORMATION STORED IN THE PROGRAM WITH THAT IN THE LIBRARY.

FILE-WRITE

THE 'WRITE' SUBCOMMAND IS USED TO STORE ALL CURRENT
INFORMATION IN THE PROGRAM IN THE LIBRARY. THE USER
IS PROMPTED FOR A RECORD NUMBER IN THE RANGE OF
1-99.

FILE-DELETE

THE 'DELETE' SUBCOMMAND IS USED TO DELETE INFORMATION
ABOUT A XENOBIOTIC FROM THE LIBRARY. THE USER IS
PROMPTED FOR A RECORD NUMBER.

FILE-DIRECTORY

THE 'DIRECTORY' SUBCOMMAND IS USED TO LIST
THE CONTENTS OF THE LIBRARY ON THE SELECTED
LISTING DEVICE. ONLY THE RECORD NUMBERS, THE
XENOBIOTIC NAMES AND THE WATER BODY NAMES ARE
PRINTED.

FILE-HELP

THE 'HELP' SUBCOMMAND LISTS THE SUBCOMMANDS
AVAILABLE AFTER THE 'FILE' COMMAND HAS BEEN
ENTERED.

ENTER COMMAND >FILE

ENTER FILE SUBCOMMAND >DIRECTORY

XENOBIOTIC WATER BODY
69 3,4-DICHLOROANILINE PURE WATER

ENTER COMMAND >FILE

ENTER FILE SUBCOMMAND >WRITE

ENTER XENOBIOTIC # >1
-
ENTER COMMAND >FILE

ENTER FILE SUBCOMMAND >DIRECTORY

XENOBIOTIC WATER BODY

```
 1 METHOXYCLOR          PURE WATER
69 3,4-DICHLOROANILINE  PURE WATER

ENTER COMMAND >FILE
              ----
ENTER FILE SUBCOMMAND >DELETE
                      ------
ENTER XENOBIOTIC # >1
                   -
```

HELP

THE 'HELP' COMMAND LISTS ALL AVAILABLE COMMANDS ON
THE SELECTED LISTING DEVICE.

```
ENTER COMMAND >HELP
              ----
```

KA KAMBDA

IF SUNLIGHT ABSORPTION RATES OF THE XENOBIOTIC ARE
DESIRED AS A FUNCTION OF WAVELENGTH, THE THE 'KA LAMBDA'
COMMAND MUST BE ENTERED BEFORE THE RUN COMMAND IS ENTERED.

```
ENTER COMMAND >KA LAMBDA
              ---------
```

LATITUDE

THE 'LATITUDE' IS ENTERED WHEN IT IS DESIRED TO LIMIT
THE SIMULATION TO A SELECTED LATITUDE OR LATITUDES.

```
ENTER COMMAND >LATITUDE
              --------
ENTER NUMBER OF LATITUDES TO BE SELECTED > 2
                                        -
ENTER LATITUDE #  1 > 20
                    --
ENTER LATITUDE #  2 > 60
                    --
```

LIST

IF IT IS DESIRED TO GET A LISTING OF THE CURRENT
VALUES OF ALL PARAMETERS ASSOCIATED WITH THE SIMULATION,
THEN THE 'LIST' COMMAND IS ENTERED.

ENTER COMMAND >LIST

LONGITUDE

THE 'LONGITUDE' COMMAND IS ENTERED TO SELECT A PARTICULAR
LONGITUDE WHEN THE TIME-OF-DAY SIMULATION IS SELECTED.

ENTER COMMAND >LONGITUDE

ENTER LONGITUDE >90.0

MAX WAVE

THE 'MAX WAVE' COMMAND IS USE TO SET THE MAXIMUM
ABSORBING WAVELENGTH FOR THE CURRENT XENOBIOTIC
AND WATER BODY. VALID WAVELENGTHS ARE:

280.0	297.5	323.1	420.0	550.0
282.5	300.0	330.0	430.0	575.0
285.0	302.5	340.0	440.0	600.0
287.5	305.0	350.0	450.0	625.0
290.0	307.5	360.0	460.0	650.0
292.5	310.0	370.0	470.0	675.0
295.0	312.5	380.0	480.0	700.0
	315.0	390.0	490.0	750.0
	317.5	400.0	400.0	800.0
	320.0	410.0	525.0	

FOR 'MID-DAY' CALCULATIONS ONLY WAVELENGTHS > 297.5 NM
ARE AVAILABLE.

ENTER COMMAND >MAX WAVE

ENTER MAXIMUM WAVELENGTH IN NANOMETERS > 330.0

THE MAXIMUM WAVELENGTH FOR ALL COMPUTATIONS WILL BE 330.0 NANOMETERS.

MID-DAY

THE 'MID-DAY' COMMAND CAUSES THE DIRECT PHOTOLYSIS RATES TO BE COMPUTED AND LISTED ON THE SELECTED OUT-PUT DEVICE. THE ROUTINE USES MID-DAY AND MID-SEASON INTENSITY VALUES.

ENTER COMMAND >MID-DAY

MIN WAVE

THE 'MIN WAVE' COMMAND SETS THE MINIMUM ABSORBING WAVELENGTH FOR THE CURRENT XENOBIOTIC AND WATER BODY DOWN TO 280.0 NM. THE DEFAULT VALUE FOR MIN WAVE IS 297.5 NM. DO NOT SET 'MIN WAVE' LESS THAN 297.5 NM WHEN PERFORMING 'MID-DAY' SIMULATIONS.

ENTER COMMAND >MIN WAVE

ENTER MINIMUM WAVELENGTH IN NANOMETERS >280.0

MODE

NOTE: IT IS IMPORTANT THAT THE USER KNOW THAT THE DEFAULT LISTING DEVICE (I.E. THE LISTING DEVICE WHEN THE GCSOLAR PROGRAM IS STARTED) IS THE FILE "FOR000.DAT" FOR VAX/VMS VERSION. FOR THE PC VERSION THE DEFAULT LISTING DEVICE IS THE FILE "GCSOLAR.LST". THESE DEFAULTS WILL REMAIN IN EFFECT UNTIL CHANGED BY THE USER WITH THE "MODE" COMMAND. ONCE THE MODE IS CHANGED TO "TTY" OR "LINE" BY THE USER, IT IS NOT POSSIBLE TO GO BACK TO THE "FILE NAME" LISTING OPTION. THE FILE IS NOT APPENDED BETWEEN "GCSOLAR" PROGRAM EXECUTION SESSIONS BUT IS INSTEAD RECREATED WITH EACH

PROGRAM EXECUTION. LISTING FILES FROM PREVIOUS SESSIONS MAY BE SAVED WITH THE RENAME COMMAND (I.E. RENAME FOR000.DAT GCSSAVE.LST 0R RENAME GCSOLAR.LST GCSOLAR1.LST).

THE 'MODE' COMMAND PROVIDES THE USER WITH ABILITY TO SELECT THE LISTING DEVICE. THE TWO POSSIBLE OPTIONS ARE 'TTY' AND 'LINE'. THE 'TTY' OPTION MEANS THAT ALL OUTPUT WILL BE DIRECTED TO THE INTERACTIVE TERMINAL THAT THE USER IS USING. THE 'LINE' OPTION CAUSES ALL OUTPUT TO GO TO THE LINEPRINTER. AFTER THE 'MODE' COMMAND IS ENTERED, THE USER IS PROMPTED FOR THE LISTING DEVICE:

ENTER COMMAND >MODE

ENTER LINE OR TTY>LINE

THIS COMMAND MAY BE GIVEN AS MANY TIMES AS DESIRED.

NAME

THE 'NAME' COMMAND IS USED TO CHANGE THE NAME OF THE XENOBIOTIC.

ENTER COMMAND >NAME

ENTER NEW XENOBIOTIC NAME > DDE

OZONE

THE 'OZONE' COMMAND IS USED TO ENTER THE AVERAGE OZONE LAYER THICKNESS FOR TIME-OF-DAY DEPENDENCE COMPUTATIONS WHEN THE TYPICAL OZONE VALUES ARE NOT SELECTED. UNITS ARE IN CM, NTP.

ENTER COMMAND >OZONE

ENTER AVERAGE OZONE LAYER THICKNESS >0.40

PLOT

IF IT IS DESIRED TO GENERATE A FILE OF THE TIME
OF DAY PHOTOLYSIS RATES FOR SUBSEQUENT PLOTTING,
THE 'PLOT' COMMAND IS ENTERED.

```
ENTER COMMAND >PLOT
              ----
```

QUANTUM

TO CHANGE THE CURRENT QUANTUM YIELD VALUE, THE
'QUANTUM' COMMAND IS ENTERED.

```
ENTER COMMAND >QUANTUM
              -------
ENTER QUANTUM YIELD > 0.12
                    ----
```

THE QUANTUM YIELD WAS CHANGED TO 0.12 IN THIS
EXAMPLE.

QUIT

THE 'QUIT' COMMAND CAUSES CONTROL TO BE RETURNED TO
THE OPERATING SYSTEM. (IT STOPS THE PROGRAM.)

```
ENTER COMMAND >QUIT
              ----
```

REFRACTIVE

THE 'REFRACTIVE' COMMAND IS USED TO CHANGE THE CURRENT
VALUE OF THE REFRACTIVE INDEX.

```
ENTER COMMAND >REFRACTIVE
              ----------
ENTER REFRACTIVE INDEX > 1.40
                       ----
```

THE REFRACTIVE INDEX WAS CHANGED TO 1.40 IN THIS

EXAMPLE.

RUN

THE 'RUN' COMMAND CAUSES EITHER THE 'MID-DAY' OR
'TIME-OF-DAY' SIMULATION TO BE INITIATED.

ENTER COMMAND >RUN

SEASON

THE 'SEASON' COMMAND PROVIDES A MEANS OF SELECTING
PARTICULAR SEASONS FOR THE SELECTED SIMULATION.

ENTER COMMAND >SEASON

HOW MANY SEASONS WOULD YOU LIKE TO SELECT? >2
-
ENTER SEASON # 1 > FALL

ENTER SEASON # 2 > WINTER

THE SIMULATION WILL BE LIMITED TO THE SEASONS OF
FALL AND WINTER IN THIS EXAMPLE.

SUN ABS

THE 'SUN ABS' COMMAND COMPUTES THE EPSILON DATA AS
FOLLOWS:
EPSILON = ABSORPTION DATA FOR THE WATER BODY
MINUS THE ABSORPTION DATA FOR PURE WATER.
EXISTING EPSILON VALUES IN THE PROGRAM ARE AUTOMATICALLY
REPLACED. THIS COMMAND IS USED IN COMPUTATIONS OF THE
RATE OF SUNLIGHT ABSORPTION BY NATURAL SUBSTANCES IN THE
WATER BODY.

ENTER COMMAND >SUN ABS

TIME-OF-DAY

THE 'TIME-OF-DAY' COMMAND CAUSES DIRECT PHOTOLYSIS RATES TO BE COMPUTED AN LISTED ON THE SELECTED OUTPUT LISTING DEVICE. THE PHOTOLYSIS RATES ARE COMPUTED AS A FUNCTION OF TIME-OF-DAY. TYPICAL OR SPECIFIC EPHEMERIDE DATA MAY BE SELECTED.

