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User's Guide for the AMS/EPA Regulatory Model (AERMOD)

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User's Guide for the AMS/EPA Regulatory Model (AERMOD)

U.S. Environmental Protection Agency
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Preface

This User's Guide for the AMS/EPA Regulatory Model (AERMOD) provides user instructions for the AERMOD model. The technical description of the AERMOD algorithms is provided in a separate Model Formulation Document (EPA, 2004a). Additional resources provided by the USEPA that may be helpful with regard to the application of AERMOD can be accessed via the Support Center for Regulatory Atmospheric Modeling (SCRAM) website at https://www3.epa.gov/ttn/scram/.

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1.0 Introduction

This section provides an overall introduction to the AERMOD model and to the AERMOD user's guide. Some suggestions are offered on how various users would best benefit from using the manuals. Also provided is an overview of the model's applicability, range of options, and basic input data and hardware requirements. The input file needed to run the AERMOD model is based on an approach that uses descriptive keywords and allows for a flexible structure and format.

1.1 How to use the AERMOD manuals

The AERMOD model user's guide has been designed in an attempt to meet the needs of various types of users, depending on their level of experience with the model. This section describes briefly how different types of users would benefit most from their use of the manual.

1.1.1 Novice users

Novice users are those whose exposure to or experience with the AERMOD model has been limited. They may be new to dispersion modeling applications in general, or new to the AERMOD model and therefore unfamiliar with the keyword/parameter approach utilized for the input file. These users should review the remainder of this Introduction to gain an overall perspective of the use of the AERMOD model, particularly for regulatory modeling applications. They should then concentrate their review on Section 2.0, which provides a brief tutorial on setting up an input file that illustrates the most commonly used options of the AERMOD model. Section 2.0 provides a basic description of the input file structure and explains some of the advantages of the keyword/parameter approach to specifying modeling options and inputs. As the user becomes more familiar with the operation of the model and encounters the need to use more advanced features of the model, he/she will want to review the contents of Section 3.0, which provides a more detailed and complete reference of the various options for running the model.

1.1.2 Experienced modelers

Experienced modelers will have had considerable experience in applying the AERMOD model in a variety of situations. They should have basic familiarity with the overall goals and purposes of regulatory modeling in general, and with the scope of options available in the AERMOD model in particular. Experienced modelers who are new to the AERMOD model will benefit from first reviewing the contents of Section 2.0 of this volume, which will give them a basic orientation to the structure, organization and philosophy of the keyword/parameter approach used for the input runstream file. Once they have a basic grasp of the input file structure and syntax rules, they will benefit most from using Section 3.0 of this volume as a reference to learn the overall capabilities of the model, or to understand the mechanics for implementing particular options. The information in Section 3.0 has a functional organization with detailed descriptions of each of the individual keyword options by functional pathway. Once they are familiar with most or all of the keywords, they may find the functional keyword reference provided in APPENDIX B useful to quickly review the proper syntax and available options/parameters for a particular keyword. They may also find the Quick Reference in APPENDIX E sufficient as a simple reminder of the available keywords for each pathway and to ensure the proper order of parameters for each input image.

Experienced modelers may also need to refer to the description of model formulation for AERMOD (EPA, 2004a) in order to gain a more complete understanding of the technical basis for the AERMOD model.

1.1.3 Management/decision makers

Those involved in a management or decision-making role for dispersion modeling applications will be especially interested in the remainder of this section, which provides an overview of the model, including its role in various regulatory programs, a brief description of the range of available options, and basic input data and computer hardware requirements needed to run the model. From this information they should understand the basic capabilities of the AERMOD model well enough to judge the suitability of the model for particular applications. They may also want to review the brief tutorial provided in Section 2.0 to learn about the nature

and structure of the input runstream file, in order to better be able to review the modeling results.

1.2 Overview of the AERMOD model

This section provides an overview of the AERMOD model, including a discussion of the regulatory applicability of the model, a description of the basic options available for running the model, and an explanation of the basic input data and hardware requirements needed for executing the model.

1.2.1 Regulatory applicability

The U.S. Environmental Protection Agency (EPA) maintains a *Guideline on Air Quality Models* (hereafter, Guideline), which is published as Appendix W to 40 CFR Part 51 (as revised). The Guideline provides the agency's guidance on regulatory applicability of air quality dispersion models in general. In general, regulatory modeling applications should be carried out in accordance with a modeling protocol that is reviewed and approved by the appropriate agency prior to conducting the modeling. The modeling protocol should identify the specific model, modeling options and input data to be used for a particular application.

1.2.2 Basic input data requirements

One of the basic inputs to AERMOD is the runstream setup file which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options. The runstream file is also commonly referred to as the control file. Another type of basic type of input data needed to run the model is the meteorological data. AERMOD requires two types of meteorological data files that are provided by the AERMET meteorological preprocessor program (EPA, 2004b). One file consists of surface scalar parameters, and the other file consists of vertical profiles of meteorological data. These meteorological data files are described briefly later in this section, and in more detail in Sections 2.0 and 3.0. For applications involving elevated terrain effects, the receptor and terrain data will need to be processed by the AERMAP terrain preprocessing program (EPA, 2004c) before input to the AERMOD model.

1.2.3 Computer hardware requirements

The current version of the AERMOD model was developed within the Microsoft Windows operating system (Windows), and has been designed to run on Windows PCs within a Command-prompt using command-line arguments to initiate a model run. The amount of storage space required on the hard disk for a particular application will depend greatly on the output options selected. Some of the optional output files of concentration data can be rather large. More information on output file products is provided in Sections 3.7 and3.8.Overview of available modeling options

The AERMOD model includes a wide range of options for modeling air quality impacts of pollution sources, making it a popular choice among the modeling community for a variety of applications. The following sections provide a brief overview of the options available in the AERMOD model.

1.2.3.1 Dispersion options

Since the AERMOD model is especially designed to support the EPA's regulatory modeling programs, the regulatory modeling options will be the default mode of operation for

the model. These options include the use of stack-tip downwash, and a routine for processing averages when calm winds or missing meteorological data occur. The model also includes non-default options for suppressing the use of stack-tip downwash, deposition modeling, NO_2 conversion, special processing for low wind conditions, and to disable the date checking for non-sequential meteorological data files. The latter option is needed to facilitate evaluation of the model. The AERMOD model also includes a non-default screening mode added specifically for integration with the AERSCREEN model interface (EPA, 2015a). The user can specify several short term averages to be calculated in a single run of the AERMOD model, as well as requesting the overall period (e.g. annual) averages.

1.2.3.2 Source options

The model is capable of handling multiple sources, including point, volume, area, open pit, and both buoyant and non–buoyant line source types. AERMOD models non-buoyant line sources as elongated area sources, and the user input required to define the source is simplified. Non-buoyant line sources may also be modeled as a string of volume sources. The buoyant line source algorithm from the Buoyant Line and Point Source (BLP) model has been incorporated into the AERMOD model beginning with version 15181. Several source groups may be specified in a single run, with the source contributions combined for each group. This is particularly useful for PSD applications where combined impacts may be needed for a subset of the modeled background sources that consume increment, while the combined impacts from all background sources (and the permitted source) are needed to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS). The model contains algorithms for modeling the effects of aerodynamic downwash due to nearby buildings on point source emissions and depositional effects on particulate emissions.

Source emission rates can be treated as constant throughout the modeling period, or may be varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources. The user may also specify a separate file of hourly emission rates for some or all of the sources included in a particular model run.

1.2.3.3 Receptor options

The AERMOD model has considerable flexibility in the specification of receptor locations. The user has the capability of specifying multiple receptor networks in a single run, and may also mix Cartesian grid receptor networks and polar grid receptor networks in the same run. This is useful for applications where the user may need a coarse grid over the whole modeling domain, but a denser grid in the area of maximum expected impacts. There is also flexibility in specifying the location of the origin for polar receptors, other than the default origin at (0,0) in x,y, coordinates.

The user can input elevated receptor heights in order to model the effects of terrain above (or below) stack base, and may also specify receptor elevations above ground level to model flagpole receptors. There is no distinction in AERMOD between elevated terrain below release height and terrain above release height, as with earlier regulatory models that distinguished between simple terrain and complex terrain. For applications involving elevated terrain, the user must also input a hill height scale along with the receptor elevation. To facilitate the generation of hill height scales for AERMOD, a terrain preprocessor, called AERMAP, has been developed (EPA, 2004c).

1.2.3.4 Meteorology options

The AERMOD model utilizes a file of surface boundary layer parameters and a file of profile variables including wind speed, wind direction, and turbulence parameters. These two types of meteorological inputs are generated by the meteorological preprocessor for AERMOD, which is called AERMET (EPA, 2004b). Both of these meteorological input files are sequential ASCII files, and the model automatically recognizes the format generated by AERMET as the default format. The model will process all available meteorological data in the specified input file by default, but the user can easily specify selected days or ranges of days to process.

1.2.3.5 Output options

The basic types of printed output available with AERMOD are:

- Summaries of high values (highest, second highest, etc.) by receptor for each averaging period and source group combination;
- Summaries of overall maximum values (e.g., the maximum 50) for each averaging period and source group combination; and
- Tables of concurrent values summarized by receptor for each averaging period and source group combination for each day of data processed. These "raw" concentration values may also be output to unformatted (binary) files, as described below.

The tables by receptor and maximum value tables can be output for the source group values or for the individual source values, or both. In addition, when maximum values for individual sources are output, the user has the option of specifying whether the maximum source values are to be the maximum values for each source independently, or the contribution of each source to the maximum group values, or both.

In addition to the tabular printed output products described above, the AERMOD model provides options for several types of file output products. One of these options for AERMOD is to output an unformatted ("binary") file of all concentration values as they are calculated. These files are often used for special postprocessing of the data. In addition to the unformatted concentration files, AERMOD provides options for several additional types of file outputs. One option is to generate a file of (X,Y) coordinates and design values (e.g., the second highest values at each receptor for a particular averaging period and source group combination) that can be easily imported into many graphics plotting packages to generate contour plots of the concentration values. Separate files can be specified for all of the averaging period and source group combinations of interest to the user.

Another output file option of the AERMOD model is to generate a file of all occurrences when a concentration value equals or exceeds a user-specified threshold. Again, separate files are generated for only those combinations of averaging period and source group that are of interest to the user. These files include the date on which the threshold violation occurred, the receptor location, and the concentration value.

AERMOD includes options for two types of output files that are designed to facilitate model evaluation. One type of file lists concentrations by rank, where only one value per date is

included. This file may be used to generate Q-Q (quantile) plots of results, where values from different models and/or observed data are paired by rank. The other type of output file provides arc maxima results along with detailed information about the plume characteristics associated with the arc maximum.

Finally, there are output options specifically for comparing model results to the 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 NAAQS. The form of these standards are based on averages of ranked values across years which complicates their evaluation, especially the 1-hour NO_2 and SO_2 standards which are based on ranked values from the distribution of daily maximum 1-hour averages.

1.2.3.6 Source contribution analyses

In air quality dispersion modeling applications, the user may have a need to know the contribution that a particular source makes to an overall concentration value for a group of sources. This section provides a brief introduction to how these types of source contribution (sometimes referred to as source culpability) analyses are performed using the AERMOD model. More detailed information about exercising these options is provided in Section 3.0.

The AERMOD model provides the option of specifying source groups for which the model calculates high values independently. However, users may often have to run the model a second time selecting only specific days where the high values occurred, and setting up each source in its own source group in order to obtain source contribution results. An EVENT processor has been incorporated into AERMOD to simplify this task when required. Also, special processing and output options, mentioned above, are included that are specific to determining source contributions with regard to the PM2.5, NO_2 and SO_2 standards.

2.0 Getting started - a brief tutorial

This section provides a brief tutorial for setting up a simple application problem with the AERMOD model, which serves as an introduction for novice users to the AERMOD model. The example illustrates the usage of the most commonly used options in the AERMOD model. A more complete description of the available options for setting up the AERMOD model is provided in Section 3.0.

The example problem presented in this section is a simple application of the AERMOD model to a single point source. The source is a hypothetical stack at a small isolated facility in a rural setting. Since the stack is below the Good Engineering Practice (GEP) stack height, the emissions from the source are subject to the influence of aerodynamic downwash due to the presence of nearby buildings. The tutorial leads the user through selection and specification of modeling options, specification of source parameters, definition of receptor locations, specification of the input meteorological data, and selection of output options. Since this discussion is aimed at novice users of the AERMOD model, a general description of the input file keyword/parameter approach is provided first.

2.1 Description of keyword/parameter approach

The input file for the AERMOD model makes use of a keyword/parameter approach to specifying the options and input data for running the model. The descriptive keywords and parameters that make up this input runstream file may be thought of as a command language through which the user communicates with the model what he/she wishes to accomplish for a particular model run. The keywords specify the type of option or input data being entered on each line of the input file, and the parameters following the keyword define the specific options selected or the actual input data. Some of the parameters are also input as descriptive secondary keywords.

The runstream file is divided into five functional "pathways." These pathways are identified by a two-character pathway ID placed at the beginning of each runstream image. The pathways and the order in which they are input to the model are as follows:

CO - for specifying overall job COntrol options;

SO - for specifying **SO**urce information;

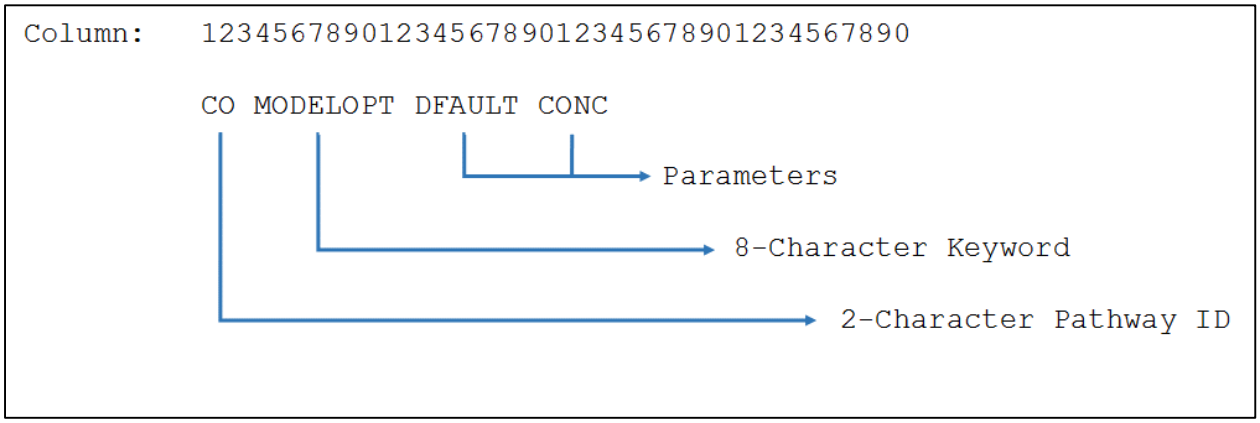
RE - for specifying **RE**ceptor information;

ME - for specifying **ME**teorology information;

EV - for specifiying **EV**ent processing;

OU - for specifying **OU**tput options.

Each line of the input runstream file consists of a pathway ID, an 8-character keyword, and a parameter list. An example of a line of input from a runstream file, with its various parts identified, is shown below:



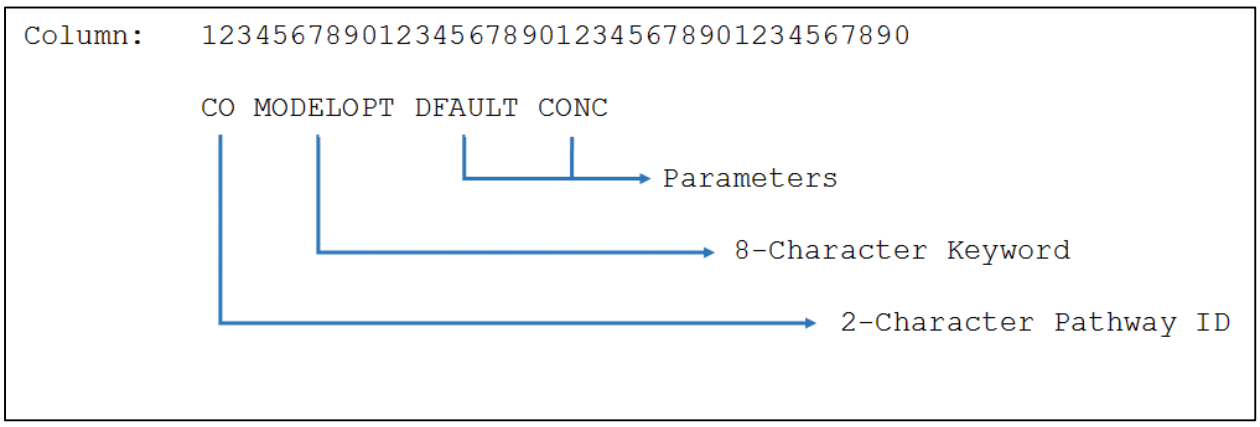
The following sections describe the rules for structuring the input runstream file, and explain some of the advantages of the keyword/parameter approach.

2.1.1 Basic rules for structuring input runstream files

While the input runstream file has been designed to provide the user with considerable flexibility in structuring the input file, there are some basic syntax rules that need to be followed. These rules serve to maintain some consistency between input files generated by different users, to simplify the job of error handling performed by the model on the input data, and to provide information to the model in the appropriate order wherever order is critical to the interpretation of the inputs. These basic rules and the various elements of the input runstream file are described in the paragraphs that follow.

One of the most basic rules is that all inputs for a particular pathway must be contiguous, i.e., all inputs for the CO pathway must come first, followed by the inputs for the SO pathway, and so on. The beginning of each pathway is identified with a "STARTING" keyword, and the ending of the pathway with the "FINISHED" keyword. Thus the first functional record of each input file must be "CO STARTING" and the last record of each input file must be "OU FINISHED." The rest of the input images will define the options and input data for a particular run.

Each record in the input runstream file is referred to as a runstream "image." Each record is read into the model as a 512-character image beginning with version 09292 (previously 132 characters). The information on each input image consists of a "pathway," a "keyword," and one or more "parameters." Each of these "fields" on the runstream image must be separated from other fields by at least one blank space. To simplify the interpretation of the runstream image by the model, the runstream file must be structured with the two-character pathway in columns 1 and 2, the eight-character keyword in columns 4 through 11, followed by the parameters beginning in column 13through the end of image, limited to 512 characters. For most keywords, the <u>order</u> of parameters following the keyword <u>is</u> important -- the exact <u>spacing</u> of the parameters <u>is not</u> important, as long as they are separated from each other by at least one blank space and do not extend beyond the 512 character limit. The example of a runstream image from the CO pathway shown above is repeated here:



Alphabetical characters can be input as either lower case or upper case letters. The model converts all character input to upper case letters internally, with the exception of the title fields and file names to be discussed later. Throughout this document, the convention of using upper case letters is followed. For numeric input data, it should be noted that all data are assumed to be in metric units, i.e., length units of meters, speed units of meters per second, temperature units of degrees Kelvin, and emission units of grams per second. In a few instances, the user has the option of specifying units of feet for length and the model will perform the conversion to meters. These exceptions are the input of receptor heights for elevated terrain and the specification of anemometer height, since these values are often more readily available in feet than in meters.

Certain keywords are mandatory and must be present in every runstream file, such as the MODELOPT keyword shown in the example above which identifies the modeling options. Other keywords are optional and are only needed to exercise particular options, such as the option to allow for the input of flagpole receptor heights. Some of the keywords are repeatable, such as the keywords to specify source parameters, while other keywords may only appear once. The keyword references are provided in Section 3.0, APPENDIX A, APPENDIX B and the Quick Reference in APPENDIX E.

With a few exceptions that are described below, the order of keywords within each pathway is not critical. For the SO pathway, the LOCATION keyword must be specified before other keywords for a particular source, and the SRCGROUP keyword must be the last keyword before SO FINISHED. For keywords on the SO pathway that accept a range of source IDs, the source parameters specified by those keywords will only be applied to the sources already defined, and will exclude any sources that are specified latter in the input file.

The PARAMETER ILEN_FLD is used to specify the maximum length of individual fields on the input runstream image, and also to declare the length of all filename and format variables. This PARAMETER is currently assigned a value of 200 beginning with version 09292 (previously 80), and is in MODULE MAIN1 in MODULES.FOR.

2.1.2 Advantages of the keyword approach

The keyword approach provides some advantages over the type of input file used by other models that require formatted input of several numeric switches. One advantage is that the keywords are descriptive of the options and inputs being used for a particular run, making it easier for a reviewer to ascertain what was accomplished in a particular run by reviewing the input file. Another advantage is that the user has considerable flexibility in structuring the inputs to improve their readability and understandability, as long as they adhere to the few basic rules described above.

Some special provisions have been made to increase the flexibility to the user in structuring the input files. One provision is to allow for blank records in the input file. This allows the user to separate the pathways from each other, or to separate a group of images, such as source locations, from the other images. Another provision is for the use of "comment lines," identified by a "**" in the pathway field. Any input image that has "**" for the pathway ID will be ignored by the model. This is especially useful for labeling the columns in the source parameter input images, as illustrated in the example problem later in this section. It may also be used to "comment out" certain options for a particular run without deleting the options and associated data (e.g., elevated terrain heights) completely from the input file. Because of the descriptive nature of the keyword options and the flexibility of the inputs it is generally much easier to make modifications to an existing input runstream file to obtain the desired result.

Another reason for improved "user-friendliness" is that detailed error-handling has been built into the model. The model provides descriptions of the location and nature of all of the errors encountered for a particular run. Rather than stopping execution at each occurrence of an input error, the model will read through and attempt to process all input records and report all errors encountered. If a fatal error occurs, then the model will not attempt to execute the model calculations.

2.2 Regulatory modeling options

The regulatory default option is controlled from the MODELOPT keyword on the CO pathway. As its name implies, this keyword controls the selection of modeling options. It is a mandatory, non-repeatable keyword, and it is an especially important keyword for understanding and controlling the operation of the AERMOD model. Unless specified otherwise through the available keyword options, the AERMOD model implements the following default options:

- Use the elevated terrain algorithms requiring input of terrain height data;
- Use stack-tip downwash (except for building downwash cases);
- Use the calms processing routines;
- Use the missing data processing routines;
- Use a 4-hour half-life for exponential decay of SO_2 for urban sources.

The parameters used to specify options on the MODELOPT keyword are character strings, called "secondary keywords," that are descriptive of the option being selected. For example, to ensure that the regulatory default options are used for a particular run, the user would include the secondary keyword "DFAULT" on the MODELOPT input. The presence of this secondary keyword tells the model to override any attempt to use a non-regulatory default option. The model will warn the user if a non-regulatory option is selected along with the DFAULT option, but will not halt processing. For regulatory modeling applications, it is strongly suggested that the DFAULT switch be set, even though the model defaults to the regulatory options without it. The MODELOPT keyword is described in more detail in the Section 3.2.2.

For any application in which a non-regulatory option is to be selected, the DFAULT switch must not be set, since it would otherwise override the non-regulatory option. The non-regulatory options are also specified by descriptive secondary keywords; for example, "NOSTD" invokes the option not to use stack-tip downwash.

2.3 Model storage limits

The AERMOD model has been designed using a dynamic storage allocation approach, where the model allocates data storage as needed based on the number of sources, receptors, source groups, and input requirements, up to the maximum amount of memory available on the computer being used. The AERMOD model uses dynamic arrays to allocate data storage at model runtime rather than at compile time. The AERMOD model preprocesses the model runstream input file to determine the data storage requirements for a particular model run, and then allocates the input data arrays before processing the setup data. Once the setup processing is completed, the model allocates storage for the result arrays. When allocating data storage, the AERMOD model traps for errors, e.g., not enough memory available to allocate. If the allocation is unsuccessful, then an error message is generated by the model and further processing is prevented. If the CO RUNORNOT NOT option is selected, the model will still go through all array allocations so that the user can determine if sufficient memory is available to complete the run. Also, an estimate of the total amount of memory needed for a particular run is printed out as part of the first page of printed output.

The storage parameters that are established at model runtime are as follows:

NSRC =	Number of Sources
NREC =	Number of Receptors
NGRP =	Number of Source Groups
NOLM =	Number of OLM Groups (OLMGROUP Keyword)
NAVE =	Number of Short Term Averaging Periods
NVAL =	Number of High Values by Receptor (RECTABLE Keyword)
NTYP =	Number of Output Types (CONC currently is the only output type)
NMAX =	Number of Overall Maximum Values (MAXTABLE Keyword)
NQF =	Number of Variable Emission Rate Factors per Source
NPDMAX =	Number of Particle Diameter Categories per Source
NVMAX =	Number of Vertices for Area Sources (including AREA, AREACIRC, and AREAPOLY source types) and/or OPENPIT Sources
NSEC =	Number of Sectors for Building Downwash Parameters (set to 36 if downwash sources are included)
NURB =	Number of Urban Areas (URBANOPT Keyword)

NNET =	Number of Cartesian and/or Polar Receptor Networks
IXM =	Number of X-coord (Distance) Values per Receptor Network
IYM =	Number of Y-coord (Direction) Values per Receptor Network
NARC =	Number of Receptor Arcs Used with EVALCART Keyword
NEVE =	Number of Events for EVENT processing

A new option, MAXDCONT, on the OU pathway (introduced with version 11059 to determine source group contributions to modeled values under the 24-hr PM2.5 and 1-hr SO2 and NO2 NAAQS) can significantly increase the memory requirements of AERMOD due to the fact that all meteorological and other variables needed to perform the MAXDCONT processing are stored in memory in order to optimize model runtime. The memory requirements for the MAXDCONT have been optimized with version 12060. A new option on the ME pathway, NUMYEARS, was also introduced with version 12060 to further reduce memory requirements for applications involving less than five (5) years of meteorological data, e.g., if one or more years of site-specific meteorological data area being used. The NUMYEARS keyword on the ME pathway allows the user to specify the number of years of data being processed for purposes of allocating array storage for the MAXDCONT option, with a default value of five (5) years being assumed if the optional NUMYEARS keyword is omitted.

2.4 Setting up a simple runstream file

This section goes through a step-by-step description of setting up a simple application problem, illustrating the most commonly used options of the AERMOD model. The example problem is based on a simple industrial source application. The input file for AERMOD for the example problem is shown in Figure 2-1. The remainder of this section explains the various parts of the input file for the AERMOD model, and also illustrates some of the flexibility in structuring the input file.

