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A REVISED USER'S GUIDE TO MESOPUFF II (V5.1)

Office of Air Quality
Clean Air
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NOTICE

PREFACE

The Interagency Workgroup on Air Quality Modeling (IWAQM) was formed to provide a focus for development of technically sound, regional air quality models for regulatory assessments of pollutant source impacts on Federal Class I areas. Meetings were held with personnel from interested Federal agencies, viz. the Environmental Protection Agency, the U.S. Forest Service, the National Park Service, and the U.S. Fish and Wildlife Service. The purpose of these meetings was to review respective regional modeling programs, to develop an organizational framework, and to formulate reasonable objectives and plans that could be presented to management for support and commitment. The members prepared a memorandum of understanding (MOU) that incorporated the goals and objectives of the workgroup and obtained signatures of management officials in each participating agency. Although no States are signatories, their participation in IWAQM functions is explicitly noted in the MOU.

This User's Guide is the third document published by the IWAQM in an effort to provide the sponsoring agencies and other interested parties information on appropriate "off-the-shelf" methods for estimating long range transport impacts of air pollutants on Federal Class I areas and impacts on regional visibility. The IWAQM members anticipate issuing additional publications related to progress toward meeting the IWAQM goals and objectives, the results of model evaluation studies, proposed and final recommendations on modeling systems for regulatory applications, and other topics related to specific objectives in the MOU.

ACKNOWLEDGEMENTS

The user's guide for the original version of MESOPUFF II was developed under a contract to Environmental Research & Technology, Inc. funded by the U.S. Environmental Protection Agency. The original user's guide was written by Joseph Scire, Frederick Lurmann, Arthur Bass, and Steven Hanna (EPA Document EPA-600/8-84-013). Much of this revised user's guide has been adapted directly from the earlier edition.

The portions of this document relating to the meteorological preprocessing programs were adapted from the CALMET model user's guide by Joseph Scire, Elizabeth Insley, and Robert Yamartino. CALMET was developed under a contract to Sigma Research Corporation funded by the California Air Resources Board.

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1.0 INTRODUCTION

1.1 Background

The development of the MESOPUFF II modeling system was sponsored by the U.S. Environmental Protection Agency (EPA) in the early 1980s. The purpose of the model development effort was to provide a modeling package which could be used in regulatory studies to assess the impact of sulfur oxides and nitrogen oxides emitted from major point and area sources over source-receptor transport distances of tens to hundreds of kilometers. Therefore, the model was designed to include effects important on the mesoscale such as spatial and temporal variability in winds, dispersion, chemical transformation, wet removal, and dry deposition.

The modeling system was documented in two reports: a model formulation document (Scire et al., 1984a) and an user's guide (Scire et al., 1984b). However, since the original model was released, a number of changes and enhancements have been made to the modeling system. Some of these modifications were made in order to accommodate changes in the format of the meteorological data products provided by the National Climatic Data Center (NCDC). Other changes, such as the addition of a flexible memory management system, the ability to output and store wet and dry flux predictions, and the addition of an option to allow continuation runs of the model were made to make the model easier to use and more flexible. Some technical improvements, such as the adjustment of the friction velocity to account for differences in surface roughness between a grid cell and an observational station measuring wind speed, were made in the revised code. In addition, range checks of variables and limits were added to prevent computational problems, and all known coding errors were corrected.

The revised modeling system contains the original set of programs, including the MESOPUFF II model along with the processor programs READ56, MESOPAC II, and MESOFILE II. In addition, several new programs have been added, including the upper air preprocessor (READ62) and the precipitation data preprocessors PXTRACT and PMERGE. These new programs have been adapted from the CALPUFF/CALMET modeling package (Scire et al., 1990) for use with MESOPUFF II.

This document is a revised version of the MESOPUFF II user's guide which describes the current configuration of the MESOPUFF II modeling system (Version 5.1). Much of the text is taken from the original document, although several new chapters have been added and other sections revised.

1.2 MESOPUFF II Modeling Package

The MESOPUFF II model is one element of an integrated modeling package. This modeling package, illustrated in Figure 1-1, also contains components for preprocessing of meteorological data (READ56, READ62, PXTRACT, PMERGE, MESOPAC II) and postprocessing of predicted concentration and wet/dry deposition fluxes (MESOFILE II). Each component of the MESOPUFF II modeling package is briefly described below.

READ56 and *READ62* are preprocessor programs that read and process the twice-daily upper air wind and temperature sounding data available from the National Climatic Data Center (NCDC) for selected stations. READ56 extracts the data required by the MESOPAC II program from a TDF5600-formatted NCDC tape and READ62 extracts the data from the more recent NCDC data format (TD6201). READ56/READ62 scan the upper air data for completeness; warning messages are printed to flag missing or incomplete soundings. A file of processed sounding data is created in a format convenient for possible editing by the user. This file is subsequently input into the MESOPAC II program.

PXTRACT is a preprocessor which extracts precipitation data for stations and time periods of interest from a fixed length, formatted precipitation data file in NCDC TD3240 format.

PMERGE reads, processes and reformats the precipitation data files created by the PXTRACT program. The output file is a formatted file, which can be directly input into the MESOPAC II model, containing the precipitation data sorted by hour rather than station. PMERGE resolves "accumulation periods" and flags suspicious or missing data.

MESOPAC II is the meteorological processor program that computes the time and space interpolated fields of meteorological variables (e.g., transport winds, mixing height) required by MESOPUFF II to describe mesoscale transport and dispersion processes. MESOPAC II reads the upper air data files created by READ56 or READ62, files of standard-formatted NCDC hourly surface meteorological data (CD144), and preprocessed precipitation data (optional). A single output file containing the gridded meteorological fields is produced which serves as an input file to MESOPUFF II.

MESOPUFF II is a Gaussian, variable-trajectory, puff superposition model designed to account for the spatial and temporal variations in transport, diffusion, chemical transformation and removal mechanisms encountered on regional scales. With the puff superposition approach,

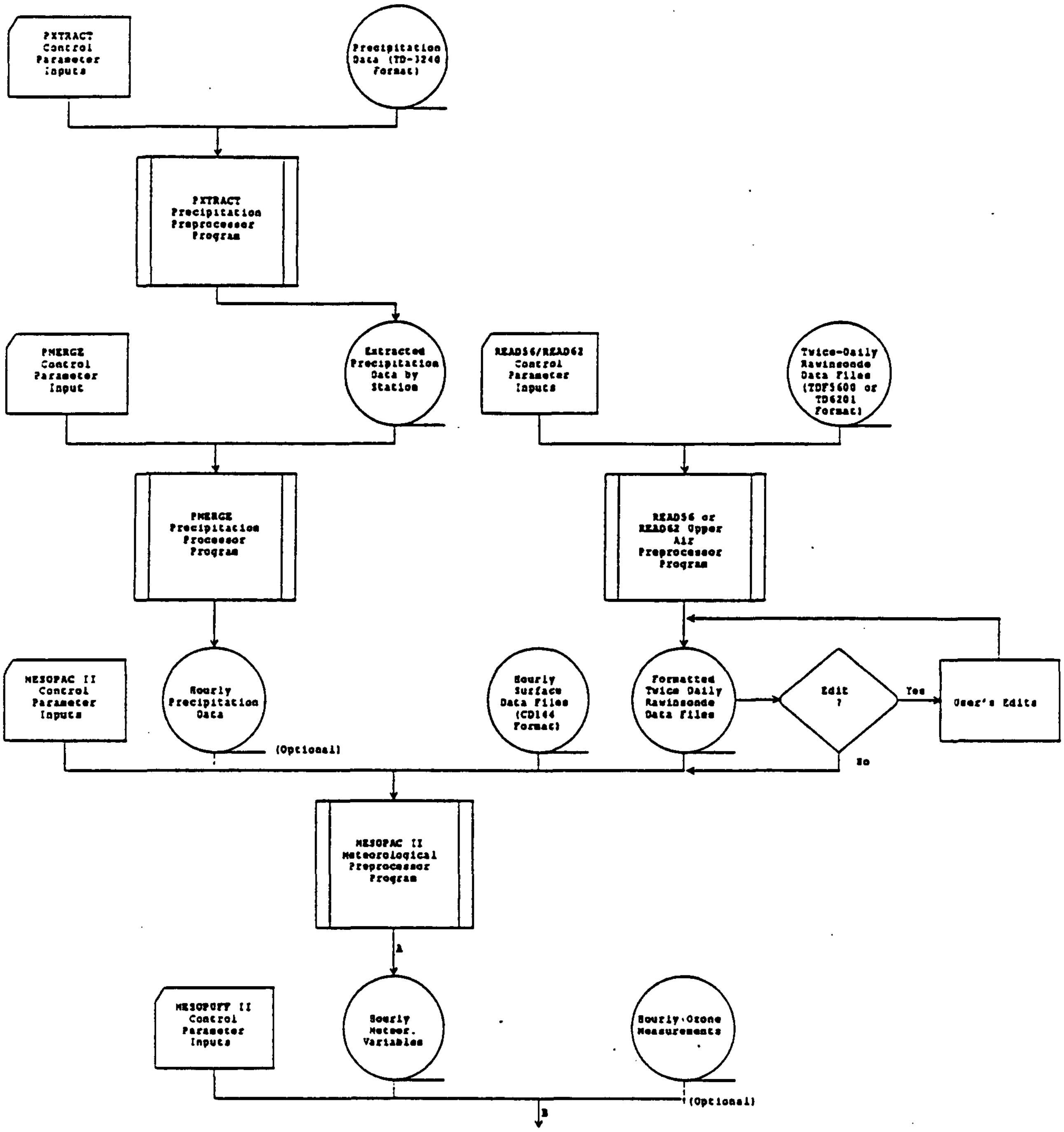

Figure 1-1. MESOPUFF II (V5.1) Modeling Package. (Continued)
(a) Meteorological Components

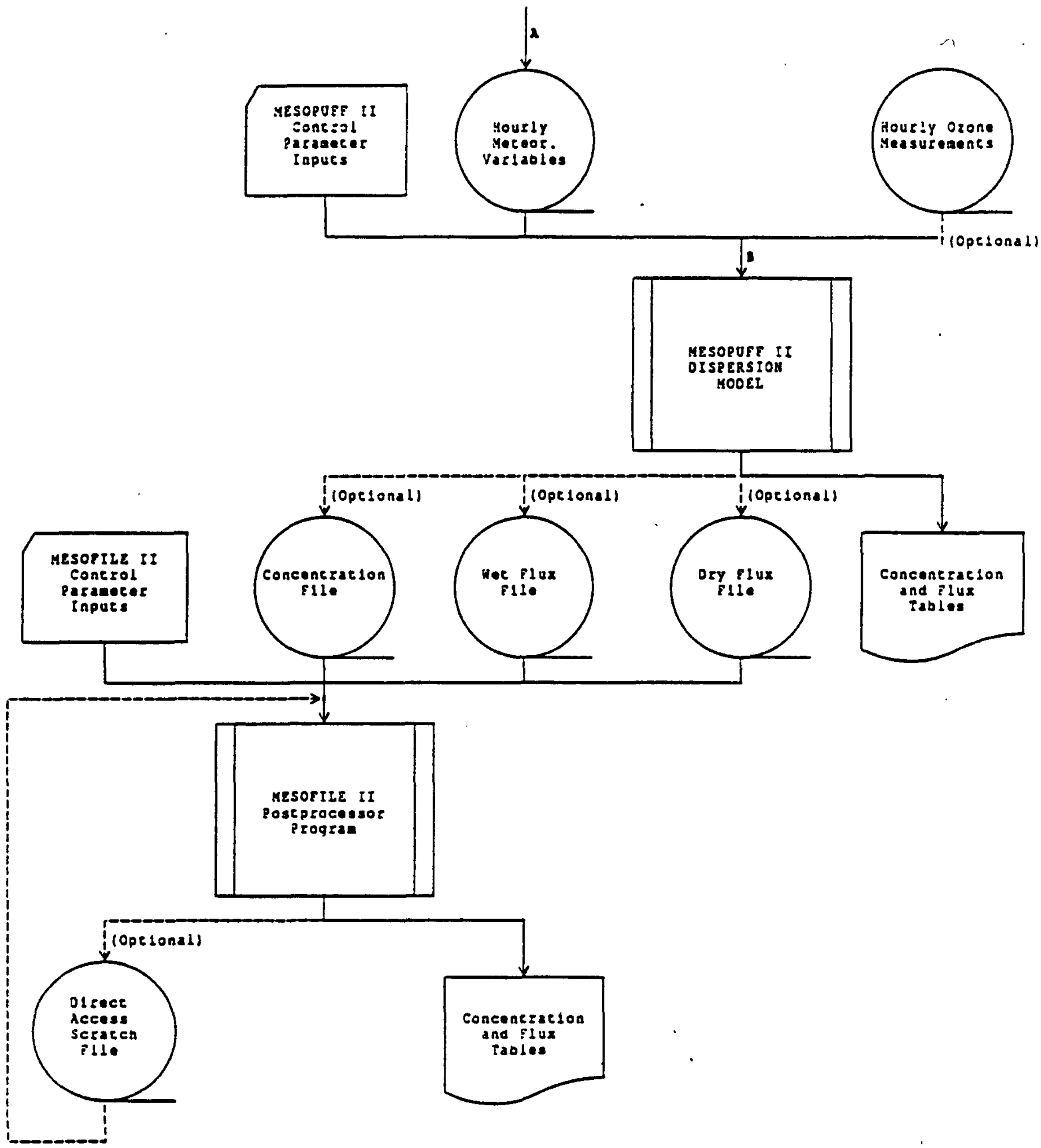

Figure 1-1. MESOPUFF II (V5.1) Modeling Package. (Concluded)
(b) Dispersion and Postprocessing Components

a continuous plume is modeled as a series of discrete puffs (Figure 1-2). Each puff is transported independently of other puffs. A puff is subject to growth by diffusion, chemical transformations, wet removal by precipitation, and dry deposition at the surface. Up to five pollutants may be modeled simultaneously.

MESOFILE II is a postprocessing program that operates on the concentration and wet/dry flux files produced by MESOPUFF II. The postprocessing functions available with MESOFILE II include flexible time averaging of gridded or non-gridded (discrete) receptor concentrations and fluxes, line printer contour plots of concentration and flux fields, statistical analysis of point-by-point or bulk differences between concentration/flux fields, and summing and scaling capabilities.

1.3 Major Features of MESOPUFF II

Table 1-1 outlines the most important features of MESOPUFF II and its processor programs. MESOPAC II supplements twice-daily rawinsonde data with hourly surface data to construct wind fields at two levels. The greater temporal and spatial resolution of the surface data allows improved treatment of plume transport. Wind fields are constructed at two user-selected levels: a lower level to represent boundary layer flow and an upper level to represent flow above the boundary layer.

In addition to the wind field module, MESOPAC II has a boundary layer module which computes from routinely-available data micrometeorological variables which describe the structure of the boundary layer (i.e., surface friction velocity, u_*, convective velocity scale, w_*, Monin-Obukhov length, L, and boundary layer height, z_i). These variables are computed by MESOPAC II from surface meteorological data and surface characteristics (i.e., land use, roughness length) provided by the user for each grid point.

MESOPUFF II accommodates up to five pollutants: sulfur dioxide (SO_2), sulfate $SO_4^=$, nitrogen oxides (NO_x = NO + NO_2), nitric acid (HNO_3), and nitrate NO_3^-. Chemical transformation rate expressions developed from the results of photochemical model simulations over a wide range of environmental conditions are used to parameterize chemical processes. The rate expressions include effects for the gas phase oxidation of SO_2 and NO_x. The $HNO_3/NH_3/NH_4NO_3$ chemical equilibrium relationship is also incorporated into the model.

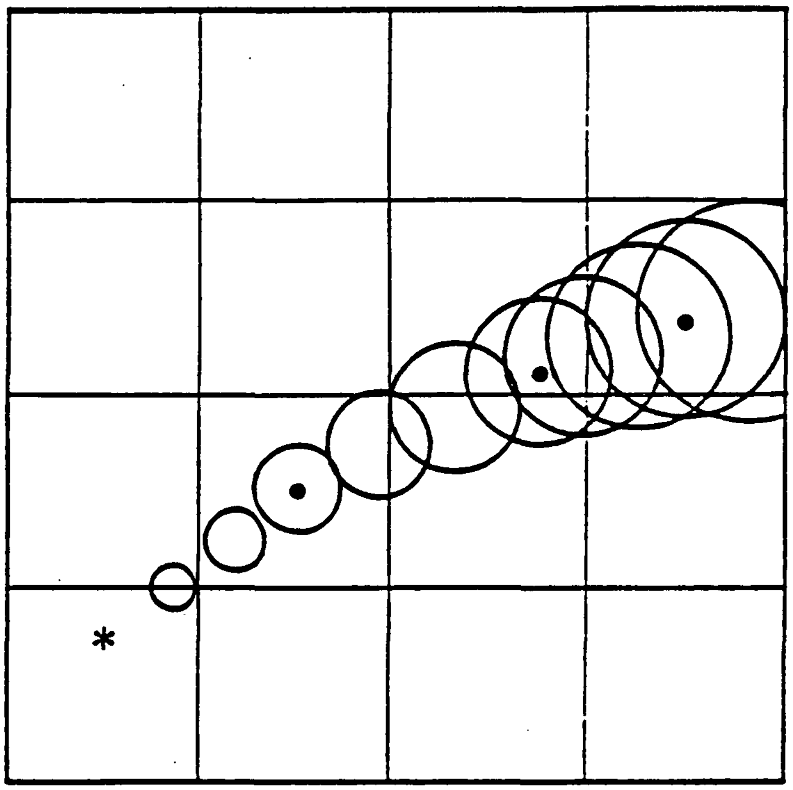

Figure 1-2. Schematic representation of puff superposition approach.

Table 1-1

Major Features of MESOPUFF II

- Uses hourly surface meteorological data, twice-daily upper air rawinsonde soundings, and hourly precipitation observations.
- Wind fields constructed for two layers (within boundary layer, above boundary layer).
- Boundary layer structure parameterized in terms of micrometeorological variables u_*, w_*, z_i, L.
- Up to five species (e.g., SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-).
- Space- and time-varying chemical transformations.
- Space- and time-varying dry deposition with a resistance model.
- Space and time-varying wet removal.
- Efficient puff sampling function.
- Concentrations, wet fluxes, and dry fluxes predicted.
- Flexible memory management system.
- Model restart/continuation option.

The dry deposition of pollutants is treated in MESOPUFF II with a resistance model. The pollutant flux is proportional to the inverse of a sum of resistances to pollutant transfer through the atmosphere to the surface. The resistances depend on the characteristics of the pollutant, the underlying surface, and atmospheric conditions. MESOPUFF II contains options for the commonly used source depletion model of dry deposition (i.e., pollutant is removed from the entire depth of the puff) or a more realistic surface depletion treatment (i.e., material is removed only from the surface layer) with a 3-layer submodule.

Precipitation scavenging can be the dominant pollutant removal mechanism during precipitation periods. MESOPUFF II contains a scavenging ratio formulation for wet removal. The scavenging ratio depends on both the type and rate of precipitation, and the characteristics of the pollutant.

MESOPUFF II uses an unique method to evaluate and sum the contributions of individual puffs to the total concentration. The model uses an integrated form of the puff sampling function that eliminates the problem of insufficient puff overlap commonly encountered with puff superposition models. This development allows continuous plumes to be accurately simulated with fewer puffs, thereby saving computational time and reducing computer storage requirements.

Among the most significant new enhancements to MESOPUFF II are the addition of options to store wet and dry fluxes, the ability to conduct continuation runs of previous simulations, and the use of a flexible memory management system which allows a global redimensioning of all of the major arrays by making simple changes to a parameter file.

1.4 Summary of Required Input Data

The required input data for MESOPUFF II and its preprocessors may be classified into four types: (1) run control parameters, (2) meteorological data, (3) surface classification (land use) data, and (4) source and emissions data. If available, hourly ozone measurements may also be input to the model. The values of the run control parameters for each program are selected by the user to define a run. For example, the starting date and length of a run, the technical options used, and control of input/output options are all determined by values of the run control parameters chosen by the user.

The meteorological data inputs required by MESOPAC II are twice-daily upper air soundings and hourly surface meteorological observations. Hourly precipitation measurements are an optional input, which are necessary if the model is to be used to simulate wet removal.

The program is designed to use standard-formatted meteorological files available from NCDC. The upper air soundings are routinely obtained twice a day at 00 GMT (7 pm EST) and 12 GMT (7 am EST). The READ56 and READ62 programs extract the following information for each sounding level:

- pressure
- height
- temperature
- wind direction
- wind speed.

The required format for upper air data is the Tape Deck Format 5600 series (TDF5600) for READ56 or the more recent format TD6201 for READ62, both in fixed record length format.

The hourly surface meteorological data for MESOPAC II consists of the following information:

- cloud cover
- ceiling height
- precipitation type
- wind speed
- wind direction
- surface pressure
- temperature
- relative humidity

The required format for the hourly surface observations is Card Deck 144 (CD144).

The CD144 formatted surface observations do not contain hourly precipitation amounts. However, hourly precipitation data are available at many stations in NCDC Tape Deck 3240 (TD-3240) format. The PXTRACT and PMERGE programs preprocess the precipitation data into the input format required by MESOPAC II.

The third type of required input data is a classification of the typical surface characteristics in each grid square. Although the user may optionally specify detailed information such as roughness length and canopy resistances, these data may not always be available. Therefore, the program requires only that land use categories be input for each grid cell. These data may be obtained from land use maps or digitized land use inventories available on tape such as the National Land Use and Land Cover Inventory (Page, 1980). Pre-selected surface roughness lengths and canopy resistances associated with each land use category are then internally assigned to the grid cells. The land use categories and default values of associated surface roughness and canopy resistance are listed in Table 6-3.

MESOPUFF II models emissions from both point and area sources. The following information is required for each point source:

- source location (x,y in grid units)
- stack height
- stack diameter
- exit velocity
- stack gas temperature
- emission rate for each pollutant.

The area source option is primarily intended to allow modeling of the large number of small point and non-point sources within urban areas as one or more sources with an effective height and initial vertical and horizontal puff size specified by the user. The following information is required for each area source:

- location (x,y in grid units)
- effective height
- initial puff size (σ_y, σ_z)
- emission rate for each pollutant.

1.5 Computer Requirements

The memory management scheme used in MESOPAC II and MESOPUFF II is designed to allow the maximum array dimensions in the model to be easily adjusted to match the requirements of a particular application. An external parameter file contains the maximum array size for all of the major arrays. A re-sizing of the program can be accomplished by modifying the appropriate variables in the parameter file.

Therefore, the memory required by the models will be determined by the particular application. The storage and computational requirements of the model are also highly application specific. For most practical applications, a minimum computer configuration would include a 486 PC, with 4 MB memory, hard disk capacity of 300-500 MB, and a tape backup unit. An annual model simulation can be broken into smaller (e.g., monthly) runs, which would reduce the disk storage requirements. However, the tradeoff is that swapping of files between tape and disk is increased, and the numbers of runs and files to be managed is greater.

As an example of the computer requirements of the modeling system, a recent application with the following characteristics:

MESOPAC II

- 12 monthly runs
- 9 surface stations
- 3 upper air stations
- 32 precipitation stations
- 51 x 51 meteorological grid

required:

- Memory:	0.7 Mb
- CPU time:	~ 2.5 hours/month (486/33 MHz)
- Input files:	~ 1 Mb/month (meteorological data)
- Output file:	~ 78 Mb/month (gridded meteorological file)
	< 1 Mb/month (other files)

and the MESOPUFF II simulations, consisting of:

MESOPUFF II

- single source
- 51 x 51 meteorological grid
- 41 x 41 sampling grid
- maximum dimension of puff arrays (MXPUFF) = 10,000
- puff release rate - 16 puffs/hour
- puff sampling rate - 2 samples/hour
- 5 species
- 26 hourly ozone stations

required:

- Memory: 1.2 Mb
- CPU time: ~ 6 hours/month (486/33 MHz)
- Input files: ~ 78 Mb/month - meteorological data (see above)
  < 1 Mb/month - other files
- Outputs: ~ 5 Mb/species/month
  ~ 75 Mb/month total for 5 species and concentrations, wet fluxes and dry fluxes.

The disk storage requirements can be significantly reduced in some applications by using a longer basic averaging time, and reducing or eliminating the sampling grid size (i.e., using non-gridded receptors only).

2.0 READ56/READ62 UPPER AIR DATA PREPROCESSORS

READ56 and READ62 are preprocessing programs which extract and process upper air wind and temperature data from standard NCDC data formats into a form required by the MESOPAC II meteorological model. READ56 operates on the older TD-5600 data format. Although this format is not currently used by NCDC, some historical data sets may contain data in this format. READ62 processes data in the current TD-6201 format. A description of the TD-6201 format available from NCDC is contained in Attachment 2A. Both programs require that the NCDC upper air data be in fixed record length format.

Although the upper air input formats are different, the user inputs to READ56 and READ62 are identical as is the processed output file. In the user input file, the user selects the starting and ending dates of the data to be extracted and the top pressure level. Also selected are processing options determining how missing data are treated. The programs will flag or eliminate sounding levels with missing data.

If the user selects the option to flag (rather than eliminate) levels with missing data, the data field of the missing variables is indicated with a series of nines. If the option to eliminate levels with missing data is chosen, only sounding levels with all non-missing values will be included in the output data file.

A formatted file of pressure, height, temperature, wind speed and wind direction at each sounding level is created by READ56/READ62 for possible editing by the user and subsequent input into the meteorological models. Before running MESOPAC II the user must edit the formatted file to either eliminate pressure levels with missing variables or replace the missing parameters with appropriate values. This may be done with a separate preprocessor program (not provided), or it may be done manually. However, the user is cautioned that the use of soundings with significant gaps due to missing data may lead to poor modeling results. In particular, adequate vertical resolution of the morning temperature structure near the surface is especially important to the meteorological model in predicting daytime mixing heights.

Two input files are required by the preprocessor: a user input control file and the NCDC upper air data file. Two output files are produced: a list file summarizing the user options selected and missing soundings encountered, and the processed data file in MESOPAC II format. Table 2-1 contains a listing of the input and output files for READ56 and READ62.

Table 2-1

READ56/READ62 Input and Output Files

(a) READ56

Unit	File Name	Type	Format	Description
5	READ56.INP	Input	Formatted	Control file containing user inputs
6	READ56.LST	Output	Formatted	List file (line printer output file)
8	TDF56.DAT	Input	Formatted	Upper air data in NCDC TD-5600 fixed record length format
9	UP.DAT*	Output	Formatted	Output file containing processed upper air data in format required by MESOPAC II

(b) READ62

Unit	File Name	Type	Format	Description
5	READ62.INP	Input	Formatted	Control file containing user inputs
6	READ62.LST	Output	Formatted	List file (line printer output file)
8	TD6201.DAT	Input	Formatted	Upper air data in NCDC TD-6201 fixed record length format
9	UP.DAT*	Output	Formatted	Output file containing processed upper air data in format required by MESOPAC II

* Should be renamed UP1.DAT (for upper air station #1), UP2.DAT (for station #2), etc. for input into the MESOPAC II model.

The READ56/READ62 control file consists of two lines of data entered in FORTRAN free format. A description of each input variable is shown in Table 2-2. A sample input file is shown in Table 2-3. Table 2-4 describes the format of the output file produced by READ56/READ62. The output list file is shown in Table 2-5. In the list file, the user inputs are printed as well as a summary of the soundings processed. Informational messages indicating problems in the data set are written in the summary. Table 2-6 shows the data set as output by READ62. The informational messages seen in the list file are also written in the data file. These messages must be removed and all missing soundings and missing parameters within a level must be filled in with appropriate data before the upper air data set is ready for input to MESOPAC II. Missing soundings should be replaced with soundings for the same time period from a representative substitute station. Missing parameters for a given level may be interpolated from the surrounding levels. Each data set must be processed on a case-by-case basis, with careful consideration given on how to deal with missing data. Table 2-7 shows the sample data set after editing by the user is complete and the upper air data is ready to be input to MESOPAC II. It should be noted that all missing value indicators have been replaced with interpolated values, and the missing 12Z sounding has been inserted in the appropriate position in the file. (In this case, data from a nearby station were used to replace the missing sounding). Note that the station ID of the substitute data has been modified to match that of the original station with missing data.

Table 2-2

READ56/READ62 Control File Inputs

RECORD 1. Starting and ending date/hour, top pressure level to extract.

Columns	Type	Variable	Description
*	INTEGER	IBYR	Starting year of data to extract (two digits).
*	INTEGER	IBDAY	Starting Julian day.
*	INTEGER	IBHR	Starting hour (00 or 12 GMT).
*	INTEGER	IEYR	Ending year of data to extract (two digits).
*	INTEGER	IEDAY	Ending Julian day.
*	INTEGER	IEHR	Ending hour (00 or 12 GMT).
*	REAL	PSTOP	Top pressure level (mb) for which data is extracted (possible values are 850 mb, 700 mb, or 500 mb). The output file will contain data from the surface to the "PSTOP"-mb pressure level.

* Entered in FORTRAN free format

Table 2-2 - Concluded

READ56/READ62 Control File Inputs

RECORD 2. Missing data control variables.

Columns	Type	Variable	Description
*	LOGICAL	LHT	Height field control variable. If LHT = T, a sounding level is eliminated if the height field is missing. If LHT = F, the sounding level is included in the output file but the height field is flagged with a "-999.9," if missing.
*	LOGICAL	LTEMP	Temperature field control variable. If LTEMP = T, a sounding level is eliminated if the temperature field is missing. If LTEMP = F, the sounding level is included in the output file but the temperature field is flagged with a "999.9", if missing.
*	LOGICAL	LWD	Wind direction field control variable. If LWD = T, a sounding level is eliminated if the wind direction field is missing. If LWD = F, the sounding level is included in the output file but the wind direction field is flagged with a "999", if missing.
*	LOGICAL	LWS	Wind speed field control variable. If LWS = T, a sounding level is eliminated if the wind speed field is missing. If LWS = F, the sounding level is included in the output file but the wind speed field is flagged with a "999", if missing.

* Entered in FORTRAN free format

Table 2-3

Sample READ56/READ62 Control File (READ56.INP, READ62.INP)

```
83 001 00  83 365 12  500.        -- Beg. yr, day, hr (GMT), End. yr, day, hr, top pressure level
.TRUE., .FALSE.,  .FASLE., .FALSE.  -- Eliminate level if height, temp., wind direction, wind speed missing ?
```

Table 2-4

READ56/READ62 Output File Format
(UPn.DAT)

HEADER RECORD 1.

Columns	Format	Variable	Description
2-6	I5	IBYR	Starting year of data in the file (two digits).
7-11	I5	IBDAY	Starting Julian day.
12-16	I5	IBHR	Starting hour (GMT).
17-21	I5	IEYR	Ending year (two digits).
22-26	I5	IEDAY	Ending Julian day.
27-31	I5	IEHR	Ending hour (GMT).
32-36	F5.0	PSTOP	Top pressure level (mb) (possible values are 850 mb, 700 mb, or 500 mb).

HEADER RECORD 2.

Columns	Format	Variable	Description
6	L1	LHT	Sounding level eliminated if height missing? (T=yes, F=no)
11	L1	LTEMP	Sounding level eliminated if temperature missing?
16	L1	LWD	Sounding level eliminated if wind direction missing?
21	L1	LWS	Sounding level eliminated if wind speed missing?

Table 2-4

READ56/READ62 Output File Format - Continued
(UPn.DAT)

DATA HEADER RECORD - For each 00 or 12 GMT sounding, a one-record data header is used followed by "N" records of data. Each record contains up to four sounding levels.

Columns	Format*	Variable	Description
4-7	I4	ITPDK	Label identifying data format of original data (e.g., 5600 or 6201 for NCDC data or 9999 for non-NCDC data).
13-17	I5	NOSTA	Station ID number.
23-30	4I2	IOBTM(4)	Year, month, day, and hour (GMT) of data.
36-37	I2	LVL	Total number of levels in the original sounding.
69-70	I2	P	Number of levels extracted from the original sounding and stored below.

* Record format is (3x, i4, 5x, i5, 5x, 4i2, 5x, i2, t69, i2)

Table 2-4

READ56/READ62 Output File Format (UPn.DAT)

DATA RECORDS (Up to four levels per record)

Columns	Format*	Variable	Description
4-9	F6.1	PRES	Pressure (mb)
11-15	F5.0	HEIGHT	Height above sea level (m)
17-21	F5.1	TEMP	Temperature (deg. K)
23-25	I3	DIR	Wind direction (degrees)
27-29	I3	WS	Wind speed (m/s)
33-38	F6.1	PRES	Pressure (mb)
40-44	F5.0	HEIGHT	Height above sea level (m)
46-50	F5.1	TEMP	Temperature (deg. K)
52-54	I3	DIR	Wind direction (degrees)
56-58	I3	WS	Wind speed (m/s)
62-67	F6.1	PRES	Pressure (mb)
69-73	F5.0	HEIGHT	Height above sea level (m)
75-79	F5.1	TEMP	Temperature (deg. K)
81-83	I3	DIR	Wind direction (degrees)
85-87	I3	WS	Wind speed (m/s)
91-96	F6.1	PRES	Pressure (mb)
98-102	F5.0	HEIGHT	Height above sea level (m)
104-108	F5.1	TEMP	Temperature (deg. K)
110-112	I3	DIR	Wind direction (degrees)
114-116	I3	WS	Wind speed (m/s)

* Record format is (4(3x,f6.1, '/',f5.0, '/',f5.1,'/',i3,'/',i3))

Table 2-5

Sample READ62 Output List File

```
                    READ62   VERSION 4.0     LEVEL 901130


STARTING DATE:                 ENDING DATE:

          YEAR =   83                    YEAR =   83
    JULIAN DAY =    1              JULIAN DAY =    3
          HOUR =    0 (GMT)              HOUR =   12 (GMT)


PRESSURE LEVELS EXTRACTED:

                    SURFACE TO   500. MB


DATA LEVEL ELIMINATED IF HEIGHT MISSING ?          T

DATA LEVEL ELIMINATED IF TEMPERATURE MISSING ?     F

DATA LEVEL ELIMINATED IF WIND DIRECTION MISSING ? F

DATA LEVEL ELIMINATED IF WIND SPEED MISSING ?      F


THE FOLLOWING SOUNDINGS HAVE BEEN PROCESSED:

      YEAR   MONTH   DAY   JULIAN DAY   HOUR (GMT)   NO. LEVELS EXTRACTED

       83      1      1        1            0                 19
       83      1      1        1           12                 30
       83      1      2        2            0                 17
       83      1      3        3            0                 29
->->->MISSING/DUPLICATE SOUNDING
       83      1      3        3           12                 19
           TOP OF SOUNDING LISTED ABOVE IS BELOW THE  500.0-MB LEVEL
```

Table 2-6

Sample READ62 Output Data File
(Before Editing and Substitution of Missing Data)

```
   83    1    0   83    3   12 500.
    T    F    F    F
  6201      93739      83 1 1 0     47                         19
  1024.0/   4./278.8/360/  1    1014.0/  84./278.4/ 43/  1    1000.0/ 198./277.8/ 84/  1    984.0/ 330./277.1/115/  2
   950.0/ 618./279.7/201/  6     943.0/ 679./280.3/209/  6     900.0/1063./278.7/233/  8    850.0/1529./276.6/243/ 10
   820.0/1819./273.5/251/ 13     814.0/1878./274.0/252/ 14     800.0/2018./276.9/254/ 16    791.0/2110./278.8/255/ 17
   750.0/2543./276.5/999/999     700.0/3099./273.5/264/ 22     650.0/3688./999.9/267/ 23    600.0/4314./999.9/999/999
   550.0/4981./259.2/255/ 29     532.0/5232./257.2/259/ 33     500.0/5698./256.0/260/ 38
  6201      93739      83 1 112     51                         30
  1025.2/   4./278.2/285/  1    1015.0/  86./277.8/300/  3    1000.0/ 207./277.3/304/  5    968.0/ 472./278.0/314/  5
   950.0/ 625./277.6/322/  4     933.0/ 772./277.2/294/  3     900.0/1064./274.6/271/  4    883.0/1217./273.1/266/  5
   866.0/1373./272.6/262/  6     850.0/1523./277.3/253/  8     800.0/2015./276.3/258/ 16    777.0/2251./275.7/262/ 19
   761.0/2419./276.0/259/ 22     750.0/2537./275.5/257/ 23     738.0/2667./274.9/255/ 26    719.0/2877./273.9/253/ 29
   700.0/3092./272.8/254/ 30     685.0/3265./271.7/253/ 32     671.0/3429./270.4/251/ 34    650.0/3680./268.4/250/ 35
   649.0/3693./268.3/250/ 35     631.0/3914./267.0/249/ 37     616.0/4102./266.4/246/ 38    610.0/4178./266.1/244/ 38
   600.0/4307./265.8/246/ 37     584.0/4517./265.1/249/ 36     568.0/4733./264.8/253/ 37    550.0/4982./262.9/256/ 38
   516.0/5470./259.1/261/ 43     500.0/5708./256.7/260/ 45
  6201      93739      83 1 2 0     47                         17
  1024.0/   4./278.0/150/  1    1017.0/  60./278.1/150/  1    1000.0/ 197./277.8/151/  1    967.0/ 470./277.3/256/  3
   950.0/ 614./276.3/265/  6     914.0/ 928./278.0/276/  8     900.0/1054./277.9/278/  8    850.0/1519./277.5/272/ 14
   813.0/1882./278.3/266/ 16     800.0/2013./277.7/266/ 17     750.0/2536./275.0/273/ 20    700.0/3089./272.1/272/ 24
   650.0/3677./269.6/260/ 29     600.0/4306./266.9/261/ 29     576.0/4625./265.5/264/ 31    550.0/4982./262.6/266/ 31
   500.0/5707./256.6/266/ 35
->->->MISSING/DUPLICATE SOUNDING
  6201      93739      83 1 3 0     52                         29
  1017.0/   4./278.4/ 20/  2    1000.0/ 142./277.9/ 46/  3     969.0/ 399./277.1/ 47/  5    953.0/ 534./276.6/ 36/  5
   950.0/ 559./276.5/ 36/  5     919.0/ 828./275.2/360/  5     900.0/ 997./276.3/332/  4    895.0/1042./276.6/316/  4
   892.0/1069./277.7/308/  4     877.0/1208./278.8/279/  4     867.0/1302./278.3/272/  5    855.0/1416./277.7/265/  6
   850.0/1464./277.6/264/  6     812.0/1835./275.1/258/  7     800.0/1955./274.9/246/  8    754.0/2433./273.9/240/ 14
   750.0/2476./273.7/240/ 14     700.0/3027./270.8/245/ 15     693.0/3107./270.6/251/ 16    688.0/3165./272.0/252/ 17
   672.0/3352./268.8/258/ 18     665.0/3434./268.5/260/ 19     650.0/3613./267.6/262/ 21    633.0/3821./266.4/264/ 22
   600.0/4238./264.2/264/ 29     598.0/4263./264.0/264/ 30     586.0/4420./265.2/259/ 32    550.0/4911./262.6/252/ 27
   500.0/5639./258.6/238/ 34
  6201      93739      83 1 312     51                         19
TOP OF SOUNDING BELOW  500.0-MB LEVEL
  1018.4/   4./273.6/290/  1    1000.0/ 151./274.7/ 14/  5     991.0/ 224./275.2/ 17/  8    950.0/ 564./272.7/ 12/ 10
   934.0/ 699./271.6/  3/ 11     901.0/ 987./273.9/354/ 11     900.0/ 996./273.9/354/ 11    850.0/1453./271.1/337/  9
   816.0/1779./272.3/298/  9     800.0/1937./271.7/280/ 10     781.0/2129./270.9/265/ 14    757.0/2378./271.4/262/ 17
   750.0/2452./271.1/262/ 17     700.0/2998./268.3/267/ 18     650.0/3577./264.7/255/ 21    600.0/4194./260.8/240/ 27
   571.0/4572./258.3/247/ 30     555.0/4786./256.3/252/ 32     550.0/4854./256.1/253/ 33
```

Table 2-7

Edited Upper Air Data Set Ready for Input to MESOPAC II

```
83    1    0   83    3   12 500.
 T    F    F    F
6201      93739      83 1 1 0     47                                  19
1024.0/    4./278.8/360/  1   1014.0/  84./278.4/ 43/  1   1000.0/ 198./277.8/ 84/  1   984.0/ 330./277.1/115/  2
 950.0/ 618./279.7/201/  6    943.0/ 679./280.3/209/  6    900.0/1063./278.7/233/  8   850.0/1529./276.6/243/ 10
 820.0/1819./273.5/251/ 13    814.0/1878./274.0/252/ 14    800.0/2018./276.9/254/ 16   791.0/2110./278.8/255/ 17
 750.0/2543./276.5/256/ 19    700.0/3099./273.5/264/ 22    650.0/3688./269.1/267/ 23   600.0/4314./264.4/255/ 23
 550.0/4981./259.2/255/ 29    532.0/5232./257.2/259/ 33    500.0/5698./256.0/260/ 38
6201      93739      83 1 112     51                                  30
1025.2/    4./278.2/285/  1   1015.0/  86./277.8/300/  3   1000.0/ 207./277.3/304/  5   968.0/ 472./278.0/314/  5
 950.0/ 625./277.6/322/  4    933.0/ 772./277.2/294/  3    900.0/1064./274.6/271/  4   883.0/1217./273.1/266/  5
 866.0/1373./272.6/262/  6    850.0/1523./277.3/253/  8    800.0/2015./276.3/258/ 16   777.0/2251./275.7/262/ 19
 761.0/2419./276.0/259/ 22    750.0/2537./275.5/257/ 23    738.0/2667./274.9/255/ 26   719.0/2877./273.9/253/ 29
 700.0/3092./272.8/254/ 30    685.0/3265./271.7/253/ 32    671.0/3429./270.4/251/ 34   650.0/3680./268.4/250/ 35
 649.0/3693./268.3/250/ 35    631.0/3914./267.0/249/ 37    616.0/4102./266.4/246/ 38   610.0/4178./266.1/244/ 38
 600.0/4307./265.8/246/ 37    584.0/4517./265.1/249/ 36    568.0/4733./264.8/253/ 37   550.0/4982./262.9/256/ 38
 516.0/5470./259.1/261/ 43    500.0/5708./256.7/260/ 45
6201      93739      83 1 2 0     47                                  17
1024.0/    4./278.0/150/  1   1017.0/  60./278.1/150/  1   1000.0/ 197./277.8/151/  1   967.0/ 470./277.3/256/  3
 950.0/ 614./276.3/265/  6    914.0/ 928./278.0/276/  8    900.0/1054./277.9/278/  8   850.0/1519./277.5/272/ 14
 813.0/1882./278.3/266/ 16    800.0/2013./277.7/266/ 17    750.0/2536./275.0/273/ 20   700.0/3089./272.1/272/ 24
 650.0/3677./269.6/260/ 29    600.0/4306./266.9/261/ 29    576.0/4625./265.5/264/ 31   550.0/4982./262.6/266/ 31
 500.0/5707./256.6/266/ 35
6201      93739      83 1 212     54                                  19
1023.0/    4./277.2/240/  1   1016.0/  60./278.3/232/  1   1000.0/ 190./278.0/103/  1   970.0/ 439./278.9/ 85/  1
 950.0/ 609./278.2/ 69/  1    900.0/1049./276.1/231/  3    897.0/1075./275.9/230/  3   850.0/1512./278.2/260/  8
 800.0/2006./277.0/270/ 14    784.0/2169./276.6/267/ 15    750.0/2527./274.6/261/ 15   700.0/3079./271.4/266/ 18
 659.0/3557./269.5/265/ 21    650.0/3666./268.9/264/ 20    641.0/3775./268.1/262/ 18   600.0/4292./265.1/247/ 21
 599.0/4305./265.0/245/ 21    550.0/4965./261.9/236/ 29    500.0/5692./258.4/244/ 36
6201      93739      83 1 3 0     52                                  29
1017.0/    4./278.4/ 20/  2   1000.0/ 142./277.9/ 46/  3    969.0/ 399./277.1/ 47/  5   953.0/ 534./276.6/ 36/  5
 950.0/ 559./276.5/ 36/  5    919.0/ 828./275.2/360/  5    900.0/ 997./276.3/332/  4   895.0/1042./276.6/316/  4
 892.0/1069./277.7/308/  4    877.0/1208./278.8/279/  4    867.0/1302./278.3/272/  5   855.0/1416./277.7/265/  6
 850.0/1464./277.6/264/  6    812.0/1835./275.1/258/  7    800.0/1955./274.9/246/  8   754.0/2433./273.9/240/ 14
 750.0/2476./273.7/240/ 14    700.0/3027./270.8/245/ 15    693.0/3107./270.6/251/ 16   688.0/3165./272.0/252/ 17
 672.0/3352./268.8/258/ 18    665.0/3434./268.5/260/ 19    650.0/3613./267.6/262/ 21   633.0/3821./266.4/264/ 22
 600.0/4238./264.2/264/ 29    598.0/4263./264.0/264/ 30    586.0/4420./265.2/259/ 32   550.0/4911./262.6/252/ 27
 500.0/5639./258.6/238/ 34
6201      93739      83 1 312     51                                  20
1018.4/    4./273.6/290/  1   1000.0/ 151./274.7/ 14/  5    991.0/ 224./275.2/ 17/  8   950.0/ 564./272.7/ 12/ 10
 934.0/ 699./271.6/  3/ 11    901.0/ 987./273.9/354/ 11    900.0/ 996./273.9/354/ 11   850.0/1453./271.1/337/  9
 816.0/1779./272.3/298/  9    800.0/1937./271.7/280/ 10    781.0/2129./270.9/265/ 14   757.0/2378./271.4/262/ 17
 750.0/2452./271.1/262/ 17    700.0/2998./268.3/267/ 18    650.0/3577./264.7/255/ 21   600.0/4194./260.8/240/ 27
 571.0/4572./258.3/247/ 30    555.0/4786./256.3/252/ 32    550.0/4854./256.1/253/ 33   500.0/5565./253.1/259/ 39
```

3.0 PXTRACT PRECIPITATION DATA EXTRACT PROGRAM

PXTRACT is a preprocessor program which extracts precipitation data for stations and time periods of interest from a formatted precipitation data file in NCDC TD-3240 format. The TD-3240 data used by PXTRACT must be in fixed record length format (as opposed to the variable record length format, which is also available from NCDC). The hourly TD-3240 precipitation data usually comes in large blocks of data sorted by station. For example, a typical TD-3240 file may contain data from over 100 precipitation stations in blocks of time of 30 years or more. Modeling applications require the data sorted by time rather than station, and usually involve limited spatial domains of tens of kilometers or less and time periods from less than one year up to 5 years. PXTRACT allows data for a particular model run to be extracted from the larger data file and creates a set of station files that are used as input files by the second-stage precipitation preprocessor, PMERGE (see Section 4).

If wet removal is not to be considered by the MESOPUFF II dispersion model, no precipitation processing needs to be done. PXTRACT (and PMERGE) are required only if wet removal is to be considered in the modeling application. In addition, the user has the option of creating a free-formatted precipitation data file that can be read directly by MESOPAC II. This option eliminates the need to run the precipitation preprocessing programs for short MESOPAC II runs (e.g., screening runs) for which the input data can easily be input manually.

The input files used by PXTRACT include a control file (PXTRACT.INP) containing user inputs, and a data file (TD3240.DAT) containing the NCDC data in fixed record length TD-3240 format. The precipitation data for stations selected by the user are extracted from the TD3240.DAT file and stored in separate output files (one file per station) called xxxxxx.DAT, where xxxxxx is the station identification code. PXTRACT also creates an output list file (PXTRACT.LST) which contains the user options and summarizes the station data extracted. Table 3-1 contains a summary of PXTRACT's input and output files.

The PXTRACT control file contains the user-specified variables which determine the method used to extract precipitation data from the input data file (i.e., by state, by station, or all stations), the appropriate state or station codes, and the time period to be extracted. A sample PXTRACT control file is shown in Table 3-2. The format and contents of the file are described in Table 3-3.

The PXTRACT output list file (PXTRACT.LST) contains a listing of the control file inputs and options. It also summarizes the station data extracted from the input TD-3240 data file, including the starting and ending date of the data for each station and the number of data records found. A sample output list file is shown in Table 3-4. The PXTRACT output data files consist of precipitation data in TD-3240 format for the time period selected by the user. Each output data file contains the data for one station. A sample output file is shown in Table 3-5.

A description of the NCDC hourly precipitation TD-3240 digital files is reproduced in Attachment 3-A at the end of this section. Both variable length record and fixed length record formats are described. However, the precipitation data preprocessors, PXTRACT and PMERGE, require the fixed record length format of 42 characters per record (See Appendix A of the TD-3240 data description).

Table 3-1

PXTRACT Input and Output Files

Unit	File Name	Type	Format	Description
1	PXTRACT.INP	Input	Formatted	Control file containing user inputs.
2	TD3240.DAT	Input	Formatted	Precipitation data in NCDC TD-3240 fixed record length format.
6	PXTRACT.LST	Output	Formatted	List file (line printer output file).
7	id1.DAT (id1 is the 6-digit station code for station #1, e.g., 040001)	Output	Formatted	Precipitation data (in TD-3240) format for station #1 for the time period selected by the user.
8	id2.DAT (id2 is the 6-digit station code for station #2, e.g., 040002)	Output	Formatted	Precipitation data (in TD-3240) format for station #2 for the time period selected by the user.

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(Up to 200 new precipitation data files are allowed by PXTRACT).

Table 3-2

Sample PXTRACT Control File (PXTRACT.INP)

```
2                          – Selection code, ICODE (1=by state, 2=by station, 3=all stations)
5                          – Number of states (ICODE=1) or stations (ICODE=2) to extract
040001                     – State or station code – (I6)
040002
040003
040004
040005
80 01 01 01 80 01 02 24    – Starting yr, month, day, hour (01-24), ending yr, month, day, hour (01-24) – (8(I2,1x))
```

Table 3-3

PXTRACT Control File Inputs (PXTRACT.INP)

RECORD 1. Data selection code.

Columns	Variable	Type	Description
*	ICODE	Integer	Selection code: 1 = extract all stations within state or states requested. 2 = input a list of station codes of stations to extract. 3 = extract all stations in the input file with data for the time period of interest.

RECORD 2. Number of state or station codes. (This record is include only if ICODE = 1 or 2)

Columns	Variable	Type	Description
*	N	Integer	If ICODE = 1: Number of state codes to follow. If ICODE = 2: Number of station codes to follow.

* Entered in FORTRAN free format

Table 3-3 (Concluded)

PXTRACT Control File Inputs (PXTRACT.INP)

RECORD 3, 4, ... 2+N **State or station codes of data to be extracted** (Each record has the following format)

Columns	Format	Variable	Description
1-6	I6	IDAT	If ICODE=1: State code (two digits). If ICODE=2: Station code (six digits) consisting of state code (two digits) followed by station ID (four digits).

NEXT RECORD. Starting/ending dates and time

Columns	Format	Variable	Description
1-2	I2	IBYR	Beginning year of data to process (two digits).
4-5	I2	IBMO	Beginning month.
7-8	I2	IBDAY	Beginning day.
10-11	I2	IBHR	Beginning hour (01-24 LST).
13-14	I2	IEYR	Ending year of data to process (two digits).
16-17	I2	IEMO	Ending month.
19-20	I2	IEDAY	Ending day.
22-23	I2	IEHR	Ending hour (01-24 LST).

* Record format is (8(i2,1x))

Table 3-4

Sample PXTRACT Output List File (PXTRACT.LST)

```
                    PXTRACT OUTPUT SUMMARY
              VERSION:  1.0      LEVEL:  901130


RUNTIME CALL NO.:        1   DATE: 11/29/90   TIME: 16:03:51.65


 Data Requested by Station ID

 Period to Extract:    1/ 1/80   1:00  to   1/ 2/80  24:00


 Requested Precipitation Station ID Numbers -- (sorted):

   No.    ID           No.    ID           No.    ID           No.    ID

    1   040001          3   040003          4   040004          5   040005
    2   040002


 Station      Starting   Ending    No. of
  Code         Date      Date      Records

 040001        1/ 1/80   1/12/80     7
 040002        1/ 1/80   1/12/80     8
 040003        1/ 1/80   1/12/80     7
 040004        1/ 1/80   1/12/80     6
 040005       12/31/79   1/ 3/80     4



RUNTIME CALL NO.:        2   DATE: 11/29/90   TIME: 16:03:53.24
DELTA TIME:        1.59 (SEC)
```

Table 3-5

Sample PXTRACT Output Precipitation Data File (040001.DAT)

```
HPD04000100HPCPHI19800100010010100 00002
HPD04000100HPCPHI19800100010010200 00002
HPD04000100HPCPHI19800100010010300 00004
HPD04000100HPCPHI19800100020010700 00000
HPD04000100HPCPHI19800100030011300 00000M
HPD04000100HPCPHI19800100120010400 00000M
HPD04000100HPCPHI19800100120010500 00000
```

4.0 PMERGE PRECIPITATION DATA PREPROCESSOR

PMERGE reads, processes and reformats the precipitation data files created by the PXTRACT program, and creates either a formatted file for input into MESOPAC II or an unformatted data file to be used in subsequent merging. The output file (PRECIP.DAT) contains the precipitation data sorted by hour, as required by MESOPAC II, rather than by station. The program can also read an existing unformatted output file and add stations to it, creating a new output file. PMERGE also resolves "accumulation periods" and flags missing or suspicious data.