ENTER COMMAND >TIME-OF-DAY

WOULD YOU LIKE TYPICAL EPHEMERIDE AND OZONE VALUES ? >YES

ENTER COMMAND >TIME-OF-DAY

WOULD YOU LIKE TYPICAL EPEMERIDE AND OZONE VALUES ? >NO
--
ENTER SOLAR DECLINATION
ENTER DEGREES
23
--
ENTER MINUTES
26
--
ENTER SECONDS
24.1

ENTER RIGHT ASCENSION
ENTER DEGREES
5
-
ENTER MINUTES
58
--
ENTER SECONDS
53.26

ENTER SIDERAL TIME
ENTER DEGREES
17
--
ENTER MINUTES
57
--
ENTER SECONDS
16.074

```
------
ENTER AVERAGE OZONE LAYER THICKNESS. > 0.34
                                    ----
ENTER LONGITUDE > 90.
                  ---
```

VISIBLE

THIS ROUTINE GENERATES TABULAR VALUES OF SOLAR INTENSITIES IN THE RANGE OF 390 TO 800 NANOMETERS. THE TABLES ARE USED TO VERIFY THE OPERATION OF THE TSLAM SUBROUTINE. SKY INTENSITIES FROM THE WHOLE SKY ON A HORIZONTAL SURFACE (H) AND THE VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY (SN) ARE PRODUCED AS A FUNCTION OF SOLAR ALTITUDE, OZONE AMOUNT, AND WAVE LENGTH.

```
ENTER COMMAND >VISIBLE
              -------
```

WATER BODY

THE 'WATER BODY' COMMAND PROVIDES A MEANS OF CHANGING THE NAME OF THE WATER BODY.

```
ENTER COMMAND >WATER BODY
              ----------
ENTER WATER IDENTIFICATION > MISSISSIPPI RIVER
                           -----------------
```

W-LAMBDA

THE 'W-LAMBDA' COMMAND CAUSES A TABLE OF W-LAMBDA VALUES, AS A FUNCTION OF SEASON, LATITUDE, AND WAVE-LENGTH, TO BE PRINTED ON THE SELECTED LISTING DEVICE. TO GENERATE MID-DAY MID-SEASON W-LMDA VALUES FOR ALL WAVELENGTHS IN THE PROGRAM ENTER THE FOLLOWING:

```
ENTER COMMAND >MAX WAVE
              --------
ENTER MAXIMUM WAVELENGTH IN NANOMETERS >800
```

ENTER COMMAND >MID-DAY

ENTER COMMAND >W-LAMBDA

ENTER COMMAND >RUN

NOTE! FOR A PARTICULAR SIMULATION, EITHER THE W-LAMBDA OR THE Z-LAMBDA TABLES MAY BE REQUESTED BUT NOT BOTH.

Z-LAMBDA

THE 'Z-LAMBDA' COMMAND CAUSES A TABLE OF Z-LAMBDA VALUES, AS A FUNCTION OF SEASON, LATITUDE, AND WAVE-LENGTH, TO BE PRINTED ON THE SELECTED LISTING DEVICE. TO GENERATE MID-DAY MID-SEASON W-LMDA VALUES FOR ALL WAVELENGTHS IN THE PROGRAM ENTER THE FOLLOWING:

ENTER COMMAND >MAX WAVE

ENTER MAXIMUM WAVELENGTH IN NANOMETERS >800

ENTER COMMAND >MID-DAY

ENTER COMMAND >W-LAMBDA

ENTER COMMAND >RUN

NOTE! FOR A PARTICULAR SIMULATION, EITHER THE Z-LAMBDA OR THE Z-LAMBDA TABLES MAY BE REQUESTED BUT NOT BOTH.

Sample Interaction Sessions

PART I.

List default values that are used as a starting point in GCSOLAR. Then, compute direct photolysis rates of methoxychlor (near surface) at latitude 40 degrees north during mid-spring as a function of time-of-day. Save data concerning chemical and environmental properties in library for future use.

ENTER COMMAND > LIST

1XENOBIOTIC NAME: METHOXYCLOR
WATER IDENTIFICATION: PURE WATER
TYPE OF ATMOSPHERE: TERRESTRIAL
QUANTUM YIELD: 0.32000
INITIAL DEPTH: 0.00100
DEPTH INCREMENT: 10.00000
FINAL DEPTH: 5.00000
REFRACTIVE INDEX: 1.34000
WAVE LENGTH*WATER ABSORPTION* EPSILON
(NM)
297.50 * 0.6900E-03 * 0.1110E+02
300.00 * 0.6100E-03 * 0.4670E+01
302.50 * 0.5700E-03 * 0.1900E+01
305.00 * 0.5300E-03 * 0.1100E+01
307.50 * 0.4900E-03 * 0.8000E+00
310.00 * 0.4500E-03 * 0.5300E+00
312.50 * 0.4300E-03 * 0.3300E+00
315.00 * 0.4100E-03 * 0.2700E+00
317.50 * 0.3900E-03 * 0.1600E+00
320.00 * 0.3700E-03 * 0.1000E+00
323.10 * 0.3500E-03 * 0.6000E-01
330.00 * 0.2900E-03 * 0.2000E-01
ALL LATITUDES WERE SELECTED.
ALL SEASONS WERE SELECTED.

ENTER COMMAND > MIN WAVE
ENTER WAVELENGTH IN NANOMETERS > 280
ENTER COMMAND > LIST

1XENOBIOTIC NAME: METHOXYCLOR
WATER IDENTIFICATION: PURE WATER
TYPE OF ATMOSPHERE: TERRESTRIAL
QUANTUM YIELD: 0.32000
INITIAL DEPTH: 0.00100
DEPTH INCREMENT: 10.00000
FINAL DEPTH: 5.00000
REFRACTIVE INDEX: 1.34000
WAVE LENGTH*WATER ABSORPTION* EPSILON
(NM)
280.00 * 0.1200E-02 * 0.2200E+04
282.50 * 0.1130E-02 * 0.2020E+04
285.00 * 0.1060E-02 * 0.1530E+04
287.50 * 0.9900E-03 * 0.6420E+03

```
   290.00  *     0.9300E-03 * 0.2710E+03
   292.50  *     0.8500E-03 * 0.1020E+03
   295.00  *     0.7700E-03 * 0.2800E+02
   297.50  *     0.6900E-03 * 0.1110E+02
   300.00  *     0.6100E-03 * 0.4670E+01
   302.50  *     0.5700E-03 * 0.1900E+01
   305.00  *     0.5300E-03 * 0.1100E+01
   307.50  *     0.4900E-03 * 0.8000E+00
   310.00  *     0.4500E-03 * 0.5300E+00
   312.50  *     0.4300E-03 * 0.3300E+00
   315.00  *     0.4100E-03 * 0.2700E+00
   317.50  *     0.3900E-03 * 0.1600E+00
   320.00  *     0.3700E-03 * 0.1000E+00
   323.10  *     0.3500E-03 * 0.6000E-01
   330.00  *     0.2900E-03 * 0.2000E-01
 ALL LATITUDES WERE SELECTED.
 ALL SEASONS WERE SELECTED.

 ENTER COMMAND > LATITUDE
 ENTER NUMBER OF LATITUDES TO BE SELECTED > 1
 ENTER LATITUDE #:  1 > 40
 ENTER COMMAND > SEASON
 HOW MANY SEASONS WOULD YOU LIKE TO SELECT? > 1
 ENTER SEASON # 1 > SPRING
 ENTER COMMAND > TIME-OF-DAY
 WOULD YOU LIKE TYPICAL EPHEMERIDE AND OZONE VALUES? YES
 ENTER LONGITUDE > 90
 ENTER COMMAND > LIST

1XENOBIOTIC NAME: METHOXYCLOR
 WATER IDENTIFICATION: PURE WATER
 TYPE OF ATMOSPHERE: TERRESTRIAL
 QUANTUM YIELD:      0.32000
 INITIAL DEPTH:      0.00100
 DEPTH INCREMENT:    10.00000
 FINAL DEPTH:        5.00000
 REFRACTIVE INDEX:   1.34000
 WAVE LENGTH*WATER ABSORPTION*  EPSILON
   (NM)
   280.00  *     0.1200E-02 * 0.2200E+04
   282.50  *     0.1130E-02 * 0.2020E+04
   285.00  *     0.1060E-02 * 0.1530E+04
   287.50  *     0.9900E-03 * 0.6420E+03
   290.00  *     0.9300E-03 * 0.2710E+03
   292.50  *     0.8500E-03 * 0.1020E+03
   295.00  *     0.7700E-03 * 0.2800E+02
```

```
   297.50  *     0.6900E-03 * 0.1110E+02
   300.00  *     0.6100E-03 * 0.4670E+01
   302.50  *     0.5700E-03 * 0.1900E+01
   305.00  *     0.5300E-03 * 0.1100E+01
   307.50  *     0.4900E-03 * 0.8000E+00
   310.00  *     0.4500E-03 * 0.5300E+00
   312.50  *     0.4300E-03 * 0.3300E+00
   315.00  *     0.4100E-03 * 0.2700E+00
   317.50  *     0.3900E-03 * 0.1600E+00
   320.00  *     0.3700E-03 * 0.1000E+00
   323.10  *     0.3500E-03 * 0.6000E-01
   330.00  *     0.2900E-03 * 0.2000E-01
 LATITUDE 40 WAS SELECTED.
 SEASON # 1 IS SP
 LONGITUDE SELECTED:  90.00
 TIME-OF-DAY COMPUTATIONS ARE REQUESTED.
 TYPICAL EPHEMERIDE AND OZONE VALUES WERE SELECTED.

 ENTER COMMAND > RUN

1XENOBIOTIC NAME: METHOXYCLOR              ELEVATION:   0.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER         LONGITUDE:  90.00
 TYPE OF ATMOSPHERE: TERRESTRIAL

  LAT.  SEASON SOLAR   MORN   EVEN     RATE    HALF LIFE
            ALT.    TIME   TIME     /SEC      HOURS
 40.00 SPRING   0.00   5.29  18.55  0.000E+00  0.000E+00
              5.00   5.81  18.04  0.218E-08  0.884E+05
             10.00   6.25  17.60  0.635E-08  0.303E+05
             20.00   7.12  16.73  0.293E-07  0.656E+04
             30.00   7.99  15.85  0.749E-07  0.257E+04
             40.00   8.91  14.94  0.138E-06  0.139E+04
             50.00   9.93  13.92  0.209E-06  0.921E+03
             60.00  11.75  12.10  0.277E-06  0.694E+03
    MIDDAY     60.09  11.92  11.92  0.278E-06  0.693E+03
0             AVG RATE DURING DALITE(SEC**-1)  0.127E-06
              RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.606E-02
              HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.114E+03
              NEAR SURFACE

 ENTER COMMAND > FILE
 ENTER FILE SUB-COMMAND > WRITE
 ENTER XENOBIOTIC # > 1
```

PART II.