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC FLAT
CO AVERTIME 3 24 PERIOD
CO POLLUTID SO2
CO RUNORNOT RUN
CO FINISHED

SO STARTING
SO LOCATION  STACK1  POINT 0.0 0.0 0.0
SO SRCPARAM  STACK1  500.0 65.00 425. 15.0 5.
SO BUILDHGT  STACK1  36*50.
SO BUILDWID  STACK1  62.26   72.64   80.80   86.51   89.59   89.95
SO BUILDWID  STACK1  87.58   82.54   75.00   82.54   87.58   89.95
SO BUILDWID  STACK1  89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDWID  STACK1  62.26   72.64   80.80   86.51   89.59   89.95
SO BUILDWID  STACK1  87.58   82.54   75.00   82.54   87.58   89.95
SO BUILDWID  STACK1  89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDLEN  STACK1  82.54   87.58   89.95   89.59   86.51   80.80
SO BUILDLEN  STACK1  72.64   62.26   50.00   62.26   72.64   80.80
SO BUILDLEN  STACK1  86.51   89.59   89.95   87.58   82.54   75.00
SO BUILDLEN  STACK1  82.54   87.58   89.95   89.59   86.51   80.80
SO BUILDLEN  STACK1  72.64   62.26   50.00   62.26   72.64   80.80
SO BUILDLEN  STACK1  86.51   89.59   89.95   87.58   82.54   75.00
SO XBADJ     STACK1 -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
SO XBADJ     STACK1 -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
SO XBADJ     STACK1 -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
SO XBADJ     STACK1 -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
SO XBADJ     STACK1  -3.43    3.34   10.00    3.34   -3.43  -10.09
SO XBADJ     STACK1 -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
SO YBADJ     STACK1  34.47   32.89   30.31   26.81   22.50   17.50
SO YBADJ     STACK1  11.97    6.08    0.00   -6.08  -11.97  -17.50
SO YBADJ     STACK1 -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
SO YBADJ     STACK1 -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
SO YBADJ     STACK1 -11.97   -6.08    0.00    6.08   11.97   17.50
SO YBADJ     STACK1  22.50   26.81   30.31   32.89   34.47   35.00
SO SRCGROUP  ALL
SO FINISHED

RE STARTING
RE GRIDPOLR  POL1 STA
RE GRIDPOLR  POL1 ORIG STACK1
RE GRIDPOLR  POL1 DIST 175. 350. 500. 1000.
RE GRIDPOLR  POL1 GDIR 36 10 10
RE GRIDPOLR  POL1 END
RE FINISHED

ME STARTING
ME SURFFILE AERMET2.SFC
ME PROFFILE AERMET2.PFL
ME SURFDATA 14735 1988 ALBANY,NY
ME UAIRDATA 14735 1988 ALBANY,NY
ME SITEDATA
ME PROFBASE  0.0 METERS
ME FINISHED

OU STARTING
OU RECTABLE ALIVE FIRST-SECOND
OU MAXTABLE ALIVE 50
OU FINISHED
```

Figure 2-1. Example Input File for AERMOD for Sample Problem

2.4.1 A simple industrial source application

For this simple tutorial, an application is selected involving a single point source of SO_2 that is subject to the influences of building downwash. The source consists of a 50-meter stack with a buoyant release that is adjacent to a building. We will assume that the stack is situated in flat terrain in a rural setting. A polar receptor network will be placed around the stack location to identify areas of maximum impact.

2.4.2 Selecting modeling options - CO pathway

The modeling options are input to the model on the Control pathway. The mandatory keywords for the CO pathway are listed below. A complete listing of all keywords is provided in APPENDIX B

STARTING -	Indicates the beginning of inputs for the pathway; this keyword is mandatory on each of the pathways.
TITLEONE -	A user-specified title line (up to 68 characters) that will appear on each page of the printed output file (an optional second title line is also available with the keyword TITLE TWO).
MODELOPT -	Controls the modeling options selected for a particular run through a series of secondary keywords.
AVERTIME -	Identifies the averaging periods to be calculated for a particular run.
POLLUTID -	Identifies the type of pollutant being modeled. At the present time, this option has no influence on the results.
RUNORNOT -	A special keyword that tells the model whether to run the full model executions or not. If the user selects not to run, then the runstream setup file will be processed and any input errors reported, but no dispersion calculations will be made.
FINISHED -	Indicates that the user is finished with the inputs for this pathway; this keyword is also mandatory on each of the other pathways.

The first two keywords are fairly self-explanatory. As discussed above in Section 2.2, the MODELOPT keyword on the CO pathway is pivotal to controlling the modeling options used for a particular run. For this example, we intend to use the regulatory default option, and have specified for the model to output concentration values. After the first three input records our input file will look something like this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
```

Note that the title parameter field does not need to be in quotations, even though it represents a single parameter. The model simply reads whatever appears beginning in column 13 out to a length of 200 characters of the TITLEONE card as the title field, without changing the lower case to upper case letters. Leading blanks are therefore significant if the user wishes to center the title within the field. Note that in the output files, only the first 68 characters of TITLEONE are printed. Note also that the spacing and order of the secondary keywords on the MODELOPT card are not significant. A MODELOPT card that looked like this:

```
CO MODELOPT CONC  FLAT
```

would have an identical result as the example above. It is suggested that the user adopt a style that is consistent and easy to read. A complete description of the available modeling options that can be specified on the MODELOPT keyword is provided in Section 3.0.

Since the pollutant in this example is SO_2, we will probably need to calculate average values for 3-hour and 24-hour time periods, and we also need to calculate averages for the full annual time period. Our runstream file might therefore look something like this after adding two more keywords:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
CO AVERTIME 3  24  PERIOD
CO POLLUTID SO2
```

Note again that the order of the parameters on the AVERTIME keyword is not critical, although the order of the short term averages given on the AVERTIME keyword will also be the order in which the results are presented in the output file. The order of the keywords within each pathway is also not critical in most cases, although the intent of the input runstream file may be easier to decipher if a consistent and logical order is followed. It is suggested that users follow the order in which the keywords are presented in Section 3.0, in APPENDIX B, and in the Quick Reference, unless there is a clear advantage to doing otherwise.

The only remaining mandatory keywords for the CO pathway are RUNORNOT and FINISHED. We will set the RUNORNOT switch to RUN for this example. If a user is unsure about the operation of certain options, or is setting up a complex runstream file to run for the first time, it may be desirable to set the model NOT to run, but simply to read and analyze the input file and report any errors or warning messages that are generated. Once the input file has been debugged using these descriptive error/warning messages, then the RUNORNOT switch can be set to RUN, avoiding a possible costly waste of resources generating erroneous results. Even if the model is set NOT to run, all of the inputs are summarized in the output file for the user to review.

Our complete runstream file for the CO pathway may look something like this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
CO MODELOPT CONC  FLAT
CO AVERTIME 3  24  PERIOD
CO POLLUTID SO2
CO RUNORNOT RUN
CO FINISHED
```

The following set of runstream images has a more structured look, but it is equivalent to the example above:

```
CO STARTING
   TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
   MODELOPT CONC  FLAT
   AVERTIME 3  24  PERIOD
   POLLUTID SO2
   RUNORNOT RUN
CO FINISHED
```

Since the pathway ID is required to begin in column 1 (see Section 2.4.8 for a discussion of this restriction), the model will assume that the previous pathway is in effect if the pathway field is left blank. The model will do the same for blank keyword fields, which will be illustrated in the next section.

In addition to these mandatory keywords on the CO pathway, the user may select optional keywords to allow the use of receptor heights above ground-level for flagpole receptors, to specify a decay coefficient or a half-life for exponential decay, and to generate an input file containing events for EVENT processing. The user also has the option of having the model periodically save the results to a file for later re-starting in the event of a power failure or other interruption of the model's execution. These options are described in more detail in Section 3.0 of this volume.

2.4.3 Specifying source inputs - SO pathway

Besides the STARTING and FINISHED keywords that are mandatory for all pathways, the Source pathway has the following mandatory keywords:

LOCATION - Identifies a particular source ID and specifies the source type and location of that source.

SRCPARAM - Specifies the source parameters for a particular source ID identified by a previous LOCATION card.

SRCGROUP - Specifies how sources will be grouped for calculational purposes. There is always at least one group, even though it may be the group of ALL sources and even if there is only one source.

Since the hypothetical source in our example problem is influenced by a nearby building, we also need to include the optional keywords BUILDHGT and BUILDWID in our input file.

The input file for the SO pathway for this example will look something like this:

```
STARTING
LOCATION  STACK1    POINT   0.0     0.0     0.0
SRCPARAM  STACK1    500.0   65.00   425.    15.0    5.0
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDHGT  STACK1    50.00   50.00   50.00   50.00   50.00   50.00
BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
BUILDWID  STACK1    87.58   82.54   75.00   82.54   87.58   89.95
BUILDWID  STACK1    89.59   86.51   80.80   72.64   62.26   50.00
BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
BUILDWID  STACK1    87.58   82.54   75.00   82.54   87.58   89.95
BUILDWID  STACK1    89.59   86.51   80.80   72.64   62.26   50.00
BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
BUILDLEN  STACK1    72.64   62.26   50.00   62.26   72.64   80.80
BUILDLEN  STACK1    86.51   89.59   89.95   87.58   82.54   75.00
BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
BUILDLEN  STACK1    72.64   62.26   50.00   62.26   72.64   80.80
BUILDLEN  STACK1    86.51   89.59   89.95   87.58   82.54   75.00
XBADJ     STACK1   -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
XBADJ     STACK1   -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
XBADJ     STACK1   -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
XBADJ     STACK1   -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
XBADJ     STACK1    -3.43    3.34   10.00    3.34   -3.43  -10.09
XBADJ     STACK1   -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
YBADJ     STACK1    34.47   32.89   30.31   26.81   22.50   17.50
YBADJ     STACK1    11.97    6.08    0.00   -6.08  -11.97  -17.50
YBADJ     STACK1   -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
YBADJ     STACK1   -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
YBADJ     STACK1   -11.97   -6.08    0.00    6.08   11.97   17.50
YBADJ     STACK1    22.50   26.81   30.31   32.89   34.47   35.00
SRCGROUP  ALL
FINISHED
```

There are a few things to note about these inputs. Firstly, the source ID (STACK1 in this example) is an alphanumeric parameter (up to eight characters) that identifies the inputs for different keywords with a particular source. It is crucial that the source be identified with a LOCATION card before any other keyword makes reference to that source, since this identifies the source type (POINT in this case), and therefore which parameters the model will allow. See Section 3.3.1 for a complete list and descriptions of the valid source types. If the effects of elevated terrain were included in this analysis, it would be important to specify the source base elevation above mean sea level (MSL) on the LOCATION card. For this example, the source base elevation is 0.0 meters MSL.

Another thing to note is that since the model uses direction-specific building dimensions for all sources with downwash, there are 36 building heights and 36 building widths entered on the appropriate keywords, one value for each 10 degree sector beginning with the 10 degree flow vector (direction <u>toward</u> which the wind is blowing), and continuing clockwise. Since the user

could not fit all 36 values on a single record, the pathway, keyword and source ID were repeated as many times as were necessary. In this case there were 6 values given on each of 6 lines for each of the building dimensions. There could have been fewer or more lines as long as exactly 36 values were entered before starting with a new keyword. Since all of the building heights were the same across the sectors (fairly realistic for the height but not for widths, unless the structure was circular), there is a short cut available for specifying numeric input in the runstream files for the model. The user can specify "repeat values" by entering a field such as "36*50.0" as a parameter for the BUILDHGT keyword. The model will interpret this as "36 separate entries, each with a value of 50.0," and store the values in the appropriate arrays within the model. Since the model must identify this as a single parameter field, there must not be any spaces between the repeat-value and the value to be repeated.

The final keyword before finishing the SO pathway must be the SRCGROUP keyword. In this example, since there is only one source, we have taken advantage of a short cut provided by the model by specifying a source group ID (which may be up to eight characters) of ALL. Whenever this card appears in an input file, it will generate a source group with a source-group ID of ALL, consisting of all sources defined for that run. The sources do not have to be explicitly identified. In a run involving multiple sources, the user may specify multiple source groups by repeating the SRCGROUP keyword. The use of the SRCGROUP card is explained in more detail in Section 3.0.

Using some of the formatting options discussed above, the SO pathway for our example may look like this, with the same result as above:

```
SO STARTING
LOCATION    STACK1   POINT  0.0 0.0 0.0
** Point Source       QS    HS    TS     VS     DS
** Parameters:       ----  ----  ----   ----   ----
   SRCPARAM STACK1   500.0 65.0  425.0  15.0    5.0
   BUILDHTS STACK1   36*50.
   BUILDWTS STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
            STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
   XBADJ    STACK1  -47.35   -55.76   -62.48   -67.29   -70.07    -70.71
            STACK1  -69.21   -65.60   -60.00   -65.60   -69.21    -70.71
            STACK1  -70.07   -67.29   -62.48   -55.76   -47.35    -37.50
            STACK1  -35.19   -31.82   -27.48   -22.30   -16.44    -10.09
            STACK1   -3.43     3.34    10.00     3.34    -3.43    -10.09
            STACK1  -16.44   -22.30   -27.48   -31.82   -35.19    -37.50
   YBADJ    STACK1   34.47    32.89    30.31    26.81    22.50     17.50
            STACK1   11.97     6.08     0.00    -6.08   -11.97    -17.50
            STACK1  -22.50    26.81   -30.31   -32.89   -34.47    -35.00
            STACK1  -34.47   -32.89   -30.31   -26.81   -22.50    -17.50
            STACK1  -11.97    -6.08     0.00     6.08    11.97     17.50
            STACK1   22.50    26.81    30.31    32.89    34.47     35.00
   SRCGROUP ALL
SO FINISHED
```

This example of the SO pathway inputs illustrates the use of the comment card to label the stack parameters on the SRCPARAM card, i.e., QS for emission rate (g/s), HS for stack height (m), TS for stack exit temperature (K), VS for exit velocity (m/s), and DS for stack diameter (m). A complete description of the source parameter card, with a list of parameters for each source type, is provided in Section 3.3 and in APPENDIX B.

Other optional inputs that may be entered on the SO pathway include specifying variable emission rate factors for sources whose emissions vary as a function of month, season, hour-of-day, or season and hour-of-day (see Section 0 for more details). The number of factors entered depends on the option selected, and factors may be input for single sources or for a range of sources.

2.4.4 Specifying a receptor network - RE pathway

As mentioned above, this example will illustrate the use of a single polar receptor network centered on the stack location. Other options available on the REceptor pathway

include specifying a Cartesian grid receptor network and specifying discrete receptor locations in either a polar or a Cartesian system. These other options are described in more detail in Section 3.4.

The RE pathway for this example will look like this:

```
RE STARTING
   GRIDPOLR POL1 STA
   GRIDPOLR POL1 ORIG STACK1
   GRIDPOLR POL1 DIST 175. 350. 500. 1000.
   GRIDPOLR POL1 GDIR 36 10 10
   GRIDPOLR POL1 END
RE FINISHED
```

Looking at the example for the RE pathway, the first thing to note about these inputs is that there is a new set of keywords, including something that looks like a STArting and ENDing. In fact the GRIDPOLR keyword can be thought of as a "sub-pathway," in that all of the information for a particular polar network must be in contiguous records, and that the starting and ending of the sub-pathway are identified. The order of secondary keywords within the sub-pathway is not critical, similar to the main pathways. Each card must be identified with a network ID (up to eight alphanumeric characters), in this case it is "POL1." Multiple networks may be specified in a single model run. The model waits until the END secondary keyword is encountered to set the variables, which may include terrain heights for receptors on elevated terrain or flagpole receptor heights if those options are being exercised by the user. The use of these optional secondary keywords is described in detail in Section 3.4.

For this example, the ORIG secondary keyword specifies the location of the origin for the polar network being defined as being the location of the source STACK1. The origin can also be specified as X and Y-coordinates. The ORIG keyword is optional, and the model will default to an origin of (0.0, 0.0) if it is omitted. The DIST keyword identifies the distances along each direction radial at which the receptors will be located. In this case there are four distances. More distances could be added by adding values to that input card or by including a continuation card with the DIST keyword, if needed. The GDIR keyword specifies that the model will Generate DIRection radials for the network, in this case there will be 36 directions, beginning with the 10 degree flow vector and incrementing every 10 degrees clockwise. The user may elect to define

Discrete DIRection radials instead by using the DDIR keyword in place of the GDIR keyword.

2.4.5 Specifying the meteorological Input - ME pathway

The MEteorology pathway has the following four mandatory keywords in addition to the common STARTING and FINISHED keywords:

SURFFILE - Specifies the filename and format for the input surface meteorological data file.

PROFFILE - Specifies the filename and format for the input profile meteorological data file.

SURFDATA - Specifies information about the surface meteorological data which will be used in the modeling.

UAIRDATA - Specifies information about the upper air meteorological data which will be used in the modeling.

PROFBASE - Specifies the base elevation above MSL for the potential temperature profile.

For the purposes of this example we will assume that the meteorological data files are for Albany, NY and that an on-site location called Hudson has also been used. We will also assume that the surface and profile data files were generated by the AERMET preprocessor, and are in the default format for AERMOD. The filename of the surface file is AERMET2.SFC and it consists of four days of data for Albany/Hudson from March 1988. The filename of the profile file is AERMET2.PFL. The data files used in this example correspond with the on-site example files used for the AERMET preprocessor program. The runstream images for the MEteorology pathway would look something like this:

```
ME STARTING
   SURFFILE  AERMET2.SFC
   PROFFILE  AERMET2.PFL
   SURFDATA  14735  1988  ALBANY,NY
   UAIRDATA  14735  1988  ALBANY,NY
   SITEDATA  99999 1988   HUDSON
   PROFBASE  0.0  METERS
ME FINISHED
```

The first parameters on the SURFFILE and PROFFILE keywords are the filenames for the surface and profile data file, respectively, which can be entered as a full DOS pathname, including the drive specification and subdirectories, up to a total of 200 characters (with the maximum number of characters controlled by the ILEN_FLD PARAMETER located in MODULE MAIN1 - see Section 2.1.1). Since there is no second parameter, the model will assume the default ASCII format for the data files. The format of the surface and profile data files is described in APPENDIX D.

The next two mandatory inputs identify the location and data period of the input meteorological data. A separate keyword is used for the surface meteorological data and for the upper air (mixing height) data. The parameters on these cards are the station number (e.g. WBAN number for NWS stations), the data period (year), and a station name. In order to identify potential errors in the model inputs, the model compares the station number from the runstream input file with values provided in the first record of the surface meteorology file, and issues warning messages if there are any mismatches. The user may also optionally input the (X,Y) coordinates for the location of the station(s), although these values are not currently used by the model. In this case, we have also included the optional SITEDATA keyword to identify the location for the on-site meteorological data that were preprocessed by AERMET.

The final mandatory keyword is PROFBASE, which is used to specify the base elevation (above MSL) for the potential temperature profile generated by AERMOD for use in the plume rise calculations. This should correspond to the base elevation for the main meteorological tower, which in this example is specified as 0.0 meters and is the same as the source base elevation.

Other optional keywords available on the ME pathway provide the user with options to specify selected days to process from the meteorological data file, and a wind direction rotation correction term. These optional inputs are described in more detail in Section 3.5.

2.4.6 Selecting output options - OU pathway

All of the keywords on the Output pathway are optional, although the model will warn the user if no printed outputs are requested and will halt processing if no outputs (printed results or file outputs) are selected. The user has considerable flexibility to select only the outputs that are needed for a particular application. The printed table keywords are:

RECTABLE - Specifies the selection of high value by receptor table output options.

MAXTABLE Specifies the selection of overall maximum value table output options.

DAYTABLE Specifies the selection of printed results (by receptor) for each day of data processed (this option can produce very large files and such be used with care).

The RECTABLE keyword provides the highest, second-highest and third-highest values by receptor. The MAXTABLE keyword provides the overall maximum 50 table. For both of these keywords, the user has additional flexibility to specify for which short term averaging periods the outputs are selected. For the MAXTABLE keyword the user can also specify the number of overall maximum values to summarize for each averaging period selected, up to a maximum number controlled by a parameter in the computer code. For this example problem we will select the highest and second-highest values by receptor, and the maximum 50 values for all averaging periods. These OU pathway inputs will look something like this:

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  ALLAVE  50
OU FINISHED
```

To simplify the input for users who request the same printed table output options for all averaging periods, these keywords recognize the secondary keyword "ALLAVE" as the first parameter for that purpose. In order to obtain the overall maximum 10 values for the 24-hour averages only, then the OU pathway images would look like this:

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  24  10
OU FINISHED
```

It should also be noted that these output table options apply only to the short-term averaging periods, such as the 3-hour and 24-hour averages used in our example. If the user has selected that PERIOD averages be calculated (on the CO AVERTIME keyword), then the output file will automatically include a table of period averages summarized by receptor (the RECTABLE option does not apply since there is only one period value for each receptor). In addition, the printed output file will include tables summarizing the highest values for each averaging period and source group.

Other options on the OU pathway include several keywords to produce output files for specialized purposes, such as generating contour plots of high values, identifying occurrences of violations of a particular threshold value (e.g. a NAAQS), and for postprocessing of the raw concentration data. These options are described in detail in Section 3.7.

The complete input runstream file for this simple example is shown in Figure 2-2. Note that a consistent style has been used for formatting and structuring the file in order to improve its readability. This input file is comparable to the version shown earlier in Figure 2-1, which used a somewhat different style.

```
CO STARTING
   TITLEONE A Simple Example Problem for the AERMOD-PRIME Model
   MODELOPT CONC  FLAT
   AVERTIME 3  24  PERIOD
   POLLUTID SO2
   RUNORNOT RUN
CO FINISHED

SO STARTING
   LOCATION  STACK1  POINT 0.0 0.0 0.0
** Point Source       QS     HS    TS    VS   DS
** Parameters:       -----  ----  ----  ----  ---
   SRCPARAM  STACK1  500.0  65.0  425.  15.0  5.0
   BUILDHGT  STACK1  36*50.
SO BUILDWID  STACK1    62.26   72.64   80.80   86.51   89.59   89.95
             STACK1    87.58   82.54   75.00   82.54   87.58   89.95
             STACK1    89.59   86.51   80.80   72.64   62.26   50.00
             STACK1    62.26   72.64   80.80   86.51   89.59   89.95
             STACK1    87.58   82.54   75.00   82.54   87.58   89.95
             STACK1    89.59   86.51   80.80   72.64   62.26   50.00
SO BUILDLEN  STACK1    82.54   87.58   89.95   89.59   86.51   80.80
             STACK1    72.64   62.26   50.00   62.26   72.64   80.80
             STACK1    86.51   89.59   89.95   87.58   82.54   75.00
             STACK1    82.54   87.58   89.95   89.59   86.51   80.80
             STACK1    72.64   62.26   50.00   62.26   72.64   80.80
             STACK1    86.51   89.59   89.95   87.58   82.54   75.00
SO XBADJ     STACK1   -47.35  -55.76  -62.48  -67.29  -70.07  -70.71
             STACK1   -69.21  -65.60  -60.00  -65.60  -69.21  -70.71
             STACK1   -70.07  -67.29  -62.48  -55.76  -47.35  -37.50
             STACK1   -35.19  -31.82  -27.48  -22.30  -16.44  -10.09
             STACK1    -3.43    3.34   10.00    3.34   -3.43  -10.09
             STACK1   -16.44  -22.30  -27.48  -31.82  -35.19  -37.50
SO YBADJ     STACK1    34.47   32.89   30.31   26.81   22.50   17.50
             STACK1    11.97    6.08    0.00   -6.08  -11.97  -17.50
             STACK1   -22.50  -26.81  -30.31  -32.89  -34.47  -35.00
             STACK1   -34.47  -32.89  -30.31  -26.81  -22.50  -17.50
             STACK1   -11.97   -6.08    0.00    6.08   11.97   17.50
             STACK1    22.50   26.81   30.31   32.89   34.47   35.00
   SRCGROUP  ALL
SO FINISHED

RE STARTING
   GRIDPOLR  POL1 STA
   GRIDPOLR  POL1 ORIG STACK1
   GRIDPOLR  POL1 DIST 175. 350. 500. 1000.
   GRIDPOLR  POL1 GDIR 36 10 10
   GRIDPOLR  POL1 END
RE FINISHED

ME STARTING
   SURFFILE AERMET2.SFC
   PROFFILE AERMET2.PFL
   SURFDATA 14735 1988 ALBANY,NY
   UAIRDATA 14735 1988 ALBANY,NY
   SITEDATA 99999 1988 HUDSON
   PROFBASE  0.0 METERS
ME FINISHED

OU STARTING
   RECTABLE ALLAVE FIRST-SECOND
   MAXTABLE ALLAVE 50
OU FINISHED
```

Figure 2-2. Example Input Runstream File for Sample Problem

2.4.7 Using the error message file to debug the input runstream file

The previous sections in this tutorial have lead through the step-by-step construction of a sample runstream input file for AERMOD. This simple example problem illustrated the usage of the most commonly used options of the AERMOD model. However, many real-time applications of the model will be much more complex than this example, perhaps involving multiple sources and source groups, multiple receptor networks, the addition of discrete receptor locations, and/or elevated terrain heights. Since humans are prone to make errors from time to time, an effort has been made to develop detailed error handling capabilities for the AERMOD model.

The error handling capabilities of the AERMOD model are designed to accomplish two things for the user. First, the model should read through the complete input file and report all occurrences of errors or suspect entries before stopping, rather than stopping on the first instance (and every instance thereafter) of an error in the input file. Second, the model should provide error and warning messages that are detailed and descriptive enough that they will help the user in his/her effort to debug the input file. The remainder of this section provides of brief introduction to the use of the model's error handling capabilities. APPENDIX C of this volume provides more details about the error handling provided by the AERMOD model, including a listing and explanation of all error and other types of messages generated by the model.

The AERMOD model generates messages during the processing of the input data and during the execution of model calculations. These messages inform the user about a range of possible conditions including:

- Errors that will halt any further processing, except to identify additional error conditions;
- Warnings that do not halt processing but indicate possible errors or suspect conditions; and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results.

As the model encounters a condition for which a message is generated, the model writes the message to a temporary storage file. At the completion of the setup processing for a run, and

at the completion of the model calculations, the model rereads the message file and generates a summary of the messages which is included in the main printed output file. If the processing of the model setup information indicates no errors or warnings, and the user has selected the option to RUN the model calculations on the CO RUNORNOT card, then the model will simply write a statement to the print file that the model setup was completed successfully. Otherwise, the model will report a summary of the messages encountered. The summary of model setup messages that would be generated for the example problem if the option NOT to run was chosen is shown in Figure 2-3. This summary table reports the total number of occurrences for each of the message types, and lists the detailed message for any fatal errors or warning messages that were generated. In this case, since there were no errors or suspicious conditions in the setup file, there are no error or warning messages listed.

An example of the warning message that would have been generated had we left out the card on the RE pathway that specifies the origin of the polar receptor network is shown below:

```
RE W220 39 REPOLR: Missing Origin (Use Default = 0,0) In GRIDPOLR      POL1
|   |   |    |        |                                                 |
|   |   |    |        |                                                 |
|   |   |    |        |                                               Hints
|   |   |    |        |
|   |   |    |      Detailed error/warning message
|   |   |    |
|   |   |  Subroutine from which message is generated
|   |   |
|   |  Line number of file where message occurred
|   |
|  Message code - including message type (E, W, I) and message number
|
Pathway ID where message originated
```

Since this is a warning message, it would have appeared at the end of the message summary table in the output file, but it would not have halted processing of the data. The last item on the message line, "Hints," may include such information as the keyword or parameter name causing the error, the source ID, group ID or (as in this case) the network ID involved, or perhaps the date variable identifying when the message occurred during the processing of the meteorological data, such as an informational message identifying the occurrence of a calm wind.