Accumulation periods are intervals during which only the total amount of precipitation is known. The time history of precipitation within the accumulation period is not available. For example, it may be known that within a six-hour accumulation period, a total of a half inch of precipitation fell, but information on the hourly precipitation rates within the period is unavailable. PMERGE resolves accumulation periods such as this by assuming a constant precipitation rate during the accumulation period. For modeling purposes, this assumption is suitable as long as the accumulation time period is short (e.g., a few hours). However, for longer accumulation periods, the use of the poorly time-resolved precipitation data is not recommended. PMERGE will eliminate and flag as missing any accumulation periods longer than a user-define maximum length.

PMERGE provides an option to "pack" the precipitation data in the unformatted output in order to reduce the size of the file. A "zero packing" method is used to pack the precipitation data. Because many of the precipitation values are zero, strings of zeros are replaced with a coded integer identifying the number of consecutive zeros that are being represented. For example, the following record with data from 20 stations requires 20 unpacked words:

0.0, 0.0, 0.0, 0.0, 0.0, 1.2, 3.5, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.7, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0

These data in packed form would be represented in six words:

-5., 1.2, 3.5, -6., 0.7, -6.

where five zero values are replaced by -5., six zero values are replaced by -6., etc. With many stations and a high frequency of zeros, very high packing ratios can be obtained with this simple method. All of the packing and unpacking operations are performed internally by PMERGE and are transparent to the user. The header records of the data file contain information flagging the file as a packed or unpacked file. If the user selects the unpacked format, each precipitation value is assigned one full word. The packing option is only available when writing unformatted output.

The input files used by PMERGE include a control file (PMERGE.INP), an optional unformatted data file (PBIN.DAT) created in a previous run of PMERGE, and up to 150 TD-3240 precipitation station files (e.g., as created by PXTRACT). The output files consists of a list file and a new data file with the data for all stations sorted by hour. This new data file may be formatted as required by MESOPAC II or unformatted if it is an intermediate file which will be merged with additional data in a subsequent PMERGE run. Table 4-1 lists the name, type, format, and contents of PMERGE's input and output data files.

The PMERGE control file (PMERGE.INP) contains the user-specified input variables indicating the number of stations to be processed, a flag indicating if data is to be added to an existing, unformatted data file, the maximum length of an accumulation period, packing options, station data, and time zone data. PMERGE allows data from different time zones to be merged by time-shifting the data to a user-specified base time zone. The format and contents of the control file are described in Table 4-2.

Sample PMERGE control files are shown in Table 4-3. Sample 1 shows an input file to merge data from 10 precipitation stations into one unformatted output file. The unformatted output file can then be renamed from PRECIP.DAT to PBIN.DAT by the user and then a control file as shown in Sample 2 can be used to merge data from 9 more precipitation stations to the 10 already processed. The combination of station data in multiple runs of PMERGE is sometimes necessary because the number of files which can be opened at one time is limited under some operationing systems (e.g., DOS). The output file from Sample 2 is a formatted file containing data from 19 precipitation stations. This formatted file can be directly input to MESOPAC II.

The PMERGE output list file (PMERGE.LST) contains a listing of the control file inputs and options. It also summarizes the number of valid and invalid hours for each station including information on the number of hours with zero or non-zero precipitation rates and the number of accumulation period hours. Additional statistics provide information by station on the frequency and type of missing data in the file (i.e., data flagged as missing in the original data file, data which is part of an excessively long accumulation period, or data missing from the input files before (after) the first (last) valid record. A sample output file is shown in Table 4-4.

Table 4-1

PMERGE Input and Output Files

Unit	File Name	Type	Format	Description
3	PBIN.DAT	Input	Unformatted	Existing PMERGE data file to which stations are to be added (used only if NBF=1).
4	PRECIP.DAT	Output	Formatted or Unformatted	Output data file created by PMERGE (a formatted PRECIP.DAT is an input file to MESOPAC II.
5	PMERGE.INP	Input	Formatted	Control file containing user inputs.
6	PMERGE.LST	Output	Formatted	List file (line printer output file).
7	User input file name	Input	Formatted	Precipitation data (in TD-3240) format for station #1. (Output file of PXTRACT.)
8	User input file name	Input	Formatted	Precipitation data (in TD-3240 format for station #2. (Output file of PXTRACT.)

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(Up to 150 new precipitation data files are allowed by PMERGE although this may be limited by the number of files an operating system will allow open at one time. Multiple runs of PMERGE may be necessary).

Table 4-2

PMERGE Control File Inputs (PMERGE.INP)

RECORD 1. General run information.

Columns	Format*	Variable	Description
1-4	I4	NFF	Number of formatted NCDC precip. data files to be processed (up to 150).
5-8	I4	NBF	Flag indicating if data is to be added to an existing unformatted precip. data file (0=no, 1=yes).
9-12	I4	MAXAP	Maximum allowed length of an accumulation period (hours). It is recommended that MAXAP be set to 12 hours or less.
13-16	I4	IOTZ	Time zone of output data (5=EST, 6=CST, 7=MST, 8=PST).
17-20	I4	IOFORM	Format of output data file (1=binary, 2=formatted)
21-24	I4	IOPACK	Flag indicating if output data are to be packed (0=no, 1=yes). Used only if IOFORM=1.

* Record format is (6i4)

Table 4-2 (Continued)

PMERGE Control File Inputs (PMERGE.INP)

RECORD 2, 3, ... 1+NFF. File names and time zone for each station (Each record has the following format)

Columns	Format*	Variable	Description
1-10	A10	CFFILES	Name of file containing formatted precipitation data (TD-3240 format) (PXTRACT output file). First six digits of file name must contain station code (SSIIII), where SS is the two digit state code, and IIII is the station ID).
12-13	I2	ISTZ	Time zone of station (5=EST, 6=CST, 7=MST, 8=PST).

* Record format is (a10, 1x, i2)

NEXT RECORD. (Necessary only if NBF=1, i.e., reading data from a binary input file).

Columns	Format	Variable	Description
1-4	i4	NBSTN	Number of stations requested from binary input file (-999 = use all stations in binary file).

NEXT RECORDS. (Necessary only if NBF=1 and NBSTN ≠ -999, one record for each binary station requested, i.e., NBSTN lines).

Columns	Format	Variable	Description
1-5	i5	IBSTN	6-digit station ids requested from binary input file (1 station id per record)

Table 4-2 (Concluded)

PMERGE Control File Inputs (PMERGE.INP)

LAST RECORD. Starting/ending dates and times.

Columns	Format*	Variable	Description
1-2	I2	IBYR	Beginning year of data to process (two digits).
4-5	I2	IBMO	Beginning month.
7-8	I2	IBDAY	Beginning day.
10-11	I2	IBHR	Beginning hour (01-24 LST).
13-14	I2	IEYR	Ending year of data to process (two digits).
16-17	I2	IEMO	Ending month.
19-20	I2	IEDAY	Ending day.
22-23	I2	IEHR	Ending hour (01-24 LST).

* Record format is (8(i2,1x))

Table 4-3

Sample PMERGE Control File (PMERGE.INP)

Sample 1

```
  10    0  12    5    1    1 --# stns,bin file?,max accum per,time zone,ioform(1=bin,2=fmt),pack(0=no,1=yes)-(6I4)
080616.dat  5
080845.dat  5
081654.dat  5
083186.dat  5
084091.dat  5
084570.dat  5
084797.dat  5
085663.dat  5
085895.dat  5
086323.dat  5
88 01 01 01 88 01 31 24 --Start yr, month, day, hr(01-24), end yr, month, day, hr(01-24)        -- (8(I2,1X))
```

Sample 2

```
   9    1  12    5    2    0 --# stns,bin file?,max accum per,time zone,ioform(1=bin,2=fmt),pack(0=no,1=yes)-(6I4)
086657.dat  5
086988.dat  5
087293.dat  5
087859.dat  5
088780.dat  5
089010.dat  5
089184.dat  5
089219.dat  5
089525.dat  5
-999
88 01 01 01 88 01 31 24 --Start yr, month, day, hr(01-24), end yr, month, day, hr(01-24)        -- (8(I2,1X))
```

Table 4-4

Sample PMERGE Output List File (PMERGE.LST)

```
                    PMERGE OUTPUT SUMMARY
               VERSION:  1.2      LEVEL:  921022


RUNTIME CALL NO.:        1   DATE: 05/11/93   TIME: 12:11:23.54


Formatted TD3240 Precipitation          Time Zone
        Input Files

        080616.dat                          5
        080845.dat                          5
        081654.dat                          5
        083186.dat                          5
        084091.dat                          5
        084570.dat                          5
        084797.dat                          5
        085663.dat                          5
        085895.dat                          5
        086323.dat                          5

Period to Extract (in time zone 5):   1/ 1/88   1:00  to   1/31/88  24:00

                    ********************


PMERGE Stations in Output File:
   No.    ID            No.    ID            No.    ID            No.    ID

    1   080616           4   083186           7   084797           9   085895
    2   080845           5   084091           8   085663          10   086323
    3   081654           6   084570
```

Table 4-4

Sample PMERGE Output List File (PMERGE.LST) - Concluded

Summary of Data from Formatted TD3240 Precipitation Files:

Valid Hours:

Station IDs	Zero	Nonzero	Accum Period	Total Valid Hours	% Valid Hours
080616	707	21	0	728	97.8
080845	723	21	0	744	100.0
081654	648	10	0	658	88.4
083186	8	0	0	8	1.1
084091	732	12	0	744	100.0
084570	712	32	0	744	100.0
084797	725	19	0	744	100.0
085663	709	35	0	744	100.0
085895	652	22	0	674	90.6
086323	620	28	0	648	87.1

Invalid Hours:

Station IDs	Flagged Missing	Excessive Accum Period	Missing Data Before First Valid Record	Missing Data After Last Valid Record	Total Invalid Hours	% Invalid Hours
080616	0	16	0	0	16	2.2
080845	0	0	0	0	0	0.0
081654	86	0	0	0	86	11.6
083186	736	0	0	0	736	98.9
084091	0	0	0	0	0	0.0
084570	0	0	0	0	0	0.0
084797	0	0	0	0	0	0.0
085663	0	0	0	0	0	0.0
085895	0	70	0	0	70	9.4
086323	96	0	0	0	96	12.9

RUNTIME CALL NO.: 2 DATE: 05/11/93 TIME: 12:11:26.29
DELTA TIME: 2.75 (SEC)

5.0 MESOPAC II METEOROLOGICAL PREPROCESSOR

MESOPAC II is a meteorological preprocessor which develops the gridded fields of winds, mixing heights, surface friction velocities, Monin-Obukhov lengths, and other meteorological variables required to drive the MESOPUFF II model. This chapter provides an overview of the technical formulation of MESOPAC II, user's instructions defining the input parameters and model options, and sample input and output files.

5.1 Technical Description

A brief description of the technical aspects of the meteorological preprocessor, MESOPAC II, is contained in the following subsections. The objective is to provide a concise summary of the basic model equations to aid the user in the selection of model options and inputs. A full description of the scientific and operational bases for the model algorithms is contained in *Development of the MESOPUFF II Dispersion Model* (Scire et al., 1984).

A flow diagram showing the major time loops (day, hour loops) and the sequence of operations within the main program is displayed in Figure 5-1. Most of the computations are performed within single-purpose subroutines (e.g., to calculate stability class, heat flux, friction velocity, etc.) which each contain loops over grid cells. A gridded surface wind field, representing 10 m height winds, is computed at the top of the hour loop after the meteorological data input operations. Near the end of the hour loop, the lower and upper layer wind fields used for plume transport, are computed. The reading and gridding of hourly precipitation data are performed as an option in the model, if wet removal is to be considered in the MESOPUFF II simulations.

5.1.1 Wind Fields

MESOPAC II constructs hourly wind fields at each grid point at <u>two</u> user-selected vertical levels: a lower level wind field representing boundary layer flow, and an upper level wind field representing flow above the boundary layer. The lower level winds are used to advect puffs within the mixed layer and to determine the plume rise of newly released puffs. The upper level winds are used to advect puffs above the boundary layer. At each time step, the appropriate wind field for advection of a puff is determined by comparison of the height of the puff center with the spatially and temporally varying mixing height. If the puff center is above (below) the mixing height at the closest grid point, the entire puff is advected with the upper (lower) level wind.

- Read User Inputs
- Write Header Records in Meteorological Output File
- Read Starting Set of Upper Air Data (00 and 12 GMT for first day)
  - Enter Day Loop
  - Compute Sunrise, Sunset Times, Solar Elevation Angles for each Hour of Day
    - Enter Hour Loop
    - Read Hourly Surface Data
    - Convert Surface Data to Proper Units, Calculate Precipitation Codes
    - If Hour = 00 GMT, Read Next 12 GMT Sounding,
      If Hour = 12 GMT, Read Next 00 GMT Sounding,
    - Calculate Surface Wind Field at Each Grid Point
    - Calculate Stability Class at Each Grid Point
    - Calculate $\overline{w'\theta'}$ at Each Grid Point
    - Calculate u_* at Each Grid Point
    - Calculate z_i at Each Grid Point
    - Calculate L at Each Grid Point
    - Calculate w_* at Each Grid Point
    - Calculate Lower Level Wind Field at Each Grid Point
    - Calculate Upper Level Wind Field at Each Grid Point
    - If using precipitation data,
      Read Hourly Precipitation Data
      Compute gridded precipitation field
    - Write Computed Meteorological Data to Output File
    - End Hour Loop
  - End Day Loop
- Close Files, Terminate Run

Figure 5-1. Flow diagram for MESOPAC II.

Considerable flexibility is allowed in choosing the most appropriate level or vertically-averaged layer for each wind field. Table 5-1 contains the available options. The default instructions are to use the winds averaged through the mixed-layer for the lower level wind field, and the wind averaged from the top of the mixed layer through the 700 mb level (~ 3000 m) for the upper level wind field. However, if desired, the user may select other levels to determine the wind fields (e.g., surface and 850 mb levels). The model may be made effectively a single level wind field model by specifying the lower and upper wind fields to be the same.

The mixed layer averaged winds are calculated from twice-daily rawinsonde data from upper air stations and hourly surface data from the typically much denser network of surface stations. Layer-averaged wind speed and wind direction computed from the rawinsonde data are used to adjust the observed hourly surface winds in the computation of the gridded wind fields. The following five step procedure, adapted from Draxler (1979), is used to determine the mixed-layer wind at each given point:

(1) A representative rawinsonde sounding (00 or 12 GMT) is selected based upon the stability class at the nearest surface station to the grid point and the time of day. Neutral/unstable and stable conditions are assumed to be represented by the 00 GMT and 12 GMT soundings, respectively.

(2) Using the sounding selected in Step (1), vertically averaged u (easterly) and v (northerly) wind components are computed through the layer from the surface to the grid point mixing height.

(3) The ratio, R, of the layer-averaged wind speed to the surface wind speed <u>at the rawinsonde station</u>, and the angular difference in wind direction, $\Delta\theta$, between the layer averaged and surface winds are calculated.

(4) The hourly surface wind data are used to calculate spatially interpolated surface wind components (u_s, v_s) at each grid point. Data from all surface stations within a user-specified 'scan-radius' of the grid point are used to compute (u_s, v_s) according to:

Table 5-1

Options for Lower and Upper Wind Fields

Option	Meteorological Data
Vertically Averaged Winds	
Surface to mixing ht[1]	Surface, Rawinsonde
Mixing ht to 850 mb	Rawinsonde
Mixing ht to 700 mb[2]	Rawinsonde
Mixing ht to 500 mb	Rawinsonde
Single Level Winds	
Surface	Surface
850 mb	Rawinsonde
700 mb	Rawinsonde
500 mb	Rawinsonde

[1] Default lower-level wind field
[2] Default upper-level wind field

$$(u_s, v_s)_{ij} = \frac{\sum_k \frac{\alpha_s}{r_s^2} \cdot (u_k, v_k)}{\sum_k \frac{\alpha_s}{r_s^2}} \qquad (5\text{-}1)$$

where,

u_s, v_s are the easterly and northerly components of the surface wind at grid point (i, j),

u_k, v_k are the easterly and northerly components of the surface wind at surface station k,

r_s is the distance from the surface station to grid point (i, j), and,

α_s is an alignment weighting factor $\alpha_s = 1\text{-}0.5\ |\sin \phi_s|$, and

ϕ_s is the angle between the observed wind direction and the line from the surface station to the grid point.

For equal values of r_s, alignment weighting causes winds at a station directly upwind or downwind of a grid point to be weighted twice as heavily as winds for a station at right angles to the grid point.

(5) The mixed-layer averaged wind at the grid point is calculated by multiplying the surface wind speed at the grid point computed in Step (4) by the wind speed ratio, R, at the nearest rawinsonde site. Similarly, the surface wind direction is adjusted by the wind direction factor, $\Delta\theta$.

The surface wind components (u_s, v_s) in Step (4) must be computed each hour regardless of the user's choice of wind fields for advection because the surface winds are also required in the calculation of atmospheric stability and the micrometeorological parameters described in Sections 5.1.2 through 5.1.6.

Vertically averaged winds from the mixing height to the 850 mb, 700 mb or 500 mb levels are computed in the following manner. The 00 GMT and 12 GMT winds at each rawinsonde station are first interpolated in time, and then vertically averaged through the layer from the grid point mixing height to the appropriate level (e.g., 700 mb). The winds at grid point (i, j) are obtained by Equation 5-1, with the summation over rawinsonde stations instead of surface stations. Only rawinsonde stations within a 'scan-radius' of the grid point are considered. The mixing height must be lower than the pressure level which defines the top of the layer; otherwise, an error message is printed and execution of the program is terminated.

If one of the single-level upper air wind fields (850 mb, 700 mb, or 500 mb) is chosen, only the wind data at the selected level is used to construct the wind field. For example, the 850 mb wind at each grid point is calculated by interpolating in time the 850 mb winds at each rawinsonde station, and then applying Equation 5-1 with the summation over the rawinsonde stations.

5.1.2 Surface Friction Velocity

The surface friction velocity, u_*, can be computed from routinely available meteorological data if the surface roughness characteristics are known. First, the sensible heat flux is calculated from an estimate of net radiation. Then u_* is determined from wind speed, surface roughness and heat flux.

The sensible heat flux, H, is estimated during daylight hours by the following equations (Maul 1980):

$$H = \alpha R + H_o \qquad (5\text{-}2)$$

$$R = 950 \beta \sin v \qquad (5\text{-}3)$$

$$H_o = 2.4C - 25.5 \qquad (5\text{-}4)$$

where,

H	is the sensible heat flux (W/m^2),
H_o	is the heat flux in the absence of incoming solar radiation (W/m^2),
α	is a land use constant, (~ 0.3),
R	is the incoming solar radiation (W/m^2),
β	is a radiation reduction factor due to the presence of clouds,
v	is the solar elevation angle, and
C	is the opaque cloud cover (in tenths).

Table 5-2 contains default values for the solar radiation reduction factor (β) due to the presence of clouds. The values of β are adapted from those used by Maul (1980).

Table 5-2

Solar Radiation Reduction Factor β

Cloud Cover (Tenths)	β
0	1.00
1	0.91
2	0.84
3	0.79
4	0.75
5	0.72
6	0.68
7	0.62
8	0.53
9	0.41
10	0.23

The sine of the solar elevation angle, sin ν, is given by:

$$\sin \nu = \sin \phi \sin K_d + \cos \phi \cos K_d \cos H_A \qquad (5\text{-}5)$$

$$H_A = (\pi/12)\,(\tau - E_m) - \lambda \qquad (5\text{-}6)$$

$$E_m = \begin{array}{l} 12. + 0.12357 \sin(D) - 0.004289 \cos(D) \\ \quad + 0.153809 \sin(2D) + 0.060783 \cos(2D) \end{array} \qquad (5\text{-}7)$$

$$D = (d-1)\,(360/365.242)\,(\pi/180) \qquad (5\text{-}8)$$

$$K_D = \sin^{-1}(0.39784989 \sin(\pi\ \sigma_A/180) \qquad (5\text{-}9)$$

$$\sigma_A = \begin{array}{l} 279.9348 + D(180/\pi) + 1.914827 \sin(D) \\ -0.079525 \cos(D) + 0.019938 \sin(2D) - 0.00162 \cos(2D) \end{array} \qquad (5\text{-}10)$$

where,

ϕ is the latitude (radians),
λ is the longitude (radians),
d is the Julian day, and
τ is the time of day (hours GMT).

With the above estimate of H, the surface friction velocity, u_*, can be estimated during unstable conditions by the method described by Wang and Chen (1980):

$$u_* = \bar{u}_* \left\{1 + a \ln\left[1 + b\, Q_o / \bar{Q}_o\right]\right\} \qquad (5\text{-}11)$$

$$\bar{u}_* = \frac{k\, u_m}{\ln(z_m / z_o)} \qquad (5\text{-}12)$$

$$z_m = z_{ms} - 4\, z_o \qquad (5\text{-}13)$$

$$Q_o = H/(\rho\, c_p) \qquad (5\text{-}14)$$

$$\bar{Q}_o = \frac{\theta\, \bar{u}_*^3}{k\, g\, z_m} \qquad (5\text{-}15)$$

$$a = \begin{cases} 0.128 + 0.005 \ln (z_o/z_m) & z_o/z_m \leq 0.01 \\ 0.107 & z_o/z_m > 0.01 \end{cases} \tag{5-16}$$

$$b = 1.95 + 32.6 \, (z_o/z_m)^{0.45} \tag{5-17}$$

where,

- k is the von Karman constant (0.4),
- c_p is the specific heat of air at constant pressure ($996 \, m^2/(s^2 \, deg)$),
- u_* is the surface friction velocity (m/s),
- Q_o is the product $\overline{w'\theta'}$ (°K m/s),
- u_m is the wind speed (m/s) measured at height z_{ms} (m),
- z_o is the surface roughness length (m), and
- ρ is the density of air (kg/m^3).

During stable conditions, u_* is determined by the following method (Venkatram 1980a):

$$u_* = \frac{C_{DN} \, u_m}{2} \left[1 + C^{0.5}\right] \tag{5-18}$$

$$C_{DN} = \frac{k}{\ln (z_m/z_o)} \tag{5-19}$$

$$C = 1 - \frac{4 \, u_o^2}{C_{DN} \, u_m^2} \qquad C \geq 0 \tag{5-20}$$

$$u_o^2 = \frac{\gamma \, z_m}{k \, A} \tag{5-21}$$

where γ and A are constants with default values of 4.7 and 1100, respectively, and C_{DN} is the neutral drag coefficient.

Adjustment for Surface Roughness

MESOPAC II requires that a site-specific wind speed measurement height and surface roughness length be specified for each surface station. The effect of the differences in surface roughness between the surface station (typically an airport) and each grid cell is incorporated into the calculations of the friction velocity and Monin-Obukhov length. As noted by Walcek et al. (1986) and Pleim et al. (1984), adjustment of the surface friction velocity for differences in surface roughness between the grid point and the site at which the wind observations are made is preferable to either assuming a constant wind speed or constant friction velocity over areas of different roughness. Therefore, MESOPAC II has been modified to use the following three-step procedure to adjust the friction velocity at each grid point for site-specific surface roughness characteristics:

(1) The friction velocity, u_{*1}, is first computed using the wind speed observation and surface roughness at the airport surface station, and the equations described above;

(2) The wind speed at the top of the surface layer (approximately one tenth the boundary layer height), is computed using the airport surface roughness and u_{*1};

(3) The wind speed at the top of the surface layer, which is less sensitive to changes in surface roughness than the lower anemometer height wind, is then used to compute the friction velocity at the grid point using the grid point-specific surface roughness length.

5.1.3 Monin-Obukhov Length

The Monin-Obukhov length, L, is defined as:

$$L \equiv -\frac{u_*^3 T_o}{g\ k\ Q_o} \tag{5-22}$$

where T_o is the observed air temperature. During unstable conditions, L is calculated directly from its definition using values of u_* and Q_o computed earlier. During stable conditions, L is given by Venkatram (1980a) as:

$$L = A\ u_*^2 \tag{5-23}$$

The constant, A, has a default value of 1100. It is the same constant that appears in Equation 5-21.

5.1.4 Mixed Layer Height

During daylight hours, solar radiation reaching the ground produces a positive (upward) flux of sensible heat which causes the growth of a well-mixed adiabatic layer. If the hourly variation of H is known, the mixed layer height, z_i, at time $\tau + 1$ can be estimated from z_i at time t in a stepwise manner (Maul 1980).

$$(z_i)_{t+1} = \left[(z_i)_t^2 + \frac{2H(1+E)\,\Delta t}{\psi_1 \rho c_p} - \frac{2(\Delta\theta)_t (z_i)_t}{\psi_1} \right]^{1/2} + \frac{(\Delta\theta)_{t+1}}{\psi_1} \qquad (5\text{-}24)$$

$$(\Delta\theta)_{t+1} = \left[\frac{2\psi_1 E H \Delta t}{\rho c_p} \right]^{1/2} \qquad (5\text{-}25)$$

where,

ψ_1 is the potential temperature lapse rate in the layer above z_i,
Δt is the time step (3600 s),
E is a constant (~0.15), and,
$\Delta\theta$ is the temperature discontinuity at the top of the mixed layer.

The lapse rate, ψ_1, is determined through a layer Δz meters above the previous hour's convective mixing height. For daytime hours up to 23 GMT, the morning (12 GMT) sounding at the nearest rawinsonde station is used to calculate ψ_1. After 23 GMT, the evening (00 GMT) sounding is used. To avoid computational problems, ψ_1, is not allowed to be less than a minimum value of 0.001 °K/m.

The neutral (shear produced) boundary layer height is given by Venkatram (1980b) as:

$$z_i = \frac{B\,u_*}{(f N_B)^{1/2}} \qquad (5\text{-}26)$$

where,

f is the Coriolis parameter,
B is a constant ($\sqrt{2}$) and
N_B is the Brunt-Vaisala frequency in the stable layer aloft.

The daytime mixing height is the maximum of the convective and mechanical values predicted by Equations 5-25 and 5-26.

In the stable boundary layer, mechanical turbulence production determines the vertical extent of dispersion. Venkatram (1980a) provides the following empirical relationship to estimate z_i during stable conditions.

$$z_i = N \, u_*^{3/2} \tag{5-27}$$

where N is a constant with a default value of 2400.

The predicted mixing height is restricted by MESOPAC II to a minimum value of 10 meters and a maximum value of 2500 meters.

5.1.5 Convective Velocity Scale

During convective conditions, turbulence is generated primarily by the sensible heat flux originating from the ground. The appropriate velocity scale during these conditions is the convective velocity, w_*.

$$w_* = \left(\frac{g}{T_o} \, Q_o \, z_i \right)^{1/3} \tag{5-28}$$

The convective velocity can be calculated directly from its definition, since Q_o and z_i are known from Equations 5-14 and 5-24, respectively.

5.1.6 Atmospheric Stability Class

The stability class at each grid point is estimated according to the Turner (1964) method using the solar radiation and reported cloud data at the nearest surface station and the interpolated surface wind speed at the grid point. A radiation index, RI, is computed based upon the value of the solar elevation angle at the nearest surface station (Table 5-3 (a)). The radiation index is an indication of potential solar radiation and varies from a value of 1 for $\nu \leq 15°$ to 4 for $\nu > 60°$. The effects of cloud cover in reducing radiation is included in the daytime insolation class, IC, computed from RI, opaque cloud cover, and ceiling height observations at the nearest surface station (Table 5-3 (b)). The daytime stability class is then determined from IC and the surface wind speed at the grid point according to Table 5-4. Nighttime stability is determined by surface wind speed and opaque cloud cover. Overcast conditions (10/10 cloud cover) result in neutral (D) stability for both day and night.

Table 5-3

Daytime Solar Insolation Classification Scheme

(a) Radiation Index as a Function of Solar Elevation Angle

Solar Elevation Angle, ν	Radiation Index, RI
0° < ν ≤ 15°	1
15° < ν ≤ 35°	2
35° < ν ≤ 60°	3
60° < ν	4

(b) Calculation of Daytime Solar Insolation Class

Cloud Cover, CC	Ceiling HT, CH (ft)	Daytime Insolation Class, IC
CC ≤ 5/10	-	RI
5/10 < CC < 10/10	CH < 7,000	RI-2*
	7,000 ≤ CH < 16,000	RI-1*
	16,000 ≤ CH	RI
CC = 10/10	CH < 7,000	0
	7,000 ≤ CH < 16,000	RI-2*
	16,000 ≤ CH	RI-1*

*IC is not allowed to be reduced to less than one (only exception is with CC = 10/10, CH < 7,000 ft).

Table 5-4

Stability Classification Criteria

Surface wind speed (knots)	Daytime Insolation Class, IC					Nighttime	
	Strong (4)	Moderate (3)	Slight (2)	Weak (1)	Overcast (0)	5/10-9/10 Cloud	< 5/10 Cloud
≤1	A	A	B	C	D	F	F
2	A	B	B	C	D	F	F
3	A	B	B	C	D	F	F
4	A	B	C	D	D	E	F
5	A	B	C	D	D	E	F
6	B	B	C	D	D	E	F
7	B	B	C	D	D	D	E
8	B	C	C	D	D	D	E
9	B	C	C	D	D	D	E
10	C	C	D	D	D	D	E
11	C	C	D	D	D	D	D
≥12	C	D	D	D	D	D	D

5.1.7 Precipitation Data

MESOPAC II has the option to produce a gridded field of hourly precipitation rates for use in modeling wet removal processes. Precipitation data need not be provided to MESOPAC II if wet removal is not to be modeled in MESOPUFF II.

MESOPAC II uses a nearest station technique to grid the precipitation data. At each grid point, the precipitation rate is taken as the value at the nearest precipitation station. If the precipitation data for a particular hour is missing from the nearest station, the next nearest station with valid data is used.

The wet deposition algorithm in MESOPUFF II also needs information on the type of precipitation (e.g., liquid or frozen precipitation). This information is derived from the precipitation type code on the CD144 surface meteorological data records. The precipitation type for a particular grid cell is taken from the nearest surface meteorological station to the grid point.

5.2 MESOPAC II User's Instructions

MESOPAC II is the meteorological preprocessor program that computes time and space interpolated fields of meteorological variables required by MESOPUFF II. The meteorological data inputs required by MESOPAC II are the upper air data files created by READ56 or READ62 (see Section 2), hourly surface meteorological observations, and optional hourly precipitation data processed by the PXTRACT and PMERGE programs. MESOPAC II, READ56, READ62, PXTRACT and PMERGE are designed to use standard-formatted meteorological files available from NCDC. The required format for the surface observations is Card Deck 144 (CD144). The surface observations must be at hourly intervals. Because CD144 surface data do not include hourly precipitation amounts, MESOPAC II reads a separate data file containing hourly precipitation data.

MESOPAC II has been modified to use a memory management system which allows the size of the arrays within the code to be easily resized by the user. Arrays dealing with the numbers of meteorological grid cells, surface stations, upper air stations, and precipitation stations are dimensioned throughout the code with parameter statements. The declaration of the values of the parameters are stored in a filed called "PARAMS.PAC". This file is automatically inserted into any MESOPAC II subroutines or functions requiring one of its parameters via FORTRAN 'include' statements. Thus, a global redimensioning of all of the model arrays dealing with the number of grid cells, for example, can be accomplished simply by modifying the PARAMS.PAC file and recompiling the program.

A sample parameter file is shown in Table 5-5. The parameter file sets the array dimensions, which are the maximum values of the variables (i.e., number of grid cells, number of meteorological stations, etc.), allowed in a run. The actual value of the variables for a particular run is set within the user input file (the control file), and can be less than the maximum value set by the parameter file.

The input and output files used by MESOPAC II are shown in Table 5-6. Because data from each surface and upper air station is stored in a separate file, the number of input files varies. The naming convention of the surface data is CDn.DAT, where n ranges from 1 through NSSTA (See Input Group 2). The upper air files are named UPn.DAT, where n is 1 through NUSTA.

The user specifies the logical unit number associated with each surface and upper air meteorological data file. Care should be taken to ensure that the unit number assigned to these files does not conflict with any of the other input or output files. All of the precipitation data is stored in a single file (PRECIP.DAT).

Figure 5-2 shows the required setup of the card image inputs for MESOPAC II. The input format consists of 17 input groups. The first 6 input groups are mandatory, followed by 8 optional input groups. The last 3 groups define the meteorological stations [surface and upper air (mandatory), precipitation (optional)]. Table 5-7 contains a complete description of all the run control variables used in MESOPAC II.

The MESOPAC II output meteorological file consists of 6 header records followed by a set of 12 data records for each hour. Table 5-8 contains a description of the variables in each record. The header records contain the date and length of the run, grid size and spacing, land use categories and surface roughness lengths at each grid point, as well as other information required by MESOPUFF II. Each set of 12 hourly data records contains all the gridded and non-gridded meteorological data needed by MESOPUFF II.

5.3 Sample MESOPAC II Inputs and Outputs

Table 5-9 contains a sample MESOPAC II input file for a 25 hour run starting on January 2, 1986. Hourly surface observations from four stations, twice daily upper air data from one station, and precipitation measurements from two locations are used as the meteorological input data. Land use classifications for each of the 20 x 20 grid cells are included in the input control file.

The accompanying sample MESOPAC II list file is presented in Attachment 5-A.

Table 5-5

Sample Parameter File (PARAMS.PAC) for MESOPAC II

```
c----------------------------------------------------------------------
c --- PARAMETER statements                                   MESOPAC II
c----------------------------------------------------------------------
c
c --- Specify parameters
      parameter(mxnx=100,mxny=100)
      parameter(mxss=100,mxus=20,mxps=100)
c
c --- Computed parameters
      parameter(mxcell=mxnx*mxny)
c
c --- GENERAL PARAMETER definitions:
c          MXNX - Maximum number of cells in the X direction
c          MXNY - Maximum number of cells in the Y direction
c          MXSS - Maximum number of surface meteorological stations
c          MXUS - Maximum number of upper air stations
c          MXPS - Maximum number of precipitation stations
c
```

Table 5-6

MESOPAC II Input and Output Files

Unit	File Name	Type	Format	Description
IN5[a]	PAC.INP	INPUT	FORMATTED	Control file containing user inputs.
(b)	CD1.DAT CD2.DAT . . . CD999.DAT	INPUT	FORMATTED	Hourly surface meteorological data for stations 1 through NSSTA in CD144 format. (One file per station).
(b)	UP1.DAT UP2.DAT . . . UP999.DAT	INPUT	FORMATTED	Upper air data in READ56/READ62 output format for stations 1 through NUSTA. (One file per station).
2	PRECIP.DAT	INPUT	FORMATTED	Hourly precipitation data. (PMERGE output format).
IOUT6[a]	PAC.LST	OUTPUT	FORMATTED	List file containing line printer output.
IOUT8[a]	PACOUT.DAT	OUTPUT	UNFORMATTED	Output file containing gridded meteorological fields and other output variables required by MESOPUFF II.

[a] Value is specified in BLOCK DATA.
[b] Value is specified by the user in the control file inputs.

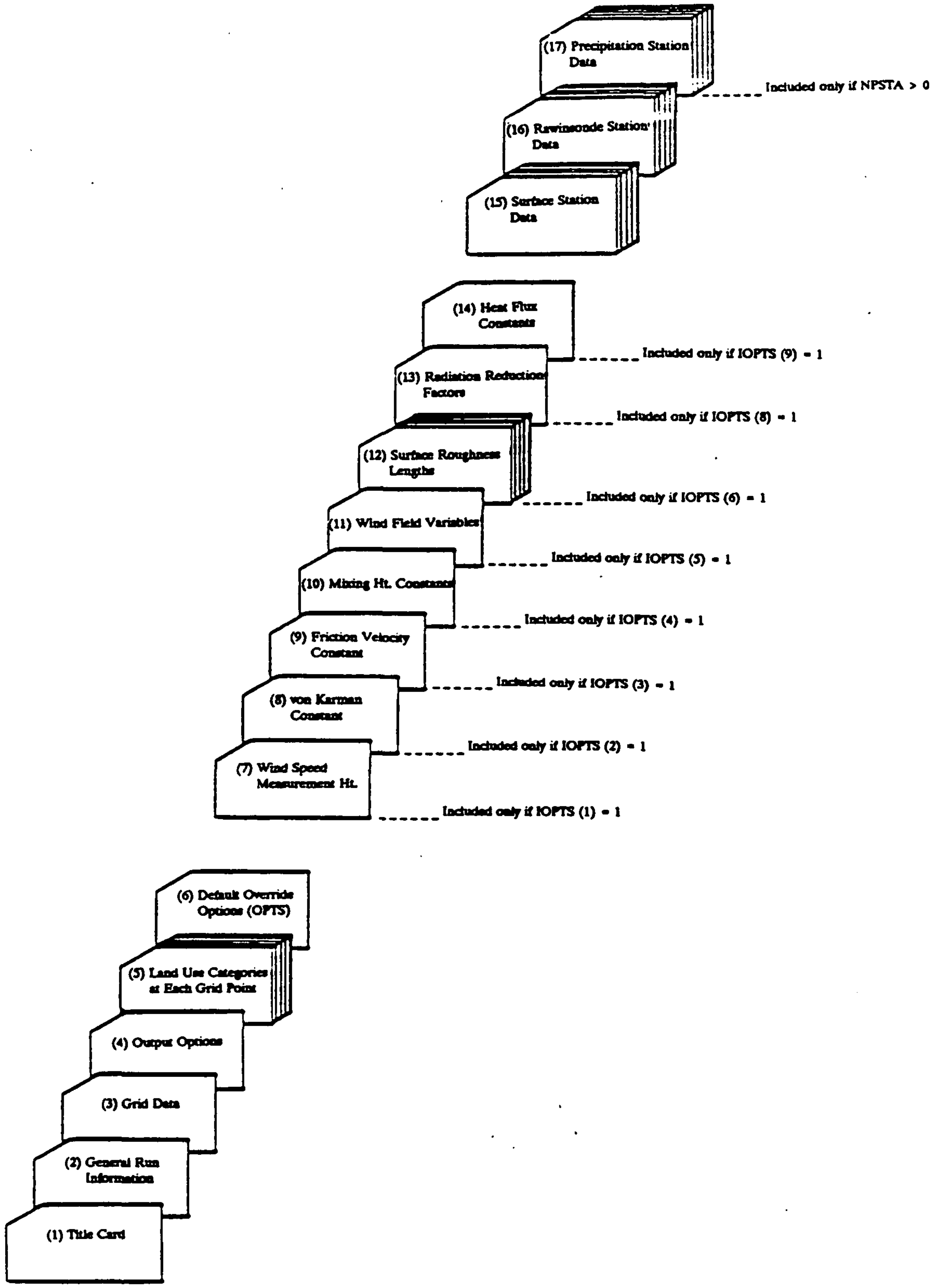

Figure 5-2. Card image input setup for MESOPAC II.

Table 5-7

MESOPAC II Inputs

INPUT GROUP 1 - RUN TITLE Format: (20A4)

Columns	Type	Variable	Description
1-80	CHARACTER *4 ARRAY	TITLE (20)	80-character title of run.

INPUT GROUP 2 - GENERAL RUN INFORMATION Format: (7I5)

Columns	Type	Variable	Description
1-5	INTEGER	NYR	Two digit year of run.
6-10	INTEGER	IDYSTR	Starting Julian day (also see Input Group 6, IOPTS (10)).
11-15	INTEGER	IHRMAX	Number of hours in run.
16-20	INTEGER	NSSTA	Number of surface meteorological stations (must be ≤ mxss as defined in "PARAMS.PAC").
21-25	INTEGER	NUSTA	Number of rawinsonde stations (must be ≤ mxus as defined in "PARAMS.PAC").
26-30	INTEGER	IBTZ	Reference time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).
31-35	INTEGER	NPSTA	Number of precipitation stations (must be ≤ mxps as defined in "PARAMS.PAC"). Set NPSTA=0 if precipitation data is not to be processed.

INPUT GROUP 3 - GRID DATA Format: (2I5,F10.0)

Columns	Type	Variable	Description
1-5	INTEGER	IMAX	Number of grid points in X (west-east) direction (must be ≤ mxnx as defined in "PARAMS.PAC").
6-10	INTEGER	JMAX	Number of grid points in Y (south-north) direction (must be ≤ mxny as defined in "PARAMS.PAC").
11-20	REAL	DGRID	Grid spacing (m).

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 4 - OUTPUT OPTIONS Format: (2L5,I5,L5,4I5)

Columns	Type	Variable	Description
1-5	LOGICAL	LSAVE	Disk/tape output control variable. If LSAVE = T, meteorological fields are written to a disk/tape file. If LSAVE = F, output is not stored on disk/tape. (LSAVE should be T if meteorological data is to be used to run MESOPUFF II).
6-10	LOGICAL	LPRINT	Printer output control variable. If LPRINT = T, meteorological fields are printed every "IPRINF" hours. If LPRINT = F, meteorological fields are not printed.
11-15	INTEGER	IPRINF	Printing interval (in hours) of meteorological fields. Used only if LPRINT = T. (IPRINF ≥ 1).
16-20	LOGICAL	LBD	Control variable for printing of input meteorological data and intermediate computed parameters. If LBD = T, these data will be printed for time periods specified by NDY1, NHR1, NDY2, and NHR2. If LBD = F, these data will not be printed. (Because this information is not of general interest, LBD should be F for most applications).
21-25	INTEGER	NDY1	Julian day for which printing of input meteorological data and intermediate computed parameters begins. Used only if LBD = T.
26-30	INTEGER	NHR1	Hour (00-23) for which printing of input meteorological data and intermediate computed parameters begins. Used only if LBD = T.
31-35	INTEGER	NDY2	Julian day for which printing of input meteorological data and intermediate computed parameters ends. Used only if LBD = T.
36-40	INTEGER	NHR2	Hour (00-23) for which printing of input meteorological data and intermediate computed parameters ends. Used only if LBD = T.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 5 - **LAND USE CATEGORIES AT EACH GRID POINT** (see Table 6-3).

JMAX lines are required, each line with IMAX land use categories (corresponding to X-coordinates 1 to IMAX). The first line contains values for Y = JMAX, the second line for Y = JMAX-1, etc.

Format: (200I2)

Columns	Type	Variable	Description
1-400	INTEGER ARRAY	ILANDU (imax, jmax)	Land use categories for each grid point.

Example:

```
3 4
1 2
```

Results in ILANDU (1,1) = 1, ILANDU (2,1) = 2
ILANDU (1,2) = 3, ILANDU (2,2) = 4.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 6 - DEFAULT OVERRIDE OPTIONS. Format: (10I1)

Columns	Type	Variable	Description
1	INTEGER ARRAY ELEMENT	IOPTS(1)	Surface wind speed measurement height control variable. IOPTS (1) is no longer active. The height at which the surface wind speed was measured is now input for each station on Input Group 15.
2	INTEGER ARRAY ELEMENT	IOPTS(2)	von Karman constant control variable. If IOPTS(2) = 1, the user must input a value of the von Karman constant (see Input Group 8). If IOPTS(2) = 0, a default value of 0.4 is used.
3	INTEGER ARRAY ELEMENT	IOPTS(3)	Control variable for input of friction velocity constants (γ, A) in Equation 5-21. If IOPTS(3) = 1, the user must input values for γ and A (see Input Group 9). If IOPTS(3) = 0, the default values $\gamma = 4.7$, $A = 1100$ are used.
4	INTEGER ARRAY ELEMENT	IOPTS(4)	Control variable for input of mixing height constants (B, E, Δz, $\partial\theta/\partial z_{min}$, N) in Equations (5-24) to (5-27). If IOPTS(4) = 1, the user must input values for these constants (see Input Group 10). If IOPTS (4)=0, the following default values are used; B = 1.41, E = 0.15, Δz = 200 m, $\partial\theta/\partial z_{min}$ = 0.001°K/m, N = 2400.
5	INTEGER ARRAY ELEMENT	IOPTS(5)	Control variable for input of wind field variables RADIUS, ILWF, IUWF. See Input Group 11 for a description of these variables. If IOPTS (5)=1, the user must input values for these variables. If IOPTS(5) = 0, the following defaults are used: RADIUS = 99 grid units, ILWF = 2, IUWF = 4.
6	INTEGER ARRAY ELEMENT	IOPTS(6)	Control variable for surface roughness lengths. If IOPTS(6) = 1, the user must input the roughness length at each grid point (see Input Group 12). If IOPTS(6) = 0, the roughness length is determined from the land use category for each grid point according to Table 6-3.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 6 - DEFAULT OVERRIDE OPTIONS. (Continued) **Format: (10I1)**

Columns	Type	Variable	Description
7	INTEGER ARRAY ELEMENT	IOPTS(7)	Option to adjust heat flux estimates using 00Z sounding data and Equation 5-24. This option is not currently active. IOPTS(7) should be 0.
8	INTEGER ARRAY ELEMENT	IOPTS(8)	Control variable for input of radiation reduction factors due to cloud cover. If IOPTS(8)=1, the user must input eleven radiation reduction factors corresponding to possible opaque sky cover of 0 to 10 tenths. (see Input Group 14). If IOPTS(8) = 0, the following default reduction factors are used; 1.00, 0.91, 0.84, 0.79, 0.75, 0.72, 0.68, 0.62, 0.53, 0.41, 0.23.
9	INTEGER ARRAY ELEMENT	IOPTS(9)	Control variable for inputs of heat flux constants of Equation 5-2 at each grid point. If IOPTS(9) = 1 the user must input a value of RADC for each grid point (see Input Group 15). If IOPTS(9) = 0, a default value of RADC = 0.3 is assigned to each grid point.
10	INTEGER ARRAY ELEMENT	IOPTS(10)	Option to begin run at point other than at beginning of surface, upper air or precipitation data files. IOPTS(10) must be 1 if the starting date of the model run does not correspond to the beginning of the meteorological files; otherwise, IOPTS(10) must be 0.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 7 - WIND SPEED MEASUREMENT HEIGHT (No longer used - see Input Group 15 for input of measurement heights)
Format: (F10.0)

Columns	Type	Variable	Default	Description
1-10	REAL	ZM	10.0	Surface height above ground (in meters) at which wind speed measurements were made.

INPUT GROUP 8 - VON KARMAN CONSTANT (Optional - included only if IOPTS(2) = 1).
Format: (F10.0)

Columns	Type	Variable	Default	Description
1-10	REAL	VK	0.4	von Karman constant.

INPUT GROUP 9 - FRICTION VELOCITY CONSTANTS (Optional - included only if IOPTS(3) = 1).
Format: 2F10.0)

Columns	Type	Variable	Default	Description
1-10	REAL	GAMMA	4.7	Constant γ in friction velocity Equation 5-21.
11-20	REAL	CONSTA	1100.	Constant A in friction velocity Equation 5-21.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 10 - MIXING HEIGHT CONSTANTS (Optional - included only if IOPTS(4) = 1).
Format: (5F10.0)

Columns	Type	Variable	Default	Description
1-10	REAL	CONSTB	1.41	Constant B in neutral stability mixing height Equation 5-26.
11-20	REAL	CONSTE	0.15	Constant E in convective mixing height Equations 5-24 and 5-25.
21-30	REAL	DELTZ	200.	Depth of layer (m) above current convective mixing height through which potential temperature gradient $\partial\theta/\partial z$ is calculated.
31-40	REAL	DPTMIN	0.001	Minimum value of ψ $(\partial\theta/\partial z)$(°K/m) used in Equations 5-24 and 5-25.
41-50	REAL	CONSTN	2400.	Constant N in stable (mechanical) mixing height Equation 5-27.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 11 - **WIND FIELD VARIABLES** (Optional - included only if IOPTS(5) = 1).
Format: (2I5,F10.0)

Columns	Type	Variable	Default	Description
1-5	INTEGER	ILWF	2	Code for lower-level wind field (see below).
6-10	INTEGER	IUWF	4	Code for upper-level wind field (see below).
11-20	REAL	RADIUS	99.	Scan radius for wind field interpolation (in grid units).

Wind Field Code (ILWF, IUWF)

1 - Surface winds (uses CD144 surface data only)

2 - Vertically-averaged winds through layer from ground to mixing height (uses CD144 surface data and rawinsonde data).

3 - Vertically-averaged winds through layer from mixing height to 850 mb (uses rawinsonde data only).

4 - Vertically-averaged winds through layer from mixing height to 700 mb (uses rawinsonde data only).

5 - Vertically-averaged winds through layer from mixing height to 500 mb (uses rawinsonde data only).

6 - 850 mb winds (uses rawinsonde data only).

7 - 700 mb winds (uses rawinsonde data only).

8 - 500 mb winds (uses rawinsonde data only).

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 12 - **SURFACE ROUGHNESS LENGTHS** (Optional - included only if IOPTS(6) = 1)
Format: (16F5.0)

Columns	Type	Variable	Default	Description
1-80	REAL ARRAY	ZO	*	Surface roughness lengths (m). If IMAX < 16, JMAX lines are required, each line with IMAX ZO values (corresponding to X grid points 1 to IMAX). Lines are in order of decreasing Y. See example in description of Input Group 5. If 16 < IMAX < 32, 2 x JMAX lines are required. (Each ZO (1,J) starts on a new line). If IMAX > 32, 3 x JMAX or more lines are required.

---

* Default roughness lengths are determined by the land use category assigned to each grid point (in Input Group 5) according to Table 6-3.

Table 5-7

MESOPAC II Inputs (Continued)

<u>INPUT GROUP 13</u> - **RADIATION REDUCTION FACTORS** (Optional - included only if IOPTS(8) = 1)
Format: (11F5.0)

Columns	Type	Variable	Default	Description
1-55	REAL ARRAY	BETA(11)	1.00, 0.91, 0.84 0.79, 0.75, 0.72 0.68, 0.62, 0.53 0.41, 0.23	Radiation reduction factors due to presence of clouds (see Equation 5-3). Eleven values corresponding to opaque sky cover of 0-10 tenths.

<u>INPUT GROUP 14</u> - **HEAT FLUX CONSTANTS** (Optional - included only if IOPTS(9) = 1)
Format: (16F5.0)

Columns	Type	Variable	Default	Description
1-80	REAL ARRAY	RADC	0.3	Heat flux land use constant, α, of Equation 5-2, for each grid point. If IMAX < 16, JMAX lines are required, each line with IMAX values (corresponding to X grid points 1 to IMAX). Lines are in order of decreasing Y. See example in description of Input Group 5. If 16 < IMAX ≤ 32, 2 x JMAX lines are required. Each RADC (1,J) starts on a new line. If IMAX > 32, 3 x JMAX or more lines are required.

Table 5-7

MESOPAC II Inputs (Continued)

INPUT GROUP 15 - SURFACE STATION DATA. 'NSSTA' cards - one for each CD144 surface station
Format: (I5, 4F10.0, F5.0, I5, I5x, 2F5.0)

Columns	Type	Variable	Description
1-5	INTEGER ARRAY ELEMENT	IDCD	Surface station ID for CD144 data (5 digits).
6-15	REAL ARRAY ELEMENT	XSCOOR	X-coordinate of station (in grid units).
16-25	REAL ARRAY ELEMENT	YSCOOR	Y-coordinate of station (in grid units).
26-35	REAL ARRAY ELEMENT	SLAT	Station latitude (decimal degrees).
36-45	REAL ARRAY ELEMENT	SLONG	Station longitude (decimal degrees).
46-50	REAL ARRAY ELEMENT	SZONE	Station time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).
51-55	INTEGER ARRAY ELEMENT	ISUNIT	Logical unit number of CD144 surface data.
56-65	-	-	No longer used - leave blank.
66-70	-	-	No longer used - leave blank.
71-75	REAL ARRAY ELEMENT	ZMSURF	Wind speed measurement height (m).
76-80	REAL ARRAY ELEMENT	Z0SURF	Surface roughness length (m) appropriate for surface meteorological station site.

Table 5-7

MESOPAC II Inputs (Concluded)

<u>INPUT GROUP 16</u> - **RAWINSONDE STATION DATA. 'NUSTA' cards - one for each rawinsonde station**
Format: (I5, 4F10.0, F5.0, I5)

Columns	Type	Variable	Description
1-5	INTEGER ARRAY ELEMENT	IDTD	Rawinsonde station identification number (5 digits).
6-15	REAL ARRAY ELEMENT	XUCOOR	X-coordinate of station (in grid units).
16-25	REAL ARRAY ELEMENT	YUCOOR	Y-coordinate of station (in grid units).
26-35	REAL ARRAY ELEMENT	ULAT	Station latitude (decimal degrees).
36-45	REAL ARRAY ELEMENT	ULONG	Station longitude (decimal degrees).
46-50	REAL ARRAY ELEMENT	UZONE	Station time zone (5 = EST, 6 = CST, 7 = MST, 8 = PST).
51-55	INTEGER ARRAY ELEMENT	IUUNIT	Local unit of processed upper air data. (READ56/READ62 output)

<u>INPUT GROUP 17</u> - **PRECIPITATION STATION DATA. 'NPSTA' cards - one for each precipitation station. Format: (I6,2F10.0)**

Columns	Type	Variable	Description
1-6	INTEGER ARRAY ELEMENT	IDP	Precipitation station ID (6 digits).
7-16	REAL ARRAY ELEMENT	XPCOOR	X-coordinate of station (in grid units).
17-26	REAL ARRAY ELEMENT	YPCOOR	Y-coordinate of station (in grid units).

