

## 4. USER'S INSTRUCTIONS

### 4.1 OPTHILL

When the subgrid scale complex terrain (CTSG) option of the CALPUFF model is invoked, two groups of additional data must be prepared by the user and entered into the CALPUFF control file: non-gridded receptor information and sub-grid scale terrain information. The purpose of the optimizer program OPTHILL is to provide the user with the means for calculating the set of terrain data that best characterizes each feature.

#### 4.1.1 CTSG Terrain Information

CTSG requires information on the location, orientation, size, and shape of each terrain feature being modeled (see Section 4.2.1). The variables that provide this information are:

xc,yc	coordinates (km) of the center of the hill
thetah	orientation (deg) of major axis of hill (clockwise from north)
zgrid	height (m) of "zero-plane" of grid above mean sea level
relief	height (m) of crest of hill above the "zero-plane" elevation
expo (1)	hill-shape exponent for major axis
expo (2)	hill-shape exponent for minor axis
scale(1)	horizontal length scale (m) along major axis
scale(2)	horizontal length scale (m) along minor axis
axmax(1)	maximum allowed axis length (m) for major axis
axmax(2)	maximum allowed axis length (m) for minor axis

The profile of the terrain along each axis of the feature is prescribed by the following equation:

$$ht(x) = \left[ \frac{1 - (x/axmax)^{expo}}{1 + (x/scale)^{expo}} \right] * relief \quad (4.1-1)$$

where ht is the height of the profile above the base of the feature, at a distance x from the peak (Figure 4.1-1).

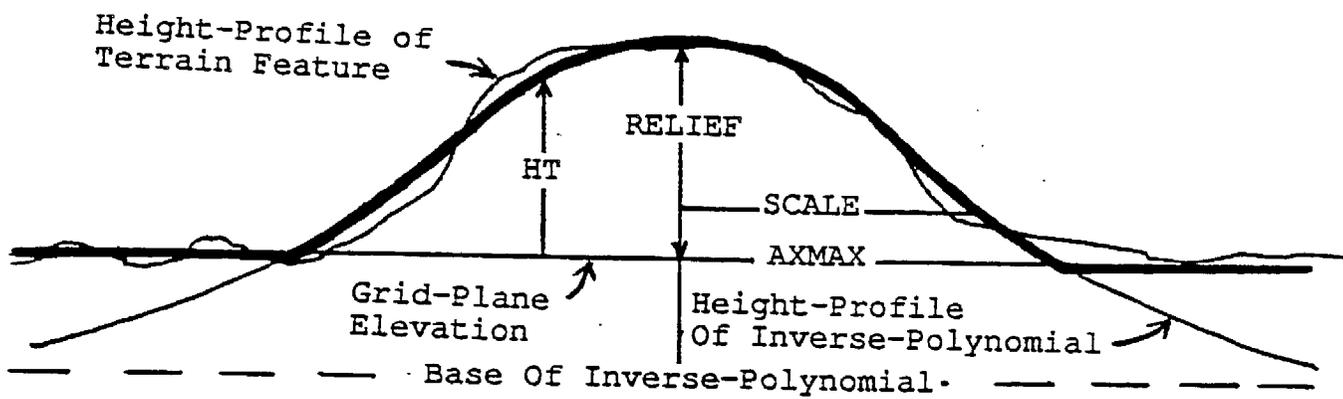


Figure 4.1-1. Profile of a terrain feature along one of its two axes. A best-fit inverse polynomial function describes this profile to CTSG.

The terrain profile-optimizing program (OPHILL) is provided to compute the hill shape exponent (EXPO) and horizontal terrain length scale (SCALE) parameters from a user-entered terrain profile. The OPHILL program performs computations for one axis (i.e., major or minor axis) of the terrain feature at a time. Therefore, two runs of OPHILL are necessary for each subgrid scale terrain feature.

The following procedure is recommended to determine the terrain inputs for the CALPUFF CTSG algorithm.

- a. Identify the sub-grid terrain features to be modeled.

Such features will generally be small enough that they could be contained within one grid-square. This does not mean that they cannot straddle two or more squares. The features should be prominent, and possibly lie near source regions so that the additional computations required by CTSG are warranted in resolving important pollutant impact areas.

- b. Decide on the orientation of the feature.

The orientation of the feature is generally evident if the feature is longer in one direction than another. If there is no dominant direction to the feature, model it as a symmetric feature, and choose an orientation of north.

- c. Obtain height-profiles along each axis of the feature.

Choose an approximate center for the feature and draw axes through it (one axis should lie along the direction of orientation). Along each axis, measure the distance between approximate intersections of the axis with marked contours. The distances so measured should extend from the contour furthest to the south to the same contour furthest to the north (for a north-south axis). Divide each of these distances by two, and tabulate the results.

- d. Identify the total elevation of the feature.

Take the peak elevation directly from the map.

- e. Identify the elevation at the base of the feature.

Generally, the base of the feature will be that point at which the feature becomes indistinguishable from terrain variations around it.

- f. Convert all elevations that were tabulated to heights above the base of the feature.
- g. Use optimizer program (OPHILL) to obtain shape parameters.

The "relief" parameter is just the peak elevation less the base elevation. The "axmax" value for each axis should be representative of the maximum extent of the feature along each axis at the elevation of the base of the feature. With these two variables fixed for each axis, the height-profile data from step c. can be put through OPHILL to obtain "expo" and "scale" for each axis.

OPHILL requires a single input file (OPHILL.INP) which contains the user's inputs describing the terrain profile, each height, and maximum axis length. The computed volumes of EXPO and SCALE for one axis of the hill are listed in the output list file (OPHILL.LST). Table 4.1-1 summarizes the OPHILL input and output file contents. The format and contents of the OPHILL control file are variables explained in Table 4.1-2.

#### 4.1.2 Example OPHILL Application

The OPHILL program is an optimization that takes a value of "relief" and "axmax," and a sequence of pairs of (x,ht) values along an axis, and returns a value of "expo" and "scale" that prescribes the profile function that best matches the (x,ht) pairs. Its use is illustrated by the following example.

Table 4.1-1  
OPHILL Input and Output Files

<u>Unit</u>	<u>File Name</u>	<u>Type</u>	<u>Format</u>	<u>Description</u>
5	OPHILL.INP	input	formatted	Control file containing user inputs
6	OPHILL.LST	output	formatted	List file (line parameter output file)

Table 4.1-2  
 OPTHILL Control File Inputs (OPTHILL.INP)

<u>Record</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Columns</u>	<u>Type of Format</u>	<u>Description</u>
1	1	TITLE(15)	1-60	15A4	60 character title
2	1	RELIEF	*	real	Height (m) of the crest of the hill above the grid elevation
3	1	AXMAX	*	real	Maximum allowed axis length (m) for the axis (major or minor) being evaluated
4	1	-	*	-	This record is skipped by the program. May contain optional text data
(Record repeated for each distance-height pair)					
5	1	DIST	*	real	Distance-height pairs describing the profile of the terrain. Units: m
5	2	HGT	*	real	

---

\* Entered in Fortran free format.

Figure 4.1-2 shows the terrain surrounding the site of EPA's "Full-Scale Plume Study" (FSPS) that was performed in the Truckee River Valley near Reno, NV, as part of the Complex Terrain Model Development Program. Nocturnal flow in this valley is frequently channeled by the high terrain to the north and south of the Tracy power plant. Elevations typical of nocturnal plume heights (4600-4800 ft. MSL) are emphasized on the figure. Given the predominant flow to the east during stable conditions, there is potential for plume impact on the feature just northeast of the plant. This feature, marked by axes in Figure 4.1-2, was named "Beacon Hill" during the study.

Following the procedures outlined above, axes were drawn over the feature and distances between fixed contour elevations were tabulated. After subtracting the elevation above sea level of the base of the feature (the floor of the river valley), these data were entered into two files. Figure 4.1-3 displays the contents of both files. The files (names axis1.inp and axis2.inp) contain "relief" and the value for "axmax" for each axis of the hill, followed by five pairs of (x,ht) values. The first record of each file is reserved for comments to identify the data. Values for "relief" and "axmax" are free-format, and should be entered anywhere in the open space provided on the next two lines. Pairs of (x,ht) should be entered right after the next comment record.

OPHILL must be invoked separately for each of the two axes of the hill. This is accomplished by renaming one input file (e.g., axis1.inp) to the OPHILL input control file name (OPHILL.INP), executing the program, renaming the output file (OPHILL.LST) to a new name (e.g., axis1.lst), and then repeating these steps for the second axis of the hill. The output files produced by OPHILL for the current example are presented in Figure 4.1-4 and 4.1-5. The output file lists the final values of the profile parameters, and it also lists the profile data provided by the user along with the corresponding data computed from the profile parameters.

With these results, hill information that is independent of the choice of coordinate system and the modeling grid for the wind model can be specified:

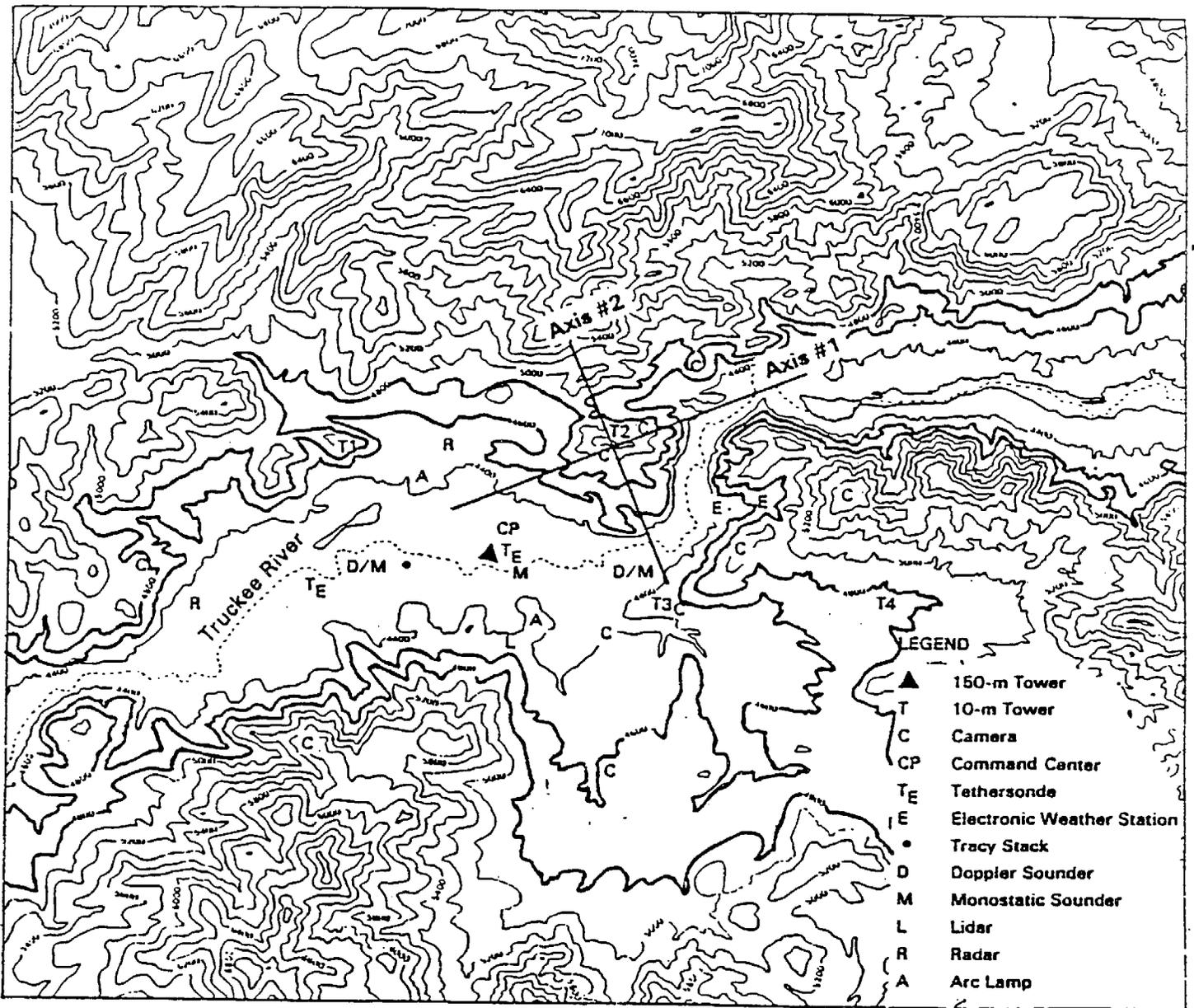


Figure 4.1-2. Map of terrain surrounding the site of the FSPS, illustrating the selection and characterization of a terrain feature for CTSG modeling.

```

Optimal SCALE and EXPO factors -- Axis #1 of example problem
300.          - Height (m) of hill crest above "zero-plane" elevation (RELIEF)
2000.         - Maximum allowed length (m) for this axis (AXMAX)
----- Distance-height pairs describing hill profile -----
564., 239.   - Dist.(m) from crest, terrain ht (m) above "zero-plane" elev.
826., 178.   (Repeated for each dist.-height pair)
1062., 150.
1193., 117.
1508., 56.

```

(a) OPTHILL.INP for Axis #1 of the hill.

```

Optimal SCALE and EXPO factors -- Axis #2 of example problem
300.          Height (m) of hill crest above "zero-plane" elevation (RELIEF)
1500.         Maximum allowed length (m) for this axis (AXMAX)
----- Distance-height pairs describing hill profile -----
302., 239.   - Dist.(m) from crest, terrain ht (m) above "zero-plane" elev.
551., 178.   (Repeated for each dist.-height pair)
708., 150.
970., 117.
1311., 56.

```

(b) OPTHILL.INP for Axis #2 of the hill.

Figure 4.1-3. Sample OPTHILL input files for (a) Axis #1 and (b) Axis #2 of the hill is in the example.

\*\*\* Optimal SCALE and EXPO factors -- Axis #1 of example problem \*\*\*

EVOL TIME LIMIT= 60. SECONDS SKIP= 10

NUMBER OF PARAMETERS FOR THIS STUDY : 4

PARAMETER	START VALUE	STEP CONTROL	LOWER LIMIT	UPPER LIMIT
1 RELIEF	0.3000E+03	0.0000E+00	0.3000E+03	0.3000E+03
2 AXMAX	0.2000E+04	0.0000E+00	0.2000E+04	0.2000E+04
3 EXPO	0.2000E+01	0.2000E+01	0.1000E+00	0.1000E+02
4 SCALE	0.2000E+04	0.1000E+04	0.2000E+02	0.2000E+06

CALCULATIONS STARTED

RETURN VALUE: 2      NORMAL RETURN

FUNCTION VALUE:      0.50303

PARAMETER VALUES:

RELIEF	=	300.00000
AXMAX	=	2000.00000
EXPO	=	1.90651
SCALE	=	1522.94500

Distance	Height	Fitted Value
564.0	239.0	237.4
826.0	178.0	186.4
1062.0	150.0	139.9
1193.0	117.0	115.5
1508.0	56.0	63.0

Figure 4.1-4. Content of output file produced by OPTHILL in processing axis #1 of sample hill.

\*\*\* Optimal SCALE and EXPO factors -- Axis #2 of example problem \*\*\*

EVOL TIME LIMIT= 60. SECONDS SKIP= 10

NUMBER OF PARAMETERS FOR THIS STUDY : 4

PARAMETER	START VALUE	STEP CONTROL	LOWER LIMIT	UPPER LIMIT
1 RELIEF	0.3000E+03	0.0000E+00	0.3000E+03	0.3000E+03
2 AXMAX	0.1500E+04	0.0000E+00	0.1500E+04	0.1500E+04
3 EXPO	0.2000E+01	0.2000E+01	0.1000E+00	0.1000E+02
4 SCALE	0.1500E+04	0.7500E+03	0.1500E+02	0.1500E+06

CALCULATIONS STARTED

RETURN VALUE: 2      NORMAL RETURN

FUNCTION VALUE:                      2.17504

PARAMETER VALUES:

RELIEF = 300.00000  
AXMAX = 1500.00000  
EXPO = 1.23912  
SCALE = 2895.90200

Distance	Height	Fitted Value
302.0	239.0	244.0
551.0	178.0	189.1
708.0	150.0	154.7
970.0	117.0	99.5
1311.0	56.0	33.5

Figure 4.1-5. Content of output file produced by OPTHILL in processing axis #2 of sample hill.

xc,yc (m)	(depends on choice of coordinates)
thetah (deg)	69°
zgrid (m)	(depends on grid for wind model)
relief (m)	300.
expo (1)	1.91
expo (2)	1.24
scale (1) (m)	1523.
scale (2) (m)	2896.
axmax (1) (m)	2000.
axmax (2) (m)	1500.

Note that scale(2) is almost twice scale(1), even though axis 1 corresponds to the longer axis of the hill. This can occur because the "scale" parameter is a property of the entire inverse-polynomial function (Equation 4.1-1), rather than just the portion of the function that is fit to the profile of the terrain. In Figure 4.1-1, the shape of the terrain might best conform to the upper 10% of the polynomial function, in which case the "scale" parameter would exceed "axmax." In this example application of the OPTHILL program, we see that axmax(2) is substantially less than axmax(1), whereas scale(2) exceeds scale(1), indicating that a comparatively smaller portion of the polynomial function represents the terrain profile along the minor axis.

## 4.2 CALPUFF Model Input Files

### 4.2.1 User Control File (CALPUFF.INP)

The selection and control of CALPUFF options are determined by user-specified inputs contained in a file called the control file. This file, CALPUFF.INP, contains all the information necessary to define a model run (e.g., starting date, run length, grid specifications, technical options, output options, etc.).

It is designed to be flexible and easy-to-use. The control file is read by a set of Fortran text processing routines contained within CALPUFF which allow the user considerable flexibility in designing and customizing the input file. An unlimited amount of optional descriptive text can be inserted within the control file to make it self-documenting. For example, the definition, allowed values, units, and default value of each input variable can be included within the control file.

The control file processor searches for pairs of special delimiter characters (!). All text outside the delimiters is assumed to be user comment information and is echoed back but otherwise ignored by the input module. Only data within the delimiter characters is processed. The input data consists of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5 !). The variable name can be lower or upper case, or a mixture of both (i.e., XX, xx, Xx are all equivalent). The variable can be a real, integer or logical array or scalar. The use of repetition factors for arrays is allowed (e.g., ! XARRAY = 3 \* 1.5 ! instead of ! XARRAY = 1.5, 1.5, 1.5 !). Different values must be separated by commas. Spaces within the delimiter pair are ignored. Exponential notation (E format) for real numbers is allowed. However, the optional plus sign should be omitted (e.g., enter +1.5E+10 as 1.5E10). The data may be extended over more than one line. The line being continued must end with a comma. Each leading delimiter must be paired with a terminating delimiter. All text between the delimiters is assumed to be data, so no user comment information is allowed to appear

within the delimiters. The inclusion in the control file of any variable that is being assigned its default value is optional.

The control file is organized into 15 major Input Groups and a variable number of subgroups within several of the major Input Groups. The first three lines of the input file consist of a run title. As shown in Table 4.2.1, the major Input Groups are defined along functional lines (e.g., technical options, output options, subgrid scale, complex terrain inputs, etc.). Each subgroup contains a set of data such as source variables, subgrid scale hill descriptions, or discrete receptor information. The number of subgroups varies with the number of sources, hills, etc., in the model run.

The major Input Groups must appear in order, i.e., Input Group 1 followed by Input Group 2, etc. However, the variables within an Input Group may appear in any order. The variable names in each Input Group are independent, so that the same name can be repeated in different Input Groups (e.g., as shown in the sample control file, species names (SO<sub>2</sub>, SO<sub>4</sub>) are used in several Input Groups). Each Input Group and subgroup must end with an Input Group terminator consisting of the word END between two delimiters (i.e., !END!). Every major Input Group, even blank Input Groups (i.e., one in which no variables are included) must end with an Input Group terminator in order to signal the end of that Input Group and the beginning of another.

The control file module has a list of variable names and array dimensions for each Input Group. Checks are performed to ensure that the proper variable names are used in each Input Group, and that no array dimensions are exceeded. Error messages result if an unrecognized variable name is encountered or too many values are entered for a variable.

A standard control file is provided along with the CALPUFF test case run as shown in Figure 4.2.1. It is recommended that a copy of the standard control file be permanently stored as a backup. Working copies of the control file may be made and then edited and customized by the user for a particular application.

Table 4.2.1. Input Groups in the CALPUFF Control File

<u>Input Group</u>	<u>Description</u>
*	Run title First three lines of control file (up to 80 characters/line)
1	General run control parameters Starting date and hour, run length, time step. Number of species.
2	Technical options Control variables determining methods for treating chemistry, wet deposition, dry deposition, dispersion, plume rise, complex terrain, and near-field puff sampling methods
3	Species list Species names, flags for determining which species are modeled, advected, emitted, and dry deposited
4	Grid control parameters Specification of meteorological, computational, and sampling grids, number of cells, vertical layers, and reference coordinates.
5	Output options Printer control variables, disk output control variables
6a,b,c	Subgrid scale complex terrain (CTSG) inputs Information describing subgrid scale hill location, shape and height. Complex terrain receptor locations and elevations.
7	Dry deposition parameters - Gases Pollutant diffusivity, dissociation constant, reactivity, mesophyll resistance, Henry's law coefficient
8	Dry deposition parameters - Particles Geometric mass mean diameter, geometric standard deviation

Table 4.2.1. Input Groups in the CALPUFF Control File - Concluded

<u>Input Group</u>	<u>Description</u>
9	Miscellaneous dry deposition parameters Reference cuticle and ground resistances, reference pollutant reactivity, vegetation state
10	Wet deposition parameters Scavenging coefficients for each pollutant and precipitation type (liquid and frozen precipitation)
11	Chemistry parameters Control variables for input of ozone data, background ozone and ammonia concentrations, nighttime transformation rates
12	Dispersion parameters Vertical dispersion constants, dispersion rate above the boundary layer, crossover distance to time-dependent dispersion coefficients, land use associated with urban dispersion
13a, b, c	Point source parameters Point source data including source location, stack parameters and emissions, and building dimensions
14a, b	Area source parameters Area source data including source location, effective height, elevation, initial sigmas and emission rates
15a, b	Non-gridded (discrete) receptor information Receptor coordinates and ground elevation

CALPUFF test run -- 2 hour simulation  
10 x 10 meteorological grid  
2 point sources

----- Run title (3 lines) -----

CALPUFF MODEL CONTROL FILE  
-----

-----  
INPUT GROUP: 1 -- General run control parameters  
-----

Starting date: Year (IBYR) -- No default ! IBYR=80 !  
Month (IBMO) -- No default ! IBMO=07 !  
Day (IBDY) -- No default ! IBDY=01 !  
Hour (IBHR) -- No default ! IBHR=00 !  
  
Length of run (hours) (IRLG) -- No default ! IRLG=2 !  
  
Number of chemical species (NSPEC)  
Default: 5 ! NSPEC=1 !  
  
Number of chemical species  
to be emitted (NSE) Default: 3 ! NSE=1 !

!END!