For new users and for particularly complex applications, it is strongly recommended that the model first be run with the RUNORNOT keyword (on the CO pathway) set NOT to run. In this way, the user can determine if the model is being setup properly by the runstream file before committing the resources to perform a complete run. The user should make a point of examining any warning messages carefully to be sure that the model is operating as expected for their application, since these messages will not halt processing by the model. In most cases, the detailed messages will provide enough information for the user to determine the location and nature of any errors in the runstream setup file. If the intent of the message is not immediately clear, then the user should refer to the more detailed descriptions provided in APPENDIX C for the particular error code generated.

In deciphering the error and warning messages, the line number provided as part of the message may be particularly helpful in locating the error within the input file. However, if it is an error of omission that is caught by the error checking performed at the completion of inputs for a pathway, then the line number will correspond to the last record for that pathway. The user may need to examine all of the messages carefully before locating the error or errors, especially since a single occurrence of certain types of errors may lead to other error conditions being identified later in the input file which do not really constitute errors in themselves. An example of this is provided in Figure 2-4, which shows some inputs for the SO pathway where the building dimension keywords have been typed incorrectly, and the associated list of error messages. Since continuation cards were being used for the building width inputs, and the keyword was entered incorrectly on the first line, the subsequent records were also taken by the model to be invalid keyword inputs. While the error messages are the same for these records, the

message originates from a different part of the model (SUBROUTINE SOCARD) for the records with the blank keyword.

Since the detailed error and warning messages are listed in the output file as part of the message summary table, there will generally not be a need for the user to examine the contents of the detailed message file. For this reason, the default operation of the model is to write the messages that are generated by a particular run to a temporary file that is deleted when the run is completed. If the user wishes to examine the complete list of detailed messages (of all types), there is an optional keyword available on the CO pathway for that purpose. The ERRORFIL keyword, which is described in detail in Section 3.2.17, allows the user to save the complete list of detailed messages to a user-specified filename.

```
*** Message Summary : AERMOD Model Execution ***

  --------- Summary of Total Messages --------

 A Total of            0 Fatal Error Message(s)
 A Total of            0 Warning Message(s)
 A Total of            0 Informational Message(s)

 A Total of           96 Hours Were Processed

 A Total of            0 Calm Hours Identified

 A Total of            0 Missing Hours Identified (  0.00 Percent)


    ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


    ********   WARNING MESSAGES   ********
               ***  NONE  ***


    ************************************
    *** AERMOD Finishes Successfully ***
    ************************************
```

Figure 2-3. Example Message Summary Table for AERMOD Runstream Execution

```
SO STARTING
LOCATION    STACK1   POINT  0.0 0.0 0.0
** Point Source       QS    HS    TS     VS     DS
** Parameters:       ----  ----  ----   ----   ----
   SRCPARAM STACK1   500.0 65.0  425.0  15.0    5.0
   BUILDHTS STACK1   36*50.
   BUILDWTS STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
            STACK1   62.26    72.64    80.80    86.51    89.59     89.95
            STACK1   87.58    82.54    75.00    82.54    87.58     89.95
            STACK1   89.59    86.51    80.80    72.64    62.26     50.00
   XBADJ    STACK1  -47.35   -55.76   -62.48   -67.29   -70.07    -70.71
            STACK1  -69.21   -65.60   -60.00   -65.60   -69.21    -70.71
            STACK1  -70.07   -67.29   -62.48   -55.76   -47.35    -37.50
            STACK1  -35.19   -31.82   -27.48   -22.30   -16.44    -10.09
            STACK1   -3.43     3.34    10.00     3.34    -3.43    -10.09
            STACK1  -16.44   -22.30   -27.48   -31.82   -35.19    -37.50
   YBADJ    STACK1   34.47    32.89    30.31    26.81    22.50     17.50
            STACK1   11.97     6.08     0.00    -6.08   -11.97    -17.50
            STACK1  -22.50    26.81   -30.31   -32.89   -34.47    -35.00
            STACK1  -34.47   -32.89   -30.31   -26.81   -22.50    -17.50
            STACK1  -11.97    -6.08     0.00     6.08    11.97     17.50
            STACK1   22.50    26.81    30.31    32.89    34.47     35.00
   SRCGROUP    ALL
SO FINISHED
```

```
  *** Message Summary For AERMOD Model Setup ***

  --------- Summary of Total Messages --------

 A Total of            9 Fatal Error Message(s)
 A Total of            0 Warning Message(s)
 A Total of            0 Informational Message(s)


    ******** FATAL ERROR MESSAGES ********
 SO E105      14        SETUP: Invalid Keyword Specified. The Troubled Keyword is     BUILDHTS
 SO E105      15        SETUP: Invalid Keyword Specified. The Troubled Keyword is     BUILDWTS
 SO E110      16       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      17       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      18       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      19       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E110      20       SOCARD: Keyword is Not Valid for This Pathway.  Keyword is     BUILDWTS
 SO E236      40        SRCQA: Not Enough BUILDHGTs Specified for SourceID              STACK1
 SO E237      40        SRCQA: Not Enough BUILDWIDs Specified for SourceID              STACK1

    ********   WARNING MESSAGES   ********
               ***  NONE  ***


    ************************************
    *** SETUP Finishes UN-successfully ***
    ************************************
```

Figure 2-4. Example of Keyword Error and Associated Message Summary Table

2.4.8 Running the model and reviewing the results

Now that we have a complete and error-free runstream input file, we are ready to run the model and then review the results. The PC-executable file available on the SCRAM website opens the runstream input and printed output files explicitly within the model using internally specified filenames of AERMOD.INP and AERMOD.OUT, respectively. The model can be executed from the command prompt by simply typing the name AERMOD, as follows:

```
C:\>AERMOD
```

The "c-prompt" of DOS has been represented by the characters "C:\>", but may appear different on different machines. The important points are that the AERMOD.EXE file either be in the directory from which you are attempting to run the model, or in a directory that is included on the DOS PATH command when the system is "booted-up." The runstream input file (AERMOD.INP) must also be located in the directory from which the model is being executed. The model can also be executed by double clicking on the executable file from Windows Explorer.

As mentioned above, the SCRAM PC-executable file for AERMOD opens the input and output files explicitly. One reason for this is to allow for the model to write an update on the status of processing to the PC terminal screen. For the AERMOD model, the model first indicates that setup information is being processed and then gives the Julian day currently being processed. If no status message is seen then the model did not load into memory properly. If the model stops after completing the setup processing, then either the RUNORNOT option was set NOT to run. If a fatal error is encountered during the setup processing, then a message to that effect will be written to the screen and model execution will be stopped. Another reason for not sending the printed output to the default output device (i.e., to the screen or redirected to a file), is so that any DOS error messages will be visible on the screen and not be written to the printed file. One such message might be that there is insufficient memory available to run the program. Handling of DOS error messages may require some knowledge of DOS, unless the meaning of the message is obvious.

The order of contents and organization of the main output file for the AERMOD model is presented in Figure 2-5.

Echo of Input Runstream Images

Summary of Runstream Setup Messages

Summary of Inputs
- Summary of Modeling Options
- Summary of Source Data Summary
- of Receptor Data Summary of
- Meteorology Data

Model Results

- Daily Results for Each Averaging Period Selected for Each Day Processed (If Applicable)
  - DAYTABLE Keyword

- PERIOD Results for Each Source Group (If Applicable)
  - PERIOD Parameter on AVERTIME Keyword

- Short Term Average Results (High, Second High, etc.) by Receptor for Each Source Group (If Applicable)
  - RECTABLE Keyword

- Overall Maximum Short Term Average Results for Each Source Group (If Applicable)
  - MAXTABLE Keyword

Summary Tables of High Values for Each Averaging Period and Source Group (Always provided if PERIOD averages or the RECTABLE keyword are used)

Summary of Complete Model Execution Messages

Figure 2-5. Organization of the AERMOD Model Output File

Each page of the output file, except for the echo of the input file images, is labeled with the model name and version number, user-specified title(s), page number, and, for the PC version of the model, the date and time of the particular run. Also included as part of the header information for each page is a one-line summary of the modeling options used for that particular run. The modeling options are listed as the secondary keywords used to control the options, such as DFAULT, CONC, etc.

Since the complete input file is normally echoed back as part of the output file, and since processing of the inputs stops when the OU FINISHED card is reached, the run can be duplicated by simply specifying the output filename as the input runstream file. Alternatively, the input records could be "cut and pasted" from the output file to a separate file using a text editor.

By default, the model will echo each line of the input runstream file to the printed output file. This provides a convenient record of the inputs as originally read into the model, without any rounding of numerical values that may appear in the input summary tables. As noted above, it also means that the output file can be used as an input file to the model to reproduce a particular application. However, for some applications, the length of the input runstream file may be too cumbersome to include the entire set of inputs at the beginning of each output file. This may happen, for example, if a large number of sources are being defined or if a large number of discrete receptor locations are used. For this reason, the user is provided with the option to "turn off" the echoing of the input file at any point within the runstream file. This is accomplished by entering the keywords "NO ECHO" in the first two fields anywhere within the runstream file. In other words, place NO in the pathway field, followed by a space and then ECHO. None of the input runstream images after the NO ECHO will be echoed to the output file. Thus, a user may choose to place NO ECHO after the Control pathway in order to keep the control options echoed, but suppress echoing the rest of the input file.

The details of the message summary tables were discussed in the previous section. A portion of the summary of modeling option inputs is shown in Figure 2-6 for the simple example described in this section. The summary of source parameter input data includes separate tables for each source type, rather than combining all sources onto a single table. In this way the column headings are specific to the source type.

Figure 2-7 presents an example of the results output for the second highest values by receptor for our sample problem. These values are the second highest 3-hour averages at each receptor location. The number in parentheses following each concentration value is the date corresponding to each value. The date is given as an eight digit integer variable that includes the year (2-digits), month, day, and hour corresponding to the end of the averaging period.

For each of the different types of model result tables, the controlling keyword is identified in Figure 2-5 at the end of the description. All of the outputs of the same type, e.g. high values by receptor, are printed together, and the order of tables loops through all source groups for a particular averaging period, and then loops through all averaging periods. The summary tables of high values at the end of the model results follow the same order of loops. An example of the summary tables for our sample problem is shown in Figure 2-8. The summaries for all averaging periods have been combined onto a single figure, but would appear on separate pages of the actual output file.

```
*** AERMOD - VERSION  15181 ***   *** A Simple Example Problem for the AERMOD-PRIME Model                    ***        05/27/16
 *** AERMET - VERSION  15181 ***   ***                                                                        ***        09:29:00
                                                                                                                          PAGE   1
 **MODELOPTs:   NonDFAULT CONC      FLAT      RURAL

                                            ***     MODEL SETUP OPTIONS SUMMARY       ***
 - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

 **Model Is Setup For Calculation of Average CONCentration Values.

   --  DEPOSITION LOGIC  --
 **NO GAS DEPOSITION Data Provided.
 **NO PARTICLE DEPOSITION Data Provided.
 **Model Uses NO DRY DEPLETION.  DRYDPLT  =  F
 **Model Uses NO WET DEPLETION.  WETDPLT  =  F

 **Model Uses RURAL Dispersion Only.

 **Model Allows User-Specified Options:
         1. Stack-tip Downwash.
         2. Model Assumes Receptors on FLAT Terrain.
         3. Use Calms Processing Routine.
         4. Use Missing Data Processing Routine.
         5. No Exponential Decay.

 **Other Options Specified:
         CCVR_Sub - Meteorological data includes CCVR substitutions

 **Model Assumes No FLAGPOLE Receptor Heights.

 **The User Specified a Pollutant Type of:  SO2

 **NOTE: Special processing requirements applicable for the 1-hour SO2 NAAQS have been disabled!!!
         User has specified non-standard averaging periods:    3-HR  24-HR
         High ranked 1-hour values are NOT averaged across the number of years modeled, and
         complete years of data are NOT required.

 **Model Calculates  2 Short Term Average(s) of:   3-HR  24-HR
     and Calculates PERIOD Averages

 **This Run Includes:      1 Source(s);       1 Source Group(s); and     144 Receptor(s)

                with:      1 POINT(s), including
                           0 POINTCAP(s) and      0 POINTHOR(s)
                 and:      0 VOLUME source(s)
                 and:      0 AREA type source(s)
                 and:      0 LINE source(s)
                 and:      0 OPENPIT source(s)


 **Model Set To Continue RUNning After the Setup Testing.

 **The AERMET Input Meteorological Data Version Date:  15181

 **Output Options Selected:
          Model Outputs Tables of PERIOD Averages by Receptor
          Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
          Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)

 **NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                 m for Missing Hours
                                                                 b for Both Calm and Missing Hours

 **Misc. Inputs:  Base Elev. for Pot. Temp. Profile (m MSL) =     0.00 ;  Decay Coef. =    0.000     ;  Rot. Angle =     0.0
                  Emission Units = GRAMS/SEC                                ;  Emission Rate Unit Factor =   0.10000E+07
                  Output Units   = MICROGRAMS/M**3

 **Approximate Storage Requirements of Model =      3.5 MB of RAM.
```

Figure 2-6. Sample of Model Option Summary Table from an AERMOD Model Output File

```
 *** AERMOD - VERSION  15181 ***   *** A Simple Example Problem for the AERMOD-PRIME Model                    ***        05/27/16
*** AERMET - VERSION  15181 ***   ***                                                                       ***        09:29:00
                                                                                                                         PAGE   9
**MODELOPTs:   NonDFAULT CONC      FLAT      RURAL

                            *** THE   1ST HIGHEST  3-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  ALL      ***
                                INCLUDING SOURCE(S):     STACK1      ,

                                 *** NETWORK ID: POL1     ;  NETWORK TYPE: GRIDPOLR ***

                                      ** CONC OF SO2      IN MICROGRAMS/M**3                          **

DIRECTION |                                                DISTANCE (METERS)
(DEGREES) |          175.00                 350.00                 500.00                 1000.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

     10.0 |      1.60637 (88030212)      4.32183 (88030215)      9.87871 (88030215)     20.31341 (88030215)
     20.0 |      1.27691 (88030212)      7.75747 (88030215)     19.35471 (88030215)     43.24437 (88030215)
     30.0 |      1.31753 (88030321)      6.80000 (88030215)     16.96932 (88030215)     37.21008 (88030215)
     40.0 |      1.37996 (88030321)      2.78658 (88030215)      6.56111 (88030215)     13.02309 (88030215)
     50.0 |      1.41988 (88030321)      2.62563 (88030115)      4.10823 (88030115)      4.68748 (88030212)
     60.0 |      1.43198 (88030321)      2.82901 (88030115)      4.55254 (88030115)      4.68748 (88030212)
     70.0 |      1.41464 (88030321)      8.49965 (88030115)     11.29511 (88030115)     11.52741 (88030115)
     80.0 |      2.58429 (88030115)     43.19500 (88030115)     48.25320 (88030115)     34.37546 (88030115)
     90.0 |      7.93417 (88030115)    113.82878 (88030115)    143.17281 (88030115)     83.53515 (88030115)
    100.0 |     49.08742 (88030112)    182.84892 (88030115)    220.83950 (88030115)    145.67439 (88030115)
    110.0 |    112.74896 (88030112)    242.27760 (88030112)    278.47891 (88030115)    163.85178 (88030115)
    120.0 |    133.57958 (88030112)    303.36780 (88030112)    329.96009 (88030112)    201.18209 (88030112)
    130.0 |     84.37449 (88030112)    177.43465 (88030112)    193.23412 (88030112)    123.90900 (88030112)
    140.0 |     34.33094 (88030112)     78.48757 (88030115)     90.16432 (88030115)     66.26935 (88030112)
    150.0 |      3.26313 (88030112)     28.20306 (88030115)     35.81299 (88030112)     33.54932 (88030112)
    160.0 |      1.45757 (88030209)      8.53192 (88030112)     13.46873 (88030112)     12.93284 (88030112)
    170.0 |      1.33663 (88030209)      2.92150 (88030112)      4.70642 (88030112)      9.87872 (88030415)
    180.0 |      1.23781 (88030212)      2.59400 (88030115)      4.58665 (88030415)     11.25826 (88030415)
    190.0 |      1.23781 (88030212)      2.62640 (88030115)      4.10607 (88030115)      6.95118 (88030415)
    200.0 |      1.23781 (88030212)      2.63486 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    210.0 |      1.23781 (88030212)      2.63700 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    220.0 |      1.23783 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.68748 (88030212)
    230.0 |      1.26732 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.68767 (88030212)
    240.0 |      1.59395 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.72694 (88030212)
    250.0 |      2.39221 (88030212)      2.63762 (88030115)      4.10609 (88030115)      5.24318 (88030212)
    260.0 |      3.44586 (88030212)      3.11001 (88030212)      4.10609 (88030115)      7.70339 (88030212)
    270.0 |      4.67900 (88030212)      4.53914 (88030212)      4.60912 (88030212)     13.41550 (88030212)
    280.0 |      6.10725 (88030212)      6.15657 (88030212)      6.42897 (88030212)     21.16129 (88030212)
    290.0 |      7.47165 (88030212)      7.75530 (88030212)      8.18188 (88030212)     27.76976 (88030212)
    300.0 |      8.45754 (88030212)      8.93592 (88030212)      9.35713 (88030212)     30.22723 (88030212)
    310.0 |      8.83767 (88030212)      9.29972 (88030212)      9.54143 (88030212)     27.40028 (88030212)
    320.0 |      8.53526 (88030212)      8.67663 (88030212)      8.65382 (88030212)     20.68075 (88030212)
    330.0 |      7.53807 (88030212)      7.17470 (88030212)      6.91694 (88030212)     13.22924 (88030212)
    340.0 |      5.96054 (88030212)      5.15139 (88030212)      4.78244 (88030212)      8.04861 (88030212)
    350.0 |      4.10326 (88030212)      3.16494 (88030212)      4.10609 (88030115)      5.75319 (88030212)
    360.0 |      2.52862 (88030212)      2.63762 (88030115)      4.10609 (88030115)      4.96113 (88030212)
```

Figure 2-7. Example Output Table of High Values by Receptor

```
 *** AERMOD - VERSION  15181 ***   *** A Simple Example Problem for the AERMOD-PRIME Model                  ***        05/27/16
*** AERMET - VERSION  15181 ***   ***                                                                     ***        09:29:00
                                                                                                                      PAGE  15
 **MODELOPTs:   NonDFAULT CONC      FLAT      RURAL

                                        *** THE SUMMARY OF MAXIMUM PERIOD (    96 HRS) RESULTS ***


                                   ** CONC OF SO2      IN MICROGRAMS/M**3                          **

                                                                                                          NETWORK
GROUP ID                       AVERAGE CONC                RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)  OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL       1ST HIGHEST VALUE IS      24.85172 AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
          2ND HIGHEST VALUE IS      23.13772 AT (     469.85,     -171.01,     0.00,     0.00,    0.00)  GP  POL1
          3RD HIGHEST VALUE IS      21.03526 AT (     303.11,     -175.00,     0.00,     0.00,    0.00)  GP  POL1
          4TH HIGHEST VALUE IS      19.33505 AT (     328.89,     -119.71,     0.00,     0.00,    0.00)  GP  POL1
          5TH HIGHEST VALUE IS      17.19043 AT (     383.02,     -321.39,     0.00,     0.00,    0.00)  GP  POL1
          6TH HIGHEST VALUE IS      16.86864 AT (     866.03,     -500.00,     0.00,     0.00,    0.00)  GP  POL1
          7TH HIGHEST VALUE IS      15.01122 AT (     939.69,     -342.02,     0.00,     0.00,    0.00)  GP  POL1
          8TH HIGHEST VALUE IS      14.27333 AT (     268.12,     -224.98,     0.00,     0.00,    0.00)  GP  POL1
          9TH HIGHEST VALUE IS      12.80321 AT (     492.40,      -86.82,     0.00,     0.00,    0.00)  GP  POL1
         10TH HIGHEST VALUE IS      12.38150 AT (     766.04,     -642.79,     0.00,     0.00,    0.00)  GP  POL1


                                                  *** THE SUMMARY OF HIGHEST  3-HR RESULTS ***


                                   ** CONC OF SO2      IN MICROGRAMS/M**3                          **

                                                          DATE                                                        NETWORK
GROUP ID                       AVERAGE CONC     (YYMMDDHH)            RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS     329.96009  ON 88030112: AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
         HIGH   2ND HIGH VALUE IS     261.07802  ON 88030112: AT (     469.85,     -171.01,     0.00,     0.00,    0.00)  GP  POL1

                                                  *** THE SUMMARY OF HIGHEST 24-HR RESULTS ***


                                   ** CONC OF SO2      IN MICROGRAMS/M**3                          **

                                                          DATE                                                        NETWORK
GROUP ID                       AVERAGE CONC     (YYMMDDHH)            RECEPTOR  (XR, YR, ZELEV, ZHILL, ZFLAG)    OF TYPE  GRID-ID
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

ALL      HIGH   1ST HIGH VALUE IS      88.89511  ON 88030124: AT (     433.01,     -250.00,     0.00,     0.00,    0.00)  GP  POL1
         HIGH   2ND HIGH VALUE IS      10.09519  ON 88030324: AT (     866.03,     -500.00,     0.00,     0.00,    0.00)  GP  POL1


 *** RECEPTOR TYPES:  GC = GRIDCART
                      GP = GRIDPOLR
                      DC = DISCCART
                      DP = DISCPOLR
```

Figure 2-8. Example of Result Summary Tables for the AERMOD Model

2.5 Modifying an existing runstream file

As noted earlier, one of the advantages of the keyword/parameter approach and the flexible format adopted for the input runstream file is that it will be easier for the user to make modifications to the runstream file and obtain the desired result. This section briefly illustrates some examples of how a runstream file can be modified. It is assumed that the reader is familiar with the operation of and basic editing commands for a text editor (i.e., a program that edits ASCII files), and is familiar with the previous sections of this tutorial.

2.5.1 Modifying modeling options

Depending on the type of analysis being performed, the user may need to modify the modeling options and run the model again. Because of the descriptive nature of the keywords and the secondary keywords used to control the modeling options, this can easily be done with the new runstream file, and usually without having to refer back to the user's guide each time a modification is attempted.

2.5.2 Adding or modifying a source or source group

Modifying the input file to add a source or a source group, or to add a source to a source group, is as simple as just adding it. There is no need to specify the total number of sources in the run, which would then have to be changed if more sources were added. The same applies to the number of groups, or the number of sources per group. If the user attempts to input more than the total number of sources or groups allowed for a particular run, an error message will be generated to that effect. Also, modifying a source group to delete a source is as easy as just deleting it from the input card, without having to change any other inputs.

Another way of "deleting" a source or a group from an input file is to place a "**" in the pathway field of the card or cards which define the source or group to "comment out" those inputs. This approach, which was discussed above in Section 2.1.2, has the advantage of leaving the input data for the source or group in the input file for possible later use. It doesn't matter whether the "**" is entered with the text editor in "insert" mode, in which case the other inputs of that line are moved over, or if it is in "overtype" mode, which would replace the pathway ID that was already there.

2.5.3 Adding or modifying a receptor network

As with source data, adding to or modifying the receptor information in the AERMOD model is relatively straight forward. The problem of having to make several changes to accomplish one small modification, such as adding a distance to a polar receptor network, has been avoided in the new model. All that the user needs to do is to add the new distance on the appropriate input card, which is easily identifiable because of the use of descriptive keywords. The model checks to ensure that the user does not attempt to specify more than the maximum number of receptors for a particular run, and generates an appropriate message if too many are input.

2.5.4 Modifying output options

Modifying the output options involves many of the same principles that are described above. In addition, all of the output options are structured in a way that allows the user to select options for specific averaging periods, so that the user may find it useful to copy a record or group of records set up for one averaging period and simply change the averaging period parameter. The other important short cut that is available for the printed table output options is to use the secondary keyword ALLAVE to indicate that the option applies to all averaging periods that are calculated. In this way, there will be no need to change the output options if a new averaging period is added to a run or if one is deleted.

3.0 Detailed keyword reference

This section of the AERMOD User's Guide provides a detailed reference for all of the input keyword options for the AERMOD model. The information provided in this section is more complete and detailed than the information provided in the Brief Tutorial in Section 2.0. Since this section is intended to meet the needs of experienced modelers who may need to understand completely how particular options are implemented in the model, the information for each keyword should stand on its own. This section assumes that the reader has a basic understanding of the keyword/parameter approach used by the model for specification of input options and data. Novice users should first review the contents of Section 2.0 in order to obtain that understanding.

3.1 Overview

The information in this section is organized by function, i.e., the keywords are grouped by pathway, and are in a logical order based on their function within the model. The order of keywords presented here is the same as the order used in the functional keyword reference in APPENDIX B, and the Quick Reference in APPENDIX E. The syntax for each keyword is provided, and the keyword type is specified - either mandatory or optional and either repeatable or non-repeatable. Unless noted otherwise, there are no special requirements for the order of keywords within each pathway, although the order in which the keywords are presented here and in APPENDIX B is recommended. Any keyword which has special requirements for its order within the pathway is so noted following the syntax and type description.

The syntax descriptions in the following sections use certain conventions. Parameters that are in all capital letters and underlined in the syntax description are secondary keywords that are to be entered as indicated for that keyword. Other parameters are given descriptive names to convey the meaning of the parameter, and are listed with an initial capital letter. Many of the parameter names used correspond to variable names used in the computer code of the model. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that keyword.

3.2 Control pathway inputs and options

The **CO**ntrol pathway contains the keywords that provide the overall control of the model run. These include the dispersion options, averaging time options, terrain height options, and others that are described below. The CO pathway must be the first pathway in the runstream input file.

3.2.1 Title information

There are two keywords that allow the user to specify up to two lines of title information that will appear on each page of the main output file from the model. The first keyword, TITLEONE, is mandatory, while the second keyword, TITLETWO, is optional. The syntax and type for the keywords are summarized below:

Syntax:	CO TITLEONE Title1 CO TITLETWO Title2
Type	TITLEONE - Mandatory, Non-repeatable TITLETWO - Optional, Non-repeatable

The parameters Title1 and Title2 are character parameters of length 200, which are read as a single field starting at column 13. The title information is taken as it appears in the runstream file without any conversion of lower case to upper case letters. If the TITLETWO keyword is not included in the runstream file, then the second line of the title in the output file will appear blank. Note that in the output files, only the first 68 characters of TITLEONE and TITLETWO are printed.