Table 5-8

Variables in the Binary MESOPAC II Output File

HEADER RECORDS - First six records of output file.

RECORD	VARIABLE	TYPE	DESCRIPTION
1	NYR	INTEGER	Starting year
1	IDYSTR	INTEGER	Starting Julian day
1	IHRMAX	INTEGER	Number of hours in run
1	NSSTA	INTEGER	Number of surface stations
1	NUSTA	INTEGER	Number of rawinsonde stations
1	IMAX	INTEGER	Number of grid points in X direction
1	JMAX	INTEGER	Number of grid points in Y direction
1	IBTZ	INTEGER	Reference time zone
1	ILWF	INTEGER	Lower-level wind field code
1	IUWF	INTEGER	Upper-level wind field code
1	DGRID	REAL	Grid spacing (m)
1	VK	REAL	von Karman constant
2	XSCOOR (nssta)	REAL ARRAY	Surface station X coordinates (grid units)
2	YSCOOR (nssta)	REAL ARRAY	Surface station Y coordinates (grid units)
3	XUCOOR (nusta)	REAL ARRAY	Upper air station X coordinates (grid units)
3	YUCOOR (nusta)	REAL ARRAY	Upper air station Y coordinates (grid units)
4	ZO(imax,jmax)	REAL ARRAY	Surface roughness lengths (m)
5	NEARS (imax,jmax)	INTEGER ARRAY	Station number of closest surface station to each grid point
6	ILANDU (imax,jmax)	INTEGER ARRAY	Land use categories (see Table 6-3)

*See Table 5-5 for complete description of variables.

Table 5-8

Variables in the Binary MESOPAC II Output File (Concluded)

HOURLY RECORDS - Repeated for each hour (i) of run.

RECORD	VARIABLE	TYPE	DESCRIPTION
3+i	NYR	INTEGER	Year
3+i	NJULDY	INTEGER	Julian day
3+i	NHR	INTEGER	Hour (00-23)
4+i	UL(imax,jmax)	REAL ARRAY	Lower-level u wind component (m/s)
5+i	VL(imax,jmax)	REAL ARRAY	Lower-level v wind component (m/s)
6+i	UUP(imax,jmax)	REAL ARRAY	Upper-level u wind component (m/s)
7+i	VUP(imax,jmax)	REAL ARRAY	Upper-level v wind component (m/s)
8+i	ZI(imax,jmax)	REAL ARRAY	Mixing height (m)
9+i	USTAR (imax,jmax)	REAL ARRAY	Friction velocity (m/s)
10+i	WSTAR(imax,jmax)	REAL ARRAY	Convective velocity scale (m/s)
11+i	CAPL(imax,jmax)	REAL ARRAY	Monin-Obukhov length (m)
12+i	IPGT(imax,jmax)	INTEGER ARRAY	PGT stability class
13+i	PRECIP(imax,jmax)	REAL ARRAY	Hourly precipitation rate (mm/hr)
14+i	AVRHO	REAL	Average surface air density (kg/m^3)
14+i	TEMPK(nssta)	REAL ARRAY	Air temperature*(K)
14+i	SRAD(nssta)	REAL ARRAY	Total solar radiation*(W/m^2)
14+i	IRH(nssta)	INTEGER ARRAY	Relative humidity*(%)
14+i	IPCODE(nssta)	INTEGER ARRAY	Precipitation code*(see Table 6-5)

*At surface meteorological stations.

Table 5-9

Sample MESOPAC II Input File

```
MESOPAC TEST CASE - 25 hr simulation skipping 1 day 1/2/86-1/3/86
   86    2   25    4    1    5    2
   20   20    10000.
    T    F   24    F    0    0    0    0
12 5 5 5 5 1 1 1 1 1 1 1 1 5 5 5 5 5 512
12 5 5 5 5 5 5 5 1 1 1 1 1 5 5 5 5 5 512
12 5 5 5 5 5 5 5 1 1 1 1 1 5 5 5 5 5 512
12 5 5 5 5 1 1 1 1 1 1 1 1 5 5 5 5 5 912
12 5 5 5 5 1 1 1 1 1 1 1 1 5 5 5 5 5 912
12 5 5 1 1 5 5 5 5 5121212 5 5 6 6 6 5 5
 5 5 5 1 1 5 5 5 5 5121212 5 5 6 6 6 5 5
 5 5 5 1 1 1 1 1 1 1 5 5 51212 1 1 1 1 1
 5 5 5 1 1 1 1 11212 1 1 1 6 6 6 6 6 1 1
 5 5 5 1 1 1 1 11212 1 1 1 6 6 6 6 6 1 1
1212 5 5 5 5 5 5 5 1 1 1 6 6 6 6 6 1 1
 5121212 5 5 5 5 5 5 1 1 1 6 6 6 6 6 1 1
 51212 1 1 1 1 1 1 1 1 1 1 5 5 1 1 1 6 6
1212 1 1 1 1 1 1 1 1 1 1 1 5 5 1 1 1 6 6
1212 6 6 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
12 6 6 6 6 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1212 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1212 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1212 1 1 1 1 1 1 1 1 1 1 1 6 6 1 1 1 1 1
121212 6 6 6 6 6 1 1 1 1 1 6 6 1 1 1 1 1
0000000001
10001         7.4       10.5      28.07     82.53    5.    11                   10.  0.1
10002        19.4       15.7      27.95     81.80    5.    12                   10.  0.1
10003        10.2       29.4      29.08     82.27    5.    13                   10.  0.1
10004        22.0       23.8      28.18     82.05    5.    14                   10.  0.1
99901         7.4       10.5      28.07     82.53    5.    15
80001         7.4       10.5
80002        12.5       18.9
```

6.0 MESOPUFF II DISPERSION MODEL

Section 6.1 contains a description of the model algorithms. The user instructions are presented in Section 6.2 and sample inputs and outputs are shown in Section 6-3.

6.1 Technical Description

A flow diagram of the MESOPUFF II dispersion model is shown in Figure 6-1. The major loops (hour loop, puff loop, and sampling loop) are indicated. Individual modules comprised of a subroutine or a group of subroutines perform the computational procedures shown in the flow chart (e.g., puff advection, diffusion, chemistry, wet and dry removal, and puff sampling). In the following subsections, each of the major algorithms of MESOPUFF II are described.

6.1.1 Basic Gaussian Puff Equations

MESOPUFF II is a Gaussian variable-trajectory puff superposition model designed to account for the spatial and temporal variation in advection, diffusion, transformation, and removal mechanisms on regional scales. A continuous plume is simulated as a series of discrete puffs. The trajectory of each puff is determined independently of preceding or succeeding puffs. Each puff is subject to space- and time-varying wet removal, dry deposition, and chemical transformation. The governing equation for a horizontally symmetric puff with a Gaussian distribution is:

$$C(s) = \frac{Q(s)}{2\pi\sigma_y^2(s)} g(s) \exp\left[- \frac{r^2(s)}{2\sigma_y^2(s)} \right] \qquad (6\text{-}1)$$

$$g(s) = \frac{2}{\sqrt{2\pi}\sigma_z} \sum_{n=-\infty}^{\infty} \exp\left[- \frac{1}{2} \frac{(H_e + 2nz_i)^2}{\sigma_z^2(s)} \right] \qquad (6\text{-}2)$$

where,

- $C(s)$ is the ground-level concentration,
- s is the distance travelled by the puff,
- $Q(s)$ is the mass of pollutant in the puff,
- $\sigma_y(s)$ is the standard deviation of the Gaussian distribution in the horizontal,
- $\sigma_z(s)$ is the standard deviation of the Gaussian distribution in the vertical,
- $r(s)$ is the radial distance from the puff center,
- z_i is the mixed-layer height, and
- H_e is the effective height of the puff center.

- Read User Inputs, Read Meteorological Data Header Records
- Write Header Record in Concentration and Flux Output Files
- Read Gridded Wind Fields for First Hour
  - Enter Hour Loop
    - Read Meteorological Data (other than wind data) for Current Hour
    - Read Gridded Wind Fields for Next Hour
    - Initialize Concentration and Flux Arrays
      - Enter Puff Loop
        - If Puff is New, Initialize Puff, Compute Plume Rise
          - Enter Sampling Loop
            - Advect Puff
            - Diffuse Puff (calculate new σ_y, σ_z – move mass in three-layer model)
            - Perform Chemistry Calculations
            - Perform Wet Removal Calculations
            - Perform Dry Deposition Calculations
            - Sample Puff (calculate concentrations and fluxes at gridded and non-gridded receptors)
          - End Sampling Loop
      - End Puff Loop
    - Compute Average Puff Concentrations (to use in next hour's chemistry calculations)
    - Compute 'IAVG'-Hour Averaged Concentrations and Fluxes
    - Write Concentrations and Fluxes to Disk and/or to List File (if end of averaging period)
    - Purge Old Puffs Off Computation Grid (if number of puffs approaches limit)
  - End Hour Loop
- Close Files, Terminate Run

Figure 6-1. Flow diagram for MESOPUFF II.

The infinite series in Equation 6-2 converges rapidly for values of $T = (\sigma_z/z_i)^2 < 0.6$; usually fewer than 3 or 4 terms are required for convergence. For T > 0.6, Equation 6-2 is expressed in an equivalent from using a Fourier series that converges quickly for large values of T (Schulman and Scire, 1980). The vertical term, g(s), reduces to the uniformly mixed limit of $1/z_i$ for $\sigma_z/z_i \geq 1.6$. In general, puffs within the daytime mixed-layer satisfy this criterion about an hour or two after release. The user is permitted to specify an initial Gaussian vertical distribution (Eq. 6-2) or an immediately uniform vertical distribution ($g(s) = 1/z_i$) for newly released puffs. MESOPUFF II allows the effect of dry deposition to be treated with the conventional source depletion method or a more realistic surface depletion (3-layer) model. These options are described in more detail in Section 6.1.5.

The dispersion parameters, σ_y and σ_z, are calculated for puff travel distances up to 100 kilometers with plume growth functions fitted to the curves of Turner (1970). These functions are of the form:

$$\sigma = a\,x^b \qquad (6\text{-}3)$$

where,

a,b are stability-dependent coefficients, and

x is the total distance travelled.

Equation 6-3 is valid, however, only if the stability class does not change during the puff's travel. Stability class variations are allowed by using a virtual distance, x_v, instead of x (Ludwig et al., 1977).

$$(\sigma_y)_t = a_y\left[(x_v)_y + \delta x\right]^{b_y} \qquad (6\text{-}4)$$

$$(\sigma_z)_t = a_z\left[(x_v)_z + \delta x\right]^{b_z} \qquad (6\text{-}5)$$

$$(x_v)_y = \left[\frac{(\sigma_y)_{t-1}}{a_y}\right]^{1/b_y} \qquad (6\text{-}6)$$

$$(x_v)_z = \left[\frac{(\sigma_z)_{t-1}}{a_z}\right]^{1/b_z} \qquad (6\text{-}7)$$

where,

$(\sigma_y)_{t-1}$, $(\sigma_z)_{t-1}$ are the values of σ_y, σ_z (m) at the previous time step, and

δx is the incremental distance travelled (m).

The values of a_y, b_y, a_z, and b_z in Equations 6-4 through 6-7 are those for the current stability class. Thus, x_v represents the distance the puff would have travelled to reach its size at time t-1 if current stability conditions were in effect throughout its travel. The incremental distance, δx, is evaluated from the midpoint of the previous time step's trajectory to the midpoint of the current trajectory. Table 6-1 contains the default values of the coefficients a_y, b_y, a_z, and b_z stored in MESOPUFF II.

The time-dependent puff growth equation used for distances greater than 10 kilometers are those given by Heffter (1965):

$$(\sigma_y)_t = (\sigma_y)_{t-1} + 0.5\ \delta t \tag{6-8}$$

$$(\sigma_z)_t = (\sigma_z)_{t-1} + \frac{a_{zt}\ \delta t}{\sqrt{t}} \tag{6-9}$$

$$a_{zt} = 0.5\ (2K_z)^{1/2} \tag{6-10}$$

where,

δt	is the incremental time (s),
t	is the total age of the puff (s), and
K_z	is the vertical eddy diffusivity (m^2/s).

The default values of K_z (and a_{zt}) are contained in Table 6-2. The option is provided in MESOPUFF II for the user to override any of the default dispersion coefficient parameters, including the crossover distance to time dependent growth (Equations 6-8 to 6-10).

MESOPUFF II allows three options for determining growth rates for puffs above the boundary layer: (1) E stability rates, (2) F stability rates, or (3) boundary layer stability rates. The default instructions are to use the E stability growth curves for puffs above the boundary layer (see variable JSUP in MESOPUFF II inputs).

Table 6-1

Puff Growth Rate Coefficients a_y, b_y, a_z, b_z

Stability Class	a_y	b_y	a_z	b_z
A	0.36	0.9	0.00023	2.10
B	0.25	0.9	0.058	1.09
C	0.19	0.9	0.11	0.91
D	0.13	0.9	0.57	0.58
E	0.096	0.9	0.85	0.47
F	0.063	0.9	0.77	0.42

Table 6-2

Vertical Diffusivity (K_z) and Puff Growth Rate Coefficient (a_{zt})

Stability Class	K_z (m^2/s)	a_{zt}
A	50	5.0
B	30	3.873
C	15	2.739
D	7	1.871
E	3	1.225
F	1	0.707

6.1.2 Grid Systems

A Cartesian coordinate reference frame is employed in MESOPAC II and MESOPUFF II. Three nested grid systems are used: a meteorological grid, a computational grid, and a sampling grid. The size of each grid is limited by the parameters, MXNX, MXNY, defined in the "params.pac" and "params.puf" files.

The meteorological grid is the system of grid points at which meteorological parameters (wind components, mixing heights, etc.) are defined. The meteorological grid is determined by inputs to MESOPAC II. It is the basic reference frame for all spatial input data to both MESOPAC II and MESOPUFF II (e.g., coordinates of meteorological stations, sources, and non-gridded receptors). The southwest corner of the meteorological grid defines the point (x,y) = (1.0, 1.0).

The computational grid determines the computational area for a MESOPUFF II run, i.e., puffs are advected and tracked only while within the computational grid. When the center of a puff is transported outside the bounds of the computational grid, this puff is eliminated in the next sampling step. Thus, all sources and receptors must be located within the computational grid. To avoid possible boundary effects, receptors should be located away from the edges of the computational grid.

The sampling grid defines the set of gridded receptors. It must be equal to or a subset of the computational grid. Its resolution is a multiple of the resolution of the computational (and meteorological) grid. It should be noted that non-gridded (discrete) receptors are not limited to be within the sampling grid; they may be placed anywhere within the computational grid. Computational savings will be realized if the sampling grid is limited only to areas of interest. The sampling grid may be eliminated entirely if sufficient coverage can be obtained with non-gridded receptors (see variable LSGRID in MESOPUFF II inputs).

Figure 6-2 illustrates one possible arrangement for the three grids. The computational grid is a 10 x 8 grid within the 11 x 9 meteorological grid. The sampling grid extends from coordinates (3.0, 2.0) to (10.0, 7.0) and has a resolution twice that of the other grids. In this example, the sampling grid size is 15 x 11.

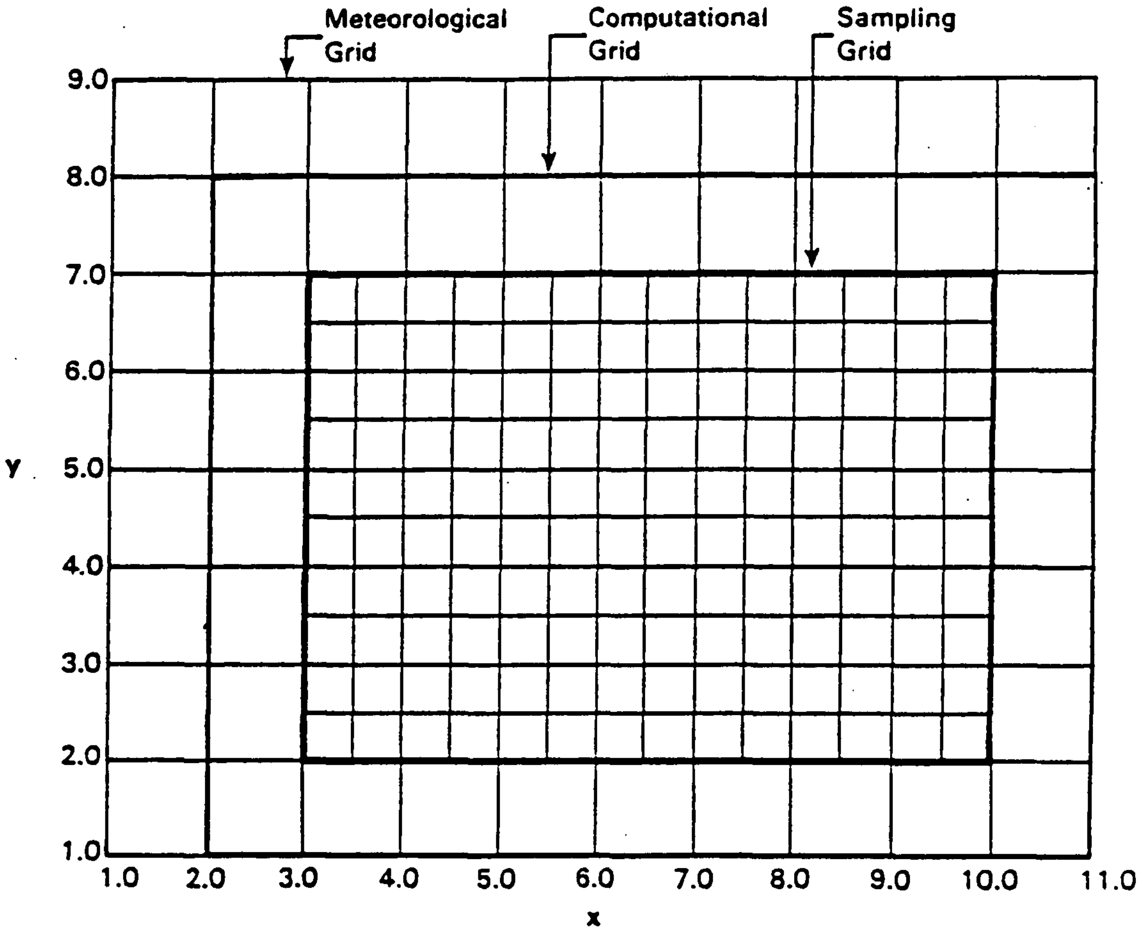

Figure 6-2. Sample meteorological, computational, and sampling grids.

6.1.3 Plume Rise

The plume rise, Δh, of each puff is computed by the Briggs (1975) plume rise equations for final rise. For unstable and neutral conditions when the puff center does not rise above the top of the boundary layer, Δh is given by:

$$\Delta h = 1.6\ F^{1/3}\ X_F^{2/3} / u_m \tag{6-11}$$

$$X_F = \begin{cases} (3.5)\ (14\ F^{5/8}) & F \le 55\ m^4/s^3 \\ (3.5)\ (34.49\ F^{2/5}) & F > 55\ m^4/s^3 \end{cases} \tag{6-12}$$

where,

- F is the initial stack plume buoyancy flux (m^4/s^3),
- X_F is the distance to final plume rise (m), and
- u_m is the larger of boundary layer (lower level) wind speed (m/s) or 1.37 m/s.

The ambient temperature at the closest surface meteorological station to the source is used in the computation of the buoyancy flux.

If the puff penetrates into the elevated stable layer above the boundary layer, the Briggs (1975) partial penetration rise equation is used to provide a second estimate of plume rise. The actual plume rise is taken as the minimum of the two plume rise estimates.

$$\Delta h = \mathit{minimum} \begin{cases} 1.6\ F^{1/3}\ X_F^{2/3} / u_m \\ \left[1.8\ z_b^3 + 18.75\ F / (u_m S)\right]^{1/3} \end{cases} \tag{6-13}$$

where,

- z_b is the distance from the stack top, h_s, to the top of the boundary layer, z_i, and
- S is the stability parameter $(g/T)(\partial\theta/\partial z)$.

The lapse rate in the elevated inversion is assumed to be 0.02° K/m, which is consistent with EPA recommendations for E stability. This yields a value of S of $6.93 \times 10^{-4}\ s^{-1}$.

For stable conditions, Δh is given by:

$$\Delta h = \begin{cases} 2.6F^{1/3}/(uS)^{1/3} & u \geq 1.37\ m/s \\ 5.0F^{1/4}/S^{3/8} & u < 1.37\ m/s \end{cases} \tag{6-14}$$

During stable conditions, the potential temperate lapse rate is assumed to be 0.02° K/m and 0.035° K/m for E and F stability, respectively. This produces values of S of $6.93 \times 10^{-4}\ s^{-1}$ and $1.21 \times 10^{-3}\ s^{-1}$, respectively.

6.1.4 Puff Trajectory Function

Puffs are advected during each sampling step according to a Lagrangian trajectory function. The change in position of a puff center over a time interval Δt is:

$$x(t+\Delta t) = x(t) + \Delta x = \int_t^{t+\Delta t} u[t';\, x(t'),\, y(t')]\, dt' \tag{6-15}$$

$$y(t+\Delta t) = y(t) + \Delta y = \int_t^{t+\Delta t} v[t';\, x(t'),\, y(t')]\, dt' \tag{6-16}$$

where, [x(t), y(t)] and [x(t + Δt), y(t + Δt)] are the puff center coordinates at the time t and t + Δt, respectively; Δx, Δy are the incremental x and y distances travelled by the puff; and u, v are the easterly and northerly components of the wind. The integrals in Equations (6-15) and (6-16) are approximated by a two-step bilinear interpolation in space and time. The coordinates of a puff center at time t + Δt are found by evaluating the vector average of two advection increments. Figure 6-3 illustrates the advection algorithm. The first increment is evaluated by assuming the wind components at [x(t), y(t)] are constant for the advection interval Δt. Thus,

$$x_1 = x(t) + (\Delta x)_1 \tag{6-17}$$

$$y_1 = y(t) + (\Delta y)_1 \tag{6-18}$$

$$(\Delta x)_1 = u[t;\, x(t),\, y(t)]\, \Delta t \tag{6-19}$$

$$(\Delta y)_1 = v[t;\, x(t),\, y(t)]\, \Delta t \tag{6-20}$$

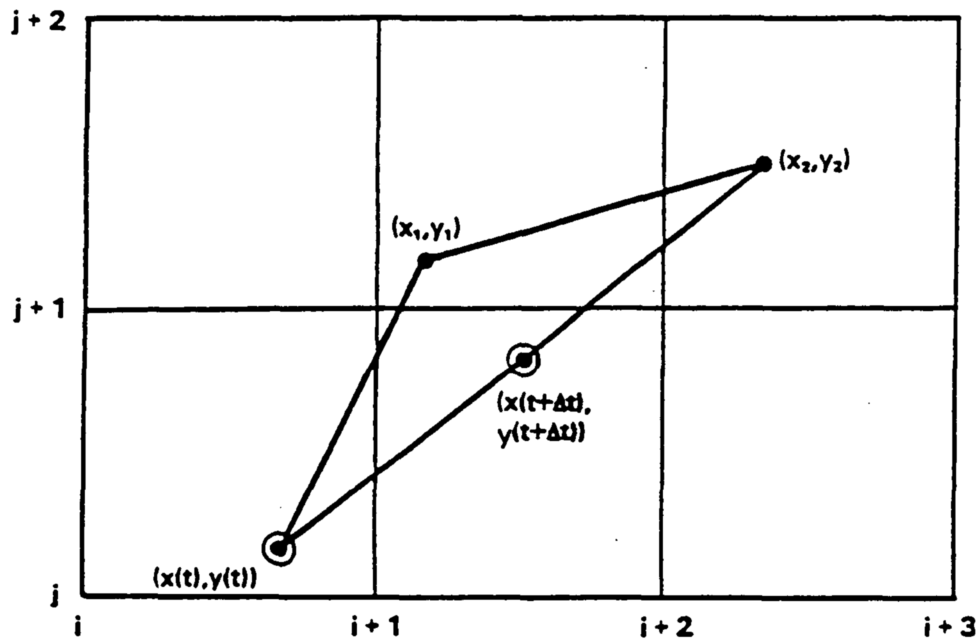

Figure 6-3. Calculation of the trajectory of a puff centerpoint.

However, because the wind changes in both space and time, a second increment is calculated using (x_1, y_1) as the beginning of the trajectory and the wind components for time $t + \Delta t$ at (x_1, y_1). Assuming these wind components are constant for a time interval Δt, the end point of this increment becomes (x_2, y_2).

$$x_2 = x_1 + (\Delta x)_2 \tag{6-21}$$

$$y_2 = y_1 + (\Delta y)_2 \tag{6-22}$$

$$(\Delta x)_2 = u\left[t + \Delta t; x_1, y_1\right] \Delta t \tag{6-23}$$

$$(\Delta y)_2 = v\left[t + \Delta t; x_1, y_1\right] \Delta t \tag{6-24}$$

Weighting each increment equally, the new puff position $[x(t + \Delta t), y(t + \Delta t)]$ is the midpoint of the line from $[x(t), y(t)]$ to (x_2, y_2). Thus, the winds at two points in space and in time are used to evaluate the trajectory of the puff.

$$x(t + \Delta t) = x(t) + 0.5 \left[(\Delta x)_1 + (\Delta x)_2\right] \tag{6-25}$$

$$y(t + \Delta t) = y(t) + 0.5 \left[(\Delta y)_1 + (\Delta y)_2\right] \tag{6-26}$$

The wind components u, v are defined only at the grid points at hourly intervals. The effective wind components at the puff center at time t are obtained by the following bilinear interpolation scheme:

$$\begin{aligned} u[t; x(t), y(t)] = {} & t_1\, \delta y_2\, \delta x_2\, u\left[t_n; i, j\right] + t_2\, \delta y_2\, \delta x_2\, u\left[t_{n+1}, i, j\right] \\ & + t_1\, \delta y_2\, \delta x_1\, u\left[t_n; i+1, j\right] + t_2\, \delta y_2\, \delta x_1\, u\left[t_{n+1}, i+1, j\right] \\ & + t_1\, \delta y_2\, \delta x_2, u\left[t_n; i, j+1\right] + t_2\, \delta y_1\, \delta x_2\, u\left[t_{n+1}, i, j+1\right] \\ & + t_1\, \delta y_1\, \delta x_1\, u\left[t_n; i+1, j+1\right] + t_2\, \delta y_1\, \delta x_1\, u\left[t_{n+1}; i+1, j+1\right] \end{aligned} \tag{6-27}$$

where,

$$t_2 = \frac{t - t_n}{t_{n+1} - t_n} \qquad t_n \le t \le t_{n+1} \tag{6-28}$$

$$t_1 = 1.0 - t_2 \tag{6-29}$$

and t_n, t_{n+1} are the times closest to time t at which the wind field is defined. The variables δx_1, δx_2, δy_1, δy_2 are the fractional x and y distances (in grid units) from the four surrounding grid points to the puff center as illustrated in Figure 6-4. The northerly wind component v[t, x(t), y(t)] is computed in an identical manner.

6.1.5 Dry Deposition - Three-Layer Model

The rate at which pollutants are deposited on the surface depends upon many factors: the characteristics of the pollutant, the underlying surface, and atmospheric conditions. The variability of surface and atmospheric conditions in space and time can cause significant variations in dry deposition rates. MESOPUFF II accounts for the spatial and temporal variations of deposition rates by the use of a resistance model. The deposition velocity, defined as the ratio of the vertical pollutant flux at a reference height to the concentration at that height, is expressed as the inverse of a sum of resistances to pollutant transfer through the atmosphere to the surface.

$$v_d = (r_a + r_s + r_c)^{-1} \qquad (6\text{-}30)$$

where,

- v_d is the deposition velocity (m/s),
- r_a is the aerodynamic resistance[1] (s/m),
- r_s is the surface resistance[1] (s/m), and
- r_c is the canopy resistance[1] (s/m).

The aerodynamic resistance, r_a, is given by Wesely and Hicks (1977) as:

$$r_a = (k\,u_*)^{-1}\left[\ln(z_s/z_o) - \psi_H\right] \qquad (6\text{-}31)$$

$$\psi_H = \begin{cases} -5z_s/L & 0 < z_s/L < 1 \\ \exp\left[0.598 + 0.39\ln(-z_s/L) - 0.090\left\{\ln(-z_s/L)\right\}^2\right] & -1 < z_s/L < 0 \end{cases} \qquad (6\text{-}32)$$

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[1] It should be noted that MESOPUFF II uses MKS units. Therefore, resistances that are commonly reported in s/cm must be converted to s/m for input to the model.

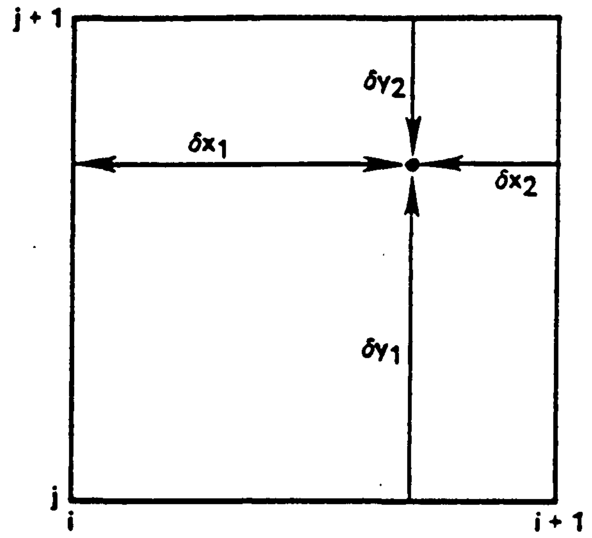

Figure 6-4. Bilinear interpolation of wind components.

where,

z_s is the reference height (10 meters),

z_o is the surface roughness length (m),

u_* is the friction velocity (m/s),

ψ_H is a function accounting for stability effects, and

k is the von Karman constant.expressed (Wesely and Hicks, 1977) as:

$$r_s = (k\ u_*)^{-1}\ k\ B^{-1} \tag{6-33}$$

where B^{-1} is the surface transfer coefficient. For SO_2, NO_x, and HNO_3, kB^{-1} is assigned a default value of 2.6. A constant value of r_s for the $SO_4^=$ and NO_3^- aerosols of 1000 s/m is assumed.

Table 6-3 contains the default canopy resistances for SO_2 as a function of land use and stability class for summertime conditions (Shieh et al., 1979). The roughness length associated with each land use category is also presented. Based upon its high solubility and reactivity, r_c for HNO_3 is assumed to be zero. The default canopy resistance for NO_x is 1500 s/m. Uptake of the $SO_4^=$ and NO_3^- aerosols by plant stomata is less relevant; therefore, total resistance for $SO_4^=$ and NO_3^- is determined by r_a and r_s (i.e., r_c = 0).

With knowledge of the concentration and the deposition velocity, the pollutant flux is determined. MESOPUFF II has two options for treating the removal of pollutant from the puff. The first option is the commonly used source depletion approximation. This method assumes that material deposited is removed from the full depth of the puff. The change in mass is:

$$Q(t+1) = Q(t)\ \exp \frac{-v_d \Delta t}{\Delta s} \int_s^{s+\Delta s} g(s')\ ds' \tag{6-34}$$

where,

Q(t), Q(t+1) is the mass (g) of the pollutant in the puff at the beginning and end of the time step,

s, s + Δs is the position of the puff at the beginning and end of the time step, and

g(s) is the vertical term of the Gaussian puff equation as given by Equation 6-2. For a puff uniformly mixed in the vertical, g(s) = $1/z_i$.

Table 6-3

Summertime SO_2 Canopy Resistances (s/m) as a Function of Land Use Type and Stability Class

Category	Land Use Type	z_o (m)	A,B,C	D	E	F
1	cropland and pasture	0.20	100.	300.	1000.	0.
2	cropland, woodland, and grazing land	0.30	100.	300.	1000.	0.
3	irrigated crops	0.05	100.	300.	1000.	0.
4	grazed forest and woodland	0.90	100.	300.	1000.	0.
5	ungrazed forest and woodland	1.00	100.	300.	1000.	0.
6	subhumid grassland and semi-arid grazing land	0.10	100.	300.	1000.	0.
7	open woodland grazed	0.20	100.	300.	1000.	0.
8	desert shrubland	0.30	200.	500.	1000.	1000.
9	swamp	0.20	50.	75.	100.	0.
10	marshland	0.50	75.	300.	1000.	0.
11	metropolitan city	1.00	1000.	1000.	1000.	0.
12	lake or ocean	10^{-4}	0.	0.	0.	0.

Source: Shieh, Wesely, and Hicks (1979).

The source depletion model effectively enhances the rate of vertical diffusion of the pollutant because mass removed at the surface is immediately replaced with material from above. However, in the atmosphere, the rate of deposition can be limited (mostly during stable conditions) by the rate of pollutant mass transfer through the boundary layer to the surface layer. This overall boundary layer resistance is not included in the aerodynamic resistance. To account for the effect of boundary layer mixing, MESOPUFF II has the option to treat puffs that have become vertically well-mixed with a 3-layer model (see Figure 6-5). The surface layer is a shallow layer (10 m) next to the ground that rapidly adjusts to changes in surface conditions. Pollutants in the middle layer are uniformly mixed to the top of the current boundary layer. The upper layer consists of pollutant material above the boundary layer dispersed upward during previous turbulent activity. The pollutant flux into the surface layer is:

$$Flux = \kappa \left(C_m - C_s\right) / \left(z_i - z_s\right) = v_d \, C_s \tag{6-35}$$

where,

κ	is an overall boundary layer eddy diffusivity (m^2/s),
C_m	is the concentration in the middle layer, and
C_s	is the concentration at the top of the surface layer.

During stable conditions, κ is given by Brost and Wyngaard (1978) as:

$$\kappa = k_1 \, u_* \, z_i \tag{6-36}$$

and during neutral or unstable conditions κ is

$$\kappa = Maximum \left\{k_1 \, u_* \, z_i, \; k_2 \, w_* \, z_i\right\} \tag{6-37}$$

The constants k_1 and k_2 have default values of 0.01 and 0.1, respectively.

The term $v_d \, C_s$ can be written as $v_d' \, C_m$, where v_d' is an effective deposition velocity taking into account boundary layer mass transfer.

$$v_d' = \frac{\kappa \, v_d}{\kappa + v_d\left(z_i - z_s\right)} \tag{6-38}$$

In the 3-layer model, only material in the surface layer is available for deposition at the surface. The effective deposition velocity, v_d' is used in Equation 6-34 to evaluate the change in pollutant mass in the puff due to dry deposition.

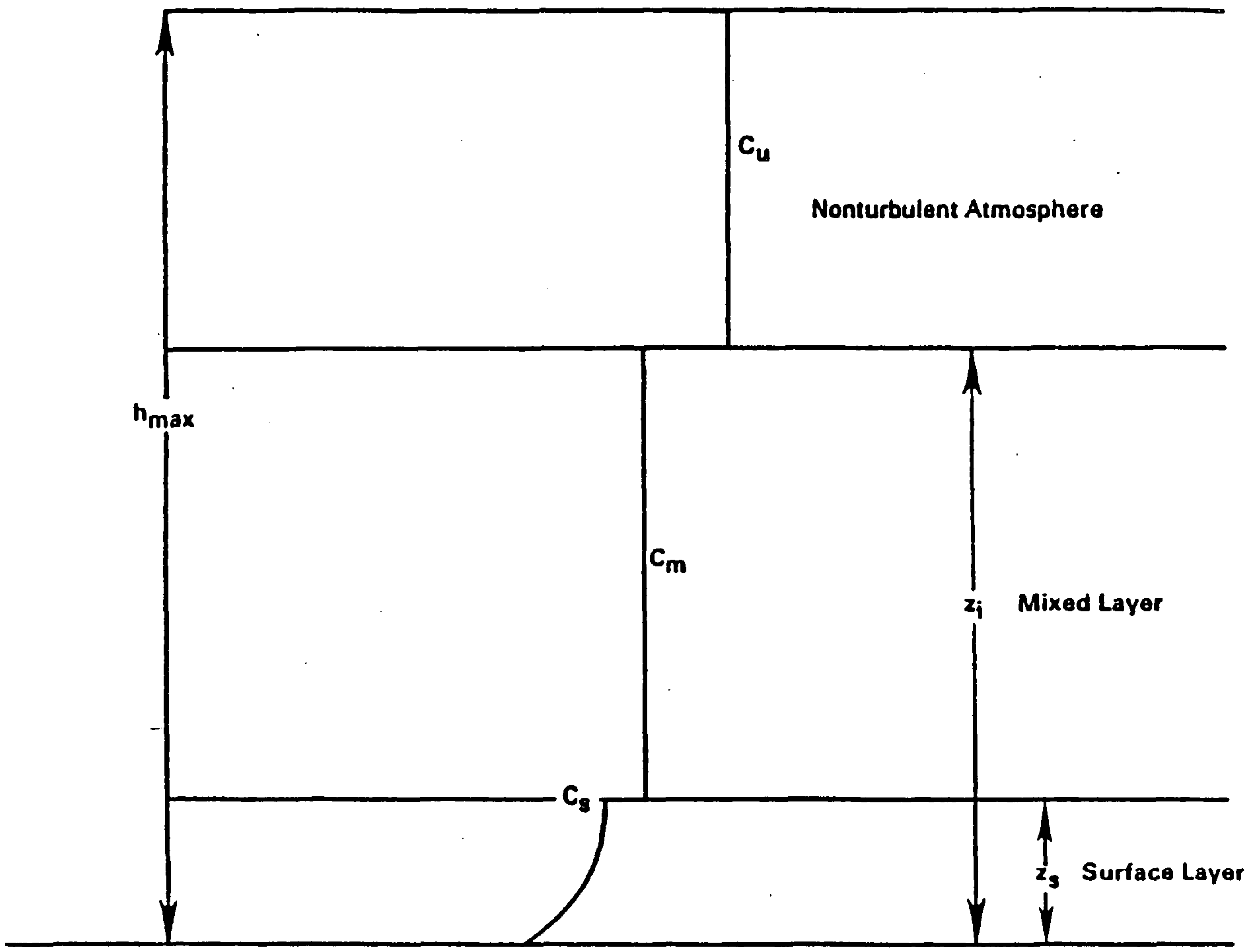

Figure 6-5. Optional three layer system used in MESOPUFF II.

6.1.6 Chemical Transformations

The chemical processes modeled in MESOPUFF II are the conversion of sulfur dioxide (SO_2) to sulfate ($SO_4^=$) and the conversion of nitrogen oxide (NO_x = NO + NO_2) to nitrate aerosol (NO_3^-). The formation of nitrate aerosol involves both photochemical reactions and chemical equilibrium considerations. NO_x is oxidized largely photochemically to gaseous nitric acid (HNO_3) and organic nitrate ($RONO_2$) such as peroxyacetylnitrate (PAN). In the presence of ammonia, a chemical equilibrium is established between gaseous HNO_3, gaseous NH_3, and the ammonium nitrate aerosol:

$$HNO_3\ (g) + NH_3\ (g) \rightleftharpoons NH_4NO_3\ (aq) \qquad (6\text{-}39)$$

The equilibrium constant for this reaction is strongly dependent on relative humidity and temperature (Stelson and Seinfeld, 1982). The organic nitrates formed from NO_x are not believed to form fine particulate aerosols.

Transformation rate expressions were developed for use in MESOPUFF II by statistically analyzing hourly transformation rates produced by a photochemical box model. The model employed the RHC/NO_x/SO_x chemical mechanisms of Atkinson et al. (1982). Plume SO_x/NO_x dispersing into background air containing ozone and reactive hydrocarbons (RHC) was simulated over a wide range of conditions representing different solar radiation intensities, temperatures, dispersion conditions, background ozone and RHC levels, plume NO_x concentrations and emissions times. The following equations represent curve fits to the hourly (daytime) conversion rates predicted by the photochemical model:

$$k_1 = 36\ R^{0.55}\ [O_3]^{0.71}\ S^{-1.29} + 3 \times 10^{-8}\ RH^4 \qquad (6\text{-}40)$$

$$k_2 = 1206\ [O_3]^{1.5}\ S^{-1.41}\ [NO_x]^{-0.33} \qquad (6\text{-}41)$$

$$k_3 = 1261\ [O_3]^{1.45}\ S^{-1.34}\ [NO_x]^{-0.12} \qquad (6\text{-}42)$$

where,

k_1	is the SO_2 to $SO_4^=$ transformation rate (percent per hour),
k_2	is the NO_x to HNO_3 + PAN transformation rate (percent per hour),
k_3	is the NO_x to HNO_3 (only) transformation rate (percent per hour),
R	is the total solar radiation (Kw/m^2),
$[O_3]$	is the background ozone concentration (ppm),
S	is a stability index ranging from 2 to 6 (PGT class A and B=2, C=3, D=4, E=5, F=6),

RH	is the relative humidity (percent), and
$[NO_x]$	is the NO_x concentration (ppm).

An empirically determined aqueous phase SO_2 conversion term ($3 \times 10^{-8}\ RH^4$) is included in the SO_2 to $SO_4^=$ transformation equation. The aqueous phase term has a minimum value of 0.2% per hour. Constant transformation rates of 0.2 and 2% per hour for SO_2 and NO_x, respectively, are used as default values for nighttime periods.

The model provides three options for the specification of background ozone concentrations: (1) hourly ozone data from a network of stations may be input; (2) a single background ozone concentration may be specified, or, (3) the default value of 80 ppb may be used. The background ammonia concentration required for the $HNO_3/NH_3/NH_4NO_3$ equilibrium calculation may be specified by the user or the default value of 10 ppb is used.

The parameterized NO_x oxidation rate depends on the NO_x concentration. In situations where puffs overlap, it would be incorrect to calculate NO_x oxidation rate based solely on the puff NO_x concentration. Similarly, the nitrate equilibrium should not assume that all the ambient NH_3 is available for one puff. Therefore, the total (local average) $SO_4^=$, NO_x, TNO_3 (total nitrate = HNO_3 + NO_3^-) concentrations due to all puffs and the available ammonia (total ammonia minus sulfate) are computed. First, the average puff concentration, C, within $\pm$ 1.5 σ_y and $\pm$ 1.5 σ_z of the puff center is calculated for each puff. For an elevated Gaussian puff, $\overline{C}$ (assuming no ground reflection) is:

$$\overline{C} = \frac{0.38\ Q}{(2\pi)^{3/2}\ \sigma_y^2\ \sigma_z} \qquad (6\text{-}43)$$

For a puff uniformly mixed in the vertical, $\overline{C}$ is:

$$\overline{C} = \frac{0.52\ Q}{(2\pi)\ \sigma_y^2\ z_i} \qquad (6\text{-}44)$$

The total local average concentration is the puff's own contribution plus that of nearby puffs (within 1.5 σ_y of the puff center). Average concentrations are computed separately for puffs within the mixed layer and for those above the mixed layer.

Although the use of Equations (6-40) through (6-42) are recommended, several other alternatives are provided in MESOPUFF II. The model allows optional user-specification of hourly transformation rates for k_1, k_2, and k_3 (three arrays of 24 values each), or the following alternative rate expressions for the SO_2 oxidation rate.

Gillani et al. (1981):

$$k_1 = 0.03\ R\ h\ [O_3] \tag{6-45}$$

where h is the plume depth (m) taken as the minimum of 3 σ_z or z_i, R is solar radiation (kw/m^2).

Henry and Hidy (1982) - (based on St. Louis data):

$$k_1 = 34.\ [O_3] \tag{6-46}$$

Henry and Hidy (1981) - (based on Los Angeles data):

$$k_1 = 85.\ [O_3] \tag{6-47}$$

6.1.7 Wet Removal

Numerous studies (e.g., Slinn et al. 1978, Scott 1978, 1981) have shown that precipitation scavenging in an efficient removal mechanism, especially for particulate pollutants such as $SO_4^{=}$. During precipitation events, wet removal can easily dominate dry deposition in pollutant removal. MESOPUFF II uses the following simple parameterization of wet removal processes:

$$Q(t+1) = Q(t)\ \exp[\ -\Lambda\ \Delta t] \tag{6-48}$$

where,

Q(t), Q(t + 1) is the mass (g) of pollutant in the puff at the beginning and end of the time step,

Λ is the scavenging ratio (s^{-1}), and

Δt is the time step (s).

Maul (1980) expresses Λ as:

$$\Lambda = \lambda\ (R / R_1) \tag{6-49}$$

where,

R	is the rainfall rate (mm/hr),
R_1	is a reference rainfall rate of 1 mm/hr, and
λ	is a scavenging coefficient (s^{-1}).

Table 6-4 contains the default values of the scavenging coefficient used in MESOPUFF II. The rainfall rate used in Equation 6-49 is that observed at the closest station to the puff center.

A precipitation code determined from the surface (CD144) observations of precipitation type/intensity is used to determine if the value of λ for liquid or frozen precipitation is most appropriate. Precipitation observations are converted to precipitation codes as shown in Table 6-5. The liquid precipitation values of λ are used for precipitation codes 1-18; the frozen precipitation values are used for codes 19-45.

6.1.8 Puff Sampling Function

MESOPUFF II simulates a continuous plume with a series of discrete puffs. The total concentration is calculated by summing the contributions of each nearby puff (within 3 σ_y of the receptor). The contribution of a single puff integrated over the distance of puff travel, Δs, during the sampling step is:

$$C(r,1s) = \frac{1}{\Delta s} \int_{s}^{s+\Delta s} \frac{Q(s)\, g(s)}{2\pi\, \sigma_y^2(s)} \exp\left[\frac{-r^2(s)}{2\, \sigma_y^2(s)}\right] ds \qquad (6\text{-}50)$$

where g(s) is the vertical term given by Equation (6-2). If it is assumed that the most significant s dependence during the sampling step is in the r(s) and Q(s) terms, this integral can be evaluated and expressed as:

$$C(r,s) = \frac{g(s)}{2\pi\, \sigma_y^2} \left[Q_o I_1 + (Q_n - Q_o)\, I_2\right] \qquad (6\text{-}51)$$

$$I_1 = \sqrt{\frac{\pi}{2a}} \exp\left[1/2\, (b^2/a - c)\right] \left\{erf\, \frac{(a+b)}{\sqrt{2a}} - erf\, \frac{(b)}{\sqrt{2a}}\right\} \qquad (6\text{-}52)$$

$$I_2 = \frac{-b}{a} I_1 + \frac{1}{a} \exp\left[1/2\, (b^2/a - c)\right] \left\{\exp\left[\frac{-1}{2} b^2/a\right] - \exp\left[\frac{-1}{2}(a + 2b + b^2/a)\right]\right\} \qquad (6\text{-}53)$$

Table 6-4

Default Values of the Scavenging Coefficient, λ (s^{-1})

Pollutant	Liquid Precipitation	Frozen Precipitation
SO_2	3×10^{-5}	0.0
$SO_4^{=}$	1×10^{-4}	3×10^{-5}
NO_x	0.0	0.0
HNO_3	6×10^{-5}	0.0
NO_3^-	1×10^{-4}	3×10^{-5}

Table 6-5

Conversion of Reported Precipitation Type/Intensity to Precipitation Codes

Liquid Precipitation			Frozen Precipitation		
Precipitation Code	Type	Intensity	Precipitation Code	Type	Intensity
1	Rain	Light	19	Snow	Light
2	Rain	Moderate	20	Snow	Moderate
3	Rain	Heavy	21	Snow	Heavy
4	Rain Showers	Light	22	Snow Pellets	Light
5	Rain Showers	Moderate	23	Snow Pellets	Moderate
6	Rain Showers	Heavy	24	Snow Pellets	Heavy
7	Freezing Rain	Light	25	Not Used	-
8	Freezing Rain	Moderate	26	Ice Crystals	*
9	Freezing Rain	Heavy	27	Not Used	-
10	Not Used	-	28	Snow Showers	Light
11	Not Used	-	29	Snow Showers	Moderate
12	Not Used	-	30	Snow Showers	Heavy
13	Drizzle	Light	31	Not Used	-
14	Drizzle	Moderate	32	Not Used	-
15	Drizzle	Heavy	33	Not Used	-
16	Freezing Drizzle	Light	34	Snow Grains	Light
17	Freezing Drizzle	Moderate	35	Snow Grains	Moderate
18	Freezing Drizzle	Heavy	36	Snow Grains	Heavy
			37	Ice Pellets	Light
			38	Ice Pellets	Moderate
			39	Ice Pellets	Heavy
			40	Not Used	-
			41	Hail	*
			42	Not Used	-
			43	Not Used	-
			44	Small Hail	*
			45	Not Used	-

* Intensity not currently reported for ice crystals, hail and small hail.

$$a = (\Delta x^2 + \Delta y^2) / \sigma_y^2 \tag{6-54}$$

$$b = [\Delta x (x_t - x_r) + \Delta y (y_t - y_r)] / \sigma_y^2 \tag{6-55}$$

$$c = [(x_t - x_r)^2 + (y_t - y_r)^2] / \sigma_y^2 \tag{6-56}$$

where,

Q_o, Q_n is the pollutant mass (g) in the puff at the beginning and end of the time step.
(x_r, y_t) are the receptor coordinates (m),
(x_t, y_t) are the puff coordinates (m) at the beginning of the sampling step, and
$\Delta x, \Delta y$ are the incremental x and y distances travelled by the puff during the sampling step.

The exponential variation of Q due to removal and chemical transformation processes is expressed with a linear function over the sampling interval. The puff trajectory segment is assumed to be a straight line. More details of the sampling function derivation are contained in Scire et al. (1984).

6.1.9 Urban Plumes

Emissions of SO_2 and NO_x and their transformation to particulate sulfate and nitrate within and downwind of urban regions can significantly influence regional scale air quality. MESOPUFF II offers the capability to model the large number of stationary and mobile sources within an urban area as one or more area sources. It is assumed that the emission distribution can be adequately represented by a Gaussian (puff-type) distribution. User-specified initial size parameters (σ_y, σ_z) and source height are required. The urban emissions may be partitioned according to effective source height and modeled as a number of area sources. Section 6.2 contains more information on the data requirements of area sources.

6.2 MESOPUFF II User's Instructions

MESOPUFF II is a variable-trajectory, puff superposition model designed to account for the spatial and temporal variations in transport, diffusion, chemical transformations, and removal mechanisms encountered on regional scales. Continuous plumes are modeled as a series of discrete puffs. Each puff is transported independently of other puffs, and is subject to growth by diffusion, chemical transformation, wet removal by precipitation, and dry deposition at the surface. MESOPUFF II will model up to five pollutants (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-) simultaneously.

One of the modifications made to the current version of MESOPUFF II is the use of a memory management system which makes it much easier to resize the major arrays within the code to accommodate a particular system's memory limitations. Arrays dealing with the number of puffs, grid cells, discrete receptors, point and area sources, surface and upper air meteorological stations, and ozone monitoring stations are dimensional throughout the code with parameter statements. The declarations of the values of the parameters are stored in a file called "PARAMS.PUF". This file is automatically inserted into any MESOPUFF II subroutine or function requiring one of its parameters via FORTRAN 'include' statements. Then, a global redimensioning of all the model arrays dealing with the maximum number of puffs, for example, can be accomplished simply by modifying the PARAMS.PUF file and recompiling the program.

A sample parameter file is shown in Table 6-6. The parameter file sets the array dimensions, which are the maximum values of the variables. The actual values for a particular run are set within the user input control file (PUFF.INP), and can be less than the maximum value set in the parameter file.

Table 6-7 summarizes the input and output files used by MESOPUFF II. Note that the logical units for the input control file and output list file are declared in the parameter file (PARAMS.PUF). The other unit number variables are declared in BLOCK DATA.

The chemical transformation module (see Section 6.1.6) contains an option to use hourly ozone monitoring data to help determine transformation rates. If this option is used, data for up to "MXOZ" ozone stations is read from the OZONE.DAT file. Table 6-8 shows the ozone data input format.

MESOPUFF II has been modified to allow the program to be executed in a series of runs. This continuation or restart option is convenient in permitting large simulations to be broken up into a series of manageable smaller runs. At the end of the first MESOPUFF II run, all the variables needed to continue the run are dumped to a file called RESTART.DAT. The user must rename this file to PREVIOUS.DAT. The second run then reads this file and continues the simulation. The second run may produce a RESTART.DAT file for a subsequent continuation run as well. The use of the restart option is controlled by the input variables ICONT (Input Group 2) and IRES (Input Group 6).