Compute effects of change in stratospheric ozone layer change of direct photolysis rate of methoxychlor. Recover data saved in library then compute rate constants for methoxychlor at an elevation of 4.0 KM above sea level.

```
 ENTER COMMAND > OZONE
 ENTER AVERAGE OZONE LAYER THICKNESS > 0.200
 ENTER COMMAND > RUN

1XENOBIOTIC NAME: METHOXYCLOR              ELEVATION:   0.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER         LONGITUDE:  90.00
 TYPE OF ATMOSPHERE: TERRESTRIAL

  LAT.  SEASON SOLAR   MORN   EVEN     RATE    HALF LIFE
             ALT.    TIME   TIME     /SEC      HOURS
  40.00 SPRING   0.00   5.29  18.55  0.000E+00  0.000E+00
               5.00   5.81  18.04  0.335E-08  0.574E+05
              10.00   6.25  17.60  0.103E-07  0.187E+05
              20.00   7.12  16.73  0.507E-07  0.380E+04
              30.00   7.99  15.85  0.136E-06  0.142E+04
              40.00   8.91  14.94  0.265E-06  0.727E+03
              50.00   9.93  13.92  0.427E-06  0.451E+03
              60.00  11.75  12.10  0.602E-06  0.320E+03
     MIDDAY     60.09  11.92  11.92  0.603E-06  0.319E+03
0              AVG RATE DURING DALITE(SEC**-1)  0.259E-06
              RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.124E-01
              HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.560E+02
              NEAR SURFACE

 ENTER COMMAND > FILE
 ENTER FILE SUB-COMMAND > READ
 ENTER XENOBIOTIC # > 1
 ENTER COMMAND > ELEVATION
 ENTER ELEVATION (KM.) >
4.0
 ENTER COMMAND > RUN

1XENOBIOTIC NAME: METHOXYCLOR              ELEVATION:   4.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER         LONGITUDE:  90.00
 TYPE OF ATMOSPHERE: TERRESTRIAL

  LAT.  SEASON SOLAR   MORN   EVEN     RATE    HALF LIFE
```

```
            ALT.    TIME   TIME     /SEC      HOURS
 40.00 SPRING   0.00   5.29  18.55  0.000E+00  0.000E+00
              5.00   5.81  18.04  0.185E-08  0.104E+06
             10.00   6.25  17.60  0.611E-08  0.315E+05
             20.00   7.12  16.73  0.371E-07  0.518E+04
             30.00   7.99  15.85  0.102E-06  0.188E+04
             40.00   8.91  14.94  0.190E-06  0.101E+04
             50.00   9.93  13.92  0.285E-06  0.676E+03
             60.00  11.75  12.10  0.375E-06  0.514E+03
    MIDDAY     60.09  11.92  11.92  0.375E-06  0.513E+03
0             AVG RATE DURING DALITE(SEC**-1)  0.172E-06
             RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.821E-02
             HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.845E+02
             NEAR SURFACE

 ENTER COMMAND > ELEVATION
 ENTER ELEVATION (KM.) >
0.0
```

PART III.

Compute direct photolysis rate constants for methoxychlor in mid-day mode. This uses solar UV data measured by Paul Bener at Davos, Switzerland. Compute dependence of specific sunlight absorption rate of methoxychlor on wavelength for mid-day, mid-spring, latitude 40 degrees north.

```
 ENTER COMMAND > MID-DAY
 ENTER COMMAND > LIST

1XENOBIOTIC NAME: METHOXYCLOR
 WATER IDENTIFICATION: PURE WATER
 TYPE OF ATMOSPHERE: TERRESTRIAL
 QUANTUM YIELD:      0.32000
 INITIAL DEPTH:      0.00100
 DEPTH INCREMENT:    10.00000
 FINAL DEPTH:        5.00000
 REFRACTIVE INDEX:   1.34000
 WAVE LENGTH*WATER ABSORPTION*  EPSILON
   (NM)
   280.00  *     0.1200E-02 * 0.2200E+04
   282.50  *     0.1130E-02 * 0.2020E+04
```

```
   285.00  *     0.1060E-02 * 0.1530E+04
   287.50  *     0.9900E-03 * 0.6420E+03
   290.00  *     0.9300E-03 * 0.2710E+03
   292.50  *     0.8500E-03 * 0.1020E+03
   295.00  *     0.7700E-03 * 0.2800E+02
   297.50  *     0.6900E-03 * 0.1110E+02
   300.00  *     0.6100E-03 * 0.4670E+01
   302.50  *     0.5700E-03 * 0.1900E+01
   305.00  *     0.5300E-03 * 0.1100E+01
   307.50  *     0.4900E-03 * 0.8000E+00
   310.00  *     0.4500E-03 * 0.5300E+00
   312.50  *     0.4300E-03 * 0.3300E+00
   315.00  *     0.4100E-03 * 0.2700E+00
   317.50  *     0.3900E-03 * 0.1600E+00
   320.00  *     0.3700E-03 * 0.1000E+00
   323.10  *     0.3500E-03 * 0.6000E-01
   330.00  *     0.2900E-03 * 0.2000E-01
 LATITUDE 40 WAS SELECTED.
 SEASON # 1 IS SP
 MID-DAY COMPUTATIONS ARE REQUESTED.

 ENTER COMMAND > RUN

1XENOBIOTIC NAME: METHOXYCLOR
 WATER IDENTIFICATION: PURE WATER
 TYPE OF ATMOSPHERE: TERRESTRIAL

 LATITUDE SEASON   DEPTH      LD         LS       KA/SEC      RATE    HALF LIFE
   40    SPRING      0.0  0.108E-02  0.120E-02  0.627E-06  0.201E-06  0.960E+03

 ENTER COMMAND > KA LAMBDA
 DO YOU WANT THE KA LAMBDA VALUES PRINTED? YES
 ENTER COMMAND > RUN

1XENOBIOTIC NAME: METHOXYCLOR
 WATER IDENTIFICATION: PURE WATER
 TYPE OF ATMOSPHERE: TERRESTRIAL

 LATITUDE SEASON   DEPTH      LD         LS       KA/SEC      RATE    HALF LIFE
   40    SPRING      0.0  0.108E-02  0.120E-02  0.627E-06  0.201E-06  0.960E+03
        0.280000E+03 0.000000E+00
        0.282500E+03 0.000000E+00
        0.285000E+03 0.000000E+00
        0.287500E+03 0.000000E+00
        0.290000E+03 0.000000E+00
        0.292500E+03 0.000000E+00
```

0.295000E+03 0.000000E+00
0.297500E+03 0.464718E-08
0.300000E+03 0.854335E-08
0.302500E+03 0.121942E-07
0.305000E+03 0.203795E-07
0.307500E+03 0.272623E-07
0.310000E+03 0.301486E-07
0.312500E+03 0.294898E-07
0.315000E+03 0.322338E-07
0.317500E+03 0.242873E-07
0.320000E+03 0.179743E-07
0.323100E+03 0.135232E-07
0.330000E+03 0.582413E-08

ENTER COMMAND > KA LAMBDA
DO YOU WANT THE KA LAMBDA VALUES PRINTED? NO

PART IV.

Compute direct photolysis rates for carbazole as a function of time-of-day for latitudes 30 degrees and 40 degrees north, longitude 90 degrees west during mid-summer and mid-winter.

ENTER COMMAND > MIN WAVE
ENTER WAVELENGTH IN NANOMETERS > 297.5
ENTER COMMAND > MAX WAVE
ENTER WAVELENGTH IN NANOMETERS > 390
ENTER COMMAND > NAME
ENTER NEW XENOBIOTIC NAME > CARBAZOLE
ENTER COMMAND > QUANTUM
ENTER QUANTUM YIELD > .0033
ENTER COMMAND > EPSILON
EPSILON DATA:

ENTER EPSILON FOR 297.50 NANOMETERS > 5540
ENTER EPSILON FOR 300.00 NANOMETERS > 3100
ENTER EPSILON FOR 302.50 NANOMETERS > 2440
ENTER EPSILON FOR 305.00 NANOMETERS > 2270
ENTER EPSILON FOR 307.50 NANOMETERS > 2390
ENTER EPSILON FOR 310.00 NANOMETERS > 2530
ENTER EPSILON FOR 312.50 NANOMETERS > 2600
ENTER EPSILON FOR 315.00 NANOMETERS > 2700

ENTER EPSILON FOR 317.50 NANOMETERS > 2920
ENTER EPSILON FOR 320.00 NANOMETERS > 3190
ENTER EPSILON FOR 323.10 NANOMETERS > 3170
ENTER EPSILON FOR 330.00 NANOMETERS > 290
ENTER EPSILON FOR 340.00 NANOMETERS > 1520
ENTER EPSILON FOR 350.00 NANOMETERS > 166
ENTER EPSILON FOR 360.00 NANOMETERS > 23
ENTER EPSILON FOR 370.00 NANOMETERS > 13
ENTER EPSILON FOR 380.00 NANOMETERS > 12
ENTER EPSILON FOR 390.00 NANOMETERS > 2
ENTER COMMAND > LATITUDE
ENTER NUMBER OF LATITUDES TO BE SELECTED > 2
ENTER LATITUDE #: 1 > 30
ENTER LATITUDE #: 2 > 50
ENTER COMMAND > SEASON
HOW MANY SEASONS WOULD YOU LIKE TO SELECT? > 2
ENTER SEASON # 1 > SUMMER
ENTER SEASON # 2 > WINTER
ENTER COMMAND > TIME-OF-DAY
WOULD YOU LIKE TYPICAL EPHEMERIDE AND OZONE VALUES? YES
ENTER LONGITUDE > 90
ENTER COMMAND > LIST

1XENOBIOTIC NAME: CARBAZOLE
WATER IDENTIFICATION: PURE WATER
TYPE OF ATMOSPHERE: TERRESTRIAL
QUANTUM YIELD: 0.00330
INITIAL DEPTH: 0.00100
DEPTH INCREMENT: 10.00000
FINAL DEPTH: 5.00000
REFRACTIVE INDEX: 1.34000
WAVE LENGTH*WATER ABSORPTION* EPSILON
(NM)
297.50 * 0.6900E-03 * 0.5540E+04
300.00 * 0.6100E-03 * 0.3100E+04
302.50 * 0.5700E-03 * 0.2440E+04
305.00 * 0.5300E-03 * 0.2270E+04
307.50 * 0.4900E-03 * 0.2390E+04
310.00 * 0.4500E-03 * 0.2530E+04
312.50 * 0.4300E-03 * 0.2600E+04
315.00 * 0.4100E-03 * 0.2700E+04
317.50 * 0.3900E-03 * 0.2920E+04
320.00 * 0.3700E-03 * 0.3190E+04
323.10 * 0.3500E-03 * 0.3170E+04
330.00 * 0.2900E-03 * 0.2900E+03
340.00 * 0.2400E-03 * 0.1520E+04

350.00 * 0.2000E-03 * 0.1660E+03
360.00 * 0.1600E-03 * 0.2300E+02
370.00 * 0.1300E-03 * 0.1300E+02
380.00 * 0.9600E-04 * 0.1200E+02
390.00 * 0.8300E-04 * 0.2000E+01
LATITUDE 30 WAS SELECTED.
LATITUDE 50 WAS SELECTED.
SEASON # 1 IS SU
SEASON # 2 IS WI
LONGITUDE SELECTED: 90.00
TIME-OF-DAY COMPUTATIONS ARE REQUESTED.
TYPICAL EPHEMERIDE AND OZONE VALUES WERE SELECTED.