3.2.2 Dispersion options

The dispersion options are controlled by the MODELOPT keyword on the CO pathway. The syntax, type, and order of the MODELOPT keyword are summarized below:

Syntax:	
CO MODELOPT	DFAULT BETA CONC AREADPLT FLAT NOSTD NOCHKD NOWARN SCREEN SCIM PVMRM PSDCREDIT FASTALL DEPOS and/or or or OLM or DDEP ELEV WARNCHKD or ARM FASTAREA and/or or ARM2 WDEP DRYDPLT WETDPLT NOURBTRAN LOWWIND1 VECTORWS or or or NODRYDPLT NOWETDPLT LOWWIND2 or LOWWIND3
Type:	Mandatory, Non-repeatable
Order:	Must precede POLLUTID, HALFLIFE and DCAYCOEF

where the secondary keyword parameters are described below (the order and spacing of these parameters is not critical):

DFAULT - Specifies that the regulatory default options will be used; note that specification of the DFAULT option will override some non-DFAULT options that may be specified in the input file, while other non-DFAULT options will cause fatal errors when DFAULT is specified (see below for details);

BETA - Non-DFAULT option that allows for draft, "Beta" test options to be used (see Section 3.2.2.2 for more details); currently includes the PSDCREDIT option (Section 3.3.7); options for capped and horizontal stack releases (3.2.2.3); the LOWWIND1, LOWWIND2, and LOWWIND3 options;

CONC - Specifies that concentration values will be calculated;

DEPOS - Specifies that total deposition flux values (both dry and wet) will be calculated;

DDEP - Specifies that dry deposition flux values will be calculated;

WDEP - Specifies that wet deposition flux values will be calculated;

AREADPLT - Specifies that a non-DFAULT method for optimized plume depletion due to dry removal mechanisms will be included in calculations for area sources;

FLAT - Specifies that the non-DFAULT option of assuming flat terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-DFAULT FLAT terrain option on a source-by-source basis; FLAT sources are identified by specifying the keyword FLAT in place of the source elevation field on the SO LOCATION keyword;

ELEV - Specifies that the default option of assuming elevated terrain will be used; Note that FLAT and ELEV may be specified in the same model run to allow specifying the non-DFAULT FLAT terrain option on a source-by-source basis;

NOSTD - Specifies that the non-DFAULT option of no stack-tip downwash will be used;

NOCHKD - Specifies that the non-DFAULT option of suspending date checking will be used for non-sequential meteorological data files;

WARNCHKD - Specifies that the option of issuing warning messages rather than fatal errors will be used for non-sequential meteorological data files;

NOWARN - Specifies that the option of suppressing the detailed listing of warning messages in the main output file will be used (the number of warning messages is still reported, and warning messages are still included in the error file controlled by the CO ERRORFIL keyword);

SCREEN - Specifies that the non-DFAULT option for running AERMOD in a screening mode will be used;

SCIM - Sampled Chronological Input Model - used only with the ANNUAL average option to reduce runtime by sampling meteorology at a user-specified regular interval; SCIM sampling parameters must be specified on the ME pathway;

PVMRM - Specifies that the Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used;

OLM - Specifies that the Ozone Limiting Method (OLM) for NO_2 conversion will be used;

ARM - Specifies that the DFAULT Ambient Ratio Method (ARM) for NO_2 conversion will be used;

ARM2 - Specifies that the Ambient Ratio Method - 2 (ARM2) for NO_2 conversion will be used;

PSDCREDIT - Specifies that the non-DFAULT BETA test option will be used to calculate the increment consumption with PSD credits using the PVMRM option;

FASTALL - Non-DFAULT option to optimize model runtime through use of an alternative implementation of horizontal meander for POINT and VOLUME sources; also optimizes model runtime for AREA/ AREAPOLY/AREACIRC and OPENPIT sources through hybrid approach (formerly associated with TOXICS option, now controlled by FASTAREA option);

FASTAREA - Non-DFAULT option to optimize model runtime through hybrid approach for AREA/ AREAPOLY/AREACIRC and OPENPIT sources (formerly associated with TOXICS option);

DRYDPLT - Option to incorporate dry depletion (removal) processes associated with dry deposition algorithms; this requires specification of dry deposition source parameters and additional meteorological variables; dry depletion will be used by default if dry deposition algorithms are invoked;

NODRYDPLT - Option to disable dry depletion (removal) processes associated with dry deposition algorithms;

WETDPLT - Option to incorporate wet depletion (removal) processes associated with wet deposition algorithms; this requires specification of wet deposition source parameters and additional meteorological variables; wet depletion will be used by default if wet deposition algorithms are invoked;

NOWETDPLT - Option to disable wet depletion (removal) processes associated with wet deposition algorithms;

NOURBTRAN - Non-DFAULT option to ignore the transition from nighttime urban boundary layer to daytime convective boundary layer (i.e., to revert to the urban option as implemented prior to version 11059);

LOWWIND1 - Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions. The LOWWIND1 option increases the minimum value of sigma-v from 0.2 m/s to 0.5 m/s, and "turns off" the horizontal meander component. The BETA keyword must also be specified in order to invoke the LOWWIND1 option (note that only one of the "LOWWIND" options can be specified in the same model run);

LOWWIND2 - Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions. The LOWWIND2 option increases the minimum value of sigma-v from 0.2 m/s to 0.3 m/s, and includes some adjustments to the horizontal meander component. The BETA keyword must also be specified in order to invoke the LOWWIND2 option (note that only one of the "LOWWIND" options can be specified in the same model run);

LOWWIND3 - Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions. The LOWWIND3 option increases the minimum value of sigma-v from 0.2 m/s to 0.3 m/s, and uses the FASTALL approach to replicate the centerline concentration accounting for horizontal meander, but utilizes an effective sigma-y and eliminates upwind dispersion. The BETA keyword must also be specified in order to invoke the LOWWIND3 option (note that only one of the "LOWWIND" options can be specified in the same model run);

VECTORWS - Option to specify that input wind speeds are vector mean (or resultant) wind speeds, rather than scalar means. Under the VECTORWS option, the adjustments to wind speeds based on Equation 112 of the AERMOD Model Formulation Document (EPA, 2004a) will be applied. The VECTORWS option is not linked with the DFAULT option.

3.2.2.1 DFAULT option

The regulatory DFAULT option in AERMOD includes the use of stack-tip downwash, incorporates the effects of elevated terrain, and includes the calms and missing data processing routines. The DFAULT option in AERMOD also forces the use of a 4-hour half-life when

modeling SO_2 in an urban source, and does not allow for exponential decay for other applications. The DFAULT option was modified beginning with version 09292 to impose a restriction on the optional urban roughness length parameter to be 1 meter for regulatory default applications.

The missing data processing routines that are included in the AERMOD model allow the model to handle missing meteorological data in the processing of short term averages. The model treats missing meteorological data in the same way as the calms processing routine, i.e., it sets the concentration values to zero for that hour, and calculates the short term averages according to EPA's calms policy, as set forth in the Guideline. Calms and missing values are tracked separately for the purpose of flagging the short term averages. An average that includes a calm hour is flagged with a 'c', an average that includes a missing hour is flagged with an 'm', and an average that includes both calm and missing hours is flagged with a 'b'. If the number of hours of missing meteorological data exceeds 10 percent of the total number of hours for a given model run, a cautionary message is written to the main output file, and the user is referred to Section 5.3.2 of "Meteorological Monitoring Guidance for Regulatory Modeling Applications" (EPA, 2004).

3.2.2.2 <u>BETA test options</u>

A 'BETA' test option switch is included on the CO MODELOPT keyword to identify and allow for new features to be added to the model that are still in a draft BETA-test status. The BETA option is a non-DFAULT option, and will result in a fatal error if the DFAULT option is also specified. Draft enhancements included in AERMOD under the BETA option include:

1) The PSDCREDIT option for PVMRM to account for NO/NO_2 chemistry of combined plumes in the computation of increment consumption with PSD credits;

2) The LOWWIND1, LOWWIND2, and LOWWIND3 options under the CO MODELOPT keyword to address concerns regarding model performance under low wind speed conditions; and

3) The ADJ_U* option incorporated in version 12345 (and later) of AERMET that adjusts the surface friction velocity (U*) under low wind/stable conditions (see the AERMET User's Guide for more details regarding the ADJ_U* option) is now a DFAULT option when using NWS data or site-specific data that does not include turbulence. However, the ADJ_U* option remains as a BETA option when paired with site-specific data that includes turbulence.

Inclusion of these draft BETA-test options does not imply any endorsement of their use for regulatory or non-regulatory applications of the model. In addition, the designation of BETA-test to

these draft enhancements does not imply that these options have completed rigorous internal ("Alpha") testing prior to being included in a public release of the model. More details regarding PSDCREDIT option are provided in Section 3.3.7; more details regarding the LOWWIND1, LOWWIND2, and LOWWIND3 options in AERMOD and the ADJ_U* option in AERMET are provided in Section 3.2.3.

3.2.2.3 Options for capped and horizontal stack releases

Options are included in AERMOD (beginning with version 06341) for modeling releases from capped and horizontal stacks. For sources that are not subject to building downwash influences, the plume rise for these capped and horizontal stacks is simulated based on an EPA Model Clearinghouse Memorandum, dated July 9, 1993. The Model Clearinghouse procedure for these sources entails setting the exit velocity very low (0.001 m/s) to account for suppression of vertical momentum of the plume and using an effective stack diameter that maintains the actual flow rate of the plume. Maintaining the flow rate will also serve to maintain the buoyancy of the plume in order to provide a more realistic estimate of plume rise. The Model Clearinghouse procedure also addresses the issue of stack-tip downwash for these cases.

The Model Clearinghouse procedure is not considered to be appropriate for sources subject to building downwash influences with the PRIME downwash algorithm for the following reason. The PRIME algorithm uses the specified stack diameter to define the initial radius of the plume for the numerical plume rise calculation, and the initial radius of the plume can significantly influence plume rise based on the PRIME algorithm. As a result, use of an effective diameter adjusted to maintain the flow rate is not appropriate and could produce unrealistic results. For PRIME downwash sources modeled using the options for capped and horizontal releases, the basic premise of the Model Clearinghouse procedure, i.e. that the vertical momentum is suppressed while the buoyancy of the plume is conserved, has been adapted for the PRIME numerical plume rise formulation. For capped stacks the initial radius of the plume is assumed to be 2 times the actual stack diameter to account for the interaction of the exiting plume with the cap. The initial vertical velocity of the plume is set at 0.001 m/s, and the initial lateral velocity of the plume is set at 25% of the initial exit velocity of the plume. For horizontal stacks, the initial vertical velocity of the plume is set at 0.001 m/s, the total exit velocity of the plume is assigned to the initial lateral velocity, and

the plume is assumed to be emitted in the downwind direction. Although this adaptation of the Model Clearinghouse procedure to PRIME downwash sources has not been validated by field tracer or wind tunnel data, analyses have shown that simply setting the exit velocity to 0.001 m/s without any further adjustment when downwash is applied, as suggested in Section 6.1 of the AERMOD Implementation Guide (EPA, 2009), may lead to overly conservative results (EPA, 2007).

The user selects the options for capped and/or horizontal releases by specifying one of the new source types on the SO LOCATION card: POINTCAP for capped stacks, and POINTHOR for horizontal releases. For each of these options, the user specifies the actual stack parameters [release height (m), exit temperature (K), exit velocity (m/s), and stack diameter (m)] using the SO SRCPARAM card as if the release were a non-capped vertical point source. The syntax of the SO LOCATION and SRCPARAM keywords is described in Sections 3.3.1 and 3.3.2 and is also summarized in APPENDIX B. The AERMOD model performs the necessary adjustments internally to account for plume rise and stack-tip downwash. For horizontal releases, the model currently assumes that the release is oriented with the wind direction, and the model does not account for directional effects that may occur with horizontal releases. The model also does not account for stacks oriented at a non-horizontal angle relative to vertical. For PRIME downwash sources, the user-specified exit velocity for horizontal releases is treated initially as horizontal momentum in the downwind direction.

3.2.2.4 Output types (CONC, DEPOS, DDEP and/or WDEP)

The user may select any or all of the output types (CONC, DEPOS, DDEP and/or WDEP) to be generated in a single model run. The order of these secondary keywords on the MODELOPT card has no effect on the order of results in the output files - the outputs will always be listed in the order of CONC, DEPOS, DDEP, and WDEP. Appropriate deposition parameters must be specified in order to output deposition fluxes using the DEPOS, DDEP, and/or WDEP keywords (see Sections 3.3.3 and 3.3.4 for more details).

3.2.2.5 Deposition depletion options

Beginning with version 04300, the dry and/or wet removal (depletion) mechanisms (the DRYDPLT and WETDPLT options in earlier versions of AERMOD) will automatically be

included in the calculated concentrations or deposition flux values if the dry and/or wet deposition processes are considered, unless the user specifies the NODRYDPLT and/or NOWETDPLT options. Note that dry and wet removal effects on calculated concentration values can be included even if deposition flux values are not being calculated. However, the additional data requirements for dry and wet deposition, described in Sections 3.3.3 and 3.3.4, must be met in order for dry and wet removal to be included in the concentration calculations. The use of the NODRYDPLT and/or NOWETDPLT options will result in a more conservative estimate of concentrations and/or deposition fluxes for applications involving deposition processes, but the degree of additional conservatism will vary depending on the source characteristics, meteorological conditions, receptor locations and terrain influences. However, the inclusion of particle deposition effects may increase ground-level concentrations for some sources compared to the same source modeled as a gaseous emission, due to the effect of gravitational settling on the particulate plume. The magnitude of this effect will depend on the source characteristics (elevated or low-level) and particle size distribution.

3.2.2.6 NO_2 conversion options

The PVMRM, OLM, ARM, and ARM2 options for modeling NO_2 conversion are DFAULT options. Only one of these options for NO_2 conversion can be specified for a given model run, and all options require that the pollutant ID be specified as 'NO2' on the CO POLLUTID card (see Section 3.2.8. These options have additional input requirements as described in Section 3.3.6.

3.2.2.7 FASTAREA and FASTALL

Beginning with version 09292, the TOXICS option is no longer used in AERMOD and the FASTAREA option on the MODELOPT is now used to select the non-DFAULT option to optimize model runtime for AREA sources (including AREA, AREAPOLY, AREACIRC and OPENPIT source types, as well as LINE sources introduced with version 12345 (see Section 3.3.1)). When the FASTAREA option is specified, the area source integration routine is optimized to reduce model runtime by incorporation of a three-tiered approach using the Romberg numerical integration, a 2-point Gaussian Quadrature routine for numerical integration, or a point source approximation, depending on the location of the receptor relative to the source. In the regulatory default mode the Romberg numerical integration is utilized for all receptors. Also beginning with version 09292, a non-DFAULT option to optimize model runtime for POINT and VOLUME

sources was included, which is selected by the FASTALL option on the MODELOPT keyword. Specification of the FASTALL option also activates the FASTAREA option if AREA sources are including in the model inputs. Both FASTALL and FASTAREA skip receptors that are more than 80 kilometers from the source.

The FASTALL option for POINT and VOLUME sources uses an alternative implementation of the horizontal meander algorithm based on an effective horizontal dispersion coefficient (σ_{yeff}) that replicates the centerline concentration based on the full meander approach. Use of the effective σ_y allows the model runtime to be optimized by skipping receptors that are more than $4\sigma_{yeff}$ off the plume centerline. Based on tests conducted to date, comparisons of concentrations based on the FASTALL option for POINT and VOLUME sources with concentrations based on the DFAULT option are similar to comparisons of concentrations for AREA sources using the FASTAREA option. The average ratio of FASTALL concentrations to DFAULT values is about 1.02 for high ranked values, showing a slight bias toward over prediction for the FASTALL option. However, the range of ratios for high ranked values shows both over predictions and under predictions relative to the DFAULT option, and differences at specific receptors may be much larger.

3.2.2.8 Urban transition

The urban option within AERMOD was modified, beginning with version 11059, to address potential issues associated with the transition from the nighttime urban boundary layer to the daytime convective boundary layer. Prior to version 11059, the enhanced dispersion due to the urban heat island during nighttime stable conditions was ignored once the rural boundary layer became convective. This could result in an unrealistic drop in the mixing height for urban sources during the morning transition to a convective boundary layer, which could contribute to overly conservative concentrations for low-level sources under such conditions. This potentially anomalous behavior was observed in a few cases during the application of AERMOD for the Risk and Exposure Assessment (REA) conducted in support of a review for the NO_2 National Ambient Air Quality Standard (NAAQS) (EPA, 2008). The potential significance of this issue for AERMOD applications in support of air quality permitting increased with the promulgation of the more recent 1-hour NO_2 and 1-hour SO_2 NAAQS in 2010.

To address this issue, AERMOD was modified to continue applying the urban boundary layer option for urban sources until the daytime (rural) convective boundary exceeds the population-dependent urban boundary layer height. This modification to the urban option within AERMOD has been evaluated using the 1985 Indianapolis SF_6 field study data (Murray and Bowne, 1988), and shows improved model performance during daytime convective conditions compared to the original implementation of the urban option. Model-to-monitor comparisons of 1-hour NO_2 concentrations from the Atlanta NO_2 REA also exhibit improved model performance with this modification to the urban option in AERMOD. A summary of these model evaluation results is provided in APPENDIX F.

The NOURBTRAN non-DFAULT option has been included to allow users to revert to the urban option as implemented prior to version 11059, which ignores the transition from the nighttime urban boundary layer to the daytime convective boundary layer. As with other non-DFAULT options in AERMOD, use of the NOURBTRAN option in regulatory modeling applications would require justification and approval on a case-by-case basis.

3.2.2.9 SCREEN mode

The screening mode of AERMOD, which is controlled by the SCREEN keyword on the MODELOPT card, forces the model calculations to represent values for the plume centerline, regardless of the source-receptor-wind direction orientation. This option is included in AERMOD to facilitate the use of the model with the AERSCREEN (EPA, 2015a) to estimate worst case impacts. Its use outside of that context is not recommended. Since the screening model is designed to be used with a non-sequential meteorological data file, representing a matrix of conditions, the SCREEN option also forces the use of the NOCHKD option described above, even if NOCHKD is not included on the MODELOPT card. The SCREEN option also restricts the averaging period options to 1-hour averages only on the AVERTIME card (see Section 3.2.2.9).

3.2.2.10 SCIM

The AERMOD model includes the non-DFAULT Sampled Chronological Input Model (SCIM) option to reduce model runtime for some uses of the model.. The SCIM option can only be used with the ANNUAL average option, and is primarily applicable to multi-year model

simulations. The approach used by the SCIM option is to sample the meteorological data at a user-specified regular interval to approximate the long-term (i.e., ANNUAL) average impacts. Studies have shown that the uncertainty in modeled results introduced by use of the SCIM option is generally lower for area sources than for point sources.

When only the regular sampling is selected, hourly concentrations are calculated in the normal fashion for each sampled hour. The annual average concentration is then simply calculated by dividing the cumulative concentration for the sampled hours by the number of hours sampled (arithmetic average), i.e.,

$$\mathbf{C} = \sum \mathbf{C_S} / \mathbf{N_S}$$

where:

C = Calculated concentration

$\sum C_S$ = Cumulatibe impacts for the sampled hours

N_S = Number of sampled hours

To use the SCIM option, the user must include the SCIM keyword on the CO MODELOPT card, and also specify the SCIM sampling parameters on the ME SCIMBYHR card. The format and syntax of the ME SCIMBYHR keyword are described in Section 3.5.7.Deposition Parameters

The AERMOD model includes algorithms for both dry and wet deposition of both particulate and gaseous emissions. The deposition algorithms incorporated into AERMOD are based on the draft Argonne National Laboratory (ANL) report (Wesely et al., 2002), with modifications based on peer review. Treatment of wet deposition was revised from Wesely et al. (2002) based on recommendations by peer review panel members (Walcek et al., 2001). A full technical description of the deposition algorithms implemented in AERMOD is provided in an EPA report specific to these algorithms (EPA, 2003).

The deposition algorithms were initially implemented in the AERMOD model under the non-DFAULT TOXICS option, which was selected by including the TOXICS keyword on the CO MODELOPT card. The TOXICS option was removed beginning with version 09292 of AERMOD.

The options in AERMOD that were formerly associated with the TOXICS option are still considered non-DFAULT options but no longer require the specification of the TOXICS option to allow their use.

Based on the guidance provided for application of the AERMOD model in Appendix W, and the history of the deposition algorithms in the AERMOD and ISC models, the particle deposition algorithms with a user-specified particle size distribution (referred to below as "Method 1") can be applied under the regulatory DFAULT option. Method 1 is comparable to the particle deposition algorithm in the ISCST3 model (EPA, 1995a). The gas deposition algorithms and the "Method 2" option for particle deposition based on the ANL draft report (Wesely, et al, 2002) are considered to be non-DFAULT options in AERMOD, and the model will issue a fatal error message and abort processing if the DFAULT option is specified with the gas deposition or Method 2 particle deposition options. With the removal of the TOXICS option, no additional option switches are required to allow use of these non-DFAULT options.

For gaseous dry deposition, the user must define seasonal categories for each of the calendar months, direction-specific land use categories, and several pollutant-specific parameters. An optional keyword is also provided to override default values for three parameters used in the gas deposition algorithm. The input requirements for "Method 1" particle deposition in AERMOD are the same as for the particle deposition algorithm in the ISCST3 model. For "Method 2" particle deposition, the user must define the fraction of the particle mass in the fine particle category (less than 2.5 microns) and a representative mass mean diameter for the particles. Table 3-1 summarizes the required keywords for the various deposition options within AERMOD and whether they are allowed under the DFAULT option. The keywords used to define inputs for deposition specified on the CO pathway are described in the sections that follow. The keywords associated with deposition specified on the SO pathway are described in sections 3.3.3 through 3.3.5.

Table 3-1 Summary of Deposition Options

Pollutant Type	Model Output Type	Required Keywords	Allowed under DFAULT?
Gaseous	CONC w/dry depletion DDEP	CO GASDEPVD or CO GDSEASON, CO GDLANUSE, and SO GASDEPOS	No
Gaseous	CONC w/wet depletion WDEP	SO GASDEPOS	No
Gaseous	CONC w/dry & wet depletion DEPOS	CO GDSEASON, CO GDLANUSE, and SO GASDEPOS	No
Particulate (“Method 1”)	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO PARTDIAM, SO PARTDENS, and SO MASSFRAX	Yes[1]
Particulate (“Method 2”)	CONC w/dry and/or wet depletion DEPOS DDEP WDEP	SO METHOD_2	No

[1] While “Method 1” is allowed under the regulatory “DFAULT” option within AERMOD, the use of “Method 1” for particulate emissions in regulatory modeling applications should follow the guidance provided in Section 7.2.7(b) of Appendix W.

The user should be aware that one or more of the following meteorological parameters are needed for deposition: precipitation code, precipitation rate, relative humidity, surface pressure, and cloud cover.

3.2.2.11 Definition of seasons for gas dry deposition

The gas deposition algorithms in AERMOD include land use characteristics and gas deposition resistance terms based on five seasonal categories defined in Table 2 of the ANL report as:

Seasonal Category 1: Midsummer with lush vegetation

Seasonal Category 2: Autumn with unharvested cropland

Seasonal Category 3: Late autumn after frost and harvest, or winter with no snow

Seasonal Category 4: Winter with snow on ground (with generally continuous snow cover)

Seasonal Category 5: Transitional spring with partial green coverage or short annuals

The user correlates these seasonal definitions to calendar months through the GDSEASON keyword on the CO pathway. The syntax and type of the GDSEASON keyword are:

Syntax:	CO GDSEASON Jan Feb Mar ... Dec
Type:	Optional, Non-repeatable

where a numeric value from 1 to 5 is entered for each of the twelve calendar months to associate it with the seasonal definitions given above. This keyword is optional for the model, but mandatory when applying the gas deposition algorithms, unless the GASDEPVD option for user-specified dry deposition velocity on the CO pathway is used, described below in Section 3.2.2.13. Note that some of the seasonal categories defined above may not apply for certain regions, such as Category 4, winter with continuous snow cover, for moderate climates.

3.2.2.12 Definition of land use categories for gas dry deposition

The gas deposition algorithms also require direction-specific land use categories based on the following land use codes and definitions (from Table 1 of the ANL report):

Land Use Category	Description
1	Urban land, no vegetation
2	Agricultural land
3	Rangeland
4	Forest
5	Suburban areas, grassy
6	Suburban areas, forested
7	Bodies of water
8	Barren land, mostly desert
9	Non-forested wetlands

The user defines the land use categories by direction sector through the GDLANUSE keyword on the CO pathway. The syntax and type of the GDLANUSE keyword are:

Syntax:	CO GDLANUSE Sec1 Sec2 Sec3 ... Sec36
Type:	Optional, Non-repeatable

where a numeric value from 1 to 9 is entered for each of the 36 direction sectors (every 10 degrees) to associate it with the land use definitions given above. This keyword is optional for the model, but mandatory when applying the gas deposition algorithms, unless the GASDEPVD option for user-specified deposition velocity is used. The first value, Sec1, corresponds with the land use category, downwind of the application site, for winds blowing toward 10 degrees, plus or minus 5 degrees. The downwind sectors are defined in clockwise order, with Sec36 corresponding to winds blowing toward 360 degrees (North), and should generally reflect conditions downwind relative to the source location. The user can specify "repeat values" by entering a field such as "36*3" as a parameter for the GDLANUSE keyword. The model will interpret this as "36 separate entries, each with a value of 3." Since the model must identify this as a single parameter field, there must not be any spaces between the repeat-value and the value to be repeated.

3.2.2.13 Option for overriding default parameters for gas dry deposition

An optional keyword is available on the Control (CO) pathway to allow the user to override the default values of the reactivity factor (f_o), and the fraction (F) of maximum green leaf area index (LAI) for seasonal categories 2 (autumn/unharvested cropland) and 5 (transitional spring), for use with the gas dry deposition algorithms.

The syntax and type of the GASDEPDF keyword are summarized below:

Syntax:	CO GASDEPDF React F_Seas2 F_Seas5 (Refpoll)
Type:	Optional, Non-repeatable

where the parameter React is the value for pollutant reactivity factor (f_o), and F_Seas2 and F_Seas5 are the fractions (F) of maximum green LAI for seasonal categories 2 and 5, respectively. The parameter Refpoll is the optional name of the pollutant. If the optional GASDEPDF keyword is omitted, then the default value of 0 is used for React, and default values of 0.5 and 0.25 are used for F_Seas2 and F_Seas5, respectively. A value of F=1.0 is used for seasonal categories 1, 3, and 4. A reactivity factor value of 1 should be input for ozone (O_3), titanium tetrachloride ($TiCl_4$), and divalent mercury (Hg^{2+}), and a value of 0.1 should be input for nitrogen dioxide (NO_2).