Table 6-6

Sample Parameter File (PARAMS.PUF) for MESOPUFF II

```
c----------------------------------------------------------------------
c --- PARAMETER statements                                 MESOPUFF II
c----------------------------------------------------------------------
c
c --- Specify parameters
      parameter(mxpuff=10000)
      parameter(mxnx=100,mxny=100)
      parameter(mxrec=1000)
      parameter(mxpts=1000,mxars=200)
      parameter(mxss=100,mxus=20)
      parameter(mxoz=50)
      parameter(io5=5,io6=6)
c
c --- Computed parameters
      parameter(mxcell=mxnx*mxny)
      parameter(maxpf5=5*mxpuff,maxpf6=6*mxpuff)
c
c --- GENERAL PARAMETER definitions:
c          MXPUFF - Maximum number active puffs on the grid
c            MXNX - Maximum number of grid cells in the X direction
c            MXNY - Maximum number of grid cells in the Y direction
c           MXREC - Maximum number of non-gridded (discrete) receptors
c           MXPTS - Maximum number of point sources
c           MXARS - Maximum number of area sources
c            MXSS - Maximum number of surface meteorological stations
c            MXUS - Maximum number of upper air stations
c            MXOZ - Maximum number of ozone stations
c
c --- FORTRAN I/O unit numbers:
c             IO5 - Control file (PUFF.INP)     - input  - formatted
c             IO6 - List file (PUFF.LST)        - output - formatted
c
```

Table 6-7

MESOPUFF II Input and Output Files

Unit*	File Name	Type	Format	Description
IO5	PUFF.INP	INPUT	FORMATTED	MESOPUFF II control file.
IN8	PACOUT.DAT	INPUT	UNFORMATTED	Meteorological data file produced by MESOPAC II.
4	PREVIOUS.DAT	INPUT	UNFORMATTED	A "restart" file produced by a previous run of MESOPUFF II, which allows a run to be continued. (Optional--Read only if ICONT = 1).
INOZ10	OZONE.DAT	INPUT	FORMATTED	File containing hourly ozone concentrations. (Optional--Read only if MO3=1).
IO6	PUFF.LST	OUTPUT	FORMATTED	List file (line printer output file).
IOUT20	PUFFOUT.DAT	OUTPUT	UNFORMATTED	Output file containing gridded and non-gridded concentrations.
IOUT22	FLUXWET.DAT	OUTPUT	UNFORMATTED	Output file containing gridded and non-gridded wet fluxes.
IOUT24	FLUXDRY.DAT	OUTPUT	UNFORMATTED	Output file containing gridded and non-gridded dry fluxes.
3	RESTART.DAT	OUTPUT	UNFORMATTED	A "restart" file produced by the current MESOPUFF II run to allow the run to be continued in a future MESOPUFF II run. (Created only if IRES=1).

* IO5 and IO6 are specified in the parameter file (PARAMS.PUF). The other unit number variables are declared in BLOCK DATA.

Figure 6-6 shows the required setup of the card-image inputs for MESOPUFF II. A complete description of all the run control variables used in MESOPUFF II are contained in Table 6-9. Section 6.3 contains a set of sample test case input and output.

The MESOPUFF II output concentration file and wet/dry flux files each consist of two header records followed by up to two records per hour containing concentration or flux data. The structure of the wet and dry flux files is identical to the concentration file. Table 6-10 contains a listing of the variables in each record of the output concentration and wet/dry flux files. The two header records contain a number of technical option control parameters and other run control inputs. One or two records per hour follow the header records. Two records are written each hour if concentrations or fluxes are predicted at both gridded and non-gridded receptors. If only one type of receptor is used, only one record per hour is written. The units of the flux fields stored in the output files are $g/m^2/s$. The concentrations are expressed in g/m^3 in the output file.

6.3 Sample MESOPUFF II Inputs and Outputs

Table 6-11 contains a control file for a MESOPUFF II run. This is a 24-hour run which uses meteorological data from a 20 x 20 grid. Concentrations of SO_2 are predicted on a 14 x 14 sampling grid and at 14 non-gridded receptors. The output list file generated by MESOPUFF II using the inputs from Table 6-11 is presented in Attachment 6-A.

Table 6-8

Format of Optional Hourly Ozone Input Data

Columns	Type	Variable	Description
1-8 (4I2)	INTEGER	IDATE (4)	Year, Month, Day, Hour
9-68 (50F4.0)	REAL ARRAY	OZPPB (MXOZ*)	Ozone concentrations (ppb) at up to MXOZ stations. A '999.' signifies missing data.

* MXOZ is a parameter defined in "params.puf".

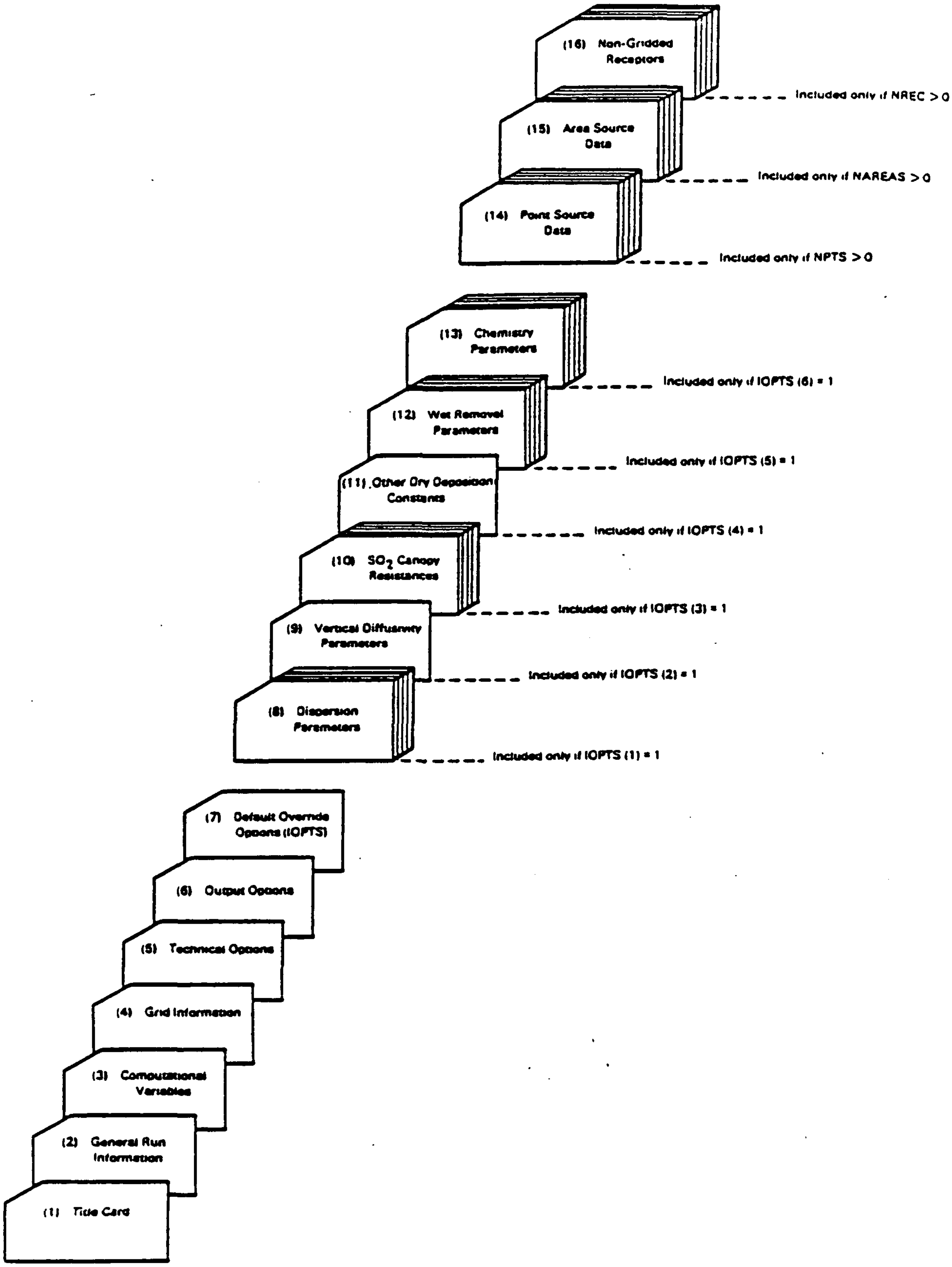

Figure 6-6. Input deck setup for MESOPUFF II.

Table 6-9

MESOPUFF II INPUTS

INPUT GROUP 1 - TITLE Format: (20A4)

Columns	Type	Variable	Description
1-80	CHARACTER *4 ARRAY	TITLE (20)	80-character title

INPUT GROUP 2 - GENERAL RUN INFORMATION Format: (9I5)

Columns	Type	Variable	Description
1-5	INTEGER	NSYR	Two-digit year of run.
6-10	INTEGER	NSDAY	Starting Julian day.
11-15	INTEGER	NSHR	Starting hour (00-23).
16-20	INTEGER	NADVTS	Number of hours in run.
21-25	INTEGER	NPTS	Number of point sources (NPTS ≤ MXPTS as defined in "params.puf").
26-30	INTEGER	NAREAS	Number of area sources (NAREAS ≤ MXARS as defined in "params.puf").
31-35	INTEGER	NREC	Number of non-gridded receptors (NREC ≤ MXREC as defined in "params.puf").
36-40	INTEGER	NSPEC	Number of chemical species to model (NSPEC = 1,2,3 or 5). NSPEC = 1 for SO_2; NSPEC = 2 for SO_2, $SO_4^=$, NSPEC = 3 for SO_2, $SO_4^=$, NO_x, NSPEC = 5 for SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-.
41-45	INTEGER	ICONT	Continuation run? (0 = no, 1 = yes).

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 3 - COMPUTATIONAL VARIABLES Format: (3I5, L5, F5.1, L5, F5.0)

Columns	Type	Variable	Description
1-5	INTEGER	IAVG	Concentration averaging time (hours).
6-10	INTEGER	NPUF	Puff release rate (puffs/hour) for each source.
11-15	INTEGER	NSAMAD	Minimum sampling rate (samples/hour).
16-20	LOGICAL	LVSAMP	Control variable for variable sampling rate option. If LVSAMP = T, the sampling rate, NSAM, will be increased at higher wind speeds according to the following equation: NSAM = maximum (NSAMAD, WS/WSAMP + 1) where WS is the wind speed (m/s), and WSAMP is a user input reference wind speed (see below). If LVSAMP = F, the sampling rate is not varied with wind speed.
21-25	REAL	WSAMP	Reference wind speed used in variable sampling rate option. Used only if LVSAMP = T. See description of LVSAMP.
26-30	LOGICAL	LSGRID	Control variable for concentration computations at sampling grid points. If LSGRID = T, concentrations are calculated at sampling grid points. (Parameters defining sampling grid are contained in Input Group 4). If LSGRID = F, concentrations are not calculated at sampling grid points. This option allows significant savings of computation time if only concentrations at non-gridded receptors are of interest.
31-35	REAL	AGEMIN	Minimum age of puffs to be sampled (in seconds). Puffs released at a time AGEMIN are not sampled. This option is intended to eliminate near-field concentration spikes at receptors located very close to sources. In general, AGEMIN should not be larger than 3600 s.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 4 - GRID INFORMATION			(See Section 6.1.2 for description of the meteorological, computational, and sampling grids). Format: (9I5)
Columns	Type	Variable	Description
1-5	INTEGER	IASTAR	Element number of the meteorological grid defining the beginning of the computation grid in the X-direction. (1 ≤ IASTAR ≤ IMAX, where IMAX is the meteorological grid size in the X-direction defined in the MESOPAC II run).
6-10	INTEGER	IASTOP	Element number of the meteorological grid defining the end of the computation grid in the X-direction. (IASTAR ≤ IASTOP ≤ IMAX).
11-15	INTEGER	JASTAR	Element number of the meteorological grid defining the beginning of the computational grid in the Y-direction. (1 ≤ JASTAR ≤ JMAX, where JMAX is the meteorological grid size in the Y-direction defined in the MESOPAC II run).
16-20	INTEGER	JASTOP	Element number of the meteorological grid defining the end of the computation grid in the Y-direction. (JASTAR ≤ JASTOP ≤ JMAX).
21-25	INTEGER	ISASTR	Element number of the meteorological grid defining the beginning of the sampling grid in the X-direction. (IASTAR ≤ ISASTR ≤ IASTOP).
26-30	INTEGER	ISASTP	Element number of the meteorological grid defining the end of the sampling grid in the X-direction. (ISASTR ≤ ISASTP ≤ IASTOP).
31-35	INTEGER	JSASTR	Element number of the meteorological grid defining the beginning of the sampling grid in the Y-direction. (JASTAR ≤ JSASTR ≤ JASTOP).
36-40	INTEGER	JSASTP	Element number of the meteorological grid defining the end of the sampling grid in the Y-direction. (JSASTR ≤ JSASTP ≤ JASTOP).
41-45	INTEGER	MESHDN	Sampling grid spacing factor. Sampling grid spacing is DGRID/MESHDN, where DGRID is the meteorological grid spacing (m) defined in the MESOPAC II run. NOTE: The sampling grid must be defined as not to exceed a maximum size of MXNX by MXNY.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 5 - TECHNICAL OPTIONS Format: (5L5)

Columns	Type	Variable	Description
1-5	LOGICAL	LGAUSS	Vertical concentration distribution option. If LGAUSS = T, a Gaussian vertical concentration distribution with reflection terms (Equation 6-2) is assumed for each puff. If LGAUSS = F, fumigated puffs immediately assume a uniform vertical concentration distribution.
6-10	LOGICAL	LCHEM	Chemical transformation option. If LCHEM = T, chemical transformation processes are modeled. If LCHEM = F, chemical processes are not modeled.
11-15	LOGICAL	LDRY	Dry deposition option. If LDRY = T, dry deposition is modeled. If LDRY = F, dry deposition is not modeled.
16-20	LOGICAL	LWET	Wet removal option. If LWET = T, wet removal is modeled. If LWET = F, wet removal is not modeled.
21-25	LOGICAL	L3VL	Three vertical layer option. L3VL = T, the 3-vertical layer model described in Section 6.1.5 is used for puffs that have become uniformly mixed in the vertical. If L3VL = F, the single layer model is assumed. NOTE: L3VL may be T with LGAUSS = T or F; however, if LGAUSS = T the 3-layer treatment does not begin until the puffs have become uniformly mixed through the boundary layer.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 6 - OUTPUT OPTIONS Format: (2L5, I5, L5, 2I5, 6L5, 2I5)

Columns	Type	Variable	Description
1-5	LOGICAL	LSAVE	Disk/tape output control variable. If LSAVE = T, concentrations are written to disk/tape file. If LSAVE = F, concentration output is not stored on tape/disk.
6-10	LOGICAL	LPRINT	Printer output control variable. If LPRINT = T, concentrations are printed every "IPRINF" hour. If LPRINT = F, concentrations are not printed.
11-15	LOGICAL	IPRINF	Printing interval (in hours) of concentrations. Used only if LPRINT = T. IPRINF must be equal to or an even multiple of IAVG.
16-20	LOGICAL	LDB	Control variable for printing of computed puff data (puff height, σ_y, σ_z, location, transformation rate, deposition velocity, wet removal rate, etc.). If LDB = T, these data will be printed for time steps NN1 to NN2. If LDB = F, this information will not be printed. This option will produce a large quantity of printout, and, for most applications should be F.
21-25	INTEGER	NN1	Time step at which printing of intermediate computed puff data begins. Used only if LDB = T, ($1 \leq NN1 \leq NADVTS$).
26-30	INTEGER	NN2	Time step at which printing of intermediate computed puff data ends. Used only if LDB = T. ($NN1 \leq NN2 \leq NADVTS$.)
31-35	LOGICAL	LWETG	Wet flux control variable for gridded receptors. If LWETG = T, wet fluxes at the gridded receptors are internally saved for printing or storage on disk or tape. If LWETG = F, the wet fluxes at the gridded receptors are not saved. (LWETG should be T only if LWET and LSGRID are also T.)

Table 6-7

MESOPUFF II INPUTS - Continued

INPUT GROUP 6 - **OUTPUT OPTIONS** - continued

Columns	Type	Variable	Description
35-60	LOGICAL	LWETNG	Wet flux control variable for non-gridded receptors. If LWETNG = T, wet fluxes at the non-gridded receptors are internally saved for printing or storage on disk or tape. If LWETNG = F, the wet fluxes at the non-gridded receptors are not saved. (LWETNG should be T only if LWET is T and NREC > 0).
41-45	LOGICAL	LDRYG	Dry flux control variable for gridded receptors. If LDRYG = T, dry fluxes at the gridded receptors are internally saved for printing or storage on disk or tape. If LDRYG = F, the dry fluxes at the gridded receptors are not saved. (LDRYG should be T only if LDRY and LSGRID are also T.)
46-50	LOGICAL	LDRYNG	Dry flux control variable for non-gridded receptors. If LDRYNG = T, dry fluxes at the non-gridded receptors are internally saved for printing or storage on disk or tape. If LDRYNG = F, the dry fluxes at the non-gridded receptors are not saved. (LDRYNG should be T only if LDRY is T and NREC > 0).
51-55	LOGICAL	LSAVEF	Disk/tape output control variable for fluxes. If LSAVEF = T, the wet and dry fluxes specified by LWETG, LWETNG, LDRYG, and LDRYNG are written to disk or tape. If LSAVEF = F, the fluxes are not stored on disk or tape.
56-60	LOGICAL	LPRFLX	Printer output control variable for fluxes. If LPRFLX = T, the wet and dry fluxes specified by LWETG, LWETNG, LDRYG, and LDRYNG are printed every 'IPRINF' hours. If LPRFLX = F, the fluxes are not printed.
61-65	INTEGER	IRES	Save results for restart option (1 = save, 0 = do not save).
66-70	INTEGER	IINT	Frequency (in hours) of restart (save results every "IINT" hours). If IINT is left blank, IINT defaults to NADVTS, which will save the restart file only at the end of the run. Used only if IRES = 1.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 7 - DEFAULT OVERRIDE OPTIONS Format: (6I1)

Columns	Type	Variable	Description
1	INTEGER ARRAY ELEMENT	IOPTS(1)	Control variable for input of dispersion parameters. If IOPTS(1) = 1, the user must input values of the following parameters related to dispersion; a_y, b_y, a_z, b_z, a_{zt}, T_m, JSUP (see Section 6.1.1 for definitions). If IOPTS(1) = 0, the default values for the parameters are used.
2	INTEGER ARRAY ELEMENT	IOPTS(2)	Control variable for input of vertical diffusivity constants. Used only if L3VL = T. If IOPTS(2) = 1, the user must input values for the constants k_1, k_2 of Equations (6-36)-(6-37). If IOPTS(2) = 0, the default values of k_1 = 0.01 and k_2 = 0.10 are used.
3	INTEGER ARRAY ELEMENT	IOPTS(3)	Control variable for input of SO_2 canopy resistances. Used only if LDRY = T. If IOPTS(3) = 1, the user must input SO_2 canopy resistances (r_c) for the stability/land use categories in Table 6-3. If IOPTS(3) = 0, the default values contained in the table are used.
4	INTEGER ARRAY ELEMENT	IOPTS(4)	Control variable for input of other dry deposition parameters. Used only if LDRY = T. If IOPTS(4) = 1, the user must input values for r_c (NO_x), r_s (gases), and r_s (particles) (see Input Group 11). If OPTS(4) = 0, the default values of these parameters are used.
5	INTEGER ARRAY ELEMENT	IOPTS(5)	Control variable for inputs of wet removal parameters. Used only if LWET = T. If IOPTS(5) = 1, the user must input values for λ (see Table 6-4). If IOPTS(5) = 0, the default values contained in the table are used.
6	INTEGER ARRAY ELEMENT	IOPTS(6)	Control variable for input of chemical transformation method flags and other chemical variables. See Input Group 13 for a complete description of the inputs. If IOPTS(6) = 1, the user must input values of these parameters. If IOPTS(6) = 0, the default values are used.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 8 - DISPERSION PARAMETERS (Optional - included only if IOPTS(1) = 1). Six input records required. Format: (5(6F10.5/), F10.0, I10)

Columns	Type	Variable	Default	Description
1-60	REAL ARRAY	AY(6)	*	Array of horizontal dispersion coefficients, a_y, in Equation 6-4 for stability classes A-F, respectively.
1-60	REAL ARRAY	BY(6)	*	Array of horizontal dispersion coefficients, b_y, in Equation 6-4 for stability classes A-F, respectively.
1-60	REAL ARRAY	AZ(6)	*	Array of vertical dispersion coefficients, a_z, in Equation 6-5 for stability classes A-F, respectively.
1-60	REAL ARRAY	BZ(6)	*	Array of vertical dispersion coefficients, b_z, in Equation 6-5 for stability classes A-F, respectively.
1-60	REAL ARRAY	AZT(6)	*	Array of time-dependent vertical dispersion coefficients, a_{zt}, in Equation 6-9, for stability classes A-F, respectively.
1-10	REAL	TMDEP	10,000	Distance (in meters) beyond which the time dependent Equations (6-8) - (6-9) are used to determine σ_y, σ_z.
11-20	INTEGER	JSUP	5	Stability class used to determine growth rates for puffs above the boundary layer. JSUP = 5 for E stability rates, JSUP = 6 for F stability rates, JSUP = 0 for boundary layer stability rates.

* See Tables 6-1 and 6-2 for default values.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 9 - VERTICAL DIFFUSIVITY CONSTANTS (Optional - included only if IOPTS(2) = 1) Format: (2F10.3)

Columns	Type	Variable	Default	Description
1-10	REAL	CON1K	0.01	Vertical dispersion constant, k_1, for stable conditions (Equation 6-36).
11-20	REAL	CON2K	0.10	Vertical dispersion constant, k_2, for convective conditions (Equation 6-37).

INPUT GROUP 10 - SO_2 CANOPY RESISTANCES (Optional - included only if IOPTS(3) = 1). Twelve input records are required. Format: (4F10.2)

Columns	Type	Variable	Default	Description
1-40	REAL ARRAY	RCSO2(12,4)	**	SO_2 canopy resistances, r_c, (SO_2), in s/m.* Four values on each record for stability classes (1) A-C, (2) D, (3) E, and (4) F. Twelve records are required, for land use categories 1-12. Entered in order of increasing numerical land use category.

* Note: Resistance units are s/m, not s/cm.
** See Table 6-3 for default values.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 11 - OTHER DRY DEPOSITION CONSTANTS (Optional - included only if IOPTS(4) = 1). Format: (6F10.2)

Columns	Type	Variable	Default	Description
1-10	REAL ARRAY ELEMENT	RCNOX(1)	130.	NO_x canopy resistance (s/m)* for stability classes A-C.
11-20	REAL ARRAY ELEMENT	RCNOX(2)	500.	NO_x canopy resistance (s/m) for stability class D.
21-30	REAL ARRAY ELEMENT	RCNOX(3)	1500.	NO_x canopy resistance (s/m) for stability class E.
31-40	REAL ARRAY ELEMENT	RCNOX(4)	1500.	NO_x canopy resistance (s/m) for stability class F.
41-50	REAL	RSGCON	2.6	Surface resistance constant for gases (SO_2, NO_x, HNO_3).
51-60	REAL	RSPART	1000.	Surface resistance (s/m) for particulates $SO_4^=$, NO_3^-.

INPUT GROUP 12 - WET REMOVAL PARAMETERS (Optional - included only if IOPTS(5) = 1). Input is on two records. Format: (5F10.2/5F10.2)

Columns	Type	Variable	Default	Description
1-50	REAL ARRAY ELEMENTS	WA(1-5,1)	**	Values of λ Equation 6-49 for liquid precipitation for pollutants 1-5, respectively, (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-).
1-50	REAL ARRAY ELEMENTS	WA(1-5,2)	**	Values of λ in Equation 6-49 for frozen precipitation for pollutants 1-5, respectively.

* Note: Resistance units are s/m, not s/cm.
** See Table 6-4 for default values.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 13 - CHEMICAL PARAMETERS (Optional - included only if IOPTS(6) = 1)
Format: (3I5, 2F5.1, 3F5.2)

Columns	Type	Variable	Default	Description
1-5	INTEGER	MSOX	2	SO_x transformation method flag. 0 = no transformation, 1 = user specified, 2 = ERT theoretical equation, 3 = Gillani equation, 4 = Henry equation for St. Louis, 5 = Henry equation for Los Angeles (see Section 6.1.6).
6-10	INTEGER	MNOX	2	NO_x transformation method flag. 0 = no transformation, 1 = user specified, 2 = ERT theoretical equation (see Section 6.1.6).
11-15	INTEGER	MO3	0	O_3 hourly input option. If MO3 = 1, hourly ozone values are required at "NOZONE" stations. IF MO3 = 0, a default ozone value (CO3B) is assumed.
16-20	REAL	CO3B	80	Default background ozone concentration (ppb). CO3B is used if MO3 = 0 or if MO3 = 1 and hourly values are missing.
21-25	REAL	CTNH3	10	Background ammonia concentration (ppb).
26-30	REAL ARRAY ELEMENT	RNITE(1)	0.2	Nighttime SO_2 loss rate (%/hour).
31-35	REAL ARRAY ELEMENT	RNITE(2)	2.0	Nighttime NO_x loss rate (%/hour).
36-40	REAL ARRAY ELEMENT	RNITE(3)	2.0	Nighttime HNO_3 formation rate (%/hour).

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 13 - Continued

The following two recorcds are included only if MSOX = 1.

Columns	Type	Variable	Description
1-80 (16F5.2)	REAL ARRAY ELEMENT	RUSER (1-16,1)	User-supplied hourly SO_2 loss rates (%/hour) for hours 1-16.
1-40 (8F5.2)	REAL ARRAY ELEMENT	RUSER (17-24,1)	User-supplied hourly SO_2 loss rates (%/hour) for hours 17-24.

The following four records are included only if MNOX = 1.

Columns	Type	Variable	Description
1-80 (16F5.0)	REAL ARRAY ELEMENT	RUSER (1-16,2)	User-supplied hourly NO_x loss rates (%/hour) for hours 1-16.
1-40 (8F5.0)	REAL ARRAY ELEMENT	RUSER (17-24,2)	User-supplied hourly NO_x loss rates (%/hour) for hours 17-24.
1-80 (16F5.0)	REAL ARRAY ELEMENT	RUSER (1-16,3)	User-supplied hourly total NO_3^- formation rates (%/hour) for hours 1-16.
1-40 (16F5.0)	REAL ARRAY ELEMENT	RUSER (17-24,3)	User-supplied hourly total NO_3^- formation rates (%/hour) for hours 17-24.

The following record is included only if MO3 = 1.

Columns	Type	Variable	Description
1-5 (I5)	INTEGER	NOZONE	Number of hourly ozone stations. NOZONE ≤ MXOZ as defined in "params.puf".

The following 'NOZONE' records are included only if MO3 = 1.

Columns	Type	Variable	Description
1-5 (F5.2)	REAL ARRAY ELEMENT	XO3	X-coordinate of ozone station (in meteorological grid units).
6-10 (F5.2)	REAL ARRAY ELEMENT	YO3	Y-coordinate of ozone station (in meteorological grid units).

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 14 - POINT SOURCE DATA. NPTS records required- one for each point source. Format: (2F5.2, F5.1, 2F5.2, F5.1, 5F10.2)

Columns	Type	Variable	Description
1-5	REAL ARRAY ELEMENT	XSTAK	X-coordinate of point source (in meteorological grid units).
6-10	REAL ARRAY ELEMENT	YSTAK	Y-coordinate of point source (in meteorological grid units).
11-15	REAL ARRAY ELEMENT	HTSTAK	Stack height (m).
16-20	REAL	D	Stack diameter (m).
21-25	REAL	W	Exit velocity (m/s).
26-30	REAL ARRAY ELEMENT	TSTAK	Stack gas temperature (°K).
31-80	REAL ARRAY ELEMENT	EMIS(1-5)	Emission rate (g/s) for pollutants 1-5 (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-). Leave field blank for secondary pollutants (HNO_3, NO_3^-) with zero emission rates.

Table 6-9

MESOPUFF II INPUTS - Continued

INPUT GROUP 15 - AREA SOURCE DATA. NAREAS records required - one for each area source. Format: (2F5.1, F5.1, 2F5.0, 5F10.2)

Columns	Type	Variable	Description
1-5	REAL ARRAY ELEMENT	XAR	X-coordinate of area source center (in meteorological grid units).
6-10	REAL ARRAY ELEMENT	YAR	Y-coordinate of area source center (in meteorological units).
11-15	REAL ARRAY ELEMENT	HTAR	Effective height of area source (m).
16-20	REAL ARRAY ELEMENT	SIGYAR	Initial σ_y (m) of area source emissions.
21-25	REAL ARRAY ELEMENT	SIGZAR	Initial σ_z (m) of area source emissions.
26-75	REAL ARRAY ELEMENTS	EMISAR(1-5)	Emission rate (g/s) of pollutants 1-5 (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-). Leave field blank for secondary pollutants with zero emission rates.

Table 6-9

MESOPUFF II INPUTS - Concluded

INPUT GROUP 16 - NON-GRIDDED RECEPTOR COORDINATES. NREC records are required - one for each non-gridded receptor.
Format: (2F10.3)

Columns	Type	Variable	Description
1-10	REAL ARRAY ELEMENT	XREC	X-coordinate of non-gridded receptor (in meteorological grid units).
11-20	REAL ARRAY ELEMENT	YREC	Y-coordinate of non-gridded receptor (in meteorological grid units).

Table 6-10

Variables in the MESOPUFF II Output Concentration and Flux Files

HEADER RECORD - The first record of the output file

Record	Type	VARIABLE	Description*
1	REAL	VERSION	MESOPUFF II version number
1	INTEGER	LEVEL	MESOPUFF II level number
1	INTEGER	NSYR	Starting year
1	INTEGER	NSDAY	Starting Julian day
1	INTEGER	NSHR	Starting hour (00-23)
1	INTEGER	NADVTS	Number of hours in run
1	INTEGER	IAVG	Averaging time (hours)
1	INTEGER	NPUF	Puff release rate (puffs/hour)
1	INTEGER	NSAMAD	Minimum sampling rate (samples/hour)
1	INTEGER	IELMET	Number of met. grid points (X direction)
1	INTEGER	JELMET	Number of met. grid points (Y direction)
1	REAL	DGRID	Grid spacing (m)
1	INTEGER	IASTAR	Start of computational grid (X direction)
1	INTEGER	IASTOP	End of computational grid (X direction)
1	INTEGER	JASTAR	Start of computational grid (Y direction)
1	INTEGER	JASTOP	End of computational grid (Y direction)
1	INTEGER	ISASTR	Start of sampling grid (X direction)
1	INTEGER	ISASTP	End of sampling grid (X direction)
1	INTEGER	JSASTR	Start of sampling grid (Y direction)
1	INTEGER	JSASTP	End of sampling grid (Y direction)
1	INTEGER	MESHDN	Sampling grid spacing factor
1	INTEGER	NPTS	Number of point sources
1	INTEGER	NAREAS	Number of area sources
1	INTEGER	NREC	Number of non-gridded receptors
1	INTEGER	IPRINF	Printing interval
1	LOGICAL	LGAUSS	Vertical conc. distribution option
1	LOGICAL	LCHEM	Chemical transformation control variable
1	LOGICAL	LDRY	Dry deposition control variable
1	LOGICAL	LWET	Wet removal control variable
1	LOGICAL	LPRINT	Printer output control variable for concentrations
1	LOGICAL	L3VL	Three vertical layer control variable
1	LOGICAL	LVSAMP	Variable sampling rate control variable
1	REAL	WSAMP	Reference wind speed for LVSAMP option
1	LOGICAL	LSGRID	Gridded receptor control variable
1	INTEGER	NSPEC	Number of chemical species modeled
1	LOGICAL	LWETG	Wet flux control variable for gridded receptors
1	LOGICAL	LWETNG	Wet flux control variable for non-gridded receptors

* See run control inputs for a complete description of variables.

Table 6-10

Variables in the MESOPUFF II Output Concentration and Flux Files - Continued

HEADER RECORD - The first record of the output file - continued.

Record	Type	Variable	Description
1	LOGICAL	LDRYG	Dry flux control variable for gridded receptors
1	LOGICAL	LDRYNG	Dry flux control variable for non-gridded receptors
1	LOGICAL	LPRFLX	Printer output control variable for fluxes

HEADER RECORD - The second record of the output file

Record	Type	Variable	Description
2**	REAL ARRAY	XREC(NREC)	X coordinates of non-gridded receptors
2**	REAL ARRAY	YREC(NREC)	Y coordinates of non-gridded receptors

HOURLY RECORDS - Repeated for each hour (i) of run

Record	Type	Variable	Description
2+i*	INTEGER ARRAY	IDPOL(4)	Year, Julian day,ending hour, and pollutant number.
2+i*	REAL ARRAY	ROUT2 (IX,JX)***	Gridded receptor concentrations (g/m^3) or wet/dry fluxes ($g/m^2/s$).
3+i**	INTEGER ARRAY	IDPOL(4)	Year, Julian day, ending hour, and pollutant number.
3+i**	REAL ARRAY	RIN1(NREC)	Non-gridded receptor concentrations (g/m^3) or wet/dry fluxes ($g/m^2/s$).

* Written only if LSGRID = T

** Written only if NREC > 0.

*** (IX,JX) is the sampling grid size.

Table 6-11

Sample Input File to MESOPUFF II

```
MESOPUFF II TEST CASE - 24 hr simulation 1/2/86
   86  002    0   24    2    0   14    1    0
    1    4    2    T   2.    T 900.
    1   20    1   20    4   17    4   17    1
    T    T    T    T    F
    T    F   24    F    0    0    F    F    F    F    F    F    0    0
100000
        0.36       0.25       0.19       0.13      0.096      0.063
        0.90       0.90       0.90       0.90       0.90       0.90
     0.00023      0.058       0.11       0.57       0.85       0.77
        2.10       1.09       0.91       0.58       0.47       0.42
         5.0      3.873      2.739      1.871      1.225      0.707
     10000.          5
14.1711.0499.06 3.0514.54349.8       10.00
10.2519.7215.24 4.2156.21819.8      400.00
        6.53      17.57                    Class I area receptors
        6.53      17.77
        6.53      17.98
        6.57      18.19
        6.70      18.40
        6.80      18.62
        6.87      18.83
        6.74      19.06
        6.61      19.34
        6.40      19.34
        6.15      19.34
        5.90      19.34
        5.65      19.34
       15.50      11.00
```

7.0 MESOFILE II POSTPROCESSOR

MESOFILE II is a postprocessing program that operates on the output concentration and wet and dry flux files produced by MESOPUFF II. It consists of a set of modular subroutines that the user explicitly invokes by card image inputs to construct the desired sequence of postprocessing operations. The modular nature of MESOFILE II provides powerful flexibility. It is possible to perform a wide variety of postprocessing operations in a sequence specifically designed to meet the user's particular needs. These features of modularity and flexibility, however, require a greater degree of user interface than a simple "black box" postprocessing program. The MESOFILE II card inputs required for the most common applications of the program are presented as examples in Section 7.8.

The following system channels are required for MESOFILE II: Logical Unit 5 for card-image inputs, Logical Unit 6 for line printer outputs, and Logical Unit 25 for MESOFILE II disk output. Logical Unit 25 is a direct-access "scratch" file used to store MESOFILE II results for subsequent analysis and/or plotting. Additional channels, defined by the user, are required for input of MESOPUFF II concentration files (see inputs to subroutine FIND). Table 7-1 summarizes the input and output files used by MESOFILE II.

The main program of MESOFILE II reads the user's card inputs and calls the appropriate subroutines. There are seven subroutines available to perform a variety of postprocessing functions. Other second-level subroutines, transparent to the user, are invoked as appropriate by the user-called subroutines. Table 7-2 contains a description of the basic form of the card inputs to MESOFILE II, as well as a list of the subroutines and their functions that are available to the user. Each subroutine requested by the user (with subroutine identifier cards) is called, in order, as it appears in the inputs. There are, however, some restrictions on the order in which subroutines may be called. For example, the pollutant of interest must be specified before the concentration data can be located; therefore, the subroutine identified in Table 7-2 as belonging to calling order Group A must precede those in Group B. Likewise, because data must be located before they can be processed, the subroutines in Group B must be called before the subroutines in Group C. At the end of the run, subroutine DECODE is automatically called as part of the normal termination of MESOFILE II. DECODE gives a useful summary of all the subroutines called, the values of the input parameters, the input/output options, and the locations (record numbers) of the MESOFILE II disk output (on FILE25.DAT) for this MESOFILE II run.

Table 7-1

MESOFILE II Input and Output Files

Unit*	File Name	Type	Format	Description
5	FILE.INP	INPUT	FORMATTED	MESOFILE II control file.
*	INFILE1.DAT INFILE2.DAT . . INFILE12.DAT	INPUT	UNFORMATTED	Output files produced by MESOPUFF II, i.e., concentrations, wet fluxes or dry fluxes.
25	FILE25.DAT	INPUT/ OUTPUT	DIRECT ACCESS	A scratch file produced by MESOFILE II. It can be accessed as input in the current or a subsequent MESOFILE II run.
6	FILE.LST	OUTPUT	FORMATTED	List file (line printer output file)

* Value is specified by user in the control file inputs.

Table 7-2

MESOFILE II Card-Image Inputs and Subroutine Identifiers

MESOFILE II CARD INPUTS

- TITLE CARD

  Up to 64 characters (columns 1-64) (followed by one set of cards as specified below for each subroutine requested by the user)

- SUBROUTINE IDENTIFIER CARD

  Contains 4-letter subroutine identifier (in Columns 1-4)

- NAMELIST INPUT CARD #1

  Read by the subroutine called

- NAMELIST INPUT CARD #2

  Read by the line printer plotting routine (needed only if line printer plots are produced and contour levels other than the default contour levels are used).

SUBROUTINE IDENTIFIER	CALLING ORDER GROUP	SUBROUTINE FUNCTION (see detailed subroutine descriptions - Sections 7.1 - 7.7)
• DEFN	A	Defines Pollutant, Grid Size, and Routes Output
• FIND	B	Locates First Order Model Output
• SEEK	B	Locates Higher Order MESOFILE II Output
• AVRG	C	Averages Arrays
• ADD1	C	Sums Arrays within one runstream
• ADD2	C	Sums Arrays from two runstreams
• STAT	C	Calculates Statistics

As indicated in Table 7-2, following a title card and the subroutine identifier card is the NAMELIST card containing the necessary input data. In FORTRAN NAMELIST formatted inputs, the first character of each input record must be a blank, followed by an & and the NAMELIST name. The input data, separated by commas, must appear between the NAMELIST name and an &END. All the NAMELIST names in MESOFILE II are either "SAME" (in subroutines called by the user via subroutine identifier cards) or "DIFF" (in the line printer plotting subroutines).

The following sections contain a detailed description of the functions, the required inputs, and the output options of each MESOFILE II subroutine. Annotated sample inputs follow each subroutine description to demonstrate each of the options available to the user. Sample inputs for the most common applications of MESOFILE II are presented in Section 7.8.

7.1 Subroutine DEFN

Subroutine DEFN allows the user to specify for a particular MESOFILE II run:

- the number of cells in the sampling grid,
- the pollutant of interest (SO_2, $SO_4^=$, NO_x, HNO_3, NO_3^-), and whether concentrations, wet fluxes, or dry fluxes are processed,
- receptor type processed in this run (gridded or non-gridded receptors), and
- the starting record of the disk output on the MESOFILE II file (FILE25.DAT).

Although a MESOPUFF II run may generate concentration and wet/dry flux data for up to five pollutants, only one type of output, for one pollutant (default = SO_2 concentration) is processed at a time by MESOFILE II. The array size, IMAX * JMAX, must be the same as the sampling grid size specified in the MESOPUFF II model run used to generate the concentration or flux data.

All MESOFILE II disk output (concentration fields, difference fields, etc.) is written to the MESOFILE II output file FILE25.DAT. Each output field requires one record of disk space on FILE25.DAT. The user must specify the record where the disk output is to start for a particular MESOFILE II run. The first output array is written at this record; the second output array is written at the next record, etc. Each time an array is written to disk, the disk file pointer is incremented by one. A particular MESOFILE II run, for example, may write n concentration arrays on Records 1 through n; the user may wish to save this output, and, on a subsequent MESOFILE II run, the output may be directed to begin at record n+1.

The starting record number for MESOFILE II disk output is not supplied with a default value; this helps prevent accidental overwriting of previously stored data. The user must specify this parameter if the MESOFILE II run is to generate any disk output. The concentration array size and pollutant are used in block data; subroutine DEFN must therefore be called only if:

- any disk output is generated in the MESOFILE II run,
- the concentration array size is different from the default 26 x 26, or
- the pollutant of interest is not SO_2.

A description of the card inputs to each MESOFILE II subroutine is contained in Section 7.9. The following are sample card inputs.

- Sample Input--Example 1A
  TITLE CARD
  DEFN
  &SAME IMAX=40,JMAX=40,IOUT=1,&END

- Sample Input--Example 1B
  TITLE CARD
  DEFN
  &SAME IPOL=2,IOUT=20,&END

The call to subroutine DEFN in Example 1A sets the concentration array size to 40 x 40. The disk file output pointer, IOUT, is given a value of 1. Any disk output that may be generated in the MESOFILE II run, therefore, will start on Record 1 of FILE25.DAT. In Example 1B, $SO_4^=$ is specified as the pollutant of interest. The disk output of this MESOFILE II run will begin on Record 20. The concentration array size is assumed (by default) to be 26 x 26.

7.2 Subroutine FIND

Subroutine FIND performs the following operations:

- reads user inputs to identify the model output to be located:
  - starting hour, day, and year of data
  - number of concentration or flux fields
  - logical unit of concentration or flux data;

- reads the header record of the new concentration or flux file;
- finds the proper position in the file corresponding to the starting hour; and
- defines the requested set of concentration/flux arrays as runstream number n, where n = 1 (first call of FIND/SEEK), n = 2 (second call of FIND/SEEK), etc.

Each call to subroutine FIND defines a runstream (i.e., one or a group of concentration or flux fields) that can be accessed by other MESOFILE II subroutines. A runstream number is a sequential internal reference number associated with a group of arrays located by subroutine FIND or SEEK and is used to identify these arrays in other MESOFILE II subroutines. FIND is one of two runstream defining subroutines (subroutine SEEK is the other). The first set of concentration/flux fields located by FIND (or seek) is referred to as Runstream 1, the second set of fields defines Runstream 2, etc.

The user specifies the FORTRAN Logical Unit number of each MESOPUFF II concentration or flux input file. The file associated with the first call to FIND must be named "INFILE1". Subsequent calls to FIND define files named INFILE2, INFILE3, etc. (up to 10 files are allowed). It is the user's responsibility to rename the MESOPUFF II output concentration or flux files to the appropriate file name for MESOFILE II (i.e., INFILEn.DAT). In selecting unit numbers for the concentration or flux files, it should be noted that the MESOFILE II input control file (MESOFILE.INP) is associated with unit 5, the output list file (MESOFILE.LST) with unit 6, and the direct-access scratch file (FILE25.DAT) with unit 25.

Because subroutine FIND is used to locate the output of any previously run model, it must be called before an attempt is made to process these data with any of the MESOFILE II data processing subroutines. <u>Before any MESOFILE II data processing subroutines of MESOFILE II are called, subroutines FIND and SEEK must be used to locate all the model output</u>. The following are sample card inputs.

- Sample Input--Example 2

```
TITLE CARD
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=24,NUNIT=10,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=11,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=12,&END
```

In example 2, the concentration data referenced by Logical Unit 10 is a MESOPUFF II run starting at Hour 0, Day 165, Year 1978. Because the model outputs concentration arrays at the conclusion of a time step, the first concentration array recorded is for Hour 1 on Day 165. The sample input above specifies Runstream 1 as consisting of 24 hourly concentration arrays, starting at Hour 1, Day 165 and ending at Hour 0, Day 166. The second call to subroutine FIND defines runstream 2 as the set of concentration arrays output from Logical Unit 11 starting at Hour 1, Day 165, through Hour 0, Day 170. Runstream Number 3 is specified as the output from the Logical Unit 12 for the same 120-hour time period.

7.3 Subroutine SEEK

Each set of data to be accessed by the data processing subroutines of MESOFILE II must be located and assigned a runstream number. The concentration data, output directly by the models to disk, are referred to as "first" order data fields and are located by calls to subroutine FIND. MESOFILE II, however, has the ability to process first order data and output the resultant fields (e.g., averaged concentration fields, summed concentration fields, or several types of concentration difference fields), to FILE25.DAT for storage and further processing. These derived fields, which have undergone at least one level of MESOFILE II processing, are referred to as "higher" order data fields. The user wishing to reference higher order data must supply the location (FILE25.DAT record number) of the data to MESOFILE II by a call to subroutine SEEK.

Subroutine SEEK performs the following operations:

- reads user inputs to identify the MESOFILE II output of interest:
  - NSTART and
  - NSTOP and
- defines the requested set of data fields as runstream number n, where n = 1 (first call of FIND/SEEK), n = 2 (second call of FIND/SEEK), etc.

The card input requirements of subroutine SEEK and other MESOFILE II subroutines are described in Section 7.9. The following are sample card inputs.

- Sample Input--Example 3

```
TITLE CARD
FIND
 &SAME IYEAR=78,IDAY=166,IHOUR=1,IGRIDS=24,NUNIT=10,&END
SEEK
```

```
 &SAME NSTART=12,NSTOP=12,&END
SEEK
 &SAME NSTART=10,NSTOP=23,&END
```

As in the previous example, Runstream Number 1 is defined as a set of 24 hourly, first order concentration arrays. Runstreams 2 and 3, however, are composed of higher order data fields. The second runstream consists of a single data field (record 12 on FILE25.DAT), whereas Runstream 3 is defined to be the 14 data arrays contained in records 10 through 23.

7.4 Subroutine AVRG

Subroutine AVRG calculates time averages of first order or higher order concentration or flux data. This subroutine performs the following operations:

- initializes NAMELIST SAME parameters to default values,
- reads user inputs,
- calculates number of arrays in the runstream specified by the user and determines a repetition factor, IREPF,
- for each array in the runstream, reads array and if requested, prints the input array and sums arrays,
- after AVETM arrays have been read and summed, divides by AVETM to obtain average, and performs linear scaling calculation, and
- if requested, writes averaged array to FILE25.DAT, writes averaged array on line printer, and plots averaged array.

The user has the option of printing, plotting, or writing the averaged arrays to FILE25.DAT. The user specifies the runstream number of the data set to be averaged and the averaging frequency (in terms of arrays), so that the appropriate block averages will be computed. A background concentration factor or a concentration multiplicative scaling factor may be included in the calculations as well. Each averaged array may be adjusted by the form:

$$\overline{C}_{ADJ} = a * \overline{C} + b \qquad (7\text{-}1)$$

The location of all MESOFILE II output (FILE25.DAT) is controlled by the IOUT variable of subroutine DEFN. The first output grid is written on record IOUT of FILE25.DAT, the next grid is written on record IOUT + 1, etc. The user specifies the location where the disk output is to start; the disk file pointer is incremented each time a grid is written to disk. The following are sample card inputs.

- Sample Input--Example 4

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
FIND
 &SAME IYEAR=78,IDAY=167,IHOUR=0,IGRIDS=12,NUNIT=10,&END
SEEK
 &SAME NSTART=1,NSTOP=30,&END
AVRG
 &SAME IRUN=1,AVETM=3,DISK=1,PLOT=1,NEWV=1,APE=1,
        IHIGH=1,&END
 &DIFF N=5,THR=-1.E-10,0.1E-6,1.E-6,10.E-6,100.E-6,20*0.0,&END
AVRG
 &SAME IRUN=2,AVETM=30,PRINT=0,DISK=1,PLOT=1,IHIGH=1,&END
AVRG
 &SAME IRUN=2,AVETM=10,PRINT=0,DISK=1,PLOT=1,IHIGH=1,&END
```

The call to subroutine DEFN sets the disk output pointer IOUT to 50. The averaged concentration arrays written to disk, therefore, will occupy records 50 through 50 + n on FILE25.DAT, where n is the number of arrays output to disk. Subroutine FIND is called to define a 12-array runstream consisting of hourly concentration fields, as illustrated schematically in Figure 7-1. Runstream Number 2 is defined as the higher order data on records 1-30 of FILE25.DAT. The first call to subroutine AVRG averages the data defined by Runstream 1 into four 3-hour averaged arrays. The maximum output available to the user is requested. The hourly concentration input fields and the averaged fields are printed. The averaged fields are also plotted (with user input contour levels) and written to disk (on records 50-53). The highest 3-hour averaged values in each field are printed (IHIGH=1). The second call to subroutine AVRG results in one 30-array average from the data in Runstream 2. Only two output options are invoked: line printer plots and disk output. The disk output is routed to Record 54 because the previous AVRG call put arrays into Records 50 to 53. The contour levels of the line printer plot will be the same as in the previous AVRG call; when new contour levels are defined (as in the first AVRG call), the plotting routine will continue to use them until other contour levels are redefined in a DIFF NAMELIST (see Section 7.9). All the parameters in NAMELIST SAME that have default values are reset to their default values each time the subroutine is called. The third AVRG call uses Runstream Number 2 data to calculate three 10-array

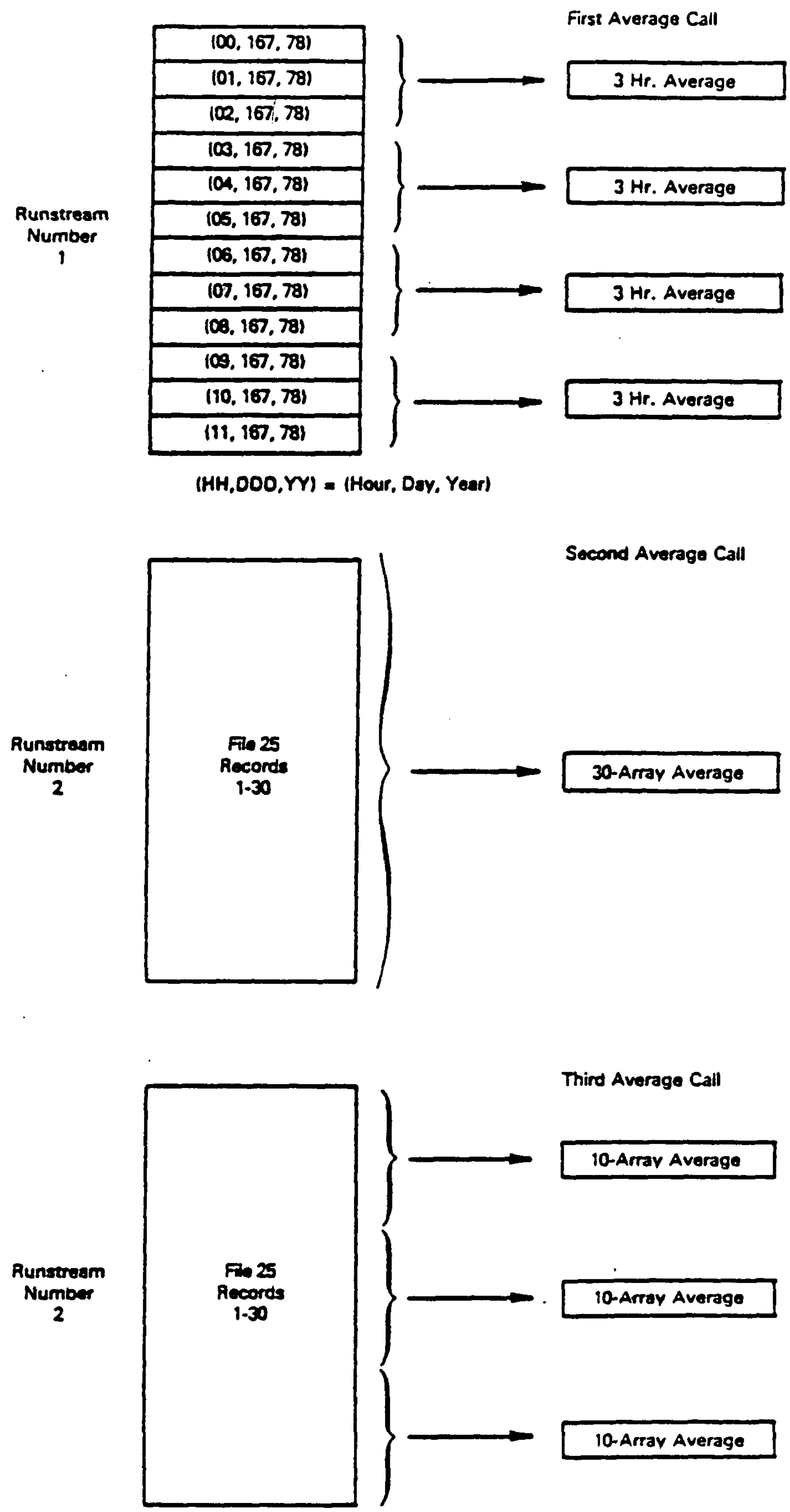

Figure 7-1. Schematic illustration of the averaging process.

averages. The output options are the same as with the second AVRG call, and the disk output is stored on Records 55 to 57 of FILE25.DAT.

7.5 Subroutine ADD1

Subroutines ADD1 is used to sum all the arrays in a runstream to yield a single summed put array. That is,

$$(C_{sum})_{ij} = \sum_{k=1}^{n} C_{ij}^{k} \qquad (7\text{-}2)$$

where $(C_{sum})_{ij}$ is the (i,j) element of the summed array, and (C_{ij}^{k}) is the (i,j) element of the k[th] array consisting of N arrays (k = 1...N). The output options include an echo of the input arrays, line printer gridded output, line printer plots, and disk output and are the same as those in subroutine AVRG. The adjustment factors a and b for the summed concentration field are also available. Each call to subroutine ADD1 will initialize the output arrays to zero before sequentially adding the concentration arrays of the specified runstream to it, unless the INIT variable is set to zero in the ADD1 input NAMELIST. With INIT = 0, a cumulative sum can be calculated with successive ADD1 calls.

The following are sample card inputs.

- Sample Input--Example 5

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
SEEK
 &SAME NSTART=1,NSTOP=6,&END
SEEK
 &SAME NSTART=20,NSTOP=22,&END
ADD1
 &SAME IRUN=1,DISK=1,&END
ADD1
 &SAME IRUN=2,INIT=0,DISK=1,&END
```

The call to subroutine DEFN requests that the disk output of this MESOFILE II run begin at record 50 on FILE25.DAT. Two runstreams are defined: a six array runstream (Number 1) and a three array runstream (Number 2). The first call to ADD1 sums the data in Runstream Number 1 (Records 1 to 6) and prints the result on the line printer and Record 50. The second ADD1 call, because INIT = 0, adds the array in Runstream Number 2 to the summed array calculated in the first ADD1 call, and the result is also written on disk (Record 51) and on the line printer.