-----  
INPUT GROUP: 2 -- Technical options  
-----

Vertical distribution used in the  
near field (MGAUSS) Default: 1 ! MGAUSS = 1 !  
0 = uniform  
1 = Gaussian  
  
Subgrid-scale complex terrain  
flag (MCTSG) Default: 0 ! MCTSG = 0 !  
0 = not modeled  
1 = modeled  
  
Near-field puffs modeled as  
elongated "slugs" ? (MSLUG) Default: 1 ! MSLUG = 1 !  
0 = no  
1 = yes (slug model used)

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 1 and 2.

```

Transitional plume rise modeled ?
(MTRANS)                Default: 1    ! MTRANS= 0 !
    0 = no (i.e., final rise only)
    1 = yes (i.e., transitional rise computed)

Chemical mechanism flag (MCHEM)    Default: 1    ! MCHEM = 1 !
    0 = chemical transformation not
        modeled
    1 = transformation rates computed
        internally (MESOPUFF II scheme)
    2 = user-specified transformation
        rates used

Wet removal modeled ? (MWET)      Default: 1    ! MWET = 1 !
    0 = no
    1 = yes

Dry deposition modeled ? (MDRY)    Default: 1    ! MDRY = 1 !
    0 = no
    1 = yes
    (dry deposition method specified
     for each species in Input Group 3)

Method used to compute dispersion
coefficients (MDISP)              Default: 3    ! MDISP = 3 !

    1 = dispersion coefficients computed from values of
        sigma u, sigma w read from SIGMA.DAT file
    2 = dispersion coefficients sigma u, sigma w computed
        internally from micrometeorological variables (u*, w*, L, etc.)
    3 = PGT dispersion coefficients for RURAL areas (computed using
        the ISCST multi-segment approximation) and MP coefficients in
        URBAN areas
    4 = same as 3 except PGT coefficients computed using
        the MESOPUFF II eqns.

```

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 2 concluded.

-----  
INPUT GROUP: 3 -- Species list  
-----

SPECIES NAME	MODELED (0=NO, 1=YES)	EMITTED (0=NO, 1=YES)	DRY	
			DEPOSITED (0=NO, 1=COMPUTED-GAS 2=COMPUTED-PARTICLE 3=USER-SPECIFIED)	

BUILD-UP SPECIES

! SO2	= 1	,	1	,	0	!
! SO4	= 0	,	0	,	0	!
! NOX	= 0	,	0	,	0	!
! HNO3	= 0	,	0	,	0	!
! NO3	= 0	,	0	,	0	!

!END!

-----  
INPUT GROUP: 4 -- Grid control parameters  
-----

METEOROLOGICAL GRID:

No. X grid cells (NX)	No default	! NX=10 !
No. Y grid cells (NY)	No default	! NY=10 !
No. vertical layers (NZ)	No default	! NZ= 5 !
Grid spacing (DGRIDKM)	No default	! DGRIDKM=4.0 !
	Units: km	
Cell face heights (ZFACE(nz+1))	No defaults	
	Units: m	

! ZFACE = 0.0, 20.0, 180., 420., 780., 1220. !

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 3 and 4.

Reference coordinates  
of SOUTHWEST corner of  
grid point (1,1):

X coordinate (XORIGKM) No default ! XORIGKM= 168.000 !  
Y coordinate (YORIGKM) No default ! YORIGKM=3839.000 !  
Units: km

UTM zone (IUTMZN) No default ! IUTMZN= 11 !

Reference coordinates of CENTER  
of the domain (used in the  
calculation of solar elevation  
angles)

Latitude (deg.) (XLAT) No default ! XLAT = 34.0 !  
Longitude (deg.) (XLONG) No default ! XLONG = 118.0 !  
Time zone (XTZ) No default ! XTZ = 8. !  
(PST=8, MST=7, CST=6, EST=5)

#### COMPUTATIONAL GRID:

The computational grid is identical to or a subset of the MET. grid.  
The lower left (LL) corner of the computational grid is at grid point  
(IBCOMP, JBCOMP) of the MET. grid. The upper right (UR) corner of the  
computational grid is at grid point (IECOMP, JECOMP) of the MET. grid.  
The grid spacing of the computational grid is the same as the MET. grid.

X index of LL corner (IBCOMP) No default ! IBCOMP = 1 !  
(1 <= IBCOMP <= NX)

Y index of LL corner (JBCOMP) No default ! JBCOMP = 1 !  
(1 <= JBCOMP <= NY)

X index of UR corner (IECOMP) No default ! IECOMP = 10 !  
(1 <= IECOMP <= NX)

Y index of UR corner (JECOMP) No default ! JECOMP = 10 !  
(1 <= JECOMP <= NY)

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 4 continued.

SAMPLING GRID (GRIDDED RECEPTORS):

The lower left (LL) corner of the sampling grid is at grid point (IBSAMP, JBSAMP) of the MET. grid. The upper right (UR) corner of the sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid. The sampling grid must be identical to or a subset of the computational grid. It may be a nested grid inside the computational grid. The grid spacing of the sampling grid is DGRIDKM/MESH DN.

Logical flag indicating if gridded receptors are used (LSAMP)      Default: T      ! LSAMP = T !  
 (T=yes, F=no)

X index of LL corner (IBSAMP)      No default      ! IBSAMP = 1 !  
 (IBCOMP <= IBSAMP <= IECOMP)

Y index of LL corner (JBSAMP)      No default      ! JBSAMP = 1 !  
 (JBCOMP <= JBSAMP <= JECOMP)

X index of UR corner (IESAMP)      No default      ! IESAMP = 10 !  
 (IBCOMP <= IESAMP <= IECOMP)

Y index of UR corner (JESAMP)      No default      ! JESAMP = 10 !  
 (JBCOMP <= JESAMP <= JECOMP)

Nesting factor of the sampling grid (MESH DN)      No default      ! MESH DN = 1 !  
 (MESH DN is an integer >= 1)

!END!

-----

INPUT GROUP: 5 -- Output Options

-----

FILE	DEFAULT VALUE	VALUE THIS RUN
----	-----	-----
Concentrations (ICON)	1	! ICON = 0 !
Dry Fluxes (IDRY)	1	! IDRY = 0 !
Wet Fluxes (IWET)	1	! IWET = 0 !

\*  
 0 = Do not create file, 1 = create file

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP). Input Group 4 concluded and Input Group 5.

LINE PRINTER OUTPUT OPTIONS:

```

Print concentrations (ICPRT)   Default: 0      ! ICPRT = 1 !
Print dry fluxes (IDPRT)     Default: 0      ! IDPRT = 0 !
Print dry fluxes (IWPRT)     Default: 0      ! IWPRT = 0 !
(0 = Do not print, 1 = Print)

Concentration print interval
(ICFRQ) in hours             Default: 1      ! ICFRQ = 1 !
Dry flux print interval
(IDFRQ) in hours             Default: 1      ! IDFRQ = 1 !
Wet flux print interval
(IWFRQ) in hours             Default: 1      ! IWFRQ = 1 !

Messages tracking progress of run written to the screen ?
(IMESG) -- 0=no, 1=yes

Fortran unit for screen output Default: 0      ! IOMESG = 0 !
(IOMESG)

```

SPECIES LIST FOR OUTPUT OPTIONS

SPECIES NAME	----- CONCENTRATIONS -----		----- DRY FLUXES -----		----- WET FLUXES -----	
	PRINTED ?	SAVED ON DISK ?	PRINTED ?	SAVED ON DISK ?	PRINTED ?	SAVED ON DISK ?
! SO2 =	1	1	0	0	0	0
! SO4 =	0	0	0	0	0	0
! NOX =	0	0	0	0	0	0
! HNO3 =	0	0	0	0	0	0
! NO3 =	0	0	0	0	0	0

!END!

-----  
INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs  
-----

-----  
Subgroup (6a)  
-----

```

Number of terrain features (NHILLS)   Default: 0      ! NHILLS = 2 !

Number of special complex terrain
receptors (NCTRECS)                   Default: 0      ! NCTRECS = 5 !

```

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 5 concluded and Input Group 6.

-----  
Subgroup (6b)  
-----

1 \*\*

HILL INFORMATION

HILL NO.		XC (km)	YC (km)	THETAH (deg.)	ZGRID (m)	RELIEF (m)	EXPO 1 (m)	EXPO 2 (m)	SCALE 1 (m)	SCALE 2 (m)	AMAX1 (m)	AMAX2 (m)		
1	! HILL =	2.5	2.0	69.	1310.	300.	1.91	1.24	1523.	2896.	2000.	1500.	! !	! !
2	! HILL =	5.0	0.0	46.	1310.	230.	1.50	1.50	3000.	1000.	4000.	2000.	! !	! !

-----  
Subgroup (6c)  
-----

1 \*\*

COMPLEX TERRAIN RECEPTOR INFORMATION

	XRCT (km)	YRCT (km)	ZRCT (m)	IHH		
! CTREC =	2.5	1.0	1430.	1	! !	! !
! CTREC =	1.0	1.5	1430.	1	! !	! !
! CTREC =	2.5	2.0	1580.	1	! !	! !
! CTREC =	5.0	0.0	1525.	2	! !	! !
! CTREC =	4.5	0.0	1430.	2	! !	! !

1

Description of Complex Terrain Variables:

- XC, YC = Coordinates of center of grid (met. grid units)
- THETAH = Orientation of major axis of hill (clockwise from North)
- ZGRID = Height of the "zero-plane" of the grid above mean sea level
- RELIEF = Height of the crest of the hill above the grid elevation
- EXPO 1 = Hill-shape exponent for the major axis
- EXPO 2 = Hill-shape exponent for the minor axis
- SCALE 1 = Horizontal length scale along the major axis
- SCALE 2 = Horizontal length scale along the minor axis
- AMAX = Maximum allowed axis length for the major axis
- BMAX = Maximum allowed axis length for the minor axis

- XRCT, YRCT = Coordinates of the complex terrain receptors
- ZRCT = Height of the ground (MSL) at the complex terrain receptor
- IHH = Hill number associated with each complex terrain receptor

\*\*

NOTE: Data for each hill and CTSG receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 6 concluded.

-----  
INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases  
-----

SPECIES NAME	DIFFUSIVITY (cm**2/s)	ALPHA STAR	REACTIVITY	MESOPHYLL RESISTANCE (s/cm)	HENRY'S LAW COEFFICIENT (dimensionless)
! SO2 =	0.1509	, 1.00E3	, 8.0	, 0.0	, 4.e-2 !
! NOX =	0.1656	, 1.00	, 8.0	, 5.0	, 3.5 !
! HNO3 =	0.1628	, 1.00	, 18.0	, 0.0	, 8.e-8 !

!END!

-----  
INPUT GROUP: 8 -- Size parameters for dry deposition of particles  
-----

SPECIES NAME	GEOMETRIC MASS MEAN DIAMETER (microns)	GEOMETRIC STANDARD DEVIATION (microns)
! SO4 =	0.48	, 2.00 !
! NO3 =	0.48	, 2.00 !

!END!

-----  
INPUT GROUP: 9 -- Miscellaneous dry deposition parameters  
-----

Reference cuticle resistance (RCUTR) (s/cm) ! RCUTR=17.0 !  
Reference ground resistance (RGR) (s/cm) ! RGR= 5.0 !  
Reference pollutant reactivity (REACTR) ! REACTR= 8.0 !

Vegetation state in unirrigated areas (IVEG) ! IVEG=1 !  
IVEG=1 for active and unstressed vegetation  
IVEG=2 for active and stressed vegetation  
IVEG=3 for inactive vegetation

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Groups 7, 8, and 9.

-----  
INPUT GROUP: 10 -- Wet Deposition Parameters  
-----

-1

Scavenging Coefficient -- Units: (sec)

Pollutant		Liquid Precip.		Frozen Precip.	
! SO2	=	3.0e-5	,	0.0	!
! SO4	=	10.0e-5	,	3.0e-5	!
! NOX	=	0.0	,	0.0	!
! HNO3	=	6.0e-5	,	0.0	!
! NO3	=	10.0e-5	,	3.0e-5	!

!END!

-----  
INPUT GROUP: 11 -- Chemistry Parameters  
-----

Ozone data input option (MOZ)      Default: 1                      ! MOZ = 1 !  
(Used only if MCHM = 1)  
  0 = use a constant background ozone value  
  1 = read hourly ozone concentrations from  
      the OZONE.DAT data file

Background ozone concentration  
(BCKO3) in ppb                      Default: 80.                      ! BCKO3 = 80. !  
(Used only if MCHM = 1 and  
MOZ = 0 or (MOZ = 1 and all hourly

Background ammonia concentration  
(BCKNH3) in ppb                      Default: 10.                      ! BCKNH3 = 10. !

Nighttime SO2 loss rate (RNITE1)  
in percent/hour                      Default: 0.2                      ! RNITE1 = 0.2 !

Nighttime NOx loss rate (RNITE2)  
in percent/hour                      Default: 2.0                      ! RNITE2 = 2.0 !

Nighttime HNO3 formation rate (RNITE3)  
in percent/hour                      Default: 2.0                      ! RNITE3 = 2.0 !

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Groups 10 and 11.

-----  
INPUT GROUP: 12 -- Dispersion parameters  
-----

Distance (km) beyond which the time-dependent  
dispersion equations are used to determine  
sigma y and sigma z (TMDEP)                   Default: 10.     ! TMDEP = 10. !

Stability class used to determine plume  
growth rates for puffs above the boundary  
layer (JSUP)                                   Default: 6       ! JSUP = 6 !

Vertical dispersion constant for stable  
conditions (k1 in Eqn. 2.7-3) (CONK1)       Default: 0.01   ! CONK1 = 0.01 !

Vertical dispersion constant for neutral/  
unstable conditions (k2 in Eqn. 2.7-4)  
(CONK2)                                      Default: 0.1     ! CONK1 = 0.01 !

Range of land use categories for which  
urban dispersion is assumed  
(IURB1, IURB2)                               Default: 100,   ! IURB1 = 100 !  
  199     ! IURB2 = 199 !

-----  
INPUT GROUPS: 13a & 13b -- Point source parameters  
-----

-----  
Subgroup (13a)  
-----

Number of point sources with  
constant emission parameters (NPT1) No default ! NPT1 = 3 !

Number of point sources with  
variable emission parameters (NPT2) No default ! NPT2 = 0 !

(If NPT2 > 0, the variable point  
source emissions are read from  
the file: PTEMARB.DAT)

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Groups 12 and 13.

-----  
 Subgroup (13b)  
 -----

a  
 POINT SOURCE DATA FOR SOURCES WITH CONSTANT EMISSION PARAMETERS  
 -----

Source No.	X UTM Coordinate (km)	Y UTM Coordinate (km)	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (deg. K)	b		c	
								Bldg. Downwash	Emission Rates (g/s)		
1	! X = 196.1,	3866.2,	5.5,	0.0,	2.0,	4.5,	273.,	0	,	1.2	! !END!
2	! X = 172.0,	3859.2,	20.5,	0.0,	2.2,	3.5,	283.,	1	,	0.9	! !END!
3	! X = 180.1,	3869.2,	85.0,	0.0,	4.5,	12.0,	450.,	1	,	22.9	! !END!

a  
 Data for each source receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

b  
 NOTE: 0 = No building downwash modeled, 1 = downwash modeled

c  
 "NSPEC" emission rates must be entered (one for every pollutant).  
 Enter emission rate of zero for secondary pollutants.

-----  
 Subgroup (13c)  
 -----

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH  
 -----

Source No.	Effective building width and height (in meters) every 10 degrees
2	! WIDTH = 36 * 12.0 !
2	! HEIGHT = 36 * 22.5 !
!END!	
3	! WIDTH = 20 * 0.0, 45.5, 48.5, 52.5, 13 * 0.0 !
3	! HEIGHT = 20 * 0.0, 78.0, 78.0, 78.0, 13 * 0.0 !
!END!	

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
 Input Group 13 concluded.

-----  
[INPUT GROUPS: 14a & 14b -- Area source parameters  
-----

-----  
Subgroup (14a)  
-----

Number of area sources with  
constant emission parameters (NAR1)      No default !    NAR1 = 2 !

Gridded area source data  
used ? (GRIDAR)                              No default !    GRIDAR = 0 !  
0 = no  
1 = yes (gridded area source  
emissions read from the file:  
AREM.DAT)

The following parameters apply to the data in the  
gridded area source emissions file (AREM.DAT)

- Effective height of emissions  
(AEFFHT) in meters                              No default !    AEFFHT = 10.0 !
  
- Initial sigma y (ASIGYI) in  
meters    No default !    ASIGYI = 3000. !
  
- Initial sigma z (ASIGZI) in  
meters    No default !    ASIGZI = 10. !

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 14.

-----  
Subgroup (14b)  
-----

a

AREA SOURCE DATA FOR SOURCES WITH CONSTANT EMISSION PARAMETERS  
-----

		b				
X UTM Coordinate (km)	Y UTM Coordinate (km)	Effect. Height (m)	Base Elevation (m)	Initial Sigma y (m)	Initial Sigma z (m)	Emission Rates (g/s)
! X = 201.1,	3886.2,	12.0,	0.0,	120.0,	20.0,	1.2 !
! X = 182.0,	3889.2,	25.0,	0.0,	550.0,	50.0,	0.9 !

! !END!  
! !END!

-----  
a  
Data for each source are treated as a separate input subgroup  
and therefore must end with an input group terminator.

b  
"NSPEC" emission rates must be entered (one for every pollutant).  
Enter emission rate of zero for secondary pollutants.

-----  
INPUT GROUPS: 15a & 15b -- Non-gridded (discrete) receptor information  
-----

-----  
Subgroup (15a)  
-----

Number of non-gridded receptors (NREC) No default ! NREC = 3 !

!END!

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 14 concluded and Input Group 15.

-----  
Subgroup (15b)  
-----

a

NON-GRIDDED (DISCRETE) RECEPTOR DATA  
-----

Receptor No.	X UTM Coordinate (km)	Y UTM Coordinate (km)	Ground Elevation (m)	
1	! X = 180.1,	3859.2,	22.0	! !END!
2	! X = 195.1,	3862.2,	65.0	! !END!
3	! X = 212.5,	3877.2,	105.0	! !END!

-----  
a

Data for each receptor are treated as a separate input subgroup  
and therefore must end with an input group terminator.

Figure 4.2.1. Sample CALPUFF Control File (CALPUFF.INP).  
Input Group 15 concluded.

CALPUFF Control File Inputs - Input Group 1

General Run Control Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
IBYR	integer	Starting year of the CALPUFF run (two digits)	-
IBMO	integer	Starting month	-
IBDY	integer	Starting day	-
IBHR	integer	Starting hour (00-23)	-
IRLG	integer	Length of the run (hours)	-
NSPEC	integer	Total number of species modeled	5
NSE	integer	Number of species emitted	3

CALPUFF Control File Inputs - Input Group 2

Technical Options

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
MGAUSS	integer	Control variable determining the vertical distribution used in the near field (0 = uniform, 1 = Gaussian)	1
MCTSG	integer	CALPUFF subgrid scale complex terrain module (CTSG) flag (0 = CTSG not modeled, 1 = CTSG modeled)	0
MSLUG	integer	Near-field puffs are modeled as elongated 1 "slugs"? (0 = no, 1 = yes)	
MTRANS	integer	Transitional plume rise modeled? (0 = only final rise computed, 1 = transitional rise computed). Note: Transitional plume rise is always computed for sources subject to building downwash effects.	1
MSHEAR	integer	Vertical wind shear above stack top modeled in plume rise? (0 = no, 1 = yes)	1
MCHEM	integer	Chemical mechanism flag 0 = chemical transformation not modeled 1 = transformation rates computed internally (MESOPUFF II scheme) 2 = user specified transformation rates used  (If MCHEM = 2, the user must prepare a file (CHEM.DAT) with a diurnal cycle of transformation rates)	1
MWET	integer	Wet removal modeled? (0 = no, 1 = yes)	1
MDRY	integer	Dry deposition modeled? (0 = no, 1 = yes) Note: The method used to determine dry deposition velocities is specified by the user on a species-by-species basis in Input Group 3.	1

CALPUFF Control File Inputs - Input Group 2 - Continued  
 Technical Options

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
MDISP	integer	<p>Method used to compute the horizontal and vertical dispersion coefficients</p> <p>1 = computed from values of <math>\sigma_v</math> and <math>\sigma_w</math> from the SIGMA.DAT file</p> <p>2 = computed from <math>\sigma_v</math> and <math>\sigma_w</math> which are calculated internally from the micrometeorological variables (<math>u_*</math>, <math>w_*</math>, L, etc.)</p> <p>3 = PGT dispersion coefficients used in RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients used in URBAN areas</p> <p>4 = same as 3 except PGT coefficients computed using the MESOPUFF II equations</p>	3

## Control File Inputs - Input Group 3

### Species List

Input Group 3 consists of a table containing three integer flags for each species. These flags indicate if a pollutant is modeled (0=no, 1=yes), emitted (0=no, 1=yes), and dry deposited (0=no, 1=yes, treated as a gas with the resistance model, 2=yes, treated as a particle with the resistance model, or 3=yes, user-specified deposition velocities used).

The chemical transformation scheme in CALPUFF is designed to simulate the conversion of  $\text{SO}_2 \rightarrow \text{SO}_4^-$  and  $\text{NO}_x \rightarrow \text{HNO}_3 \leftrightarrow \text{NO}_3^-$ . Therefore, the five pollutants in CALPUFF are labeled as  $\text{SO}_2$ ,  $\text{SO}_4^-$ ,  $\text{NO}_x$ ,  $\text{HNO}_3$ , and  $\text{NO}_3^-$ . However, by setting the appropriate flags controlling the various technical options (chemical transformation, deposition, etc.), other reactive or non-reactive pollutants can be simulated even through the pollutant labels will refer to the  $\text{SO}_x/\text{NO}_x$  system of pollutants.

The user has control over which species are to be emitted and dry deposited in a particular run. If the dry deposition flag is set equal to 3 for any pollutant, a file called VD.DAT must be made available to the model. This file contains a diurnal cycle of 24 user-specified deposition velocities for each pollutant flagged (see Section 4.2.5).

The format of the species list table is:

```
-----
INPUT GROUP: 3 -- Species list
-----
```

SPECIES NAME	MODELED (0=NO, 1=YES)	EMITTED (0=NO, 1=YES)	DRY DEPOSITED (0=NO, 1=COMPUTED-GAS 2=COMPUTED-PARTICLE 3=USER-SPECIFIED)
<b>BUILD-UP SPECIES</b>			
! SO2	= 1	, 1	, 1 !
! SO4	= 1	, 1	, 2 !
! NOX	= 1	, 1	, 1 !
! HNO3	= 1	, 0	, 1 !
! NO3	= 1	, 0	, 2 !

!END!