3.2.2.14 Deposition velocity and resistance outputs

In order to facilitate review and testing of the deposition algorithms in the AERMOD model, the model includes an option to output the main resistance terms and deposition velocities for gaseous and particle sources. These optional outputs are generated if the user specifies the 'CO DEBUGOPT MODEL' option described in Section 3.2.16. The gas deposition data are written to a file called GDEP.DAT, which includes the values of R_a, R_b, R_c, and V_{dg} (see Wesely, et al, 2002, for definitions) for each source and for each hour modeled. A header record is included to identify the columns. The particle deposition data are written to a file called PDEP.DAT, which includes the values of R_a, R_p, V_g, and V_d for each source and for each hour modeled. The particle outputs are labeled as being based on either Method 1 or Method 2. For Method 1, results are output for each particle size category. The filename and file units for these data files are hardcoded in the model, and the files are overwritten each time the model is executed. Since these files include data for each source for each hour, file sizes may become large.

3.2.3 Low wind parameters

Draft BETA test options are included in AERMOD (beginning with the version dated 12345) for addressing concerns regarding model performance under low wind speed conditions, including the LOWWIND1, LOWWIND2, and LOWWIND3 options on the MODELOPT

keyword. The LOWWIND1 BETA option increases the minimum value of sigma-v from 0.2 to 0.5 m/s and "turns off" the horizontal meander component. The LOWWIND2 BETA option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, but incorporates the meander component with some adjustments. Under the LOWWIND2 option an upper limit of 0.95 is applied to the meander factor (FRAN). The LOWWIND3 BETA option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, uses the FASTALL approach to replicate the centerline concentration accounting for horizontal meander, but utilizes an effective sigma-y and eliminates upwind dispersion. The LOWWIND1, LOWWIND2, and LOWWIND2 BETA options are mutually exclusive and the model will issue a fatal warning message if more than one LowWind option is specified.

Although the LOWWIND1, LOWWIND2 and LOWWIND3 BETA options incorporate preset values for the minimum sigma-v, and in the case of LOWWIND2 and LOWWIND3 the maximum meander factor, consistent with the developmental nature and the BETA status of these options, a LOW_WIND keyword has been added to the CO pathway that allows users to adjust the minimum sigma-v value (SVmin) for both LowWind options (within a range of 0.01 to 1.0 m/s), and the minimum wind speed value (WSmin), within a range from 0.01 to 1.0 m/s. Inclusion of the LOW_WIND keyword is intended to facilitate further testing and evaluation of the LowWind options. Absent user-specified values on the LOW_WIND keyword, a default value of 0.2828 m/s is used for WSmin, consistent with the default applied in previous versions of AERMOD based on SQRT(2*SVmin*SVmin) with SVmin=0.2. The LOW_WIND keyword also allows users to adjust the maximum value for the meander factor (FRANmax), within a range of 0.50 to 1.0, inclusive, when the LOWWIND2 option is used. The syntax and type of the LOW_WIND keyword are:

Syntax:	CO LOW_WIND SVmin (WSmin) [for LOWWIND1] CO LOW_WIND SVmin (WSmin (FRANmax)) [for LOWWIND2] CO LOW_WIND SVmin (WSmin (FRANmax)) [for LOWWIND3]
Type:	Optional, Non-repeatable

where SVmin is the minimum value of sigma-v, within a range of 0.01 to 1.0 m/s, WSmin is the minimum wind speed, within a range of 0.01 to 1.0 m/s, and FRANmax is the maximum meander factor under the LOWWIND2 option, within a range of 0.50 to 1.0, inclusive. The WSmin parameter on the LOW_WIND keyword is optional for both LowWind options, and the FRANmax

parameter is also optional for the LOWWIND2 and LOWWIND3 options. However, a value for WSmin must also be included in order to specify a value for FRANmax.

In addition to the adjustments to SVmin and meander described above, all of the LOWWIND BETA options also modify the adjustment of vector mean wind speeds (based on Eq. 112, p. 79, of the AERMOD Model Formulation Document (EPA, 2004a)) to use the original values of sigma-v based on Section 4.1.6 of the AERMOD Model Formulation Document, before they are adjusted based on SVmin.

In addition to the LOWWIND BETA options, an option has been incorporated in the AERMET meteorological processor (beginning with the version dated 12345) to address concerns regarding model performance under low wind conditions. The ADJ_U* option in AERMET, which adjusts the surface friction velocity (U*) under low-wind/stable conditions based on Qian and Venkatram (2011), can be used with or without the LOWWIND1, LOWWIND2 or LOWWIND3 options. Although the ADJ_U* option may be used with NWS data or with site-specific data that does not include turbulence under DFAULT, the ADJ_U* option when used with the BETA LOWWIND options are used is also considered a non-Default option. Beginning with version 16216 of AERMET, an adjustment to U* under the ADJ_U* option is also available as a DFAULT option for applications utilizing the Bulk Richardson Number (BULKRN) method, based on Luhar and Raynor (2009) (see also AECOM (2010)) when used with site-specific data that does not include turbulence. The ADJ_U* option when used with site-specific data that does include tublulence is currently considered a BETA option. See the AERMET Model Change Bulletin (MCB) #4 and the AERMET User's Guide for additional details regarding the ADJ_U* option in AERMET.

As noted above, the LowWind BETA options in AERMOD are considered to be non-Default options and are therefore subject to the alternative model provisions in Section 3.2 of Appendix W (40 CFR Part 51). Users should coordinate with the appropriate reviewing authority regarding the procedures and requirements for approval of these BETA options for regulatory modeling applications. APPENDIX G provides a summary of evaluations of the LowWind BETA options in AERMOD in conjunction with the ADJ_U* option in AERMET.

3.2.4 Input parameters for NO_2 conversion options

This section provides a description of the AERMOD inputs related to the PVMRM and OLM options for modeling the conversion of NO to NO_2, and, beginning with version 13350, the Default Ambient Ratio Method (ARM) option and Ambient Ratio Method 2 (ARM2). A technical description of the PVMRM algorithm as incorporated within AERMOD is provided in the AERMOD Model Formulation Document (EPA, 2004a)). Additional information regarding options for NO2 modeling are provided in Technical Support Document (TSD) for NO2-related AERMOD Modifications (EPA, 2015b). Background on the original development of the PVMRM option is provided by Hanrahan (1999a and 1999b).

The ARM option is based on Tier 2 of the multi-tiered approach for modeling NO_2 impacts discussed in Section 5.4.2 of Appendix W (EPA, 2005). Further guidance on the application of the ARM approach is provided in a clarification memo issued on March 1, 2011 (EPA, 2011). The ARM2 option is based on work sponsored by API (API, 2013) to develop a method to adjust the modeled NO_x concentrations based on an empirical relationship between ambient NO_x and ambient NO_2 concentrations. A key difference between the PVMRM and OLM methods, as compared to the ARM and ARM2 methods, is that ARM and ARM2 do not require the user to input background ozone (O_3) concentrations. In addition, the ARM and ARM2 options do not require user-specified in-stack NO_2/NO_x ratios, as required by PVMRM and OLM; however, the default minimum ratio utilized in the ARM2 method may not be appropriate in cases where the sources being modeled are known to have relatively high in-stack NO_2/NO_x ratios.

The PVMRM and OLM algorithms have been implemented as DFAULT options, which means that the PVMRM and OLM options can be used if the DFAULT keyword is included on the CO MODELOPT card. As described in Section 3.3.7, a BETA-test draft model option, PSDCREDIT, has been added for use when an application is for increment consumption with PSD credits using PVMRM. The special source grouping required for the PSDCREDIT option is also described below in Section 3.3.7.

It is important to note that the OLM, PVMRM, ARM, and ARM2 options listed above for modeling the conversion of NO to NO_2 are NOT applied to the background NO_2 concentrations

input through the SO BACKGRND option (described in Section 3.3.8.2). The background NO_2 concentrations, if provided, will be added to the modeled NO_2 concentrations after the NO-NO_2 conversion has been calculated. For Tier 2 applications involving temporally-varying background NO_2 concentrations, the ARM or ARM2 option in AERMOD should be used to ensure that the ambient ratios are applied only to the modeled NO_2 concentrations before adding the contribution from background NO_2 concentrations.

3.2.4.1 Specifying ozone concentrations for PVMRM and OLM options

The background ozone concentrations for the PVMRM and OLM options can be input as a single value through the OZONEVAL keyword on the CO pathway, as temporally-varying values through the O3VALUES keyword on the CO pathway, or as hourly values from a separate data file specified through the OZONEFIL keyword on the CO pathway. The user must specify background ozone concentrations through the OZONEVAL, O3VALUES, or OZONEFIL keyword in order to use the PVMRM or OLM options. The OZONEVAL or O3VALUES keyword may also be specified with the OZONEFIL keyword, in which case the value(s) entered on the OZONEVAL or O3VALUES keyword will be used to substitute for hours with missing ozone data in the hourly ozone data file. Beginning with version 13350 users can vary background ozone concentrations by wind sector. For applications that include sector-varying background ozone concentrations, the sectors are defined based on the CO O3SECTOR keyword, as follows:

Syntax:	CO O3SECTOR StartSect1 StartSect2 . . . StartSectN, where N ≤ 6
Type:	Optional, Non-Repeatable

For applications that include sector-varying background concentration the minimum sector width allowed is 30 degrees and warning messages will be issued for sector widths less than 60 degrees. **Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file.**

The syntax of the OZONEVAL keyword is as follows:

Syntax:	CO OZONEVAL O3Value (O3Units) (w/o sectors) or CO OZONEVAL SECTn O3Value (O3Units) (w/ sectors)
Type:	Optional, Non-repeatable

where the O3Value parameter is the background ozone concentration in the units specified by the optional O3Units parameter (PPM, PPB, or UG/M3), and SECTn refers to the user-specified sector defined on the optional O3SECTOR keyword for which the O3Value inputs are applied. If the optional O3Units parameter is missing, then the model will assume units of micrograms/cubic-meter (UG/M3) for the background ozone values. If units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb).

The syntax of the O3VALUES keyword is as follows, and is similar to the EMISFACT keyword on the SO pathway (Section 3.3.11) for specifying temporally-varying emission rates:

Syntax:	CO O3VALUES O3Flag O3values(i), i=1,n (w/o sectors) or CO O3VALUES SECTn O3Flag O3values(i), i=1,n (w/ sectors)
Type:	Optional, Repeatable

where the SECTn parameter specifies the applicable sector as defined on the optional O3SECTOR keyword, and where the parameter O3Flag is the variable ozone concentration flag, and must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

<u>ANNUAL</u> - annual ozone value (n=1); equivalent to OZONEVAL keyword in PPB,

<u>SEASON</u> - ozone values vary seasonally (n=4),

<u>MONTH</u> - ozone values vary monthly (n=12),

<u>HROFDY</u> - ozone values vary by hour-of-day (n=24),

<u>WSPEED</u> - ozone values vary by wind speed (n=6),

<u>SEASHR</u> - ozone values vary by season and hour-of-day (n=96),

HRDOW - ozone values vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n=72),

HRDOW7 - ozone values vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=168),

SHRDOW - ozone values vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=288),

SHRDOW7 - ozone values vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=672),

MHRDOW - ozone values vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=864), and

MHRDOW7 - ozone values vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=2,016).

The O3Values array is the array of ozone values, where the number of values is shown above for each O3Flag option. The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword. If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The O3VALUES keyword may be repeated as many times as necessary to input all of the ozone values, and repeat values may be used for the numerical inputs.

The order of inputs specified for the hour-of-day/day-of-week options (HRDOW, SHRDOW, SHRDOW7, etc.) are by hour-of-day, then season or month, if applicable, and then by day-of-week. For the HRDOW/SHRDOW/MHRDOW options, the days of the week are specified in the order of Weekdays (M-F), Saturdays, and Sundays. For the HRDOW7/SHRDOW7/ MHRDOW7 options, the days of the week are specified in the order of Mondays, Tuesdays, etc., through Sundays. Section 3.3.11 below includes an example illustrating the order of inputs for these options for the EMISFACT keyword.

Ozone concentrations specified on the O3VALUES keyword are assumed to be in units of PPB unless the OZONUNIT keyword is specified. The syntax of the OZONUNIT keyword is as follows:

Syntax:	CO OZONUNIT OzoneUnits
Type:	Optional, Non-repeatable

where the OzoneUnits parameter specifies the units as parts-per-billion (PPB), parts-per-million (PPM), or micrograms/cubic-meter (UG/M3). Units specified on the CONCUNIT keyword are only applied to ozone concentrations input thought O3VALUES keyword, which assumes default units of PPB if the OZONUNIT keyword is not specified. Ozone concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb).

Hourly ozone concentrations can be input through the optional OZONEFIL keyword. The syntax of the OZONEFIL keyword is as follows:

Syntax:	CO OZONEFIL O3FileName (O3Units) (O3Format) (w/o sectors) or CO OZONEFIL SECTn O3FileName (O3Units) (O3Format) (w/ sectors)
Type:	Optional, Non-repeatable

where the O3FileName parameter is the filename for the hourly ozone concentration file, the optional O3Units parameter specifies the units of the ozone data (PPM, PPB, or UG/M3, with UG/M3 as the default), and the optional O3Format parameter specifies the Fortran format to read the ozone data. If sector-varying ozone concentrations are being used, based on the CO O3SECTOR keyword, then the applicable sector ID needs to specified, e.g., ‘SECT1’ indicates that values are specified for the first sector. The O3FileName can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

The hourly ozone file must include the year, month, day, and hour, followed by the ozone concentration, in that order (unless specified differently through the O3Format parameter). The year can be specified as either a 2-digit or 4-digit year. If an optional Fortran format is specified using the O3Format parameter, the year, month, day, and hour variables must be read as integers using the Fortran 'I' format specifier, and the ozone concentration must be read as a real variable, using the

Fortran 'F,' 'E,' or 'D' format specifiers, e.g., (4I2,F8.3). Note that ozone values that do not include decimal places can be read as F*x*.0, where *x* is the length of the data field. However, ozone values that to not include decimal places may be read incorrectly if the O3Format specified for reading the data includes decimal places. For example, a value of '1234' would be interpreted as '123.4' if a format of F4.1 was used. The O3Format parameter must include the open and close parentheses as shown in the example, and may also include embedded spaces if double quotes (") are used to delimit the field. A warning message will be generated if the specified format does not meet these requirements, and AERMOD may also issue a fatal error message when reading the file in cases where real variables are read with an integer format, or vice versa.

If the optional O3Format parameter is missing, then the model will read the ozone data using a Fortran 'free' format, i.e., assuming that commas or spaces separate the data fields, and that the fields are in the order given above. The date sequence in the ozone data file must match the date sequence in the hourly meteorological data files. As with the OZONEVAL keyword, if units of PPM or PPB are used, then the model will convert the concentrations to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb).

Values of ozone concentrations in the ozone data file that are less than zero or greater than or equal to 900.0 will be regarded as missing. If background ozone values have been specified using the OZONEVAL and/or O3VALUES keyword, then the appropriate value will be used to substitute for missing ozone data from the ozone file. If no OZONEVAL or O3VALUES keywords are used, then the model will assume full conversion of NO to NO_2 for hours with missing ozone data.

3.2.4.2 Specifying the ambient equilibrium NO_2/NO_x ratio (PVMRM, OLM)

The PVMRM option for modeling conversion of NO to NO_2 incorporate a default NO_2/NO_x ambient equilibrium ratio of 0.90. Beginning with version 11059 of AERMOD, a default equilibrium ratio of 0.90 has also been incorporated in the OLM option. A NO_2/NO_x equilibrium ratio other than 0.90 can be specified for either the PVMRM or OLM option through the optional NO2EQUIL keyword on the CO pathway. The syntax of the NO2EQUIL keyword is as follows:

Syntax:	CO NO2EQUIL NO2Equil
Type:	Optional, Non-repeatable

where the NO2Equil parameter is the NO_2/NO_x equilibrium ratio and must be between 0.10 and 1.0, inclusive.

3.2.4.3 Specifying the default in-stack NO_2/NO_x ratio (PVMRM OLM)

The PVMRM and OLM options for modeling conversion of NO to NO_2 require that an in-stack NO_2/NO_x ratio be specified. Based on guidance issued June 28, 2010 (EPA, 2010b), regarding the 1-hour NO_2 NAAQS, AERMOD has been modified to require the user to specify in-stack NO_2/NO_x ratios for each source under the OLM and PVMRM options, i.e., AERMOD no longer assumes a default in-stack ratio of 0.10 for the OLM or PVMRM option.

The in-stack NO_2/NO_x ratio can be specified for the PVMRM or OLM options by using either the CO NO2STACK keyword to specify a default value to be used for all sources, or by using the SO NO2RATIO keyword to specify a value on a source-by-source basis. The SO NO2RATIO keyword can also be used to override the default value for specific sources if the CO NO2STACK keyword has been specified. The syntax of the NO2STACK keyword is as follows:

Syntax:	CO NO2STACK NO2Ratio
Type:	Optional, Non-repeatable

where the NO2Ratio parameter is the default in-stack NO_2/NO_x ratio that will be used, unless overridden on a source-by-source basis by the SO NO2RATIO keyword (described below). The value of NO2Ratio must be between 0.0 and 1.0, inclusive. Users should note that while CO NO2STACK is an optional keyword, the OLM and PVMRM options require the user to specify an in-stack NO_2/NO_x ratio for each source, using either the CO NO2STACK or SO NO2RATIO keyword (described in Section 3.3.6.1), or both.

3.2.5 Averaging time options

The averaging periods for AERMOD are selected using the AVERTIME keyword on the

CO (Control) pathway. The syntax and type of the AVERTIME keyword are summarized below:

Syntax:	CO AVERTIME Time1 Time2 . . . TimeN MONTH PERIOD or ANNUAL
Type:	Mandatory, Non-repeatable

where the parameters Time1 . . . TimeN refer to the user-specified short term averaging periods of 1, 2, 3, 4, 6, 8, 12, and/or 24 hours, the secondary keyword MONTH refers to monthly averages (for calendar months), the secondary keyword PERIOD refers to the average for the entire data period, and the secondary keyword ANNUAL refers to an annual average. Any of the short term averaging periods listed above may be selected for a given run. Since the monthly averages are treated as short term averages, the user can select appropriate output options, such as the second highest values by receptor, on the OU pathway. The location of the PERIOD or ANNUAL keyword in the parameter list is not critical. The order of the short term averaging periods (including MONTH) is also not critical, although it does control the order of the averaging period result tables in the main output file. Generally, it is recommended that the short term averaging periods be input in increasing order, unless there is a clear advantage in doing otherwise.

The user may specify either the PERIOD keyword or the ANNUAL keyword, but not both. For concentration calculations for a single year data file, the PERIOD and ANNUAL keywords produce the same results. **However, the ANNUAL average option applies only to complete years of data, and for multi-year data files, the ANNUAL average output is based on the average of the ANNUAL values across the years of data processed.**

For deposition calculations, the PERIOD keyword will provide a total deposition flux for the full period of meteorological data that is modeled, including multi-year data files, with default units of g/m^2, whereas the ANNUAL keyword will provide an annualized rate of the deposition flux with default units of $g/m^2/yr$.

Use of the ANNUAL average option for meteorological data periods of less than a year will result in a fatal error. For meteorological data periods of longer than a year, if the meteorological

data file does not contain complete years of data, any data remaining after the last complete year will be ignored for the ANNUAL average, and a warning message will be generated. The treatment of short term averages with multiple-year data files is comparable to their treatment when the CO MULTYEAR option is used.

3.2.6 Performing multiple year analyses with MULTYEAR option

The MULTYEAR keyword on the CO pathway provides an option for the user to perform a multiple year analysis such as would be needed to determine the "high-sixth-high in five years" design value for determining PM-10 impacts without the need for postprocessing of multiple concentration files, and for multiple year analyses associated with the 24-hour PM2.5 NAAQS and 1-hour NO_2 and SO_2 NAAQS which are based on concentrations averaged across the number of years processed. More information regarding the 24-hour PM2.5 and 1-hour NO_2 and SO_2 NAAQS is provided in Sections 3.2.14 and 3.2.15. Since the multiple year option makes use of the model re-start capabilities described in the Section 3.2.13, the MULTYEAR keyword is not compatible with the SAVEFILE or INITFILE keywords. The model will generate a fatal error message if the user attempts to exercise both options in a single run. The syntax and type of the MULTYEAR keyword is summarized below:

Syntax:	CO MULTYEAR (H6H) Savfil (Inifil)
Type:	Optional, Non-repeatable

where the optional H6H field, formerly used to highlight the use of the MULTYEAR option for determining the High-6th-High (H6H) 24-hour average for the “pre-1997” PM-10 NAAQS, is no longer required since the “post-1997” PM-10 NAAQS was vacated. A warning message will be generated if the H6H field is included on the MULTYEAR keyword indicating that it is not required. The Savfil parameter specifies the filename for saving the results arrays at the end of each year of processing, and the Inifil parameter specifies the filename to use for initializing the results arrays at the beginning of the current year. The Inifil parameter is optional, and should be left blank for the first year in the multi-year series of runs. The MULTYEAR option works by accumulating the high short term average results from year to year through the mechanism of the re-start save file. The model may be setup to run in a batch file with several years of meteorological data, and at the

end of each year of processing, the short term average results reflect the cumulative high values for the years that have been processed. The PERIOD average results are given for only the current year, but the model carries the highest PERIOD values from year to year and includes the cumulative highest PERIOD averages in the summary table at the end of the run.

When setting up a batch file to perform a multiple year analysis, the user would first create an input runstream file for the first year with all of the applicable modeling options, the source inventory data, the receptor locations, the meteorology options for the first year and the output file options. To obtain the PM-10 design value, be sure to include the SIXTH highest value on the OU RECTABLE card (see Section 3.7.1). For the CO MULTYEAR card for the first year, the user would only specify the Savfil parameter, and may use a card such as:

```
CO MULTYEAR YEAR1.SAV
```

For the subsequent years, the user could copy the input file created for Year-1, and edit the files to change the year parameters and meteorology filename on the ME pathway (and possibly in the title information), and edit the MULTYEAR cards. For the subsequent years, both the Savfil and Inifil parameters must be specified, with the Savfil for Year-1 becoming the Inifil for Year-2, and so on. The MULTYEAR cards (one for each AERMOD run) might look like this:

```
CO MULTYEAR YEAR1.SAV (First year)
CO MULTYEAR YEAR2.SAV YEAR1.SAV (Second year)
CO MULTYEAR YEAR3.SAV YEAR2.SAV (Third year)
CO MULTYEAR YEAR4.SAV YEAR3.SAV (Fourth year)
CO MULTYEAR YEAR5.SAV YEAR4.SAV (Fifth year)
```

The MULTYEAR keyword option is separate from the ability of the AERMOD model to process a multiple-year meteorological data file in a single model run. The latter capability can be used for applications of the model to long term risk assessments where the average impacts over a long time period are of concern rather than the maximum annual average determined from five individual years. The MULTYEAR option can only be used when PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER is specified as the pollutant ID.

3.2.7 Urban modeling option

The AERMOD model allows the user to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. Beginning with version 06341, multiple urban areas can be specified within the same model run. Multiple areas may be applicable for large domains that encompass more than one identifiable urban area where the separation is large enough to warrant separate treatment of the urban boundary layer effects. Use of the option for multiple urban areas eliminates the need for post-processing for such applications. The urban area(s) are defined using one or more instances of the URBANOPT keyword on theCO pathway. The sources that are to be modeled with urban effects and the urban area that will be applied to each source are identified using the URBANSRC keyword on the SO pathway (see Section 3.3.10). The syntax and type of the URBANOPT keyword are summarized below:

Syntax:	**For Multiple Urban Areas:** CO URBANOPT UrbanID UrbPop (UrbName) (UrbRoughness) **For Single Urban Areas:** CO URBANOPT UrbPop (UrbName) (UrbRoughness)
Type:	Optional, Repeatable for multiple urban areas

where the UrbanID parameter is the alphanumeric urban ID defined by the user (up to eight characters) when multiple urban areas are defined, the UrbPop parameter specifies the population of the urban area, the optional UrbName parameter may be used to identify the name of the urban area, and the optional UrbRoughness parameter may be used to specify the urban surface roughness length. Note the UrbName must be specified if the user wants to specify the urban roughness length. A default value of 1.0 meter will be used for the urban roughness length if the UrbRoughness parameter is omitted. Beginning with version 09292, any value for the urban roughness length other than 1.0 meter will be treated as a non-DFAULT option. Caution should be used when specifying a non-default urban roughness length, and use of a non-default value should be clearly documented and justified. Note that the syntax of the URBANOPT keyword for single urban areas has not changed from previous versions of AERMOD, so that existing input files will not require modification.

3.2.8 Specifying the pollutant type

The POLLUTID keyword is used to identify the type of pollutant being modeled for a particular run. The syntax, type, and order of the POLLUTID keyword are summarized below:

Syntax:	CO POLLUTID Pollut (H1H or H2H or INC)
Type:	Mandatory, Non-repeatable

where the Pollut parameter may be a pollutant name of up to eight characters. Examples include SO2, NOX, CO, PM10, TSP, and OTHER. Some pollutant names, by themselves or in combination with other model options, have special meaning and will affect how AERMOD computes the final results based on the current NAAQS. The parameters H1H, H2H, and INC disable the special processing requirements associated the 1-hr NO_2 and SO_2 NAAQS and the 24-hr PM2.5 NAAQS. Specifying one of these keywords will allow for modeling PM2.5 24-hr increments which are based on the H2H value, and also allow evaluating NO_2 options in AERMOD based on incomplete years of field measurements. The pollutants names with special meaning that will affect how AERMOD computes the results include:

- PM10 (orPM-10) with the multi-year option for generating the high-sixth-high in five years (see Section 3.2.14.2),
- PM25 (or PM-2.5, PM2.5, or PM-25) (see Section 3.2.14.1,
- NO2 when computing 1-hour averages (See Sections 3.2.6 and 3.2.15),
- NO2 is required when using OLM or PVMRM options for simulating the conversion of NO to NO_2 (see Section 3.2.2.6),
- SO2 when computing 1-hour averages (see Sections 3.2.6 and 3.2.15),
- SO2 triggers the use of a 4-hour half-life for SO2 decay for urban applications under the regulatory default options (see Sections 3.2.2.1 and 3.2.9), and
- The MULTYEAR option can only be used when PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER is specified as the pollutant ID.

3.2.9 Modeling with exponential decay

The model provides the option to use exponential decay of the pollutant being modeled. Two keywords are available for this purpose, the HALFLIFE and DCAYCOEF keywords. The syntax, type, and order of these keywords are summarized below:

Syntax:	CO HALFLIFE Haflif CO DCAYCOEF Decay
Type:	Optional, Non-repeatable

where the Haflif parameter is used to specify the half life for exponential decay in seconds, and the parameter Decay is used to specify the decay coefficient in units of s^{-1}. The relationship between these parameters is DECAY = 0.693/HAFLIF.

Only one of these keywords may be specified in a given run. If more than one is encountered, a non-fatal warning message is generated and the first specification is used in the modeling.