7.6 Subroutine ADD2

Subroutine ADD2 calculates the sum of arrays in two runstreams. That is,

$$D_{ij}^{k} = A_{ij}^{k} + B_{ij}^{k} \qquad (7\text{-}3)$$

where the summation extends over all k = 1...N arrays in runstreams A and B, and D is the resultant runstream. Two runstreams numbers must therefore be supplied to subroutine ADD2 as input, and both runstreams must contain the same number of concentration arrays. The other NAMELIST inputs are the same as the subroutine ADD1 inputs. The following are sample card inputs.

- Sample Input--Example 6

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=6,NUNIT=10,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=6,NUNIT=11,&END
ADD2
 &SAME IRUN1=1,IRUN2=2,DISK=1,PLOT=1,&END
```

The call to subroutine DEFN requests that disk output start on record 50 of FILE25.DAT. Six output arrays of two MESOPUFF II runs are defined as Runstreams 1 and 2 with the calls to subroutine FIND. The arrays of each runstream are added together, printed, written to disk, and plotted with the default contour levels. The summing process of the two 6-array runstreams results in an output runstream of 6 arrays.

7.7 Subroutine STAT

Subroutine STAT is designed to produce quantitative as well as qualitative measures of the point-by-point and bulk differences between two gridded concentration or flux fields--a "base" field and a "test" or "perturbed" field. The base concentration fields are reference fields resulting from a particular model run specified by the user. The test concentration fields can be any other model output generated with some test parameter of the model varied; for example, the emission inventory, deposition velocity, decay rate, time step, or even the mesoscale model used, may be varied and the results defined as the test concentration fields.

When the user has defined a base case and test case concentration field or flux (or set of fields), line printer plots or gridded tables of the following fields may be produced:

- the base field, identified as BF,
- the test field, identified as TF,
- the difference field, identified as DF = $C_B - C_T$,
- the fractional difference field identified as FDF = $\frac{C_B - C_T}{C_B}$, and
- the weighted difference field identified as WDF = $\frac{C_B - C_T}{\overline{C}_B}$

where C_B is the base field concentration at a particular grid point, C_T is the test field concentration at that point, and C_B is defined below.

The fractional difference field, FDF, can be calculated only for grid points with nonzero base field concentrations, but because the FDF is most meaningful in comparing base case and test case plumes which overlap exactly or nearly exactly, the FDF is calculated only for those points in the intersection of the two plumes (that is $C_B = 0$ and $C_T = 0$)

The WDF is the difference field weighted by the average base plume concentration (C_B).

$$\overline{C_B} = \frac{\sum_{n=1}^{N} (C_B)_n}{N} \quad (7\text{-}4)$$

where N includes only those points in the base field plume (defined as the set of points in the base field with nonzero concentrations).

In addition to line printer plots of the DF, FDF, and WDF, subroutine STAT has the ability to write these fields to the MESOFILE II direct access disk output file (FILE25.DAT).

Variation of some test parameters can substantially change the nature of the concentration or flux distribution in the base and test plumes. The nature of these differences in turn determines which of the difference field representations is appropriate for a particular analysis. The FDF field is useful in determining the relative spatial location of the base and test plumes and differences in the distributions, and should be used when the effect of the input parameter does not change the gross spatial distribution of the plume. The WDF allows the differences in concentration to be weighted by a constant factor.

Subroutine STAT also generates a set of quantitative (statistical) measures of the differences in the base case and test case concentration fields. Whereas the graphical output is optional, the statistical output is always produced. Figure 7-2 is a sample of the statistical output. The statistics calculated and the subsets of the grid over which the calculations are performed are contained in Table 7-3 and Figure 7-3. Clearly, the most meaningful statistic for a given base case-test comparison depends heavily on the nature of the test parameter varied and must be determined by the user.

Figure 7-4 is a flow chart of subroutine STAT. The input variables are defined in Section 7.9. It is assumed that the statistics for multi-array runstreams are to be calculated on an array-by-array basis; the variable BYONE, therefore, has a default value of 1. It is possible, however, to logically concatenate successive arrays in a particular runstream by specifying BYONE = 0. For example, consider base case and test case runstreams consisting of three 24-hour averages. If BYONE = 1, array-by-array statistics (i.e., 3 sets of statistics, one set for each 24-hour averaged array) will be produced; BYONE = 0 will result in only one set of statistics over the entire 72-hour period.

```
THE FOLLOWING RECORDS WERE USED AS THE BASE FIELD:
FIRST RECORD =     46      LAST RECORD =     46

THE FOLLOWING RECORDS WERE USED AS THE PERTURBED FIELD:
FIRST RECORD =     51      LAST RECORD =     51


STATISTICS FOR THE SET OF ALL GRID POINTS:


AVERAGE BASE FIELD VALUE (AVEB) =  0.15684E-06
AVERAGE PERTURBED FIELD VALUE (AVEP) =  0.16300E-06
AVERAGE DEVIATION (AD) = -0.61647E-08
AVERAGE ABSOLUTE DEVIATION (AAD) =  0.52787E-07
MAXIMUM LOCAL DEVIATION (XMLD) =  0.91118E-05
DIFFERENCE OF MAXIMA (DLM) B-P = -0.21656E-05
FRACTIONAL DIFFERENCE OF MAXIMA (FDLM) B-P = -0.26802E+00
MAXIMUM BASE FIELD VALUE (XMBF) =  0.80800E-05
MAXIMUM PERTURBED FIELD VALUE (XMPF) =  0.10246E-04


STATISTICS FOR THE SET OF POINTS WITHIN THE UNION OF THE TWO PLUMES:

AVERAGE DEVIATION (ADI) = -0.11512E-07
AVERAGE ABSOLUTE DEVIATION (AADI) =  0.98574E-07
CORRELATION COEFFICIENT (RBA) =  0.79


STATISTICS FOR THE SET OF POINTS WITHIN THE INTERSECTION OF THE TWO PLUMES:

AVERAGE DEVIATION (ADO) = -0.54887E-08
AVERAGE ABSOLUTE DEVIATION (AADO) =  0.97060E-07
AVERAGE FRACTIONAL DEVIATION (AFDO) = -0.33695E+00
AVERAGE ABSOLUTE FRACTIONAL DEVIATION (AAFDO) =  0.61030E+00
MAXIMUM ABSOLUTE FRACTIONAL DEVIATION (XMLFDO) =  0.25661E+02


PLUME CHARACTERISTICS


TOTAL NUMBER OF GRID POINTS =       676
NUMBER OF GRID POINTS CONTAINED IN THE INTERSECTION OF THE BASE AND PERTURBED PLUMES =       344
NUMBER OF NON-ZERO CONCENTRATIONS (BASE OR PERTURBED) =       362
NUMBER OF GRID POINTS IN THE BASE PLUME =       350
NUMBER OF GRID POINTS IN THE PERTURBED PLUME =       356
AVERAGE BASE PLUME VALUE (AVEBO) =  0.30292E-06
AVERAGE PERTURBED PLUME VALUE (AVEPO) =  0.30952E-06
FRACTIONAL DEVIATION OF THE MEANS (FDM) = -0.21788E-01
```

Figure 7-2. Sample of statistical output.

Table 7-3

Statistical Measures Calculated by Subroutine STAT

		Variable Name	Grid Points Included
1.	Mean base plume concentration, $\overline{C}_B$	AVEB0	BP
2.	Mean test (perturbed) plume concentration, C_T	AVEP0	TP
3.	Mean base field concentration	AVEB	BF
4.	Mean test field concentration	AVEP	TF
5.	Average deviation, C_B-C_T	AD	BFTF
		AD1	BTU
		AD0	BTI
6.	Average absolute deviation, C_B-C_T	AAD	BFTF
		AAD1	BTU
		AAD0	BTI
7.	Maximum local deviation, MAX (C_B-C_T)	XMLD	BFTF
8.	Maximum base field value, MAX (C_B)	XMBF	BF
9.	Maximum test field value, MAX (C_T)	XMPF	TF
10.	Difference of maxima, MAX (C_B) - MAX (C_T)	DLM	DFTF
11.	Fractional difference of maxima, $\frac{MAX\ (C_B)\ -\ MAX\ (C_T)}{MAX\ (C_B)}$	FDLM	BFTF
12.	Correlation coefficient, $\frac{\overline{C_B C_T} - \overline{C}_B\,\overline{C}_T}{\left[\left(\overline{C_B^2} - (\overline{C}_B)^2\right)\left(\overline{C_T^2} - (\overline{C}_T)^2\right)\right]^{1/2}}$	RBA	BTU

Table 7-3

Statistical Measures Calculated by Subroutine STAT (Concluded)

		Variable Name	Grid Points Included
13.	**Average fractional deviation,** $\overline{\frac{C_B - C_T}{C_B}}$	AFD0	BTI
14.	**Average absolute fractional deviation** $\overline{\frac{C_B - C_T}{C_B}}$	AAFD0	BTI
15.	**Maximum absolute fractional deviation,** $MAX\ \frac{C_B - C_T}{C_B}$	XMLFD0	BTI
16.	Fractional deviation of the means $\frac{\overline{C}_B - \overline{C}_T}{\overline{C}_B}$	FDM	$\overline{X}_B$ - BP $\overline{X}_T$ - TP

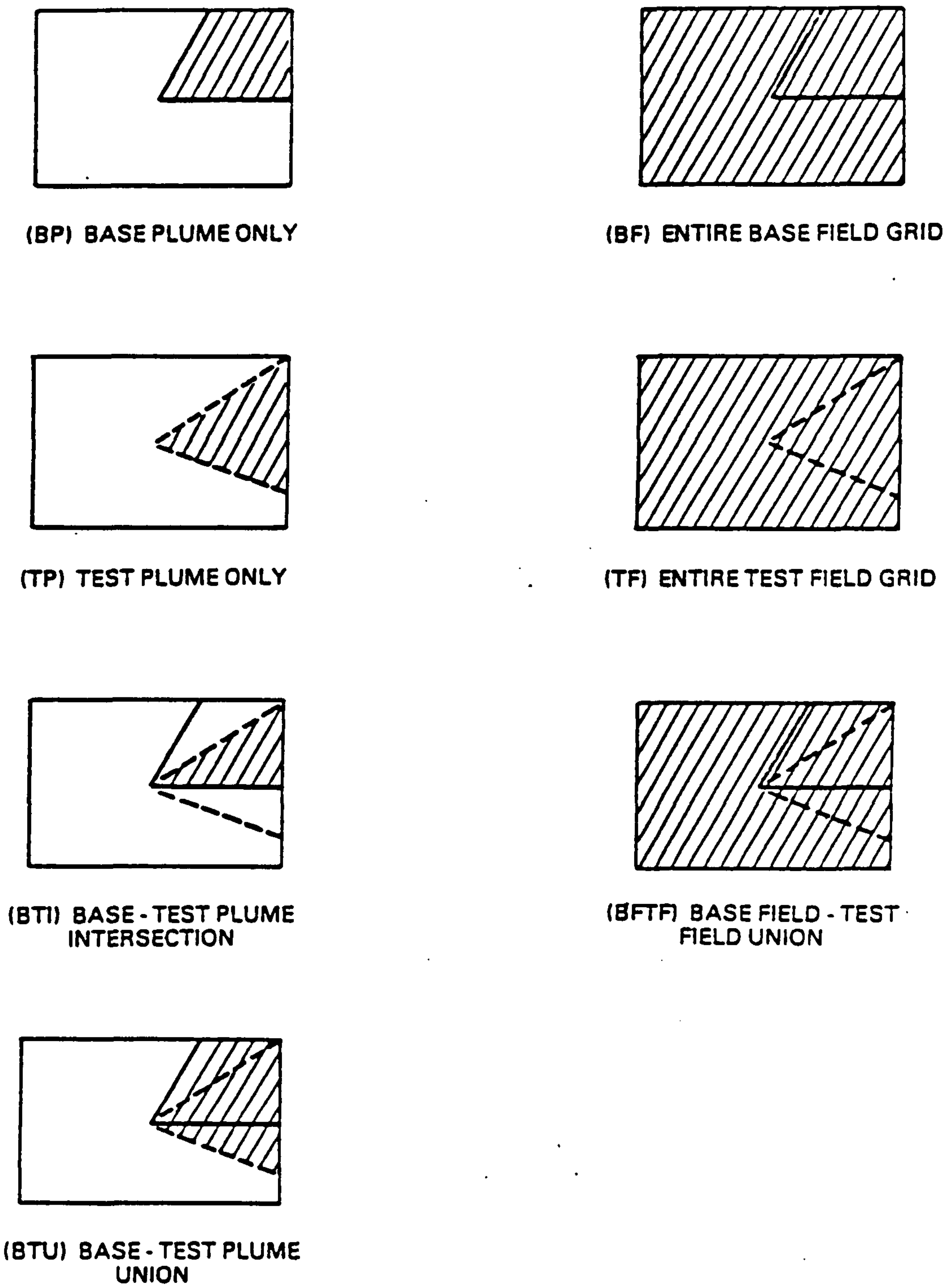

Figure 7-3. Grid subsets used in statistical calculations.

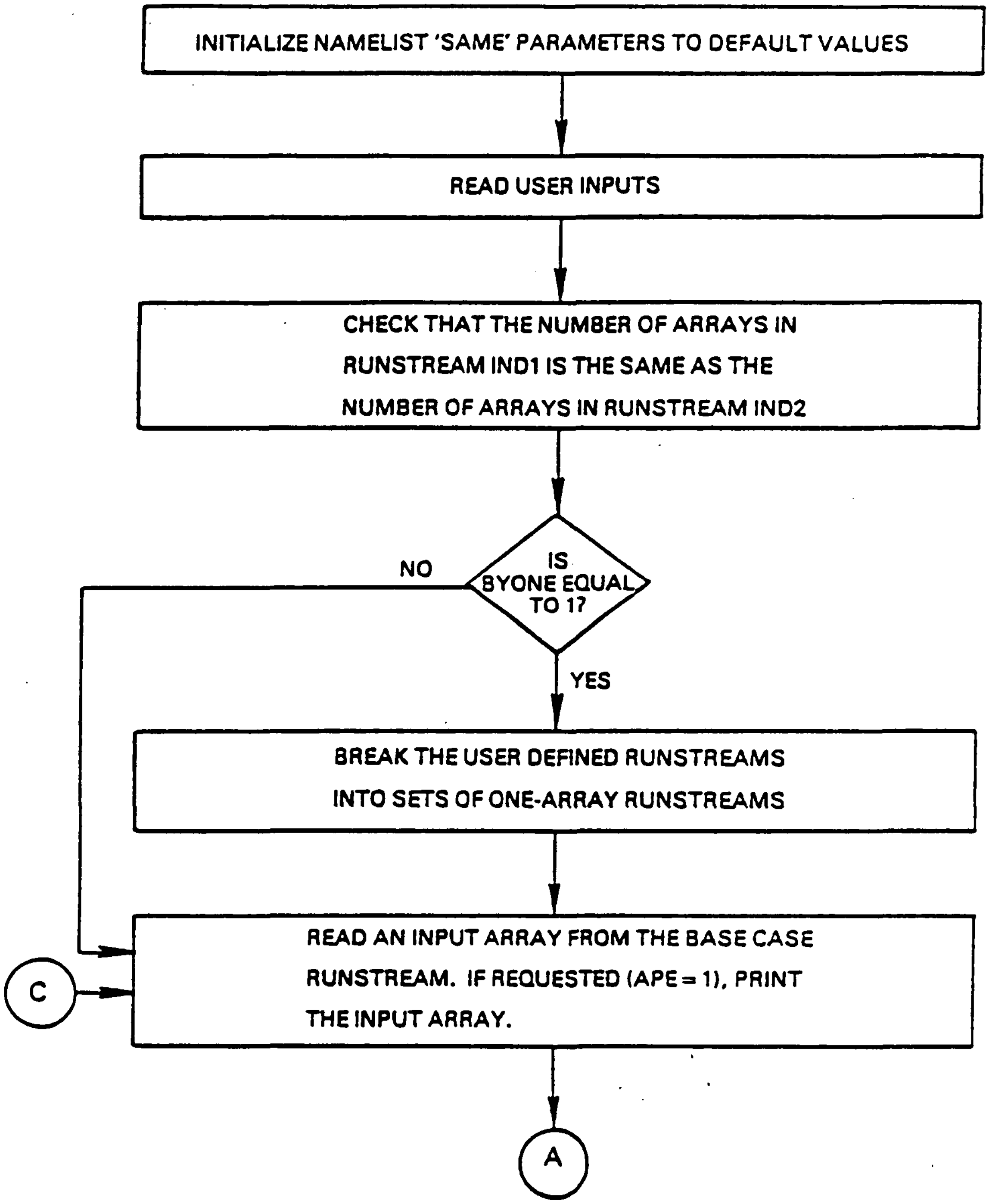

Figure 7-4. Flow chart of subroutine STAT.

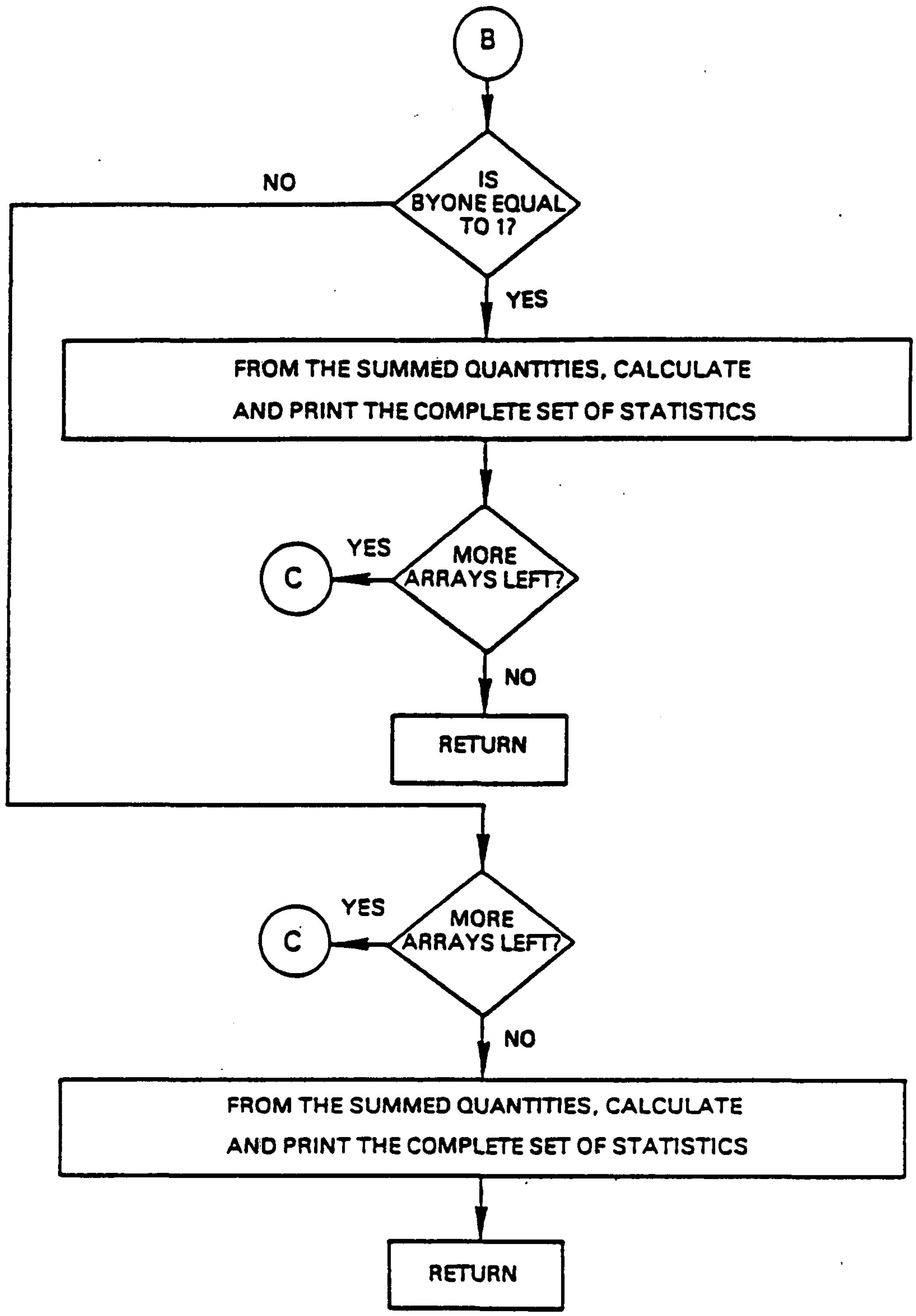

Figure 7-4. Flow chart of subroutine STAT. (Continued)

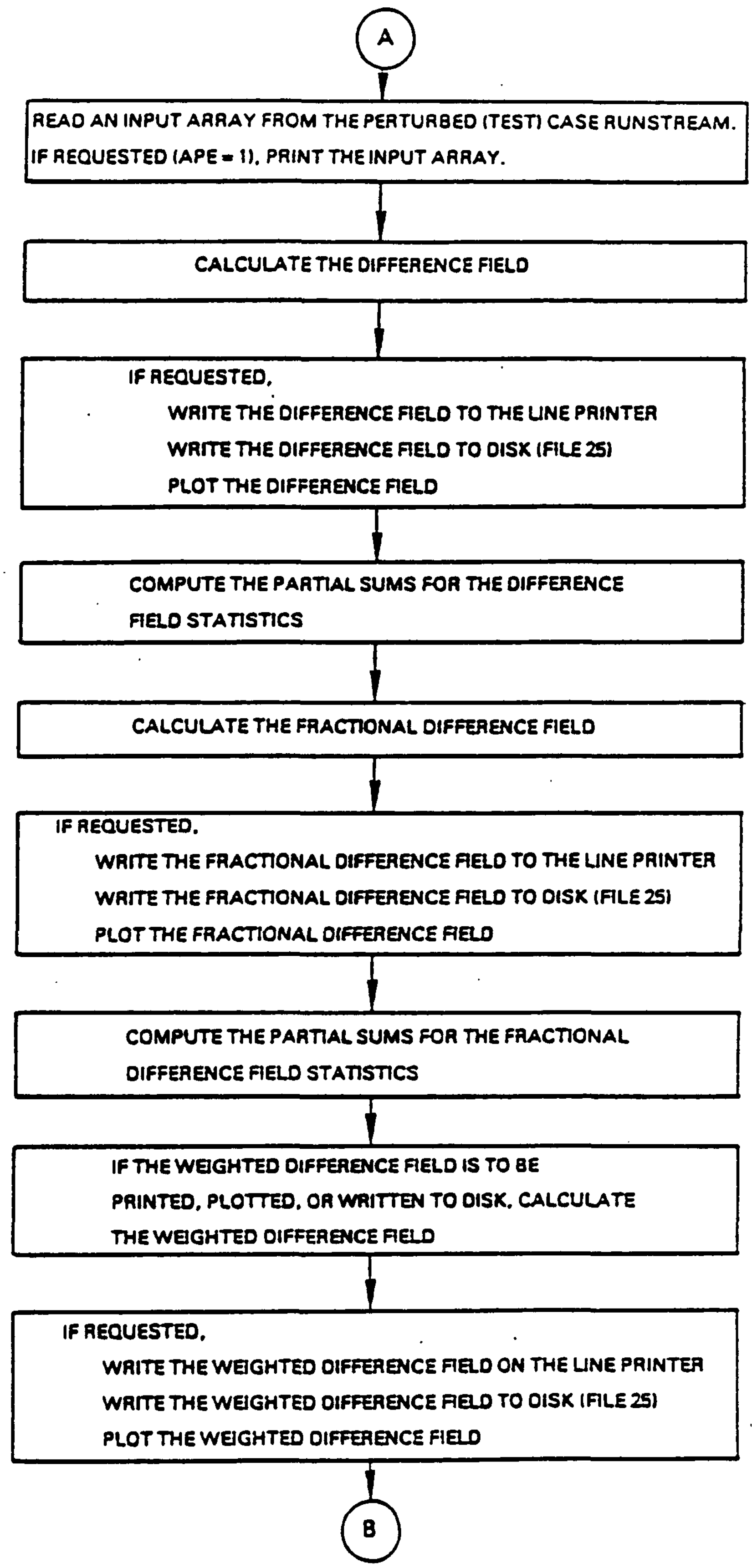

Figure 7-4. Flow chart of subroutine STAT. (Concluded)

It is possible to write DF, FDF, or WDF to the MESOFILE II direct access disk output file (FILE25.DAT), although only one of these fields can be written on a particular call to STAT.

The following are sample card inputs.

- Sample Input--Example 7

```
TITLE CARD
DEFN
 &SAME IOUT=50,&END
SEEK
 &SAME NSTART=9,NSTOP=12,&END
SEEK
 &SAME NSTART=19,NSTOP=22,&END
SEEK
 &SAME NSTART=28,NSTOP=32,&END
STAT
 &SAME IND1=1,IND2=2,DISKD=1,PLOTD=1,NEWVD=1,&END
 &DIFF THR=-100.E-6,-5.E-6,-1.E-6,-.5E-6,-1.E-15,0,1.E-15,
 .5E-6,1.E-6,5.E-6,15*0.0,N=10,&END
STAT
 &SAME IND1=1,IND2=3,DISKD=1,PLOTD=1,&END
```

In this example, the call to subroutine DEFN requests that the disk output of this MESOFILE II run start at Record 50 of FILE25.DAT. Three runstreams are defined by calls to subroutines SEEK, each consisting of four arrays. The first call to STAT results in four sets of statistics; each array of Runstream 1 is compared to the corresponding array of Runstream 2. The fields associated with the runstream identified with IND1 are defined to be the base case fields; IND2 and IND3 define the test case fields. The difference fields are plotted with the user-specified contour levels in the DIFF NAMELIST, and they are written to FILE25.DAT (on Records 50 to 53). The second call to STAT will produce statistics comparing the arrays in Runstream 1 (base case) to the arrays in Runstream 3 (test case). The difference fields are plotted with the same contour levels as in the previous STAT call; when new contour levels are defined (in the DIFF NAMELIST), they become the "default" contour levels for subsequent calls to the plotting routine. The difference fields are written to FILE25.DAT on Records 54 to 57.

7.8 Sample Card Inputs for Some Useful MESOFILE II Applications

- Calculate 24-hour SO_2 averages from hourly output of two model runs; write results on disk, including peak 24-hour values for each averaging time.

```
TITLE CARD
DEFN
 &SAME IOUT=1,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=10,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=120,NUNIT=11,&END
AVRG
 &SAME IRUN=1,AVETM=24,DISK=1,IHIGH=1,&END
AVRG
 &SAME IRUN=2,AVETM=24,DISK=1,IHIGH=1,&END
```

- Perform statistical analysis of the 24-hour average concentrations calculated for two model runs in example above.

```
TITLE CARD
SEEK
 &SAME NSTART=1,NSTOP=5,&END
SEEK
 &SAME NSTART=6,NSTOP=10,&END
STAT
 &SAME IND1=1,IND2=2,&END
```

- Calculate and plot sums of the hourly SO_2 output of two model runs (useful for runs made with different subsets of the entire source inventory; the resulting horizontal sum is a superposition of the concentration fields reflecting the effects of the sources modeled in two runs).

```
TITLE CARD
DEFN
 &SAME IOUT=11,&END
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=24,NUNIT=10,&END
```

```
FIND
 &SAME IYEAR=78,IDAY=165,IHOUR=1,IGRIDS=24,NUNIT=11,&END
ADD2
 &SAME IRUN1=1,IRUN2=2,PRINT=0,PLOT=1,&END
```

7.9 MESOFILE II Parameter File

MESOFILE II uses the same memory management system as MESOPAC II and MESOPUFF II, which is based on the use of an external parameter file. Arrays dealing with the number of sampling grid cells and non-gridded receptors are dimensioned throughout the code with parameter statements. The declarations of the values of the parameters are stored in a file called "PARAMS.FIL". This file is automatically inserted into any MESOFILE II subroutine or function requiring one of its parameters via FORTRAN "include" statements. In this way, a global redimensioning of all the model arrays dealing with grid cells or non-gridded receptors can be accomplished simply by modifying the PARAMS.FIL file and recompiling the program.

A sample parameter file is shown in Table 7-4. The parameter file sets the array dimensions, which are the maximum values of the variables. The actual values for a particular run are set in the user inputs and can be less than the maximum value set in the parameter file. The parameter file also sets the logical unit numbers for the input control file (FILE.INP) and the output list file (FILE.LST). The unit numbers for the concentration and flux MESOPUFF II output files are read in from the control file. The logical unit number of the direct-access scratch file (FILE25.DAT) is set to 25 internally within the program.

7.10 MESOFILE II Run Control Parameter Descriptions

A complete description of the run control inputs to each MESOFILE II subroutine is contained in Table 7-5.

Table 7-4

Sample Parameter File (PARAMS.FIL) for MESOFILE II

```
c--------------------------------------------------------------------
c --- PARAMETER statements                               MESOFILE II
c--------------------------------------------------------------------
c
c --- Specify parameters
      parameter(mxnx=100,mxny=100)
      parameter(mxrec=1000)
      parameter(io5=5,io6=6)
c
c --- Computed parameters
      parameter(mxnx2=2*mxnx-1,mxny2=2*mxny-1)
      parameter(mxcell=mxnx*mxny)
c
c --- GENERAL PARAMETER definitions:
c          MXNX - Maximum number of grid cells in the X direction
c          MXNY - Maximum number of grid cells in the Y direction
c         MXREC - Maximum number of non-gridded (discrete) receptors
c
c --- FORTRAN I/O unit numbers:
c           IO5 - Control file (FILE.INP)     - input  - formatted
c           IO6 - List file (FILE.LST)        - output - formatted
c
```

Table 7-5

MESOFILE II Inputs

Card Inputs to Subroutine DEFN

SUBROUTINE DEFN

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IPOL	INTEGER	Concentration or flux species code as defined below. IPOL Species 1 SO_2 concentration 2 $SO_4^{=}$ concentration 3 NO_x concentration 4 HNO_3 concentration 5 NO_3^- concentration 6 Wet SO_2 flux 7 Wet $SO_4^{=}$ flux 8 Wet NO_x flux 9 Wet HNO_3 flux 10 Wet NO_3^- flux 11 Dry SO_2 flux 12 Dry $SO_4^{=}$ flux 13 Dry NO_x flux 14 Dry HNO_3 flux 15 Dry NO_3^- flux	1
IRTYPE	INTEGER	Receptor type (IRYTPE=1 for gridded receptors, IRTYPE=2 for non-gridded receptors).	1
IMAX	INTEGER	Number of elements of the concentration array in the X direction.	26
JMAX	INTEGER	Number of elements of the concentration array in the Y direction.	26
IOUT	INTEGER	Record number of FILE25.DAT at which MESOFILE II disk output is to start.	-
NREC	INTEGER	Number of non-gridded receptors.	0

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine FIND

SUBROUTINE FIND

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IHOUR	INTEGER	Ending hour of the first concentration or flux array of interest.	-
IDAY	INTEGER	Day number of the first concentration or flux array of interest.	-
IYEAR	INTEGER	Year of the first concentration or flux array of interest.	-
IGRIDS	INTEGER	Number of concentration or flux arrays.	-
NUNIT	INTEGER	Logical unit number of concentration or flux data.	-

---

The file associated with the first call to FIND must be named INFILE1.DAT, the second call with INFILE2.DAT, etc. Up to 12 first-order files (INFILE1.DAT through INFILE12.DAT), may be processed in a single run of MESOFILE II.

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine SEEK

SUBROUTINE SEEK

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
NSTART	INTEGER	Starting disk record number on FILE25.DAT of the output of interest.	-
NSTOP	INTEGER	Ending disk record number on FILE25.DAT of the output of interest.	-

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine AVRG

SUBROUTINE AVRG

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN	INTEGER	Runstream number.	-
AVETM	INTEGER	Averaging time (in terms of number of arrays).	-
PRINT	INTEGER	Line printer output control variable. If PRINT = 1, averaged concentration or flux arrays are printed. If PRINT = 0, averaged concentration or flux arrays are not printed.	1
IFORM	INTEGER	Format control variable for line printer output. If IFORM=1, non-gridded receptor concentrations or fluxes are printed in F12.2 format. If IFORM=2, non-gridded receptor data are printed in 1PE12.4 format.	2
DISK	INTEGER	Disk output control variable. If DISK = 1, average concentration or flux arrays are written on disk. If DISK = 0 averaged arrays are not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If PLOT = 1, plots are produced. If PLOT = 0, plots are not produced.	0
NEWV	INTEGER	Plotter contour values control variable. If NEWV = 1, user inputs contour values (if NEWV = 1, user must include a DIFF NAMELIST card with the appropriate contour information). If NEWV = 0, use default contour values.	0
IHIGH	INTEGER	Variable controlling printing of highest value in the gridded or non-gridded concentration or flux field after averaging and scaling operations. If IHIGH = 1, the high value will be printed. If IHIGH = 0, the high value will not be computed.	0

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine AVRG (Continued)

SUBROUTINE AVRG

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
APE	INTEGER	Controls echo of input (unaveraged) fields. If APE = 1, input fields are printed; If APE = 0, input fields are not printed.	0
a,b	REAL	Adjustment factors for the averaged concentration or flux field. a = multiplicative factor, b = additive factor, of the form, $C_{adj} = a * C + b$	a=1. b=0.
NEWMES	INTEGER	Control variable for label on output plots and derived printed fields (i.e., those controlled by PLOT and PRINT input variables). If NEWMES = 1, a user-supplied label (up to 70 characters) is printed with each plot or output field. This label must be included in the input file as a separate line immediately after the "SAME" NAMELIST (i.e., before the "DIFF" NAMELIST, if it is present). If NEWMES = 0, the following default label is used: "CONCENTRATIONS (G/M**3)".	0
ISCHEK	INTEGER	Variable controlling internal checking of species codes. If ISCHEK = 1, the species code of every input field is required to be the same and match "IPOL" specified in subroutine DEFN. If ISCHEK = 0, this species code checking feature is disabled (e..g, to allow summing of flux fields of different pollutants such as SO_2 and SO_4).	1

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to the Printer Plotting Routine

NAMELIST TITLE - DIFF

(included only for line printer plots with user input contour levels)

Parameter	Type	Definition	Default
N	INTEGER	Number of contour levels (must be $\leq$ 25)	9
THR(25)	REAL ARRAY	Contour values*	-1.0×10^{-10} 0.1×10^{-6} 0.5×10^{-6} 1.0×10^{-6} 2.0×10^{-6} 5.0×10^{-6} 10.0×10^{-6} 25.0×10^{-6} 50.0×10^{-6}

*The first element of THR should be less than the minimum value of the field being plotted.

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine ADD1

SUBROUTINE ADD1

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN	INTEGER	Runstream number.	-
INIT	INTEGER	Determines whether the summing array is initialized to zero. If INIT = 1, array initialized to zero. If INIT = 0, array is not initialized.	1
PRINT	INTEGER	Line printer output control variable. If PRINT = 1, summed array is printed. If PRINT = 0, summed array is not printed.	1
IFORM	INTEGER	Format variable for line printer output. If IFORM = 1, non-gridded receptor concentrations or fluxes are printed in F12.2 format. If IFORM=2, non-gridded receptor data are printed in 1PE12.4 format.	2
DISK	INTEGER	Disk output control variable. If DISK = 1, summed array is written on disk; If DISK = 0, summed array is not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If PLOT = 1, plots are produced; If PLOT = 0, plots are not produced.	0
NEWV	INTEGER	Plotter contour values control variable. If NEWV = 1, user input contour values (if NEWV = 1, user must include a DIFF NAMELIST card with the appropriate contour information); If NEWV = 0, use default contour values.	0
IHIGH	INTEGER	Variable controlling printing of highest value in the gridded or non-gridded concentration or flux field after summing and scaling operations. If IHIGH = 1, the high value will be printed. If IHIGH = 0, the high value will not be computed.	0

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine ADD1 (Continued)

SUBROUTINE ADD1

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
APE	INTEGER	Controls echo of input fields. If APE = 1, input fields are printed. If APE = 0, input fields are not printed.	0
a,b	REAL	Adjustment factors for the summed concentration field, a=multiplicative factor, b=additive factor, of the form, $C_{adj} = a * C + b$	a = 1. b = 0.
NEWMES	INTEGER	Control variable for label on output plots and derived printed fields (i.e., those controlled by PLOT and PRINT input variables). If NEWMES = 1, a user-supplied label (up to 70 characters) is printed with each plot or output field. This label must be included in the input file as a separate line immediately after the "SAME" NAMELIST (i.e., before the "DIFF" NAMELIST, if it is present). If NEWMES = 0, the following default label is used: "CONCENTRATIONS (G/M**3)".	0
ISCHEK	INTEGER	Variable controlling internal checking of species codes. If ISCHEK =1, the species code of every input field is required to be the same and match "IPOL" specified in subroutine DEFN. If ISCHEK = 0, this species code checking feature is disabled (e.g., to allow summing of flux fields of different pollutants such as SO_2 and $SO_4^=$).	1

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine ADD2

SUBROUTINE ADD2

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IRUN1	INTEGER	Runstream Number 1.	--
IRUN2	INTEGER	Runstream Number 2.	--
PRINT	INTEGER	Line printer output control variable. If PRINT = 1, summed arrays are printed; If PRINT = 0, arrays are printed; If PRINT = 0, summed arrays are not printed.	1
IFORM	INTEGER	Format variable for line printer output. If IFORM = 1, non-gridded receptor concentrations are printed in F12.2 format. If IFORM=2, non-gridded receptor concentrations are printed in 1PE12.4 format.	2
DISK	INTEGER	Disk output control variable. If DISK = 1, summed arrays are written on disk. If DISK = 0, summed arrays are not written on disk.	0
PLOT	INTEGER	Line printer plotting control variable. If plot = 1, plots are produced. If plot = 0, plots are not produced.	0
NEWV	INTEGER	In NEWV = 1, user inputs contour values (if NEWV = 1, user must include a DIFF NAMELIST card with the appropriate contour information). If NEWV = 0, use default contour values.	0
APE	INTEGER	Controls echo of input fields. If APE = 1, input fields are printed. If APE = 0, input fields are not printed.	0
IHIGH	INTEGER	Variable controlling printing of highest value in the gridded or non-gridded concentration or flux field after summing and scaling operations. If IHIGH = 1, the high value will be printed. If IHIGH = 0, the high value will not be computed.	0

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine ADD2 (Continued)

SUBROUTINE ADD2

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
a,b	REAL	Adjustment factors for the summed concentration fields, a = multiplicative factor b = additive factor of the form, $C_{adj} = a * C + b$	a = 1. b = 0.
NEWMES	INTEGER	Control variable for label on output plots and derived printed fields (i.e., those controlled by PLOT and PRINT input variables). If NEWMES = 1, a user-supplied label (up to 70 characters) is printed with each plot or output field. This label must be included in the input file as a separate line immediately after the "SAME" NAMELIST (i.e., before the "DIFF" NAMELIST, if it is present). If NEWMES = 0, the following default label is used: "CONCENTRATIONS (G/M**3)".	0
ISCHEK	INTEGER	Variable controlling internal checking of species codes. If ISCHEK = 1, the species code of every input field is required to be the same and match "IPOL" specified in subroutine DEFN. If ISCHEK = 0, this species code checking feature is disabled (e.g., to allow summing of flux fields of different pollutants such as SO_2 and $SO_4^=$).	1

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine STAT

SUBROUTINE STAT*

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
IND1	INTEGER	Base case runstream number.	-
IND2	INTEGER	Perturbed (test) case runstream number.	-
BYONE	INTEGER	Determines whether multi-array runstreams are to be treated as one concatenated data set (producing one set of statistics) or as a group of one-array runstreams (producing a set of statistics for each array pair). If BYONE = 1, array by-array statistics calculated; If BYONE = 0, collective statistics calculated.	1
PRINTD	INTEGER	Line printer output control variable for the difference fields. If PRINTD = 1, difference fields are printed; If PRINTD = 0, difference fields are not printed.	0
DISKD	INTEGER	Disk output control variable for the output fields. If DISKD = 1, difference fields are written on disk; If DISKD = 0, difference fields are not written on disk.	0
PLOTD	INTEGER	Line printer plotting control variable for the difference fields. If PLOTD = 1, plots are produced; If PLOTD = 0, plots are not produced.	0

* SUBROUTINE STAT is designed to compute statistics from gridded fields of data only, non-gridded data cannot be analyzed with this routine.

Table 7-5

MESOFILE II Inputs (Continued)

Card Inputs to Subroutine STAT (Continued)

SUBROUTINE STAT

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
NEWVD	INTEGER	Plotter contour values control variable. If NEWVD = 1, user inputs contour values (if NEWVD = 1, user must include a DIFF NAMELIST card with the appropriate contour information). In NEWVD = 0, use default contour values.	0
PRINTF	INTEGER	Same as PRINTD, except for the fractional difference fields.	0
DISKF	INTEGER	Same as DISKD, except for the fractional difference fields.	0
PLOTF	INTEGER	Same as PLOTD, except for the fractional difference fields.	0
NEWVF	INTEGER	Same as NEWVD, except for the fractional difference fields.	0
PRINTW	INTEGER	Same as PRINTD, except for the weighted difference fields.	0
DISKW	INTEGER	Same as DISKD, except for the weighted difference fields.	0
PLOTW	INTEGER	Same as PLOTD, except for the weighted difference fields.	0
NEWVW	INTEGER	Same as NEWVD, except for the weighted difference fields.	0
APE	INTEGER	Controls echo of input fields. If APE = 1, input fields are printed. If APE = 0, input fields are not printed.	0

Table 7-5

MESOFILE II Inputs (Concluded)

Card Inputs to Subroutine STAT (Concluded)

SUBROUTINE STAT

NAMELIST TITLE - SAME

Parameter	Type	Definition	Default
NEWMES	INTEGER	Control variable for label on output plots and derived printed fields (i.e., those controlled by PLOT and PRINT input variables). If NEWMES = 1, a user-supplied label (up to 70 characters) is printed with each plot or output field. This label must be included in the input file as a separate line immediately after the "SAME" NAMELIST (i.e., before the "DIFF" NAMELIST, if it is present). If NEWMES = 0, the following default label is used: "CONCENTRATIONS (G/M**3)".	0
ISCHEK	INTEGER	Variable controlling internal checking of species codes. If ISCHEK = 1, the species code of every input field is required to be the same and match "IPOL" specified in subroutine DEFN. If ISCHEK = 0, this species code checking feature is disabled (e.g., to allow summing of flux fields of different pollutants such as SO_2 and $SO_4^=$).	1

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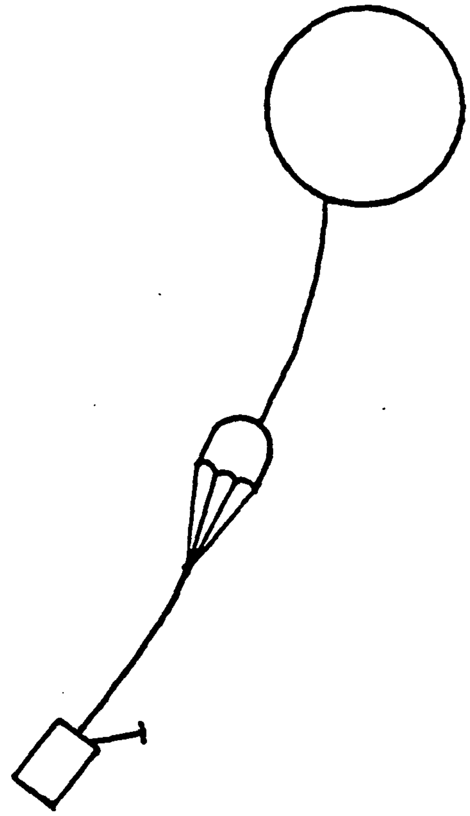
APPENDIX A

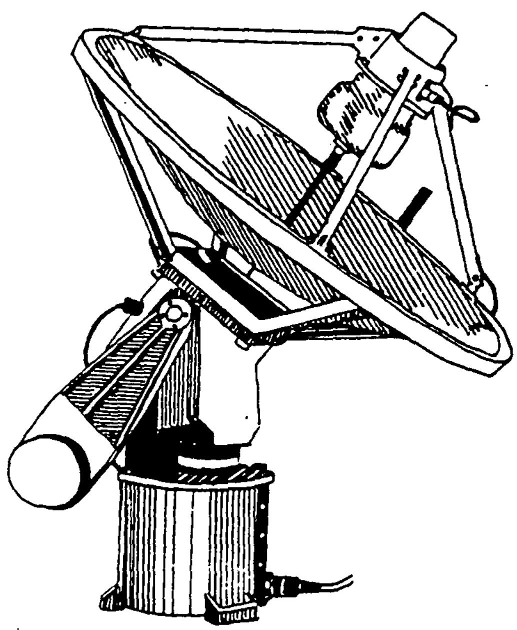
TD-6200 SERIES

NCDC UPPER AIR DATA FORMAT DESCRIPTION

TD-6200 SERIES
NCDC UPPER AIR
DIGITAL FILES



DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA



NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION / ENVIRONMENTAL DATA AND INFORMATION SERVICE / NATIONAL CLIMATIC CENTER ASHEVILLE, N.C.

NCDC UPPER AIR
DIGITAL FILES
TD-6200 SERIES

Prepared by
National Climatic Data Center
Federal Building
Asheville, North Carolina

May 1986

This document was prepared by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Service, National Climatic Data Center, Asheville, North Carolina.

This document is designed to provide general information on the content, origin, format, integrity and the availability of this data file.

Errors found in this document should be brought to the attention of the Data Base Administrator, NCDC.

INTRODUCTION

SOURCE

The Upper Air Observations in this digital data file include stations operated by the National Weather Service, U.S. Navy, and certain South American stations whose data receive quality control at the National Climatic Data Center (NCDC). Additional Upper Air Observations from the Global Tele-Communications Systems (GTS), and the U.S. Air Force are also included in this digital file but are not quality controlled by NCDC.

A list of these files are:

TD-6201 U.S. Rawinsonde observations 1946-Present. (Includes U.S. Navy observations, U.S. Air Force, National Meteorological Center (NMC), and South American cooperative observations. Derived from TD-5600.)

TD-6202 Northern Hemisphere GTS observations 1963-1970, and Southern Hemisphere 1966-1970. (These data were extracted from NMC Operations ARchive and processed into TD-5683.)

TD-6203 Global GTS observations 1971-1979. (These data are a composite of NOAA's National Meteorological Center (NMC) and U.S. Air Force Global Weather Center (GWC). Derived from TD-5681.)

TD-6210 Marine Upper Air 1946-To Date.

These data were collected from sources listed below:

1. CD-545, CD-645 that were converted to TD-5600 data set.
2. TD-5600 Marine Area (ships) that were converted to TD-6201/2.
3. TD-6201 Marine Area (ships) to date.
4. NMC Upper Air Marine (ships) 1973-to date.
5. Data from TD-6203, TD-5681 and GWC were not used in this data set.

These data are currently on three (3) tapes with the period record:

TAPE #1 1946 THRU 1969
TAPE #2 1970 THRU 1979
TAPE #3 1980 THRU 1987

The sort is by 10 degree square, year, month, day, hour within the above tape periods. Additional periods will be added as updates, starting with 1988 from sources 3 and 4 above, when received.

Duplicates were removed giving priority listed above (1,2,3,4). QC flags are 0-9 for non NMC data, for NMC data they are A-Z.

Background Information TD-6201

TD-6201:	PERIOD:
National Weather Service	Jan. 1946 - Current
U.S. Air Force	Jan. 1946 - Dec. 1970
U.S. Navy	July 1949 - Current

The information contained in TD-6201 includes pressure surface, height of the pressure surface, temperature, relative humidity, wind direction and speed. Beginning with Jan 1981, the elapsed time since release of the sonde is included. The pressure levels included fall into three categories:

1. Mandatory levels — Levels required by the WMO for transmission in parts A and C of a coded RAWIND report.

2. Standard levels — Levels used for internal processing by the NCDC, but not generally reported in a coded message.

3. Significant levels — Levels required to adequately describe a sounding, as transmitted in parts B and D of a coded message.

The number of mandatory and standard levels has increased over time. Table 1 lists the levels that are expected for a given period of record. Significant levels were not generally included in the earlier periods. Significant levels are included for most stations only after July 1952.

Levels below the surface were generated for the period January 1, 1981 through February 28, 1986. However, these levels only contain unknown values ('9999') for all data elements. Beginning March 1, 1986 this practice was stopped.

The actual time of releases from Jan. 1946 through May 1957 were usually 03, 09, 15, 21 GMT, 16, 17 = 15Z and 20, 21, 22, 23 = 21Z. Beginning June 1957 the scheduled time of release is used instead of the actual hour. The time of observations were changed from 03, 09, 15, 21 GMT to 00, 06, 12, and 18 GMT. Observations outside the plus or minus one-hour tolerance were reported as actual time, GMT. Stations scheduled to record only one observation daily are allowed a six-hour tolerance.

Relative humidities were computed with respect to ice from Jan. 1946 through Sept. 1948 and to water after that. Beginning Oct. 1948 relative humidity was computed over a water surface whenever the dry bulb was below freezing.

Observing practice for wind measurements varied from current practice. from Jan. 1946 to June 1949, wind directions were observed on a 16-point compass. These directions were converted to degrees before inclusion in TD-6201.

TABLE 1

Mandatory and Standard Levels TD-6201

Surface	1/46-6/49	7/49-12/55	1/56-6/57	7/57-12/60	1/61-Present
1000	*	*	*	*	*
950	*	*	*	*	*
900	*	*	*	*	*
850	*	*	*	*	*
800	*	*	*	*	*
750	*	*	*	*	*
700	*	*	*	*	*
650	*	*	*	*	*
600	*	*	*	*	*
550	*	*	*	*	*
500	*	*	*	*	*
450	*	*	*	*	*
400	*	*	*	*	*
350	*	*	*	*	*
300	*	*	*	*	*
250	*	*	*	*	*
200	*	*	*	*	*
175	*	*	*	*	*
150	*	*	*	*	*
125	*	*	*	*	*
100	*	*	*	*	*
80	*	*	*	*	*
70					*
60	*	*	*	*	*
50	*	*	*	*	*
40	*	*	*	*	*
30	*	*	*	*	*
25				*	*
20	*	*	*	*	*
15		*	*	*	*
10	*	*	*	*	*
7		*	*	*	*
5		*	*	*	*
4		*	*	*	*
3		*	*	*	*
2		*	*	*	*
1.5					*
1					*

Background Information TD-6202

TD-6202:	PERIOD:
National Meteorological Center (NMC)	
Northern Hemisphere	Sept. 1963 - Dec. 1970
Southern Hemisphere	June 1966 - Dec. 1970.

These data were assimilated from normal International communication channels and no detailed quality control measures were employed when converting to TD-5683. The observations, therefore, were subject to the usual errors inherent in such a collection.

The U/A observations contain all available mandatory and significant levels transmitted under International agreement. The period of record may vary from station to station, the general collection began Sept. 1963 and continued through Dec. 1970 (Northern Hemisphere). Stations in the Southern Hemisphere are usually not available until mid 1966 or later through Dec. 1970.

Relative humidities are derived statistically for RH's not reported originally.

Background Information TD-6203

TD-6203:	PERIOD:
National Meteorological Center (NMC)	July 1971 - Dec. 1978
Air Force Global Weather Center (AFGWC)	July 1971 - Dec. 1978

These U/A observations are a collection of data built by the National Climatic Data Center (NCDC). These data were received from NMC and AFGWC. NCDC converted these two data sources separately into TD-5681. Then these data sources were combined giving priority to the NMC source.

Areal coverage is worldwide.

The digital file contains: Station Identification (land and ships), Latitude and Longitude of location, date/time, and elements:

LEVEL QUALITY INDICATOR - results by level.

TIME - elapsed time since release.

PRESSURE - by level in kilopascals.

HEIGHT - by level in geopotential meters.

TEMPERATURE - by level in degrees Celsius.

RELATIVE HUMIDITY - by level in degrees Celsius.

WIND - Direction and speed by level.

QUALITY CONTROL FLAGS - by level for time, pressure, height, temperature, relative humidity, wind, and type of level.

SPECIAL NOTES

QUALITY

U.S. data processed by the NCDC are subjected to extensive quality control procedures. Suspect data are returned to a verifier for manual correction. GTS data are subjected to various degrees of automated quality control by the receiving agency. NCDC accepts the data as correct during the reformatting procedure. Therefore, the user must be prepared to perform his own quality checks on GTS data. (The primary function of NMC and AFGWC is to produce forecasts, not to provide an archive data base.)

When corrections are made to a level, that level will appear in the record twice. The first occurrence of the level will be the original observed values, with a level quality indicator of "2" or "4". The corrected data will appear in the second occurrence of the level, with quality indicator of "6".

USE OF THE MANUAL

This manual was designed so that reference to other reference material should be unnecessary. However, additional information may be obtained by writing or calling:

National Climatic Data Center E/CC42
ATTN: USER Services Branch
Federal Building
Asheville, North Carolina 28801-2696

Telephone inquiries may be directed to:

Commercial 704 259-0682
FTS 672-0682

Read carefully, the general tape notations, and coding practices.

TAPE FORMAT

MANUAL AND TAPE NOTATIONS

1. FILE (NCDC Variable Length Storage Structure)

   A. Physical Characteristics

Data in this file are retained in chronological order by station. Although library tapes are normally maintained as described below, different characteristics including fixed length records can be furnished on request. Additional charges may be accrued for special processing.

2. RECORD

   A. Physical Characteristics

Each logical record contains one station's Upper Air (U/A) Observation (Rawinsonde, Radiosonde, or Pibal) for each specific Upper Air Sounding (normally 2 each day). The record consists of a control word, an identification portion, and a data portion. The control word is used by the computer operating system for record length determination. For many systems this control word is transparent to the "users" program. The identification portion identifies the observing station, latitude, longitude, day and time (of release), and the number of repeating groups to follow. The data portion contains the U/A meteorological values and the quality control flag fields for each level. The data portion repeats for each level in the observation. The maximum number of levels is 200. This number was chosen so that observations containing one-minute wind data may be recorded in this format.

Record length	:	Variable with maximum of 7232 characters
Blocked	:	12000 characters maximum
Media	:	ASCII 9 Track
Density	:	6250 BPI
Parity	:	Odd
Label	:	ANSI Standard Labeled
File	:	1 File per tape

B. FORMAT (VARIABLE RECORD)

1. The first five fields constitute the ID PORTION, and occur at the beginning of each record. The next ten fields of the record contain the DATA PORTION. The DATA PORTION is repeated for each level in the observation. The maximum number of levels is 200.

Each logical record is of variable length with a maximum of 7232 characters. Each logical record contains a station's complete Upper Air Observation for a specific release time. The form of a record is:

ID PORTION (32 characters) Fixed length

	STATION ID	LAT	LAT CODE	LONG	LONG CODE	DATE/TIME	NUMBER VALUES
	XXXXXXXX	XXXX	X	XXXXX	X	XXXXXXXXXX	XXX
TAPE FIELD	001	002	003	004	005	006	007

DATA PORTION (36 Characters) repeated Number-Values Times

	LVL-QLTY INDCTR	TIME	PRESSURE	HEIGHT	TEMP	RH	WIND DIR	WIND SPD	QUALITY FLAGS	TYPE OF LEVEL
	X	XXXX	XXXXX	XXXXXX	XXXX	XXX	XXX	XXX	XXXXXX	X
TAPE FIELD	008	009	010	011	012	013	014	015	016	017

	RH	WIND DIR	WIND SPD	QUALITY FLAGS	TYPE OF LEVEL
	XXX	XXX	XXX	XXXXXX	X
TAPE FIELD	1998	1999	2000	2001	2002

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION
001	001-008	STATION IDENTIFICATION
002	009-012	LATITUDE
003	013	LATITUDE CODE N/S
004	014-018	LONGITUDE
005	019	LONGITUDE CODE E/W
006	020-029	DATE AND TIME (YR/MO/DY/HR)
007	030-032	NUMBER OF DATA PORTION GROUPS THAT FOLLOW
008	033	LEVEL QUALITY INDICATOR
009	034-037	TIME (ELAPSED TIME SINCE RELEASE)
010	038-042	PRESSURE
011	043-048	HEIGHT
012	049-052	TEMPERATURE
013	053-055	RELATIVE HUMIDITY
014	056-058	WIND DIRECTION
015	059-061	WIND SPEED
016	062-067	FLAG FIELD (QUALITY FLAGS)
017	068	TYPE OF LEVEL
(1958-1972) (1973-1987) (1988-2002)	(7125-7160) (7161-7196) (7197-7232)	DATA GROUPS IN THE SAME FORM AS TAPE FIELDS 008-017. REPEATED AS MANY TIMES AS NEEDED TO COMPLETE ONE UPPER AIR OBSERVATION. A MAXIMUM OF 200 LEVELS ARE POSSIBLE.

The following COBOL and FORTRAN statements are to be used as guidelines only. NCDC recognizes the fact that many different types of equipment are used in processing these data. It is impossible to cover all the idiosyncrasies of every system.

Typical ANSI COBOL Data Description.

This ANSI Standard COBOL Data Description is expected to work on most systems.