CALPUFF Control File Inputs - Input Group 4

Grid Control Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
NX	integer	Number of grid cells in the X direction of the meteorological grid	-
NY	integer	Number of grid cells in the Y direction of the meteorological grid	-
DGRID	real	Grid spacing (km) of the meteorological grid	-
XORIGKM	real	Reference UTM X coordinate (km) of the southwest corner of grid cell (1,1) of the meteorological grid	-
YORIGKM	real	Reference UTM Y coordinate (km) of the southwest corner of grid cell (1,1) of the meteorological grid	-
IUTMZN	integer	UTM zone of coordinates	-
XLAT	real	Reference latitude (deg.) of the center of the modeling domain (used in solar elevation angle calculations)	-
XLONG	real	Reference longitude (deg.) of the center of the modeling domain	-
XTZ	real	Reference time zone of the center of the modeling domain (PST=8, MST=7, CST=6, EST=5)	-
NZ	integer	Number of vertical layers	-
ZFACE	real array	Cell face heights (m) for the meteorological grid (NZ + 1 values must be entered). Note: Cell center (grid point) height of layer "i" is (ZFACE(i+1) + ZFACE(i))/2.	-
IBCOMP	integer	X index of lower left corner of the computational grid (1 ≤ IBCOMP ≤ NX)	-
JBCOMP	integer	Y index of lower left corner of the computational grid (1 ≤ JBCOMP ≤ NY)	-

CALPUFF Control File Inputs - Input Group 4 - Continued  
Grid Control Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
IECOMP	integer	X index of upper right corner of the computational grid ( $1 \leq \text{IECOMP} \leq \text{NX}$ )	-
JBCOMP	integer	Y index of upper right corner of the computational grid ( $1 \leq \text{JECOMP} \leq \text{NY}$ )	-
LSAMP	logical	Flag indicating if an array of gridded receptors (i.e., sampling grid) is used (T = yes, F = no)	-
IBSAMP	integer	X index of lower left corner of the sampling grid ( $\text{IBCOMP} \leq \text{IBSAMP} \leq \text{IECOMP}$ )	-
JBSAMP	integer	Y index of lower left corner of the sampling grid ( $\text{JBCOMP} \leq \text{JBSAMP} \leq \text{JECOMP}$ )	-
IESAMP	integer	X index of upper right corner of the sampling grid ( $\text{IBCOMP} \leq \text{IESAMP} \leq \text{IECOMP}$ )	-
JESAMP	integer	Y index of upper right corner of the sampling grid ( $\text{JBCOMP} \leq \text{JESAMP} \leq \text{JECOMP}$ )	-
MESH DN	integer	Nesting factor of the sampling grid ( $\text{MESH DN} \geq 1$ ) The grid spacing of the sampling grid is $\text{DGRIDKM}/\text{MESH DN}$ .	-

CALPUFF Control File Inputs - Input Group 5

Output Options

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
ICON	integer	Control variable for creation of an output disk file (CONC.DAT) containing concentrations fields (species stored in this file are controlled by the output species table described below). (0 = do not create CONC.DAT, 1 = create CONC.DAT)	1
IDRY	integer	Control variable for creation of an output disk file (DFLX.DAT) containing dry flux fields (the species stored in this file are controlled by the output species table in Input Group 5 described below). (0 = do not create DFLX.DAT, 1 = create DFLX.DAT)	1
IWET	integer	Control variable for creation of an output disk file (WFLX.DAT) containing wet flux fields. (The species stored in this file are controlled by the output species table in Input Group 5 described below). (0 = do not create WFLX.DAT, 1 = create WFLX.DAT)	1
ICPRT	integer	Control variable for printing of concentration fields to the output list file (CALPUFF.LST). (0 = do not print any concentrations, 1 = print concentrations indicated in output species table)	0
IDPRT	integer	Control variable for printing of dry flux fields to the output list file (CALPUFF.LST). (0 = do not print any dry fluxes, 1 = print dry fluxes indicated in output species table)	0
IWPRT	integer	Control variable for printing of wet flux fields to the output list file (CALPUFF.LST). (0 = do not print any wet fluxes, 1 = print wet fluxes indicated in output species table)	0
ICFRQ	integer	Printing interval for the concentration fields. Concentrations are printed every "ICFRQ" hours. (Used only if ICPRT = 1).	1
IDFRQ	integer	Printing interval for the dry flux fields. Dry fluxes are printed every "IDFRQ" hours. (Used only if IDPRT = 1).	1

CALPUFF Control File Inputs - Input Group 5 - Continued

Output Options

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
IWFRQ	integer	Printing interval for the wet flux fields. Wet fluxes are printed every "IWFRQ" hours. (Used only if IWPRT = 1).	1
IMESG	integer	Control variable determining if messages tracking the progress of the run are written to the screen (0 = not written, 1 = written)	1
IDMESG	integer	Fortran unit number of the screen	0

CALPUFF Control File Inputs - Input Group 5  
Output Options

In addition to the variable described above, Input Group 5 also contains a table of species with a series of flags indicating if the pollutant's concentration and wet/dry flux fields are to be printed to the output list file (CALPUFF.LST) or stored in the output disk files (CONC.DAT, DFLX.DAT, and WFLX.DAT).

The format of the species output table is shown below. A value of 0 indicated "no", and a value of 1 indicates "yes".

SPECIES LIST FOR OUTPUT OPTIONS

SPECIES NAME	----- CONCENTRATIONS -----		----- DRY FLUXES -----		----- WET FLUXES -----	
	PRINTED ?	SAVED ON DISK ?	PRINTED ?	SAVED ON DISK ?	PRINTED ?	SAVED ON DISK ?
! SO2 =	1	1	0	0	0	0
! SO4 =	0	0	0	0	0	0
! NOX =	0	0	0	0	0	0
! HNO3 =	0	0	0	0	0	0
! NO3 =	0	0	0	0	0	0
!END!						

CALPUFF Control File Inputs - Input Group 6  
Subgrid Scale Complex Terrain (CTSG) Inputs

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 6a - General CTSG Parameters)			
NHILLS	integer	Number of subgrid scale terrain features	0
NCTRECS	integer	Number of special subgrid scale complex terrain receptors	0
(Input Group 6b - Hill Information)			
XC	real	X coordinate (km) of the center of the hill on the subgrid scale meteorological grid	-
YC	real	Y coordinate (km) of the center of the hill on the meteorological grid	-
THETAH	real	Orientation for the major axis of the hill (in degrees) clockwise from north	-
ZGRID	real	Height (m) of the "zero-plane" of the grid above mean sea level	-
RELIEF	real	Height (m) of the crest of the hill above the grid elevation	-
EXPO1	real	Hill shape exponent for the major axis of the hill	-
EXPO2	real	Hill shape exponent for the minor axis of the hill	-
SCALE1	real	Horizontal length scale of the hill along the major axis	-
SCALE2	real	Horizontal length scale of the hill along the minor axis	-
AMAX1	real	Maximum allowed axis length for the major axis of the hill	-
AMAX2	real	Maximum allowed axis length for the minor axis of the hill	-

The variables in Input Group 6b are entered for each of the "NHILLS" subgrid scale hills treated in the model run. The data for each hill is treated as a separate input subgroup, and therefore must end with an input group terminator (i.e., !END!). The format of Input Group 6b is shown below.

CALPUFF Control File Inputs - Input Group 6  
 Subgrid Scale Complex Terrain (CTSG) Inputs

-----  
 Subgroup (6b)  
 -----

1 \*\*

HILL INFORMATION

HILL NO.		XC (km)	YC (km)	THETAH (deg.)	ZGRID (m)	RELIEF (m)	EXPO 1 (m)	EXPO 2 (m)	SCALE 1 (m)	SCALE 2 (m)	AMAX1 (m)	AMAX2 (m)		
1	! HILL =	2.5	2.0	69.	1310.	300.	1.91	1.24	1523.	2896.	2000.	1500.	!	!END
2	! HILL =	5.0	0.0	46.	1310.	230.	1.50	1.50	3000.	1000.	4000.	2000.	!	!END

Note that the hill number is an optional user comment which is outside of the delimiter containing the required data. The data for each hill must follow the opening delimiter and "HILLDAT=". The data for each hill is followed by a closing delimiter and an input group terminator (i.e., !END!).

CALPUFF Control File Inputs - Input Group 6  
Subgrid Scale Complex Terrain (CTSG) Inputs

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 6c - CTSG Receptor Data)			
XRCT	real	X coordinate (km) on the meteorological grid system of a CTSG receptor	-
YRCT	real	Y coordinate (km) on the meteorological grid system of a CTSG receptor	-
ZRCT	real	Height (m) of the ground above mean sea level at the CTSG receptor	-
IHH	integer	Hill number associated with this CTSG receptor	-

The variables in Input Group 6c are entered for each of the "NCTRECS" complex terrain receptors in the model run. The data for each receptor is treated as a separate input subgroup, and therefore must end with an input group terminator (i.e., !END!). The format of Input Group 6c is shown below.

```
-----
Subgroup (6c)
-----
```

```

                                     1 **
COMPLEX TERRAIN RECEPTOR INFORMATION

      XRCT      YRCT      ZRCT      IHH
      (km)      (km)      (m)
      -----
! CTREC = 2.5   1.0   1430.   1   ! !END!
! CTREC = 1.0   1.5   1430.   1   ! !END!
! CTREC = 2.5   2.0   1580.   1   ! !END!
! CTREC = 5.0   0.0   1525.   2   ! !END!
! CTREC = 4.5   0.0   1430.   2   ! !END!
```

The data for each CTSG receptor must follow an opening delimiter and "CTREC=". The data for each receptor is followed by a closing delimiter and an input group terminator (i.e., !END!).

CALPUFF Control File Inputs - Input Group 7

Dry Deposition Parameters - Gases

Input Group 7 consists of a table containing the following five parameters which are required by the resistance deposition model for computing deposition velocities for gases:

- Pollutant diffusivity ( $\text{cm}^2/\text{s}$ ) (see Eqn. 2.7-10)
- Aqueous phase dissociation constant,  $\alpha_*$  (see Eqn. 2.7-17)
- Pollutant reactivity (see Eqn. 2.7-15)
- Mesophyll resistance,  $r_m$  (s/cm) (see Section 2.4.1)
- Henry's Law coefficient, H (dimensionless) (see Eqn. 2.7-17)

These parameters must be specified for each pollutant with a dry deposition flag of "1" in the species list (Input Group 3) indicating the use of the resistance model for a gas.

The format of the input table is shown below:

new table coming

-----  
 INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases  
 -----

SPECIES NAME	DIFFUSIVITY ( $\text{cm}^2/\text{s}$ )	ALPHA STAR	REACTIVITY	MESOPHYLL RESISTANCE (s/cm)	HENRY'S LAW COEFFICIENT (dimensionless)
-----	-----	-----	-----	-----	-----
! SO2 =	0.1509	1.00E3	8.0	0.0	4.e-2
! NOX =	0.1656	1.00	8.0	5.0	3.5
! HNO3 =	0.1628	1.00	18.0	0.0	8.e-8
!END!					

CALPUFF Control File Inputs - Input Group 8  
Dry Deposition Parameters - Particles

Input Group 8 consists of a table containing the geometric mass mean diameter (microns) and the geometric standard deviation (microns) required by the resistance deposition model for computing deposition velocities for particulate matter.

These parameters must be specified for each pollutant with a dry deposition flag of "2" in the species list (Input Group 3) indicating the use of the resistance model for a pollutant deposited as particulate matter.

The format of the input table is shown below:

-----  
INPUT GROUP: 8 -- Size parameters for dry deposition of particles  
-----

SPECIES NAME	GEOMETRIC MASS MEAN DIAMETER (microns)	GEOMETRIC STANDARD DEVIATION (microns)
! SO4 =	0.48	2.00 !
! NO3 =	0.48	2.00 !

!END!

CALPUFF Control File Inputs - Input Group 9  
Miscellaneous Dry Deposition Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
RCUTR	real	Reference cuticle resistance (s/cm) (see Eqn. 2.7-15)	17.
RGR	real	Reference ground resistance (s/cm) (see Eqn. 2.7-16)	5.
REACTR	real	Reference pollutant reactivity (see Eqn. 2.7-15)	8.
IVEG	integer	Vegetation state in unirrigated areas 1 = vegetation is active and unstressed 2 = vegetation is active and stressed 3 = vegetation is inactive	-

CALPUFF Control File Inputs - Input Group 10  
Wet Deposition Parameters

Input Group 10 consists of a table containing pollutant-dependent values of the scavenging coefficient,  $\lambda$ , defined by Equation (2.9-2), for both liquid and frozen precipitation types. The format of the input table is shown below.

-----  
 INPUT GROUP: 10 -- Wet Deposition Parameters  
 -----

-1

Scavenging Coefficient -- Units: (sec)

Pollutant	Liquid Precip.	Frozen Precip.
-----	-----	-----
! SO2 =	3.0e-5	0.0
! SO4 =	10.0e-5	3.0e-5
! NOX =	0.0	0.0
! HNO3 =	6.0e-5	0.0
! NO3 =	10.0e-5	3.0e-5

!END!

CALPUFF Control File Inputs - Input Group 11  
Chemistry Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
MOZ	integer	Control variable for the input of hourly ozone data used in the chemical transformation module (Used only if MCHEM=1) 0 = use a constant background ozone value in chemistry calculation 1 = use hourly ozone concentrations from the OZONE.DAT data file	1
BLK03	real	Background ozone concentration in ppb 80. (Used only if MCHEM=1 and MOZ=0 or if (MOZ=1 and all hourly ozone data are missing))	
BLKNH3	real	Background ammonia concentration in ppb	10.
RNITE1	real	Nighttime SO <sub>2</sub> loss rate in percent/hour (k <sub>1</sub> in Eqn. 2.8-2)	0.2
RNITE2	real	Nighttime NO <sub>x</sub> loss rate in percent/hour (k <sub>2</sub> in Eqn. 2.8-3)	2.0
RNITE3	real	Nighttime HNO <sub>3</sub> formation rate in percent/hour (k <sub>3</sub> in Eqn. 2.8-4)	2.0

CALPUFF Control File Inputs - Input Group 12

Dispersion Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
TMDEP	real	Total puff travel distance (km) beyond which the time-dependent dispersion equation of Heffter (1965)	10.0
JSUP	integer	Stability class used to determine dispersion rates for puffs above the boundary layer (e.g., 6 = F stability)	6
CONK1	real	Vertical dispersion constant for stable conditions ( $k_1$ in Eqn. 2.7-3)	0.01
CONK2	real	Vertical dispersion constant for neutral/unstable conditions ( $k_2$ in Eqn. 2.7-4)	0.10
IURB1, IURB2	integers	Land use categories associated with urban areas. MP dispersion coefficients are used when puff is over land use type IURB1 through IURB2, and if MDISP = 3 or 4.	100, 199

CALPUFF Control File Inputs - Input Group 13

Point Source Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 13a - General Data)			
NPT1	integer	Number of point sources with constant emission parameters	-
NPT2	integer	Number of point sources with arbitrarily-varying emission parameters (If NPT2 > 0, the point source emissions file PTEMARB.DAT must be provided)	-
(Input Group 13b - Point Source Data for Sources with Constant Stack and Emission Parameters)			
XUTM	real	X coordinate (km) of the stack on the meteorological grid	-
YUTM	real	Y coordinate (km) of the stack on the meteorological grid	-
HSTAK	real	Stack height (m)	-
SELEV	real	Stack base elevation (m) above mean sea level	-
DIAM	real	Stack diameter (m)	-
EXITW	real	Stack gas exit velocity (m/s)	-
EXITT	real	Stack gas exit temperature (deg. K)	-
IDOWN	integer	Building downwash flag 0 = building downwash not modeled, 1 = building downwash modeled	-
EMS	real array	Emission rate (g/s) of each modeled species Note: "NSPEC" values must be entered.	-

The variables in Input Group 13b are entered for each of the "NPT1" point sources with constant emission parameters. The data for each source is treated as a separate input subgroup, and therefore, must end with an input group terminator (i.e., !END!). The format of Input Group 13b is shown below.

CALPUFF Control File Inputs - Input Group 13

Point Source Parameters

-----  
 Subgroup (13b)  
 -----

a

POINT SOURCE DATA FOR SOURCES WITH CONSTANT EMISSION PARAMETERS

-----

Source No.	X UTM Coordinate (km)	Y UTM Coordinate (km)	Stack Height (m)	Base Elevation (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temp. (deg. K)	b		c	
								Bldg. Downwash	Emission Rates (g/s)		
1	! X = 196.1,	3866.2,	5.5,	0.0,	2.0,	4.5,	273.,	0	,	1.2	! !END!
2	! X = 172.0,	3859.2,	20.5,	0.0,	2.2,	3.5,	283.,	1	,	0.9	! !END!
3	! X = 180.1,	3869.2,	85.0,	0.0,	4.5,	12.0,	450.,	1	,	22.9	! !END!

-----

a  
 Data for each source receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

b  
 NOTE: 0 = No building downwash modeled, 1 = downwash modeled

c  
 "NSPEC" emission rates must be entered (one for every pollutant).  
 Enter emission rate of zero for secondary pollutants.

Note that the source number is an optional user comment which is outside of the delimiter containing the required source data. The data for each source must follow an opening delimiter and "X=". The data for each source is followed by a closing delimiter and an input group terminator.

CALPUFF Control File Inputs - Input Group 13  
Point Source Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 13c - Building Dimension Data)			
WIDTH	real array	Array of 36 direction-specific building dimensions for flow vectors from 10°-360° in 10° increments	-
HEIGHT	real array	Array of 36 direction-specific building dimensions for flow vectors from 10°-360° in 10° increments	-

The variables in Input Group 13c are entered for each point source for which IDOWN=1 in Input Group 13b. The data for each point source is treated as a separate input subgroup and therefore must end with an input group terminator (i.e., !END!). The format of Input Group 13c is shown below.

```

-----
Subgroup (13c)
-----

                BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
                -----
Source
No.      Effective building width and height (in meters) every 10 degrees
-----
                -----
2        ! WIDTH = 36 * 12.0 !
2        ! HEIGHT = 36 * 22.5 !
!END!
3        ! WIDTH = 20 * 0.0, 45.5, 48.5, 52.5, 13 * 0.0 !
3        ! HEIGHT = 20 * 0.0, 78.0, 78.0, 78.0, 13 * 0.0 !
!END!

```

Note that the source number is an optional user comment which is outside of the delimiters. The data for each source must follow an opening delimiter and either "WIDTH=" or "HEIGHT=". The data for each source is followed by a closing delimiter and an input group terminator (i.e., !END!).

CALPUFF Control File Inputs - Input Group 14  
Area Source Parameters

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 14a - General Area Source Data)			
NAR1	integer	Number of area sources with constant emission parameters	-
IGRDAR	integer	Gridded area source data used? (0 = no, 1 = yes)	-
AEFFHT	real	Effective height (m) of gridded area source emissions	-
ASIGYI	real	Initial horizontal dispersion coefficient ( $\sigma_y$ ), in meters, of gridded area source emissions	-
ASIGZI	real	Initial vertical dispersion coefficient ( $\sigma_z$ ), in meters, of gridded area source emissions	-
(Input Group 14b - Area Source Data for Sources with Constant Emissions)			
XUTM	real	X coordinate (km) of the center of the area source on the meteorological grid	-
YUTM	real	Y coordinate (km) of the center of the area source on the meteorological grid	-
HTEFF	real	Effective height (m) of the area source	-
AELEV	real	Base elevation (m) above mean sea level	-
SIGYI	real	Initial horizontal dispersion coefficient ( $\sigma_y$ ), in meters, of the area source	-
SIGZI	real	Initial vertical dispersion coefficient ( $\sigma_z$ ), in meters, of the area source	-
EMIS	real	Emission rate (g/s) of each modeled species Note: "NSPEC" values must be entered	-

The variables in Input Group 14b are entered for each of the "NAR1" area sources with constant emissions. The data for each source is treated as a separate input subgroup, and therefore, must end with an input group terminator (i.e., !END!). The format of Input Group 14b is shown below.

CALPUFF Control File Inputs - Input Group 14  
Area Source Parameters

-----  
Subgroup (14b)  
-----

-----  
AREA SOURCE DATA FOR SOURCES WITH CONSTANT EMISSION PARAMETERS  
-----

X UTM Coordinate (km)	Y UTM Coordinate (km)	Effect. Height (m)	Base Elevation (m)	Initial Sigma y (m)	Initial Sigma z (m)	Emission Rates (g/s)
! X = 201.1,	3886.2,	12.0,	0.0,	120.0,	20.0,	1.2 !
! X = 182.0,	3889.2,	25.0,	0.0,	550.0,	50.0,	0.9 !

a  
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b  
"NSPEC" emission rates must be entered (one for every pollutant).  
Enter emission rate of zero for secondary pollutants.

Note that the receptor number is an optional user comment which is outside of the delimiter. The data for each source must follow an opening delimiter and "X=". The data for each source is followed by a closing delimiter and an input group terminator.

CALPUFF Control File Inputs - Input Group 15  
Non-Gridded (Discrete) Receptor Data

<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Default Value</u>
(Input Group 15a - General Discrete Receptor Data)			
NREC	integer	Number of non-gridded receptors	-
(Input Group 15b - Discrete Receptor Data)			
XUTM	real	X coordinate (km) of the receptor on the meteorological grid	-
YUTM	real	Y coordinate (km) of the receptor on the meteorological grid	-
ELEV	real	Ground elevation (m) above mean sea level of the receptor	-

The variables in Input Group 15b are entered for each of the "NREC" discrete receptors. The data for each receptor is treated as a separate input subgroup, and therefore, must end with an input group terminator (i.e., !END!). The format of Input Group 15b is shown below.

```

-----
Subgroup (15b)
-----
                                     a
                               NON-GRIDDED (DISCRETE) RECEPTOR DATA
                               -----
Receptor      X UTM      Y UTM      Ground
No.           Coordinate Coordinate Elevation
              (km)       (km)       (m)
-----
1      ! X = 180.1,   3859.2,   22.0   ! !END!
2      ! X = 195.1,   3862.2,   65.0   ! !END!
3      ! X = 212.5,   3877.2,  105.0   ! !END!
-----

```

a  
Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

The data for each receptor must follow an opening delimiter and "X=". The data for each receptor is followed by a closing delimiter and an input group terminator (i.e., !END!).

#### 4.2.2 Meteorological Data File (CALMET.DAT)

The CALMET.DAT file contains the meteorological data fields required to drive the CALPUFF model. It also contains certain geophysical fields, such as terrain elevations, surface roughness lengths, and land use types, used by both the CALMET meteorological model and CALPUFF. Although the input requirements of CALPUFF are designed to be directly compatible with CALMET, meteorological fields produced by other meteorological models can be substituted for the CALMET output as long as the required variables are produced and the output is reformatted to be consistent with the CALMET.DAT file specifications described in this section.

##### CALMET.DAT File - Header Records

The CALMET.DAT file consists of a set of up to fourteen header records, followed by a set of hourly data records. The header records contains a descriptive title of the meteorological run, information including the horizontal and vertical grid systems of the meteorological grid, the number, type, and coordinates of the meteorological stations included in the CALMET run, gridded fields of surface roughness lengths, land use, terrain elevations, leaf area indexes, and a pre-compute field of the closest surface meteorological station number to each grid point.

The actual number of header records may vary because, as explained below, records containing surface, upper air, and precipitation station coordinates are not included if these stations were not included in the run.

The following variables stored in the CALMET.DAT header records are checked in the setup phase of the CALPUFF model run to ensure compatibility with variables specified in the CALPUFF control file: number of grid cells in the X and Y directions, grid size, reference UTM coordinates of the grid origin, and UTM zone of the grid origin.