ENTER COMMAND > CORRECT
ENTER ABSORPTION OR EPSLION > EPSILON
ENTER WAVELENGTH > 330
ENTER NEW VALUE > 2900
ENTER COMMAND > LIST

1XENOBIOTIC NAME: CARBAZOLE
WATER IDENTIFICATION: PURE WATER
TYPE OF ATMOSPHERE: TERRESTRIAL
QUANTUM YIELD: 0.00330
INITIAL DEPTH: 0.00100
DEPTH INCREMENT: 10.00000
FINAL DEPTH: 5.00000
REFRACTIVE INDEX: 1.34000
WAVE LENGTH*WATER ABSORPTION* EPSILON
(NM)
297.50 * 0.6900E-03 * 0.5540E+04
300.00 * 0.6100E-03 * 0.3100E+04
302.50 * 0.5700E-03 * 0.2440E+04
305.00 * 0.5300E-03 * 0.2270E+04
307.50 * 0.4900E-03 * 0.2390E+04
310.00 * 0.4500E-03 * 0.2530E+04
312.50 * 0.4300E-03 * 0.2600E+04
315.00 * 0.4100E-03 * 0.2700E+04
317.50 * 0.3900E-03 * 0.2920E+04
320.00 * 0.3700E-03 * 0.3190E+04
323.10 * 0.3500E-03 * 0.3170E+04
330.00 * 0.2900E-03 * 0.2900E+04
340.00 * 0.2400E-03 * 0.1520E+04
350.00 * 0.2000E-03 * 0.1660E+03
360.00 * 0.1600E-03 * 0.2300E+02
370.00 * 0.1300E-03 * 0.1300E+02
380.00 * 0.9600E-04 * 0.1200E+02

390.00 * 0.8300E-04 * 0.2000E+01
LATITUDE 30 WAS SELECTED.
LATITUDE 50 WAS SELECTED.
SEASON # 1 IS SU
SEASON # 2 IS WI
LONGITUDE SELECTED: 90.00
TIME-OF-DAY COMPUTATIONS ARE REQUESTED.
TYPICAL EPHEMERIDE AND OZONE VALUES WERE SELECTED.

ENTER COMMAND > RUN

1XENOBIOTIC NAME: CARBAZOLE ELEVATION: 0.00 (Km.)
WATER IDENTIFICATION: PURE WATER LONGITUDE: 90.00
TYPE OF ATMOSPHERE: TERRESTRIAL

LAT.	SEASON	SOLAR ALT.	MORN TIME	EVEN TIME	RATE /SEC	HALF LIFE HOURS
30.00	SUMMER	0.00	5.13	18.85	0.000E+00	0.000E+00
		5.00	5.61	18.37	0.307E-05	0.627E+02
		10.00	6.01	17.96	0.708E-05	0.272E+02
		20.00	6.81	17.17	0.224E-04	0.859E+01
		30.00	7.59	16.39	0.434E-04	0.443E+01
		40.00	8.36	15.62	0.648E-04	0.297E+01
		50.00	9.13	14.85	0.835E-04	0.231E+01
		60.00	9.90	14.08	0.981E-04	0.196E+01
		70.00	10.71	13.27	0.108E-03	0.177E+01
		80.00	11.89	12.09	0.115E-03	0.168E+01
	MIDDAY	80.09	11.99	11.99	0.115E-03	0.168E+01

0 AVG RATE DURING DALITE(SEC**-1) 0.636E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.314E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.220E+00
NEAR SURFACE

30.00	WINTER	0.00	6.84	17.32	0.000E+00	0.000E+00
		5.00	7.33	16.83	0.309E-05	0.623E+02
		10.00	7.77	16.39	0.712E-05	0.270E+02
		20.00	8.70	15.46	0.225E-04	0.854E+01
		30.00	9.80	14.36	0.436E-04	0.441E+01
	MIDDAY	39.86	12.08	12.08	0.649E-04	0.297E+01

0 AVG RATE DURING DALITE(SEC**-1) 0.350E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.132E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.524E+00
NEAR SURFACE

50.00	SUMMER	0.00	4.18	19.79	0.000E+00	0.000E+00
		5.00	4.88	19.10	0.299E-05	0.643E+02

```
            10.00   5.44  18.54  0.689E-05  0.279E+02
            20.00   6.50  17.47  0.218E-04  0.883E+01
            30.00   7.54  16.44  0.423E-04  0.455E+01
            40.00   8.60  15.38  0.632E-04  0.305E+01
            50.00   9.76  14.22  0.814E-04  0.236E+01
            60.00  11.79  12.19  0.958E-04  0.201E+01
    MIDDAY     60.09  11.99  11.99  0.959E-04  0.201E+01
0            AVG RATE DURING DALITE(SEC**-1)  0.506E-04
            RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.284E+01
            HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.244E+00
            NEAR SURFACE

  50.00 WINTER   0.00   7.72  16.44  0.000E+00  0.000E+00
            5.00   8.46  15.70  0.295E-05  0.652E+02
            10.00   9.19  14.98  0.679E-05  0.284E+02
    MIDDAY     19.86  12.08  12.08  0.213E-04  0.906E+01
0            AVG RATE DURING DALITE(SEC**-1)  0.111E-04
            RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.348E+00
            HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.199E+01
            NEAR SURFACE
```

PART V.

Compute direct photolysis rate constants for carbazole for the date June 21, 1976 at latitude 34.00 degrees north, longitude 83.2 degrees west near the surface of a water body (0.001 CM).

```
 ENTER COMMAND > TIME-OF-DAY
 WOULD YOU LIKE TYPICAL EPHEMERIDE AND OZONE VALUES? NO
 ENTER SOLAR DECLINATION

 ENTER DEGREES
23
 ENTER MINUTES
26
 ENTER SECONDS
24.1
 ENTER RIGHT ASCENSION

 ENTER DEGREES
5
 ENTER MINUTES
```

58
 ENTER SECONDS
53.26
 ENTER SIDEREAL TIME

 ENTER DEGREES
17
 ENTER MINUTES
57
 ENTER SECONDS
16.047
 ENTER AVERAGE OZONE LAYER THICKNESS > .30
 ENTER COMMAND > LATITUDE
 ENTER NUMBER OF LATITUDES TO BE SELECTED > 1
 ENTER LATITUDE #: 1 > 34
 ENTER COMMAND > LONGITUDE
 ENTER LONGITUDE > 83.2
 ENTER COMMAND > LIST

1XENOBIOTIC NAME: CARBAZOLE
 WATER IDENTIFICATION: PURE WATER
 TYPE OF ATMOSPHERE: TERRESTRIAL
 QUANTUM YIELD: 0.00330
 INITIAL DEPTH: 0.00100
 DEPTH INCREMENT: 10.00000
 FINAL DEPTH: 5.00000
 REFRACTIVE INDEX: 1.34000
 WAVE LENGTH*WATER ABSORPTION* EPSILON
   (NM)
   297.50 *   0.6900E-03 * 0.5540E+04
   300.00 *   0.6100E-03 * 0.3100E+04
   302.50 *   0.5700E-03 * 0.2440E+04
   305.00 *   0.5300E-03 * 0.2270E+04
   307.50 *   0.4900E-03 * 0.2390E+04
   310.00 *   0.4500E-03 * 0.2530E+04
   312.50 *   0.4300E-03 * 0.2600E+04
   315.00 *   0.4100E-03 * 0.2700E+04
   317.50 *   0.3900E-03 * 0.2920E+04
   320.00 *   0.3700E-03 * 0.3190E+04
   323.10 *   0.3500E-03 * 0.3170E+04
   330.00 *   0.2900E-03 * 0.2900E+04
   340.00 *   0.2400E-03 * 0.1520E+04
   350.00 *   0.2000E-03 * 0.1660E+03
   360.00 *   0.1600E-03 * 0.2300E+02
   370.00 *   0.1300E-03 * 0.1300E+02
   380.00 *   0.9600E-04 * 0.1200E+02

```
   390.00  *     0.8300E-04 * 0.2000E+01
 LATITUDE  34.00 WAS SELECTED.
 SEASON # 1 IS SU
 SEASON # 2 IS WI
 LONGITUDE SELECTED:  83.20
 TIME-OF-DAY COMPUTATIONS ARE REQUESTED.
 SPECIFIC EPHEMERIDE AND OZONE VALUES WERE SELECTED.

 ENTER COMMAND > RUN

1XENOBIOTIC NAME: CARBAZOLE              ELEVATION:   0.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER        LONGITUDE:  83.20
 TYPE OF ATMOSPHERE: TERRESTRIAL

  LAT.        SOLAR   MORN   EVEN     RATE   HALF/LIFE
             ALT.    TIME   TIME     /SEC     HOURS
  34.00         0.00   4.28  18.66  0.000E+00  0.000E+00
               5.00   4.81  18.14  0.306E-05  0.630E+02
              10.00   5.24  17.70  0.704E-05  0.273E+02
              20.00   6.09  16.85  0.223E-04  0.864E+01
              30.00   6.91  16.03  0.432E-04  0.446E+01
              40.00   7.72  15.23  0.645E-04  0.299E+01
              50.00   8.52  14.42  0.830E-04  0.232E+01
              60.00   9.33  13.61  0.976E-04  0.197E+01
              70.00  10.18  12.76  0.108E-03  0.178E+01
    MIDDAY    79.44  11.47  11.47  0.114E-03  0.169E+01
0             AVG RATE DURING DALITE(SEC**-1)  0.626E-04
              RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.324E+01
              HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.214E+00
              NEAR SURFACE

 ENTER COMMAND > FILE
 ENTER FILE SUB-COMMAND > WRITE
 ENTER XENOBIOTIC # > 2
```

PART VI.

Compute average direct photolysis rate constants for carbazole in well mixed layers of various depths. Use time and place specified in PART V.

```
 ENTER COMMAND > DEPTH
 ENTER INITIAL DEPTH > .001
```

ENTER FINAL DEPTH > 4000.001
ENTER DEPTH INCREMENT > 1000
ENTER COMMAND > LIST

1XENOBIOTIC NAME: CARBAZOLE
WATER IDENTIFICATION: PURE WATER
TYPE OF ATMOSPHERE: TERRESTRIAL
QUANTUM YIELD: 0.00330
INITIAL DEPTH: 0.00100
DEPTH INCREMENT: 1000.00000
FINAL DEPTH: 4000.00098
REFRACTIVE INDEX: 1.34000
WAVE LENGTH*WATER ABSORPTION* EPSILON
(NM)
297.50 * 0.6900E-03 * 0.5540E+04
300.00 * 0.6100E-03 * 0.3100E+04
302.50 * 0.5700E-03 * 0.2440E+04
305.00 * 0.5300E-03 * 0.2270E+04
307.50 * 0.4900E-03 * 0.2390E+04
310.00 * 0.4500E-03 * 0.2530E+04
312.50 * 0.4300E-03 * 0.2600E+04
315.00 * 0.4100E-03 * 0.2700E+04
317.50 * 0.3900E-03 * 0.2920E+04
320.00 * 0.3700E-03 * 0.3190E+04
323.10 * 0.3500E-03 * 0.3170E+04
330.00 * 0.2900E-03 * 0.2900E+04
340.00 * 0.2400E-03 * 0.1520E+04
350.00 * 0.2000E-03 * 0.1660E+03
360.00 * 0.1600E-03 * 0.2300E+02
370.00 * 0.1300E-03 * 0.1300E+02
380.00 * 0.9600E-04 * 0.1200E+02
390.00 * 0.8300E-04 * 0.2000E+01
LATITUDE 34.00 WAS SELECTED.
SEASON # 1 IS SU
LONGITUDE SELECTED: 83.20
TIME-OF-DAY COMPUTATIONS ARE REQUESTED.
SPECIFIC EPHEMERIDE AND OZONE VALUES WERE SELECTED.