```
FD   UA-DATA
     LABEL RECORDS ARE STANDARD
     RECORDING MODE D
     BLOCK CONTAINS 12000 CHARACTERS.
01   UA-RECORD.
     02   STATION-NUMBER            PICTURE X(8).
     02   LATITUDE.
          03   LATITUDE-NUM         PICTURE 9999.
          03   LATITUDE-ALPH        PICTURE X.
     02   LONGITUDE.
          03   LONGITUDE-NUM        PICTURE 99999.
          03   LONGITUDE-ALPH       PICTURE X.
     02   DATE-TIME.
          03   YEAR                 PICTURE 9(4).
          03   MONTH                PICTURE 99.
          03   DAYS                 PICTURE 99.
          03   HOUR                 PICTURE 99.
     02   NUMBER-OF-LEVELS          PICTURE 999.
     02   LEVEL-RECORD
               OCCURS 1 to 200 TIMES DEPENDING ON NUMBER-OF-LEVELS.
          03   QUALITY-INDICATOR    PICTURE X.
          03   ELAPSED-TIME         PICTURE 999V9.
          03   PRESSURE             PICTURE 999V99.
          03   HEIGHT               PICTURE S99999
                                    SIGN LEADING SEPARATE.
          03   TEMPERATURE          PICTURE S99V9
                                    SIGN LEADING SEPARATE.
          03   RELATIVE-HUMIDITY    PICTURE 999.
          03   WIND-DIRECTION       PICTURE 999.
          03   WIND-SPEED           PICTURE 999.
          03   FLAGS.
               04   TIME-FLAG         PICTURE X.
               04   PRESSURE-FLAG     PICTURE X.
               04   HEIGHT-FLAG       PICTURE X.
               04   TEMPERATURE-FLAG  PICTURE X.
               04   R-H-FLAG          PICTURE X.
               04   WIND-FLAG         PICTURE X.
               04   TYPE-OF-LEVEL     PICTURE X.
```

FORTRAN 77 Example 1.

This description is for those systems that can handle variable blocked records normally.

```
         IMPLICIT INTEGER (A-Z)

         OPEN (10,FILE = 'FILENAME',ACCESS = 'SEQUENTIAL', STATUS = 'OLD',
        +   RFORM = 'VB',MREL = '1230',TYPE = 'ANSI',BLOCK = '12000')
C           LAST line of OPEN statement is SPERRY UNIQUE

         CHARACTER*8 STNID
         CHARACTER*1 LATA,LONA,QIND(200),TIMEF(200),PRESSF(200),
        +            HGTF(200),TEMPF(200),RHF(200),WINDF(200),TYPLEV(200)

         REAL*4 LAT,LON,ETIME(200),PRESS(200),HGT(200),TEMP(200)

         DIMENSION ETIME(200),PRESS(200),HGT(200),
        +          TEMP(200),RH(200),WD(200),WS(200)

         READ (10,20,END=999) STNID,LAT,LATA,LON,LONA,YEAR,
        +           MONTH,DAY,HOUR,NUMLEV,(QIND(J),ETIME(J),
        +           PRESS(J),HGT(J),TEMP(J),RH(J),WD(J),WS(J),
        +           TIMEF(J),PRESSF(J),HGTF(J),TEMPF(J),RHF(J),
        +           WINDF(J),TYPLEV(J),J=1,NUMLEV)

20       FORMAT (A8,F4.0,A1,F5.0,A1,I4,3(I2),I3,200(A1,F4.1,F5.2,
        +        F6.0,F4.1,3(I3),7A1))
```

IBM JCL NOTES.

(1) For ASCII Variable specify:
LREC = 7236
RECFM = DB
OPTCODE = Q

(2) For EBCDIC Variable specify:
LRECL = 7236
RECFM = VB

FORTRAN 77 Example 2.

This description is for those systems that can't handle variable blocked records normally.

```
$ MOUNT/FOREIGN/BLOCKSIZE=12000 MT:  tapename TAPE:  ! THIS IS VAX
.....                                                ! UNIQUE

      PROGRAM TAPEREAD
      IMPLICIT INTEGER (A-Z)
      .....
      OPEN(1,FILE=TAPE:',ACCESS='SEQUENTIAL',FORM=FORMATTED',
     +      STATUS='OLD',READONLY)

      CHARACTER BUFFER*12000             ! YOUR MACHINE MUST SUPPORT
      CHARACTER *8 STNID                 ! CHARACTER VARIABLES THIS LARGE
      CHARACTER*1 LATA,LONA,QIND(200),TIMEF(200),PRESSF(200),
     +           HGTF(200),TEMPF(200),RHF(200),WINDF(200),TYPLEV(200)

      REAL*4 LAT,LON,ETIME(200),PRESS(200),HGT(200),TEMP(200)

      DIMENSION ETIME(200),PRESS(200),HGT(200),TEMP(200),RH(200),
     +         WD(200),WS(200)
      .....
      NBYTES=0
    5 NBEG=1
      READ(1,101,END=99)BUFFER            !READ IN PHYSICAL RECORD (BLOCK)
   10 NBEG=NBEG+NBYTES
      READ(BUFFER(NBEG:NBEG+3,102)NBYTES  !READ THE CONTROL WORD
      IF( NBYTES.EQ.O )GO TO 5
      READ(BUFFER(NBEG+4:NBEG+NBYTES-1),103)STNID,LAT,LATA,LON,LONA,YEAR,
     +     MONTH,DAY,HOUR,NUMLEV,(QIND(J),ETIME(J),PRESS(J),HGT(J),TEMP(J),
     +     RH(J),WD(J),WS(J),TIMEF(J),PRESSF(J),HGTF(J),TEMPF(J),RHF(J),
     +     WINDF(J),TYPLEV(J),J=1,NUMLEV)

      .....
      .....
      GO TO 10
   99 CONTINUE
      .....
      .....
      STOP 'FINISHED'
  101 FORMAT(A)
  102 FORMAT(I4)
  103 FORMAT(A8,F4.0,A1,F5.0,A1,I4,3(I2),I3,200(A1,F4.1,F5.2,
     +F6.0,F4.1,3(I3),7A1))
      END
```

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
001	1-8	STATION-ID	STATION IDENTIFICATION—For U.S. controlled and cooperative stations, the WBAN number (TD-6201). For stations received through GTS, the WMO number (TD-6202). TD-6203 has general WMO numbers but some are WBAN numbers. This field may contain alphabetic characters for ships and remote sensed observations. Numeric station numbers are right justified and zero filled, while alphanumeric station indentifiers are left justified and blank filled. If unknown, this field contains "99999999". If the station identification is unknown, both latitude and longitude must be present.
002	9-12	LATITUDE	LATITUDE—The station latitude in degrees and minutes. When unknown, this field contains "9999". Latitude will not normally appear for land stations.
003	13	LATITUDE CODE	LATITUDE CODE— CODE used to indicate the Northern (N) or Southern (S) latitudes.
004	14-18	LONGITUDE	LONGITUDE—The station longitude in degrees and minutes. When unknown, this field contains "99999". Longitude will not normally appear for land stations.
005	19	LONGITUDE CODE	LONGITUDE CODE—CODE used to indicate Longitudes East (E) or West (W).
006	20-29	DATE-TIME	DATE/TIME—The scheduled time of the observation, as defined by WMO. The format of date/time is YYYYMMDDHH, i.e., year, month, day, hour. This field may never be unknown.
	20-23	YEAR	YEAR-This is the Year of record. Range of values are 1946-current year processed.
	24-25	MONTH	MONTH-This is the Month of record. Range of value are 01 to 12.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
	26-27	DAY	DAY-This is the Day of record, Range of values are 01 to 31.
	28-29	HOUR	HOUR-This is the Hour of record. Range of value are 00 to 23. Hour is GMT. Normal scheduled observation times are 00 and 12 GMT. For selected periods and areas observations may have been taken at other times, especially 06 and 18 GMT.
007	30-32	NUMBER-REPEAT-GROUPS	NUMBER-OF-REPEATING-GROUPS--This number represents the number of data levels found in the current observation, including edited levels. Range of values are 001-200. Two hundred is the maximum number of levels.
008	33	LEVEL-QUALITY-INDCTR	LEVEL-QUALITY-INDICATOR--Denotes the results of any quality controls applied to this level. Range is as follows: 0 Original values are correct. 1 Original values are missing. 2 Original values doubtful, a corrected level follows. 3 Original values doubtful, uncorrected. 4 Original values in error, a corrected level follows. 5 Original values in error, uncorrected. 6 Corrected level. 9 Level not checked. A-Z Indicators supplied by NMC. (A-G, blank) Automatic via computer system. A Passed vertical consistency check with tight limits. B Failed vertical consistency check and has not been recomputed. C Failed vertical consistency check and was recomputed. D Failed vertical consistency check with tight limits and passed with loose limits. E (Not assigned) F Has been checked but did not pass vertical consistency check with loose limits. G (Not assigned) blank (Not specified)

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
008 continued			(H-P, $) Manual via Human Intervention H Hold value for next analysis run I (Same as A) J (Same as B) K (Same as C) L (Same as D) M (Same as E) N (Same as F) O (Same as G) P Purge from analysis run
009	34-37	TIME-SINCE-RELEASE	TIME-The elapsed time since the release of the sounding in minutes and tenths. If the elapsed time is not known, this field contains "9999". Range is 0001 through 9999. Available only for U.S. quality controlled stations beginning Jan. 1981.
010	38-42	PRESSURE-AT-LEVEL	PRESSURE-Atmospheric pressure at the current level in kilopascals and hundredths. If unknown, this field contains "99999". (TD6201 only - Subsurface levels were generated from Jan. 1, 1981 through Feb. 28, 1986. The values were always unknown. This practice was stopped Mar. 1, 1986.)
011	43-48	HEIGHT-AT-LEVEL	HEIGHT-Geopotential height of the current level in whole meters. If unknown, this field contains "-99999". Range of values are -99999 through 99999.
012	49-52	TEMPERATURE AT-LEVEL	TEMPERATURE-The free air temperature at the current level in degrees and tenths Celsius. If unknown, this field contains "-999". Range of values -999 through 999.
013	53-55	RELATIVE-HUMIDITY AT-LEVEL	RELATIVE-HUMIDITY-The relative humidity at the current level in whole percent. If unknown, this field contains "999". In TD-6202, relative humidities are derived statistically for RH's not reported originally.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
014	56-58	WIND-DIRECTION AT-LEVEL	WIND-DIRECTION-Direction of the wind at the current level in whole degrees (nearest five degrees for observations received through GTS). If unknown, this field contains "999".
015	59-61	WIND-SPEED AT-LEVEL	WIND-SPEED-Speed of the wind in whole meters per second. If unknown, this field contains "999".
016	62-67	QUALITY-FLAGS	QUALITY-FLAG-FIELD--This field contains the results of any quality control procedures, identifying each individual element found in error (see table below).

QUALITY CONTROL FLAG

- 0 Element is correct
- 1 Element is doubtful
- 2 Element is in error
- 3 Replacement value
- 4 Assumed or estimated value
- 9 Element not checked
- A-Z Indicators supplied by NMC

(A-G, blank) Automatic via computer system.

- A Passed vertical consistency check with tight limits.
- B Failed vertical consistency check and has not been recomputed.
- C Failed vertical consistency check and was recomputed.
- D Failed vertical consistency check with tight limits and passed with loose limits.
- E (Not assigned)
- F Has been checked but did not pass vertical consistency check with loose limits.
- G (Not assigned)
- blank (Not specified)

(H-P, $) Manual via Human Intervention

- H Hold value for next analysis run
- I (Same as A)
- J (Same as B)
- K (Same as C)
- L (Same as D)
- M (Same as E)
- N (Same as F)
- O (Same as G)
- P Purge from analysis run

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
	62	TIME-QF	Time Quality Flag
	63	PRESSURE-QF	Pressure Quality Flag
	64	HEIGHT-QF	Height Quality Flag
	65	TEMPERATURE-QF	Temperature Quality Flag
	66	RELATIVE-HUMIDITY-QF	Relative Humidity Quality Flag
	67	WIND-QF	Wind Quality Flag
017	68	TYPE-OF	TYPE OF LEVEL FLAG--See Table below. 0 Surface 1 Mandatory 2 Significant 3 Generated 4 Tropopause 5 Maximum wind 9 Other/unspecified NOTE: TD-6201 through December 1975 will contain Type of Level Flags 0, 1, and 9 only. The significant flag is not present.

APPENDIX B

TD-3240 PRECIPITATION

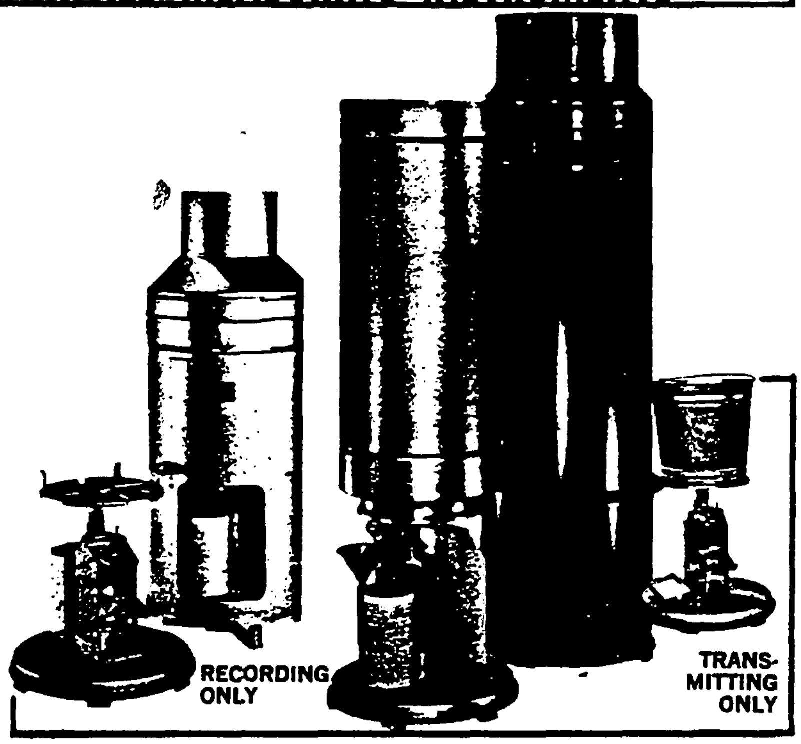
DATA FORMAT DESCRIPTION

TD-3240

HOURLY PRECIPITATION

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

RAINFALL MEASURING INSTRUMENTS



DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NATIONAL ENVIRONMENTAL SATELLITE DATA AND INFORMATION SERVICE

NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, N.C.

HOURLY PRECIPITATION DATA

TD-3240

Prepared by
National Climatic Data Center
Federal Building
Asheville, North Carolina

JUNE 1990

This document was prepared by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite Data and Information Service, National Climatic Data Center, Asheville, North Carolina.

This document is designed to provide general information on the content, origin, format, integrity and the availability of this data file.

Errors found in this document should be brought to the attention of the Data Base Administrator, NCDC.

INTRODUCTION

HISTORY AND DATA SOURCE

The observations in this Hourly Precipitation Data File were taken by observers at principle (primary) stations, secondary stations, and cooperative observer stations operated by the National Weather Service (NWS), and the Federal Aviation Agency (FAA).

Approximately 5500 stations have recorded precipitation data through the period of this digital file. Initially from August 1984 to September 1951, data were keyed on punched cards by the regional Weather Records Processing Centers. Then the task was transferred to the National Climatic Data Center (NCDC) in Asheville, NC. The hourly precipitation data file was transferred from punched cards to magnetic tape (TD-9657) during the late 1960s. This data file was then converted to the element file structure during 1984.

Several recording (weighing) rain gauge instruments were used in measuring hourly precipitation, but by September 1963 many Fischer Porter precipitation gauge instruments with automated readout, recorded on paper tape, were phased in. By early 1965, about 200 of these were in operation and they became the primary recording instrument. Currently, there are approximately 2000 Fischer Porter gauges in operation. The Universal Rain gauge is the other primary instrument used to create this data file. It has an automated readout recorded on paper charts. Station and dates of commissioning of weighing rain gauges are in the Station History listings available at the NCDC in Asheville, NC.

The data in this file are a combination of original observations of hourly and daily accumulated precipitation. Precipitation values are checked and edited as necessary on an automated and manual edit.

Data before 1984 were converted from existing digital files (TD-9747) to the element structure format. These (historical) data were processed through a gross value check only. Beginning January 1984, the hourly precipitation data were processed through a completely revised system which produces the element structure database file. Data are subjected to new computer editing procedures reducing the manual handling of the data.

This data file is unique when compared to the other NCDC Element Files. No corrected or edited data are available in this data file. The data are classified as original data.

Areal coverage includes the United States, Puerto Rico, Virgin Islands, and U.S. protectorates located in the Pacific.

The hourly digital file contain: record type, station identification, dates, units of measurement indicator, data flags, and element type.

Hourly Precipitation Data: Hourly precipitation including the daily total. These are the only data in this file.

PURPOSE OF THIS MANUAL

This manual was designed so that reference to other reference material should be unnecessary. Inventories, station listings, or any additional information may be obtained if necessary by writing or calling:

National Climatic Data Center E/CC42
ATTN: User Services Branch
Federal Building
Asheville, North Carolina 28801-2696

Telephone inquiries may be directed to:

Commercial 704 259-0682
FTS 672-0682

Read carefully the "Manual and Tape Notations" and "Code Definitions and Remarks" sections.

SPECIAL NOTES

1. QUANTITY-DATA COMPACTION

It stands to reason that for most hours the non-occurrence of precipitation is prevalent. Therefore, in order to save space in the digital file, there are entries only for:

1. The first day and hour of each month were observations were taken even if no precipitation occurred during that month.
2. Hours with precipitation > zero.
3. Beginning and ending hours of missing periods.
4. Beginning and ending hours of accumulating periods.
5. Beginning and ending periods of deleted data.
6. First and last day of each month where the required charts or forms never were received or processed at NCDC.

TAPE FORMAT

MANUAL AND TAPE NOTATIONS

1. FILE (NCDC Variable Length Storage Structure)

   A. Physical Characteristics

   Data in this set are retained in chronological order by station.

   B. COBOL OR FORTRAN Data Description

The following statements may be used to read a logical record in COBOL or FORTRAN for variable length.

(1) Typical ANSI COBOL

```
FD   INDATA
     LABEL RECORDS ARE STANDARD
     RECORD MODE D
     BLOCK CONTAINS 12000 CHARACTERS
     DATA RECORD IS DATA-RECORD

01   DATA RECORD
     02 RECORD TYPE                    PIC X(3)
     02 STATION-ID                     PIC X(8)
     02 ELEMENT-TYPE                   PIC X(4)
     02 ELEMENT-UNITS                  PIC XX
     02 YEAR                           PIC 9(4)
     02 MONTH                          PIC 99
     02 DAY                            PIC 9(4)
     02 NUMBER-VALUES                  PIC 9(3)
     02 DAILY-ENTRY
     OCCURS 1 TO 100 TIMES DEPENDING ON NUMBER-VALUES
        04 HOUR                        PIC 9(4)
        04 DATA-VALUE                  PIC 9(6)
        04 FLAG-1                      PIC X
        04 FLAG-2                      PIC X
```

(2) Typical FORTRAN 77

```
DEFINE FILE 10 (ANSI, VB, 1230, 12000)
CHARACTER*3 RECTYP
CHARACTER*8 STNID
CHARACTER*4 ELMTYP
CHARACTER*2 EUNITS
CHARACTER*1 FLAG1, FLAG2
DIMENSION IVALUE(100), FLAG1(100), FLAG2(100), IHR(100)

READ (10,20,END=999) RECTYP, STNID, ELMTYP, EUNITS, IYEAR, IMON,
IDAY, NUMVAL, ((IHR(J), IVALUE(J), FLAG1(J), FLAG2(J)),
J=1,NUMVAL)

20 FORMAT (A3, A8, A4, A2, I4, I2, I4, I3, 100(I4, I6, 2A))
```

NOTE: If you do not have FORTRAN 77, you can read the character data described above into integer variables.

C. IBM JCL NOTES

(1) For ASCII Variable specify:

LRECL = 1234
RECFM = DB
OPTCODE = Q

(2) For EBCDIC Variable specify:

LRECL = 1234
RECFM = VB

2. RECORD

A. Physical Characteristics

Each logical record contains one day of one station's occurrences of precipitation. The record consists of a control word and identification portion, and a data portion. The control word is used by the computer operating system for record length determination. The identification portion identifies the observing station, year, month, day, and record element units code. The data portion contains the hour, precipitation occurrence and measurement flags. The data portion is repeated for as many values as occur in the given time interval.

NCDC Library Tapes are structured as follows:

Record Length	:	Variable with maximum of 1230 characters
Blocked	:	12000 characters
Media	:	ASCII 9 Track
Density	:	6250 BPI
Parity	:	Odd
Label	:	ANSI Standard Labeled
File	:	1 File per tape

B. FORMAT (VARIABLE RECORD)

The first eight tape fields, the ID PORTION of the record, describe the characteristics of the entire record. The DATA PORTION of the record contains information about each element value reported. This portion is repeated for as many values as occur in the daily record of hourly values plus the daily total.

Each logical record is of variable length with a maximum of 1230 characters. Each logical record contains a station's data for a specific meteorological element over a one-day interval. The form of a record is:

ID PORTION (30 characters) Fixed Length

	REC TYP	STATION ID	ELEM TYPE	UNT	YEAR	MON	DAY	NO. VAL
	XXX	XXXXXXXX	XXXX	XX	XXXX	XX	XXXX	XXX
TAPE FIELD	001	002	003	004	005	006	007	008

DATA PORTION (12 Character Data Portion repeats the number of times indicated by the data value stored in Tape Field 008)

	HRMN	DATA ELEM VALUE	FL 1	FL 2	HRMN	DATA ELEM VALUE	FL 1	FL 2
	XXXX	XXXXXX	X	X	XXXX	XXXXXX	X	X
TAPE FIELD	009	010	011	012	013	014	015	016

	HRMN	DATA ELEM VALUE	FL 1	FL 2
	XXXX	XXXXXX	X	X
TAPE FIELD	105	106	107	108

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION
001	001-003	RECORD TYPE
002	004-011	STATION ID
003	012-015	METEOROLOGICAL ELEMENT TYPE
004	016-017	MET. ELEMENT MEASUREMENT UNITS
005	018-021	YEAR
006	022-023	MONTH
007	024-027	DAY (Right justified zero filled)
008	028-030	NUMBER OF DATA GROUPS THAT FOLLOW
009	031-034	HOUR (Left justified zero filled)
010	035-040	VALUE OF METEOROLOGICAL ELEMENT
011	041	MEASUREMENT FLAG 1
012	042	QUALITY FLAG 2
(013-016)	(043-054)	DATA GROUPS IN THE SAME FORM AS
(017-020)	(055-066)	TAPE FIELDS 009-012. REPEATED
(021-024)	(067-078)	AS MANY TIMES AS NEEDED TO
		CONTAIN ONE DAY OF HOURLY VALUES
(105-108)	(319-330)	

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
001	1-3	Record-Type	The type of data stored in this record. Value is "HPD".
002	4-11	Station-ID	This 8-character station identifier is assigned by the National Climatic Data Center. See State Code Table.
	4-5	State-Code	STATE CODE as indicated. Range of value is 01 to 48, 66, 67, and 91.

STATE CODE TABLE

01 Alabama	28 New Jersey
02 Arizona	29 New Mexico
03 Arkansas	30 New York
04 California	31 North Carolina
05 Colorado	32 North Dakota
06 Connecticut	33 Ohio
07 Delaware	34 Oklahoma
08 Florida	35 Oregon
09 Georgia	36 Pennsylvania
10 Idaho	37 Rhode Island
11 Illinois	38 South Carolina
12 Indiana	39 South Dakota
13 Iowa	40 Tennessee
14 Kansas	41 Texas
15 Kentucky	42 Utah
16 Louisiana	43 Vermont
17 Maine	44 Virginia
18 Maryland	45 Washington
19 Massachusetts	46 West Virginia
20 Michigan	47 Wisconsin
21 Minnesota	48 Wyoming
22 Mississippi	49 Not Used
23 Missouri	(1st Order Only)
24 Montana	50 Alaska
25 Nebraska	51 Hawaii
26 Nevada	66 Puerto Rico
27 New Hampshire	67 Virgin Islands
	91 Pacific Islands

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
	6-9	Cooperative Network Index	Cooperative Network Index Number assigned by NCDC. (Station List) Range 0001 thru 9999.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
	10-11	Cooperative Network Division Number	Cooperative Network Division Number. The division number will always be 00 in this HPD data set.
003	12-15	Element-Type	The type of data element stored in this record. Range of values is listed below. HPCP Hourly precipitation data. This is the only data type reported. (Includes the daily total.)
004	16-17	Element-Units	The units and decimal position of the data value for this record. Range of values is listed below. HI Hundredths of inches. Data stored and observed to the sam accuracy. HT Data stored as hundredths of inches, but is observed to tenths only. (Primarily Fischer Porter) TI Same description as HT.
005	18-21	Year	This is the year of record. Range of values is generally from 1948-current year processed. (Few stations begin earlier.)
006	22-23	Month	Month of record. Range of value is 01-12.
007	24-27	Day	Day of record. Range of value 0001-0031. Days are right justified zero filled.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
008	28-30	Number-Reported-Values	This denotes the actual number of values. Range of values is 2 to 100. NOTE: A record may contain fewer or more data values than you might expect. A daily record of hourly values may contain as few as 2 data values or as many as 100 data values. If a particular data value was not taken, there is no entry for it. Missing values are reported as missing. See Flag 1 definitions.
009	31-34	Time-Of-Value	This contains the ending time of the precipitation 0100-2500. The hour is left justified, zero filled. Hour 2500 contains the daily total, and it will always be the last value of a record. Midnight = 2400. Local Standard Time in use.
010	35-40	DATA-VALUE	The actual precipitation data value. The data value portion is a six-digit integer. Units and decimal position, if appropriate, are indicated in the ELEMENT-UNITS field described in Tape Field 004. Range = 000000-099999. 000000 will be used only on the first hour of each month unless there is precipitation during that hour, in which case the measured value will be provided. On other days during the month without precipitation, no entry will be made. 099999 indicates that the DATA-VALUE is unknown.

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
011	41	FLAG1	The Data Measurement Flag.

FLAG1 Table (Measurement Flag)

A Accumulated period and amount. An accumulated period indicates that the precipitation amount is correct, but the exact beginning and ending times are only known to the extent that the precipitation occurred sometime within the accumulation period. Begin accumulation data value in Tape Field 010 will always be 099999. The examples below do not represent the actual data format. They are used to illustrate the use of data measurement Flag 1.

Example 1: 01 0100099999Ab 01 15000000Ab. (Precipitation on the 1st day of a month was accumulated from 0100 through 1500 hours. Total accumulation was .80 inch of precipitation.)

Example 2: 03 0500099999Ab 03 2500 099999Ib 04 18000000180Ab. (Accumulation of precipitation began on day 03 at 0500 hours. Day 03 daily total was incomplete due to the accumulating period continuing into the next day. On day 04 at 1800 hours, the accumulation period ended. The total accumulation was 1.80 inches of precipitation.)

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS

011 (continued)

Example 3: (Month 02) 03 0100099999aB 03 2500099999Ib 04 0800000180B 04 2500000180Ib. (Accumulation of precipitation began on (Month 02), day 03 at 0100 hours. Day 03 of (Month 02) daily total was incomplete due to the accumulating period continuing into the next month. On (Month 03) day 01 at 0100 hours the accumulation continues. On (Month 03) day 04 at 0800 hours, the accumulation period ended with 1.80 inches precipitation being recorded. The daily total on the 4th was considered incomplete.)

D Deleted Flag. (Beginning and ending of a deleted period.) A deleted value indicates that the original data were received, but were unreadable or clearly recognized as noise.

E = Estimated Value

I Incomplete Flag. This flag occurs only in the daily total.

M Missing Flag. (Beginning and ending of a missing period.) A missing flag indicates that the data were not received. This flag appears on the first and last day of each month for which data were not received or not processed by NCDC.

Prior to 1984 a missing period was recorded as " 00000M" at the beginning and ending hours. If precipitation occurred during the last hour of the missing period, the second M appears with a non-zero value.

Beginning in 1984 the beginning and ending hours of the missing period are recorded as "099999M".

TAPE FIELD	TAPE RECORD POSITION	ELEMENT NAME	CODE DEFINITIONS AND REMARKS
011 (continued)			b(blank) no Flag needed.
012	42	FLAG2	This flag not used at this time. The field will always be blank.

EXAMPLES OF HOW FLAGS ARE USED

This precipitation accumulation from list month day 02 to 2nd month day 04.

Month	Day	Hour	Data Value	
01	0002	0500	000030bb	
		1000	099999Ab	Accumulation begins
		2500	000030Ib	Incomplete daily total
02	0001	0100	099999Ab	Accumulation continues
		2500	099999Ib	Incomplete daily total
	0004	1400	000390Ab	Accumulation ends
		2500	000390Ib	Daily total

Accumulated precipitation for 1 monthly only.

01	0002	1000	099999Ab	Accumulation begins
		2500	099999Ib	Incomplete daily total
	0031	2400	000320Ab	Accumulation ends
		2500	000320Ib	Incomplete daily total

Accumulated, deleted, and missing precipitation data through months 01 and 02.

01	0001	0100	000000bb	First record of the month
	0002	1100	099999Ab	Accumulation begins
		2500	099999Ib	Incomplete daily total
02	0001	0100	099999Ab	Accumulation continues
		1400	000630Ab	Accumulation ends
		1500	099999Db	Deleted data begins
		2500	000630Ib	Incomplete daily total
02	0028	1300	099999Db	Deleted data ends
		1400	099999Mb	Missing data
		2400	099999Mb	Missing data
		2500	099999Ib	Incomplete daily total

Required precipitation charts or forms were never received at NCDC.

01	0001	0100	099999Mb	Missing data
		2500	099999Mb	
	0031	0100	099999Mb	
		2500	099999Mb	
02	0001	0100	099999Mb	

	2500	099999Mb
0028	0100	099999Mb
	2500	099999Mb

NOTE: blank = b

SAMPLE RECORD
(As seen from a tape dump)

```
(column           1         2         3         4         5         6
 scale)  123456789012345678901234567890123456789012345678901234567890

(data)   0058HPD17001100HPCPHI198104000600204000000l2bb2500000012bb
```

(The symbol 'b' denotes a blank)

DUMP POSITION	RECORD POSITION	CONTENTS	MEANING		
1-4		0058	Record control word used by the operating system. (Contains the total number of characters in the record - not available to user programs.)		
5-7	1-3	HPD	RECORD-TYPE		
8-15	4-11	17001100	STATION-ID for state 17, station 0011, DIV 00		
16-19	12-15	HPCP	ELEMENT-TYPE		
20-21	16-17	HI	ELEMENT-UNITS		
22-25	18-21	1981	YEAR		
26-27	22-23	04	MONTH		
28-31	24-37	0006	DAY OF THE MONTH (Day 06 right justified)		
32-34	28-30	002	NUM-VALUES; two data entries to follow		
35-38	31-34	0400	TIME-OF-VALUES (Precip from 03:01 to 04:00)	X X	
39-44	35-40	000012	DATA-VALUE	X X	FIRST DATA
45	41	b	FLAG-1	X X	ENTRY
46	42	b	FLAG-2	X	
47-50	43-46	2500	TIME-OF-VALUE (daily total)	X X	
51-56	47-52	000012	DATA-VALUE	X X	SECOND DATA
57	53	b	FLAG-1	X X	ENTRY
58	54	b	FLAG-2	X	

In this case, hours midnight-0300 and 0400-2400 reported no precipitation.

APPENDIX A
FIXED DATA STRUCTURE (TD-3240)

Definitions and general information about Hourly Precipitation data are contained in the basic documentation used to describe the format of variable length records.

1. File (NCDC Fixed Length (User Services))

   A. Physical Characteristics

      Data in this file are retained in chronological order by station.

   B. COBOL or FORTRAN Data Descriptions

      The following statements may be used to read a logical record in COBOL or FORTRAN for fixed length.

      (1) Typical ANSI COBOL

```
FD   INDATA
     LABEL RECORDS ARE STANDARD
     RECORD MODE F
     BLOCK CONTAINS 6300 CHARACTERS
     DATA RECORD IS DATA-RECORD

01   DATA-RECORD
     02 RECORD-TYPE                 PIC X(3)
     02 STATION-ID                  PIC X(8)
     02 ELEMENT-TYPE                PIC X(4)
     02 ELEMENT-UNITS               PIC XX
     02 YEAR                        PIC 9(4)
     02 MONTH                       PIC 99
     02 DAY                         PIC 9(4)
     02 NUMBER-VALUES               PIC 9(3)
     02 HOUR                        PIC 9(4)
     02 DATA-VALUE                  PIC 9(6)
     02 FLAG-1                      PIC X
     02 FLAG-2                      PIC X
```

(2) Typical FORTRAN 77 Data and File Description

```
DEFINE FILE 10 (ANSI, FB, 42,6300)
CHARACTER*3 RECTYP
CHARACTER*8 STNID
CHARACTER*4 ELMTYP
CHARACTER*2 EUNITS
CHARACTER*1 FLAG1, FLAG2

READ (10, 20, END=999) RECTYP, STNID, ELMTYP, EUNITS, IYEAR, IMON,
IDAY, NUMVAL, IHR, IVALUE, FLAG1, FLAG2

20 FORMAT (A3, A8, A4, A2, I4, I2, I4, I3, I4, I6, 2A1)
```

NOTE: If you do not have FORTRAN 77, you can read the character data described above into integer variables.

1. RECORD

A. Physical Characteristics

Each logical record contains one station's specific occurrence for a one hour time interval. The record consists of an identification portion, and a data portion. The identification portion identifies the observing station, element codes, year, month, and day. The data portion contains one hourly time interval data value and flags. The data portion is not repeated.

Fixed,Length (User Services) Tapes are structured as follows:

Data Length	:	FIXED 42 characters
Blocked	:	6300 characters
Media	:	ASCII or EBCDIC Modes - 9 Track
Parity	:	Odd
Label	:	ANSI standard labeled (ASCII only) or unlabeled
File	:	1 file per tape
Density	:	800, 1600, or 6250 BPI

TAPE FIELD	TAPE RECORD POSITION	ELEMENT DESCRIPTION
001	001-003	RECORD TYPE
002	004-011	STATION ID
003	012-015	METEOROLOGICAL ELEMENT TYPE
004	016-017	MET. ELEMENT MEASUREMENT UNITS
005	018-021	YEAR
006	022-023	MONTH
007	024-027	DAY (Right justified zero filled)
008	028-030	NUMBER OF DATA GROUPS THAT FOLLOW
009	031-034	HOUR (Left justified zero filled)
010	035-040	VALUE OF METEOROLOGICAL ELEMENT
011	041	MEASUREMENT FLAG 1
012	042	QUALITY FLAG 2

B. FORMAT (FIXED RECORD)

1. The first eight tape fields, the ID PORTION of the record, describe the characteristics of the entire record. The DATA PORTION of the record contains information about each element value reported. this portion contains only one hourly occurrence.

Each logical record is fixed with 42 characters. Each logical record contains a station's hourly time interval for the specified day. The form of a record is:

ID PORTION (30 characters) Fixed Length

	REC TYP	STATION ID	ELEM TYPE	UNT	YEAR	MON	DAY	NO. VAL
	XXX	XXXXXXXX	XXXX	XX	XXXX	XX	XXXX	XXX
TAPE FIELD	001	002	003	004	005	006	007	008

DATA PORTION (12 Character Data Portion occurs only 1 time as indicated in Field 008)

	HRMN	DATA ELEM VALUE	FL 1	FL 2
	XXXX	XXXXXX	X	X
TAPE FIELD	105	106	107	108

FIXED
SAMPLE RECORD
(As seen from a tape dump)

b = blank

```
(column          1         2         3         4         5         6
 scale)  123456789012345678901234567890123456789012345678901234567890

(data)   HPD17001100HPCPHI19810400060010400000012bb
```

(The symbol 'b' denotes a blank)

COLUMN	CONTENTS	MEANING
1-3	HPD	RECORD-TYPE
4-11	17001100	STATION-ID for state 17, station 0011, DIV 00
12-15	HPCP	ELEMENT-TYPE
16-17	HI	ELEMENT-UNITS
18-21	1981	YEAR
22-23	04	MONTH (April)
24-27	0006	DAY OF THE MONTH (Day 06 right justified)
28-30	001	NUM-VALUES; One data entry follows
31-34	0400	TIME-OF-VALUES (Precip from 03:01 to 04:00)
35-40	000012	DATA-VALUE
41	b	FLAG-1
42	b	FLAG-2

APPENDIX C

SAMPLE MESOPAC II INPUT AND OUTPUT FILES

SAMPLE MESOPAC II INPUT FILE (PAC.INP)

```
MESOPAC TEST CASE - 25 hr simulation skipping 1 day 1/2/88-1/3/88
   88    2   25    6    3    5   19
   22   22    10000.
    T    T   24    F    0    0    0    0
 1 5 1 1 6 1 1 912121212 1101010101212121212
 1 1 1 1 1 1 1 1 11212 1 1 1 111101112121212
1111 1 1 1 1 1 1 1 1 1 1 1 1 111111112121212
111111 1101010 5 1 1 1 1 1 1 9 9111112121212
 5 1 1 1 110 1 1 1 1 1 1 1 1 9 9 11212121212
 5 5 1 1 1 1 1 1 1 9 9 1 1 9 9 9111212121212
11 5 5 1 1 11010 1 9 9 9 9 9 9 1111212121212
111111 1 510101010 1 9 9 9 9 911111212121212
11 5 510 51010101010 9 9 9 9 911111212121212
12 5 510 51010101010 9 9 9 91111111212121212
12 5 5 5 51010101010 9 9 9 9 611111212121212
121212 5 51010101010 9 9 9 91111111212121212
1212121212 51010 9 9 9 9 9 91111121212121212
1212121212 5 5 9 9 9 9 9 9 11111121212121212
121212121212 5 5 9 9 9 9 9 1111212121212121212
121212121212 5 5 9 9 9 9 1 1 11212121212121212
12121212121212 5 5 9 9 9 1 5 912121212121212
1212121212121212 5 9 9 9 9 912121212121212121212
121212121212 5 512 9 9 912121212121212121212
12121212121212 5 5121212121212121212121212121212
12121212121212121212121212121212121212121212
12121212121212121212121212121212121212121212
0000000001
12835      0.3      19.3     26.58     81.87   5.    11              6.1  0.1
12836      1.4      -3.2     24.55     81.75   5.    12              7.0  0.1
12839     16.0      10.7     25.80     80.30   5.    13              7.0  0.1
12842     -6.1      34.8     27.97     82.53   5.    14              6.7  0.1
12843     14.7      31.2     27.65     80.42   5.    15              6.7  0.1
12844     17.7      20.4     26.68     80.12   5.    16              6.7  0.1
72201      1.6      -3.4     24.53     81.73   5.    17
72203     17.7      20.3     26.67     80.12   5.    18
72210     -4.7      31.5     27.68     82.38   5.    19
080616    11.8      20.6
080845    17.8      17.0
081654     9.8      21.2
083186     0.3      19.4
084091    14.0       7.3
084570     1.4      -3.2
084797    -0.1      35.2
085663    16.0      10.7
085895     8.1      22.1
086323    13.6      16.6
086657     6.0      21.5
086988    14.5      12.1
087293    12.8      23.8
087859    16.1      25.2
088780    10.6      10.1
089010    14.1      10.3
089184     5.7      24.9
089219    14.4      31.0
089525    17.7      20.5
```

SAMPLE MESOPAC II OUTPUT FILE (PAC.LST)

RUNTIME CALL NO.: 1 DATE: 06/15/93 TIME: 12:32:26.06

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****

MESOPAC TEST CASE - 25 hr simulation skipping 1 day 1/2/88-1/3/88

YEAR OF RUN (NYR) = 88
JULIAN DAY OF START OF RUN (IDYSTR) = 2
NUMBER OF HOURS IN RUN (IHRMAX) = 25
NUMBER OF SURFACE STATIONS (NSSTA) = 6
NUMBER OF RAWINSONDE STATIONS (NUSTA) = 3
NUMBER OF PRECIPITATION STATIONS (NPSTA) = 19
BASE TIME ZONE (IBTZ) = 5 (E.S.T.)

GRID INFORMATION:

GRID SIZE IN X (WEST-EAST) DIRECTION (IMAX) = 22
GRID SIZE IN Y (SOUTH-NORTH) DIRECTION (JMAX) = 22
GRID SPACING (DGRID) = 10000.0 (M)

OUTPUT OPTIONS:

GENERATED METEOROLOGICAL FIELDS OUTPUT TO TAPE ? (LSAVE) = T
METEOROLOGICAL FIELDS PRINTED ? (LPRINT) = T
PRINT FREQUENCY (IPRINF) = 24 (HOURS)
INPUT MET. DATA & INTERMEDIATE COMPUTED PARAMETERS PRINTED ? (LDB) = F
TIME PERIOD FOR WHICH INPUT MET. DATA & INTERMEDIATE PARAMETERS PRINTED (NDY1,NHR1,NDY2,NHR2) = DAY 0 HR 0 TO DAY 0 HR 0

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****

DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)
USER INPUT SURFACE WIND SPEED MEASUREMENT HT (ZM) IOPTS(1) = 0
USER INPUT VON KARMAN CONSTANT (VK) IOPTS(2) = 0
USER INPUT FRICTION VELOCITY CONSTANTS (GAMMA,CONSTA) IOPTS(3) = 0
USER INPUT MIXING HT CONSTANTS (CONSTB,CONSTE,DELTZ,DPTMIN,CONSTN) IOPTS(4) = 0
USER INPUT WIND FIELD VARIABLES (RADIUS,ILWF,IUWF) IOPTS(5) = 0
USER INPUT SURFACE ROUGHNESS LENGTHS (Z0) AT EACH GRID POINT IOPTS(6) = 0
HEAT FLUX CORRECTED USING MIXING HT DATA ? IOPTS(7) = 0
USER INPUT FACTORS (BETA) FOR RADIATION REDUCTION DUE TO CLOUD COVER IOPTS(8) = 0
USER INPUT LAND USE HEAT FLUX CONSTANTS (RADC) IOPTS(9) = 0
RUN NOT STARTING AT BEGINNING OF SURFACE AND UPPER AIR DATA FILES ? IOPTS(10) = 1

SURFACE WIND SPEED MEASUREMENT HEIGHT (ZM) = 10.0 (M)

VON KARMAN CONSTANT (VK) = 0.400

FRICTION VELOCITY CONSTANTS:
GAMMA = 4.7
CONSTA = 1100.0

MIXING HEIGHT CONSTANTS:
NEUTRAL STABILITY MIXING HT CONSTANT (CONSTB) = 1.41
CONVECTIVE MIXING HT CONSTANT (CONSTE) = 0.15
DEPTH OF LAYER THROUGH WHICH POTENTIAL TEMP. GRADIENT IS CALCULATED (DELTZ) = 200.0 (M)
MINIMUM STABLE POTENTIAL TEMP. GRADIENT (DPTMIN) = 0.0010 (DEG K/M)
STABLE MECHANICAL MIXING HT CONSTANT (CONSTN) = 2400.0

WIND FIELD VARIABLES:
SCAN RADIUS (RADIUS) = 99.0 (GRID UNITS)

```
    CODE FOR LOWER-LEVEL WIND FIELD (ILWF) =  2 (SEE BELOW)
    CODE FOR UPPER-LEVEL WIND FIELD (IUWF) =  4 (SEE BELOW)

        WIND FIELD CODE (ILWF,IUWF)

                  1  -  SURFACE WINDS (CD144 DATA)
                  2  -  WINDS AVERAGED THROUGH LAYER FROM GROUND TO MIXING HT (CD144,TDF5600 DATA)
                  3  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 850 MB (TDF5600 DATA)
                  4  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 700 MB (TDF5600 DATA)
                  5  -  WINDS AVERAGED THROUGH LAYER FROM MIXING HT TO 500 MB (TDF5600 DATA)
                  6  -  850 MB WINDS (TDF5600 DATA)
                  7  -  700 MB WINDS (TDF5600 DATA)
                  8  -  500 MB WINDS (TDF5600 DATA)

REDUCTION FACTORS OF SOLAR RADIATION DUE TO CLOUD COVER:
    CLOUD COVER (TENTHS)    0      1      2      3      4      5      6      7      8      9      10
    BETA                  1.000  0.910  0.840  0.790  0.750  0.720  0.680  0.620  0.530  0.410  0.230

                                                   MESOPAC    VERSION  2.40   LEVEL 930430
*****************************************************************************************************

LAND USE CATEGORIES FOR EACH GRID POINT

Multiply all values by 10 **   0

22 I   1   5   1   1   6   1   1   9  12  12  12  12   1  10  10  10  10  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
21 I   1   1   1   1   1   1   1   1   1  12  12   1   1   1   1  11  10  11  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
20 I  11  11   1   1   1   1   1   1   1   1   1   1   1   1   1  11  11  11  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
19 I  11  11  11   1  10  10  10   5   1   1   1   1   1   1   9   9  11  11  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
18 I   5   1   1   1   1  10   1   1   1   1   1   1   1   1   9   9   1  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
17 I   5   5   1   1   1   1   1   1   1   9   9   1   1   9   9   9  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
16 I  11   5   5   1   1   1  10  10   1   9   9   9   9   9   9   1  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
15 I  11  11  11   1   5  10  10  10  10   1   9   9   9   9   9  11  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
14 I  11   5   5  10   5  10  10  10  10  10   9   9   9   9   9  11  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
13 I  12   5   5  10   5  10  10  10  10  10   9   9   9   9  11  11  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
12 I  12   5   5   5   5  10  10  10  10  10   9   9   9   9   6  11  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
11 I  12  12  12   5   5  10  10  10  10  10   9   9   9   9  11  11  11  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
10 I  12  12  12  12  12   5  10  10   9   9   9   9   9   9  11  11  12  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 9 I  12  12  12  12  12   5   5   9   9   9   9   9   9   1  11  11  12  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 8 I  12  12  12  12  12  12   5   5   9   9   9   9   9   1  11  12  12  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 7 I  12  12  12  12  12  12   5   5   9   9   9   9   1   1   1  12  12  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 6 I  12  12  12  12  12  12  12   5   5   9   9   9   1   5   9  12  12  12  12  12  12  12
   I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 5 I  12  12  12  12  12  12  12  12   5   9   9   9   9   9  12  12  12  12  12  12  12  12
```

4	12	12	12	12	12	12	5	5	12	9	9	9	12	12	12	12	12	12	12	12	12	12
3	12	12	12	12	12	12	12	5	5	12	12	12	12	12	12	12	12	12	12	12	12	12
2	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
1	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

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SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

Multiply all values by 10 ** -3

22	200	1000	200	200	100	200	200	200	0	0	0	0	200	500	500	500	500	0	0	0
21	200	200	200	200	200	200	200	200	200	0	0	200	200	200	200	1000	500	1000	0	0
20	1000	1000	200	200	200	200	200	200	200	200	200	200	200	200	200	1000	1000	1000	0	0
19	1000	1000	1000	200	500	500	500	1000	200	200	200	200	200	200	200	200	1000	1000	0	0
18	1000	200	200	200	200	500	200	200	200	200	200	200	200	200	200	200	200	0	0	0
17	1000	1000	200	200	200	200	200	200	200	200	200	200	200	200	200	200	1000	0	0	0
16	1000	1000	1000	200	200	200	500	500	200	200	200	200	200	200	200	200	1000	0	0	0
15	1000	1000	1000	200	1000	500	500	500	500	200	200	200	200	200	200	1000	1000	0	0	0
14	1000	1000	1000	500	1000	500	500	500	500	500	200	200	200	200	200	1000	1000	0	0	0
13	0	1000	1000	500	1000	500	500	500	500	500	200	200	200	200	1000	1000	1000	0	0	0
12	0	1000	1000	1000	1000	500	500	500	500	500	200	200	200	200	100	1000	1000	0	0	0
11	0	0	0	1000	1000	500	500	500	500	500	200	200	200	200	1000	1000	1000	0	0	0
10	0	0	0	0	0	1000	500	500	200	200	200	200	200	200	1000	1000	0	0	0	0
9	0	0	0	0	0	1000	1000	200	200	200	200	200	200	200	1000	1000	0	0	0	0
8	0	0	0	0	0	0	1000	1000	200	200	200	200	200	200	1000	0	0	0	0	0
7	0	0	0	0	0	0	1000	1000	200	200	200	200	200	200	200	0	0	0	0	0
6	0	0	0	0	0	0	0	1000	1000	200	200	200	200	1000	200	0	0	0	0	0
5	0	0	0	0	0	0	0	0	1000	200	200	200	200	200	0	0	0	0	0	0
4	0	0	0	0	0	0	1000	1000	0	200	200	200	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1000	1000	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
    I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
  1 I   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    I   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
     --------------------------------------------------------------------------------
        1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20
```

SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

Multiply all values by 10 ** -3

```
 22 I   0   0
    I   +   +
 21 I   0   0
    I   +   +
 20 I   0   0
    I   +   +
 19 I   0   0
    I   +   +
 18 I   0   0
    I   +   +
 17 I   0   0
    I   +   +
 16 I   0   0
    I   +   +
 15 I   0   0
    I   +   +
 14 I   0   0
    I   +   +
 13 I   0   0
    I   +   +
 12 I   0   0
    I   +   +
 11 I   0   0
    I   +   +
 10 I   0   0
    I   +   +
  9 I   0   0
    I   +   +
  8 I   0   0
    I   +   +
  7 I   0   0
    I   +   +
  6 I   0   0
    I   +   +
  5 I   0   0
    I   +   +
  4 I   0   0
    I   +   +
  3 I   0   0
    I   +   +
  2 I   0   0
    I   +   +
  1 I   0   0
    I   +   +
     --------
       21  22
```

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****

LAND USE HEAT FLUX CONSTANTS (RADC) AT EACH GRID POINT

Multiply all values by 10 ** -4

22 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
21 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
17 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
16 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
14 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
13 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
12 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
8 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
7 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1 I	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

LAND USE HEAT FLUX CONSTANTS (RADC) AT EACH GRID POINT

Multiply all values by 10 ** -4

22 I	3000	3000
I	+	+
21 I	3000	3000
I	+	+
20 I	3000	3000

```
     I    +     +
  19 I 3000  3000
     I    +     +
  18 I 3000  3000
     I    +     +
  17 I 3000  3000
     I    +     +
  16 I 3000  3000
     I    +     +
  15 I 3000  3000
     I    +     +
  14 I 3000  3000
     I    +     +
  13 I 3000  3000
     I    +     +
  12 I 3000  3000
     I    +     +
  11 I 3000  3000
     I    +     +
  10 I 3000  3000
     I    +     +
   9 I 3000  3000
     I    +     +
   8 I 3000  3000
     I    +     +
   7 I 3000  3000
     I    +     +
   6 I 3000  3000
     I    +     +
   5 I 3000  3000
     I    +     +
   4 I 3000  3000
     I    +     +
   3 I 3000  3000
     I    +     +
   2 I 3000  3000
     I    +     +
   1 I 3000  3000
     I    +     +
      -----------
        21    22
```

MESOPAC VERSION 2.40 LEVEL 930430

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SURFACE METEOROLOGICAL STATIONS

STATION	CD144 ID	GRID COORDINATES X (GRID UNITS)	Y (GRID UNITS)	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	TIME ZONE	CD144 LOGICAL UNIT	Anem. Ht. (m)	Surface Roughness (m)
1	12835	0.30	19.30	26.580	81.870	5.	11	6.10	0.100
2	12836	1.40	-3.20	24.550	81.750	5.	12	7.00	0.100
3	12839	16.00	10.70	25.800	80.300	5.	13	7.00	0.100
4	12842	-6.10	34.80	27.970	82.530	5.	14	6.70	0.100
5	12843	14.70	31.20	27.650	80.420	5.	15	6.70	0.100
6	12844	17.70	20.40	26.680	80.120	5.	16	6.70	0.100

UPPER AIR STATIONS

STATION	STATION ID	GRID COORDINATES X (GRID UNITS)	Y (GRID UNITS)	LATITUDE (DEGREES)	LONGITUDE (DEGREES)	TIME ZONE	LOGICAL UNIT
1	72201	1.60	-3.40	24.530	81.730	5.	17
2	72203	17.70	20.30	26.670	80.120	5.	18
3	72210	-4.70	31.50	27.680	82.380	5.	19

PRECIPITATION STATIONS

STATION	TD3240 ID	GRID COORDINATES X (GRID UNITS)	Y (GRID UNITS)
1	80616	11.80	20.60
2	80845	17.80	17.00
3	81654	9.80	21.20
4	83186	0.30	19.40
5	84091	14.00	7.30
6	84570	1.40	-3.20
7	84797	-0.10	35.20
8	85663	16.00	10.70
9	85895	8.10	22.10
10	86323	13.60	16.60
11	86657	6.00	21.50
12	86988	14.50	12.10
13	87293	12.80	23.80
14	87859	16.10	25.20
15	88780	10.60	10.10
16	89010	14.10	10.30
17	89184	5.70	24.90
18	89219	14.40	31.00
19	89525	17.70	20.50

```
HEADER RECORDS FROM UPPER AIR DATA FILE:    1
 IBYRU =            88  IBJULU =           1  IBHRU =            0
 IEYRU =            88  IEJULU =         366  IEHRU =           12
 PTOP =     500.000
 LHT =  F  LTEMP =  F  LWD =  F  LWS =  F

HEADER RECORDS FROM UPPER AIR DATA FILE:    2
 IBYRU =            88  IBJULU =           1  IBHRU =            0
 IEYRU =            88  IEJULU =         366  IEHRU =           12
 PTOP =     500.000
 LHT =  F  LTEMP =  F  LWD =  F  LWS =  F

HEADER RECORDS FROM UPPER AIR DATA FILE:    3
 IBYRU =            88  IBJULU =           1  IBHRU =            0
 IEYRU =            88  IEJULU =         366  IEHRU =           12
 PTOP =     500.000
 LHT =  F  LTEMP =  F  LWD =  F  LWS =  F

                                          MESOPAC    VERSION  2.40   LEVEL 930430
****************************************************************************************************
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STATION NUMBER OF CLOSEST SURFACE MET. STATION TO EACH GRID POINT

Multiply all values by 10 ** -1

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
22	I	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
21	I	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20	I	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19	I	10	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18	I	10	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
17	I	10	10	10	10	10	10	10	10	10	60	60	60	60	60	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
16	I	10	10	10	10	10	10	10	10	30	30	30	30	30	30	60	60	60	60	60	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15	I	10	10	10	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	60	60	60
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
14	I	10	10	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
13	I	10	10	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
12	I	10	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11	I	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10	I	10	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9	I	10	10	10	10	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
8	I	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
7	I	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6	I	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5	I	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4	I	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	I	20	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2	I	20	20	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1	I	20	20	20	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

MESOPAC VERSION 2.40 LEVEL 930430

STATION NUMBER OF CLOSEST UPPER AIR STATION TO EACH GRID POINT

Multiply all values by 10 ** -1

22	I	30	30	30	30	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

```
21 I 30  30  30  30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
20 I 30  30  30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
19 I 30  30  30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
18 I 30  30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
17 I 30  30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
16 I 30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
15 I 30  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
14 I 10  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
13 I 10  10  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
12 I 10  10  10  10  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
11 I 10  10  10  10  10  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
10 I 10  10  10  10  10  10  10  20  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 9 I 10  10  10  10  10  10  10  10  20  20  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 8 I 10  10  10  10  10  10  10  10  10  10  20  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 7 I 10  10  10  10  10  10  10  10  10  10  10  20  20  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 6 I 10  10  10  10  10  10  10  10  10  10  10  10  10  20  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 5 I 10  10  10  10  10  10  10  10  10  10  10  10  10  10  20  20  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 4 I 10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  20  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 3 I 10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  20  20  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 2 I 10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  20  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
 1 I 10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  20  20
   I +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
   ---------------------------------------------------------------------------------------
     1   2   3   4   5   6   7   8   9   10  11  12  13  14  15  16  17  18  19  20  21  22
```

HEADER RECORDS FROM PRECIPITATION DATA FILE

NUMBER OF PRECIPITATION STATIONS = 19

STATION NUMBER	STATION ID
1	80616
2	80845
3	81654
4	83186
5	84091

6	84570
7	84797
8	85663
9	85895
10	86323
11	86657
12	86988
13	87293
14	87859
15	88780
16	89010
17	89184
18	89219
19	89525

MESOPAC VERSION 2.40 LEVEL 930430

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STATION NUMBER OF CLOSEST PRECIPITATION STATION TO EACH GRID POINT

Multiply all values by 10 ** 0

```
22 I  4  4 11 11 11 11  9  9  9  3  3  1 13 13 13 19 19 19 19 19 19 19
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
21 I  4  4 11 11 11 11 11  9  3  3  1  1  1  1 19 19 19 19 19 19 19 19
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
20 I  4  4  4 11 11 11 11  9  3  3  1  1  1  1 19 19 19 19 19 19 19 19
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
19 I  4  4  4 11 11 11 11  3  3  3  1  1  1 10 10 19 19 19 19 19 19 19
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
18 I  4  4  4  4 11 11 11  3  3  1  1 10 10 10 10  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
17 I  4  4  4  4 11 11 11  3  3 10 10 10 10 10 10  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
16 I  4  4  4  4 11 11 11  3 10 10 10 10 10 10 10  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
15 I  4  4  4  4  4 11 15 15 10 10 10 10 10 10 10  2  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
14 I  4  4  4  4 15 15 15 15 15 15 10 10 12 12 12 12  2  2  2  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
13 I  4  4  4 15 15 15 15 15 15 15 15 12 12 12 12 12  8  8  8  2  2  2
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
12 I  4  4 15 15 15 15 15 15 15 15 15 15 12 12 12  8  8  8  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
11 I  4  4 15 15 15 15 15 15 15 15 15 15 16 16  8  8  8  8  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
10 I  4 15 15 15 15 15 15 15 15 15 15 15 16 16 16  8  8  8  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 9 I 15 15 15 15 15 15 15 15 15 15 15 15 16 16 16  8  8  8  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 8 I 15 15 15 15 15 15 15 15 15 15 15  5  5  5  5  5  8  8  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 7 I 15 15 15 15 15 15 15 15 15 15  5  5  5  5  5  5  5  5  8  8  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 6 I  6  6 15 15 15 15 15 15 15 15  5  5  5  5  5  5  5  5  5  5  8  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 5 I  6  6  6 15 15 15 15 15 15  5  5  5  5  5  5  5  5  5  5  5  5  8
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
 4 I  6  6  6  6  6 15 15 15  5  5  5  5  5  5  5  5  5  5  5  5  5  5
   I  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +  +
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
3	6	6	6	6	6	6	15	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
2	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
1	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5

MESOPAC VERSION 2.40 LEVEL 930430

PGT STABILITY CLASS year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -1

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
22	50	50	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40
21	50	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40
20	50	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40
19	50	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40
18	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40
17	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40
16	50	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40
15	50	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
14	50	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
13	50	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
12	50	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
11	50	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
10	50	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
9	50	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
8	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
7	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
6	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
5	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
4	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
3	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
2	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
1	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

METEOROLOGICAL DATA AT SURFACE STATIONS - YR:88 JULIAN DAY: 2 HR:23

STATION	PREC.	TEMP	SOLAR RAD.	REL. HUMIDITY	CLOUD COVER	PRECIP. CODE
1		292.6	0.0	90	6	0
2		293.7	0.0	97	10	0
3		296.5	0.0	82	9	0
4		292.6	0.0	84	10	0
5		292.0	0.0	97	6	0
6		295.9	0.0	79	6	0

MESOPAC VERSION 2.40 LEVEL 930430

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SURFACE KINEMATIC HEAT FLUX (M*DEG K/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -5

22 I	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928	928
21 I	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928	928
20 I	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928	928
19 I	917	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928
18 I	917	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928
17 I	917	917	917	917	917	917	917	917	917	928	928	928	928	928	928	928	928	928	928	928	928	928
16 I	917	917	917	917	917	917	917	917	327	327	327	327	327	327	928	928	928	928	928	928	928	928
15 I	917	917	917	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	928	928	928
14 I	917	917	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
13 I	917	917	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
12 I	917	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
11 I	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
10 I	917	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
9 I	917	917	917	917	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
8 I	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
7 I	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
6 I	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
5 I	125	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327	327	327
4 I	125	125	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327	327
3 I	125	125	125	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327	327

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
2	125	125	125	125	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327	327
1	125	125	125	125	125	125	125	125	125	125	125	327	327	327	327	327	327	327	327	327	327	327

MESOPAC VERSION 2.40 LEVEL 930430

SURFACE FRICTION VELOCITY (M/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -3

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
22	287	478	294	300	101	316	325	336	50	52	53	56	407	541	576	609	628	72	71	69	66	64
21	279	282	286	294	302	313	324	337	340	53	55	402	431	464	495	762	658	784	74	72	69	67
20	459	464	282	290	300	312	325	339	345	362	382	406	433	464	495	763	784	787	75	73	70	68
19	459	462	470	292	394	408	424	543	358	365	383	404	428	454	481	506	762	768	73	71	69	67
18	463	281	287	297	308	414	334	348	362	367	383	400	419	440	460	479	493	70	70	69	67	66
17	472	478	296	305	316	328	340	354	367	369	382	396	411	425	439	453	690	66	66	66	65	64
16	485	490	498	315	325	336	445	458	356	367	379	389	399	408	423	433	662	63	63	63	63	62
15	500	505	512	326	533	442	453	466	460	372	382	390	399	406	411	633	639	61	61	61	61	60
14	513	519	526	432	545	451	463	456	468	479	387	395	403	408	412	632	634	60	60	60	60	59
13	77	532	538	443	556	461	471	464	474	485	393	402	408	414	634	638	638	60	59	59	59	59
12	82	544	550	557	566	469	462	471	481	491	399	407	415	421	130	644	643	60	60	59	59	59
11	87	52	53	566	574	458	467	477	486	497	403	411	419	424	647	648	647	61	60	59	59	58
10	90	53	54	54	55	567	469	478	386	393	402	410	418	424	646	647	61	60	60	59	59	58
9	92	54	54	55	55	569	576	376	384	391	399	407	413	419	640	641	61	60	59	59	58	58
8	95	54	55	55	55	56	575	582	381	387	394	401	407	411	631	60	60	59	58	58	58	57
7	97	55	55	55	56	56	575	580	377	383	388	393	398	403	406	59	58	58	58	57	57	57
6	100	56	56	56	56	56	55	578	582	378	383	387	390	605	397	58	57	57	57	56	56	56
5	103	57	57	57	57	57	55	55	580	375	378	381	384	387	57	56	56	56	56	56	56	55
4	106	58	58	58	58	57	582	581	56	374	375	376	56	56	56	55	55	55	55	55	55	55
3	111	60	60	59	59	58	58	585	583	56	56	55	55	55	55	55	54	54	54	54	54	54
2	115	61	61	61	60	60	59	58	57	56	56	55	55	55	54	54	54	54	53	53	53	53
1	119	63	62	62	61	61	60	58	57	57	56	55	54	54	54	53	53	53	53	53	53	53

MESOPAC VERSION 2.40 LEVEL 930430

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MIXING HEIGHT (M) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** 0

22 I	370	793	383	394	77	426	445	467	27	28	30	32	623	956	1048	1140	1194	46	45	43
21 I	354	359	368	383	399	420	443	469	476	29	31	612	679	758	835	1595	1282	1665	48	46
20 I	746	757	359	375	394	418	445	475	487	523	567	620	684	758	835	1599	1665	1676	49	47
19 I	746	754	773	379	594	625	662	960	515	530	569	616	673	735	801	863	1595	1616	47	46
18 I	757	357	370	388	411	640	463	493	523	534	569	608	651	699	749	796	831	45	44	43
17 I	779	793	386	405	426	451	477	505	533	538	567	599	631	664	697	731	1376	41	41	40
16 I	810	824	845	424	445	467	713	743	510	535	560	583	605	626	660	684	1292	38	38	38
15 I	848	862	880	447	933	705	733	764	750	545	566	585	605	620	633	1208	1225	36	36	36
14 I	883	897	915	682	967	728	756	739	768	795	577	596	613	626	635	1205	1212	35	35	35
13 I	51	930	948	707	994	751	777	758	784	811	592	611	626	640	1212	1222	1222	35	35	35
12 I	57	964	979	997	1022	771	753	776	800	827	605	624	642	655	112	1242	1238	36	35	35
11 I	61	29	29	1022	1043	745	766	790	814	840	613	633	650	664	1248	1252	1248	36	35	35
10 I	65	29	30	30	31	1024	771	792	575	592	611	631	648	661	1245	1248	36	36	35	35
9 I	67	30	30	31	31	1030	1049	553	570	587	605	622	637	650	1228	1232	36	35	35	34
8 I	70	30	31	31	31	32	1046	1065	564	577	594	609	622	633	1202	35	35	35	34	34
7 I	72	31	31	31	32	32	1046	1059	556	568	581	592	603	613	620	34	34	34	33	33
6 I	75	32	32	32	32	32	31	1056	1065	558	568	577	585	1130	600	33	33	33	32	32
5 I	79	33	33	33	32	32	31	31	1059	551	558	564	570	577	32	32	32	32	32	31
4 I	83	34	34	34	33	33	1065	1062	31	549	551	553	31	32	31	31	31	31	31	31
3 I	88	35	35	35	34	34	33	1075	1068	32	32	31	31	31	31	31	30	30	30	30
2 I	93	36	36	36	35	35	34	33	33	32	31	31	31	31	30	30	30	30	30	30
1 I	99	38	37	37	37	36	35	34	33	32	31	31	30	30	30	30	29	29	29	29
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

MIXING HEIGHT (M) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** 0

22 I	41	39

	21	22
21	44	41
20	45	43
19	44	42
18	42	41
17	40	39
16	38	37
15	36	36
14	35	35
13	34	34
12	34	34
11	34	34
10	34	34
9	34	33
8	33	33
7	33	32
6	32	32
5	31	31
4	31	31
3	30	30
2	30	30
1	29	29

MESOPAC VERSION 2.40 LEVEL 930430

MONIN-OBUKHOV LENGTH (M) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -1

22	908	2512	951	988	112	1097	1164	1240	28	29	31	34	1820	3224	3646	4075	4338	56	55	52
21	856	873	902	951	1006	1077	1157	1246	1274	31	34	1778	2045	2364	2694	6381	4767	6756	60	56
20	2315	2363	872	927	988	1071	1164	1267	1310	1444	1607	1812	2062	2364	2694	6400	6756	6814	61	58
19	2318	2349	2430	939	1710	1831	1977	3244	1412	1466	1615	1795	2018	2271	2546	2814	6381	6493	58	56

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18	2362	867	908	969	1045	1889	1225	1331	1441	1482	1615	1762	1931	2125	2327	2527	2674	54	53	52
17	2454	2514	963	1026	1097	1184	1274	1375	1479	1497	1607	1729	1854	1983	2116	2253	5238	48	48	47
16	2584	2646	2733	1090	1164	1239	2179	2304	1394	1485	1579	1668	1750	1835	1966	2062	4816	43	43	43
15	2746	2810	2885	1171	3122	2148	2262	2390	2332	1524	1603	1676	1751	1809	1860	4406	4487	40	40	41
14	2898	2963	3042	2057	3272	2241	2357	2289	2409	2520	1644	1717	1784	1835	1869	4390	4422	39	39	39
13	66	3108	3189	2158	3396	2336	2444	2365	2475	2588	1701	1776	1835	1886	4422	4471	4471	39	39	39
12	75	3258	3326	3409	3523	2422	2343	2442	2543	2657	1751	1826	1895	1947	185	4568	4552	40	39	39
11	83	30	31	3522	3623	2310	2398	2498	2600	2715	1784	1860	1929	1982	4601	4617	4601	40	39	39
10	89	31	32	32	33	3532	2420	2509	1636	1701	1776	1852	1921	1973	4585	4601	41	40	39	38
9	94	32	32	33	33	3562	3650	1555	1619	1684	1751	1818	1878	1929	4503	4519	40	40	38	38
8	98	33	33	33	34	34	3635	3725	1595	1644	1709	1767	1818	1860	4374	40	39	38	38	37
7	103	33	34	34	34	34	3635	3695	1563	1611	1660	1701	1742	1784	1809	38	38	37	36	36
6	109	34	35	35	35	35	33	3680	3724	1571	1611	1644	1676	4028	1734	36	36	36	35	35
5	116	36	36	36	35	35	34	34	3694	1548	1571	1595	1619	1644	35	35	35	35	34	34
4	125	37	37	37	37	36	3724	3709	34	1540	1548	1556	34	34	34	34	33	33	33	33
3	134	39	39	39	38	38	37	3769	3739	35	34	34	33	33	33	33	32	32	32	32
2	145	41	41	41	40	39	38	37	36	35	34	33	33	33	32	32	32	32	31	31
1	156	43	43	42	42	41	39	38	36	35	34	33	32	32	32	31	31	31	31	31

MONIN-OBUKHOV LENGTH (M) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -1

22	48	45
21	53	49
20	54	51
19	53	50
18	50	48
17	46	45
16	43	42
15	40	40

	21	22
14	39	39
13	38	38
12	38	38
11	38	38
10	38	37
9	37	37
8	37	36
7	36	35
6	35	35
5	34	34
4	33	33
3	32	32
2	31	31
1	31	31

MESOPAC VERSION 2.40 LEVEL 930430

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CONVECTIVE VELOCITY SCALE (M/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

GRID NOT PRINTED -- all values zero

MESOPAC VERSION 2.40 LEVEL 930430

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LOWER LEVEL WIND U-FIELD (M/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -2

22	403	406	411	419	408	411	413	416	418	422	428	439	454	474	499	524	539	541	536	525	513	503
21	392	395	402	411	405	410	415	420	426	433	444	459	478	502	527	549	562	563	556	544	530	518
20	385	389	396	396	404	411	418	425	433	441	452	466	484	505	529	550	563	566	560	551	539	527
19	384	389	397	399	407	415	424	431	439	448	458	470	485	502	521	539	551	555	552	545	536	527
18	389	394	396	404	413	422	430	438	446	454	463	473	484	496	510	523	533	538	538	534	528	522
17	399	405	405	412	421	430	438	446	454	461	469	477	485	493	501	511	518	523	525	523	521	517
16	413	410	416	423	431	440	448	455	463	470	476	483	489	494	499	506	511	514	516	516	515	513
15	428	424	430	436	443	451	458	466	473	479	486	492	497	501	505	509	512	513	514	514	513	512

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 I	339	439	444	450	456	463	469	476	483	489	496	502	507	512	515	518	519	519	518	516	515	513
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 I	350	355	458	463	469	475	481	487	493	499	506	512	518	523	526	528	528	526	524	521	518	515
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 I	359	364	370	377	482	486	492	497	502	508	514	520	526	531	535	536	535	533	529	526	522	518
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11 I	367	372	377	383	391	498	502	506	510	515	521	526	531	535	539	540	539	536	533	529	525	521
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 I	372	376	381	387	393	400	408	513	516	520	523	528	532	535	538	539	538	536	533	529	525	522
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 I	375	379	383	388	394	400	407	415	521	523	525	528	531	533	535	536	535	534	531	528	524	521
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 I	376	380	383	388	393	398	405	412	419	427	528	529	530	531	532	532	532	530	528	525	523	520
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 I	377	379	383	386	390	395	401	407	414	421	428	531	530	530	529	529	528	527	525	523	521	518
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6 I	376	378	381	384	387	392	396	402	407	414	420	425	431	530	528	527	526	525	523	521	519	517
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 I	375	377	379	381	384	387	391	396	401	406	411	417	422	426	528	526	525	523	521	520	518	516
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 I	373	374	376	378	380	383	386	390	394	399	404	409	413	417	420	423	525	523	521	519	517	515
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 I	371	372	373	374	376	378	381	385	388	393	398	402	406	409	412	415	417	523	521	518	516	514
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 I	369	370	370	371	373	375	377	380	384	388	392	396	399	402	405	408	410	412	414	518	516	514
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 I	367	367	368	369	370	371	374	377	380	384	387	391	394	396	399	401	404	406	408	409	516	514
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

MESOPAC VERSION 2.40 LEVEL 930430

LOWER LEVEL WIND V-FIELD (M/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -2

22 I	9	6	2	5	272	289	309	331	355	380	407	439	475	515	558	598	621	625	614	593	569	545
I	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
21 I	12	10	6	0	264	283	304	329	356	386	421	461	505	553	598	636	659	662	648	624	596	569
I	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20 I	14	12	9	242	258	279	302	329	357	388	423	461	504	550	596	637	661	666	655	635	609	582
I	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19 I	14	13	9	244	261	282	305	331	358	387	419	454	492	532	573	610	634	642	635	618	597	574
I	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18 I	13	11	237	250	267	287	309	333	358	385	412	442	473	505	538	568	589	599	598	587	571	554
I	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
17 I	11	8	246	259	275	293	314	336	358	381	405	428	452	475	499	521	538	549	552	548	539	527
I	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
16 I	8	247	256	269	284	301	320	339	359	379	398	417	434	450	466	481	494	503	509	509	506	500
I	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15 I	7	258	267	279	293	308	325	343	361	379	395	410	423	434	444	454	462	469	474	477	477	475
I	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
14 I	53	267	276	287	300	315	331	347	364	380	395	409	420	428	435	441	445	449	452	455	456	456
I	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
13 I	56	54	282	293	305	319	335	351	367	383	398	411	423	431	436	439	441	442	442	443	443	443
I	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
12 I	61	59	56	52	308	322	337	353	370	386	402	416	427	436	442	444	443	442	439	438	436	435

I	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
11 I	67	65	62	58	53	322	337	353	370	388	404	419	431	440	446	448	446	443	439	436	433	430
I	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
10 I	77	74	71	67	62	56	49	346	364	382	399	415	428	438	444	446	445	441	437	432	428	425
I	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
9 I	89	87	83	79	74	67	59	51	351	369	387	404	418	429	435	438	438	435	430	426	422	418
I	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
8 I	104	102	99	94	88	81	73	64	54	44	370	387	402	413	420	424	425	424	421	417	413	410
I	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+
7 I	122	120	117	113	106	99	90	80	69	58	48	365	380	391	400	406	409	409	408	406	403	401
I	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	+	+
6 I	142	141	139	134	128	119	110	99	87	76	65	55	45	368	378	385	390	392	393	392	391	390
I	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+
5 I	165	165	163	159	152	143	132	121	108	96	84	71	60	51	355	364	370	374	377	378	378	378
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+
4 I	190	191	189	185	178	168	157	145	131	118	102	87	75	64	56	50	350	356	360	363	365	366
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+
3 I	215	217	216	211	204	194	182	169	154	135	118	103	89	78	69	61	55	338	344	348	352	354
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
2 I	239	242	241	236	229	218	206	190	171	151	134	117	103	91	81	72	65	59	54	334	338	342
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
1 I	261	264	263	258	250	240	224	205	185	166	147	131	116	103	92	82	75	68	62	58	326	330
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22

MESOPAC VERSION 2.40 LEVEL 930430

UPPER LEVEL WIND U-FIELD (M/S)   year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -2

22 I	281	282	282	283	283	283	283	282	281	279	278	276	275	274	273	272	272	272	272	273	273	274
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21 I	283	284	285	285	285	285	284	283	282	280	278	277	275	274	273	272	272	272	272	272	273	274
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20 I	287	287	288	288	288	287	286	285	283	281	279	277	276	274	273	272	272	272	272	272	273	274
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19 I	291	290	291	291	290	289	288	286	285	283	280	278	276	275	273	272	272	272	272	272	273	274
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18 I	295	294	294	294	293	292	290	289	286	284	282	279	277	276	274	273	272	272	272	273	273	274
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17 I	300	299	298	297	296	295	293	291	289	286	284	281	279	277	275	274	273	273	273	273	274	275
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16 I	306	304	303	301	300	299	296	294	291	289	286	283	280	278	277	275	274	274	274	274	275	275
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15 I	312	310	308	306	304	302	300	297	295	291	288	285	283	280	278	277	276	275	275	275	275	276
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14 I	318	316	314	311	309	307	304	301	298	295	291	288	285	283	281	279	278	277	276	276	277	277
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13 I	325	323	320	317	315	312	309	306	302	299	295	292	288	286	283	281	280	279	278	278	278	279
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12 I	333	330	327	324	321	318	314	311	307	303	299	295	292	289	286	284	283	281	280	280	280	280
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11 I	341	338	335	331	328	324	320	316	312	308	304	300	296	293	290	288	286	284	283	282	282	282
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10 I	349	346	342	339	335	330	326	322	318	313	309	305	301	297	294	291	289	287	286	285	284	284
I	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9 I	357	354	351	347	342	338	333	329	324	319	314	310	306	302	298	295	293	291	289	288	287	286

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
8	365	362	359	355	350	346	340	335	330	325	320	316	311	307	303	300	297	295	293	291	290	289
7	373	370	367	363	358	353	348	343	337	332	327	322	317	312	308	305	302	299	297	295	294	292
6	381	378	375	371	366	361	356	350	344	339	333	328	323	318	314	310	307	304	301	299	297	296
5	388	385	382	379	374	369	363	357	351	346	340	334	329	324	319	315	312	308	305	303	301	299
4	394	392	389	386	381	376	371	365	359	353	347	341	335	330	325	321	317	313	310	307	305	303
3	400	398	395	392	388	383	378	372	366	359	353	347	342	336	331	326	322	318	315	312	309	307
2	404	403	401	398	394	389	384	378	372	366	360	354	348	342	337	332	327	323	320	316	313	311
1	408	407	405	402	399	395	390	384	378	372	365	359	353	348	342	337	332	328	324	321	318	315

MESOPAC VERSION 2.40 LEVEL 930430

UPPER LEVEL WIND V-FIELD (M/S) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
22	547	554	562	571	582	594	607	621	634	647	659	670	678	685	690	693	694	694	693	691	688	685
21	548	555	563	572	583	595	607	621	634	647	659	669	678	685	690	693	695	695	694	692	689	686
20	550	556	564	573	583	594	607	620	633	646	658	668	677	684	690	693	695	695	694	693	690	687
19	551	557	564	573	583	594	606	618	631	644	655	666	675	683	688	692	694	695	694	692	690	687
18	552	557	564	572	582	592	604	616	628	641	652	663	672	680	686	690	692	693	693	691	689	686
17	552	557	563	571	580	590	601	613	625	637	649	659	669	677	683	687	690	691	691	690	688	685
16	551	556	562	569	578	587	598	609	621	633	644	655	664	672	679	683	686	688	689	688	686	683
15	549	554	560	567	575	584	594	605	616	628	639	650	659	667	674	679	682	684	685	685	683	681
14	547	552	557	563	571	580	590	600	611	622	633	644	653	661	668	673	677	680	681	682	680	678
13	543	548	554	560	567	575	585	595	605	616	627	637	646	655	662	667	671	674	676	677	677	675
12	539	544	549	555	562	570	579	589	599	610	620	630	639	648	655	660	665	668	671	672	673	672
11	535	539	544	550	557	564	573	582	592	602	613	622	632	640	647	653	658	662	665	667	668	668
10	529	534	539	544	551	558	566	575	585	595	605	614	623	632	639	646	651	655	658	661	663	663
9	524	528	532	538	544	551	559	568	577	587	596	606	615	623	631	638	643	648	651	654	657	658
8	518	521	526	531	537	544	552	560	569	578	588	597	606	615	622	629	635	640	644	648	650	652
7	512	515	519	524	530	537	544	552	561	570	579	588	597	606	614	621	627	632	637	640	643	646
6	506	509	512	517	523	529	536	544	552	561	570	579	588	597	605	612	618	624	629	633	636	639

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
5	500	502	506	510	515	522	528	536	544	553	562	571	579	588	596	603	610	616	621	626	629	633
4	495	497	500	504	509	514	521	528	536	545	553	562	571	579	587	595	601	608	613	618	622	626
3	490	492	494	498	502	508	514	521	529	537	545	554	562	571	579	586	593	600	605	611	615	619
2	486	487	490	493	497	502	508	514	522	529	537	546	554	562	570	578	585	592	598	603	608	612
1	483	484	486	488	492	497	502	508	515	523	530	538	547	555	563	570	577	584	590	596	601	606

MESOPAC VERSION 2.40 LEVEL 930430

PRECIPITATION RATE (MM/HR) year: 88 month: 1 day: 2 Julian day: 2 hour: 23

Multiply all values by 10 ** -3

22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	1524	1524	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1524	1524	1524	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1524	1524	1524	1524	1524	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	1524	1524	1524	1524	1524	1524	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
     I    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   2 I 1524  1524  1524  1524  1524  1524  1524     0     0     0     0     0     0     0     0     0     0     0     0     0
     I    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
   1 I 1524  1524  1524  1524  1524  1524  1524  1524     0     0     0     0     0     0     0     0     0     0     0     0
     I    +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +     +
     ----------------------------------------------------------------------------------------------------------------------
          1     2     3     4     5     6     7     8     9    10    11    12    13    14    15    16    17    18    19    20

PRECIPITATION RATE (MM/HR)                                         year: 88 month:  1 day:  2 Julian day:   2 hour: 23

Multiply all values by 10 **  -3

  22 I    0     0
     I    +     +
  21 I    0     0
     I    +     +
  20 I    0     0
     I    +     +
  19 I    0     0
     I    +     +
  18 I    0     0
     I    +     +
  17 I    0     0
     I    +     +
  16 I    0     0
     I    +     +
  15 I    0     0
     I    +     +
  14 I    0     0
     I    +     +
  13 I    0     0
     I    +     +
  12 I    0     0
     I    +     +
  11 I    0     0
     I    +     +
  10 I    0     0
     I    +     +
   9 I    0     0
     I    +     +
   8 I    0     0
     I    +     +
   7 I    0     0
     I    +     +
   6 I    0     0
     I    +     +
   5 I    0     0
     I    +     +
   4 I    0     0
     I    +     +
   3 I    0     0
     I    +     +
   2 I    0     0
     I    +     +
   1 I    0     0
     I    +     +
     -----------
         21    22
RUNTIME CALL NO.:        2   DATE: 06/15/93   TIME: 12:33:29.39
DELTA TIME:       63.33 (SEC)
```

APPENDIX D

SAMPLE MESOPUFF II INPUT AND OUTPUT FILES

SAMPLE MESOPUFF II INPUT FILE (PUFF.INP)

```
MESOPUFF II TEST CASE - 24 hr simulation 1/2/88, uses hrly ozone
   88  002    0   24    1    0   13    5    0
    1    4    2    T   2.    T 900.
    1   22    1   22    4   19    4   19    2
    T    T    T    T    T
    T    T   12    F    0    0    T    T    T    T    T    T    0    0
100001
      0.36      0.25      0.19      0.13     0.096     0.063
      0.90      0.90      0.90      0.90      0.90      0.90
   0.00023     0.058      0.11      0.57      0.85      0.77
      2.10      1.09      0.91      0.58      0.47      0.42
       5.0     3.873     2.739     1.871     1.225     0.707
    10000.         5
    2    2    1   80   10  0.2  2.0  2.0
   16
12.7 38.5
12.3 35.3
 5.2 40.1
 5.4 41.7
 5.9 43.3
 2.5 59.8
 3.3 62.5
16.1 16.0
16.7 15.3
17.8 13.9
14.5 12.0
17.4 10.0
15.7  8.4
15.1 20.7
16.8 20.7
-0.6 19.9
15.5   9.0 50.  6.1 14.9 434.    100.0      50.0     150.0
       2.5      13.5               Class I area receptors
       2.5      12.0
       4.0      12.0
       5.0      11.0
       5.5       9.5
       6.5       9.0
       6.5       7.5
       8.0       8.0
       7.5       6.5
       9.0       6.0
       8.0      5.75
       7.0       4.0
       8.5       3.5
```

PARTIAL LISTING OF SAMPLE MESOPUFF II OUTPUT FILE (PUFF.LST)

RUNTIME CALL NO.: 1 DATE: 06/15/93 TIME: 12:33:59.54

MESOPUFF VERSION 5.10 LEVEL 930530

****

MESOPUFF II TEST CASE - 24 hr simulation 1/2/88, uses hrly ozone

GENERAL RUN INFORMATION:

YEAR OF RUN (NSYR) = 88
JULIAN DAY OF START OF RUN (NSDAY) = 2
HOUR OF START OF RUN (NSHR) = 0
LENGTH OF RUN (NADVTS) = 24 (HOURS)
NUMBER OF POINT SOURCES (NPTS) = 1
NUMBER OF AREA (URBAN) SOURCES (NAREAS) = 0
NUMBER OF NONGRIDDED RECEPTORS (NREC) = 13
NUMBER OF POLLUTANT SPECIES (NSPEC) = 5
Continuation Run ? (ICONT) = 0

COMPUTATIONAL VARIABLES:

CONCENTRATION AVERAGING TIME (IAVG) = 1 (HOUR(S))
PUFF RELEASE RATE (NPUF) = 4 (PUFFS/HOUR)
MINIMUM SAMPLING RATE (NSAMAD) = 2 (SAMPLES/HOUR)
SAMPLING RATE VARIED WITH WIND SPEED ? (LVSAMP) = T
SAMPLING RATE WIND SPEED INTERVAL (WSAMP) = 2.00 (M/S)
CONCENTRATIONS CALCULATED AT SAMPLING GRID POINTS ? (LSGRID) = T
PUFFS YOUNGER THAN "AGEMIN" SECONDS ARE NOT SAMPLED (AGEMIN) = 900. (SECONDS)

GRID INFORMATION:

BEGINNING OF COMPUTATIONAL GRID IN X-DIRECTION (IASTAR) = 1
END OF COMPUTATIONAL GRID IN X-DIRECTION (IASTOP) = 22
BEGINNING OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTAR) = 1
END OF COMPUTATIONAL GRID IN Y-DIRECTION (JASTOP) = 22
BEGINNING OF SAMPLING GRID IN X-DIRECTION (ISASTR) = 4
END OF SAMPLING GRID IN X-DIRECTION (ISASTP) = 19
BEGINNING OF SAMPLING GRID IN Y-DIRECTION (JSASTR) = 4
END OF SAMPLING GRID IN Y-DIRECTION (JSASTP) = 19
SAMPLING GRID SPACING FACTOR (MESHDN) = 2

TECHNICAL OPTIONS:

GAUSSIAN VERTICAL CONCENTRATION DISTRIBUTION ? (LGAUSS) = T
CHEMICAL PROCESSES MODELED ? (LCHEM) = T
DRY DEPOSITION MODELED ? (LDRY) = T
WET REMOVAL MODELED ? (LWET) = T
3 VERTICAL LAYERS ? (L3VL) = T

OUTPUT OPTIONS:

CONCENTRATIONS STORED ON TAPE ? (LTAPE) = T
CONCENTRATIONS PRINTED ? (LPRINT) = T
PRINT INTERVAL (IPRINF) = 12
PUFF PARAMETERS PRINTED EACH SAMPLING STEP ? (LDB) = F
TIME STEPS FOR WHICH PUFF PARAMETERS PRINTED (NN1,NN2) = 0, 0

WET FLUXES AT GRIDDED RECEPTORS COMPUTED ? (LWETG) = T
WET FLUXES AT NONGRIDDED RECEPTORS COMPUTED ? (LWETNG) = T
DRY FLUXES AT GRIDDED RECEPTORS COMPUTED ? (LDRYG) = T

DRY FLUXES AT NONGRIDDED RECEPTORS COMPUTED ? (LDRYNG) = T
WET AND DRY FLUXES STORED ON TAPE ? (LSAVEF) = T
WET AND DRY FLUXES PRINTED ? (LPRFLX) = T
Restart file saved ? (IRES) = 0
Results saved every "IINT" time steps -- (IINT) = 0

MESOPUFF VERSION 5.10 LEVEL 930530

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DEFAULT OVERRIDE OPTIONS (0=NO,1=YES)

USER INPUT SIGY, SIGZ VARIABLES (IOPTS(1)) =	1
USER INPUT VERTICAL DIFFUSIVITY CONSTANTS (IOPTS(2)) =	0
USER INPUT DRY DEP. SO2 CANOPY RESISTANCES (IOPTS(3)) =	0
USER INPUT OTHER DRY DEP. CONSTANTS (IOPTS(4)) =	0
USER INPUT WET REMOVAL CONSTANTS (IOPTS(5)) =	0
USER INPUT CHEMICAL TRANSFORMATION VARIABLES (IOPTS(6)) =	1

SIGY, SIGZ VARIABLES:

AY =	0.36000	0.25000	0.19000	0.13000	0.09600	0.06300
BY =	0.90000	0.90000	0.90000	0.90000	0.90000	0.90000
AZ =	0.00023	0.05800	0.11000	0.57000	0.85000	0.77000
BZ =	2.10000	1.09000	0.91000	0.58000	0.47000	0.42000
AZT (IN M) =	5.00000	3.87300	2.73900	1.87100	1.22500	0.70700

THDEP = 10000. (M)
STABILITY CLASS USED IN SIGY, SIGZ CALCULATIONS FOR PUFFS ABOVE BOUNDARY LAYER (JSUP) = 5
(0 = BOUNDARY LAYER STABILITY CLASS, 5 = E STABILITY, 6 = F STABILITY)

VERTICAL DIFFUSIVITY CONSTANTS:
CON1K = 0.010 (M**2/S)
CON2K = 0.100 (M**2/S)

LAND USE CATEGORY	SO2 CANOPY RESISTANCE (S/M)			
	A,B,C	D	E	F
1	100.00	300.00	1000.00	0.00
2	100.00	300.00	1000.00	0.00
3	100.00	300.00	1000.00	0.00
4	100.00	300.00	1000.00	0.00
5	100.00	300.00	1000.00	0.00
6	100.00	300.00	1000.00	0.00
7	100.00	300.00	1000.00	0.00
8	200.00	500.00	1000.00	1000.00
9	50.00	75.00	100.00	0.00
10	75.00	300.00	1000.00	0.00
11	1000.00	1000.00	1000.00	0.00
12	0.00	0.00	0.00	0.00

DRY DEPOSITION CONSTANTS:
CANOPY RESISTANCE FOR NOX IN S/M (RCNOX) = 130.00 (A,B,C) 500.00 (D) 1500.00 (E) 1500.00 (F)
SURFACE RESISTANCE CONSTANT FOR GASES (RSGCON) = 2.60
SURFACE RESISTANCE FOR PARTICLES (RSPART) = 1000.00 (S/M)

WET REMOVAL CONSTANTS:

	SO2	SO4	NOX	HNO3	NO3
WA (LIQUID PRECIP.)	3.00E-05	1.00E-04	0.00E+00	6.00E-05	1.00E-04
WA (FROZEN PRECIP.)	0.00E+00	3.00E-05	0.00E+00	0.00E+00	3.00E-05

WHERE Q/QO = EXP(-WA * (P/PO) * DT)
QO IS POLLUTANT MASS IN PUFF AT TIME T
Q IS POLLUTANT MASS IN PUFF AT TIME T + DT

WA IS THE WET REMOVAL CONSTANT (1/S)
P IS THE PRECIPITATION RATE (MM/HR)
PO IS A REFERENCE PRECIPITATION RATE OF 1 MM/HR
DT IS THE SAMPLING INTERVAL

CHEMICAL TRANSFORMATION VARIABLES:
SOX TRANSFORMATION METHOD FLAG (MSOX) = 2
0 - NO TRANSFORMATION
1 - USER SPECIFIED
2 - ERT THEORETICAL EQUATION
3 - GILLANI EQUATION
4 - HENRY EQUATION FOR ST. LOUIS
5 - HENRY EQUATION FOR LOS ANGELES
NOX TRANSFORMATION METHOD FLAG (MNOX) = 2
0 - NO TRANSFORMATION
1 - USER SPECIFIED
2 - ERT THEORETICAL EQUATION
OZONE INPUT METHOD FLAG (MO3) = 1
0 - DEFAULT OZONE VALUE USED
1 - HOURLY OZONE VALUES READ
DEFAULT BACKGROUND OZONE (CO3B) = 8.0 (PPB)
TOTAL AMMONIA CONCENTRATION (CTNH3) = 1.0 (PPB)
NIGHTTIME TRANSFORMATION RATES:
SO2 LOSS RATE (RNITE(1)) = 0.2 (%/HOUR)
NOX LOSS RATE (RNITE(2)) = 2.0 (%/HOUR)
TOTAL NO3 FORMATION RATE (RNITE(3)) = 2.0 (%/HOUR)
HOURLY OZONE VALUES READ -- NUMBER OF OZONE STATIONS (NOZONE) = 16
GRID COORDINATES OF OZONE STATIONS:

STATION	X-COORDINATE	Y-COORDINATE
1	13.	39.
2	12.	35.
3	5.	40.
4	5.	42.
5	6.	43.
6	3.	60.
7	3.	63.
8	16.	16.
9	17.	15.
10	18.	14.
11	15.	12.
12	17.	10.
13	16.	8.
14	15.	21.
15	17.	21.
16	-1.	20.

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POINT SOURCE DATA

SOURCE	GRID COORDINATES X	Y	STACK HT (M)	DIAMETER (M)	EXIT VEL. (M/S)	TEMP. (DEG K)	EMISSION RATES (G/S) SO2	SO4	NOX	HNO3	NO3
1	16.	9.	50.00	6.10	14.90	434.00	1.000E+02	5.000E+01	1.500E+02	0.000E+00	0.000E+00

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NONGRIDDED RECEPTOR LOCATIONS

RECEPTOR	X (GRID UNITS)	Y (GRID UNITS)
1	2.500	13.500
2	2.500	12.000
3	4.000	12.000
4	5.000	11.000
5	5.500	9.500
6	6.500	9.000
7	6.500	7.500
8	8.000	8.000
9	7.500	6.500
10	9.000	6.000
11	8.000	5.750
12	7.000	4.000
13	8.500	3.500

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INFORMATION READ FROM METEOROLOGICAL DATA FILE:

YEAR OF METEOROLOGICAL DATA = 88
METEOROLOGICAL DATA BEGINS ON JULIAN DAY 2
NUMBER OF HOURS OF METEOROLOGICAL DATA = 25

METEOROLOGICAL GRID SIZE IN X (WEST-EAST) DIRECTION = 22
METEOROLOGICAL GRID SIZE IN Y (SOUTH-NORTH) DIRECTION = 22
METEOROLOGICAL GRID SPACING = 10000.0 (M)
BASE TIME ZONE = 5 (E.S.T.)

VON KARMAN CONSTANT = 0.40
CODE FOR LOWER-LEVEL WIND FIELD (ILWF) = 2
CODE FOR UPPER-LEVEL WIND FIELD (IUWF) = 4

NUMBER OF STATIONS USED IN CONSTRUCTION OF METEOROLOGICAL DATA FIELDS
SURFACE: 6
RAWINSONDE: 3

STATION TYPE	GRID COORDINATES X (GRID UNITS)	Y (GRID UNITS)
SURFACE	0.30	19.30
SURFACE	1.40	-3.20
SURFACE	16.00	10.70
SURFACE	-6.10	34.80
SURFACE	14.70	31.20
SURFACE	17.70	20.40
RAWINSONDE	1.60	-3.40
RAWINSONDE	17.70	20.30
RAWINSONDE	-4.70	31.50

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SURFACE ROUGHNESS LENGTH (M) AT EACH GRID POINT

Multiply all values by 10 ** -2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
22	20	100	20	20	10	20	20	20	0	0	0	0	20	50	50	50	50	0	0	0	0	0
21	20	20	20	20	20	20	20	20	20	0	0	20	20	20	20	100	50	100	0	0	0	0
20	100	100	20	20	20	20	20	20	20	20	20	20	20	20	20	100	100	100	0	0	0	0
19	100	100	100	20	50	50	50	100	20	20	20	20	20	20	20	20	100	100	0	0	0	0
18	100	20	20	20	20	50	20	20	20	20	20	20	20	20	20	20	20	0	0	0	0	0
17	100	100	20	20	20	20	20	20	20	20	20	20	20	20	20	20	100	0	0	0	0	0
16	100	100	100	20	20	20	50	50	20	20	20	20	20	20	20	20	100	0	0	0	0	0
15	100	100	100	20	100	50	50	50	50	20	20	20	20	20	20	100	100	0	0	0	0	0
14	100	100	100	50	100	50	50	50	50	50	20	20	20	20	20	100	100	0	0	0	0	0
13	0	100	100	50	100	50	50	50	50	50	20	20	20	20	100	100	100	0	0	0	0	0
12	0	100	100	100	100	50	50	50	50	50	20	20	20	20	10	100	100	0	0	0	0	0
11	0	0	0	100	100	50	50	50	50	50	20	20	20	20	100	100	100	0	0	0	0	0
10	0	0	0	0	0	100	50	50	20	20	20	20	20	20	100	100	0	0	0	0	0	0
9	0	0	0	0	0	100	100	20	20	20	20	20	20	20	100	100	0	0	0	0	0	0
8	0	0	0	0	0	0	100	100	20	20	20	20	20	20	100	0	0	0	0	0	0	0
7	0	0	0	0	0	0	100	100	20	20	20	20	20	20	20	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	100	100	20	20	20	20	100	20	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	100	20	20	20	20	20	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	100	100	0	20	20	20	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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STATION NUMBER OF CLOSEST SURFACE MET. STATION TO EACH GRID POINT

Multiply all values by 10 ** -2

22	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600	600
21	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600	600

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
20	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600	600
19	100	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600
18	100	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600
17	100	100	100	100	100	100	100	100	100	600	600	600	600	600	600	600	600	600	600	600	600	600
16	100	100	100	100	100	100	100	100	300	300	300	300	300	300	600	600	600	600	600	600	600	600
15	100	100	100	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	600	600	600
14	100	100	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
13	100	100	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
12	100	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
11	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
10	100	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
9	100	100	100	100	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
8	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
7	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
6	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
5	200	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
4	200	200	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300	300
3	200	200	200	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300	300
2	200	200	200	200	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300	300
1	200	200	200	200	200	200	200	200	200	200	200	300	300	300	300	300	300	300	300	300	300	300

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LAND USE CATEGORIES FOR EACH GRID POINT

Multiply all values by 10 ** -1

22	10	50	10	10	60	10	10	90	120	120	120	120	10	100	100	100	100	120	120	120	120	120
21	10	10	10	10	10	10	10	10	10	120	120	10	10	10	10	110	100	110	120	120	120	120
20	110	110	10	10	10	10	10	10	10	10	10	10	10	10	10	110	110	110	120	120	120	120
19	110	110	110	10	100	100	100	50	10	10	10	10	10	10	90	90	110	110	120	120	120	120
18	50	10	10	10	10	100	10	10	10	10	10	10	10	10	90	90	10	120	120	120	120	120

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
17	50	50	10	10	10	10	10	10	10	90	90	10	10	90	90	90	110	120	120	120	120	120
16	110	50	50	10	10	10	100	100	10	90	90	90	90	90	90	10	110	120	120	120	120	120
15	110	110	110	10	50	100	100	100	100	10	90	90	90	90	90	110	110	120	120	120	120	120
14	110	50	50	100	50	100	100	100	100	100	90	90	90	90	90	110	110	120	120	120	120	120
13	120	50	50	100	50	100	100	100	100	100	90	90	90	90	110	110	110	120	120	120	120	120
12	120	50	50	50	50	100	100	100	100	100	90	90	90	90	60	110	110	120	120	120	120	120
11	120	120	120	50	50	100	100	100	100	100	90	90	90	90	110	110	110	120	120	120	120	120
10	120	120	120	120	120	50	100	100	90	90	90	90	90	90	110	110	120	120	120	120	120	120
9	120	120	120	120	120	50	50	90	90	90	90	90	90	10	110	110	120	120	120	120	120	120
8	120	120	120	120	120	120	50	50	90	90	90	90	90	10	110	120	120	120	120	120	120	120
7	120	120	120	120	120	120	50	50	90	90	90	90	10	10	10	120	120	120	120	120	120	120
6	120	120	120	120	120	120	120	50	50	90	90	90	10	50	90	120	120	120	120	120	120	120
5	120	120	120	120	120	120	120	120	50	90	90	90	90	90	120	120	120	120	120	120	120	120
4	120	120	120	120	120	120	50	50	120	90	90	90	120	120	120	120	120	120	120	120	120	120
3	120	120	120	120	120	120	120	50	50	120	120	120	120	120	120	120	120	120	120	120	120	120
2	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
1	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120

MESOPUFF VERSION 5.10 LEVEL 930530

STATION NUMBER OF CLOSEST OZONE MEASUREMENT STATION TO EACH GRID POINT

Multiply all values by 10 ** 0

22	16	16	16	16	16	16	16	14	14	14	14	14	14	14	14	15	15	15	15	15	15	15
21	16	16	16	16	16	16	16	14	14	14	14	14	14	14	14	15	15	15	15	15	15	15
20	16	16	16	16	16	16	16	14	14	14	14	14	14	14	14	15	15	15	15	15	15	15
19	16	16	16	16	16	16	16	14	14	14	14	14	14	14	14	15	15	15	15	15	15	15
18	16	16	16	16	16	16	16	14	14	14	14	14	14	8	8	8	8	8	15	15	15	15
17	16	16	16	16	16	16	16	14	14	8	8	8	8	8	8	8	8	9	9	9	10	10
16	16	16	16	16	16	16	11	11	11	11	8	8	8	8	8	8	9	9	9	10	10	10
15	16	16	16	16	16	16	11	11	11	11	11	11	8	8	8	9	9	10	10	10	10	10

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
14	16	16	16	16	16	11	11	11	11	11	11	11	11	11	11	9	10	10	10	10	10	10
13	16	16	16	16	16	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	10
12	16	16	16	16	11	11	11	11	11	11	11	11	11	11	11	11	12	10	10	10	10	10
11	16	16	16	16	11	11	11	11	11	11	11	11	11	11	11	12	12	12	12	12	12	12
10	16	16	16	11	11	11	11	11	11	11	11	11	11	11	13	12	12	12	12	12	12	12
9	16	16	16	11	11	11	11	11	11	11	11	13	13	13	13	13	12	12	12	12	12	12
8	16	16	11	11	11	11	11	11	13	13	13	13	13	13	13	13	13	12	12	12	12	12
7	16	16	11	11	11	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	12	12
6	16	11	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12	12
5	16	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	12
4	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12
3	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
2	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
1	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13

MESOPUFF VERSION 5.10 LEVEL 930530

GROUND-LEVEL SO2 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	2	2	2	2	2	2	3	5	6	8	9	9	8	4	1	0	0	0	0	0	0	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
20	3	5	7	9	9	9	10	11	15	20	26	32	39	46	53	49	28	6	0	0	0	0	0	0	0
19	8	14	21	27	30	31	32	34	39	47	57	66	75	87	106	132	142	86	12	0	0	0	0	0	0
18	16	28	42	56	67	71	70	68	69	73	79	85	90	94	102	119	159	219	142	11	0	0	0	0	0
17	24	39	59	82	102	112	111	103	93	87	85	85	85	84	84	88	98	139	253	158	3	0	0	0	0
16	27	40	59	83	107	123	124	113	96	81	71	64	59	52	46	43	44	53	112	259	109	0	0	0	0
15	24	32	43	58	76	90	93	84	69	53	41	30	23	16	11	8	6	5	9	82	279	21	0	0	0
14	19	20	24	29	36	43	44	39	31	21	14	8	4	2	1	0	0	0	0	0	101	310	0	0	0
13	13	11	10	10	12	13	13	11	8	5	3	1	0	0	0	0	0	0	0	0	5	326	39	0	0
12	9	6	4	3	2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	279	0	0
11	5	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GROUND-LEVEL SO2 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0
26	0	0	0	0	0	0

	26	27	28	29	30	31
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0
16	0	0	0	0	0	0
15	0	0	0	0	0	0
14	0	0	0	0	0	0
13	0	0	0	0	0	0
12	0	0	0	0	0	0
11	0	0	0	0	0	0
10	0	0	0	0	0	0
9	0	0	0	0	0	0
8	0	0	0	0	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

GROUND-LEVEL SO4 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21	1	1	1	1	1	1	1	2	2	3	4	5	6	6	5	2	0	0	0	0	0	0	0	0	0
20	2	4	6	7	7	7	7	8	10	14	17	21	25	29	33	30	17	3	0	0	0	0	0	0	0
19	7	11	17	21	23	24	24	24	27	32	38	44	49	56	66	80	84	49	7	0	0	0	0	0	0
18	13	22	33	44	52	54	53	50	49	51	54	57	59	61	65	73	94	125	79	6	0	0	0	0	0
17	20	31	47	65	79	86	84	76	67	61	58	57	56	55	53	54	59	81	141	86	2	0	0	0	0
16	22	32	47	65	83	94	94	84	70	58	49	43	39	34	30	27	27	31	63	141	58	0	0	0	0
15	20	26	34	46	59	69	71	63	51	38	28	21	15	11	7	5	3	3	5	45	148	11	0	0	0
14	16	17	19	23	28	33	34	30	23	16	10	6	3	1	1	0	0	0	0	0	53	161	0	0	0
13	12	10	8	8	9	10	10	8	6	4	2	1	0	0	0	0	0	0	0	0	3	167	20	0	0
12	8	5	3	2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	141	0	0
11	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
 1 I  0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I  +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
   -----------------------------------------------------------------------------------------------------------------------------
      1    2    3    4    5    6    7    8    9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24   25
```