3.2.10 Flagpole receptor height option

The FLAGPOLE keyword specifies that receptor heights above local ground level (i.e. flagpole receptors) are allowed on the REceptor pathway. The FLAGPOLE keyword may also be used to specify a default flagpole receptor height other than 0.0 meters. The syntax and type of the FLAGPOLE keyword are summarized below:

Syntax:	CO FLAGPOLE (Flagdf)
Type:	Optional, Non-repeatable

where Flagdf is an optional parameter to specify a default flagpole receptor height. If no parameter is provided, then a default flagpole receptor height of 0.0 meters is used. Any flagpole receptor heights that are entered on the Receptor pathway will override the default value, but are ignored if the FLAGPOLE keyword is not present on the Control pathway, and a non-fatal warning message is generated.

3.2.11 To run or not to run - that is the question

Because of the improved error handling and the "defensive programming" that has been employed in the design of the AERMOD model, it is intended that the model will read through all of the inputs in the runstream file regardless of any errors or warnings that may be encountered. If a fatal error occurs in processing of the runstream information, then further model calculations will be aborted. Otherwise, the model will attempt to run. Because of the great many options available in the AERMOD model, and the potential for wasted resources if a large run is performed with some incorrect input data, the RUNORNOT keyword has been included on the Control pathway to allow the user to specify whether to RUN the model and perform all of the calculations, or NOT to run and only process the input runstream data and summarize the setup information. The syntax and type of the RUNORNOT keyword are summarized below:

Syntax:	CO RUNORNOT RUN or NOT
Type:	Mandatory, Non-repeatable

3.2.12 Generating an input file for EVENT processing

The AERMOD model contains the EVENTFIL keyword on the CO pathway to control whether or not the AERMOD model will generate an input file for EVENT processing. The syntax and type of the EVENTFIL keyword are summarized below:

Syntax:	CO EVENTFIL (Evfile) (Evopt)
Type:	Optional, Non-repeatable

where the optional Evfile parameter specifies the name of the EVENT input file to be generated (the maximum length of the file name is set by the ILEN_FLD parameter in MODULE MAIN1), and the optional parameter, Evopt, specifies the level of detail to be used in the EVENT output file. Valid inputs for the Evopt parameter are the secondary keywords of SOCONT and DETAIL (see the EVENTOUT keyword on the OUtput pathway, Section 3.7.2). The default filename used if no parameters are specified is EVENTS.INP, and the default for the level of detail is DETAIL. If only one parameter is present, then it is taken to be the Evfile, and the default will be used for Evopt.

The primary difference between routine AERMOD and EVENT processing is in the

treatment of source group contributions. The AERMOD model treats the source groups independently. EVENT processing is designed to provide source contributions to particular events, such as the design concentrations determined from AERMOD, or user specified events. The user may specify the "events" to process using the EVent pathway, which lists specific combinations of receptor location, source group, and averaging period. By specifying the EVENTFIL keyword, an input runstream file will be generated that can be used directly for EVENT processing. The events included in the generated EVENT processing input file are the design concentrations defined by the RECTABLE keyword and the threshold violations identified by the MAXIFILE keyword on the OU pathway.

3.2.13 The model re-start capability

The AERMOD model has an optional capability to store intermediate results into an unformatted file, so that the model run can be continued later in case of a power failure or a user interrupt. This re-start option is controlled by the SAVEFILE and INITFILE keywords on the CO pathway. The syntax and type of these keywords are summarized below:

Syntax:	CO SAVEFILE (Savfil) (Dayinc) (Savfl2) CO INITFILE (Inifil)
Type:	Optional, Non-repeatable

The SAVEFILE keyword instructs the model to save the intermediate results to a file, and controls the save options. All three parameters for this keyword are optional. If the user specifies only the Savfil parameter, then the intermediate results are saved to the same file (and overwritten) each time. If the user specifies both the Savfil and the Savfl2 parameters, then the model alternates between the two files for storing intermediate results. The latter approach requires additional disk space to handle two storage files. However, selecting two files avoids the potential problem that the power failure or interrupt might occur while the temporary file is open and the intermediate results are being copied to it. In such a case, the temporary results file would be lost.

The optional Dayinc parameter allows the user to specify the number of days between successive dumps. The default is to dump values at the end of each day, i.e., Dayinc = 1. For larger

modeling runs, where the SAVEFILE option is most useful, the additional execution time required to implement this option is very small compared to the total runtime. To be most effective, it is recommended that results be saved at least every 5 days.

If no parameters are specified for the SAVEFILE keyword, then the model will store intermediate results at the end of each day using a default filename of TMP.FIL.

The INITFILE keyword works in conjunction with the SAVEFILE keyword, and instructs the model to initialize the results arrays from a previously saved file. The optional parameter, Inifil, identifies the unformatted file of intermediate results to use for initializing the model. If no Inifil parameter is specified, then the model assumes the default filename of TMP.FIL. If the file doesn't exist or if there are any errors encountered in opening the file, then a fatal error message is generated and processing is halted.

Note: It is important to note that if both the SAVEFILE and INITFILE keywords are used in the same model run, then different filenames must be specified for the Savfil and Inifil parameters. Otherwise, the model will encounter an error in opening the files, and further processing will be halted.

3.2.14 Processing for particulate matter (PM) NAAQS

3.2.14.1 Processing for fine particulate matter (PM-2.5)

A NAAQS for fine particulate matter, with aerodynamic particle diameters of 2.5 microns or less (PM-2.5), was promulgated in 1997, and the 24-hour standard was revised in December 2006. For attainment demonstrations, the PM-2.5 standard is based on a 3-year average of the 98th percentile 24-hour average and a 3-year average of the annual mean concentration at each ambient monitor. EPA issued new recommendations in May 2014 (EPA, 2014) regarding appropriate modeling procedures for use in modeling demonstrations of compliance with the PM2.5 NAAQS that is intended to supersede the earlier guidance issued in March 2010 (EPA, 2010a). The May 2014 guidance, which addresses the issue of secondary formation of PM2.5 due to precursor emissions, has modified the earlier guidance regarding use of the average of the first-highest 24-hour average concentrations across the number of years modeled to represent the modeled

contribution for a cumulative impact assessment and recommends using the average of the eighth-highest (98th percentile) of 24-hour concentrations to represent the modeled contribution for a cumulative impact assessment. Use of the first-highest 24-hour average is still appropriate for significant contribution determinations. Note that the use of a 3-year average for monitored design values to determine attainment of the NAAQS does not preempt the requirement in Section 8.3.1.2 of the *Guideline on Air Quality Models* (40 CFR Part 51, Appendix W) for use of 5 years of National Weather Service (NWS) data, and the 5-year average of modeled impacts serves as an unbiased estimate of the 3-year average for purposes of modeling demonstrations of compliance with the NAAQS.

Based on EPA's May 2014 draft recommendations, the 24-hour modeled contribution to the design value for purposes of modeling demonstrations of compliance with the PM-2.5 NAAQS is based on the highest of the eighth-highest (H8H) concentrations at each receptor, if one year of site-specific meteorological data is input to the model, or the highest of the multi-year average of the eighth-highest (H8H) concentrations at each receptor, if more than one year of meteorological data is input to the model. In other words, the model calculates the eighth-highest 24-hour concentration at each receptor for each year modeled, averages those eighth-highest concentrations at each receptor across the number of years of meteorological data, and then selects the highest, across all receptors, of the N-year averaged eighth-highest values.

Similar to the 24-hour averages, an unbiased estimate of the 3-year average annual mean is simply the annual mean, if only one year of site-specific meteorological data is input to the model, or the multi-year average of the annual means if multiple years of meteorological data are used. The annual design value for PM-2.5 is then based on the highest annual average across the receptor domain for single-year meteorological data input, or the highest of the multi-year averaged annual means across the receptor domain for multi-year meteorological data input.

The special processing of the 24-hour and annual averages for the PM-2.5 NAAQS is triggered by specifying a pollutant ID of 'PM25', 'PM-2.5', 'PM2.5' or 'PM-25' on the CO POLLUTID card. In this case, the model will compute the 24-hour and annual average design values as described in the previous paragraphs. In order for the PM-2.5 processing to work correctly for multiple year periods, the yearly meteorological data files can be concatenated into a

single multi-year file for input into the model, or the MULTYEAR option (Section 3.2.6) can be used with separate model runs for each year. There is no requirement to remove the header records between concatenated surface meteorological data files prior to running the model, and multi-year meteorological data files can also be generated by processing multi-year inputs in AERMET. (NOTE: While the MULTYEAR option with separate yearly meteorological data files can be used to determine the modeled design values for PM2.5, the OU MAXDCONT option (see Section 3.7.2.8) to determine contributions from other source groups to the cumulative modeled design value will not work with the MULTYEAR option or with separate meteorological data files for each year.) Processing the average of the individual annual mean values across multiple years for PM-2.5 also requires use of the ANNUAL average option on the AVERTIME keyword, rather than PERIOD average. The PERIOD option computes a single multi-year average concentration for each receptor, which may give slightly different results than the multi-year average of individual ANNUAL mean concentrations due to differences in the number of calms and/or missing data from year to year.

In order to comply with these processing requirements, the following restrictions are applied to the PM-2.5 NAAQS processing whenever a pollutant ID of ‘PM25’, 'PM2.5', ‘PM-2.5’ or ‘PM-25’ is specified on the CO POLLUTID keyword:

1. The averaging periods on the AVERTIME keyword are limited to the 24-hour and ANNUAL averages. Use of the PERIOD average or use of a short-term average other than 24-hour will result in a fatal error message being generated.

2. The FIRST (or 1ST) highest value should be requested on the RECTABLE keyword for 24-hour averages for estimating modeled PM2.5 contributions for compliance with the NAAQS. However, the model places no restriction on the ranks requested on the RECTABLE keyword since selection of ranks lower than the FIRST highest may be needed to determine whether a source or group of sources is contributing significantly to modeled violations of the NAAQS.

3. The model will only process meteorological data for periods of record that span complete years, although the meteorological data period does not need to follow

calendar years (i.e., the data period does not need to start on January 1, hour 1). If the period of record spans less than one complete year of data, a fatal error message will be generated and the model run will be unsuccessful. If additional meteorological data remains after the end of the last complete year of data, the remaining data will be ignored, and a non-fatal warning message will be generated specifying the number of hours ignored.

4. The MULTYEAR keyword on the CO pathway can be used to calculate multi-year averages for the PM-2.5 NAAQS; however, the MAXDCONT option will not work with the MULTYEAR. Multiple year analyses are best accomplished by including the multiple years of meteorology in a single data file.

5. Since the 24-hour average design values for PM-2.5 analyses, based on the H1H averaged over N years, may consist of averages over a multi-year period, they are not compatible with the EVENT processor, and the high ranked values generated based on the RECTABLE keyword will not be included in the EVENTFIL. However, if the MAXIFILE option is used to output 24-hour averages exceeding a user-defined threshold, these individual exceedances may be used with the EVENT processor. Therefore, if the EVENTFIL option is used without the MAXIFILE option for PM-2.5 analyses, a non-fatal warning message will be generated, and the EVENTFIL option will be ignored.

3.2.14.2 Processing for particulate matter of 10 microns or less (PM-10)

The 24-hour NAAQS for particulate matter with aerodynamic particle diameters of 10 microns or less (PM-10) is in the form of an expected exceedance value, which cannot be exceeded more than once per year on average over a three year period for purposes of monitored attainment demonstrations. Modeling demonstrations of compliance with the PM-10 NAAQS are based on the High-$N+1$-High value over N years, or in the case of five years of NWS meteorological data, the High-6th-High (H6H) value over five years. In the AERMOD model, the H6H 24-hour average over five years can be modeled in one of two ways: 1) running five individual years and combining the results using the CO MULTYEAR option, as described above in Section 3.2.6) using a single

five-year meteorological data file and specifying the SIXTH (or 6TH) highest value on the OU RECTABLE card. If applied properly, the 24-hour average results of these two approaches will be equivalent. The special processing consisting of the 99th percentile 24-hour value averaged over *N* years for PM-10 in versions of AERMOD prior to 09292, referred to as the "Post-1997" PM-10 option, has been removed since that standard was vacated.

3.2.15 Processing for 1-hour NO_2 and SO_2 NAAQS

New 1-hour NAAQS for NO_2 and SO_2 were promulgated in February 2010 and June 2010, respectively. EPA has issued guidance related to dispersion modeling in support of these 1-hour standards (EPA, 2010b; EPA, 2010c; and EPA, 2011). The form of these new 1-hour standards is similar, based on a percentile rank from the annual distribution of daily maximum 1-hour values, averaged across the number of years processed. For the 1-hour NO_2 standard, the modeled design value is based on the 98th-percentile of the daily maximum 1-hour values, which is represented by the eighth-highest of the daily maximum 1-hour values across the year. The 1-hour SO_2 modeled design value is based on the 99th-percentile, or fourth-highest, of the daily maximum 1-hour values across the year. For typical multi-year modeling analysis based on 5 years of NWS meteorological data, the modeled design value is the 5-year average of the eighth-highest values daily maximum 1-hour values for NO_2, or fourth-highest values for SO_2.

The form of these new 1-hour standards complicates the process of determining the modeled design value as well as the analyses that may be required to determine whether a particular source or group of sources contributes significantly to any modeled violations of the standards, paired in time and space. Several enhancements have been incorporated into AERMOD, beginning with version 11059, to facilitate the modeling analyses required to demonstrate compliance with these new standards. These enhancements are described in Section 3.7.2. The ability of the model to exercise these new options is facilitated by specifying 'NO2' or 'SO2' as the pollutant ID on the CO POLLUTID keyword, with the following restrictions. Whenever a pollutant ID of 'NO2' or 'SO2' is specified and 1-hour averages are selected, the options to calculate 1-hour NO_2 or SO_2 design values based on the distribution of daily maximum 1-hour values will be allowed, unless short-term averaging periods other than 1-hour are also specified on the AVERTIME keyword. If other short-term averages are specified, non-fatal warning messages will be generated and the

options for processing 1-hour NO_2 or SO_2 design values will be disabled. In that case, the 1-hour modeled design values will be processed the same as other short-term averages, based on the overall distribution of hourly values. Also, if ANNUAL or PERIOD averages are specified on the AVERTIME keyword along with 1-hour averages, a non-fatal warning message will be generated unless the CO MULTYEAR keyword is specified, since the annual NAAQS for NO_2 and SO_2 is based on the highest PERIOD or ANNUAL average from an individual year, rather than an average across the years modeled. However, the special processing based on daily maximum1-hour values will be still applied for the 1-hour averages in these cases since the ANNUAL or PERIOD averages may be appropriate if only 1 year of site-specific meteorological data is modeled.

3.2.16 Debugging output option

The DEBUGOPT keyword on the CO pathway allows the user to request detailed files of intermediate calculation results for debugging purposes. There are a number of types of debug information that AERMOD can generate. For each type specified, the user can also specify a filename of the file to which the debug output should be written. Filenames are optional. If omitted, AERMOD will use a default filename. The syntax and type of the DEBUGOPT keyword are summarized below. Listed are the debug types and filename pairs. While multiple types of debugging information can be specified, note that there are some related types in which case only one type within the group can be specified:

Syntax:	CO DEBUGOPT MODEL (Dbgfil) and/or METEOR (Dbmfil) and/or PRIME (Prmfil) and/or DEPOS and/or [AREA (AreaDbFil) or LINE (LineDbFil)] and/or [PVMRM (Dbpvfil) or OLM (OLMfil) or ARM (ARMfil) or ARM2 (ARM2fil)]
Type:	Optional, Non-repeatable

where the types of debug information and optional filename references include,:

- MODEL, (Dbgfil): Model type debug data. Default filename: MODEL.DBG.
- METEOR, (Dbmfile): Meteorological profile data. Default filename: METEOR.DBG.

- PRIME, (Prmfil): PRIME downwash debug data. Default filename: PRIME.DBG.
- DEPOS: Deposition debug information. Only default filenames will be used: GDEP.DAT for gas deposition and PDEP.DAT for particle deposition.
- AREA, (AreaDbFil) **or** LINE, (LineDbFil): Area or Line source debugging data (includes OPENPIT). May only specify one.
- PVMRM, (Dbpvfil) **or** OLM, (OLMfil) **or** ARM (ARMfil) **or** ARM2 (ARM2fil): NO to NO_2 conversion debug data. Default filenames: PVMRM.DBG, OLM.DBG, ARM.DBG, OR ARM2.DBG, respectively. May only specify one, consistent with the NO2 conversion option specified with the MODELOPT keyword.

Use the DEBUGOPT keyword with **CAUTION**: it can produce very large files! Note that the model will overwrite the debug files, without warning, if they already exist.

3.2.17 Detailed error listing file

The ERRORFIL keyword on the CO pathway allows the user to request a detailed listing file of all the messages generated by the model. This includes the error and warning messages that are listed as part of the message summaries provided in the main output file, and also any informational messages (such as occurrences of calm winds) and quality assurance messages that are generated. The syntax and type of the ERRORFIL keyword are summarized below:

Syntax:	CO ERRORFIL (Errfil)
Type:	Optional, Non-repeatable

where the Errfil parameter is the name of the detailed message file. If the optional Errfil parameter is left blank, then the model will use a default filename of ERRORS.LST. A complete description of the error and other types of messages generated by the model is provided in APPENDIX C.

3.3 Source pathway inputs and options

The **SO**urce pathway contains the keywords that define the source information for a particular model run. The model currently handles four source types identified as point, volume, area sources (including non-buoyan line and open pit sources), and buoyant line sources. The input parameters vary depending on the source type. For point sources, the user can also identify building

dimensions for nearby structure that cause aerodynamic downwash influences on the source. The user can also identify groups of sources for which the model will combine the results.

The LOCATION keyword, which identifies the source type and location, must be the first keyword entered for each source. In general, the order of the keywords is not important. However, there are some exceptions such as, the SRCGROUP keyword must be the last keyword before the SO FINISHED keyword unless the PSDCREDIT keyword is specified on the MODELOPT card, in which case SRCGROUP is replaced with the PSDGROUP keyword. Additional exceptions are discussed in the sections specific to applicable keywords. The user may group all of the LOCATION cards together, then group the source parameter cards together, or they may want to group all input cards for a particular source together. All sources are given a source ID by the user, which is used to link the source parameter inputs to the correct source or sources. The source ID can be any alphanumeric string of up to eight characters.

As noted in Section 2.3, the number of sources is allocated dynamically at the time AERMOD is run. This value, in concert with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

3.3.1 Identifying source types and locations

The LOCATION keyword is used to identify the source type and the location of each source to be modeled. The LOCATION card must be the first card entered for each source since it identifies the source type, and dictates which parameters are needed and/or accepted. The syntax, type and order of the LOCATION keyword are summarized below:

Syntax:	**When Srctyp = POINT, VOLUME, AREA, AREAPOLY, AREACIRC, or OPENPIT** SO LOCATION Srcid Srctyp Xs Ys (Zs) **When Srctyp = LINE or BUOYLINE** SO LOCATION Srcid Srctyp Xs1 Ys1 Xs2 Ys2 (Zs)
Type:	Mandatory, Repeatable
Order:	Must be first card for each source input

where the Srcid parameter is the alphanumeric source ID defined by the user (up to eight

characters), Srctyp is the source type, which is identified by one of the secondary keywords - POINT, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, LINE, or BUOYLINE. Xs and Ys, are the x and y coordinates of the source location in meters for POINT, VOLUME, AREA, AREAPOLY, AREACIRC, and OPENPIT source types. For the LINE source type, Xs1 and Ys1 are the x and y coordinates for the midpoint of one end of the LINE while Xs2 and Ys2 are the x and y coordinates for the midpoint of the other end of the LINE. For the BUOYLINE source the definitions of Xs1, Ys1, Xs2, and Ys2 are similar to the definitions for the LINE source, but there is a subtle difference due to the current implementation of the buoyant line source algorithm in AERMOD. Currently, AERMOD can only model a single buoyant line source, but the source can be comprised of one or multiple lines. When specifying a buoyant line source, the LOCATION keyword and parameters should be repeated for each individual line that comprises the buoyant line source. BUOYLINE should be specified as the source type (Srctyp), and each line should be given a unique source ID (Srcid). Xs1 and Ys1 are the x and y coordinates of the most westerly endpoint of the line. Xs2 and Ys2 are the x and y coordinates of the most easterly endpoint of the line. Zs is the optional elevation of the source above sea-level and is applicable for all source types.

The three area source types, as well as the LINE source type use the same numerical integration algorithm for estimating impacts from area sources, and are merely different options for specifying the shape of the area source. The AREA source keyword may be used to specify a rectangular-shaped area source with arbitrary orientation; the AREAPOLY source keyword may be used to specify an area source as an irregularly-shaped polygon of up to 20 sides; and the AREACIRC source keyword may be used to specify a circular-shaped area source (modeled as an equal-area polygon of 20 sides). Beginning with version 12345, a LINE source type was added to the SO pathway. The LINE source type option allows users to specify line-type sources based on a start-point and end-point of the line and the width of the line, as an alternative to the current AREA source type for rectangular sources. The LINE source type utilizes the same routines as the AREA source type, and will give identical results for equivalent source inputs. The LINE source type also includes an optional initial sigma-z parameter on the SRCPARAM keyword to account for initial dilution of the emissions. AREA and LINE source types do not include the horizontal meander component in AERMOD. Since the LINE source type utilizes the AREA source algorithms, the runtime optimizations associated with the FASTAREA option will also apply to LINE sources if included.

The OPENPIT source algorithm can be used to model particulate or gaseous emissions from open pits, such as surface coal mines and rock quarries. The OPENPIT algorithm uses an effective area for modeling pit emissions, based on meteorological conditions, and then utilizes the numerical integration area source algorithm to model the impact of emissions from the effective area sources. A complete technical description of the OPENPIT source algorithm is provided in the ISC3 Model User's Guide - Volume II (EPA, 1995b).

Beginning with version 15181, the BUOYLINE source type was added to the SO pathway for buoyant line sources. The current implementation is based on the buoyant line source algorithm in the Buoyant Line and Point Source (BLP) dispersion model (Schulman et al., 1980) with very little modification and similar limitations. As mentioned above, only a single buoyant line source, comprised of one or multiple lines, can be modeled. Multiple lines are assumed to be parallel, though each line can have a different length, height, and base elevation. However, the BUOYLINE source type also requires the user to input average values of length, width, height, and separation distance for the set of lines that comprise the buoyant line source. These parameters are discussed in more detail in Section 3.3.2. Refer to the BLP User's Guide (Schulman, et. al. (1980) for detailed information about the formulation of the buoyant line source algorithm.

Note that the source elevation, Zs, is an optional parameter. If the default option to include elevated terrain effects is used and the source elevation is omitted, a warning message will be generated and the source elevation will be given a value of 0.0. The source elevation is not used by the model if the non-default FLAT terrain option is used. While the default units of Zs are meters, the user may also specify source elevations to be in feet by adding the SO ELEVUNIT FEET card immediately following the SO STARTING card. The x (east-west) and y (north-south) coordinates are for the center of the source for POINT, VOLUME, and AREACIRC sources, and are for one of the vertices of the source for AREA, AREAPOLY, and OPENPIT sources. The source coordinates may be input as Universal Transverse Mercator (UTM) coordinates, or may be referenced to a user-defined origin.

Certain types of non-buoyant line sources can be handled in AERMOD using a string of volume sources, or as an elongated area source. The volume source algorithms are most applicable to line sources with some initial plume depth, such as conveyor belts and rail lines. Section 1.2.2 of

the ISC Model User's Guide - Volume II (EPA, 1995b) provides technical information on how to model a line source with multiple volume sources. The use of the AERMOD area source algorithm for elongated rectangles would be most applicable to near ground level line sources, such as a viaduct. The area source algorithm is applied identically to both AREA and LINE source types and AERMOD should produce the same results for an elongated area source defined as either an AREA or LINE source type.

The source ID entered on the LOCATION card identifies that source for the remainder of the SO pathway inputs. Since the model accepts alphanumeric strings of up to eight characters for the source ID, the sources can be identified with descriptive names, such as STACK1, STACK2, BOILER3, SLAGPILE, etc. This may also be useful if line sources are being modeled as multiple volume or areas, as discussed above. Since they are part of the same physical source, they can be given names that will identify them as being related, such as LINE1A, LINE1B, LINE1C, etc.

3.3.2 Specifying source release parameters

The main source parameters are input on the SRCPARAM card, which is a mandatory keyword for each source being modeled. Since the input parameters vary depending on the source type, the different source types handled by the AERMOD model are discussed separately.

3.3.2.1 POINT source inputs

The AERMOD POINT source algorithms are used to model releases from stacks and isolated vents, as well as other kinds of sources. The syntax, type and order for the SRCPARAM card for POINT sources are summarized below:

Syntax:	SO SRCPARAM Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Ptemis - point emission rate in g/s,
Stkhgt - release height above ground in meters,
Stktmp - stack gas exit temperature in degrees K,
Stkvel - stack gas exit velocity in m/s, and
Stkdia - stack inside diameter in meters.

An example of a valid SRCPARAM input card for a point source is given below:

SO SRCPARAM	STACK1	16.71	35.0	444.0	22.7	2.74

where the source ID is STACK1, the emission rate is 16.71 g/s, the release height is 35.0 m, the exit temperature is 444.0 K, the exit velocity is 22.7 m/s, and the inside stack diameter is 2.74 m. All of the parameters must be present on the input card.

If a value of 0.0 is input for the exit temperature, AERMOD will adjust the exit temperature for each hour to match the ambient temperature. This option allows the user to model a plume that is released at ambient temperature. The user may also model a plume with an exit temperature that exceeds the ambient temperature by a fixed amount by entering a negative value for exit temperature equal in magnitude to the temperature difference. The model will add the absolute value of a negative exit temperature to the ambient temperature for each hour to obtain the exit temperature used in computing the buoyancy flux of the plume. The AERMOD model does not include algorithms to model plumes that are released at temperatures below ambient temperature. Such releases should be modeled with a dense gas model.

Since the AERMOD model uses direction-specific building dimensions for all sources subject to building downwash, there are no building parameters entered on the SRCPARAM card. Building dimensions are entered on the BUILDHGT, BUILDWID, BUILDLEN, XBADJ, and YBADJ cards described below in Section 3.3.9.

3.3.2.2 VOLUME source inputs

The AERMOD VOLUME source algorithms are used to model releases from a variety of industrial sources, such as building roof monitors, multiple vents, and conveyor belts. The syntax, type and order for the SRCPARAM card for VOLUME sources are summarized below:

Syntax:	SO SRCPARAM Srcid Vlemis Relhgt Syinit Szinit
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Vlemis - volume emission rate in g/s,
Relhgt - release height (center of volume) above ground, in meters,
Syinit - initial lateral dimension of the volume in meters, and
Szinit - initial vertical dimension of the volume in meters.

The following table, which is explained in more detail in Section 1.2.2 of the ISC Model User's Guide - Volume II, summarizes the suggested procedures to be used for estimating the initial lateral and vertical dimensions for various types of volume and line sources.