ENTER COMMAND > RUN

1XENOBIOTIC NAME: CARBAZOLE ELEVATION: 0.00 (Km.)
WATER IDENTIFICATION: PURE WATER LONGITUDE: 83.20
TYPE OF ATMOSPHERE: TERRESTRIAL

LAT. SOLAR MORN EVEN RATE HALF/LIFE
ALT. TIME TIME /SEC HOURS

34.00 0.00 4.28 18.66 0.000E+00 0.000E+00
5.00 4.81 18.14 0.306E-05 0.630E+02
10.00 5.24 17.70 0.704E-05 0.273E+02
20.00 6.09 16.85 0.223E-04 0.864E+01
30.00 6.91 16.03 0.432E-04 0.446E+01
40.00 7.72 15.23 0.645E-04 0.299E+01
50.00 8.52 14.42 0.830E-04 0.232E+01
60.00 9.33 13.61 0.976E-04 0.197E+01
70.00 10.18 12.76 0.108E-03 0.178E+01
MIDDAY 79.44 11.47 11.47 0.114E-03 0.169E+01
0 AVG RATE DURING DALITE(SEC**-1) 0.626E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.324E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.214E+00
DEPTH OF WATER BODY: 0.100E-02

34.00 0.00 4.28 18.66 0.000E+00 0.000E+00
5.00 4.81 18.14 0.215E-05 0.897E+02
10.00 5.24 17.70 0.490E-05 0.393E+02
20.00 6.09 16.85 0.152E-04 0.127E+02
30.00 6.91 16.03 0.292E-04 0.659E+01
40.00 7.72 15.23 0.437E-04 0.440E+01
50.00 8.52 14.42 0.567E-04 0.340E+01
60.00 9.33 13.61 0.671E-04 0.287E+01
70.00 10.18 12.76 0.747E-04 0.258E+01
MIDDAY 79.44 11.47 11.47 0.790E-04 0.244E+01
0 AVG RATE DURING DALITE(SEC**-1) 0.430E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.223E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.311E+00
DEPTH OF WATER BODY: 0.100E+04

34.00 0.00 4.28 18.66 0.000E+00 0.000E+00
5.00 4.81 18.14 0.158E-05 0.122E+03
10.00 5.24 17.70 0.359E-05 0.536E+02
20.00 6.09 16.85 0.110E-04 0.175E+02
30.00 6.91 16.03 0.210E-04 0.915E+01
40.00 7.72 15.23 0.315E-04 0.610E+01
50.00 8.52 14.42 0.411E-04 0.468E+01
60.00 9.33 13.61 0.490E-04 0.393E+01
70.00 10.18 12.76 0.547E-04 0.352E+01
MIDDAY 79.44 11.47 11.47 0.580E-04 0.332E+01
0 AVG RATE DURING DALITE(SEC**-1) 0.313E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.162E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.427E+00
DEPTH OF WATER BODY: 0.200E+04

34.00 0.00 4.28 18.66 0.000E+00 0.000E+00

```
             5.00   4.81  18.14  0.122E-05  0.158E+03
            10.00   5.24  17.70  0.276E-05  0.698E+02
            20.00   6.09  16.85  0.837E-05  0.230E+02
            30.00   6.91  16.03  0.160E-04  0.121E+02

1XENOBIOTIC NAME: CARBAZOLE              ELEVATION:   0.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER        LONGITUDE:  83.20
  LAT.  SEASON SOLAR   MORN   EVEN     RATE    HALF LIFE
           ALT.   TIME   TIME     /SEC      HOURS
 TYPE OF ATMOSPHERE: TERRESTRIAL

            40.00   7.72  15.23  0.240E-04  0.803E+01
            50.00   8.52  14.42  0.314E-04  0.614E+01
            60.00   9.33  13.61  0.375E-04  0.514E+01
            70.00  10.18  12.76  0.420E-04  0.458E+01
    MIDDAY     79.44  11.47  11.47  0.447E-04  0.431E+01
0            AVG RATE DURING DALITE(SEC**-1)  0.240E-04
            RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.124E+01
            HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.558E+00
            DEPTH OF WATER BODY: 0.300E+04

  34.00         0.00   4.28  18.66  0.000E+00  0.000E+00
             5.00   4.81  18.14  0.978E-06  0.197E+03
            10.00   5.24  17.70  0.220E-05  0.875E+02
            20.00   6.09  16.85  0.665E-05  0.290E+02
            30.00   6.91  16.03  0.127E-04  0.152E+02
            40.00   7.72  15.23  0.190E-04  0.101E+02
            50.00   8.52  14.42  0.249E-04  0.772E+01
            60.00   9.33  13.61  0.299E-04  0.644E+01
            70.00  10.18  12.76  0.336E-04  0.573E+01
    MIDDAY     79.44  11.47  11.47  0.357E-04  0.539E+01
0            AVG RATE DURING DALITE(SEC**-1)  0.191E-04
            RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.989E+00
            HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.701E+00
            DEPTH OF WATER BODY: 0.400E+04
```

PART VII.

Compute direct photolysis rate constants for carbazole at various depths in a water column. Use time and place specified in PART V.

```
 ENTER COMMAND > DEPTH POINT
```

ENTER DELTA DEPTH > .001
ENTER COMMAND > RUN

1XENOBIOTIC NAME: CARBAZOLE ELEVATION: 0.00 (Km.)
WATER IDENTIFICATION: PURE WATER LONGITUDE: 83.20
TYPE OF ATMOSPHERE: TERRESTRIAL

LAT.	SOLAR ALT.	MORN TIME	EVEN TIME	RATE /SEC	HALF/LIFE HOURS
34.00	0.00	4.28	18.66	0.000E+00	0.000E+00
	5.00	4.81	18.14	0.306E-05	0.630E+02
	10.00	5.24	17.70	0.704E-05	0.273E+02
	20.00	6.09	16.85	0.223E-04	0.864E+01
	30.00	6.91	16.03	0.432E-04	0.446E+01
	40.00	7.72	15.23	0.645E-04	0.299E+01
	50.00	8.52	14.42	0.830E-04	0.232E+01
	60.00	9.33	13.61	0.976E-04	0.197E+01
	70.00	10.18	12.76	0.108E-03	0.178E+01
MIDDAY	79.44	11.47	11.47	0.114E-03	0.169E+01

0 AVG RATE DURING DALITE(SEC**-1) 0.626E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.324E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.214E+00
DEPTH OF WATER BODY: 0.100E-02

34.00	0.00	4.28	18.66	0.000E+00	0.000E+00
	5.00	4.81	18.14	0.144E-05	0.133E+03
	10.00	5.24	17.70	0.325E-05	0.591E+02
	20.00	6.09	16.85	0.985E-05	0.195E+02
	30.00	6.91	16.03	0.188E-04	0.103E+02
	40.00	7.72	15.23	0.282E-04	0.683E+01
	50.00	8.52	14.42	0.369E-04	0.522E+01
	60.00	9.33	13.61	0.441E-04	0.437E+01
	70.00	10.18	12.76	0.494E-04	0.390E+01
MIDDAY	79.44	11.47	11.47	0.525E-04	0.367E+01

0 AVG RATE DURING DALITE(SEC**-1) 0.282E-04
RATE INTEGRATED OVER FULL DAY(DAY**-1) 0.146E+01
HALF LIFE INTEGRATED OVER FULL DAY(DAYS) 0.475E+00
DEPTH OF WATER BODY: 0.100E+04

34.00	0.00	4.28	18.66	0.000E+00	0.000E+00
	5.00	4.81	18.14	0.695E-06	0.277E+03
	10.00	5.24	17.70	0.154E-05	0.125E+03
	20.00	6.09	16.85	0.448E-05	0.430E+02
	30.00	6.91	16.03	0.839E-05	0.229E+02
	40.00	7.72	15.23	0.127E-04	0.152E+02
	50.00	8.52	14.42	0.169E-04	0.114E+02

```
          60.00   9.33  13.61  0.206E-04  0.936E+01
          70.00  10.18  12.76  0.234E-04  0.822E+01
   MIDDAY     79.44  11.47  11.47  0.251E-04  0.767E+01
0           AVG RATE DURING DALITE(SEC**-1)  0.131E-04
          RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.680E+00
          HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.102E+01
          DEPTH OF WATER BODY: 0.200E+04

 34.00        0.00   4.28  18.66  0.000E+00  0.000E+00
           5.00   4.81  18.14  0.342E-06  0.563E+03
          10.00   5.24  17.70  0.742E-06  0.259E+03
          20.00   6.09  16.85  0.209E-05  0.923E+02
          30.00   6.91  16.03  0.386E-05  0.499E+02

1XENOBIOTIC NAME: CARBAZOLE              ELEVATION:   0.00 (Km.)
 WATER IDENTIFICATION:  PURE WATER        LONGITUDE:  83.20
  LAT.  SEASON SOLAR   MORN   EVEN     RATE    HALF LIFE
          ALT.   TIME   TIME    /SEC      HOURS
 TYPE OF ATMOSPHERE: TERRESTRIAL

          40.00   7.72  15.23  0.588E-05  0.327E+02
          50.00   8.52  14.42  0.796E-05  0.242E+02
          60.00   9.33  13.61  0.989E-05  0.195E+02
          70.00  10.18  12.76  0.114E-04  0.168E+02
   MIDDAY     79.44  11.47  11.47  0.124E-04  0.156E+02
0           AVG RATE DURING DALITE(SEC**-1)  0.630E-05
          RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.326E+00
          HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.213E+01
          DEPTH OF WATER BODY: 0.300E+04

 34.00        0.00   4.28  18.66  0.000E+00  0.000E+00
           5.00   4.81  18.14  0.172E-06  0.112E+04
          10.00   5.24  17.70  0.366E-06  0.526E+03
          20.00   6.09  16.85  0.998E-06  0.193E+03
          30.00   6.91  16.03  0.182E-05  0.106E+03
          40.00   7.72  15.23  0.280E-05  0.688E+02
          50.00   8.52  14.42  0.386E-05  0.499E+02
          60.00   9.33  13.61  0.488E-05  0.394E+02
          70.00  10.18  12.76  0.574E-05  0.335E+02
   MIDDAY     79.44  11.47  11.47  0.627E-05  0.307E+02
0           AVG RATE DURING DALITE(SEC**-1)  0.311E-05
          RATE INTEGRATED OVER FULL DAY(DAY**-1)  0.161E+00
          HALF LIFE INTEGRATED OVER FULL DAY(DAYS)  0.431E+01
          DEPTH OF WATER BODY: 0.400E+04

 ENTER COMMAND > QUIT
```

FORTRAN Source code Documentation

I. IDENTIFICATION
A. TITLE: BENER, ROUTINE FOR PRODUCING SOLAR INTENSITY TABLES.
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB., 1976
D. REVISION: NONE

II. PURPOSE
THE ROUTINE GENERATES TABULAR VALUES OF INTENSITIES AS FOUND IN BENER ON PAGES 22-39. THE TABLES WERE USED TO VERIFY THE DATA THAT IS PRODUCED BY AN EQUATION THAT WAS FIT TO BENER'S DATA. SKY INTENSITIES FROM THE WHOLE SKY ON A HORIZONTAL SURFACE (H) AND THE VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY (SN) ARE PRODUCED AS A FUNCTION OF SOLAR ALTITUDE, OZONE AMOUNT, AND WAVELENGTH. ALL INTENSITIES PERTAIN TO SEA LEVEL AND CLOUDLESS SKIES.

III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: BLUE AND TABOUT
C. COMMON STORAGE: IOUNIT

IV. USAGE
A. ENTRY POINT: BENER
B. CALLING SEQUENCE: CALL BENER
C. INPUT ARGUMENTS: NONE
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD
BENER VARIES THE VALUES OF THE SOLAR ALTITUDE, OZONE AMOUNT, AND WAVE LENGTH WHILE MAKING CALLS TO BLUE. SUBROUTINE BLUE PERFORMS THE ACTUAL COMPUTATIONS OF THE SOLAR INTENSITIES.
REFERENCE: BENER,P., U.S. ARMY REPORT DATA 37-68-C-1017, DAVOS PALTZ, SWITZERLAND, 1972, PP 22-39.