Sample Fortran read statements for the CALMET.DAT header records are:

```
c --- Header record 1 -- Run title
      READ(iunit)TITLE

c --- Header record 2 -- General run and grid information
      READ(iunit)VERMET, LEVMET, IBYR, IBMO, IBDY, IBHR, IBTZ, IRLG, IRTYPE,
      1 NXM, NYM, NZM, XGRIDM, XORIGM, YORIGM, IUTMZNM, IWFCOD, NSSTA,
      2 NUSTA, NPSTA, NOWSTA, NLU, IWAT1, IWAT2, LCALGRD

c --- Header record 3 -- Vertical cell face heights (nz+1 values)
      READ(iunit)CLAB1,ZFACEM

c --- Header records 4 and 5 -- Surface station coordinates
      if(nssta.gt.0)then
          READ(iunit)CLAB2,XSSTA
          READ(iunit)CLAB3,YSSTA
      endif

c --- Header records 6 and 7 -- Upper air station coordinates
      if(nusta.gt.0)then
          READ(iunit)CLAB4,XUSTA
          READ(iunit)CLAB5,YUSTA
      endif

c --- Header records 8 and 9 -- Precipitation station coordinates
      if(npsta.gt.0)then
          READ(iunit)CLAB6,XPSTA
          READ(iunit)CLAB7,YPSTA
      endif

c --- Header record 10 -- Surface roughness lengths
      READ(iunit)CLAB8,ZO

c --- Header record 11 -- Land use categories
      READ(iunit)CLAB9,ILANDU
```

c --- Header record 12 -- Terrain elevations

READ(iunit)CLAB10,ELEV

c --- Header record 13 - Leaf area indexes

READ(iunit)CLAB11,XLAI

c --- Header record 14 - Nearest surface station to each grid point

READ(iunit)CLAB12,NEARS

where the following declarations apply:

real ZFACEM(nzm+1),XSSTA(nssta),YSSTA(nssta),XUSTA(nusta),YUSTA(nusta)

real XPSTA(npsta),YPSTA(npsta)

real ZO(nxm,nym),ELEV(nxm,nym),XLAI(nxm,nym)

integer ILANDU(nxm,nym),NEARS(nxm,nym)

character\*80 TITLE(3)

character\*8 VERMET,LEVMET,CLAB1,CLAB2,CLAB3,CLAB4,CLAB5,CLAB6

character\*8 CLAB7,CLAB8,CLAB9,CLAB10,CLAB11,CLAB12

logical LCALGRD

CALMET.DAT file - Header Records

<u>Header Record No.</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
1	1	TITLE	C*80 array	Array with three 80-character lines of the user's title of the CALMET run
2	1	VERMET	C*8	CALMET model version number
2	2	LEVMET	C*8	CALMET model level number
2	3	IBYR	integer	Starting year of CALMET run
2	4	IBMO	integer	Starting month
2	5	IBDY	integer	Starting day
2	6	IBHR	integer	Starting hour
2	7	IBTZ	integer	Base time zone (05=EST, 06=CST, 07=MST, 08=PST)
2	8	IRLG	integer	Run length (hours)
2	9	IRTYPE	integer	Run type (must be run type 1 to drive CALPUFF)
2	10	NXM	integer	Number of grid cells in the X direction
2	11	NYM	integer	Number of grid cells in the Y direction
2	12	NZM	integer	Number of vertical layers
2	13	XGRIDM	real	Grid spacing (m)
2	14	XORIGM	real	UTM X coordinate (m) of southwest corner of grid point (1,1)
2	15	YORIGM	real	UTM Y coordinate (m) of southwest corner of grid point (1,1)
2	16	IUTMZN	integer	UTM zone of coordinates

<sup>a</sup> C\*80 = Character\*80

C\*8 = Character\*8

CALMET.DAT file - Header Records

<u>Header Record No.</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
2	17	IWFCOD	integer	Wind field module used (0=objective analysis, 1=diagnostic model)
2	18	NSSTA	integer	Number of surface meteorological stations
2	19	NUSTA	integer	Number of upper air stations
2	20	NPSTA	integer	Number of precipitation stations
2	21	NOWSTA	integer	Number of overwater stations
2	22	NLU	integer	Number of land use categories
2	23	IWAT1	integer	Range of land use categories
2	24	IWAT2	integer	corresponding to water surfaces (IWAT1 to IWAT2, inclusive)
2	25	LCALGRD	logical	Flag indicating if special meteorological parameters required by CALPUFF and the CTSG module of CALPUFF are contained in the file (i.e., LCALGRD must be TRUE to use the CTSG option of CALPUFF)
3	1	CLAB1	C*8	Variable label ('ZFACE')
3	2	ZFACEM	real array	Heights (m) of cell faces (NZM + 1 values)
4 <sup>b</sup>	1	CLAB2	C*8	Variable label ('XSSTA')
4 <sup>b</sup>	2	XSSTA	real	X UTM coordinates (m) of each array surface met. station

<sup>a</sup> C\*8 = Character\*8

<sup>b</sup> Included only if NSSTA > 0

CALMET.DAT file - Header Records

<u>Header Record No.</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
5 <sup>b</sup>	1	CLAB3	C*8	Variable label ('YSSTA')
5 <sup>b</sup>	2	YSSTA	real	Y UTM coordinates (m) of each array surface met. station
6 <sup>c</sup>	1	CLAB4	C*8	Variable label ('XUSTA')
6 <sup>c</sup>	2	XUSTA	real array	X UTM coordinates (m) of each upper air met. station
7 <sup>c</sup>	1	CLAB5	C*8	Variable label ('YUSTA')
7 <sup>c</sup>	2	YUSTA	real array	Y UTM coordinate (m) of each upper air met. station
8 <sup>d</sup>	1	CLAB6	C*8	Variable label ('XPSTA')
8 <sup>d</sup>	2	XPSTA	real array	X UTM coordinate (m) of each precipitation station
9 <sup>d</sup>	1	CLAB7	C*8	Variable label ('YPSTA')
9 <sup>d</sup>	2	YPSTA	real array	Y UTM coordinate (m) of each precipitation station
10	1	CLAB8	C*8	Variable label ('Z0')
10	2	Z0	real array	Gridded field of surface roughness lengths (m)
11	1	CLAB9	C*8	Variable label ('ILANDU')
11	2	ILANDU	integer array	Gridded field of land use category for each grid cell

<sup>a</sup> C\*8 = Character\*8

<sup>b</sup> Included only if NSSTA > 0

<sup>c</sup> Included only if NUSTA > 0

<sup>d</sup> Included only if NPSTA > 0

CALMET.DAT file - Header Records

<u>Header Record No.</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
12	1	CLAB10	C*8	Variable label ('ELEV')
12	2	ELEV	real array	Gridded field of terrain elevations for each grid cell
13	1	CLAB11	C*8	Variable label ('XLAI')
13	2	XLAI	real array	Gridded field of leaf area index for each grid cell
14	1	CLAB12	C*8	Variable label ('NEARS')
14	2	NEARS	integer array	Nearest surface met. station to each grid point

---

<sup>a</sup> C\*8 = Character\*8

## CALMET.DAT File - Data Records

The CALMET.DAT data records include hourly fields of winds and meteorological variables. In addition to the regular CALMET output variables, the CALMET.DAT file may contain three-dimensional fields of the vertical velocity and air temperature. The presence of these fields in the CALMET output file is flagged by the header record logical variable, LCALGRD, having a value of TRUE.

The data records contain three-dimensional gridded fields of U, V, and W wind components and air temperature, two-dimensional fields of PGT stability class, surface friction velocity, mixing height, Monin-Obukhov length, convective velocity scale, and precipitation rate, and values of the temperature, air density, short-wave solar radiation, relative humidity, and precipitation type codes defined at the surface meteorological stations.

Sample Fortran read statements for the CALMET.DAT data records are:

c --- Read U, V, W wind components

```
      Loop over vertical layers, k
      READ(iunit)CLABU, ((UMET(i, j, k), i=1, nxm), j=1, nym)
      READ(iunit)CLABV, ((VMET(i, j, k), i=1, nxm), j=1, nym)
      if(LCALGRD)READ(iunit)CLABW, ((WMET(i, j, k), i=1, nxm), j=1, nym)
      End loop over vertical layers
```

c --- Read 3-D temperature field

```
      if(LCALGRD)
      Loop over vertical layers, k
      READ(iunit)CLABT, ((TMET(i, j, k), i=1, nxm), j=1, nym)
      End loop over vertical layers
      endif
```

c --- Read 2-D meteorological fields

```
READ(iunit)CLABSC,IPGT
READ(iunit)CLABUS,USTAR
READ(iunit)CLABZI,HTMIX
READ(iunit)CLABL,XMONIN
READ(iunit)CLABWS,WSTAR
READ(iunit)CLABRMM,RMM
```

c --- Read 1-D variables defined at surface met. stations

```
READ(iunit)CLABTK,TEMPSS
READ(iunit)CLABD,RHOSS
READ(iunit)CLABQ,QSWSS
READ(iunit)CLABRH,IRHSS
READ(iunit)CLABPC,IPCODE
```

where the following declarations apply:

```
real UMET(nxm,nym,nzm),VMET(nxm,nym,nzm),WMET(nxm,nym,nzm)
real TMET(nxm,nym,nzm)
real USTAR(nxm,nym),HTMIX(nxm,nym),XMONIN(nxm,nym)
real WSTAR(nxm,nym),RMM(nxm,nym)
real TEMPSS(nssta),RHOSS(nssta),QSWSS(nssta)
integer IPGT(nxm,nym)
integer IRHSS(nssta),IPCODE(nssta)
character*8 CLABU,CLABV,CLABW,CLABT,CLABSC,CLABUS,CLABZI
character*8 CLABL,CLABWS,CLABRMM,CLABTK,CLABD,CLABQ,CLABRH
character*8 CLABPC
```

CALMET.DAT file - Data Records

<u>Record Type</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
1	1	CLABU	C*8	Variable label ('U-LEVxxx', where xxx indicates the layer number)
1	2	UMET	real array	U-component (m/s) of the winds at array each grid point
2	1	CLABV	C*8	Variable label ('V-LEVxxx', where xxx indicates the layer number)
2	2	VMET	real array	V-component (m/s) of the winds at each grid point
3 <sup>b</sup>	1	CLABW	C*8	Variable label ('W-LEVxxx', where xxx indicates the layer number)
3 <sup>b</sup>	2	WMET	real array	W-component (m/s) of the winds at each grid point
(Record types 1,2,3 repeated NZM times (once per layer) as a set)				
4 <sup>b</sup>	1	CLABT	C*8	Variable label ('T-LEVxxx', where xxx indicates the layer number)
4 <sup>b</sup>	2	TMET	real array	Air temperature (deg. K) at each grid point
(Record type 4 repeated NZM times (once per layer))				
5	1	CLABSC	C*8	Variable label ('IPGT')
5	2	IPGT	integer array	PGT stability class

<sup>a</sup> C\* 8 = Character\*8

<sup>b</sup> Record types 3 and 4 are included only if LCALGRD is TRUE

CALMET.DAT file - Data Records

<u>Record Type</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
6	1	CLABUS	C*8	Variable label ('USTAR')
6	2	USTAR	real array	Surface friction velocity (m/s)
7	1	CLABZI	C*8	Variable label ('ZI')
7	2	HTMIX	real array	Mixing height (m)
8	1	CLABL	C*8	Variable label ('EL')
8	2	XMONIN	real array	Monin-Obukhov length (m)
9	1	CLABWS	C*8	Variable label ('WS')
9	2	WSTAR	real array	Convective velocity scale (m/s)
10	1	CLABRMM	C*8	Variable label ('RMM')
10	2	RMM	real array	Precipitation rate (mm/hr). Required only if wet deposition is modeled.
11	1	CLABTK	C*8	Variable label ('TEMPK')
11	2	TEMPSS	real array	Temperature (deg. K) at each surface met. station
12	1	CLABD	C*8	Variable label ('RHO')
12	2	RHOSS	real array	Air density (kg/m <sup>3</sup> ) at each surface met. station

---

<sup>a</sup>C\*8 = Character\*8

CALMET.DAT file - Data Records

<u>Record Type</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
13	1	CLABQ	C*8	Variable label ('QSW')
13	2	QSWSS	real array	Short-wave solar radiation ( $W/m^2$ ) at each surface met. station
14	1	CLABRH	C*8	Variable label ('IRH')
14	2	IRHSS	integer array	Relative humidity (percent) at each surface met. station
15	1	CLABPC	C*8	Variable label ('IPGT')
15	2	IPCODE	real array	Precipitation type code

---

<sup>a</sup> C\*8 = Character\*8

CALMET.DAT file - Data Records

<u>Record Type</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
6	1	CLABUS	C*8	Variable label ('USTAR')
6	2	USTAR	real array	Surface friction velocity (m/s)
7	1	CLABZI	C*8	Variable label ('ZI')
7	2	HTMIX	real array	Mixing height (m)
8	1	CLABL	C*8	Variable label ('EL')
8	2	XMONIN	real array	Monin-Obukhov length (m)
9	1	CLABWS	C*8	Variable label ('WS')
9	2	WSTAR	real array	Convective velocity scale (m/s)
10	1	CLABRMM	C*8	Variable label ('RMM')
10	2	RMM	real array	Precipitation rate (mm/hr). Required only if wet deposition is modeled.
11	1	CLABTK	C*8	Variable label ('TEMPK')
11	2	TEMPSS	real array	Temperature (deg. K) at each surface met. station
12	1	CLABD	C*8	Variable label ('RHO')
12	2	RHOSS	real array	Air density (kg/m <sup>3</sup> ) at each surface met. station

---

<sup>a</sup>C\*8 = Character\*8

CALMET.DAT file - Data Records

<u>Record Type</u>	<u>Variable No.</u>	<u>Variable Name</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
13	1	CLABQ	C*8	Variable label ('QSW')
13	2	QSWSS	real array	Short-wave solar radiation ( $W/m^2$ ) at each surface met. station
14	1	CLABRH	C*8	Variable label ('IRH')
14	2	IRHSS	integer array	Relative humidity (percent) at each surface met. station
15	1	CLABPC	C*8	Variable label ('IPGT')
15	2	IPCODE	real array	Precipitation type code

---

<sup>a</sup> C\*8 = Character\*8

#### 4.2.3 Point Source Emissions File With Arbitrarily Varying Emissions (PTEMARB.DAT)

The PTEMARB.DAT file contains point source emissions data for sources with detailed, arbitrarily varying emissions parameters. In the PTEMARB.DAT file, values for the stack parameters and emission rates can be specified for each time step in the run. Plume rise is computed within the CALPUFF model for each source.

PTEMARB.DAT is a sequential, unformatted data file consisting of three header records, followed by a set of data records containing time-invariant source information. The time-invariant records contain the stack height, diameter, coordinates, and optional descriptive codes for each source. The time varying emissions and stack parameter data follow in subsequent records. One data record per source is required for each time period (e.g., usually at hourly intervals).

The data in the PTEMARB.DAT file is independent of the horizontal and vertical grid systems being used in the model. The horizontal coordinates are specified in terms of UTM coordinates. The vertical layers receiving the emissions of the source are based on the plume rise of the source computed internally by the model. However, the PTEMARB.DAT file does contain time-dependent data specifying the emission parameters for a particular time period.

## PTEMARB.DAT File - Header Records

The header records of the PTEMARB.DAT file contain the number of sources, starting and ending time periods of data in the file, and a list of the emitted species. Sample Fortran read statements are:

```
READ(iunit)FNAME2, NSRC2, NSE2, IUTMZ2, IBDAT2, IBTIM2, IEDAT2,  
1 IETIM2, VRS2, LABEL2
```

```
READ(iunit)CSLST2  
READ(iunit)XWEM2
```

where the following declarations apply:

```
CHARACTER*12 FNAME2, VRS2, LABEL2, CSLST2(nse2)  
REAL XWEM2(nse2)
```

PTEMARB.DAT - Header Record 1 - General Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	FNAME2	C*12	Data set name	PTEMARB
2	NSRC2	integer	Number of sources in the file	10
3	NSE2	integer	Number of species emitted	3
4	IUTM22	integer	UTM zone in which source coordinates are specified	11
5	IBDAT2	integer	Date of beginning of data in the file (YYJJJ, where YY=year, JJJ=Julian day)	84220
6	IBTIM2	integer	Hour of beginning of data in the file (00-23, LST)	00
7	IEDAT2	integer	Date of ending of data in the file (YYJJJ, where YY=year, JJJ=Julian day)	84224
8	IETIM2	integer	Hour of ending of data in the file (00-23, LST)	23
9	VRS2	C*12	Data set version	Base Case
10	LABEL2	C*12	Data set label	Major pts.

---

<sup>a</sup> C\*12 = Character\*12

PTEMARB.DAT - Header Record 2 - Species List

<u>No.</u> <sup>*</sup>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	C*12	Species identifier for species 1	S02
2	C*12	Species identifier for species 2	S04
.	.	.	.
.	.	.	.
.	.	.	.
3	C*12	Species identifier for species "NSE2"	NOX

---

\* "NSE2" elements of CSLST2 array

<sup>a</sup> C\*12 = Character\*12

PTEMARB.DAT - Header Record 3 - Molecular Weights

<u>No.</u> *	<u>Type</u>	<u>Description</u>	<u>Sample Values</u>
1	real	Molecular weight for species 1	64. (SO2)
2	real	Molecular weight for species 2	96. (SO4)
.	.	.	.
.	.	.	.
.	.	.	.
NSE2	Real	Molecular weight for species "NSE"	30. (NOX as NO)

---

\* "NSE2" elements of XMWEM2 array

## PTEMARB.DAT File - Data Records

The PTEMARB.DAT file contains two types of data records. A set of time-invariant records are read after the header records. These records specify the time-invariant source parameters, including the source coordinates, stack height, and diameter. A set of time-varying data follows. The time-varying records contain the stack temperature, exit velocity, flow rate, and emission rate for each species.

Sample Fortran read statements for time-invariant data records are:

```
Loop over sources
  READ(iunit)CID,TIDATA
End loop over sources
```

where the following declarations apply:

```
CHARACTER*16 CID
REAL TIDATA(7)
```

Sample Fortran read statements for time-varying data records are:

```
Loop over time periods
  READ(iunit)IBDAT,IBTIM,IEDAT,IETIM
  Loop over sources
    READ(iunit)CID,TEMPK,VEXIT,VOLFLOW,QEMIT
  End loop over sources
End loop over time periods
```

where the following declarations apply:

CHARACTER\*16 CID

REAL QEMIT(nse2)

PTEMARB.DAT - Time-Invariant Data Record Contents  
(Repeated for each source)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CID	C*16	Source identifier (16 characters=4 words)
2	TIDATA(1)	real	Easting UTM coordinate (km) of the source
3	TIDATA(2)	real	Northing UTM coordinate (km) of the source
4	TIDATA(3)	real	Stack height (m)
5	TIDATA(4)	real	Stack diameter (m)
6	TIDATA(5)	real	Stack base elevation (m)
7	TIDATA(6)	real	User defined flag (e.g., industry code)
8	TIDATA(7)	real	User defined flag (e.g., fuel code)

---

<sup>a</sup> C\*16 = Character\*16

PTEMARB.DAT - Time-Varying Data Record Contents

(First record of "NSRC2"+1 records required for each time period)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	IBDAT	integer	Beginning date for which data in this set is valid (YYJJJ, where YY=year, JJJ=Julian day)
2	IBTIM	integer	Beginning hour for which data in this set is valid (00-23, LST)
3	IEDAT	integer	Ending date for which data in this set is valid (YYJJJ, where YY=year, JJJ=Julian day)
4	IETIM	integer	Ending hour for which data in this set is valid (00-23, LST)

---

Example:

Data Valid for 1 hour:

IBDAT=89183, IBTIM=00, IEDAT=89183, IETIM=00

IBDAT=89183, IBTIM=01, IEDAT=89183, IETIM=01

IBDAT=89183, IBTIM=02, IEDAT=89183, IETIM=02

Data Valid for 3 hours:

IBDAT=89183, IBTIM=00, IEDAT=89183, IETIM=02

IBDAT=89183, IBTIM=03, IEDAT=89183, IETIM=05

IBDAT=89183, IBTIM=06, IEDAT=89183, IETIM=08

PTEMARB.DAT - Time-Varying Data Record Contents  
 (Next "NSRC2" records)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CID	C*16	Source identifier (must match values in time-invariant records)
2	TEMPK	real	Exit temperature (deg. K)
3	VEKIT	real	Exit velocity (m/s)
4	VOLFLOW	real	Volumetric flow rate (m <sup>3</sup> /s)
Next NSE2	QEMIT	real array	Emission rates (g/s) for each species in the order specified in Header Record 2

---

<sup>a</sup> C\*16 = Character\*16

#### 4.2.4 Area Source Emissions File (AREM.DAT) with Arbitrarily Varying Emissions

Time independent area source data are contained in the CALPUFF control file (CALPUFF.INP). The AREM.DAT emissions file contains time-dependent gridded area source emissions data. AREM.DAT is a sequential, unformatted data file containing one two-dimensional grid for each emitted species modeled by CALPUFF for each time step. There are three header records with information describing the grid system, dates and time of data in the file, species names, and molecular weights.

The total emission rate for each pollutant is specified for the grid column. Individual source information is not stored in the file, so plume rise is not computed by CALPUFF for the AREM.DAT emissions. The effective height and initial vertical and horizontal plume dimensions ( $\sigma_y$ ,  $\sigma_z$ ) are specified by the user in the control file (CALPUFF.INP) for the gridded area source inventory.

#### AREM File - Header Records

The header records contain information regarding the horizontal grid system, species emitted, molecular weights, and dates of the data contained in the file. These data are checked by CALPUFF in the setup phase of the model run to ensure the parameters are compatible with those specified in the CALPUFF control file. Any mismatch in the specifications results in an error message and termination of the run.

Sample Fortran read statements for the header records are:

```
READ(iunit)FNAME4, IGTYP4, NX4, NY4, DELX4, DELY4, XORIG4, YORIG4, IUTMZ4,  
1 NSE4, IBDAT4, IBTIM4, IEDAT4, IETIM4, VRS4, LABEL4
```

```
READ(iunit)CSLST4
```

```
READ(iunit)XMWEM4
```

where the following declarations apply:

```
CHARACTER*12 FNAME4, VRS4, LABEL4, CSLST4(nse4)  
REAL XMWEM4(nse4)
```

AREM - Header Record 1 - General Grid, Species, and Date Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	FNAME4	C*12	Data set name	AREM
2	IGTYP4	integer	Horizontal grid type (always = 1 for CALPUFF runs)	1
3	NX4	integer	Number of grid cells in the X direction	30
4	NY4	integer	Number of grid cells in the Y direction	30
5	DELX4	real	Grid spacing (km) in the X direction	5.
6	DELY4	real	Grid spacing (km) in the Y direction	5.
7	XORIG4	real	Reference X UTM coordinate (km) of the southwest corner of grid cell (1,1)	168.000
8	YORIG4	real	Reference Y UTM coordinate (km) of the southwest corner of grid cell (1,1)	3839.000
9	IUTMZ4	integer	UTM zone of horizontal coordinates	11
10	NSE4	integer	Number of species emitted	3
11	IBDAT4	integer	Date of beginning of data in file (YYJJJ, where YY=year, JJJ=Julian day)	84220
12	IBTIM4	integer	Hour of beginning of data in file (00-23, LST)	00
13	IEDAT4	integer	Date of ending of data in file (YYJJJ, where YY=year, JJJ=Julian day)	84224
14	IETIM4	integer	Hour of ending of data in file (00-23, LST)	23
15	VRS4	C*12	Data set version	Base Case
16	LABEL4	C*12	Data set label	'84 - KERN

<sup>a</sup> C\*12 = Character\*12

AREM - Header Record 2 - Species List

<u>No.</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	C*12	Species identifier for species 1	SO2
2	C*12	Species identifier for species 2	SO4
.	.	.	.
.	.	.	.
.	.	.	.
NSE4	C*12	Species identifier for species "NSE4"	NOX

---

\* "NSE4" elements of CSLST4 array

<sup>a</sup> C\*12 = Character\*12

AREM - Header Record 3 - Molecular Weights

<u>No.</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	real	Molecular weight for species 1	64. (SO2)
2	real	Molecular weight for species 2	96. (SO4)
.	.	.	.
.	.	.	.
.	.	.	.
NSE4	real	Molecular weight for species "NSE4"	30. (NOX)

---

\* "NSE4" elements of XMWEM1 array

## AREM.DAT File - Data Records

The AREM.DAT file contains a set of "NSE4"+1 records for each time period (e.g., hour). The first data record of each set defines the time period over which the emissions data in the following records are valid. The next "NSE4" records each contain a species identifier and a two-dimensional gridded field of emissions.