Table 3-2. Summary of Suggested Procedures for Estimating Initial Lateral Dimensions σyo and Initial Vertical Dimensions σzo for Volume and Line Sources

Type of Source		Procedure for Obtaining Initial Dimension
(a) Initial Lateral Dimension (σ_{yo})		
Single Volume Source	σ_{yo} =	length of side divided by 4.3
Line Source Represented by Adjacent Volume Sources (see Figure 1-8 (a) in EPA, 1995a)	σ_{yo} =	length of side divided by 2.15
Line Source Represented by Separated Volume Sources (see Figure 1-8(b) in EPA, 1995a)	σ_{yo} =	center to center distance divided by 2.15
(b) Initial Vertical Dimension (σ_{zo})		
Surface-Based Source ($h_e \sim 0$)	σ_{zo} =	vertical dimension of source divided by 2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	σ_{zo} =	building height divided by 2.15

Elevated Source ($h_e > 0$) not on or Adjacent to a Building	σ_{zo} =	vertical dimension of source divided by 4.3

3.3.2.3 AREA source type

The AERMOD area source algorithm is used to model low level or ground level releases with no plume rise (e.g., storage piles, slag dumps, and lagoons). The AERMOD model uses a numerical integration approach for modeling impacts from area sources. When the FASTAREA or FASTALL option is specified, the area source integration routine is optimized to reduce model runtime. This is accomplished by incorporation of a three-tiered approach using the Romberg numerical integration, a 2-point Gaussian Quadrature routine for numerical integration, or a point source approximation based on the location of the receptor relative to the source. In the regulatory default mode the Romberg numerical integration is utilized for all receptors.

The AERMOD model includes various options for specifying the shape of an area source: the AREA source type may be used to specify rectangular areas that may also have a rotation angle specified relative to a north-south orientation; the LINE source type is a simplified representation of an elongated area source and does not utilize a rotation angle; the AREAPOLY source type may be used to specify an area source as an irregularly-shaped polygon of up to 20 sides; the AREACIRC source keyword may be used to specify a circular-shaped area source (modeled as an equal-area polygon of 20 sides); and the OPENPIT source type can be used to model open rectangular pits such as surface coal mines and rock quarries. The OPENPIT source type also includes an optional rotation angle. The source parameter inputs for each of the area source types is described below.

3.3.2.4 AREA source inputs

The rotation angle for rectangular AREA sources is specified relative to the vertex used to define the source location on the SO LOCATION card (e.g., the southwest corner). The syntax, type and order for the SRCPARAM card for AREA sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Xinit (Yinit) (Angle) (Szinit)
Type:	Mandatory, Repeatable

Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),

Relhgt - release height above ground in meters,

Xinit - length of X side of the area (in the east-west direction if Angle is 0 degrees) in meters,

Yinit - length of Y side of the area (in the north-south direction if Angle is 0 degrees) in meters (optional),

Angle - orientation angle for the rectangular area in degrees from North, measured positive in the clockwise direction (optional), and

Szinit - initial vertical dimension of the area source plume in meters (optional).

It should be noted that the emission rate for the area source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source.

If the optional Yinit parameter is omitted, then the model assumes that the area is a square, i.e., Yinit = Xinit. If the optional Angle parameter is omitted, then the model assumes that the area is oriented in the north-south and east-west directions, i.e., Angle = 0.0. If the Angle parameter is input, and the value does not equal 0.0, then the model will rotate the area clockwise around the vertex defined on the SO LOCATION card for this source. Figure 3-1 illustrates the relationship between the Xinit, Yinit, and Angle parameters and the source location, (Xs,Ys), for a rotated rectangle. The Xinit dimension is measured from the side of the area that is counterclockwise along the perimeter from the vertex defined by (Xs,Ys), while the Yinit dimension is measured from the side of the area that is clockwise from (Xs,Ys). The Angle parameter is measured as the orientation relative to North of the side that is clockwise from (Xs,Ys), i.e. the side with length Yinit. The Angle parameter may be positive (for clockwise rotation) or negative (for counterclockwise rotation), and a warning message is generated if the absolute value of Angle is greater than 180

degrees. The selection of the vertex to use for the source location is not critical, as long as the relationship described above for the Xinit, Yinit, and Angle parameters is maintained.

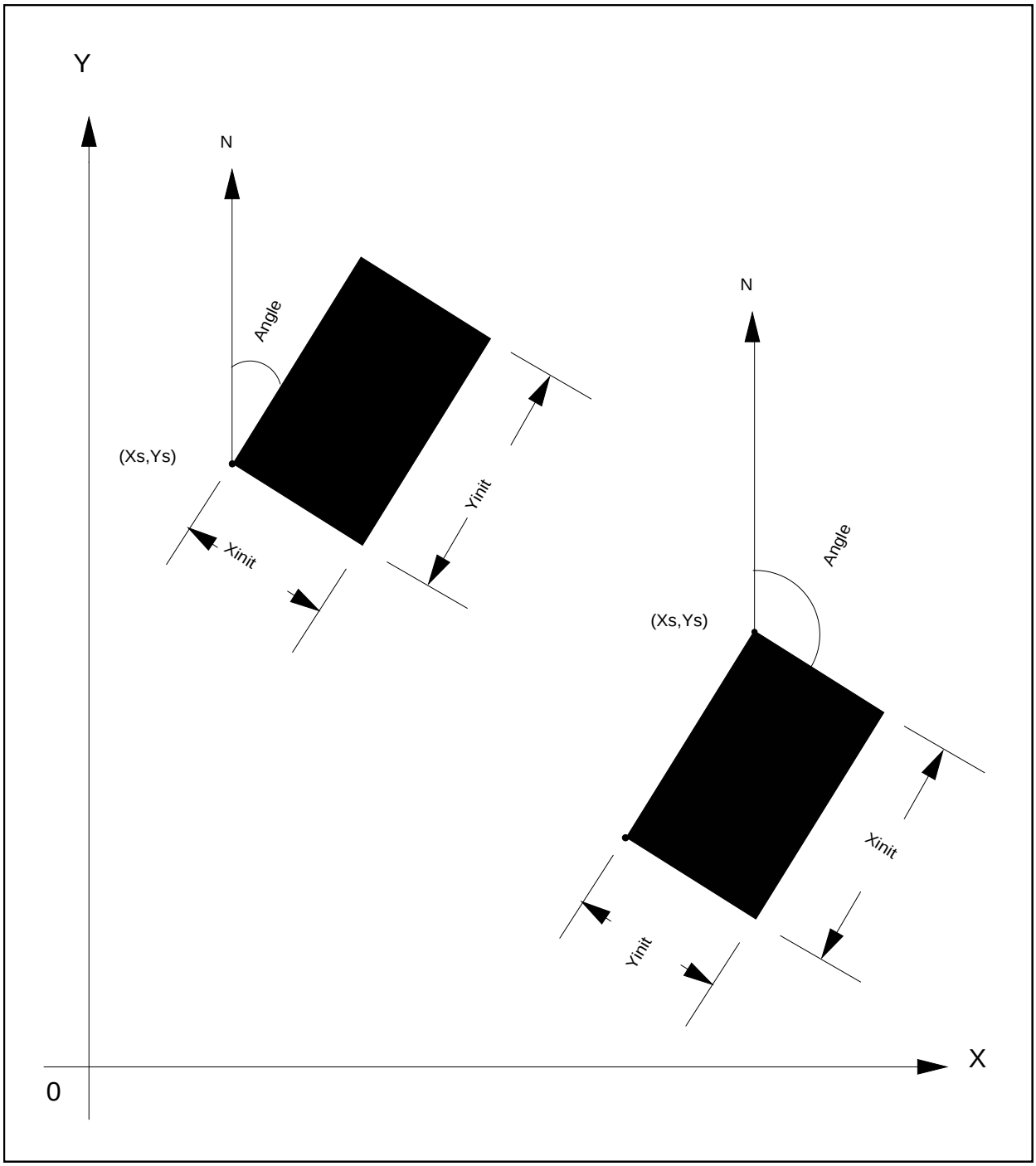


Figure 3-1. Relationship of Area Source Parameters for Rotated Rectangle

By making the Yinit and Angle parameters optional, the area source input data for the previous versions of the ISC model can be used with the AERMOD model. The aspect ratio (i.e., length/width) for area sources should generally be less than about 100 to 1. If this is exceeded, then the model will generate a non-fatal warning message, and the user should consider subdividing the area to achieve a 100 to 1 aspect ratio (or less) for all subareas.

The optional Szinit parameter may be used to specify an initial vertical dimension to the area source plume, similar to the use of the Szinit parameter for volume sources. This parameter may be important when the area source algorithm is used to model mechanically generated emission sources, such as mobile sources. In these cases, the emissions may be turbulently mixed near the source by the process that is generating the emissions, and therefore occupy some initial depth. For more passive area source emissions, such as evaporation or wind erosion, the Szinit parameter may be omitted, which is equivalent to using an initial sigma-z of zero.

An example of a valid SRCPARAM input card for a rectangular area source is given

```
SO SRCPARAM        SLAGPILE    0.00155.0      50.0  100.0    30.0
```

where the source ID is SLAGPILE, the emission rate is 0.0015 g/(s-m^2), the release height is 5.0 m, the X-dimension is 50.0 m, the Y-dimension is 100.0 m, and the orientation angle is 30.0 degrees clockwise from North.

Since the numerical integration algorithm can handle elongated areas with aspect ratios of up to 100 to 1, the AERMOD area source algorithm may be useful for modeling certain types of line sources. User's now have the option of specifying a line-type source as either AREA or LINE. There are no restrictions on the placement of receptors relative to area sources for the AERMOD model. Receptors may be placed within the area and at the edge of an area. The AERMOD model will integrate over the portion of the area that is upwind of the receptor. However, since the numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide. More technical information about the application of the AERMOD area source algorithm is provided in Sections 1.2.3 and 2.2.3 of the ISC Model User's Guide -

Volume II (EPA, 1995b).

3.3.2.5 AREAPOLY source inputs

The AREAPOLY source type may be used to specify an area source as an arbitrarily-shaped polygon of between 3 and 20 sides (the number of sides allowed may be increased by modifying the NVMAX parameter in MODULE MAIN1). This source type option provides the user with considerable flexibility for specifying the shape of an area source. The syntax, type and order for the SRCPARAM card for AREAPOLY sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Nverts (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),

Relhgt - release height above ground in meters,

Nverts - number of vertices (or sides) of the area source polygon,

Szinit - initial vertical dimension of the area source plume in meters (optional).

As with AREA sources, the emission rate for the source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source. The locations of the vertices are specified by use of the AREAVERT keyword, which applies only to AREAPOLY sources. The syntax, type and order for the AREAVERT keyword used for AREAPOLY sources are summarized below:

Syntax:	SO AREAVERT Srcid Xv(1) Yv(1) Xv(2) Yv(2) ... Xv(i) Yv(i)
Type:	Mandatory for AREAPOLY sources, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Xv(i) and Yv(i) are the x-coordinate and y-coordinate values of the vertices of the area source polygon. There must by Nverts pairs of coordinates for the area source, where Nverts in the number of vertices specified for that source on the SRCPARAM card. The first vertex, Xv(1) and Yv(1), must also match the coordinates given for the source location on the LOCATION card, Xs and Ys. The remaining vertices may be defined in either a clockwise or counter- clockwise order from the point used for defining the source location.

Receptors may be placed within the area and at the edge of an area. The AERMOD model will integrate over the portion of the area that is upwind of the receptor. However, since the numerical integration is not performed for portions of the area that are closer than 1.0 meter upwind of the receptor, caution should be used when placing receptors within or adjacent to areas that are less than a few meters wide.

3.3.2.6 AREACIRC source inputs

The AREACIRC source type may be used to specify an area source as a circular shape. The model will automatically generate a regular polygon of up to 20 sides to approximate the circular area source. The polygon will have the same area as that specified for the circle. The syntax, type and order for the SRCPARAM card for AREACIRC sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Radius (Nverts) (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in g/(s-m^2),
Relhgt - release height above ground in meters,
Radius - radius of the circular area in meters,
Nverts - number of vertices (or sides) of the area source polygon (optional, 20 sides will be used if omitted),
Szinit - initial vertical dimension of the area source plume in meters (optional).

As with AREA sources, the emission rate for the source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source.

3.3.2.7 OPENPIT source inputs

The AERMOD model accepts rectangular pits with an optional rotation angle specified relative to a north-south orientation and the vertex used to define the source location on the SO LOCATION card (e.g., the southwest corner). The syntax, type and order for the SRCPARAM card for OPENPIT sources are summarized below:

Syntax:	SO SRCPARAM Srcid Opemis Relhgt Xinit Yinit Pitvol (Angle)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Opemis - open pit emission rate in g/(s-m^2),

Relhgt - average release height above the base of the pit in meters,

Xinit - length of X side of the open pit (in the east-west direction if Angle is 0 degrees) in meters,

Yinit - length of Y side of the open pit (in the north-south direction if Angle is 0 degrees) in meters,

Pitvol - volume of open pit in cubic meters, and

Angle - orientation angle for the rectangular open pit in degrees from North, measured positive in the clockwise direction (optional).

The same emission rate is used for both concentration and deposition calculations in the

AERMOD model. It should also be noted that the emission rate for the open pit source is an emission rate per unit area as with the other area source types. This is different from the point and volume source emission rates, which are total emissions for the source. The Relhgt parameter cannot exceed the effective depth of the pit, which is calculated by the model based on the length, width and volume of the pit. A Relhgt of 0.0 indicates emissions that are released from the base of the pit.

If the optional Angle parameter is input, and the value does not equal 0.0, then the model will rotate the open pit clockwise around the vertex defined on the SO LOCATION card for this source. The relationship between the Xinit, Yinit, and Angle parameters and the source location, (Xs,Ys), for a rotated pit is the same as for rectangular area sources. The Xinit dimension is measured from the side of the area that is counterclockwise along the perimeter from the vertex defined by (Xs,Ys), while the Yinit dimension is measured from the side of the open pit that is clockwise along the perimeter from (Xs,Ys). Unlike the area source inputs, the Yinit parameter is not optional for open pit sources. The Angle parameter is measured as the orientation relative to North of the side that is clockwise from (Xs,Ys), i.e. the side with length Yinit. The Angle parameter may be positive (for clockwise rotation) or negative (for counterclockwise rotation), and a warning message is generated if the absolute value of Angle is greater than 180 degrees. The selection of the vertex to use for the source location is not critical, as long as the relationship described above for the Xinit, Yinit, and Angle parameters is maintained.

The aspect ratio (i.e., length/width) of open pit sources should be less than 10 to 1. However, since the pit algorithm generates an effective area for modeling emissions from the pit, and the size, shape and location of the effective area is a function of wind direction, an open pit cannot be subdivided into a series of smaller sources. Aspect ratios of greater than 10 to 1 will be flagged by a warning message in the output file, and processing will continue. Since open pit sources cannot be subdivided, the user should characterize irregularly-shaped pit areas by a rectangular shape of equal area. **Receptors should not be located within the boundaries of the pit; concentration and/or deposition at such receptors will be set to zero.** Such receptors will be identified during model setup and will be flagged in the summary of inputs.

An example of a valid SRCPARAM input card for an open pit source is given below:

SO SRCPARAM NORTHPIT 1.15E-4 0.0 150.0 500.0 3.75E+6 30.0

where the source ID is NORTHPIT, the emission rate is 1.15E-4 g/(s-m^2), the release height is 0.0 m, the X-dimension is 150.0 m, the Y-dimension is 500.0 m, the pit volume is 3.75E+6 cubic meters (corresponding to an effective pit depth of about 50 meters) and the orientation angle is 30.0 degrees clockwise from North.

3.3.2.8 LINE source inputs

The syntax, type and order for the SRCPARAM card for LINE sources are summarized below:

Syntax:	SO SRCPARAM Srcid Lnemis Relhgt Width (Szinit)
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Lnemis - line source emission rate in g/(s-m^2),

Relhgt - average release height above ground in meters (unless ELEVUNIT keyword is used to specify elevations in feet),

Width - width of the source in meters (with a minimum width of 1m),

Szinit - initial vertical dimension of the line source in meters (optional).

As noted above, the LINE source type option in AERMOD uses the same algorithms as used for the AREA source type for rectangular sources, and will give identical results for equivalent source definitions. The LINE source emission rate is in g/(s-m^2) and the model assumes that emissions are uniformly distributed across the dimensions of the LINE source. As with the AREA source type, the LINE source type does not include the horizontal meander component that is incorporated for POINT and VOLUME sources. Also, as with the AREA source type, the LINE source type will estimate concentrations (and/or deposition) at receptors located within the dimensions of the source.

3.3.2.9 BUOYLINE source inputs

The syntax, type and order for the SRCPARAM card for BUOYLINE source is summarized below:

Syntax:	SO SRCPARAM Srcid Blemis Relhgt
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each line input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular line within the buoyant line source, and the other parameters are as follows:

Blemis - buoyant line emission rate in g/(s-m^2) for the individual line,

Relhgt - average release height of the individual line above ground in meters (unless ELEVUNIT keyword is used to specify elevations in feet).

The buoyant line source also requires the user to enter average values representative of the source as a whole and not for the individual lines that comprise the buoyant line source. These are entered as parameters on the BLPINPUT keyword:

Syntax:	SO BLPINPUT Blavgblen Blavgbhgt Blavgbwid Blavglwid Blavgbsep Blavgfprm
Type:	Mandatory, Non-Repeatable

where the parameters are defined as follows (the order shown is the same as the input in BLP with the variable names used in BLP shown in parentheses):

Blavgblen (L) - average building length (m),

Blavgbhgt (HB) - average building height (m),

Blavgbwid (WB) - average building width (m),

Blavglwid (WM) - average line source width (m) (of the individual lines),

Blavgbsep (DX) - average building separation (m) (between the individual lines),

Blavgfprm (FPRIME) - average buoyancy parameter (m^4/s^3).

3.3.3 Specifying gas deposition parameters

3.3.3.1 Source parameters for gas deposition (dry and/or wet)

The input of source parameters for dry and wet deposition of gaseous pollutants is controlled by the GASDEPOS keyword on the SO pathway. The gas deposition variables may be input for a single source, or may be applied to a range of sources.

The syntax, type, and order for the GASDEPOS keyword are summarized below:

Syntax:	SO GASDEPOS Srcid (or Srcrng) Da Dw rcl Henry
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, the parameter Da is the diffusivity in air for the pollutant being modeled (cm^2/s), Dw is the diffusivity in water for the pollutant being modeled (cm^2/s), rcl is the cuticular resistance to uptake by lipids for individual leaves (s/cm), and Henry is the Henry's Law constant (Pa m^3/mol). Values of the physical parameters for several common pollutants may be found in the appendices to the ANL report (Wesely, et. al, 2002).

3.3.3.2 Option for specifying the deposition velocity for gas dry deposition

An optional keyword is available on the Control (CO) pathway to allow the user to specify the dry deposition velocity for gaseous emissions. A single dry deposition velocity can be input for a given model run, and is used for all sources of gaseous pollutants. Selection of this option will by-pass the algorithm for computing deposition velocities for gaseous pollutants, and should only be used when sufficient data to run the algorithm are not available. Results of the AERMOD model based on a user-specified deposition velocity should be used with extra caution.

The syntax and type of the GASDEPVD keyword are summarized below:

Syntax:	CO GASDEPVD Uservd
Type:	Optional, Non-repeatable

where the parameter Uservd is the gaseous dry deposition velocity (m/s). A non-fatal warning message is generated by the model if a value of Uservd greater than 0.05 m/s (5 cm/s) is input by the user. When the GASDEPVD keyword is used, the GDSEASON, GDLANUSE, and GASDEPRF keywords for the CO pathway, and the GASDEPOS keyword for the SO pathway, are no longer applicable and cannot be used in the same model run. As a result, gas wet deposition processes (DEPOS, WDEP, and WETDPLT) cannot be simulated with the GASDEPVD option is used.

3.3.4 Specifying source parameters for particle deposition

The AERMOD model includes two methods for handling dry and/or wet deposition of particulate emissions. Method 1 is used when a significant fraction (greater than about 10 percent) of the total particulate mass has a diameter of 10 μm or larger, or when the particle size distribution is known. The particle size distribution must be known reasonably well in order to use Method 1. Method 2 may be used when the particle size distribution is not well known and when a small fraction (less than 10 percent of the mass) is in particles with a diameter of 10 μm or larger. The deposition velocity for Method 2 is calculated as the weighted average of the deposition velocity for particles in the fine mode (i.e., less than 2.5 μm in diameter) and the deposition velocity for the coarse mode (i.e., greater than 2.5 μm but less than 10 μm in diameter). As described in Section 0, use of the Method 2 option is considered non-DFAULT.

3.3.4.1 Specifying particle inputs for Method 1

The input of source variables for particle deposition using Method 1 is controlled by three keywords on the SO pathway, PARTDIAM, MASSFRAX, and PARTDENS. These inputs are comparable to the particulate inputs used in the ISCST3 model (EPA,1995a). The particle variables may be input for a single source, or may be applied to a range of sources.

The syntax, type and order for these three keywords are summarized below:

Syntax:	SO PARTDIAM Srcid (or Srcrng) Pdiam(i), i=1,Npd SO MASSFRAX Srcid (or Srcrng) Phi(i), i=1,Npd SO PARTDENS Srcid (or Srcrng) Pdens(i), i=1,Npd
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, and where the Pdiam array consists of the mass-mean aerodynamic particle diameter (microns) for each of the particle size categories, the Phi array is the corresponding mass fractions (between 0 and 1) for each of the categories, and the Pdens array is the corresponding particle density (g/cm^3) for each of the categories.

The number of particle size categories for a particular source is Npd. The user does not explicitly tell the model the number of categories being input, but if continuation cards are used to specify particle size variables, all inputs of a keyword for a particular source or source range must be contiguous, and the number of categories must agree for each of the three keywords input for a particular source. As many continuation cards as needed may be used to define the inputs for a particular keyword. The model checks the inputs to ensure that the mass fractions sum to 1.0 (within 2 percent) for each source input, and issues a warning message if that range is exceeded. The model also ensures that mass fractions for each particle size category are within the proper range (between 0 and 1), and issues fatal error messages for any value exceeded that range.

3.3.4.2 Specifying particle inputs for Method 2

The Method 2 particle information is input through the METHOD_2 keyword on the SO pathway. The syntax, type, and order for the METHOD_2 keyword are summarized below:

Syntax:	SO METHOD_2 Srcid (or Srcrng) FineMassFraction Dmm
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, the parameter FineMassFraction is the fraction (between 0 and 1) of particle mass emitted in the fine mode, less than 2.5 microns, and Dmm is the representative mass-mean aerodynamic particle diameter in

microns. Estimated values of fine particle fractions and mass mean diameters for various pollutants are provided in Appendix B of the ANL report (Wesely, et al, 2002).

3.3.5 Specifying Emission and Output Units

Since the AERMOD model allows for both concentration and deposition to be output in the same model run, the EMISUNIT keyword (see Section 3.3.13) cannot be used to specify emission unit factors if more than one output type is being generated. The AERMOD model therefore allows for concentration and deposition units to be specified separately through the CONCUNIT and DEPOUNIT keywords, respectively. The syntax and type of the CONCUNIT keyword are summarized below:

Syntax:	SO CONCUNIT Emifac Emilbl Conlbl
Type:	Optional, Non-repeatable

where the parameter Emifac is the factor to convert emission rate input units to the desired output units, Emilbl is the label for the emission input units (up to 40 characters), and Conlbl is the output unit label (up to 40 characters) for concentration calculations. The syntax and type of the DEPOUNIT keyword are summarized below:

Syntax:	SO DEPOUNIT Emifac Emilbl Deplbl
Type:	Optional, Non-repeatable

where the parameter Emifac is the factor to convert emission rate input units to the desired output units, Emilbl is the label for the emission input units (up to 40 characters), and Deplbl is the output unit label (up to 40 characters) for deposition calculations.

3.3.6 Source input parameters for NO_2 conversion options

3.3.6.1 Specifying in-stack NO_2/NO_x ratios by source for PVMRM and OLM

As noted above, the PVMRM, and OLM options for modeling NO_2 conversion require in-stack NO_2/NO_x ratios to be specified for each source, i.e., AERMOD no longer assumes a default in-stack ratio of 0.10 for the OLM option. The user can specify in-stack NO_2/NO_x ratios through

the optional NO2RATIO keyword on the SO pathway. The syntax of the NO2RATIO keyword is as follows:

Syntax:	SO NO2RATIO SrcID or SrcRange NO2Ratio
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the SrcID or SrcRange identify the source or sources for which the inputs apply, and where the NO2Ratio parameter specifies the in-stack ratio. In this way, the user can specify a single in-stack NO_2/NO_x ratio for a group of stacks. For example, the following input:

```
SO NO2RATIO  STACK1-STACK10   0.15
```

will apply the in-stack ratio of 0.15 to sources with IDs falling within the range STACK1 to STACK10. Any value specified on the SO NO2RATIO card will override the default ratio, if any, specified on the CO NO2STACK card. Users should note that while SO NO2RATIO is an optional keyword, the PVMRM and OLM options require the user to specify an in-stack NO_2/NO_x ratio for each source, using either the CO NO2STACK (Section 3.2.4.3) or SO NO2RATIO cards, or both.

3.3.6.2 Specifying combined plumes for OLM

The OLM option for modeling NO_2 conversion includes an option for specifying which sources are to be modeled as combined plumes, i.e., where the NOx within the plumes competes for the available ambient ozone. Sources which are not specified for modeling as combined plumes will be modeled as individual plumes, i.e., where all of the ambient ozone is available for conversion of NO to NO_2. The selection of individual or combined plume option for OLM is specified through the OLMGROUP keyword on the SO pathway. The syntax of the OLMGROUP card is as follows:

Syntax:	SO OLMGROUP OLMGrpID SrcID's and/or SrcRange's or SO OLMGROUP ALL
Type:	Optional, Repeatable (except for OLMGROUP ALL)
Order:	Must follow the LOCATION card for each source input; OLMGROUP ALL must follow the LOCATION card for all sources

where OLMGrpID identifies a group to be treated as a combined plume with OLM, and the SrcID's and/or SrcRange's identify the sources to be included in the OLM group. As with the SO SRCGROUP card, individual source IDs and source ranges may be used on the same record, and if more than one input card is needed to define the sources for a particular OLM group, then additional records may be input by repeating the pathway, keyword and OLM group ID. A user can also specify an OLMGrpID of ALL, which means that OLM will be applied on a combined plume basis to all sources. However, unlike the SO SRCGROUP card, the results will not be output for a specific OLM group unless the same group of sources is also identified on a SRCGROUP card. Another constraint for the OLMGROUP keyword is that a source cannot be included in more than one OLM group.

If a source is not selected for an OLMGROUP card, then OLM will be applied to that source as an individual plume. Other than the similarity in syntax, there is no connection in the model between the groups defined on the OLMGROUP card and groups defined on the SRCGROUP card. The OLMGROUP card relates to how the results are processed within the model for the OLM option, and the SRCGROUP card simply controls how source impacts are grouped in the model outputs.