I. IDENTIFICATION
A. TITLE: BLUE, ROUTINE FOR COMPUTING SOLAR INTENSITY VALUES.
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB., 1976
D. REVISION: NONE

II. PURPOSE
TO RETURN H AND SN(SEE BELOW) VALUES FOR A GIVEN SOLAR ALTITUDE, OZONE AMOUNT, AND WAVE LENGTH.

III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: BLUEOT
C. COMMON STORAGE: BLUEUE

IV. USAGE

A. ENTRY POINT: BLUE

B. CALLING SEQUENCE: THE FORTRAN CALLING SEQUENCE IS:

CALL BLUE(SOLAT,WAVE,OZAMT,H,SN,ERR)

C. INPUT ARGUMENTS:

SOLATINTEGER- SOLAR ALTITUDE

WAVEREAL- WAVE LENGTH

OZAMTREAL- OZONE AMOUNT

D. OUTPUT ARGUMENTS:

HREAL- SKY INTENSITY FROM THE WHOLE SKY ON A HORIZONTAL SURFACE.

SNREAL- VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY

ERRINTEGER- ERROR CODE RETURN

E. ERROR CONDITIONS AND RETURNS:

ERR = 0 - NO ERRORS

ERR = 1 - IF AN INVALID SOLAR ALTITUDE IS ENCOUNTERED.

ERR = 2 - IF AN INVALID WAVE LENGTH IS ENCOUNTERED.

V. ALGORITHM OR METHOD

H AND SN (0 KM. ASL) ARE AVAILABLE IN BENER (SEE PREVIOUS DISCUSSION OF SUBROUTINE BENNER) TO MAKE THE DATA READILY AVAILABLE IN A COMPACT FORM FOR COMPUTER USE, EQUATIONS WERE DEVELOPED FOR H AND SN AS A FUNCTION OF OZONE AMOUNT, WAVE LENGTH, AND SOLAR ALTITUDE. EQUATIONS OF THE FOLLOWING FORM WERE FIT TO THE DATA:

LOG(H(X)) = LOG(H(X0)) - T * (X-X0)

WHERE X IS THE OZONE AMOUNT AND X0 = 0.3375

LOG(H(X0) = LOG(H(XLO) + T * (XLO - 0.3375)

WHERE XLO = THE MINIMUM OZONE AMOUNT, 0.24 CM.

T = LOG(H(XLO)) - LOG(H(XHI)) / (XHI - XLO)

WHERE XHI = THE MAXIMUM OZONE AMOUNT, 0.44 CM.

SIMILAR EXPRESSIONS WERE DEVELOPED FOR THE SN DATA. THERE ARE 150 EQUATIONS FOR COMPUTING THE H VALUES AND 150 EQUATIONS FOR THE SN VALUES. AN EQUATION EXISTS FOR EACH SOLAR ALTITUDE AND WAVELENGTH. EACH EQUATION REQUIRES TWO CONSTANTS AND ARE STORED IN THE C ARRAY PAIR-WISE. THE CONSTANTS FOR THE H EXPRESSION ARE STORED IN THE FIRST 300 LOCATIONS OF C AND THE LAST 300 ELEMENTS OF THE C ARRAY ARE USED FOR STORING THE CONSTANTS FOR THE HN EXPRESSION.

THE SOLAR ALTITUDE VALUES SUPPORTED ARE 0, 5, 10, 20, 30, 40, 50, 60, 70, 80, AND 90 AND HAVE CORRESPONDING INDICIES OF I = 1, 2, ... 10. THE FOLLOWING WAVE LENGTHS ARE SUPPORTED: 297.5, 300., 302.5, 305., 307.5, 310., 312.5, 315., 317.5, 320., 325., 330., 340., 360., AND 380. AND HAVE CORRESPONDING INDICIES OF J = 1, 2, ... 15. SUBSCRIPTS FOR THE H CONSTANTS IN THE C ARRAY ARE

COMPUTED AS FOLLOWS:
ISUB = (I-1) * 30 + (J-1) * 2 + 1
AND ISUBP1 = ISUB + 1
SUBSCRIPTS FOR THE SH CONSTANTS ARE FOUND BY SIMPLY
ADDING 300 TO THE RESULTS ABOVE.

I. IDENTIFICATION
A. TITLE: CONVER, A FORTRAN ROUTINE TO CONVERT SOLAR INTENSITY GIVEN IN TERMS OF WATTS INTO SOLAR INTENSITY IN TERMS OF PHOTONS/SEC. ADDITIONALLY, VALUES FOR NEW
WAVE LENGTH INTERVALS ARE COMPUTED.
B. SOURCE LANGUAGE FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB., 1977
D. REVISION: NONE
II. PURPOSE
TO CONVERT SOLAR INTENSITY IN TERMS OF WATTS/CM**2/NM TO PHOTONS/CM**2/NM/SEC.
III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED NONE
C. COMMON STORAGE: NONE
IV. USAGE
A. ENTRY POINT: CONVER
B. CALLING SEQUENCE:
CALL CONVER(X,Y)
C. INPUT ARGUMENTS:
X REAL - ARRAY OF 15 INTENSITY VALUES IN UNITS OF WATTS/CM**2/NM
D. OUTPUT ARGUMENTS:
Y REAL - ARRAY OF 17 INTENSITY VALUES GIVEN IN PHOTONS/CM**2/NM/SEC
E. ERROR CONDITIONS AND RETURNS: NONE
V. ALGORITHM OR METHOD
SOLAR INTENSITY VALUES WERE RECORDED IN UNITS OF WATTS/CM**2/NM IN BENER'S REPORT. THESE DATA WERE CONVERTED TO PHOTONS/CM**2/NM/SEC BY THE FOLLOWING EQUATION:
I(PHOTONS/CM**2/NM/SEC) = I(WATTS/CM**2/NM) * LAMBDA(NM)
* 5.035E15.
WHERE LAMBDA(NM) REPRESENTS THE WAVELENGTH IN NM.
THE CONSTANT IS DERIVED FROM THE FOLLOWING EQUATION:
E(ENERGY) = H*C/LAMBDA
WHERE H = 6.6256E-34 JOULE SEC
C = 2.99792E17 NM/SEC
SUBSTITUTING FOR H AND C GIVES
E = 19.86E-17/LAMBDA(NM) JOULES/PHOTON
SO,
SINCE 1 WATT = 1 JOULE/SEC, IT FOLLOWS THAT 1 WATT
CORRESPONDS TO LAMBDA(NM)/1.986E-16 OR LAMBDA(NM)

*5.035E15 PHOTONS/SEC.

I. IDENTIFICATION
A. TITLE: BLOCK DATA, DATA INITIALIZATION FOR THE SOLAR PROGRAM
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB., 1977
D. REVISION: NONE

II. PURPOSE
TO INITIALIZE VARIABLES INTERNAL TO THE SOLAR PROGRAM AND TO INITIALIZE CERTAIN DEFAULT VALUES THAT MAY BE CHANGED AT THE USER'S DISCRETION.

III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: NONE
C. COMMON STORAGE: INPT, IOUNIT

IV. USAGE
A. ENTRY POINT: NONE
B. CALLING SEQUENCE: NONE
C. INPUT ARGUMENTS: NONE
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD
THE BLOCK DATA ROUTINE SERVES TO INITIALIZE VARIABLES THAT RESIDE IN COMMON. A DEFINITION FOR EACH OF THE VARIABLES FOLLOWS:
INTSINTEGER - VARIABLE USED TO STORE ALL INTEGER
- VARIABLES IN THE INPT COMMON STATEMENT
FLTSREAL- VARIABLE USED TO STORE ALL REAL VARIABLES
- IN THE INPT COMMON STATEMENT
ABWATREAL- ATTENUATION COEFFICIENTS OF THE REFRACTIVE
- MEDIUM INITIALIZED WITH COEFFICIENTS
- FOR DISTILLED WATER.
RIVERREAL - ALPHANUMERIC ARRAY USED TO STORE THE NAME
- OF THE WATER BODY. INITIALIZED TO
- 'PURE WATER'
EPPESTREAL- MOLAR EXTINCTION COEFFICIENTS OF THE
- SUBJECT POLLUTANT. DEFAULT VALUES ARE
- FOR 'METHOXYCHLOR'
SEASEREAL- ARRAY TO STORE USER SELECTED SEASONS
- OF THE YEAR.
PNAMEREAL- ALPHANUMERIC ARRAY USED TO STORE THE NAME
- OF THE SUBJECT POLLUTANT. INITIALIZED
- 'METHOCYCHLOR.
WAVEREAL- ARRAY OF VALID WAVELENGTHS USED IN
- THE SOLAR PROGRAM.
DMSREAL- ALPHANUMERIC ARRAY USED TO PROMPT FOR

- EPHEMERIDE DATA.
    DMS1REAL- ALPHANUMERIC ARRAY USED TO PROMPT FOR
- EPHEMRIDE DATA.
    XXREAL- ARRAY TO STORE USER SELECTED EPHEMERIDE DATA.
    QREAL- QUANTUM YIELD FOR REACTION OF POLLUTANT.
    MUSUBRREAL- REFRACTIVE INDEX
    DINITREAL- INITIAL DEPTH FOR DEPTH COMPUTATIONS
    DINCREAL- DEPTH INCREMENT FOR THE DEPTH COMPUTATIONS
    DFINALREAL- FINAL DEPTH FOR THE DEPTH COMPUTATION
    AVEOZOREAL- USED TO STORE USER SELECTED OZONE AMOUNT
    XLONREAL- USED TO STORE USER SELECTED LONGITUDE.
    DEFDECREAL- A 3 X 4 MATRIX CONTAINING DEFAULT SEASONAL
- DATA FOR SOLAR DECLINATION. THE DATA IS
- ORGANIZED WITH THE ROWS 1, 2, AND 3
- REPRESENTING DEGREES, MINUTES, AND SECONDS
- RESPECTIVELY. THE FOUR CLOUMNS REPRESENT
- THE SEASONS; 1 - SPRING, 2 - SUMMER, ETC.
    DEFRGTREAL- A 3 X 4 MATRIX CONTAINING DEFAULT SEASONAL
RIGHT ASCENSION DATA. ORGANIZATION IS THE SAME
- AS DEFDEC.
    DEFSIDREAL- A 3 X 4 MATRIX CONTAINING DEFAULT SEASONAL
- SIDEREAL TIMES. ORGANIZED LIKE DEFDEC WITH
- THE EXCEPTION THAT HOURS ARE STORED IN ROW 1.
    DEFOZAREAL- A 10 X 4 MATRIX THAT CONTAINS DEFAULT
- SEASONAL VALUES OF OZONE AMOUNTS. THE
- ROWS REPRESENT VARYING SOLAR ALTITUDES
- AND THE COLUMNS REPRESENT VARYING SEASONS.
- THE ROW SUBSCRIPTS CORRESPOND TO THE
- SOLAR ALTITUDES 5, 10 ,20, 30 ... 80, 90.
- THE COLUMNS CORRESPOND TO THE SEASONS;
- 1 - SPRING, 2 - SUMMER, ETC.
    IPLOTINTEGER- 0 - NO PLOT FILE IS CREATED.
- 1 -   PLOT FILE IS CREATED.
    NUMBERINTEGER- USED TO STORE THE NUMBER OF WAVELENGTHS
- TO BE CONSIDERED FOR THE SUBJECT
- POLLUTANT. INITIALIZED TO 39.
    ILATSWINTEGER - USED TO STORE THE NUMBER OF USER SELECTED
-LATITUDES. VALID ENTRIES ARE 0 - 10.
- ALL LATITUDES ARE SELECTED IF THE ENTRY
- IS 0.
    ILATTMINTEGER- ARRAY TO STORE USER SELECTED LATITUDES.
    IKALAMINTEGER - 0 - DO NOT PRODUCE KA LAMBDA TABLES.
- 1 -   PRODUCE KA LAMBDA TABLES.
    ISEASWINTEGER- USED TO STORE THE NUMBER OF USER SELECTED
- SEASONS. VALID ENTRIES ARE 0 - 4.
- ALL SEASONS ARE SELECTED IF THE ENTRY IS 0.