Sample Fortran read statements for a set of data records are:

```
Loop over time periods (e.g., Hours)
  READ(iunit)IBDAT,IBTIM,IEDAT,IETIM
    Loop over species
      READ(iunit)CSPEC,QEMIT
    End loop over species
  End loop over time periods
```

where the following declarations apply:

```
CHARACTER*12 CSPEC
REAL QEMIT(nx4,ny4)
```

AREM - Data Record Contents

(Record 1 of each set)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	IBDAT	integer	Beginning date for which data in this set is valid (YYJJJ, where YY=year, JJJ=Julian day)
2	IBTIM	integer	Beginning time for which data in this set is valid (00-23, LST)
3	IEDAT	integer	Ending date for which data in this set is valid (YYJJJ, where YY=year, JJJ=Julian day)
4	IETIM	integer	Ending time for which data in this set is valid (00-23, LST)

---

Example:

Data Valid for 1 hour:

IBDAT=89183, IBTIM=00, IEDAT=89183, IETIM=00

IBDAT=89183, IBTIM=01, IEDAT=89183, IETIM=01

IBDAT=89183, IBTIM=02, IEDAT=89183, IETIM=02

Data Valid for 3 hours:

IBDAT=89183, IBTIM=00, IEDAT=89183, IETIM=02

IBDAT=89183, IBTIM=03, IEDAT=89183, IETIM=05

IBDAT=89183, IBTIM=06, IEDAT=89183, IETIM=08

AREM - Data Record Contents  
 (Records 2, 3, ... "NSE4"+1 of each set)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CSPEC	C*12	Species identifier (up to 12 characters)
Next NX4*NY4	QEMIT array	real	Area source emission rate (g/s) of species "CSPEC" for each grid column (QEMIT(nx4,ny4))

---

<sup>a</sup> C\*12 = Character\*12

#### 4.2.5 User-Specified Deposition Velocity Data File (VD.DAT)

The CALPUFF model requires that the user specify the a method for determining dry deposition velocities for each species. In Input Group 3 of the control file, one of the following flags must be specified for each pollutant.

- 0 = no dry deposition (deposition velocities set to zero)
- 1 = resistance model used - pollutant deposited as a gas
- 2 = resistance model used - pollutant deposited as a particle
- 3 = user-specified deposition velocities used

Note that different methods can be used for different pollutants in the same CALPUFF run.

If any species are flagged as using "user-specified" deposition velocities, CALPUFF reads a formatted user-prepared data file with a 24-hour diurnal cycle of deposition velocities for each species flagged. The 24 values correspond to hours 01-24 (LST) of the simulated day. Twenty-four values must be entered for each flagged pollutant, even if the model run is for less than a full diurnal cycle. The units of the deposition velocities are m/s.

An example of a user-specified VD.DAT file is shown in Table 4.2.5-1. The VD.DAT file uses a control file format (see Section 4.2.1). All text outside the delimiters (!) is considered as user comment information and is echoed back but otherwise ignored by the input module. Each data line consists of a delimiter followed by the species name, 24 deposition velocities, and a terminating delimiter. The data may extend over more than one line. The line being continued must end with a comma. The control file format allows the use of repetition factors (e.g., 3 \* 1.0 instead of 1.0, 1.0, 1.0). The order in which the species are entered in the file is not important. However, the file must end with an input group terminator (i.e., !END!).

The model checks that values have been entered for each species flagged as using user-specified deposition velocities. An error message is printed and execution of the run is terminated if any values are missing. The run will also terminate with an error message from the input routine if too many values are entered (i.e., more than 24 values for a particular pollutant). The species names must match those used in the chemical mechanism of the model.

Table 4.2.5-1. Sample user-specified deposition velocity file for two species.

DEPOSITION VELOCITY FILE (VD.DAT)  
-----

VD.DAT contains a 24-hour diurnal cycle of deposition velocities for each species flagged as using user-specified values in the control file (CALPUFF.INP).

NOTE: Units are in m/s.  
-----

SPECIES NAME	Deposition Velocities (m/s)
-----	-----
! HNO3	= 5*1.5e-2, 4*1.7e-2, 3*1.8e-2, 3*1.9e-2, 3*1.7e-2, 6*1.5e-2 !
! SO2	= 5*0.8e-2, 13*1.0e-2, 6*0.8e-2 !
!END!	

#### 4.2.6 Hourly Ozone Data File (OZONE.DAT)

If the MESOPUFF II chemical mechanism is used to simulate the chemical transformation of  $\text{SO}_2 \rightarrow \text{SO}_4^-$  and  $\text{NO}_x \rightarrow \text{HNO}_3 \leftrightarrow \text{NO}_3^-$ , estimates of background ambient ozone concentration levels are required to compute the hourly conversion rates. CALPUFF provides two options for the user to provide these data: (1) a single, typical background value appropriate for the modeling region, or (2) hourly ozone data from one or more ozone monitoring stations. The selection of Option 2 requires that a file called OZONE.DAT be created with the necessary data.

OZONE.DAT is a sequential, formatted data file containing three types of records: single header record, time-invariant data records, and hourly ozone data records. The header record contains information on the number of stations in the data set, the time period of the data, and descriptive information regarding the file. The time-invariant records contain the coordinates of each of the ozone stations. The time-varying data consists of hourly ozone concentrations at each of the ozone stations.

## OZONE.DAT File - Header Record

The header records of the OZONE.DAT file contain the name, version, and label of the data set, the number of ozone stations, and starting and ending time periods of data in the file. A sample Fortran read statement for the header record is:

```
READ(iunit,*)FNAMEO,NOZSTA,IUTMZO,IBDATO,IBTIMO,IEDATO,  
1 IETIMO,VRSO,LABELO
```

where the following declaration applies:

```
CHARACTER*12 FNAMEO,VRSO,LABELO.
```

OZONE.DAT - Header Record - General Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Values</u>
1	FNAMEO	C*12	Data set name	OZONE
2	NOZSTA	integer	Number of ozone stations in the file	3
3	IUTMZO	integer	UTM zone in which ozone station coordinates are specified	11
4	IBDATO	integer	Date of beginning of data in the file (YYJJJ, where YY=year, JJJ=Julian day)	84220
5	IBTIMO	integer	Hour of beginning of data in the file (00-23, LST)	00
6	IEDATO	integer	Date of ending of data in the file (YYJJJ, where YY=year, JJJ=Julian day)	84224
7	IETIMO	integer	Hour of ending of data in the file (00-23, LST)	23
8	VRSO	C*12	Data set version	Base Case
9	LABELO	C*12	Data set label	Major pts.

---

<sup>a</sup> C\*12 = Character\*12

## OZONE.DAT File - Data Records

The OZONE.DAT file contains two types of data records. A set of time-invariant records are read after the header records. These records specify the coordinates of each ozone station. A set of time-varying data follows, which contain the hourly ozone concentration (in ppm) for each station.

Sample Fortran read statements for time-invariant data records are:

```
Loop over stations  
  READ(iunit,*)CID,XOZ,YOZ  
End loop over stations
```

where the following declaration applies:

```
CHARACTER*16 CID
```

Sample Fortran read statements for time-varying data records are:

```
Loop over hours  
  READ(iunit,*)IYR,IJUL,IHR,OZCONC  
End loop over hours
```

where the following declaration applies:

```
REAL OZCONC(nozsta)
```

OZONE.DAT - Time-Invariant Data Record Contents

(Repeated for each station)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CID	C*16	Station identifier (16 characters=4 words)
2	XOZ	real	Easting UTM coordinate (km) of the ozone station
3	YOZ	real	Northing UTM coordinate (km) of the ozone station

---

<sup>a</sup> C\*16 = Character\*16

OZONE.DAT - Time-Varying Data Record Contents  
(One record per hour)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	IYR	integer	Year of data (two digits)
2	IJUL	integer	Julian day
3	IHR	integer	Hour of data
Next	OZCONC	real	Ozone concentration (ppm) at each ozone "NOZSTA"arraystation (in the same order as the station coordinates in the time-invariant records)

#### 4.2.7 User-specified Chemical Transformation Rate Data File (CHEM.DAT)

If chemical conversion is to be considered by CALPUFF, the user must specify a variable in the control file, MCHEM, which determines how chemical transformation rates are computed. The options for MCHEM are:

- 0 = chemical transformation is not modeled
- 1 = the MESOPUFF II chemical scheme is used to compute transformation rates
- 2 = user-specified 24-hour cycles of transformation rates are used

If MCHEM is set equal to 2, CALPUFF reads a formatted user-prepared data file with 24-hour diurnal cycles of transformation rates  $k_1$ ,  $k_2$ ,  $k_3$  (described in Section 2.8). The nature of the equilibrium relationship assumed between pollutants 4 and 5 (e.g.,  $\text{HNO}_3$  and  $\text{NO}_3^-$ ) precludes the use of a user-specified conversion rate between these pollutants. If  $\text{NO}_3$  is being modeled, the  $\text{NH}_4\text{NO}_3$  dissociation constant is determined as a function of temperature and relative humidity as described in Section 2.8.1.

A sample user-specified CHEM.DAT file is shown in Table 4.2.7-1. The CHEM.DAT file uses a control file format (see Section 4.2.1). All text outside the delimiters (!) is considered as user comment information and is echoed back but otherwise ignored by the input module. Each data line consists of a delimiter followed by the species name, 24 conversion rates, and a terminating delimiter. The data may extend over more than one line. The line being continued must end with a comma. The control file format allows the user of repetition factors (e.g., 3 \* 1.0 instead of 1.0, 1.0, 1.0). The order in which the species are entered in the file is not important. However, the file must end with an input group terminator (i.e., !END).

The model checks that the proper number of values have been entered for each conversion rate. An error message is printed and execution of the run is terminated if any values are missing. The run will also terminate with an error message from the input routine if too many values are entered (i.e., more than 24 values).

Table 4.2.7-1. Sample user-specified chemical transformation rate data file (CHEM.DAT).

CHEMICAL TRANSFORMATION RATE FILE (CHEM.DAT)

-----

CHEM.DAT contains a 24-hour diurnal cycle of chemical transformation rates for the chemical transformation of SO<sub>2</sub> to SO<sub>4</sub>, and NO<sub>x</sub> to HNO<sub>3</sub>/PAN.

k1 = SO<sub>2</sub> to SO<sub>4</sub> transformation rate(percent/hour)

k2 = NO<sub>x</sub> to HNO<sub>3</sub> + PAN transformation rate (percent/hour)

k3 = NO<sub>x</sub> to HNO<sub>3</sub> (only) transformation rate (percent/hour)

TRANSFORMATION RATE (percent/hour)

-----

! K1 = 7\*0.2, 0.4, 0.8, 1.2, 1.6, 3\*2.0, 1.6, 1.2, 0.8, 0.4, 6\*0.2 !  
! K2 = 7\*2.0, 4.0, 8.0,12.0,15.0,3\*20.0,15.0,12.0, 8.0, 4.0, 6\*2.0 !  
! K3 = 7\*2.0, 3.0, 6.0, 8.0,11.0,3\*15.0,11.0, 8.0, 6.0, 3.0, 6\*2.0 !

!END!

#### 4.2.8 Site-Specific Turbulence Data (SIGMA.DAT)

CALPUFF provides several options for computing the dispersion coefficients,  $\sigma_y$  and  $\sigma_z$ . In Input Group 2 of the control file, the user specifies a value for the dispersion method flag, MDISP:

- 1 = dispersion coefficients computed from values of  $\sigma_v$  and  $\sigma_w$  read from a data file (SIGMA.DAT),
- 2 = dispersion coefficients determined from internally computed values of  $\sigma_v$  and  $\sigma_w$  based on similarity scaling relationships,
- 3 = PGT coefficients (computed using the ISCST multi-segment approximation) used for rural areas and MP coefficients used in urban areas,
- 4 = same as 3 except that the PGT coefficients are computed using the MESOPUFF II equations.

Section 2.2.1 contains more information on these options. If Option 1 is selected, the user must prepare a data file with hourly values of  $\sigma_v$  and  $\sigma_w$ . This option is intended primarily for application to a single source or facility with onsite measurements of  $\sigma_v$  and  $\sigma_w$ . Therefore, only one set of observations are allowed in the data base and they are assumed to apply over the entire computational region.

SIGMA.DAT is a sequential, formatted data file containing a single time-invariant header record followed by a set of hourly data records. The header record contains some general descriptive information on the file and specifies the time period of the data in the file. The time-varying data records consist of a date and hour followed by values of  $\sigma_v$  and  $\sigma_w$ .

## SIGMA.DAT File - Header Record

The header record of the SIGMA.DAT file contains the name, version, and label of the data set, and the starting and ending time periods of the data in the file. A sample Fortran read statement for the header record is:

```
READ(iunit)FNAMES, IBDATS, IBTIMS, IEDATS, IETIMS, VRSS, LABELS
```

where the following declaration applies:

```
CHARACTER*12 FNAMES, VRSS, LABELS
```

SIGMA.DAT - Header Record - General Data

<u>NO.</u>	<u>VARIABLE</u>	<u>TYPE</u> <sup>a</sup>	<u>DESCRIPTION</u>	<u>SAMPLE</u> <u>VALUES</u>
1	FNAMES	C*12	Data set name	SIGMA
2	IBDATS	integer	Date of beginning of data in the file (YYJJJ, where YY=year and JJJ=Julian day)	84220
3	IBTIMS	integer	Hour of beginning of data in the file (00-23, LST)	00
4	IEDATS	integer	Date of ending of data in the file (YYJJJ, where YY=year and JJJ=Julian day)	84224
5	IBTIMS	integer	Hour of ending of data in the file (00-23, LST)	23
6	VRSS	C*12	Data set version	Base Case
7	LABELS	C*12	Data set label	Onsite10m

---

<sup>a</sup> C\*12 = Character\*12

## SIGMA.DAT File - Data Records

The SIGMA.DAT file contains one data record per hour. Each record contains values for  $\sigma_v$  and  $\sigma_w$ , in m/s, at a 10 meter measurement height. A sample read statement for the hourly data records is:

```
Loop over hours  
  
    READ(iunit,*)IYR,IJUL,IHR,SIGU,SIGW  
  
End loop over hours
```

SIGMA.DAT - Time-Varying Data Record Contents  
(One record per hour)

<u>NO.</u>	<u>VARIABLE</u>	<u>TYPE</u> <sup>a</sup>	<u>DESCRIPTION</u>
1	IYR	integer	Year of data (two digits)
2	IJUL	integer	Julian day
3	IHR	integer	Hour of data
4	SIGV	real	Standard deviation (m/s) of the horizontal crosswind component of the wind ( $\sigma_v$ )
5	SIGW	real	Standard deviation (m/s) of the vertical component of the wind ( $\sigma_w$ )

### 4.3 CALPUFF Output Files

#### 4.3.1 Concentration File (CONC.DAT)

The CONC.DAT file is an unformatted data file containing gridded fields of time averaged concentrations predicted by CALPUFF. The creation and contents of the CONC.DAT file are controlled by user-specified inputs in Input Group 7 of the control file (see Section 4.2.1). The control file variable ICON must be set equal to one in order to create the CONC.DAT file.

#### CONC.DAT File - Header Records

The CONC.DAT file consists of five header records followed by a set of data records. The header records contain information describing the version of the model used in the run creating the file, horizontal and vertical grid data, a user-input title, a list of the species combinations stored in the output file, and receptor information.

Sample FORTRAN read statements for the header records are:

```
READ(iunit)CMODEL, VER, LEVEL, IBYR, IBJUL, IBHR,  
1 IRLG, IAVG, NXM, NYM, DXKM, DYKM, IONE, IBCOMP, IECOMP, JBCOMP, JECOMP,  
2 IBSAMP, JBSAMP, IESAMP, JESAMP, MESHDN, NPTS, NAREAS, NDREC, NCTREC, LSGRID,  
3 NSPOUT  
READ(iunit)TITLE  
READ(iunit)CSOUT  
READ(iunit)XREC, YREC, ZREC  
READ(iunit)XRCT, YRCT, ZRCT, IHILL
```

where the following declarations apply:

```
Character*80 TITLE(3)  
Character*15 CSOUT(NSPOUT)  
Character*12 CMODEL, VER, LEVEL
```

Real XREC(NDREC), YREC(NDREC), ZREC(NDREC)

Real XRCT(NCTREC), YRCT(NCTREC), ZRCT(NCTREC)

Integer IHILL(NCTREC)

Unformatted CONC.DAT file - Header Record 1 - General Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Value</u>
1	CMODEL	C*12	Model name	CALPUFF
2	VER	C*12	Model version number	1.0
3	LEVEL	C*12	Model level number	900330
4	IBYR	integer	Starting year of the run	80
5	IBJUL	integer	Starting Julian day	183
6	IBHR	integer	Starting hour (00-23)	8
7	IRLG	integer	Length of run (hours)	5
8	IAVG	integer	Averaging time (hours) of output concentrations	1
9	NXM	integer	Number of grid points in meteorological grid (X direction)	20
10	NYM	integer	Number of grid points in meteorological grid (Y direction)	20
11	DXKM	real	Grid spacing (km) in the X direction	5.
12	DYKM	real	Grid spacing (km) in the Y direction	5.
13	IONE	integer	Number of receptor layers (must be equal to one for CALPUFF runs)	1
14	IBCOMP	integer	Start of computational grid in X direction	1
15	IECOMP	integer	End of computational grid in X direction	20
16	JBCOMP	integer	Start of computational grid in Y direction	1
17	JECOMP	integer	End of computational grid in Y direction	20
18	IBSAMP	integer	Start of sampling grid in X direction	1
19	JBSAMP	integer	End of sampling grid in X direction	20

---

<sup>a</sup> C\*12 = Character\*12

Unformatted CONC.DAT file - Header Record 1 - General Data (Concluded)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Sample Value</u>
20	IESAMP	integer	Start of sampling grid in Y direction	1
21	JESAMP	integer	End of sampling grid in Y direction	20
22	MESHDN	integer	Sampling grid spacing factor	1
23	NPTS	integer	Number of point sources	2
24	NAREAS	integer	Number of area sources	0
25	NDREC	integer	Number of discrete receptors	0
26	NCTREC	integer	Number of complex terrain receptors	0
27	LSGRID	logical	Sampling grid flag (T = gridded receptors, F = no gridded receptors)	T
28	NSPOUT	integer	Number of output species	5

Unformatted CONC.DAT file - Header Record 2 - Run Title

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	title array	C*80	User-specified run title (three lines of up to 70 characters/line)

Header Record 3 - List of Species in Output File

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1-NSPEC	CSOUT array	C*15	Species name (first 11 characters) and layer (last 3 characters) of concentrations stored in the output file. CALPUFF concentrations are always computed at ground-level and therefore are labeled as layer 1.

---

<sup>a</sup> C\*80 = Character\*80

C\*15 = Character\*15

Header Record 4 - Discrete Receptors

(Included only if NDREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XREC	real array	X-coordinate (km) of each discrete receptor
2	YREC	real array	Y-coordinate (km) of each discrete receptor
3	ZREC	real array	Ground level elevation (m) of each discrete receptor

Header Record 5 - Complex Terrain Receptors

(Included only if NCTREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XRCT	real array	X-coordinate (km) of each complex terrain receptor
2	YRCT	real array	Y-coordinate (km) of each complex terrain receptor
3	ZRCT	real array	Ground level elevation (m) of each complex terrain receptor
4	IHILL	integer array	Hill number associated with this receptor

## CONC.DAT File - Data Records

The CONC.DAT data records consist of a set of "NSPOUT+1" records for each hour of the CALPUFF run (NSPOUT is the number of output species in the CALPUFF run). The first record of each set contains the date and hour of the data in the records which follow it. The next "NSPOUT" records contain the predicted concentrations in  $\text{g}/\text{m}^3$ , for each species, flagged for output in the control file.

Sample FORTRAN read statements for the data records are:

```
LOOP OVER OUTPUT SPECIES  
  
GRIDDED RECEPTOR CONCENTRATIONS  
IF(LSGRID)READ(iunit)CSPECG, CONCG  
  
DISCRETE RECEPTOR CONCENTRATIONS  
IF(NDREC.GT.0)READ(iunit)CSPECD, CONCD  
  
COMPLEX TERRAIN RECEPTOR CONCENTRATIONS  
IF(NCTREC.GT.0)READ(iunit)CSPECCT, CONCCT  
  
END LOOP OVER OUTPUT SPECIES
```

where the following declarations apply:

```
Character*15 CSPECG, CPSECD, CSPECCT  
Real CONCG(nxg,nyg) 1 CONCD(NDREC), CONCCT(NCTREC)
```

and

```
nxg = IESAMP - IBSAMP+1  
nyg = JESAMP - JBSAMP+1
```

Unformatted CONC.DAT File - Data Records

(Record 1 of each set)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	NYR	integer	Year of concentration data (two digits)
2	NJUL	integer	Julian day of data
3	NHR	integer	Hour (00-23) of data

(Next Data Record)

(Included only if LSGRID=TRUE)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CSPECG	C*15	Species name (first 12 characters) and layer (last 3 characters) of the concentrations in this record. (Note: Layer is always "001" in CALPUFF output).
Next	CONCG	real	"IAVG" - hour averaged concentrations (g/m <sup>3</sup> )
	NXG*NYG	array	for each sampling grid point.

---

<sup>a</sup> C\*15 = Character\*15

#### 4.3.2 Dry Flux File (DFLX.DAT)

The DFLX.DAT file is an unformatted data file containing gridded fields of time averaged dry deposition fluxes predicted by CALPUFF. The creation and contents of the DFLX.DAT file are controlled by user-specified inputs in Input Group 7 of the control file (see Section 4.2.1).

The control file variable IDRY must be set equal to one in order to create the DFLX.DAT file. The species saved in the output file are also controlled by the user by setting flags in the output species table in Input Group 7 of the control file. The model checks that only deposited species are flagged for output into the DFLX.DAT file. The effects of dry deposition on ambient concentrations can be evaluated without saving the dry fluxes in the output file if the actual values of the deposition fluxes are not of interest.

#### DFLX.DAT File - Header Records

The DFLX.DAT file consists of five header records followed by a set of data records. The header records contain information describing the version of the model used in the run creating the file, horizontal and vertical grid data, a user-input run title, and a list of the deposited species stored in the output file, and receptor information.

Sample FORTRAN read statements for the header records are:

```
READ(iunit)CMODEL, VER, LEVEL, IBYR, IBJUL, IBHR, IRLG,  
1 IAVG, NXM, NYM, DXKM, DYKM, IONE, IBCOMP, IECOMP, JBCOMP, JECOMP  
2 IBSAMP, JBSAMP, IESAMP, JESAMP, MESHDN, NPTS, NAREAS, NDREC, NCTREC, LSGRID,  
3 NDFOUT  
READ(iunit)TITLE  
READ(iunit)CDFOUT  
READ(iunit)XREC, YREC, ZREC  
READ(iunit)XRCT, YRCT, ZRCT, IHILL
```

where the following declarations apply:

Character\*80 TITLE(3)

Character\*15 CDFOUT(NDFOUT)

Character\*12 CMODEL, VER, LEVEL

Real XREC(NDREC), YREC(NDREC), ZREC(NDREC)

Real XRCT(NCTREC), YRCT(NCTREC), ZRCT(NCTREC)

Integer IHILL(NCTREC)

Unformatted DFLX.DAT file - Header Record 1 - General Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Value</u>
1	CMODEL	C*12	Model name	CALPUFF
2	VER	C*12	Model version number	1.0
3	LEVEL	C*12	Model level number	900330
4	IBYR	integer	Starting year of the run	80
5	IBJUL	integer	Starting Julian day	183
6	IBHR	integer	Starting hour (00-23)	8
7	IRLG	integer	Length of run (hours)	5
8	IAVG	integer	Averaging time (hours) of output concentrations	1
9	NXM	integer	Number of grid points in meteorological grid (X direction)	20
10	NYM	integer	Number of grid points in meteorological grid (Y direction)	20
11	DXKM	real	Grid spacing (km) in the X direction	5.
12	DYKM	real	Grid spacing (km) in the Y direction	5.
13	IONE	integer	Number of grid points in meteorological grid (X direction)	1
14	IBCOMP	integer	Start of computational grid in X direction	1
15	IECOMP	integer	End of computational grid in X direction	20
16	JBCOMP	integer	Start of computational grid in Y direction	1
17	JECOMP	integer	End of computational grid in Y direction	20
18	IBSAMP	integer	Start of sampling grid in X direction	1
19	JBSAMP	integer	End of sampling grid in X direction	20

---

<sup>a</sup> C\*12 = Character\*12

Unformatted DFLX.DAT file - Header Record 1 - General Data (Concluded)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Sample Value</u>
20	IESAMP	integer	Start of sampling grid in Y direction	1
21	JESAMP	integer	End of sampling grid in Y direction	20
22	MESHON	integer	Sampling grid spacing factor	1
23	NPTS	integer	Number of point sources	2
24	NAREAS	integer	Number of area sources	0
25	NDREC	integer	Number of discrete receptors	0
26	NCTREC	integer	Number of complex terrain receptors	0
27	LSGRID	logical	Sampling grid flag (T = gridded receptors, F = no gridded receptors)	T
28	NDFOUT	integer	Number of dry deposited species stored in the output file	5

Unformatted DFLX.DAT file - Header Record 2 - Run Title

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	title array	C*80	User-specified run title (three lines of up to 70 characters/line)

Header Record 3 - List of Species-Layers in Output File

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1-NDFOUT	CDFOUT array	C*15	Species name (first 11 characters) and dry flux flag (last 3 characters) of data stored in the output file. The dry flux flag is ' DF'.