GROUND-LEVEL SO4 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS   year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

```
31 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
30 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
29 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
28 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
27 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
26 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
25 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
24 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
23 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
22 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
21 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
20 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
19 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
18 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
17 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
16 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
15 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
14 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
13 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
12 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
11 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
10 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
 9 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
 8 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
 7 I  0    0    0    0    0    0
   I  +    +    +    +    +    +
 6 I  0    0    0    0    0    0
```

	26	27	28	29	30	31
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

GROUND-LEVEL NOX CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
21	1	2	2	2	2	2	2	3	4	6	9	11	12	12	11	6	1	0	0	0	0	0	0	0	0
20	4	6	9	12	13	12	13	15	20	27	35	44	53	63	75	73	43	8	0	0	0	0	0	0	0
19	11	19	28	36	41	42	42	45	52	63	77	90	103	120	149	192	212	129	18	0	0	0	0	0	0
18	21	37	56	76	91	97	96	92	93	99	108	118	125	132	143	170	234	329	214	16	0	0	0	0	0
17	31	52	80	112	141	157	156	142	128	119	116	119	121	121	119	124	140	208	382	237	5	0	0	0	0
16	35	54	81	115	149	174	177	160	135	113	98	89	84	76	67	62	63	78	169	391	163	0	0	0	0
15	32	42	58	81	107	128	134	121	99	76	57	42	32	23	16	11	8	7	13	124	419	31	0	0	0
14	25	27	32	40	51	62	64	57	45	31	20	11	6	3	1	1	0	0	0	0	152	463	0	0	0
13	18	15	14	14	16	19	19	16	12	7	4	2	1	0	0	0	0	0	0	0	8	484	58	0	0
12	12	8	5	4	3	4	3	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	415	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
11	7	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

GROUND-LEVEL NOX CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -8

	1	2	3	4	5	6
31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0
26	0	0	0	0	0	0
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0

```
16 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
15 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
14 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
13 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
12 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
11 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
10 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 9 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 8 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 7 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 6 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 5 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 4 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 3 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 2 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
 1 I  0   0   0   0   0   0
   I  +   +   +   +   +   +
    --------------------------
     26  27  28  29  30  31
```

MESOPUFF VERSION 5.10 LEVEL 930530

```
*****************************************************************************************************************
```

GROUND-LEVEL HNO3 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -9

```
31 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
30 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
29 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
28 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
27 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
26 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
25 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
24 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
23 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
```

	26	27	28	29	30	31
26	0	0	0	0	0	0
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0
16	0	0	0	0	0	0
15	0	0	0	0	0	0
14	0	0	0	0	0	0
13	0	0	0	0	0	0
12	0	0	0	0	0	0
11	0	0	0	0	0	0
10	0	0	0	0	0	0
9	0	0	0	0	0	0
8	0	0	0	0	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

GROUND-LEVEL NO3 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

22 I	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
21 I	1	2	3	3	3	3	3	4	5	7	9	11	12	11	8	4	0	0	0	0	0	0	0	0	0
20 I	5	9	12	15	15	15	15	17	22	28	35	43	51	56	56	44	22	4	0	0	0	0	0	0	0
19 I	15	24	36	45	50	50	49	52	58	67	77	86	96	107	115	119	107	56	7	0	0	0	0	0	0
18 I	29	48	72	94	108	112	107	102	101	104	108	110	110	112	115	118	125	137	76	5	0	0	0	0	0
17 I	43	68	101	136	164	175	168	150	133	122	115	109	102	94	90	91	87	92	121	67	1	0	0	0	0
16 I	50	71	101	137	170	188	184	162	134	111	94	82	70	56	46	43	41	40	55	100	35	0	0	0	0
15 I	47	58	74	96	120	136	136	119	94	71	53	39	27	17	11	7	5	4	4	30	85	5	0	0	0
14 I	39	39	42	48	57	65	64	55	41	28	18	10	5	2	1	0	0	0	0	0	28	69	0	0	0
13 I	29	23	19	18	18	20	19	16	11	6	3	1	1	0	0	0	0	0	0	0	1	64	5	0	0
12 I	20	12	7	5	4	4	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0
11 I	13	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 I	7	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 I	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 I	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

GROUND-LEVEL HNO3 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -9

31 I	0	0	0	0	0	0
30 I	0	0	0	0	0	0
29 I	0	0	0	0	0	0
28 I	0	0	0	0	0	0
27 I	0	0	0	0	0	0

Multiply all values by 10 ** -11

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	1	0	0	0	1	1	1	2	2	3	3	2	0	0	0	0	0	0	0	0	0	0	0
21	4	6	8	9	8	7	7	10	13	18	23	28	32	29	19	6	0	0	0	0	0	0	0	0	0
20	15	24	34	41	43	42	42	47	59	75	93	112	134	143	124	67	17	1	0	0	0	0	0	0	0
19	42	69	101	127	141	142	140	145	157	180	204	227	253	276	273	212	101	20	1	0	0	0	0	0	0
18	84	139	206	272	319	336	327	308	296	298	306	311	311	312	313	289	215	95	13	0	0	0	0	0	0
17	128	201	300	410	509	568	568	515	452	410	395	387	368	343	325	309	258	160	53	4	0	0	0	0	0
16	154	221	315	435	567	673	705	648	553	472	424	391	347	290	238	205	161	83	39	9	0	0	0	0	0
15	154	191	248	328	433	537	585	549	461	370	297	236	175	115	70	44	26	9	2	1	0	0	0	0	0
14	136	139	153	179	224	278	306	286	232	169	117	74	41	18	7	3	1	0	0	0	0	0	0	0	0
13	111	89	76	73	79	92	98	88	66	43	24	12	5	1	0	0	0	0	0	0	0	0	0	0	0
12	84	51	33	22	19	19	18	15	10	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	57	29	13	6	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	33	15	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	15	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

```
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
   2 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
   1 I  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
     ------------------------------------------------------------------------------------------------------
        1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
```

GROUND-LEVEL NO3 CONCENTRATIONS (G/M**3) AT SAMPLING GRID POINTS , year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

```
  31 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  30 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  29 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  28 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  27 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  26 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  25 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  24 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  23 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  22 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  21 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  20 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  19 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  18 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  17 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  16 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  15 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  14 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  13 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  12 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  11 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
  10 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
   9 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
   8 I  0   0   0   0   0   0
     I  +   +   +   +   +   +
```

```
7 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
6 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
5 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
4 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
3 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
2 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
1 I  0   0   0   0   0   0
  I  +   +   +   +   +   +
   -----------------------------
    26  27  28  29  30  31
```

GROUND-LEVEL SO2 CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION
1	2.6267E-09	2	5.9056E-08	3	2.3974E-07	4	4.2951E-07
5	2.5897E-08	6	1.2942E-09	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

GROUND-LEVEL SO4 CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION
1	2.1679E-09	2	5.0650E-08	3	1.9569E-07	4	3.4460E-07
5	2.1371E-08	6	1.0382E-09	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

GROUND-LEVEL NOX CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION
1	3.2952E-09	2	7.2394E-08	3	3.1425E-07	4	5.8497E-07
5	3.5583E-08	6	1.8464E-09	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

GROUND-LEVEL HNO3 CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION
1	4.7902E-10	2	1.2704E-08	3	4.3410E-08	4	7.4206E-08
5	4.7275E-09	6	2.1196E-10	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

GROUND-LEVEL NO3 CONCENTRATION (G/M**3) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION	RECEPTOR	CONCENTRATION
1	1.3718E-11	2	3.6523E-10	3	1.2830E-09	4	2.4799E-09
5	2.2207E-10	6	1.5050E-11	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

MESOPUFF VERSION 5.10 LEVEL 930530

****

WET SO2 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

GRID NOT PRINTED -- all values zero

MESOPUFF VERSION 5.10 LEVEL 930530

```
************************************************************************************************************************
```

WET SO4 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

GRID NOT PRINTED -- all values zero

MESOPUFF VERSION 5.10 LEVEL 930530

```
************************************************************************************************************************
```

WET NOX FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

GRID NOT PRINTED -- all values zero

MESOPUFF VERSION 5.10 LEVEL 930530

```
************************************************************************************************************************
```

WET HNO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

GRID NOT PRINTED -- all values zero

MESOPUFF VERSION 5.10 LEVEL 930530

```
************************************************************************************************************************
```

WET NO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

GRID NOT PRINTED -- all values zero

MESOPUFF VERSION 5.10 LEVEL 930530

```
************************************************************************************************************************
```

DRY SO2 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -10

```
31 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
30 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
28 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
27 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
26 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
25 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
24 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
23 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
22 I   0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
21 I   1    1    1    2    2    2    1    1    1    2    2    2    3    3    5    4    1    0    0    0    0    0    0    0    0
```

20	3	4	6	8	9	8	8	7	6	7	8	10	12	19	37	45	28	6	0	0	0	0	0	0	0
19	7	12	18	24	27	27	24	20	17	16	18	20	24	37	76	122	139	84	12	0	0	0	0	0	0
18	14	24	36	49	57	57	49	38	29	25	25	26	29	41	74	111	155	216	142	11	0	0	0	0	0
17	20	33	51	70	83	84	71	52	37	29	27	27	28	40	64	82	96	138	255	159	3	0	0	0	0
16	22	34	50	69	83	84	71	51	36	27	22	20	19	24	35	41	44	53	112	263	111	0	0	0	0
15	19	26	36	47	56	57	48	35	25	17	13	9	7	6	7	7	6	5	9	83	287	21	0	0	0
14	14	16	19	22	25	25	22	16	11	7	4	3	1	1	0	0	0	0	0	0	104	319	0	0	0
13	9	9	8	8	8	7	6	4	3	2	1	0	0	0	0	0	0	0	0	0	5	334	12	0	0
12	6	4	3	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	0	0
11	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

DRY SO2 FLUX (G/M**2/S) AT SAMPLING GRID POINTS   year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -10

31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0
26	0	0	0	0	0	0

	26	27	28	29	30	31
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0
16	0	0	0	0	0	0
15	0	0	0	0	0	0
14	0	0	0	0	0	0
13	0	0	0	0	0	0
12	0	0	0	0	0	0
11	0	0	0	0	0	0
10	0	0	0	0	0	0
9	0	0	0	0	0	0
8	0	0	0	0	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

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DRY SO4 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

31 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22 I	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
21 I	1	1	1	1	1	1	1	2	2	3	4	5	6	6	5	2	0	0	0	0	0	0	0	0	0
20 I	2	4	6	7	7	7	7	8	10	14	17	21	25	29	32	29	17	3	0	0	0	0	0	0	0
19 I	7	11	16	21	23	24	23	24	27	32	38	43	49	55	65	79	83	49	7	0	0	0	0	0	0
18 I	13	22	33	44	51	54	52	49	49	50	53	56	59	60	64	72	93	124	78	6	0	0	0	0	0
17 I	19	31	47	64	79	85	83	75	66	60	58	57	56	54	53	54	58	80	139	85	2	0	0	0	0
16 I	22	32	47	65	82	93	93	83	70	57	49	43	39	34	29	27	26	31	62	140	57	0	0	0	0
15 I	20	26	34	46	59	68	70	63	50	38	28	21	15	11	7	5	3	3	5	44	147	11	0	0	0
14 I	15	17	19	23	28	33	33	29	23	16	10	6	3	1	1	0	0	0	0	0	53	159	0	0	0
13 I	11	9	8	8	9	10	10	8	6	4	2	1	0	0	0	0	0	0	0	0	3	166	20	0	0
12 I	7	5	3	2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	141	0	0
11 I	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10 I	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9 I	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DRY SO4 FLUX (G/M**2/S) AT SAMPLING GRID POINTS   year: 88 month: 1 day: 2 Julien day: 2 hour: 12

Multiply all values by 10 ** -11

31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0
26	0	0	0	0	0	0
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0
16	0	0	0	0	0	0
15	0	0	0	0	0	0
14	0	0	0	0	0	0
13	0	0	0	0	0	0
12	0	0	0	0	0	0
11	0	0	0	0	0	0
10	0	0	0	0	0	0
9	0	0	0	0	0	0
8	0	0	0	0	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0

	26	27	28	29	30	31
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

DRY NOX FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	2	1	0	1	1	1	1	1	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0
21	6	11	14	16	15	13	11	11	11	13	16	20	23	24	20	11	2	0	0	0	0	0	0	0	0
20	26	43	62	76	80	74	65	53	50	55	67	82	100	119	141	137	80	16	0	0	0	0	0	0	0
19	71	123	182	231	250	237	202	162	134	131	148	170	194	226	281	362	401	243	34	0	0	0	0	0	0
18	140	241	365	478	536	512	423	316	238	206	208	223	236	248	270	319	441	622	406	31	0	0	0	0	0
17	202	336	510	682	782	755	615	442	311	244	223	224	228	227	224	232	263	392	725	452	9	0	0	0	0
16	219	342	503	670	777	761	624	446	308	227	187	168	158	144	126	115	118	147	320	744	311	0	0	0	0
15	189	264	358	456	525	517	429	311	213	148	107	80	61	44	30	20	15	13	25	236	799	59	0	0	0
14	136	163	193	221	240	233	194	140	94	60	37	21	12	6	2	1	0	0	0	0	290	884	0	0	0
13	86	84	82	79	76	69	55	39	24	14	7	3	1	0	0	0	0	0	0	0	15	924	112	0	0
12	49	38	27	20	16	13	9	6	3	1	1	0	0	0	0	0	0	0	0	0	0	0	806	0	0

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
11	27	16	9	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	13	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DRY NOX FLUX (G/M**2/S) AT SAMPLING GRID POINTS   year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0
26	0	0	0	0	0	0
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0

16 I	0	0	0	0	0	0
I	+	+	+	+	+	+
15 I	0	0	0	0	0	0
I	+	+	+	+	+	+
14 I	0	0	0	0	0	0
I	+	+	+	+	+	+
13 I	0	0	0	0	0	0
I	+	+	+	+	+	+
12 I	0	0	0	0	0	0
I	+	+	+	+	+	+
11 I	0	0	0	0	0	0
I	+	+	+	+	+	+
10 I	0	0	0	0	0	0
I	+	+	+	+	+	+
9 I	0	0	0	0	0	0
I	+	+	+	+	+	+
8 I	0	0	0	0	0	0
I	+	+	+	+	+	+
7 I	0	0	0	0	0	0
I	+	+	+	+	+	+
6 I	0	0	0	0	0	0
I	+	+	+	+	+	+
5 I	0	0	0	0	0	0
I	+	+	+	+	+	+
4 I	0	0	0	0	0	0
I	+	+	+	+	+	+
3 I	0	0	0	0	0	0
I	+	+	+	+	+	+
2 I	0	0	0	0	0	0
I	+	+	+	+	+	+
1 I	0	0	0	0	0	0
I	+	+	+	+	+	+
	26	27	28	29	30	31

MESOPUFF VERSION 5.10 LEVEL 930530

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DRY HNO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

31 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
29 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
28 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
27 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
26 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
25 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
24 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
23 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
22	0	1	2	1	0	1	1	2	2	4	4	5	5	3	1	0	0	0	0	0	0	0	0	0	0
21	8	13	17	19	17	14	13	17	23	31	41	51	58	54	36	15	2	0	0	0	0	0	0	0	0
20	33	54	76	88	88	80	77	83	105	133	166	205	245	264	238	173	85	16	0	0	0	0	0	0	0
19	92	154	220	267	277	262	247	250	273	316	363	411	464	502	491	466	420	224	29	0	0	0	0	0	0
18	180	301	440	553	602	586	537	496	482	494	514	530	538	529	493	465	498	561	329	24	0	0	0	0	0
17	258	421	617	796	902	910	838	731	638	582	555	535	505	448	387	363	356	390	538	305	6	0	0	0	0
16	277	431	614	796	930	976	919	790	648	536	463	408	353	280	207	178	171	171	253	464	174	0	0	0	0
15	234	333	445	558	654	705	679	583	459	347	263	197	142	90	50	31	22	17	21	148	441	26	0	0	0
14	159	206	244	279	313	334	323	273	204	139	90	52	29	12	4	2	0	0	0	0	137	366	0	0	0
13	88	102	105	103	103	103	95	78	53	32	17	8	3	0	0	0	0	0	0	0	7	342	48	0	0
12	41	40	34	27	22	20	15	12	7	3	1	0	0	0	0	0	0	0	0	0	0	0	387	0	0
11	16	13	9	5	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	6	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DRY HNO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS   year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -11

31	0	0	0	0	0	0
30	0	0	0	0	0	0
29	0	0	0	0	0	0
28	0	0	0	0	0	0
27	0	0	0	0	0	0

	26	27	28	29	30	31
26	0	0	0	0	0	0
25	0	0	0	0	0	0
24	0	0	0	0	0	0
23	0	0	0	0	0	0
22	0	0	0	0	0	0
21	0	0	0	0	0	0
20	0	0	0	0	0	0
19	0	0	0	0	0	0
18	0	0	0	0	0	0
17	0	0	0	0	0	0
16	0	0	0	0	0	0
15	0	0	0	0	0	0
14	0	0	0	0	0	0
13	0	0	0	0	0	0
12	0	0	0	0	0	0
11	0	0	0	0	0	0
10	0	0	0	0	0	0
9	0	0	0	0	0	0
8	0	0	0	0	0	0
7	0	0	0	0	0	0
6	0	0	0	0	0	0
5	0	0	0	0	0	0
4	0	0	0	0	0	0
3	0	0	0	0	0	0
2	0	0	0	0	0	0
1	0	0	0	0	0	0

MESOPUFF VERSION 5.10 LEVEL 930530

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DRY NO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -14

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	1	1	0	0	0	1	1	1	2	2	3	3	2	0	0	0	0	0	0	0	0	0	0	0
21	4	6	8	9	8	7	8	10	13	18	23	28	32	30	19	6	0	0	0	0	0	0	0	0	0
20	15	24	34	41	43	42	42	47	60	76	94	114	136	146	126	69	17	1	0	0	0	0	0	0	0
19	41	69	100	126	138	138	136	141	156	180	205	229	256	280	279	217	104	21	1	0	0	0	0	0	0
18	83	136	202	264	303	310	297	281	276	282	291	296	297	300	303	285	219	99	13	0	0	0	0	0	0
17	123	193	286	383	458	487	466	415	365	333	315	299	279	256	244	244	227	174	65	4	0	0	0	0	0
16	141	202	288	387	478	528	515	451	372	307	262	228	195	158	129	119	114	105	84	19	0	0	0	0	0
15	132	164	212	273	339	384	382	334	264	199	149	110	78	50	30	21	15	11	9	4	0	0	0	0	0
14	107	110	120	137	162	183	182	156	118	79	51	29	16	7	3	1	0	0	0	0	0	0	0	0	0
13	78	64	55	51	53	56	54	45	30	18	9	4	2	0	0	0	0	0	0	0	0	0	0	0	0
12	54	33	21	14	11	11	9	7	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	34	17	8	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	19	8	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	9	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

DRY NO3 FLUX (G/M**2/S) AT SAMPLING GRID POINTS year: 88 month: 1 day: 2 Julian day: 2 hour: 12

Multiply all values by 10 ** -14

31 I	0	0	0	0	0	0
I	+	+	+	+	+	+
30 I	0	0	0	0	0	0
I	+	+	+	+	+	+
29 I	0	0	0	0	0	0
I	+	+	+	+	+	+
28 I	0	0	0	0	0	0
I	+	+	+	+	+	+
27 I	0	0	0	0	0	0
I	+	+	+	+	+	+
26 I	0	0	0	0	0	0
I	+	+	+	+	+	+
25 I	0	0	0	0	0	0
I	+	+	+	+	+	+
24 I	0	0	0	0	0	0
I	+	+	+	+	+	+
23 I	0	0	0	0	0	0
I	+	+	+	+	+	+
22 I	0	0	0	0	0	0
I	+	+	+	+	+	+
21 I	0	0	0	0	0	0
I	+	+	+	+	+	+
20 I	0	0	0	0	0	0
I	+	+	+	+	+	+
19 I	0	0	0	0	0	0
I	+	+	+	+	+	+
18 I	0	0	0	0	0	0
I	+	+	+	+	+	+
17 I	0	0	0	0	0	0
I	+	+	+	+	+	+
16 I	0	0	0	0	0	0
I	+	+	+	+	+	+
15 I	0	0	0	0	0	0
I	+	+	+	+	+	+
14 I	0	0	0	0	0	0
I	+	+	+	+	+	+
13 I	0	0	0	0	0	0
I	+	+	+	+	+	+
12 I	0	0	0	0	0	0
I	+	+	+	+	+	+
11 I	0	0	0	0	0	0
I	+	+	+	+	+	+
10 I	0	0	0	0	0	0
I	+	+	+	+	+	+
9 I	0	0	0	0	0	0
I	+	+	+	+	+	+
8 I	0	0	0	0	0	0
I	+	+	+	+	+	+

```
7 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
6 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
5 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
4 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
3 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
2 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
1 I  0    0    0    0    0    0
  I  +    +    +    +    +    +
   -----------------------------
    26   27   28   29   30   31
```

WET SO2 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	0.0000E+00	2	0.0000E+00	3	0.0000E+00	4	0.0000E+00
5	0.0000E+00	6	0.0000E+00	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

WET SO4 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	0.0000E+00	2	0.0000E+00	3	0.0000E+00	4	0.0000E+00
5	0.0000E+00	6	0.0000E+00	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

WET NOX FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	0.0000E+00	2	0.0000E+00	3	0.0000E+00	4	0.0000E+00
5	0.0000E+00	6	0.0000E+00	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

WET HNO3 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	0.0000E+00	2	0.0000E+00	3	0.0000E+00	4	0.0000E+00
5	0.0000E+00	6	0.0000E+00	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

WET NO3 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	0.0000E+00	2	0.0000E+00	3	0.0000E+00	4	0.0000E+00
5	0.0000E+00	6	0.0000E+00	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

DRY SO2 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX

1	2.2593E-11	2	4.1386E-10	3	2.0118E-09	4	3.5559E-09
5	1.9716E-10	6	6.8601E-12	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

DRY SO4 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	2.1564E-12	2	4.7074E-11	3	1.9312E-10	4	3.4167E-10
5	2.1045E-11	6	1.0310E-12	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

DRY NOX FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	2.2073E-11	2	3.4776E-10	3	2.0194E-09	4	3.5804E-09
5	2.0217E-10	6	6.8521E-12	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

DRY HNO3 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	3.1181E-11	2	3.5782E-10	3	2.5824E-09	4	4.4524E-09
5	2.7401E-10	6	1.2200E-11	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

DRY NO3 FLUX (G/M**2/S) AT NONGRIDDED RECEPTORS YEAR: 88 MONTH: 1 DAY: 2 HOUR: 12

RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX	RECEPTOR	FLUX
1	1.3732E-14	2	3.3581E-13	3	1.2271E-12	4	2.1187E-12
5	1.3868E-13	6	6.3909E-15	7	0.0000E+00	8	0.0000E+00
9	0.0000E+00	10	0.0000E+00	11	0.0000E+00	12	0.0000E+00
13	0.0000E+00						

APPENDIX E

SAMPLE MESOFILE II INPUT AND OUTPUT FILES

SAMPLE MESOFILE II INPUT FILE (FILE.INP)

```
Calculate 24-hr average SO2 concentrations and fluxes and plot
DEFN
 &SAME IPOL=1, IRTYPE=1, IMAX=31, JMAX=31, IOUT=1, &END
FIND
 &SAME IYEAR=88, IDAY=2, IHOUR=1, IGRIDS= 24, NUNIT=10, &END
AVRG
 &SAME IRUN=1, AVETM=24, PRINT=1, A=1.0, B=0., PLOT=1, DISK=1,
       NEWV=0, APE=0, NEWMES=0, ISCHEK=0, IHIGH=1, &END
DEFN
 &SAME IPOL=6, IRTYPE=1, IMAX=31, JMAX=31, IOUT=2, &END
FIND
 &SAME IYEAR=88, IDAY=2, IHOUR=1, IGRIDS= 24, NUNIT=11, &END
AVRG
 &SAME IRUN=2, AVETM=24, PRINT=1, A=1.0, B=0., PLOT=1, DISK=1,
       NEWV=1, APE=0, NEWMES=1, ISCHEK=0, IHIGH=1, &END
Wet Deposition Fluxes (g/m**2/s)
 &DIFF N=6, THR=-1.E-10,1.0E-11,1.0E-10,1.0E-9,5.0E-9,1.0E-8, &END
DEFN
 &SAME IPOL=11, IRTYPE=1, IMAX=31, JMAX=31, IOUT=3, &END
FIND
 &SAME IYEAR=88, IDAY=2, IHOUR=1, IGRIDS= 24, NUNIT=12, &END
AVRG
 &SAME IRUN=3, AVETM=24, PRINT=1, A=1.0, B=0., PLOT=1, DISK=1,
       NEWV=1, APE=0, NEWMES=1, ISCHEK=0, IHIGH=1, &END
Dry Deposition Fluxes (g/m**2/s)
 &DIFF N=6, THR=-1.0E-10,1.0E-10,1.0E-9,1.0E-8,5.0E-8,1.0E-7, &END
```

SAMPLE MESOFILE II OUTPUT FILE (FILE.LST)

RUNTIME CALL NO.: 1 DATE: 06/15/93 TIME: 12:36:50.36

VERSION NUMBER 2.3
LEVEL 930530

MESOFILE II

DATA READ FROM MESOPUFF OUTPUT FILE -- UNIT: 10 RUNSTREAM: 1

VERSON= 5.1 LEVEL=930530 NSYR=88 NSDAY= 2 NSHR= 0 NADVTS= 24 IAVG= 1 NPUF= 4 NSAMAD= 2 IELMET=22 JELMET=22
DGRID= 10000.0 IASTAR= 1 IASTOP=22 JASTAR= 1 JASTOP=22 ISASTR= 4 ISASTP=19 JSASTR= 4 JSASTP=19 MESHDN= 2 NPTS= 1
NAREAS= 0 NREC= 13 IPRINF= 12 LGAUSS=T LCHEM=T LDRY=T LWET=T LPRINT=T L3VL=T LVSAMP=T USAMP= 2.00 LSGRID=T
NSPEC= 5
LWETG=T LWETNG=T LDRYG=T LDRYNG=T LPRFLX=T
XREC= 2.50 2.50 4.00 5.00 5.50 6.50 6.50 8.00 7.50 9.00 8.00 7.00 8.50
YREC=13.50 12.00 12.00 11.00 9.50 9.00 7.50 8.00 6.50 6.00 5.75 4.00 3.50

CONCENTRATIONS (G/M**3) year: 88 Julian day: 3 Ending hour: 0 Pollutant: 1

Multiply all values by 10 ** -9

31 I	12	7	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
30 I	29	21	13	6	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
29 I	58	46	33	20	10	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
28 I	100	88	70	50	31	16	7	3	1	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
27 I	150	143	127	104	76	49	27	12	4	1	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
26 I	199	203	197	179	150	114	76	44	21	8	2	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
25 I	230	249	260	260	243	210	165	116	72	37	16	5	1	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
24 I	226	260	291	315	324	313	279	228	169	113	65	32	12	3	0	0	1	1	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
23 I	186	225	269	314	354	379	381	353	300	234	169	109	61	27	9	5	7	9	7	2
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
22 I	133	165	206	256	312	370	417	439	424	377	312	240	171	112	63	33	27	33	34	20
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
21 I	92	113	140	178	228	292	364	433	480	491	465	409	332	250	183	124	69	53	64	62
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
20 I	74	86	102	123	154	198	260	339	426	500	547	559	525	438	327	245	178	87	57	88
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
19 I	68	78	89	102	118	141	173	223	301	402	506	584	624	615	539	399	299	256	134	115
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18 I	66	76	86	98	110	123	138	155	188	256	368	500	602	653	672	650	504	345	313	145
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
17 I	61	69	79	92	106	122	135	143	148	163	212	318	468	601	679	709	710	583	370	293
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
16 I	54	59	67	78	94	114	136	153	157	152	151	172	241	374	548	690	764	797	674	445
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
15 I	54	56	59	67	80	102	131	161	183	188	178	161	150	159	237	443	714	881	917	812
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
14	65	68	69	72	82	102	134	176	217	247	260	254	229	186	142	137	253	613	1080	1084
13	88	96	101	104	112	133	170	223	284	337	377	412	448	458	419	334	246	188	275	957
12	115	133	146	156	167	190	232	293	368	442	501	550	620	708	812	905	970	923	781	503
11	131	157	180	198	211	226	249	281	324	375	425	466	508	554	592	615	637	692	730	896
10	124	149	173	190	197	193	184	174	169	176	193	206	206	209	216	237	214	251	276	318
9	95	108	122	131	130	116	95	73	58	51	53	54	50	45	43	47	47	34	9	0
8	58	61	64	65	60	50	36	23	14	10	8	7	6	3	1	0	0	0	0	0
7	28	26	25	23	20	15	10	5	3	1	1	0	0	0	0	0	0	0	0	0
6	11	9	7	6	5	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0
5	4	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

CONCENTRATIONS (G/M**3) year: 88 Julian day: 3 Ending hour: 0 Pollutant: 1

Multiply all values by 10 ** -9

31	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
22	4	0	0	0	0	0	0	0	0	0	0
21	21	1	0	0	0	0	0	0	0	0	0
20	65	7	0	0	0	0	0	0	0	0	0
19	132	25	0	0	0	0	0	0	0	0	0

```
   I    +     +     +     +     +     +     +     +     +     .     .
18 I  222    93     1     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
17 I  168   282     4     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
16 I  234   413    31     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
15 I  494   188   147     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
14 I 1074   585   594     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
13 I 1531  1417   191     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
12 I  359  1136  1474     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
11 I  797   580    83   131     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
10 I  164     1     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 9 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 8 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 7 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 6 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 5 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 4 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 3 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 2 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
 1 I    0     0     0     0     0     0     0     0     0     0     0
   I    +     +     +     +     +     +     +     +     +     +     +
     ------------------------------------------------------------
       21    22    23    24    25    26    27    28    29    30    31
HIGHEST GRIDDED VALUE for (yr,day,hour) = (88,  3, 0)  Pollutant:  1  (I,J) = (  21,  13)   MAX. VALUE =   1.5315E-06

**************************************************************
*000000000000000000000000000000000000000000000000000000000000*
*                                                            *
*                                                            *
*                                                            *
*                                                            *
*0                                                           *
*1000                                                        *
* 111000                                                     *
*    11100                                                   *
*       1100                                                 *
*         1100                                               *
*           1100                                             *
*             1100                                           *
*               1100                                         *
*                 1100                                       *
*                   1100                                     *
*                     1100                                   *
*                       1100                                 *
```

```
*                         11000                               *
*1                          1110                              *
*011                11         100                            *
* 001              1221111      110                           *
*   01             22 222211      100 0                       *
*    01            11     2211     1100100                    *
*     01             22     2211     11 110                   *
*      0             11       2211        1                   *
*                      22       221        0                  *
*       1              112        21       10                 *
*       0                122       211      1                 *
*        1                112       221                       *
*        01                 122       21                      *
*         0                  112       21    0                *
*                              122      211  10               *
*                               112  2222221111               *
*         0                       12 333332222                *
*    000001                        12223  33 11               *
*000011111              11111111111111 233  210               *
*1111                11122222222222222  223 321               *
*                    222                1123332               *
*                    1122               22 22210              *
*                      11222222222222    2221011              *
*                        1111111111122221111 00               *
*                                    11111000                 *
*1           11111111111111111111111111110                    *
*01111111111100000000000000000000000000000                    *
* 00000000000                                                 *
*                                                             *
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*                                                             *
*                                                             *
*                                                             *
*                                                             *
*                                                             *
*0000000000000000000000000000000000000000000000000000000000000*
***************************************************************
```

CONCENTRATIONS (G/M**3)   PLOT NUMBER: 1

VALUE	RANGE				
0	-1.00000E-10	LE	X	LT	1.00000E-07
1	1.00000E-07	LE	X	LT	5.00000E-07
2	5.00000E-07	LE	X	LT	1.00000E-06
3	1.00000E-06	LE	X	LT	2.00000E-06
4	2.00000E-06	LE	X	LT	5.00000E-06
5	5.00000E-06	LE	X	LT	1.00000E-05
6	1.00000E-05	LE	X	LT	2.50000E-05
7	2.50000E-05	LE	X	LT	5.00000E-05
8	5.00000E-05	LE	X		

```
DATA READ FROM MESOPUFF OUTPUT FILE -- UNIT:  11  RUNSTREAM:   2
    VERSON=  5.1  LEVEL=930530  NSYR=88  NSDAY=  2  NSHR= 0  NADVTS=   24  IAVG=    1  NPUF=  4  NSAMAD=  2  IELMET=22  JELMET=22
    DGRID=  10000.0  IASTAR= 1  IASTOP=22  JASTAR= 1  JASTOP=22  ISASTR= 4  ISASTP=19  JSASTR= 4  JSASTP=19  MESHDN= 2  NPTS=   1
```

```
NAREAS=  0  NREC=  13  IPRINF=  12  LGAUSS=T  LCHEM=T  LDRY=T  LWET=T  LPRINT=T  L3VL=T  LVSAMP=T  WSAMP=  2.00  LSGRID=T
NSPEC= 5
LWETG=T  LWETNG=T  LDRYG=T  LDRYNG=T  LPRFLX=T
XREC= 2.50  2.50  4.00  5.00  5.50  6.50  6.50  8.00  7.50  9.00  8.00  7.00  8.50
YREC=13.50 12.00 12.00 11.00  9.50  9.00  7.50  8.00  6.50  6.00  5.75  4.00  3.50
```

Wet Deposition Fluxes (g/m**2/s)   year: 88 Julian day: 3 Ending hour: 0 Pollutant: 6

Multiply all values by 10 ** -12

31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	1	1	2	4	4	3	3	0	0	0	0	0	0	0	0	0	0	0
25	4	6	9	14	22	29	37	42	41	34	19	5	0	0	0	0	0	0	0	0
24	22	31	46	66	94	131	169	208	234	233	190	116	39	3	0	0	0	0	0	0
23	76	107	149	203	276	371	483	605	730	830	841	695	405	136	11	0	0	0	0	0
22	206	270	350	452	581	738	923	1137	1381	1650	1909	2023	1731	982	301	29	0	0	0	0
21	420	522	636	766	914	1086	1281	1494	1734	2020	2391	2896	3378	3115	1802	542	62	0	0	0
20	686	813	930	1039	1147	1260	1376	1490	1597	1701	1843	2132	2810	3805	3887	2345	556	26	0	0
19	903	1025	1109	1155	1176	1179	1170	1141	1087	1010	925	870	985	1679	2811	2822	934	90	0	0
18	947	1031	1061	1034	967	877	771	651	528	404	296	203	153	268	938	1681	1190	1024	155	0
17	777	812	791	721	619	500	381	271	176	107	55	29	10	16	290	1229	1770	1595	239	0
16	493	488	448	381	298	212	139	81	41	19	6	0	0	0	24	301	1910	1857	130	0
15	239	220	189	149	105	64	37	18	6	2	0	0	0	0	0	0	300	2022	772	0
14	88	75	58	42	25	14	6	2	0	0	0	0	0	0	0	0	0	58	234	0
13	24	17	11	7	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
5 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
4 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1 I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Wet Deposition Fluxes (g/m**2/s) year: 88 Julian day: 3 Ending hour: 0 Pollutant: 6

Multiply all values by 10 ** -12

31 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
30 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
29 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
28 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
27 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
26 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
25 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
24 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
23 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
22 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
21 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
20 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
19 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
18 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
17 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
16 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
15 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
14 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
13 I	0	0	0	0	0	0	0	0	0	0	0
I	+	+	+	+	+	+	+	+	+	+	+
12 I	0	0	0	0	0	0	0	0	0	0	0

```
    I    +    +    +    +    +    +    +    +    +    +    +
11  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
10  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 9  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 8  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 7  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 6  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 5  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 4  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 3  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 2  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
 1  I    0    0    0    0    0    0    0    0    0    0    0
    I    +    +    +    +    +    +    +    +    +    +    +
     -------------------------------------------------------------
        21   22   23   24   25   26   27   28   29   30   31
HIGHEST GRIDDED VALUE for (yr,day,hour) = (88,  3, 0)  Pollutant:  6  (I,J) = (  15,  20)   MAX. VALUE =   3.8867E-09

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*0000000000000000000000000000000000000000000000000000000000000*
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*                                                             *
*       000000000000                                          *
*    0001111111111100                                         *
*00000111   1111111110000                                     *
*11111   11122222222211111                                    *
*     1111222         2211100                                 *
*  1112222              222110                                *
*11222           222222222 21100                              *
*22          2223333333332 22110                              *
*           22333         322221100                           *
*         2233             33322211                           *
*        233                  32 110                          *
*      223                     322210                         *
*    2233                       3   1                         *
*  2233             333333                                    *
*  33       3333333322222233     2 1100                       *
*        33322222222      2233   322211                       *
*  333333222            22  22    33 2                        *
*  222222           22221122  3       1                       *
*                 22111110112 23      2                       *
*              22211 1110 0012 2      1                       *
*            22111  1000    112 3   2 1                       *
*         22211  1110       011223  3 2                       *
```

```
*      222111  11000          000223 3                        *
*222222111   1100              12232                          *
*111111    1100                00112 2                        *
*     1111100                   11121                         *
*  11100000                     00000                         *
*11000                                                        *
*00                                                           *
*                                                             *
*                                                             *
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*0000000000000000000000000000000000000000000000000000000000*
************************************************************

Wet Deposition Fluxes (g/m**2/s)                               PLOT NUMBER:    2
VALUE                     RANGE
  0     -1.00000E-10  LE  X  LT   1.00000E-11
  1      1.00000E-11  LE  X  LT   1.00000E-10
  2      1.00000E-10  LE  X  LT   1.00000E-09
  3      1.00000E-09  LE  X  LT   5.00000E-09
  4      5.00000E-09  LE  X  LT   1.00000E-08
  5      1.00000E-08  LE  X

DATA READ FROM MESOPUFF OUTPUT FILE -- UNIT:  12  RUNSTREAM:   3
    VERSON=  5.1  LEVEL=930530  NSYR=88  NSDAY=  2  NSHR= 0  NADVTS=   24  IAVG=    1  NPUF=  4  NSAMAD=  2  IELMET=22  JELMET=22
    DGRID=  10000.0  IASTAR= 1  IASTOP=22  JASTAR= 1  JASTOP=22  ISASTR= 4  ISASTP=19  JSASTR= 4  JSASTP=19  MESHDN= 2  NPTS=   1
    NAREAS=   0  NREC=  13  IPRINF=  12  LGAUSS=T  LCHEM=T  LDRY=T  LWET=T  LPRINT=T  L3VL=T  LVSAMP=T  WSAMP=   2.00  LSGRID=T
    NSPEC= 5
    LWETG=T  LWETNG=T  LDRYG=T  LDRYNG=T  LPRFLX=T
    XREC= 2.50  2.50  4.00  5.00  5.50  6.50  6.50  8.00  7.50  9.00  8.00  7.00  8.50
    YREC=13.50 12.00 12.00 11.00  9.50  9.00  7.50  8.00  6.50  6.00  5.75  4.00  3.50


Dry Deposition Fluxes (g/m**2/s)                          year: 88 Julian day:   3 Ending hour:  0  Pollutant: 11

Multiply all values by 10 ** -11

31 I   4    2    1    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
30 I   9    7    4    3    1    1    0    0    0    0    0    0    0    0    0    0    0    0    0    0
   I   +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +    +
29 I  18   15   12    8    5    3    1    1    0    0    0    0    0    0    0    0    0    0    0    0
```

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
28	33	30	26	21	15	9	5	3	1	0	0	0	0	0	0	0	0	0	0	0
27	51	52	50	44	36	26	17	9	4	1	0	0	0	0	0	0	0	0	0	0
26	72	78	81	79	72	60	44	28	15	6	2	0	0	0	0	0	0	0	0	0
25	90	103	113	118	117	108	92	69	45	24	10	3	0	0	0	0	0	0	0	0
24	100	120	138	152	159	158	148	127	99	67	38	17	5	1	0	0	1	1	0	0
23	102	128	152	173	187	193	192	181	162	134	100	62	32	13	5	4	6	8	6	2
22	103	131	157	180	197	206	211	211	207	197	176	142	100	65	45	28	24	31	32	19
21	106	136	163	184	197	203	204	207	213	221	225	218	191	163	155	125	70	50	61	58
20	112	143	171	191	199	196	187	181	185	198	217	238	248	252	264	251	202	97	55	82
19	114	146	175	195	202	193	173	151	141	149	170	198	237	310	403	381	318	287	137	108
18	106	136	164	184	193	186	162	130	104	96	112	144	188	293	500	599	493	359	320	140
17	87	111	134	154	165	163	146	119	91	69	63	82	131	246	484	647	682	572	369	295
16	64	79	96	111	123	127	123	113	98	76	54	43	61	158	402	611	723	774	652	446
15	46	54	64	76	89	101	112	120	124	115	92	64	47	66	176	393	647	833	901	767
14	39	44	51	62	80	105	134	167	195	208	203	184	157	128	108	116	227	561	1013	1074
13	43	49	56	69	93	133	191	271	355	412	435	443	459	471	450	381	292	219	268	900
12	53	61	70	83	107	152	237	375	544	678	744	740	719	777	934	1063	1178	1123	1053	632
11	59	70	79	89	105	140	217	351	506	621	671	637	551	525	568	589	622	653	690	747
10	56	65	73	78	82	98	143	214	276	297	286	251	202	174	158	154	134	155	172	177
9	43	47	50	50	49	53	70	95	104	92	73	59	45	35	29	29	29	21	6	0
8	26	26	26	24	21	21	25	31	29	20	12	8	5	3	1	0	0	0	0	0
7	13	12	10	8	7	6	6	7	6	3	1	0	0	0	0	0	0	0	0	0
6	5	4	3	2	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
5	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dry Deposition Fluxes (g/m**2/s)

year: 88 Julian day: 3 Ending hour: 0 Pollutant: 11

Multiply all values by 10 ** -11

31	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
22	3	0	0	0	0	0	0	0	0	0	0
21	20	1	0	0	0	0	0	0	0	0	0
20	60	6	0	0	0	0	0	0	0	0	0
19	118	22	0	0	0	0	0	0	0	0	0
18	203	81	1	0	0	0	0	0	0	0	0
17	156	243	3	0	0	0	0	0	0	0	0
16	237	309	24	0	0	0	0	0	0	0	0
15	502	127	31	0	0	0	0	0	0	0	0
14	1033	562	59	0	0	0	0	0	0	0	0
13	1514	1361	24	0	0	0	0	0	0	0	0
12	444	1028	162	0	0	0	0	0	0	0	0
11	378	162	25	13	0	0	0	0	0	0	0
10	17	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0

```
3 I    0     0     0     0     0     0     0     0     0     0     0
  I    +     +     +     +     +     +     +     +     +     +     +
2 I    0     0     0     0     0     0     0     0     0     0     0
  I    +     +     +     +     +     +     +     +     +     +     +
1 I    0     0     0     0     0     0     0     0     0     0     0
  I    +     +     +     +     +     +     +     +     +     +     +
   -----------------------------------------------------------------
       21    22    23    24    25    26    27    28    29    30    31
HIGHEST GRIDDED VALUE for (yr,day,hour) = (88,  3, 0)  Pollutant: 11  (I,J) = (  21,  13)   MAX. VALUE =    1.5144E-08

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*0000000000000000000000000000000000000000000000000000000000000*
*                                                             *
*000                                                          *
*11100                                                        *
*   11000                                                     *
*     11100                                                   *
*        11000                                                *
*          1110                                               *
*             100                                             *
*              1100                                           *
*                1100                                         *
*  1111111111      11                                         *
* 1222222222211      00                                       *
*12          2211    1100                                     *
*2             22111   1100                                   *
*                2221    110                                  *
*                   2111   1000000000000                      *
*                    22211  1111111111110                     *
*                       22111           10                    *
*                         222111         10                   *
*                            222111       1                   *
*                               222                           *
*                                  11      0                  *
*                                  2211111 10                 *
*                                    222221 1                 *
*                  2                      2                   *
*2               22122                     1                  *
*12              11 1122                   21                 *
* 12                  1122                  20                *
*  122                  11                   10               *
*   11222        11       2                   1               *
*     11122      2211     12                2                 *
*        11        2211111 1                1                 *
*                    2222211         22222 2                  *
*         1               22         333332                   *
*         2                          222 32                   *
*                                       33 3                  *
*        1                     2222222  223 1                 *
*        2                     3333333    23 2                *
*                              2222222     221 0              *
*        2                                 21 11              *
*        122                            22211100              *
*         112               2222222222222110000               *
*           12222 22222222222111111111111110                  *
*            111121111111111       10000                      *
*                1     11111111111110                         *
*                   1110000000000000                          *
*     11111111111111000                                       *
*1111100000000000000000                                       *
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*00000                                                         *
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*                                                              *
*0000000000000000000000000000000000000000000000000000000000000*
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Dry Deposition Fluxes (g/m**2/s)   PLOT NUMBER: 3

VALUE	RANGE				
0	-1.00000E-10	LE	X	LT	1.00000E-10
1	1.00000E-10	LE	X	LT	1.00000E-09
2	1.00000E-09	LE	X	LT	1.00000E-08
3	1.00000E-08	LE	X	LT	5.00000E-08
4	5.00000E-08	LE	X	LT	1.00000E-07
5	1.00000E-07	LE	X		

Calculate 24-hr average SO2 concentrations and fluxes and plot

****

ROUTINE CALLED	POLLUTANT	ARRAY SIZE	STARTING RECORD OF DISK OUTPUT	RECEPTOR TYPE	NO. NG RECEPTORS
DEFN	SO2 CONC.	31 X 31	1	GRIDDED	0

****

ROUTINE CALLED	DEFINES RUNSTREAM NO.	LOGICAL UNIT	YR/DAY/HR	NO. GRIDS
FIND	1	10	88/ 2/ 1	24

****

ROUTINE CALLED	AVERAGING TIME	PRINTER OUTPUT	DISK OUTPUT	PLOT	CONTOUR LEVELS	INPUT FIELDS PRINTED
AVRG	24	YES	YES (1- 1)	YES	DEFAULT	NO

RUNSTREAM NO.	ORDER	A	B	IFORM	NEWMES	ISCHEK	IHIGH
1	FIRST	1.00000E+00	0.00000E+00	2	0	0	1

****

ROUTINE CALLED	POLLUTANT	ARRAY SIZE	STARTING RECORD OF DISK OUTPUT	RECEPTOR TYPE	NO. NG RECEPTORS
DEFN	WET SO2 FLUX	31 X 31	2	GRIDDED	13

****

ROUTINE CALLED	DEFINES RUNSTREAM NO.	LOGICAL UNIT	YR/DAY/HR	NO. GRIDS
FIND	2	11	88/ 2/ 1	24

****

ROUTINE CALLED	AVERAGING TIME	PRINTER OUTPUT	DISK OUTPUT	PLOT	CONTOUR LEVELS	INPUT FIELDS PRINTED
AVRG	24	YES	YES (2- 2)	YES	USERS	NO

RUNSTREAM NO.	ORDER	A	B	IFORM	NEWMES	ISCHEK	IHIGH
2	FIRST	1.00000E+00	0.00000E+00	2	1	0	1

****

ROUTINE CALLED	POLLUTANT	ARRAY SIZE	STARTING RECORD OF DISK OUTPUT	RECEPTOR TYPE	NO. NG RECEPTORS
DEFN	DRY SO2 FLUX	31 X 31	3	GRIDDED	13

****

ROUTINE CALLED	DEFINES RUNSTREAM NO.	LOGICAL UNIT	YR/DAY/HR	NO. GRIDS
FIND	3	12	88/ 2/ 1	24

****

ROUTINE CALLED	AVERAGING TIME	PRINTER OUTPUT	DISK OUTPUT	PLOT	CONTOUR LEVELS	INPUT FIELDS PRINTED
AVRG	24	YES	YES (3- 3)	YES	USERS	NO

RUNSTREAM NO.	ORDER	A	B	IFORM	NEWMES	ISCHEK	IHIGH
3	FIRST	1.00000E+00	0.00000E+00	2	1	0	1

****

RUNTIME CALL NO.: 2 DATE: 06/15/93 TIME: 12:36:54.21
DELTA TIME: 3.85 (SEC)

TECHNICAL REPORT DATA

(Please read Instructions on reverse before completing)

1. REPORT NO. EPA-454/B-94-025	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE A Revised User's Guide to MESOPUFF II (V5.1)		5. REPORT DATE August 1994
		6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Joseph S. Scire and Elizabeth M. Insley Sigma Research Corporation		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Sigma Research Corporation 196 Baker Avenue Concord, MA 01742		10. PROGRAM ELEMENT NO.
		11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency Office of Air Quality Planning and Standards, TSD Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This document is a revised version of the MESOPUFF II user's guide which describes the current configuration of the MESOPUFF II modeling system (Version 5.1). Much of the text is taken from the original document, although several new chapters have been added and other sections revised. The revised modeling system contains the original set of programs, along with several new programs which includes the upper air preprocessor (READ62) and the precipitation data preprocessors PXTRACT and PMERGE.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Meteorology Air Quality Dispersion Model Visibility Aerosols	New Source Review Air Pollution Control	
18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS (Report) Unclassified	21. NO. OF PAGES 296
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