IWLAMINTEGER- 0 - DO NOT PRODUCE W LAMBDA TABLES.
- 1 - PRODUCE W LAMBDA TABLES.
IZLAMINTEGER- 0 - DO NOT PRODUCE Z LAMBDA TABLES.
- 1 - PRODUCE Z LAMBDA TABLES.
IBENINTEGER - 0 - DO NOT PRODUCE BENNER'S DATA FOR
- THE PURPOSE OF TESTING THE REGRESSION
- EQUATIONS. IF 1, DO SO.
MIDINTEGER- 0 - DO NOT PRODUCE MID-DAY MID-SEASON
- PHOTOLYSIS RATES. IF 1, DO SO.
IVISINTEGER- 0 - DO NOT PRODUCE A TABLE OF VISIBLE
- INTENSITY DATA. IF 1, DO SO.
ITIMEINTEGER - 0 - DO NOT PRODUCE TIME-OF-DAY PHOTOLYSIS RATES.
- 1 - PRODUCE TIME-OF-DAY PHOTOLYSIS RATES.
ITYPINTEGER - 0 - USE TYPICAL OZONE AND EPHEMERIDE DATA
- WHEN COMPUTING TIME-OF-DAY PHOTOLYSIS
- RATES. IF 1, THEN USE USER SELECTED
- VALUES.
IUNITINTEGER- LOGICAL UNIT FOR PRESENTING ALL INTENSITY
- AND RATE DATA. USER SPECIFIED AS TO THE
- LINE PRINTER OR THE INTERACTIVE DEVICE.
- DEFAULT VALUE IS 5.
IPRTINTEGER- LOGICAL UNIT FOR THE LINE PRINTER.
- DEFAULTS TO UNIT 6.
ITTYININTEGER- LOGICAL UNIT FOR INTERACTIVE INPUT. (5).
ITTYOTINTEGER- LOGICAL UNIT FOR INTERACTIVE OUTPUT. (5).
IRIOINTEGER- LOGICAL UNIT FOR THE POLLUTANT AND
- WATER BODY DATABASE. (2).
IPLTINTEGER- LOGICAL UNIT FOR THE PLOT FILE. (1).
ISOLINTEGER- LOGICAL UNIT FOR THE INVISIBLE
- SOLAR INTENSITY FILE. (3).
INEWINTEGER- LOGICAL UNIT FOR THE REGRESSION
- COEFFICIENT FILE.
IHSNINTEGER- LOGICAL UNIT FOR THE VISIBLE SOLAR
- INTENSITY DATA. (7).

I. IDENTIFICATION

A. TITLE: DEPEND, ROUTINE TO COMPUTE PHOTOLYSIS RATES AND HALF-LIVES AS A FUNCTION OF TIME-OF-DAY.

B. SOURCE LANGUAGE: FORTRAN IV

C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976

D. REVISION:NONE

II. PURPOSE

FOR USER SELECTED DATES AND POSITIONS ON THE NORTHERN HEMISPHERE, THIS ROUTINE COMPUTES PHOTOLYSIS RATES AND HALF-LIVES FOR XENOBIOTICS IN WATERBODIES AS A FUNCTION OF TIME-OF-DAY.

III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: BLUE, CONVER, TIMEOD, TSLAM AND ZLAM.
C. COMMON STORAGE: INPT,IOUNIT
IV. USAGE
A. ENTRY POINT:DEPEND
B. CALLING SEQUENCE: CALL MIDDAY
C. INPUT ARGUMENTS:
THE FOLLOWING PARAMETERS ARE REQUIRED AND ARE TRANSMITTED TO THE SUBROUTINE VIA THE INPT COMMON BLOCK:
Q, MUSUBR, ABWAT, RIVER, EPPEST, DINIT,
DINC, DFINAL, SEASE, PNAME, WAVE, AVEOZO,
XLON, XX, NUMBER, ILATSW, ILATTM, ISEASW,
IKALAM, IWLAM AND IZLAM.
A DESCRIPTION OF THESE VARIABLES CAN BE FOUND IN THE BLOCK DATA DOCUMENTATION.
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE
V. ALGORITHM OR METHOD
GIVEN MOLAR EXTINCTION COEFFICIENTS OF THE POLLUTANT AT WAVE LENGTHS > 297.5 NM, THE ATTENTUATION COEFFICIENTS AND REFRACTIVE INDEX OF THE REACTION MEDIUM, THE QUANTUM YIELD FOR THE REACTION OF THE POLLUTANT, THE AVERAGE OZONE THICKNESS IN CM, THE LATITUDE AND LONGITUDE, THE SOLAR DECLINATION, THE SOLAR RIGHT ASCENSION, AND THE SIDEREAL TIME FOR THE DATE OF INTEREST, THE ROUTINE COMPUTES DIRECT PHOTOLYSIS RATES.
SEE DOCUMENTATION INTERNAL TO THE SUBROUTINE FOR MORE DETAIL AND THE FOLLOWING REFERENCE:
R. G. ZEPP AND D. M. CLINE, RATES OF DIRECT PHOTOLYSIS IN AQUATIC ENVIRONMENT. ENVIRONMENTAL SCIENCE AND TECHNOLOGY. 11:4. PP 359-366.(1977)

I. IDENTIFICATION
A. TITLE: GRAPH
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R ZEPP, FEB. 1976
D. REVISION: NONE
II. PURPOSE
THIS ROUTINE IS A SOFTWARE HOOK TO IMPLEMENT A PLOTTING PROCEDURE FOR THE KA-LAMBDA VALUES.
III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: NONE
C. COMMON STORAGE: NONE
IV. USAGE

A. ENTRY POINT: GRAPH
B. CALLING SEQUENCE:
CALL GRAPH(X1,S1)
C. INPUT ARGUMENTS:
X1REAL- ARRAY OF WAVELENGTHS
S1REAL- ARRAY OF KA-LAMBDA VALUES.
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE
V. ALGORITHM OR METHOD
NONE

I. IDENTIFICATION
A. TITLE: INPUT1, USER INTERFACE TO THE SOLAR PACKAGE.
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976
D. REVISION:NONE
II. PURPOSE
THIS ROUTINE SERVES AS THE PRIMARY INTERFACE BETWEEN THE USER AND THE SOLAR PACKAGE. THE USER SUPPLIES INPUT VALUES FOR THE CONDITIONS TO BE SIMULATED. THIS ROUTINE SUPPLIES DEFAULT VALUES IN THE EVENT THE USER DOES NOT SPECIFY THE NECESSARY PARAMETERS.
III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: NONE
C. COMMON STORAGE: INPT,IOUNIT
IV. USAGE
A. ENTRY POINT: INPUT1
B. CALLING SEQUENCE:
CALL INPUT1
C. INPUT ARGUMENTS:NONE
D. OUTPUT ARGUMENTS:
ALL ARE RETURNED VIA COMMON AND ARE SPECIFIC FOR THE TYPE OF SIMULATION SELECTED.
E. ERROR CONDITIONS AND RETURNS: NONE
V. ALGORITHM OR METHOD
THE COMMAND DRIVEN ROUTINE, INPUT1, USES AN INTERACTIVE COMPUTER TERMINAL TO PROMPT THE USER FOR INPUT AND, SUBSEQUENTLY, TO RECEIVE THE USER'S RESPONSE. WHENEVER THE USER IS PROMPTED, HE MAY RESPOND WITH THE COMMAND, HELP, TO GET A LISTING OF THE VALID COMMANDS. A FULL DESCRIPTION OF THE COMMANDS IS GIVEN IN THE USER'S MANUAL.

I. IDENTIFICATION
A. TITLE: MIDDAY, ROUTINE TO COMPUTE PHOTOLYSIS RATES AND HALF-LIVES.

B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976
D. REVISION:NONE

II. PURPOSE

FOR USER SELECTED SEASONS AND LATITUDES, THIS ROUTINE COMPUTES PHOTOLYSIS RATES AND HALF-LIVES FOR XENOBIOTICS IN WATERBODIES. THE COMPUTED VALUES ARE FOR MID-SEASON, MID-DAY CONDITIONS.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: CONVER,ZLAM
C. COMMON STORAGE: INPT,IOUNIT

IV. USAGE

A. ENTRY POINT:MIDDAY
B. CALLING SEQUENCE: CALL MIDDAY
C. INPUT ARGUMENTS:

THE FOLLOWING PARAMETERS ARE REQUIRED AND ARE TRANSMITTED TO THE SUBROUTINE VIA THE INPT COMMON BLOCK:

Q, MUSUBR, ABWAT, RIVER, EPPEST, DINIT,
DINC, DFINAL, SEASE, PNAME, WAVE, NUMBER,
ILATSW, ILATTM, IKALAM, ISEASW, IWLAM, AND
IZLAM.

A DESCRIPTION OF THESE VARIABLES CAN BE FOUND IN THE BLOCK DATA DOCUMENTATION.

D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD

GIVEN MOLAR EXTINCTION COEFFICIENTS OF THE POLLUTANT AT WAVE LENGTHS > 297.5 NM, THE ATTENTUATION COEFFICIENTS AND REFRACTIVE INDEX OF THE REACTION MEDIUM, THE QUANTUM YIELD FOR THE REACTION OF THE POLLUTANT AND THE AVERAGE OZONE THICKNESS IN CM FOR THE SEASON AND LATITUDE OF INTEREST, THE ROUTINE COMPUTES DIRECT PHOTOLYSIS RATES. SEE DOCUMENTATION INTERNAL TO THE SUBROUTINE FOR MORE DETAIL AND THE FOLLOWING REFERENCE:

R. G. ZEPP AND D. M. CLINE, RATES OF DIRECT PHOTOLYSIS IN AQUATIC ENVIRONMENT. ENVIRONMENTAL SCIENCE AND TECHNOLOGY. 11:4. PP 359-366.

I. IDENTIFICATION

A. TITLE: SOLAR MAIN PROGRAM FOR THE SOLAR PACKAGE.
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1977
D. REVISION: NONE

II. PURPOSE

THIS ROUTINE FUNCTIONS AS THE MAIN DRIVER FOR THE SOLAR

PACKAGE, INVOKING VARIOUS SUBROUTINES AS THEY ARE REQUIRED.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE

B. OTHER ROUTINES REQUIRED: BENNER, DEPEND, INPUT1, MIDDAY, DEPEND AND VIS.

C. COMMON STORAGE: INPT, IOUNIT, BLUEUE

IV. USAGE

A. ENTRY POINT: N/A

B. CALLING SEQUENCE: N/A

C. INPUT ARGUMENTS: N/A

D. OUTPUT ARGUMENTS: N/A

E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD

SUBROUTINE INPUT1 IS CALLED TO SOLICIT INPUT FROM THE USER TO DETERMINE WHAT FUNCTION IS TO BE PERFORMED. UPON RETURN FROM SUBROUTINE INPUT1, ONE OF THE OTHER SUBROUTINES IS CALLED TO EXECUTE THE FUNCTION REQUESTED BY THE USER.