---

<sup>a</sup> C\*80 = Character\*80

C\*15 = Character\*15

Header Record 4 - Discrete Receptors

(Included only if NDREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XREC	real array	X-coordinate (km) of each discrete receptor
2	YREC	real array	Y-coordinate (km) of each discrete receptor
3	ZREC	real array	Ground level elevation (m) of each discrete receptor

Header Record 5 - Complex Terrain Receptors

(Included only if NCTREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XRCT	real array	X-coordinate (km) of each complex terrain receptor
2	YRCT	real array	Y-coordinate (km) of each complex terrain receptor
3	ZRCT	real array	Ground level elevation (m) of each complex terrain receptor
4	IHILL	integer array	Hill number associated with this receptor

## DFLX.DAT File - Data Records

The DFLX.DAT data records consist of a set of "NDFOUT+1" records for each hour of the CALPUFF runs (NDFOUT is the number of species flagged as being stored in the output file). The first record of each set contains the data and hour of the data in the records which follow it. The next "NDFOUT" records contain predicted one-hour averaged dry deposition fluxes in  $\text{g}/\text{m}^2/\text{s}$  for each relevant species.

Sample FORTRAN read statements for the data records are:

```
LOOP OVER DRY DEPOSITED SPECIES STORED ON DISK  
GRIDDED RECEPTOR DRY FLUXES  
  IF(LSGRID)READ(iunit)CDFG,DFLXG  
  
DISCRETE RECEPTOR DRY FLUXES  
  IF(NDREC.GT.0)READ(iunit)CDFD,DFLXD  
  
COMPLEX TERRAIN RECEPTOR DRY FLUXES  
  IF (NCTREC.GT.0)READ(iunit)CDFCT,DFLXCT  
END LOOP OVER DRY DEPOSITED SPECIES STORED ON DISK
```

where the following declarations apply:

```
Character*15 CDFG,CDFD,CDFCT  
Real DFLXG(nxg,nyg),DFLXD(NDREC),DFLXCT(NCTREC)
```

and

```
nxg = IESAMP - IBSAMP+1  
nyg = JESAMP - JBSAMP+1
```

Unformatted DFLX.DAT File - Data Records

(Record 1 of each set)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	NYR	integer	Year of dry flux data (two digits)
2	NJUL	integer	Julian day of data
3	NHR	integer	Hour (00-23) of data

(Next Data Record)

(Included only if LSGRID = TRUE)

<u>No.</u>	<u>Variable</u>	<u>Type<sup>a</sup></u>	<u>Description</u>
1	CDFG	C*15	Species name (first 12 characters) and dry flux flag (last 3 characters = 'DF') of the data in this record
Next NXG*NYG	DFLXG	real array	"IAYG" - hour averaged dry deposition fluxes (g/m <sup>2</sup> /s) for each gridded receptor

---

<sup>a</sup> C\*15 = Character\*15

Unformatted DFLX.DAT File - Data Records

(Next Data Record)

(Included only if NDREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CDFD	C*15	Species name (first 12 characters) and dry flux flag (last 3 characters = 'DF') of the data in this record
Next NDREC	DFLXD	real array	"IAVG" - hour averaged dry deposition fluxes (g/m <sup>2</sup> /s) for each discrete receptor

(Next Data Record)

(Included only if NCTREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CDFCT	C*15	Species name (first 12 characters) and dry flux flag (last 3 characters = 'DF') of the data in this record
Next NCTREC	DFLXCT	real array	"IAVG" - hour averaged dry deposition fluxes (g/m <sup>2</sup> /s) at each complex terrain (CTSG) receptor

---

<sup>a</sup> C\*15 = Character\*15

### 4.3.3 Wet Flux File (WFLX.DAT)

The WFLX.DAT file is an unformatted data file containing gridded fields of time averaged wet deposition fluxes predicted by CALPUFF. The creation and contents of the WFLX.DAT file are controlled by user-specified inputs in Input Group 7 of the control file (see Section 4.2.1).

The control file variable IWET must be set equal to one in order to create the WFLX.DAT file. The species saved in the output file are also controlled by the user by setting flags in the output species table in Input Group 7 of the control file. The model checks that only deposited species are flagged for output into the WFLX.DAT file. The effects of wet deposition on ambient concentrations can be evaluated without saving the wet fluxes in the output file if the actual values of the deposition fluxes are not of interest.

#### WFLX.DAT File - Header Records

The WFLX.DAT file consists of five header records followed by a set of data records. The header records contain information describing the version of the model used in the run creating the file, horizontal and vertical grid data, a user-input run title, and a list of the deposited species stored in the output file, and receptor information.

Sample FORTRAN read statements for the header records are:

```
READ(iunit)CMODEL, VER, LEVEL, IBYR, IBJUL, IBHR, IRLG,  
1 IAVG, NXM, NYM, DXKM, DYKM, IONE, IBCOMP, IECOMP, JBCOMP, JECOMP  
2 IBSAMP, JBSAMP, IESAMP, JESAMP, MESHDN, NPTS, NAREAS, NDREC, NCTREC, LSGRID,  
3 NWFOUT  
READ(iunit)TITLE  
READ(iunit)CWFOUT  
READ(iunit)XREC, YREC, ZREC  
READ(iunit)XRCT, YRCT, ZRCT, IHILL
```

where the following declarations apply:

Character\*80 TITLE(3)

Character\*15 CWFOUT(NWFOUT)

Character\*12 CMODEL, VER, LEVEL

Real XREC(NDREC), YREC(NDREC), ZREC(NDREC)

Real XRCT(NCTREC), YRCT(NCTREC), ZRCT(NCTREC)

Integer IHILL(NCTREC)

Unformatted WFLX.DAT file - Header Record 1 - General Data

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>	<u>Sample Value</u>
1	CMODEL	C*12	Model name	CALPUFF
2	VER	C*12	Model version number	1.0
3	LEVEL	C*12	Model level number	900330
4	IBYR	integer	Starting year of the run	80
5	IBJUL	integer	Starting Julian day	183
6	IBHR	integer	Starting hour (00-23)	8
7	IRLG	integer	Length of run (hours)	5
8	IAVG	integer	Averaging time (hours) of output concentrations	1
9	NXM	integer	Number of grid points in meteorological grid (X direction)	20
10	NYM	integer	Number of grid points in meteorological grid (Y direction)	20
11	DXKM	real	Grid spacing (km) in the X direction	5.
12	DYKM	real	Grid spacing (km) in the Y direction	5.
13	IONE	integer	Number of grid points in meteorological grid (X direction)	1
14	IBCOMP	integer	Start of computational grid in X direction	1
15	IECOMP	integer	End of computational grid in X direction	20
16	JBCOMP	integer	Start of computational grid in Y direction	1
17	JECOMP	integer	End of computational grid in Y direction	20
18	IBSAMP	integer	Start of sampling grid in X direction	1

---

<sup>a</sup> C\*12 = Character\*12

Unformatted WFLX.DAT file - Header Record 1 - General Data (Concluded)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>	<u>Sample Value</u>
19	JBSAMP	integer	End of sampling grid in X direction	20
20	IESAMP	integer	Start of sampling grid in Y direction	1
21	JESAMP	integer	End of sampling grid in Y direction	20
22	MESHON	integer	Sampling grid spacing factor	1
23	NPTS	integer	Number of point sources	2
24	NAREAS	integer	Number of area sources	0
25	NDREC	integer	Number of discrete receptors	0
26	NCTREC	integer	Number of complex terrain receptors	0
27	LSGRID	logical	Sampling grid flag (T = gridded receptors, F = no gridded receptors)	T
28	NWFOUT	integer	Number of wet deposited species stored in the output file	5

Unformatted WFLX.DAT file - Header Record 2 - Run Title

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	title array	C*80	User-specified run title (three lines of up to 70 characters/line)

Header Record 3 - List of Species-Layers in Output File

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1-NWFOUT	CWFOUT array	C*15	Species name (first 11 characters) and wet flux flag (last 3 characters) of data stored in the output file. The wet flux flag is 'WF'.

---

<sup>a</sup> C\*80 = Character\*80

C\*15 = Character\*15

Unformatted WFLX.DAT File

Header Record 4 - Discrete Receptors

(Included only if NDREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XREC	real array	X-coordinate (km) of each discrete receptor
2	YREC	real array	Y-coordinate (km) of each discrete receptor
3	ZREC	real array	Ground level elevation (m) of each discrete receptor

Header Record 5 - Complex Terrain Receptors

(Included only if NCTREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	XRCT	real array	X-coordinate (km) of each complex terrain receptor
2	YRCT	real array	Y-coordinate (km) of each complex terrain receptor
3	ZRCT	real array	Ground level elevation (m) of each complex terrain receptor
4	IHILL	integer array	Hill number associated with this receptor

## WFLX.DAT File - Data Records

The WFLX.DAT data records consist of a set of "NWFOUT+1" records for each hour of the CALPUFF runs (NWFOUT is the number of species flagged as being stored in the output file). The first record of each set contains the data and hour of the data in the records which follow it. The next "NWFOUT" records contain predicted one-hour averaged wet deposition fluxes in  $\text{g/m}^2/\text{s}$  for each relevant species.

Sample FORTRAN read statements for the data records are:

```
LOOP OVER WET DEPOSITED SPECIES STORED ON DISK  
  GRIDDED RECEPTOR WET FLUXES  
    IF (LSGRID) READ(iunit) CWFG, WFLXG  
  
  DISCRETE RECEPTOR WET FLUXES  
    IF (NDREC.GT.0) READ(iunit) CWFD, WFLXD  
  
  COMPLEX TERRAIN RECEPTOR WET FLUXES  
    IF (NCTREC.GT.0) READ(iunit) CWFCT, WFLXCT  
  
END LOOP OVER WET DEPOSITED SPECIES STORED ON DISK
```

where the following declarations apply:

```
Character*15 CWFG, CWFD, CWFCT  
Real WFLXG(nxg,nyg), WFLXD(NDREC), WFLXCT(NCTREC)
```

and

```
nxg = IESAMP - IBSAMP+1  
nyg = JESAMP - JBSAMP+1
```

Unformatted WFLX.DAT File - Data Records

(Record 1 of each set)

<u>No.</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
1	NYR	integer	Year of wet flux data (two digits)
2	NJUL	integer	Julian day of data
3	NHR	integer	Hour (00-23) of data

(Next Data Record)

(Included only if LSGRID = TRUE)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CWFG	C*15	Species name (first 12 characters) and wet flux flag (last 3 characters = 'WF') of the data in this record
Next NXG*NYG	WFLXG	real array	"IAYG" - hour averaged wet deposition fluxes (g/m <sup>2</sup> /s) for each gridded receptor

---

<sup>a</sup> C\*15 = Character\*15

Unformatted WFLX.DAT File - Data Records

(Next Data Record)  
 (Included only if NDREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CWFD	C*15	Species name (first 12 characters) and wet flux flag (last 3 characters = 'WF') of the data in this record
Next NDREC	WFLXD	real array	"IAVG" - hour averaged wet deposition fluxes (g/m <sup>2</sup> /s) for each discrete receptor

(Next Data Record)  
 (Included only if NCTREC > 0)

<u>No.</u>	<u>Variable</u>	<u>Type</u> <sup>a</sup>	<u>Description</u>
1	CWFACT	C*15	Species name (first 12 characters) and wet flux flag (last 3 characters = 'WF') of the data in this record
Next NCTREC	WFLXD	real array	"IAVG" - hour averaged wet deposition fluxes (g/m <sup>3</sup> /s) at each complex terrain (CTSG) receptor

---

<sup>a</sup> C\*15 = Character\*15

#### 4.4 POSTPRO Postprocessing Program

The POSTPRO program is a postprocessor designed to produce ranked tabulations of averages of selected concentration (or wet/dry deposition flux) data obtained from either the CALGRID or the CALPUFF model. Its capabilities and options include:

- User-selected processing periods.
- User-selected chemical species.
- User-selected layer from which concentration data are obtained.
- Option to include gridded receptors, discrete receptors, and complex terrain receptors in any combination.
- Option to scale all concentration/deposition data by means of a linear function of the form:  $a \cdot C + b$  (where C is concentration/deposition).
- User-specified averaging time.
- Option to produce tables of the "top-50" average concentration/deposition data (includes time and receptor information) for specified averaging times.
- Option to produce tables of the "top-N" (user specifies the number N) average concentration/deposition data at each receptor for specified averaging times.
- Option to produce a table of the annual (or length-of-run) average concentration/deposition at each receptor.
- Option to print concentration/deposition averages for selected days.

Two input files are read by POSTPRO: a user-input control file and the unformatted concentration/deposition data file generated by either CALPUFF or CALGRID. The output file, POSTPRO.LST contains the printed data selected by the user. Table 4-4.1 contains a summary of the input files and output file for POSTPRO.

The POSTPRO control file contains the user's inputs entered in Fortran free format. A description of each input variable is shown in Table 4-4.2. A sample input file is presented in Table 4-4.3. A sample output file is shown in Table 4-4.4.

Table 4.4-1

## POSTPRO Input and Output Files

<u>Unit</u>	<u>File Name</u>	<u>Type</u>	<u>Format</u>	<u>Description</u>
5	POSTPRO.INP	input	formatted	Control file containing user inputs
7	POSTPRO.LST	output	formatted	List file (line printer output file)
4	CALOUT.DAT	input	unformatted	CALPUFF or CALGRID output file containing modeled concentration/deposition data.

Table 4.4-2

POSTPRO Control File Inputs (POSTPRO.INP)

Record 1. Beginning date and time.

<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
*	ISYR	integer	Starting year of data to print (two digit)
*	JSDAY	integer	Starting Julian day (1-366)
*	ISHR	integer	Starting hour (00-23)

---

\* Entered in Fortran free format

Table 4.4-2 (Continued)

## POSTPRO Control File Inputs (POSTPRO.INP)

Records 2-7. Run length, species, layer, and receptor-types.

<u>Record</u> <sup>1</sup>	<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
2	*	NHRS	integer	Number of hours to include.
3	*	ASPEC	character	Chemical species to include (there are 36 in CALGRID, and 5 in CALPUFF output from which one is selected).
4	*	ILAYER	integer	Layer from which data are obtained (set to -1 for dry deposition flux, or -2 for wet deposition flux)
5	*	LG	logical	Control variable for selecting gridded receptor data. (T=include, F=do not include)
6	*	LD	logical	Control variable for selecting discrete receptor data. (T=include, F=do not include)
7	*	LCT	logical	Control variable for selecting complex terrain receptor data. (T=include, F=do not include)

---

\* Entered in Fortran free format

<sup>1</sup> Note: One variable entered per input record.

Table 4.4-2 (Continued)

POSTPRO Control File Inputs (POSTPRO.INP)

Record 8. Constants for scaling concentration/deposition data.

<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
*	A	real	Multiplicative constant
*	B	real	Additive constant
			(Use zero for <u>both</u> if no scaling is wanted)

---

\* Entered in Fortran free format

Table 4-4.2 (Continued)

## POSTPRO Control File Inputs (POSTPRO.INP)

Records 9-14 Averaging<sup>2</sup> and "top-50" tabulation control variables<sup>3</sup>.

<u>Record</u> <sup>1</sup>	<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
9	*	NAVG	integer	User-specified averaging time. (hours).
10	*	L1T50	logical	Control variable for top-50 table of 1-hr averages (T= include, F=do not include).
11	*	L3T50	logical	Control variable for top-50 table of 3-hr averages (T= include, F=do not include).
12	*	L24T50	logical	Control variable for top-50 table of 24-hr averages (T= include, F=do not include).
13	*	LNT50	logical	Control variable for top-50 table of navg-hr averages (T= include, F=do not include).
14	*	LRT50	logical	Control variable for top-50 table of length-of-run averages (T= include, F=do not include).

---

\* Entered in Fortran free format

<sup>1</sup> Note: One variable entered per input record.

<sup>2</sup> Note: The averaging is actually performed in units determined by the CALGRID or CALPUFF run. If this unit is 1 hour, then the 1-hr, 3-hr (etc.) naming convention holds. If the basic unit is 2 hours, then 2-hr, 6-hr (etc.) averages are printed. The variable reported as "mavg" in the POSTPRO output file gives the basic unit of time, and the POSTPRO output tables explicitly account for "mavg" in reporting (for example) "3 \* 2 hr" averages.

<sup>3</sup> Note: Top-50 tables include only those receptor types (gridded, discrete, or complex terrain) that are selected by setting the corresponding control variables (LG,LD,LCT) equal to "T".

Table 4.4-2 (Continued)

## POSTPRO Control File Inputs (POSTPRO.INP)

Records 15-20 "N-TOP" tabulation control variables<sup>2</sup>.

<u>Record</u> <sup>1</sup>	<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
15	*	NTOP	integer	User-specified number of "top" concentration/deposition values to tabulate at each receptor (the maximum number is 4).
16	*	L1TOPN	logical	Control variable for top-NTOP table of 1-hr averages (T= include, F=do not include).
17	*	L3TOPN	logical	Control variable for top-NTOP table of 3-hr averages (T= include, F=do not include).
18	*	L24TOPN	logical	Control variable for top-NTOP table of 24-hr averages (T= include, F=do not include).
19	*	LNTOPN	logical	Control variable for top-NTOP table of navg-hr averages (T= include, F=do not include).
20	*	LRAVG	logical	Control variable for table of length-of-run average (T= include, F=do not include).

---

\* Entered in Fortran free format

<sup>1</sup> Note: One variable entered per input record.

<sup>2</sup> Note: NTOP tables are produced for all receptors (gridded, discrete, and complex terrain) that are included in the data-file.

Table 4.4-2 (Continued)

## POSTPRO Control File Inputs (POSTPRO.INP)

Records 21-24 Daily output control variables.

<u>Record</u> <sup>1</sup>	<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
21	*	LECH1	logical	Control variable for printing all 1-hr averages for days in IECHO array.
22	*	LECH3	logical	Control variable for printing all 3-hr averages for days in IECHO array.
23	*	LECH24	logical	Control variable for printing all 24-hr averages for days in IECHO array.
24	*	LECHN	logical	Control variable for printing all navg-hr averages for days in IECHO array.

---

\* Entered in Fortran free format

<sup>1</sup> Note: One variable entered per input record.

Table 4.4-2 (Concluded)

POSTPRO Control File Inputs (POSTPRO.INP)

Record 25. IECHO array for selecting days for detailed printout.

<u>Columns</u>	<u>Variable</u>	<u>Type</u>	<u>Description</u>
*	IECHO(366)	integer	Sequence of 366 control variables that identify those days for which averages of concentration/deposition will be printed - see records 21-24. Each variable represents one Julian day, so all 366 values must be filled in. (0=do not print, 1=print).

---

\* Entered in Fortran free format





Table 4.4-4 (Continued)  
Sample POSTPRO Output File (POSTPRO.LST)

-----  
POSTPRO Version 0.0 Level 890515  
-----

ECHO OPTION -

DRY DEPOSITION AT EACH RECEPTOR IS PRINTED FOR THE FOLLOWING DAYS (0-NOT printed; 1-PRINTED):

```

1000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000
0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000
0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000
0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000 0000000000
  
```

AND FOR THE FOLLOWING AVERAGING PERIODS: (NOTE THAT THE AVERAGING PERIOD IN MODEL IS MAVG = 1 HR.)  
 1\*MAVG-HOUR AVERAGES  
 3\*MAVG-HOUR AVERAGES

1 \* 1-HOUR AVERAGE DRY DEPOSITION AT EACH RECEPTOR FOR THE PERIOD ENDING YEAR: 80 DAY: 1 HOUR: 1

GRIDDED RECEPTORS:

G3 DF

Multiply all values by 10 \*\* -21

```

10 I 0 0 0 0 0 0 0 0 0 0
   I + + + + + + + + + +
  9 I 0 36 27 18 16 31 36 39 42 0
   I + + + + + + + + + +
  8 I 0 38 36 32 26 31 24 20 11 0
   I + + + + + + + + + +
  7 I 0 49 56 65 19 22 25 58 55 0
   I + + + + + + + + + +
  6 I 0 11 22 33 38 31 40 39 43 0
   I + + + + + + + + + +
  5 I 0 38 33 35 29 31 12 13 15 0
   I + + + + + + + + + +
  4 I 0 51 28 41 21 29 35 35 39 0
   I + + + + + + + + + +
  3 I 0 34 34 28 29 30 30 20 16 0
   I + + + + + + + + + +
  2 I 0 32 29 29 14 16 17 43 39 0
   I + + + + + + + + + +
  1 I 0 0 0 0 0 0 0 0 0 0
   I + + + + + + + + + +
-----
   1  2  3  4  5  6  7  8  9 10
  
```

1 \* 1-HOUR AVERAGE DRY DEPOSITION AT EACH RECEPTOR FOR THE PERIOD ENDING YEAR: 80 DAY: 1 HOUR: 2

GRIDDED RECEPTORS:

G3 DF

Multiply all values by 10 \*\* -21

```

10 I 0 0 0 0 0 0 0 0 0 0
  
```

Table 4.4-4 (Continued)  
Sample POSTPRO Output File (POSTPRO.LST)

I	+	+	+	+	+	+	+	+	+	+
9 I	0	53	27	17	29	57	63	64	57	0
I	+	+	+	+	+	+	+	+	+	+
8 I	0	38	35	38	41	48	51	59	11	0
I	+	+	+	+	+	+	+	+	+	+
7 I	0	44	49	68	22	25	28	65	62	0
I	+	+	+	+	+	+	+	+	+	+
6 I	0	8	36	52	54	46	54	50	62	0
I	+	+	+	+	+	+	+	+	+	+
5 I	0	37	40	48	57	63	14	14	17	0
I	+	+	+	+	+	+	+	+	+	+
4 I	0	50	27	38	26	41	49	40	36	0
I	+	+	+	+	+	+	+	+	+	+
3 I	0	42	44	40	38	35	36	37	12	0
I	+	+	+	+	+	+	+	+	+	+
2 I	0	49	53	52	13	14	16	38	36	0
I	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+

---

	1	2	3	4	5	6	7	8	9	10
--	---	---	---	---	---	---	---	---	---	----

1 \* 1-HOUR AVERAGE DRY DEPOSITION AT EACH RECEPTOR FOR THE PERIOD ENDING

YEAR: 80 DAY: 1 HOUR: 3

GRIDDED RECEPTORS:

O3 DF

Multiply all values by 10 \*\* -21

10 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+
9 I	0	64.	28	17	40	72	83	85	72	0
I	+	+	+	+	+	+	+	+	+	+
8 I	0	40	35	45	61	69	73	83	11	0
I	+	+	+	+	+	+	+	+	+	+
7 I	0	42	47	78	28	26	28	70	70	0
I	+	+	+	+	+	+	+	+	+	+
6 I	0	6	45	70	71	54	63	61	79	0
I	+	+	+	+	+	+	+	+	+	+
5 I	0	39	52	62	76	90	17	16	19	0
I	+	+	+	+	+	+	+	+	+	+
4 I	0	50	26	37	36	56	62	39	33	0
I	+	+	+	+	+	+	+	+	+	+
3 I	0	49	52	45	42	39	36	33	9	0
I	+	+	+	+	+	+	+	+	+	+
2 I	0	58	63	59	13	13	15	34	35	0
I	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+

---

	1	2	3	4	5	6	7	8	9	10
--	---	---	---	---	---	---	---	---	---	----

3 \* 1-HOUR AVERAGE DRY DEPOSITION AT EACH RECEPTOR FOR THE PERIOD ENDING

YEAR: 80 DAY: 1 HOUR: 3

GRIDDED RECEPTORS:

Table 4.4-4 (Continued)  
 Sample POSTPRO Output File (POSTPRO.LST)

03 DF

Multiply all values by 10 \*\* -21

10	I	0	0	0	0	0	0	0	0	0
	I	+	+	+	+	+	+	+	+	+
9	I	0	51	27	17	28	53	61	63	57
	I	+	+	+	+	+	+	+	+	+
8	I	0	39	35	39	43	49	49	54	11
	I	+	+	+	+	+	+	+	+	+
7	I	0	45	51	70	23	24	27	64	62
	I	+	+	+	+	+	+	+	+	+
6	I	0	9	34	52	54	44	53	50	61
	I	+	+	+	+	+	+	+	+	+
5	I	0	38	42	48	54	62	15	15	17
	I	+	+	+	+	+	+	+	+	+
4	I	0	50	27	39	28	42	48	38	36
	I	+	+	+	+	+	+	+	+	+
3	I	0	42	43	37	36	35	34	30	12
	I	+	+	+	+	+	+	+	+	+
2	I	0	47	48	47	13	14	16	38	37
	I	+	+	+	+	+	+	+	+	+
1	I	0	0	0	0	0	0	0	0	0
	I	+	+	+	+	+	+	+	+	+
		1	2	3	4	5	6	7	8	9
		10								

Table 4.4-4 (Continued)  
 Sample POSTPRO Output File (POSTPRO.LST)

POSTPRO Version 0.0 Level 890515

03 DF  
 TOP-50 1 \* 1-HOUR AVERAGE DRY DEPOSITION VALUES

YEAR	DAY	HOUR	RECEPTOR	TYPE	DRY DEPOSITION
80	1	3	( 6, 5)	G	9.0070E-20
80	1	3	( 8, 9)	G	8.5233E-20
80	1	3	( 7, 9)	G	8.3397E-20
80	1	3	( 8, 8)	G	8.3044E-20
80	1	3	( 9, 6)	G	7.9424E-20
80	1	3	( 4, 7)	G	7.8376E-20
80	1	3	( 5, 5)	G	7.6365E-20
80	1	3	( 7, 8)	G	7.3132E-20
80	1	3	( 9, 9)	G	7.1782E-20
80	1	3	( 6, 9)	G	7.1737E-20
80	1	3	( 5, 6)	G	7.1163E-20
80	1	3	( 4, 6)	G	7.0285E-20
80	1	3	( 8, 7)	G	6.9562E-20
80	1	3	( 9, 7)	G	6.9556E-20
80	1	3	( 6, 8)	G	6.8801E-20
80	1	2	( 4, 7)	G	6.7830E-20
80	1	2	( 8, 7)	G	6.4592E-20
80	1	1	( 4, 7)	G	6.4591E-20
80	1	3	( 2, 9)	G	6.4044E-20
80	1	2	( 8, 9)	G	6.3663E-20
80	1	3	( 3, 2)	G	6.3423E-20
80	1	3	( 7, 6)	G	6.3421E-20
80	1	2	( 7, 9)	G	6.3225E-20
80	1	2	( 6, 5)	G	6.3023E-20
80	1	2	( 9, 7)	G	6.2481E-20
80	1	2	( 9, 6)	G	6.1996E-20
80	1	3	( 4, 5)	G	6.1879E-20
80	1	3	( 7, 4)	G	6.1558E-20
80	1	3	( 8, 6)	G	6.1409E-20
80	1	3	( 5, 8)	G	6.1152E-20
80	1	2	( 8, 8)	G	5.8750E-20
80	1	3	( 4, 2)	G	5.8690E-20
80	1	3	( 2, 2)	G	5.8492E-20
80	1	1	( 8, 7)	G	5.8306E-20
80	1	2	( 9, 9)	G	5.7497E-20
80	1	2	( 6, 9)	G	5.7180E-20
80	1	2	( 5, 5)	G	5.6923E-20
80	1	3	( 6, 4)	G	5.6198E-20
80	1	1	( 3, 7)	G	5.6175E-20
80	1	1	( 9, 7)	G	5.4977E-20
80	1	2	( 5, 6)	G	5.4476E-20
80	1	2	( 7, 6)	G	5.4444E-20
80	1	3	( 6, 6)	G	5.4259E-20
80	1	2	( 3, 2)	G	5.2987E-20
80	1	2	( 2, 9)	G	5.2854E-20
80	1	3	( 3, 5)	G	5.2306E-20
80	1	3	( 3, 3)	G	5.2065E-20
80	1	2	( 4, 2)	G	5.1880E-20
80	1	2	( 4, 6)	G	5.1509E-20
80	1	1	( 2, 4)	G	5.1430E-20

Table 4.4-4 (Continued)  
Sample POSTPRO Output File (POSTPRO.LST)

POSTPRO Version 0.0 Level 890515

03 DF

TOP-50 3 \* 1-HOUR AVERAGE DRY DEPOSITION VALUES

YEAR	DAY	HOUR	RECEPTOR	TYPE	DRY DEPOSITION
80	1	3	( 4, 7)	G	7.0266E-20
80	1	3	( 8, 7)	G	6.4153E-20
80	1	3	( 8, 9)	G	6.2737E-20
80	1	3	( 9, 7)	G	6.2338E-20
80	1	3	( 6, 5)	G	6.1507E-20
80	1	3	( 9, 6)	G	6.1483E-20
80	1	3	( 7, 9)	G	6.0856E-20
80	1	3	( 9, 9)	G	5.7219E-20
80	1	3	( 5, 6)	G	5.4451E-20
80	1	3	( 5, 5)	G	5.4209E-20
80	1	3	( 8, 8)	G	5.3810E-20
80	1	3	( 6, 9)	G	5.3414E-20
80	1	3	( 7, 6)	G	5.2694E-20
80	1	3	( 4, 6)	G	5.1741E-20
80	1	3	( 2, 9)	G	5.1130E-20
80	1	3	( 3, 7)	G	5.0853E-20
80	1	3	( 2, 4)	G	5.0226E-20
80	1	3	( 8, 6)	G	5.0155E-20
80	1	3	( 7, 8)	G	4.9346E-20
80	1	3	( 6, 8)	G	4.9067E-20
80	1	3	( 3, 2)	G	4.8390E-20
80	1	3	( 7, 4)	G	4.8346E-20
80	1	3	( 4, 5)	G	4.8271E-20
80	1	3	( 2, 2)	G	4.6643E-20
80	1	3	( 4, 2)	G	4.6631E-20
80	1	3	( 2, 7)	G	4.4882E-20
80	1	3	( 6, 6)	G	4.3808E-20
80	1	3	( 3, 3)	G	4.3370E-20
80	1	3	( 5, 8)	G	4.2832E-20
80	1	3	( 3, 5)	G	4.1982E-20
80	1	3	( 6, 4)	G	4.1896E-20
80	1	3	( 2, 3)	G	4.1542E-20
80	1	3	( 2, 8)	G	3.8848E-20
80	1	3	( 4, 4)	G	3.8634E-20
80	1	3	( 4, 8)	G	3.8575E-20
80	1	3	( 2, 5)	G	3.8339E-20
80	1	3	( 8, 2)	G	3.8090E-20
80	1	3	( 8, 4)	G	3.8012E-20
80	1	3	( 4, 3)	G	3.7429E-20
80	1	3	( 9, 2)	G	3.6750E-20
80	1	3	( 5, 3)	G	3.6217E-20
80	1	3	( 9, 4)	G	3.6154E-20
80	1	3	( 3, 8)	G	3.5413E-20
80	1	3	( 6, 3)	G	3.4969E-20
80	1	3	( 3, 6)	G	3.4474E-20
80	1	3	( 7, 3)	G	3.3812E-20
80	1	3	( 8, 3)	G	3.0179E-20
80	1	3	( 5, 9)	G	2.8136E-20
80	1	3	( 5, 4)	G	2.7636E-20
80	1	3	( 3, 9)	G	2.7293E-20

Table 4.4-4 (Continued)  
 Sample POSTPRO Output File (POSTPRO.LST)

POSTPRO Version 0.0 Level 890515

3 HIGHEST 1 \* 1-HOUR AVERAGE DRY DEPOSITION VALUES AT EACH GRIDDED RECEPTOR (YEAR, DAY, ENDING HOUR)

RECEPTOR	HIGHEST	2ND HIGHEST	3RD HIGHEST
1, 1	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 2	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 3	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 4	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 5	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 6	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 7	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 8	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1, 9	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
1,10	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
2, 1	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
2, 2	5.8492E-20 (80, 1, 3)	4.9139E-20 (80, 1, 2)	3.2297E-20 (80, 1, 1)
2, 3	4.8882E-20 (80, 1, 3)	4.1904E-20 (80, 1, 2)	3.3840E-20 (80, 1, 1)
2, 4	5.1430E-20 (80, 1, 1)	4.9665E-20 (80, 1, 3)	4.9584E-20 (80, 1, 2)
2, 5	3.9453E-20 (80, 1, 3)	3.8425E-20 (80, 1, 1)	3.7138E-20 (80, 1, 2)
2, 6	1.1179E-20 (80, 1, 1)	8.2087E-21 (80, 1, 2)	6.4056E-21 (80, 1, 3)
2, 7	4.9122E-20 (80, 1, 1)	4.3904E-20 (80, 1, 2)	4.1621E-20 (80, 1, 3)
2, 8	3.9661E-20 (80, 1, 3)	3.8499E-20 (80, 1, 2)	3.8386E-20 (80, 1, 1)
2, 9	6.4044E-20 (80, 1, 3)	5.2854E-20 (80, 1, 2)	3.6491E-20 (80, 1, 1)
2,10	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
3, 1	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
3, 2	6.3423E-20 (80, 1, 3)	5.2987E-20 (80, 1, 2)	2.8759E-20 (80, 1, 1)
3, 3	5.2065E-20 (80, 1, 3)	4.3933E-20 (80, 1, 2)	3.4110E-20 (80, 1, 1)
3, 4	2.8382E-20 (80, 1, 1)	2.6578E-20 (80, 1, 2)	2.6449E-20 (80, 1, 3)
3, 5	5.2306E-20 (80, 1, 3)	4.0439E-20 (80, 1, 2)	3.3203E-20 (80, 1, 1)
3, 6	4.5342E-20 (80, 1, 3)	3.6281E-20 (80, 1, 2)	2.1798E-20 (80, 1, 1)
3, 7	5.6175E-20 (80, 1, 1)	4.9278E-20 (80, 1, 2)	4.7106E-20 (80, 1, 3)
3, 8	3.5774E-20 (80, 1, 1)	3.5380E-20 (80, 1, 3)	3.5086E-20 (80, 1, 2)
3, 9	2.8159E-20 (80, 1, 3)	2.6987E-20 (80, 1, 2)	2.6734E-20 (80, 1, 1)
3,10	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
4, 1	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
4, 2	5.8690E-20 (80, 1, 3)	5.1880E-20 (80, 1, 2)	2.9323E-20 (80, 1, 1)
4, 3	4.4563E-20 (80, 1, 3)	3.9563E-20 (80, 1, 2)	2.8160E-20 (80, 1, 1)
4, 4	4.0678E-20 (80, 1, 1)	3.7998E-20 (80, 1, 2)	3.7227E-20 (80, 1, 3)
4, 5	6.1879E-20 (80, 1, 3)	4.7778E-20 (80, 1, 2)	3.5155E-20 (80, 1, 1)
4, 6	7.0285E-20 (80, 1, 3)	5.1509E-20 (80, 1, 2)	3.3430E-20 (80, 1, 1)
4, 7	7.8376E-20 (80, 1, 3)	6.7830E-20 (80, 1, 2)	6.4591E-20 (80, 1, 1)
4, 8	4.5368E-20 (80, 1, 3)	3.8446E-20 (80, 1, 2)	3.1910E-20 (80, 1, 1)
4, 9	1.7558E-20 (80, 1, 1)	1.7417E-20 (80, 1, 2)	1.6928E-20 (80, 1, 3)
4,10	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
5, 1	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)	0.0000E+00 ( 0, 0, 0)
5, 2	1.3691E-20 (80, 1, 1)	1.3012E-20 (80, 1, 2)	1.2632E-20 (80, 1, 3)
5, 3	4.1648E-20 (80, 1, 3)	3.7915E-20 (80, 1, 2)	2.9087E-20 (80, 1, 1)
5, 4	3.5701E-20 (80, 1, 3)	2.6345E-20 (80, 1, 2)	2.0861E-20 (80, 1, 1)
5, 5	7.6365E-20 (80, 1, 3)	5.6923E-20 (80, 1, 2)	2.9340E-20 (80, 1, 1)
5, 6	7.1163E-20 (80, 1, 3)	5.4476E-20 (80, 1, 2)	3.7714E-20 (80, 1, 1)
5, 7	2.8084E-20 (80, 1, 3)	2.2427E-20 (80, 1, 2)	1.8669E-20 (80, 1, 1)
5, 8	6.1152E-20 (80, 1, 3)	4.1115E-20 (80, 1, 2)	2.6231E-20 (80, 1, 1)

Table 4.4-4 (Continued)  
Sample POSTPRO Output File (POSTPRO.LST)

5, 9	3.9903E-20	(80, 1, 3)	2.8520E-20	(80, 1, 2)	1.5985E-20	(80, 1, 1)
5,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
6, 1	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
6, 2	1.5563E-20	(80, 1, 1)	1.4193E-20	(80, 1, 2)	1.3476E-20	(80, 1, 3)
6, 3	3.9316E-20	(80, 1, 3)	3.5460E-20	(80, 1, 2)	3.0132E-20	(80, 1, 1)
6, 4	5.6198E-20	(80, 1, 3)	4.0516E-20	(80, 1, 2)	2.8974E-20	(80, 1, 1)
6, 5	9.0070E-20	(80, 1, 3)	6.3023E-20	(80, 1, 2)	3.1429E-20	(80, 1, 1)
6, 6	5.4259E-20	(80, 1, 3)	4.6420E-20	(80, 1, 2)	3.0746E-20	(80, 1, 1)
6, 7	2.5723E-20	(80, 1, 3)	2.4545E-20	(80, 1, 2)	2.2134E-20	(80, 1, 1)
6, 8	6.8801E-20	(80, 1, 3)	4.7700E-20	(80, 1, 2)	3.0699E-20	(80, 1, 1)
6, 9	7.1737E-20	(80, 1, 3)	5.7180E-20	(80, 1, 2)	3.1326E-20	(80, 1, 1)
6,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
7, 1	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
7, 2	1.7407E-20	(80, 1, 1)	1.5965E-20	(80, 1, 2)	1.5003E-20	(80, 1, 3)
7, 3	3.5891E-20	(80, 1, 2)	3.5773E-20	(80, 1, 3)	2.9771E-20	(80, 1, 1)
7, 4	6.1558E-20	(80, 1, 3)	4.8769E-20	(80, 1, 2)	3.4710E-20	(80, 1, 1)
7, 5	1.7070E-20	(80, 1, 3)	1.4145E-20	(80, 1, 2)	1.2494E-20	(80, 1, 1)
7, 6	6.3421E-20	(80, 1, 3)	5.4444E-20	(80, 1, 2)	4.0217E-20	(80, 1, 1)
7, 7	2.8296E-20	(80, 1, 3)	2.7935E-20	(80, 1, 2)	2.5206E-20	(80, 1, 1)
7, 8	7.3132E-20	(80, 1, 3)	5.1338E-20	(80, 1, 2)	2.3568E-20	(80, 1, 1)
7, 9	8.3397E-20	(80, 1, 3)	6.3225E-20	(80, 1, 2)	3.5945E-20	(80, 1, 1)
7,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
8, 1	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
8, 2	4.2844E-20	(80, 1, 1)	3.7655E-20	(80, 1, 2)	3.3772E-20	(80, 1, 3)
8, 3	3.7123E-20	(80, 1, 2)	3.2929E-20	(80, 1, 3)	2.0486E-20	(80, 1, 1)
8, 4	4.0091E-20	(80, 1, 2)	3.9310E-20	(80, 1, 3)	3.4635E-20	(80, 1, 1)
8, 5	1.5898E-20	(80, 1, 3)	1.4325E-20	(80, 1, 2)	1.3363E-20	(80, 1, 1)
8, 6	6.1409E-20	(80, 1, 3)	4.9658E-20	(80, 1, 2)	3.9397E-20	(80, 1, 1)
8, 7	6.9562E-20	(80, 1, 3)	6.4592E-20	(80, 1, 2)	5.8306E-20	(80, 1, 1)
8, 8	8.3044E-20	(80, 1, 3)	5.8750E-20	(80, 1, 2)	1.9636E-20	(80, 1, 1)
8, 9	8.5233E-20	(80, 1, 3)	6.3663E-20	(80, 1, 2)	3.9316E-20	(80, 1, 1)
8,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
9, 1	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
9, 2	3.9007E-20	(80, 1, 1)	3.6109E-20	(80, 1, 2)	3.5134E-20	(80, 1, 3)
9, 3	1.5835E-20	(80, 1, 1)	1.1764E-20	(80, 1, 2)	8.9821E-21	(80, 1, 3)
9, 4	3.9166E-20	(80, 1, 1)	3.6343E-20	(80, 1, 2)	3.2954E-20	(80, 1, 3)
9, 5	1.8973E-20	(80, 1, 3)	1.6525E-20	(80, 1, 2)	1.4854E-20	(80, 1, 1)
9, 6	7.9424E-20	(80, 1, 3)	6.1996E-20	(80, 1, 2)	4.3029E-20	(80, 1, 1)
9, 7	6.9556E-20	(80, 1, 3)	6.2481E-20	(80, 1, 2)	5.4977E-20	(80, 1, 1)
9, 8	1.1317E-20	(80, 1, 3)	1.1176E-20	(80, 1, 2)	1.0661E-20	(80, 1, 1)
9, 9	7.1782E-20	(80, 1, 3)	5.7497E-20	(80, 1, 2)	4.2377E-20	(80, 1, 1)
9,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 1	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 2	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 3	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 4	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 5	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 6	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 7	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 8	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10, 9	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)
10,10	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)	0.0000E+00	( 0, 0, 0)

HIGHEST VALUES FOR PERIOD

Multiply all values by 10 \*\* -21

```

10 I 0 0 0 0 0 0 0 0 0 0
    I + + + + + + + + + +
    9 I 0 64 28 18 40 72 83 85 72 0

```

Table 4.4-4 (Continued)  
Sample POSTPRO Output File (POSTPRO.LST)

I	+	+	+	+	+	+	+	+	+	+
8 I	0	40	36	45	61	69	73	83	11	0
I	+	+	+	+	+	+	+	+	+	+
7 I	0	49	56	78	28	26	28	70	70	0
I	+	+	+	+	+	+	+	+	+	+
6 I	0	11	45	70	71	54	63	61	79	0
I	+	+	+	+	+	+	+	+	+	+
5 I	0	39	52	62	76	90	17	16	19	0
I	+	+	+	+	+	+	+	+	+	+
4 I	0	51	28	41	36	56	62	40	39	0
I	+	+	+	+	+	+	+	+	+	+
3 I	0	49	52	45	42	39	36	37	16	0
I	+	+	+	+	+	+	+	+	+	+
2 I	0	58	63	59	14	16	17	43	39	0
I	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+
-----										
	1	2	3	4	5	6	7	8	9	10

2ND HIGHEST VALUES FOR PERIOD

Multiply all values by 10 \*\* -21

10 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+
9 I	0	53	27	17	29	57	63	64	57	0
I	+	+	+	+	+	+	+	+	+	+
8 I	0	38	35	38	41	48	51	59	11	0
I	+	+	+	+	+	+	+	+	+	+
7 I	0	44	49	68	22	25	28	65	62	0
I	+	+	+	+	+	+	+	+	+	+
6 I	0	8	36	52	54	46	54	50	62	0
I	+	+	+	+	+	+	+	+	+	+
5 I	0	38	40	48	57	63	14	14	17	0
I	+	+	+	+	+	+	+	+	+	+
4 I	0	50	27	38	26	41	49	39	36	0
I	+	+	+	+	+	+	+	+	+	+
3 I	0	42	44	40	38	35	36	33	12	0
I	+	+	+	+	+	+	+	+	+	+
2 I	0	49	53	52	13	14	16	38	36	0
I	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+
-----										
	1	2	3	4	5	6	7	8	9	10

3RD HIGHEST VALUES FOR PERIOD

Multiply all values by 10 \*\* -21

10 I	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+
9 I	0	36	27	17	16	31	36	39	42	0
I	+	+	+	+	+	+	+	+	+	+
8 I	0	38	35	32	26	31	24	20	11	0
I	+	+	+	+	+	+	+	+	+	+
7 I	0	42	47	65	19	22	25	58	55	0
I	+	+	+	+	+	+	+	+	+	+
6 I	0	6	22	33	38	31	40	39	43	0

Table 4.4-4 (Concluded)  
 Sample POSTPRO Output File (POSTPRO.LST)

	I	+	+	+	+	+	+	+	+	+	
5	I	0	37	33	35	29	31	12	13	15	0
	I	+	+	+	+	+	+	+	+	+	+
4	I	0	50	26	37	21	29	35	35	33	0
	I	+	+	+	+	+	+	+	+	+	+
3	I	0	34	34	28	29	30	30	20	9	0
	I	+	+	+	+	+	+	+	+	+	+
2	I	0	32	29	29	13	13	15	34	35	0
	I	+	+	+	+	+	+	+	+	+	+
1	I	0	0	0	0	0	0	0	0	0	0
	I	+	+	+	+	+	+	+	+	+	+
		1	2	3	4	5	6	7	8	9	10

## 5. REFERENCES

- Arya, S.P.S., 1984: Parametric relations for the atmospheric boundary layer. *Bound. Layer Meteor.*, 30, 57-73.
- Atkinson, R., A.C. Lloyd and L. Wings, 1982: An updated chemical mechanism for hydrocarbon/NO<sub>x</sub>/SO<sub>2</sub> photooxidation suitable for inclusion in atmospheric simulation models. *Atmospheric Environ.*, 16, 1341.
- Barad, M.L. (ed.), 1958: Project Prairie Grass: a field program in diffusion. Geophysical Research Papers, No. 59, Vols. I and II, AFCRF-TR-58-235, Air Force Cambridge Research Center, Bedford, MA.
- Barrie, L.A., 1981: The prediction of rain acidity and SO<sub>2</sub> scavenging in eastern North America. *Atmospheric Environ.*, 15, 31-41.
- Benkley, C.W. and A. Bass, 1979: Development of mesoscale air quality simulation models. Volume 2. User's guide to MESOPLUME (Mesoscale Plume Segment) model. EPA-600/7-79-xxx. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Benkley, C.W. and L.L. Schulman, 1979: Estimating hourly mixing depths from historical meteorological data. *J. Appl. Meteor.*, 18, 772-780.
- Berkowicz, R. and L.P. Prahm, 1982: Evaluation of the profile method for estimation of surface fluxes of momentum and heat. *Atmospheric Environ.*, 16, 2809-2819.
- Binkowski, F.S., 1979: A simple semi-empirical theory for turbulence in the atmospheric surface layer. *Atmospheric Environ.*, 13, 247-253.
- Blackadar, A.K. and H. Tennekes, 1968: Asymptotic similarity in neutral barotropic planetary boundary layers. *J. Atmos. Sci.*, 25, 1025-1020.
- Bowers, J.F. and A.J. Anderson, 1981: An evaluation study for the Industrial Source Complex (ISC) dispersion model. EPA 450/4-81-002, U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Bowers, J.F., J.R. Bjorklund and C.S. Cheney, 1979: Industrial Source Complex (ISC) dispersion model user's guide. Volume I. EPA-450/4-79-030. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Briggs, G.A., 1973: Diffusion estimates for small emissions (Draft). Air Resources Atmospheric Turbulence and Diffusion Laboratory. ATOL No. 79.
- Briggs, G.A., 1975: Plume rise predictions. In: *Lectures on Air Pollution and Environmental Impact Analyses*. American Meteorological Society, Boston, MA, pp. 59-111.
- Briggs, G.A., 1983: Diffusion modeling with convective scaling. Urban scale variations of turbulence parameters and fluxes. AMS Specialty Conference on Air Quality Modeling of the Urban Boundary Layer, Baltimore, MD.