I. IDENTIFICATION

A. TITLE: TABOUT, A FORTRAN IV ROUTINE TO PRINT AN IDENTIFICATION LINE AND ONE OR MORE LINES OF NUMERICAL QUANTITIES.

B. SOURCE LANGUAGE: FORTRAN IV

C. AUTHOR, DATE: D. CLINE AND R. ZEPP , FEB., 1976

D. REVISION: NONE

II. PURPOSE

TO PRINT AN IDENTIFICATION RECORD AND ONE OR MORE LINES OF NUMERICAL QUANTITIES DEPENDING UPON THE NUMBER OF QUANTITIES REQUESTED PER LINE. THIS ROUTINE IS USED TO OUTPUT VARIOUS TABLES ASSOCIATED WITH THE SOLAR PROGRAM.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE

B. OTHER ROUTINES REQUIRED: NONE

C. COMMON STORAGE: IOUNIT

IV. USAGE

A. ENTRY POINT: TABOUT

B. CALLING SEQUENCE: THE FORTRAN CALLING SEQUENCE IS:

CALL TABOUT(X,TITL,N)

C. INPUT ARGUMENTS:

XREAL - ARRAY OF NUMERICAL QUANTITIES TO BE PRINTED.

TITLREAL- A THREE CHARACTER TITLE INCLUDING CARRIAGE CONTROL

NINTEGER- TOTAL NUMBER OF NUMERICAL QUANTITIES TO BE PRINTED.

D. OUTPUT ARGUMENTS: NONE

E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD

I. IDENTIFICATION

A. TITLE: TIMEOD, ROUTINE TO COMPUTE THE TIME OF DAY

B. SOURCE LANGUAGE: FORTRAN IV

C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976

D. REVISION: NONE

II. PURPOSE

TO COMPUTE LOCAL TIME OF DAY AS A FUNCTION OF SOLAR ZENITH ANGLE, LATITUDE, LONGITUDE, AND EPHEMERIDE DATA. ALTERNATIVELY, THE TIME OF DAY FOR SOLAR NOON AND ITS CORRESPONDING SOLAR ZENITH ANGLE CAN BE COMPUTED.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE

B. OTHER ROUTINES REQUIRED: NONE

C. COMMON STORAGE: NONE

IV. USAGE

A. ENTRY POINT: TIMEOD

B. CALLING SEQUENCE:

CALL TIMEOD(THETA,X,UT,XLAT,XLON,ZZ)

C. INPUT ARGUMENTS:

THETAREAL

THETAREALSOLAR ZENITH ANGLE (INPUT IF ZZ NE 0.)

XREALARRAY OF EPHEMERIDE DATA

1-3SOLAR DECLINATION IN DEGREES, MIN, AND SEC

4-6RIGHT ASCENSION IN DEGREES, MINUTES, AND SEC.

7-9SIDEREAL TIME IN HOURS, MINUTES, AND SECONDS

XLATREALLATITUDE IN DECIMAL DEGREES

XLONREALLONGITUDE IN DECIMAL DEGREES

ZZREALIF 0, THEN DO SOLAR NOON COMPUTATIONS

IF 1, THEN DO STANDARD COMPUTATIONS

D. OUTPUT ARGUMENTS:

THETAREALIF ZZ = 1, SOLAR ZENITH ANGLE

UTREALARRAY CONTAINING THE MORNING AND AFTERNOON TIMES CORRESPONDING TO A GIVEN SOLAR ZENITH ANGLE, LATITUDE, LONGITUDE, AND EPHEMERIDE DATA.

E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD

GREEN HAS PRESENTED AN EXPRESSION FOR COMPUTING THE SOLAR ZENITH ANGLE OF THE SUN USING THE TIME OF DAY. THE EXPRESSION WAS REWRITTEN TO COMPUTE THE TIME OF DAY WHEN GIVEN A SOLAR ZENITH ANGLE, LATITUDE, LONGITUDE, AND EPHEMERIDE DATA. ALTERNATIVELY, THE SOLAR ZENITH ANGLE AND THE TIME OF DAY CORRESPONDING TO SOLAR NOON IS COMPUTED. GREEN'S SUBROUTINE WAS MODIFIED TO PERFORM THESE COMPUTATIONS.

REFERENCE: GREEN, ET AL, PHOTOCHEM. PHOTOBIOL. 19,251, (1974).

I. IDENTIFICATION

A. TITLE: TSLAM, ROUTINE TO COMPUTE H AND SN INTENSITY VALUES FOR THE VISIBLE SPECTRUM: 390-800 NM.

B. SOURCE LANGUAGE: FORTRAN IV

C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976

D. REVISION: NONE

II. PURPOSE

TO COMPUTE H, SKY INTENSITY FROM THE WHOLE SKY ON A HORIZONTAL SURFACE, AND SN, VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY FOR WAVELENGTHS IN THE RANGE OF 390 TO 800 NAMOMETERS.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE

B. OTHER ROUTINES REQUIRED: NONE

C. COMMON STORAGE: INPT

IV. USAGE

A. ENTRY POINT: TSLAM

B. CALLING SEQUENCE:

CALL TSLAM(OZAMT,SOLALT,WAV,H,SN,IERR)

C. INPUT ARGUMENTS:

OZAMTREALOZONE AMOUNT, CM.

SOLALTREALSOLAR ALTITUDE, DEGREES

WAVREALWAVE LENGTH IN NANOMETERS

D. OUTPUT ARGUMENTS:

H REALSKY INTENSITY FROM THE WHOLE SKY ON A HORIZONTAL SURFACE.

SNREALVERTICAL COMPONENT OF DIRECT SOLAR INTENSITY.

IERRINTEGERERROR FLAG

E. ERROR CONDITIONS AND RETURNS:

IERR- 0 - NORMAL RETURN

- 1 - INVALID WAVELENGTH

- 2 - INVALID SOLAR ALTITUDE

V. ALGORITHM OR METHOD

VALUES OF DIRECT AND SKY INTENSITY IN THE VISIBLE REGION (390-800 NM) WERE COMPUTED BY EQUATIONS THAT ARE DESCRIBED BY LEIGHTON ("PHOTOCHEMISTRY OF AIR POLLUTION", ACADEMIC PRESS, NEW YORK, N.Y., 1961,PP. 6-41).

SN = TSLAM * TALLAM * IOL * COSZ

H = G * (1 - TSLAM) * TALLAM * IOL *COSZ

IN THESE EQUATIONS, TSLAM IS THE ATMOSPHERIC TRANSMISSITIVITY RELATIVE TO SCATTERING AND DIFFUSION, TALLAM IS THE ATMOSPHERIC TRANSMISSIVITY AS AFFECTED BY ABSORPTION BY GASES, MAINLY OZONE, IOL IS EXTRATERRESTRAL SOLAR IRRADIANCE, Z IS SOLAR ZENITH ANGLE AND G IS THE FRACTION OF SCATTERED SUNLIGHT THAT IS IN THE FOWARD DIRECTION. IN THESE COMPUTATIONS G IS ASSUMED EQUAL TO 0.5. TSLAM IS COMPUTED BY EQUATIONS

II-9 AND II-11 IN LEIGHTON, TALLAM IS CALCULATED BY EQ II-13, IN LEIGHTON, AND VALUES OF IOL WERE TAKEN FROM JOHNSONS'S DATA (J. METEROL., 11,431(1954).

I. IDENTIFICATION
A. TITLE: VIS, ROUTINE FOR PRODUCING SOLAR INTENSITY TABLES IN THE RANGE OF 390 - 800 NANOMETERS.
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976
D. REVISION: NONE

II. PURPOSE
THE ROUTINE GENERATES TABULAR VALUES OF SOLAR INTENSITIES IN THE RANGE OF 390 TO 800 NANOMETERS. THE TABLES ARE USED TO VERIFY THE OPERATION OF THE TSLAM SUBROUTINE. SKY INTENSITIES FROM THE WHOLE SKY ON A HORIZONTAL SURFACE (H) AND THE VERTICAL COMPONENT OF DIRECT SOLAR INTENSITY (SN) ARE PRODUCED AS A FUNCTION OF SOLAR ALTITUDE, OZONE AMOUNT, AND WAVE LENGTH.

III. RESTRICTIONS
A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: TABOUT,TSLAM
C. COMMON STORAGE: INPT,IOUNIT

IV. USAGE
A. ENTRY POINT: VIS
B. CALLING SEQUENCE: CALL VIS
C. INPUT ARGUMENTS: NONE
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD
VIS VARIES THE VALUES OF SOLAR ALTITUDE, OZONE AMOUNT, AND WAVELENGTH WHILE MAKING CALLS TO TSLAM. SUBROUTINE TSLAM PERFORMS THE ACTUAL COMPUTATIONS OF THE SOLAR INTENSITIES.

I. IDENTIFICATION
A. TITLE: ZLAM, ROUTINE TO PRINT Z-LAMBDA AND W-LAMBDA TABLES
B. SOURCE LANGUAGE: FORTRAN IV
C. AUTHOR, DATE: D. CLINE AND R. ZEPP, FEB. 1976
D. REVISION: NONE

II. PURPOSE
TO PRODUCE TABLES OF Z-LAMBDA AND W-LAMBDA INTENSITY VALUES AS A FUNCTION OF SEASON, LATITUDE, AND WAVE-LENGTH. AN ADDITIONAL TABLE IS PRINTED THAT CONTAINS Z-LAMBDA AND W-LAMBDA VALUES FOR THE SUMMER SEASON FOR LATITUDES 0, 40, AND 70.

III. RESTRICTIONS

A. MACHINE DEPENDENCY: NONE
B. OTHER ROUTINES REQUIRED: NONE
C. COMMON STORAGE: INPT,IOUNIT

IV. USAGE

A. ENTRY POINT: ZLAM
B. CALLING SEQUENCE:
CALL ZLAM(TABLE)
C. INPUT ARGUMENTS:
TABLEREAL- ARRAY OF SIZE (39,4,10) THAT REPRESENTS
- THE 39 WAVELENGTHS,THE 4 SEASONS, AND
- THE 10 LATITUDES
IZLAMINTEGER- ARGUMENT IN COMMON, IF EQUAL TO 0,
- THEN W-LAMBDA TABLES ARE GENERATED; IF
- EQUAL TO UNITY, THE Z-LAMBDA TABLES ARE
- PRINTED.
D. OUTPUT ARGUMENTS: NONE
E. ERROR CONDITIONS AND RETURNS: NONE

V. ALGORITHM OR METHOD

THIS ROUTINE SIMPLY PRINTS THE INPUT DATA IN A TABULAR FORM. THE APPROPRIATE HEADING IS SELECTED AS A FUNCTION IZLAM. NOTE! ALL SEASONS, LATITUDES, AND WAVELENGTHS SHOULD BE SELECTED TO GET A FULL TABLE OF VALUES. FOR DEFINITIONS OF Z-LAMBDA AND W-LAMBDA, SEE ZEPP AND CLINE (ENVIRONMENTAL SCIENCE AND TECHNOLOGY. 11:4. PP 359-366(1977))