- Briggs, G.A., 1985: Analytical parameterizations of diffusion: the convective boundary layer. *J. Clim. and Appl. Meteor.*, **24**, 1167-1186.
- Brighton, P.W.M., 1978: Strongly stratified flow past three-dimensional obstacles. *Quart. J.R. Met. Soc.*, **104**, 289-307.
- Britter, R.E., J.C.R. Hunt and K.J. Richards, 1981: Airflow over a two-dimensional hill: studies of velocity speed-up, roughness effects and turbulence. *Quart. J.R. Met. Soc.*, **107**, 92-110.
- Brost, R.A. and J.C. Wyngaard, 1978: A model study of the stably stratified planetary boundary layer. *J. Atmos. Sci.*, **35**, 1427-1400.
- Calvert, J.G., F. Su, J.W. Bottenheim and O.P. Strausz, 1978: Mechanism of the homogeneous oxidation of sulfur dioxide in the troposphere. *Atmospheric Environ.*, **12**, 197.
- Caughey, S.J., 1981: Observed characteristics of the atmospheric boundary layer. In: *Atmospheric Turbulence and Air Pollution Modeling*. F.T.M. Nieuwstadt and H. Van Dop, Eds. D. Reidel Publishing Company, Boston, MA.
- Chamberlain, A.C., 1975: The movement of particles in plant communities. In: *Vegetation and the Atmosphere*. Volume I, Principles. Academic Press, J.L. Monteith, Ed.
- Ching, J.K.S., D.C. Doll and J. Kaneshiro, 1981: Temporal variation of ground heat flux for soil and concrete using net radiation data. AMS Fifth Symposium on Turbulence, Diffusion, and Air Pollution. March 9-13, Atlanta, GA.
- Ching, J.K.S., J.M. Godowitch, J.F. Clarke and A.H. Auer, 1983: Urban scale variations of turbulence parameters and fluxes. AMS Specialty Conference on Air Quality Modeling of the Urban Boundary Layer, Baltimore, MD.
- Clark, J.F., J.K.S. Ching and J.M. Godowitch, 1982: An experimental study of turbulence in an urban environment. U.S. Environmental Protection Agency, NTIS PB-226085, 151 pp.
- Deardorff, J.W. and G.E. Willis, 1975: A parameterization of diffusion into the mixed layer. *J. Appl. Meteor.*, **14**, 1451-1458.
- Deardorff, J.W. and G.E. Willis, 1982: Ground-level concentrations due to fumigation into an entraining mixed-layer. *Atmospheric Environ.*, **16**, 1159-1170.
- DeBruin, H.A.R. and A.A.M. Holtslag, 1982: A simple parameterization of the surface fluxes of sensible and latent heat during daytime compared with the Penman-Monteith concept. *J. Appl. Meteor.*, **21**, 1610-1621.
- DiCristofaro, D.C., D.G. Strimaitis, B.R. Greene, R.J. Yamartino, A. Venkatram, D.A. Godden, T.F. Lavery and B.A. Egan, 1985: EPA complex terrain model development program: Fifth milestone report - 1985. EPA-600/3-85/069, U.S. Environmental Protection Agency, Research Triangle Park, NC.

- Douglas, S. and R. Kessler, 1988: User's guide to the diagnostic wind model. California Air Resources Board, Sacramento, CA.
- Draxler, R.R., 1976: Determination of atmospheric diffusion parameters. *Atmospheric Environ.*, 10, 99-105.
- Draxler, R.R., 1984: Diffusion and transport experiments. In: *Atmospheric Science and Power Production*. D. Randerson, Ed. DOE/TIC-27601, NTIS, Springfield, VA.
- Drazin, P.G., 1961: On the steady flow of a fluid of variable density past an obstacle. *Tellus*, 13, 239-251.
- Dumbauld, R.K., J.C. Rafferty and H.E. Cramer, 1976: Dispersion-deposition from aerial spray releases. Preprint Volume for the Third Symposium on Atmospheric Diffusion and Air Quality, American Meteorological Society, Boston, MA.
- Forrest, J., R.W. Garber and L. Newman, 1981: Conversion rates in power plant plumes based on filter pack data: the coal-fired Cumberland plume. *Atmospheric Environ.*, 15, 2273.
- Fowler, D. and M.H. Unsworth, 1979: Turbulent transfer of sulphur dioxide to a wheat crop. *Quart. J.R. Meteor. Soc.*, 105, 767-784.
- Godowitch, J.M., J.K.S. Ching and J.F. Clarke, 1981: Urban/rural and temporal variations in PBL turbulence parameters and length scales over St. Louis, MO. AMS Fifth Symposium on Turbulence, Diffusion, and Air Pollution. March 9-13, Atlanta, GA.
- Golder, D., 1972: Relations among stability parameters in the surface layer. *Bound. Layer Met.*, 3, 46-58.
- Goldberg, P.H., J.P. Myers, K.W. Wiltsee and P. Morgenstern, 1977: Handbook for the single source (CRSTER) model. Walden Division of Abcor, Inc., Wilmington, MA.
- Hales, J.M., D.C. Powell and T.D. Fox, 1977: STRAM - An air pollution model incorporating non-linear chemistry, variable trajectories, and plume segment diffusion. EPA-450/3-77-012. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Hanna, S.R., G.A. Briggs, J. Deardorff, B.A. Egan, F.A. Gifford and F. Pasquill, 1977: AMS workshop on stability classification schemes and sigma curves - summary of recommendations. *Bull. Am. Meteor. Soc.*, 58, 1305-1309.
- Hanna, S.R., L.L. Schulman, R.J. Paine, J.E. Pleim and M. Baer, 1985: Development and evaluation of the offshore and coastal dispersion model. *JAPCA*, 35, 1039-1047.
- Hanna, S.R., J.C. Weil and R.J. Paine, 1986: Plume model development and evaluation. Report Number D034-500. Electric Power Research Institute, Palo Alto, CA.

- Hefter, J.L., 1965: The variations of horizontal diffusion parameters with time for travel periods of one hour or longer. *J. Appl. Meteor.*, 4, 153-156.
- Hicks, B.B. and P.S. Liss, 1976: Transfer of SO<sub>2</sub> and other reactive gases across the air-sea interface. *Tellus*, 28, 348-354.
- Hicks, B.B., 1981: An examination of turbulence statistics in the surface boundary layer. *Bound. Layer Meteor.*, 21, 389-402.
- Hicks, B.B., 1982: In: *Critical Assessment Document on Acid Deposition (Chapter VII-Dry Deposition)*. ATDL Contribution File No. 81/24. Atmospheric Turbulence and Diffusion Laboratory, NOAA, Oak Ridge, TN.
- Hicks, B.B., 1985: Behavior of turbulence statistics in the convective boundary layer. *J. Clim. and Appl. Meteor.*, 24, 607-614.
- Hildebrand, P.H. and B. Ackerman, 1984: Urban effects on the convective boundary layer. *J. Atmos. Sci.*, 41, 76-91.
- Holtslag, A.A.M. and A.P. Van Ulden, 1983: A simple scheme for daytime estimates of the surface fluxes from routine weather data. *J. Clim. and Appl. Meteor.*, 22, 517-529.
- Hosker, R.P., 1974: A comparison of estimation procedures for overwater plume dispersion. *Proceedings of the Symposium on Atmospheric Diffusion and Air Pollution*. American Meteorological Society, Boston, MA.
- Hosker, R.P., Jr. and S.E. Lindberg, 1982: Review: atmospheric deposition and plant assimilation of gases and particles. *Atmospheric Environ.*, 16, 889-910.
- Hosker, R.P., 1984: Flow and diffusion near obstacles. In: *Atmospheric Science and Power Production*. R. Randerson, Ed. DOE/TIC-27601. National Technical Information Service, Springfield, Virginia.
- Huber, A.H. and W.H. Snyder, 1982: Wind tunnel investigation of the effects of a rectangular-shaped building on dispersion of effluents from short adjacent stacks. *Atmospheric Environ.*, 17, 2837-2848.
- Hunt, J.C.R., 1982: Diffusion in the stable boundary layer. In: *Atmospheric Turbulence and Air Pollution Modeling*. F.T.M. Nieuwstadt and H. van Dop, Eds. D. Reidel Publishing Co., Boston, MA.
- Hunt, J.C.R. and W.H. Snyder, 1980: Experiments on stably and neutrally stratified flow over a model three-dimensional hill. *J. Fluid Mech.*, 96, 671-704.
- Hunt, J.C.R., J.S. Puttock and W.H. Snyder, 1979: Turbulent diffusion from a point source in stratified and neutral flows around a three-dimensional hill (Part I - Diffusion equation analysis). *Atmospheric Environ.*, 13, 1227-1239.
- Hunt, J.C.R. and R.J. Mulhearn, 1973: Turbulent dispersion from sources near two-dimensional obstacles. *J. Fluid Mech.*, 61, 245-274.

- Irwin, J.S., 1979: Scheme for estimating dispersion parameters as a function of release height. EPA-600/4-79-062. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Irwin, J.S., 1983: Estimating plume dispersion - a comparison of several sigma schemes. *J. Clim. and Appl. Meteor.*, 22, 92-114.
- Karamchandani, P., F. Lurmann and A. Venkatram, 1985: ADOM/TADAP model development program. Volume 8: Central operator. Ontario Ministry of the Environment, Toronto, Ontario, Canada.
- Kerman, B.R., 1982: A similarity model of shoreline fumigation. *Atmospheric Environ.*, 16, 467-477.
- Kessler, R.C., 1989: User's Guide. Systems Applications, Inc. Version of the Colorado State University Mesoscale Model. California Air Resources Board, Sacramento, CA.
- Kitaigorodskii, S.A., 1973: The physics of air-sea interaction. Israel Program for Scientific Translations. Jerusalem.
- Lamb, R.G., 1981: Diffusion in the convective boundary layer. In: *Atmospheric Turbulence and Air Pollution Modeling*. T.F.M. Nieuwstadt and K. van Dop, eds. D. Reidel Publishing Company, Boston, MA.
- Landsberg, H.E., 1981: *The Urban Heat Island*. Academic Press, New York, NY.
- LeMone, M., 1978: The marine boundary layer. In: *Proceedings of Workshop on the Planetary Boundary Layer*. American Meteorological Society, Boston, Ma, pp 182-234.
- Levine, S.Z. and S.E. Schwartz, 1982: In-cloud and below-cloud of scavenging of nitric acid vapor. *Atmospheric Environ.*, 16, 1725-1734.
- Ludwig, F.L., L.S. Gasiorek and R.E. Ruff, 1977: Simplification of a Gaussian puff model for real-time minicomputer use. *Atmospheric Environ.*, 11, 431-436.
- Lyons, W. and H. Cole, 1973: Fumigation and plume trapping on the shores of Lake Michigan during stable onshore flow. *J. Appl. Meteor.*, 12, 494-510.
- Maul, P.R., 1980: Atmospheric transport of sulfur compound pollutants. Central Electricity Generating Bureau MID/SSD/80/0026/R. Nottingham, England.
- Misra, P.K., 1980: Dispersion from tall stacks into a shoreline environment. *Atmospheric Environ.*, 14, 397-400.
- Moller U. and G. Shumann, 1970: Mechanisms of transport from the atmosphere to the earth's surface. *J. Geophys. Res.*, 75, 3013-3019.
- NCAR, 1985: The NCAR eulerian regional acid deposition model. NCAR/TN-256 + STR, National Center for Atmospheric Research, Boulder, Colorado.
- Nieuwstadt, F.T.M., 1977: The dispersion of pollutants over a water surface. Eighth International Technical Meeting on Air Pollution, Modeling, and It's Application. NATO/CCMS Doc. No. 80, pp. 337-359.

- Nieuwstadt, F.T.M., 1984: Some aspects of the turbulent stable boundary layer. *Bound. Layer Meteor.*, 30, 31-55.
- O'Dell, R.A., M. Taheri and R.L. Kabel, 1977: A model for uptake of pollutants by vegetation. *JAPCA*, 27, 1104-1109.
- Oke, T.R., 1978: *Boundary Layer Climates*. John Wiley & Sons, New York, NY.
- Oke, T.R., 1982: The energetic basis of the urban heat island. *Quart. J R. Met. Soc.*, 108, 1-24.
- Panofsky, H.A., H. Tennekes, D.H. Lenschow and J.C. Wyngaard, 1977: The characteristics of turbulent velocity components in the surface layer under convective conditions. *Bound. Layer Meteor.*, 11, 355-361.
- Pasquill, F., 1976: Atmospheric dispersion parameters in Gaussian plume modeling: Part II. Possible requirements for change in the Turner workbook values. EPA-600/4-76-030b, U.S. Environmental Protection Agency, Research Triangle Park, No. Carolina. 53 pp.
- Peterson, W.B., 1986: A demonstration of INPUFF with the MATS data base. *Atmospheric Environ.*, 20, 1341-1346.
- Pierce, T.E and D.B. Turner, 1980: User's guide for MPTEP. EPA-600/8-80-016. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Pleim, J., A. Venkatram and R.Y. Yamartino, 1985: ADOM/TADAP model development program. Volume 4. The dry deposition model. Ontario Ministry of the Environment, Rexdale, Ontario, Canada.
- Raynor, G.S., S. SethuRaman and R.M. Brown, 1979: Formation and characteristics of coastal internal boundary layers during onshore flow. *Bound. Layer Meteor.*, 16, 487-514.
- Riley, J.J., H.T. Liu and E.W. Geller, 1976: A numerical and experimental study of stably stratified flow around complex terrain. EPA Report No. EPA-600/4-76-021, Res. Tri. Pk., NC, 41 p.
- Rittmann, B.E., 1982: Application of the two-thirds law to plume rise from industrial-sized sources. *Atmospheric Environ.*, 16, 2575-2579.
- Schulman, L.L. and J.S. Scire, 1980: Buoyant Line and Point Source (BLP) dispersion model user's guide. Document P-7304-B. Environmental Research & Technology, Inc., Concord, MA.
- Schulman, L.L. and J.S. Scire, 1981: The development and capabilities of the BLP Model. In: *Proceedings APCA Specialty Conference on Dispersion Modeling from Complex Sources*. St. Louis.
- Schulman, L.L. and S.R. Hanna, 1986: Evaluation of downwash modifications to the Industrial Source Complex Model. *JAPCA*, 36, 258-264.
- Scire, J.S. and L.L. Schulman, 1979: Modeling plume rise from low-level buoyant line and point sources. In: *Proceedings Second Joint Conference on Applications of Air Pollution Meteorology*. New Orleans.

- Scire, J.S. and L.L. Schulman, 1981: Evaluation of the BLP and ISC models with SF<sub>6</sub> tracer data and SO<sub>2</sub> measurements at aluminum reduction plants. In: *Proceedings APCA Specialty Conference on Dispersion Modeling from Complex Sources*. St. Louis.
- Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984: Development of the MESOPUFF II dispersion model. EPA-600/3-84-057. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Scire, J.S., F.W. Lurmann, A. Bass and S.R. Hanna, 1984: User's guide to the MESOPUFF II model and related processor programs. EPA-600/8-84-013. U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Scire, J.S. and A. Venkatram, 1985: The contribution of in-cloud oxidation of SO<sub>2</sub> to wet scavenging of sulfur in convective clouds. *Atmospheric Environ.*, 19, 637-650.
- Scire, J.S., R.J. Yamartino, G.R. Carmichael, and Y.S. Chang, 1989: CALGRID: A Mesoscale Photochemical/Grid Model. Volume II: User's Guide. California Air Resources Board, Sacramento.
- Scire, J.S., E. Insley and R.J. Yamartino, 1990: Model formulation and user's guide for the CALMET meteorological model. Prepared for the California Air Resources Board. Sigma Research Corporation, Westford, MA.
- Scott, B.C., 1978: Parameterization of sulfate removal by precipitation. *J. Appl. Meteorol.*, 17, 1375-1389.
- Scott, B.C., 1981: Sulfate washout ratios in winter storms. *J. Appl. Meteor.*, 20, 619-625.
- Sehmel, G.A. and S.L. Sutter, 1974: Particle deposition rates on a water surface as a function of particle diameter and air velocity. *J. Rechs Atmos.*, III, 911-918.
- Sehmel, G.A., 1980: Particle and gas dry deposition - a review. *Atmospheric Environ.*, 14, 983-1011.
- Shepherd, J.G., 1974: Measurements of the direct deposition of sulphur dioxide onto grass and water by the profile method. *Atmospheric Environ.*, 8, 69-74.
- Sheppard, P.A., 1956: Airflow over mountains. *Quart. J.R. Meteor. Soc.*, 82, 528-529.
- Slinn, S.A. and W.G.N. Slinn, 1980: Predictions for particle deposition on natural waters. *Atmospheric Environ.*, 14, 1013-1016.
- Slinn, W.G.N., L. Hasse, B.B. Hicks, A.W. Hogan, D. Lal, P.S. Liss, K.O. Munnich, G.A. Sehmel and O. Vittori, 1978: Some aspects of the transfer of atmospheric trace constituents past the air-sea interface. *Atmospheric Environ.*, 12, 2055-2087.
- Snyder, W.H., R.E. Britter and J.C.R. Hunt, 1980: A fluid modeling study of the flow structure and plume impingement on a three-dimensional hill in stably stratified flow. *Proc. Fifth Int. Conf. on Wind Engr.* (J.E. Cermak, ed.), 1: 319-329, Pergamon Press, New York, NY.

- Snyder, W.H. and J.C.R. Hunt, 1984: Turbulent diffusion from a point source in stratified and neutral flow around a three-dimensional hill (Part II - Laboratory measurement of surface concentrations). *Atmospheric Environ.*, 18, 1969-2002.
- Stelson, A.W., and J.H. Seinfeld, 1982: Relative humidity and temperature dependence of the ammonium nitrate dissociation constant. *Atmospheric Environ.*, 16, 983-992.
- Stelson, A.W., M.E. Bassett and J.H. Seinfeld, 1983: *Thermodynamic Equilibrium Properties of Aqueous Solutions of Nitrate, Sulfate and Ammonium*. Acid Precipitation, Chemistry of Particles, Fog and Rain. J. Teasley, ed. Ann Arbor Science, Woburn, MA.
- Strimaitis, D.G., T.F. Lavery, A. Venkatram, D.C. DiCristofaro, B.R. Greene and B.A. Egan, 1984: EPA complex terrain model development program: Fourth milestone report - 1984. EPA-600/3-84-110, U.S. Environmental Protection Agency, Research Triangle Park, NC.
- Stunder, M. and S. SethuRaman, 1985: A comparative evaluation of the coastal internal boundary layer height equations. *Bound. Layer Meteor.*, 32, 177-204.
- Thuiller, R.H., 1982: Dispersion characteristics in the lee of complex structures. *JAPCA*, 32, 526-532.
- Unsworth, M.H. and J.L. Monteith, 1972: Aerosol and solar radiation in Britain. *Quart. J.R. Met. Soc.*, 98, 778-797.
- Van Egmond, N.D. and H. Kesseboom, 1983: Mesoscale air pollution dispersion models - II. Lagrangian Puff model and comparison with eulerian grid model. *Atmospheric Environ.*, 17, 267-274.
- Van Ulden, A.P. and A.A.M. Holtslag, 1985: Estimation of atmospheric boundary layer parameters for diffusion applications. *J. Clim. and App. Meteor.*, 24, 1196-1207.
- Venkatram, A., 1980a: Estimating the Monin-Obukhov length in the stable boundary layer for dispersion calculations. *Bound. Layer Meteorol.*, 19, 481-485.
- Venkatram, A., 1980b: Estimation of turbulence velocity scales in the stable and the unstable boundary layer for dispersion applications. In: *Eleventh NATO-CCSM International Technical Meeting on Air Pollution Modeling and its Application*. 54-56.
- Voldner, E.C., L.A. Barrie and A. Sirois, 1986: A literature review of dry deposition of oxides of sulphur and nitrogen with emphasis on long-range transport modeling in North America. *Atmospheric Environ.*, 20, 2101-2123.
- Wang, I.T. and P.C. Chen, 1980: Estimations of heat and momentum fluxes near the ground. *Proc. 2nd Joint Conf. On Applications of Air Poll. Meteorology*. New Orleans, LA, March 24-27. 764-769.
- Warner, J., 1972: The structure and intensity of turbulence in air over the sea. *Quart. J.R. Met. Soc.*, 98, 175-186.



06247

- Weil, J.C. and R. P. Brower, 1983: Estimating convective boundary layer parameters for diffusion application. Draft Report Prepared by Environmental Center, Martin Marietta Corp. for Maryland Dept. of Natural Resources.
- Weber, A.H., J.S. Irwin, W.B. Peterson, J.J. Mathis and J.P. Kahler, 1982: Spectral scales in the atmospheric boundary layer. *J. Appl. Meteor.*, 21, 1622-1632.
- Weil, J.C., 1985: Updating applied diffusion models. *J. Clim. Appl. Meteor.*, 24, 1111-1130.
- Wesely, M.L. and B.B. Hicks, 1977: Some factors that affect the deposition rates of sulfur dioxide and similar gases on vegetation. *J. Air Poll. Control Assoc.*, 27, 1110-1116.
- White, J.M, F.D. Eaton and A.H. Auer, 1978: The net radiation budget of the St. Louis metropolitan area. *J. Appl. Met.*, 17, 593-599.
- Wilson, W.E., 1981: Sulfate formation in point source plumes: a review of recent field studies. *Atmospheric Environ.*, 15, 2573.
- Yamartino, R.J., 1977: A dispersion model for low wind speed conditions: theory and experimental application. Paper 77-58.6 presented at the 70th Annual Meeting of the Air Pollution Control Assoc., Toronto, Canada.
- Yamartino, R.J., P.G. Luehring and R.M. Stern, 1979: Analysis of several low wind speed tracer experiments. *Proc. of the NATO/CCMS 10th Int. Tech. Meeting on Air Poll. Modeling and Its Applications*. Rome, Italy, 325-338.
- Yamartino, R.J., J.S. Scire, S.R. Hanna, G.R. Carmichael and Y.S. Chang, 1989: CALGRID: A Mesoscale Photochemical Grid Model. Volume I: Model Formulation Document. California Air Resources Board, Sacramento, CA.
- Zannetti, P., 1981: An improved puff algorithm for plume dispersion simulation. *J. Appl. Meteor.*, 20, 1203-1211.