If the user identifies one or more groups of sources to apply OLM on a combined plume basis using the OLMGROUP card, the model will still need to calculate the concentration for individual plumes within the OLM group in order for the model to sum the results for the sources listed on the SRCGROUP card(s). The individual source concentrations are calculated by applying the ratio of the combined concentration for the OLM group with and without OLM to each source within the OLM group.

3.3.6.3 Specifying ambient NO_2/NO_x ratios for the ARM and ARM2 options

The Default ARM and ARM2 options, incorporated in AERMOD beginning with version 13350, are both based on applying an ambient ratio of NO_2/NO_x to a modeled NO_x concentration to estimate ambient NO_2 concentrations. The ARM option utilizes separate ambient ratios for modeling 1-hr and annual NO_2 impacts, whereas the ARM2 option applies an ambient ratio to the 1-hr modeled NO_x concentrations based on a formula derived empirically from ambient monitored ratios of NO_2/NO_x. Default values based on EPA recommendations for the 1-hr and annual ambient ratios under the ARM option are 0.80 (EPA, 2011) and 0.75 (EPA, 2005), respectively. The ARM2 option includes default upper and lower limits on the ambient ratio applied to the modeled NO_x concentration of 0.9 and 0.5, respectively. The default ratios for the ARM and ARM2 options can be modified using the optional ARMRATIO on the CO pathway as follows:

Syntax:	CO ARMRATIO ARM_ 1h (ARM_ann) *For ARM Option* or CO ARMRATIO ARM2_Min ARM2_Max *For ARM2 Option*
Type:	Optional, Non-Repeatable

3.3.7 Modeling NO_2 increment credits with PVMRM

Due to the ozone-limiting effects of the PVMRM option, the predicted concentrations of NO_2 are not linearly proportional to the emission rate. Therefore, the approach of modeling NO_2 increment consumption with PSD credits through the use of a negative emission rate for credit sources cannot be used with the PVMRM option. However, the draft PSDCREDIT option allows modeling PSD increment credits for NO_2 when the PVMRM option is specified. The PSDCREDIT option is currently implemented as a BETA-test option, and requires that the PVMRM and BETA options be specified on the CO MODELOPT card (see Section 3.2.2). The PSDCREDIT option utilizes a new PSDGROUP keyword, described below, to identify which sources consume or expand increment. This option is not valid if the OLM option is specified, and no comparable option is available for modeling increment credits with the OLM option. The user should check with the appropriate reviewing authority for further guidance on modeling increment credits for NO_2.

A general discussion of concepts related to modeling increment consumption is provided

below, followed by a description of inputs required to use the BETA-test PSDCREDIT option for PVMRM.

3.3.7.1 Increment consuming and baseline sources

Increment is the maximum allowable increase in concentration of a pollutant above a baseline concentration for an area defined under the Prevention of Significant Deterioration (PSD) regulations. The PSD baseline area can be an entire State or a subregion of a State such as a county or group of counties. Increment standards exist for three pollutants: SO_2 (3-hr, 24-hr, and annual averages), NO_2 (annual average), and PM-10 (24-hr and annual average). Increment consumption is the additional air quality impact above a baseline concentration.

The baseline concentration is the ambient concentration of the pollutant that existed in the area at the time of the submittal of the first complete permit application by any source in that area subject to PSD regulations. A baseline source is any source that existed prior to that first application and the baseline date is the date of the PSD application. This baseline date is referred to as the minor source baseline date in PSD regulations. By definition, baseline sources do not consume increment. However, any baseline source that retires from service after the baseline date expands the increment available to new sources. Therefore, a PSD modeling analysis performed for a new source may need to account for this increment expansion. Such an analysis may therefore involve identification of three groups of sources: 1) increment-consuming sources; 2) retired (increment-expanding) baseline sources; and 3) existing, non-retired, baseline sources.

3.3.7.2 Calculating increment consumption under the PSDCREDIT option

Calculating increment consumption under the PSDCREDIT option in AERMOD is not a simple arithmetic exercise involving the three groups of sources defined above. Since the amount of ozone available in the atmosphere limits the conversion of NO to NO_2, interactions of plumes from the existing and retired baseline sources with those from the increment consuming sources must be considered as part of the calculation of net increment consumption. Without the PSDCREDIT option, properly accounting for the potential interaction of plumes among the different source categories would require post-processing of results from multiple model runs. Internal “post”-processing algorithms have been incorporated in AERMOD under the PSDCREDIT

option to account for the apportioning of the three groups of sources to properly calculate increment consumption from a single model run.

Define the following three source groupings for the discussion that follows:

A = increment-consuming sources;
B = non-retired baseline sources; and
C = retired baseline, increment-expanding sources.

The calculation of the amount of increment consumption by the **A** sources cannot simply be estimated by modeling the **A** sources alone because of the possible interaction of those plumes with the plumes from **B** sources. The PVMRM algorithm is designed to account for such plume interactions and calculate the total NO to NO_2 conversion in the combined plumes based on the amount of ozone available. Therefore, the total increment consumption by the **A** sources is given by the difference between (1) the total future impact of increment consuming sources and non-retired baseline sources (**A**+**B**) and (2) the total current impact (**B**), which can be expressed as (**A**+**B**) – (**B**). Here (**A**+**B**) represents the value that would be compared against the National Ambient Air Quality Standard (NAAQS) for NO_2 during PSD review of the **A** sources.

In a case where some of the baseline sources have been retired from service (**C** sources), the PSD regulations allow the consideration of increment expansion when assessing compliance with the PSD increment. However, the amount of increment expansion cannot be estimated by simply modeling the **C** sources alone because of the possible interaction of those plumes with the plumes from **B** sources. Therefore, the total increment expansion, i.e., PSD credit, is calculated as the difference between (1) the total impact prior to the retirement of **C** sources, i.e. (**B**+**C**), and (2) the total impact from existing (non-retired) baseline sources (**B**), which can be expressed as (**B**+**C**) – (**B**).

Finally, the net increment consumption is given by the difference between total increment consumption and the total increment expansion, or

$$[(\mathbf{A}+\mathbf{B}) - (\mathbf{B})] - [(\mathbf{B}+\mathbf{C}) - (\mathbf{B})] \qquad \text{(Equation 1)}$$

Note that in the absence of any increment expansion, the net increment consumption is equal to the total increment consumption [(**A**+**B**) – (**B**)], as described above.

These expressions of net increment consumption and expansion cannot be interpreted as algebraic equations. Instead, the terms within parentheses represent the results of separate model runs that account for the combined effects of NO_x conversion chemistry on specific groups of sources. The expression shown in Equation 1 above represents four model simulations: (**A**+**B**), (**B**), (**B**+**C**), and (**B**) again. In this case, the two (**B**) terms do cancel each other and we are left with:

$$[(\mathbf{A}+\mathbf{B})] - [(\mathbf{B}+\mathbf{C})] \qquad \text{(Equation 2)}$$

The expression presented in Equation 2 summarizes how the net increment consumption calculation is performed under the PSDCREDIT option. Under this option, AERMOD first models the **A** and **B** groups together, then models the **B** and **C** groups together, and finally computes the difference to obtain the desired result, i.e., the value to compare to the PSD increment standard. In order for AERMOD to perform the special processing associated with this option, the user must define which sources belong to each of the groupings defined above. The next section describes how this is accomplished.

3.3.7.3 Specifying source groups under the PSDCREDIT option

The PSDCREDIT option introduces limitations on grouping sources in order to calculate increment consumption as described in the previous section. A new keyword, PSDGROUP, is used to group the sources to correctly calculate the increment consumption. The syntax, type, and order are similar to the regular SRCGROUP keyword and are summarized below:

Syntax:	SO PSDGROUP Grpid Srcid's and/or Srcrng's
Type:	Mandatory for PSDCREDIT option, Repeatable
Order:	Must follow the last keyword in the SO pathway before FINISHED

If the PSDCREDIT model option is specified, the PSDGROUP keyword must be used. The SRCGROUP keyword cannot be used with the PSDCREDIT option since results from other groupings beyond these three do not have any meaning when the PSDCREDIT option is invoked

and sources are allocated to the calculation of increment consumption. Special source groups for outputting model results are defined within AERMOD for the PSDCREDIT option, as described in the next section.

Only the following special PSD group ID's can be used. Failure to use these group ID's will result in a fatal error message during setup processing by AERMOD. The group ID's are:

INCRCONS –	increment-consuming sources (group **A** above); these can be new sources or modifications to existing sources;
NONRBASE –	existing, non-retired baseline sources (group **B** above); and
RETRBASE –	retired (increment-expanding or PSD credit) baseline sources (group **C** above).

It is important to note that the source emission inputs for sources included in the RETRBASE PSD group must be entered as positive numbers, unlike other types of PSD credit modeling where negative emissions are input to simulate the impact of the credit sources on the increment calculation. The increment-expanding contribution from RETRBASE sources is accounted for within the AERMOD model under the PSDCREDIT option.

The group ID's can appear in any order, but these are the only three that can be specified. If there are no retired baseline sources (i.e., no baseline sources are retired), the keyword RETRBASE can be omitted. Likewise, if there are no non-retired baseline sources (i.e., all baseline sources have been retired), the NONRBASE keyword can be omitted. The special group ID 'ALL' that can be used with the SRCGROUP keyword cannot be used with the PSDGROUP keyword. As with the SRCGROUP keyword for non-PSDCREDIT applications, the group ID's are repeatable and they must be the last keyword before FINISHED on the SO pathway when the PSDCREDIT option is specified.

Source ranges, which are described in more detail in Section 3.3.9, are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway, keyword and group ID. A source can appear in only one of these source groups, and must be assigned to one of the groups.

The requirements for specifying sources and source groups under the PSDCREDIT option are summarized below:

- The SRCGROUP keyword cannot be used with the PSDCREDIT option;
- Special PSD group ID's must be used with the PSDGROUP keyword;
- The group ID ALL is not allowed when the PSDCREDIT option is specified;
- A source must appear in one, and only one, of the PSDGROUPs; and
- Emission rates for increment-expanding (RETRBASE) sources must be entered as positive values.

3.3.7.4 Model outputs under the PSDCREDIT option

Unlike the regular SRCGROUP keyword, the PSDGROUP keyword does not define how the source impacts are grouped for model output. As described in the previous sections, the PSDGROUP keyword defines the different categories of sources needed in order to properly account for NO_x conversion chemistry under the PVMRM option.

The model outputs under the PSDCREDIT option in AERMOD are based on demonstrating compliance with the air quality standards, i.e., the NAAQS and PSD increment for NO_2. As a result, AERMOD uses hardcoded "SRCGROUP" names of 'NAAQS' and 'PSDINC' to label these two types of outputs. The results output under the 'NAAQS' source group label are based on the calculation of (**A**+**B**) as described above in Section 3.3.7.2. The results reported under the 'PSDINC' source group label are based on the expression presented above in Equation 2.

3.3.8 Background concentrations

Beginning with version 11059, users can specify uniform or temporally varying background concentrations using the BACKGRND keyword on the SO pathway, and beginning with version 13350 users can vary background concentrations by wind sector. Background concentrations can be included with any source group to estimate cumulative ambient impacts. Background concentrations can be specified using a range of options similar to those available with the EMISFACT keyword for source emissions, or on an hourly basis from a separate data file.

3.3.8.1 Defining background concentration sectors

For applications that include sector-varying background concentrations, the sectors are defined based on the SO BGSECTOR keyword, as follows:

Syntax:	SO BGSECTOR StartSect1 StartSect2 . . . StartSectN, where N ≤ 6
Type:	Optional, Non-Repeatable

For applications that include sector-varying background concentration the minimum sector width allowed is 30 degrees and warning messages will be issued for sector widths less than 60 degrees. **Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file.**

3.3.8.2 Specifying the background concentration

For applications that do not include sector-varying background concentrations, the syntax of the BACKGRND keyword is as follows:

Syntax:	SO BACKGRND BGflag BGvalue(i), i=1,n and/or SO BACKGRND HOURLY BGfilnam (BGformat)
Type:	Optional, Repeatable

where the BGflag parameter is the variable background concentration flag, BGvalue is the array of background concentration values associated with BGflag, HOURLY indicates use of an hourly background file, BGfilnam is the filename for the hourly background data, and BGformat is the optional Fortran format of the hourly background file (‘free’ format is used by default). The BGfilnam can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

For applications that include sector-varying background concentrations, the syntax of the BACKGRND keyword is as follows:

Syntax:	SO BACKGRND SECTn BGflag BGvalue(i), i=1,n and/or SO BACKGRND SECTn HOURLY BGfilnam (BGformat)
Type:	Optional, Repeatable

where the SECTn parameter identifies the applicable sector as defined on the SO BGSECTOR keyword, and the other parameters are as defined above.

The HOURLY background file must include the year, month, day, and hour, followed by the background concentration, in that order (unless specified differently through the BGformat parameter). The year can be specified as either a 2-digit or 4-digit year. If an optional Fortran format is specified using the BGformat parameter, the year, month, day, and hour variables must be read as integers using the Fortran I format, and the background concentration must be read as a real variable, using the Fortran F, E, or D format, e.g., (4I2,F8.3). Note that background values that do not include decimal places can be read as Fx.0, where x is the length of the data field. The BGformat parameter must include the open and close parentheses as shown in the example, and may also include embedded spaces if double quotes (“) are used to delimit the field. A warning message will be generated if the specified format does not meet these requirements, and AERMOD may also issue a fatal error message when reading the file in cases where real variables are read with an integer format, or vice versa.

If the optional BGformat parameter is missing, then the model will read the background data using a Fortran ‘free’ format, i.e., assuming that commas or spaces separate the data fields, and that the fields are in the order given above. The date sequence in the background data file must also match the date sequence in the hourly meteorological data files.

Note that the HOURLY option and an option to specify values based on the BGflag parameter can both be specified in the same model run. This allows the user to specify background concentrations on a temporally-varying basis, such as SEASHR, that can be used to substitute for missing values in an hourly background file. **NOTE: AERMOD will issue a fatal error message and abort processing if missing data are encountered in an HOURLY background file unless the user provides other temporally-varying background concentrations (e.g., SEASHR, etc.) to substitute for missing data.** Background concentration units can be specified using the

BACKUNIT keyword, described below. If the BACKUNIT keyword is omitted, default units of PPB are assumed for background NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants. Background concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb).

To include background concentrations with a particular source group, the reserved "source ID" of BACKGROUND (or BACKGRND) can be included on the SRCGROUP keyword, including source group ALL. **NOTE:** AERMOD will NOT automatically include background concentrations in source group ALL, but the user can specify that background be included in results for group ALL by including the BACKGROUND (or BACKGRND) keyword after 'ALL' on the SRCGROUP keyword. Users can also include the NOBACKGROUND (or NOBACKGRND) keyword after 'ALL' on the SRCGROUP keyword to explicitly indicate that BACKGROUND is NOT included with group 'ALL.' The contribution of background concentrations can also be tracked separately by including a source group with BACKGROUND as the only "source ID." **NOTE: The source of background concentrations and the method used to incorporate background concentrations in a cumulative impact assessment involves several considerations and should be documented and justified on a case-by-case basis.**

Background concentrations specified with the BACKGRND keyword are combined with source impacts on a temporally-paired basis to estimate cumulative ambient impacts. However, since modeled concentrations are not calculated for hours with calm or missing meteorological data, background concentrations are also omitted for those hours. This may result in the background contribution being lower than expected for short-term averages of 3-hours up to 24-hours for periods when the denominator used to calculate the multi-hour average is adjusted in accordance with EPA's calms policy (see Section 8.3.4.2 of Appendix W), which is implemented within the AERMOD model. For example, if 12 hours out of a 24-hour period are calm or missing, the calms policy dictates that the 24-hour average concentration would be based on the sum of the 12 non-calm/non-missing hours divided by 18. The contribution from background concentrations would also be based on the sum of background values for the 12 non-calm/non-missing hours, divided by 18. If background was specified as uniform during that 24-hour period, then the contribution from background would appear to be 33.3% lower than expected (i.e., 12/18).

The BGflag parameter must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

ANNUAL -	annual background value (n=1),
SEASON -	background values vary seasonally (n=4),
MONTH -	background values vary monthly (n=12),
HROFDY -	background values vary by hour-of-day (n=24),
WSPEED -	background values vary by wind speed (n=6),
SEASHR -	background values vary by season and hour-of-day (n=96),
HRDOW -	background values vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n=72),
HRDOW7 -	background values vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=168),
SHRDOW -	background values vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=288),
SHRDOW7 -	background values vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=672),
MHRDOW -	background values vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=864), and
MHRDOW7 -	background values vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=2,016).

The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword. If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The BACKGRND keyword may be repeated as many times as necessary to input all of the background values, and repeat values may be used for the numerical inputs, e.g., 12*25.6 can be used to specify a value of 25.6 for 12 adjacent “cells” within the array of values.

3.3.8.3 Specifying background concentration units

Background concentration units can be specified on the optional BACKUNIT keyword on

the SO pathway. The syntax of the BACKUNIT keyword is as follows:

Syntax:	SO BACKUNIT BGUnits
Type:	Optional, Non-repeatable

where the BGUnits parameter specifies the units as parts-per-billion (PPB), parts-per-million (PPM), or micrograms/cubic-meter (UG/M3). Units specified on the BACKUNIT keyword are applied to HOURLY and temporally-varying background values if both are included in the same model run. If the BACKUNIT keyword is omitted, default units of PPB are assumed for background NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants. Background concentrations specified in units of PPB or PPM are converted to UG/M3 based on reference temperature (25 C) and pressure (1013.25 mb).

3.3.9 Specifying building downwash information

As noted above, the AERMOD model include algorithms to model the effects of buildings downwash on emissions from nearby or adjacent point sources. The building downwash algorithms do not apply to volume or area sources. For a technical description of the building downwash algorithms in AERMOD, the user is referred to Schulman, et. al. (2000). The AERMOD model uses direction-specific information for all building downwash cases.

There are five keywords that are used to specify building downwash information: BUILDHGT, BUILDWID, BUILDLEN, XBADJ, YBADJ. The syntax, type and order for the BUILDHGT keyword, used to input direction specific building heights, are summarized below:

Syntax:	SO BUILDHGT Srcid (or Srcrng) Dsbh(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of specifying a range of sources (the Srcrng parameter) for which the building heights apply, instead of identifying a single source. This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10.

Since the model reads the source range as a single input field there must not be any spaces between the source IDs. The model then places the building heights that follow (the Dsbh(i) parameter) into the appropriate arrays for all Srcid's that fall within that range, including STACK1 and STACK10.

When comparing a source ID to the range limits for a Srcrng parameter, the model separates the source IDs into three parts: an initial alphabetical part, a numerical part, and then the remainder of the string. Each part is then compared to the corresponding parts of the source range, and all three parts must satisfy the respective ranges in order for the source ID to be included. If there is no numeric part, then the ID consists of only one alphabetical part. If the ID begins with a numeric character, then the initial alphabetical part defaults to a single blank. If there is no trailing alphabetical part, then the third part also defaults to a single blank part. If the trailing part consists of more than one alphabetical or numeric field, it is all lumped into one character field. For example, the source ID 'STACK2' consists of the parts 'STACK' plus '2' plus a single trailing blank, ' '. By comparing the separate parts of the source IDs, it can be seen that STACK2 falls between the range 'STACK1-STACK10.' For a three-part example, it can also be seen that VENT1B falls within the range of VENT1A-VENT1C. However, VENT2 does not fall within the range of VENT1A to VENT3B, since the third part of VENT2 is a single blank, which does not fall within the range of A to C. This is because a blank character will precede a normal alphabetical character. Normally, the source ranges will work as one would intuitively expect for simple source names. Most importantly, for names that are made up entirely of numeric characters, the source ranges will be based simply on the relative numerical values. The user is strongly encouraged to check the summary of model inputs to ensure that the source ranges were interpreted as expected, and also to avoid using complex source names in ranges, such as AA1B2C-AB3A3C. Since the order of keywords within the SO pathway is quite flexible, it is also important to note that the building heights will only be applied to those sources that have been defined previously in the input file.

Following the Srcid or the Srcrng parameter, the user inputs 36 direction-specific building heights (Dsbh parameter) in meters, beginning with the 10 degree flow vector (wind blowing toward 10 degrees from north), and incrementing by 10 degrees in a clockwise direction. Some examples of building height inputs are presented below:

```
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.

SO BUILDHGT STACK1 36*34.0

SO BUILDHGT STACK1-STACK10 33*34.0 3*0.0

SO BUILDHGT STACK1 35.43  36.45  36.37  35.18  32.92  29.66  25.50  20.56
SO BUILDHGT STACK1 15.00  20.56  25.50  29.66  32.92  35.18  36.37  36.45
SO BUILDHGT STACK1 35.43  33.33  35.43  36.45   0.00  35.18  32.92  29.66
SO BUILDHGT STACK1 25.50  20.56  15.00  20.56  25.50  29.66  32.92  35.18
SO BUILDHGT STACK1 36.37  36.45  35.43  33.33
```

The first example illustrates the use of repeat cards if more than one card is needed to input all of the values. The values are processed in the order in which they appear in the input file, and are identified as being repeat cards by repeating the Srcid parameter. The first and second examples produce identical results within the model. The second one illustrates the use of a repeat value that can simplify numerical input in some cases. The field "36*34.0" is interpreted by the model as "repeat the value 34.0 a total of 36 times." This is also used in the third example where the building height is constant for directions of 10 degrees through 330 degrees, and then is set to 0.0 (e.g. the stack may be outside the region of downwash influence) for directions 340 through 360. The third example also uses a source range rather than a single source ID. The last example illustrates building heights which vary by direction, and shows that the number of values on each card need not be the same. For improved readability of the input file, the user may want to put the numerical inputs into "columns," but there are no special rules regarding the spacing of the parameters on this keyword.

The BUILDWID keyword is used to input direction-specific building widths for downwash analyses. The syntax for this keyword, which is very similar to the BUILDHGT keyword, is summarized below, along with the type and order information:

Syntax:	SO BUILDWID Srcid (or Srcrng) Dsbw(i),i=1,36	(16 for LT)
Type:	Optional, Repeatable	
Order:	Must follow the LOCATION card for each source input	

For a description of the Srcid and Srcrng parameters, and for a discussion and examples of the

numeric input options, refer to the BUILDHGT keyword above. The Dsbw(i) parameter contains the 36 direction-specific building widths. The directions proceed in a clockwise direction, beginning with the 10 degree flow vector.

The BUILDLEN keyword is used to input direction-specific along-flow building lengths for downwash analyses. Figure 3-2 shows the relationship of the projected building to this dimension. The syntax for this keyword, which is very similar to the BUILDHGT keyword, is summarized below, along with the type and order information:

Syntax:	SO BUILDLEN Srcid (or Srcrng) Dsbl(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, and for a discussion and examples of the numeric input options, refer to the BUILDHGT keyword above. The Dsbl(i) parameter contains the 36 direction-specific building lengths. The directions proceed in a clockwise direction, beginning with the 10 degree flow vector. Figure 3-2 shows the relationship of the projected building to these distances.

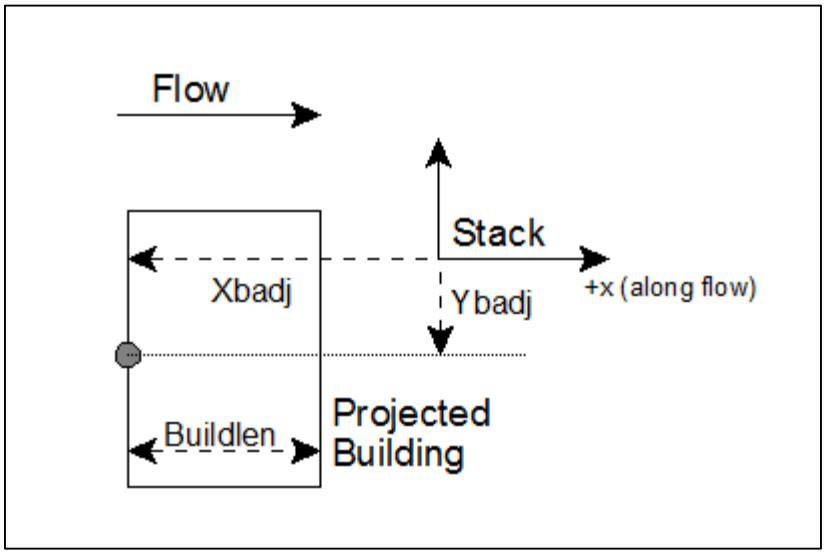


Figure 3-2. Schematic Diagram Identifying New Building Data for Prime Downwash

The XBADJ and YBADJ keywords are used to input direction-specific along-flow and

across-flow distances from the stack to the center of the upwind face of the projected building, respectively. Figure 3-2 shows the relationship of the projected building to these distances. The syntax for these keywords, which is very similar to the BUILDHGT keyword, are summarized below, along with the type and order information:

Syntax:	SO XBADJ Srcid (or Srcrng) Xbadj(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

Syntax:	SO YBADJ Srcid (or Srcrng) Ybadj(i),i=1,36
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, refer to the BUILDHGT keyword above. The Xbadj(i) parameter contains the 36 direction-specific along-flow distances from the stack to the center of the upwind face and the Ybadj(i) parameter contains the 36 direction-specific across-flow distances from the stack to the center of the upwind face. The directions proceed in a clockwise direction, beginning with the 10 degree flow vector.

3.3.10 Specifying urban sources

As discussed in Section 3.2.7, the AERMOD model allows the user to incorporate the effects of increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions. The user specifies the parameters for one or more urban areas on the CO URBANOPT card (see Section 3.2.7), and identifies which sources are to be modeled with urban effects and the urban area that will apply to each source affected using the SO URBANSRC card. If a source is not included on the URBANSRC card, it will be modeled without the urban effects. The syntax, type and order for the URBANSRC keyword are summarized below:

Syntax:	**For Multiple Urban Areas:** SO URBANSRC UrbanID SrcID's and/or SrcRng's **For Single Urban Areas:** SO URBANSRC SrcID's and/or SrcRng's or SO URBANSRC ALL (to specify all sources as URBAN)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the UrbanID parameter is the alphanumeric urban ID (up to eight characters) defined by the user on the CO URBANOPT keyword when multiple urban areas are defined, and the SrcID's and SrcRng's are the individual source IDs and/or source ID ranges that are to be modeled with urban effects. Source ranges are described in more detail in Section 3.3.9. As with the URBANOPT keyword, the syntax of the URBANSRC keyword for applications with single urban areas has not changed from the previous version of AERMOD, so that existing input files will not require modification. However, beginning with version 12060, users can specify that all sources are to be treated as urban sources by specifying 'ALL' on the SO URBANSRC keyword for applications with a single urban area. Since the URBANSRC ALL option is identified during the pre-SETUP phase, there are no restrictions on the order of the URBANSRC ALL keyword within the SO pathway.

3.3.11 Specifying variable emission factors (EMISFACT)

The AERMOD model provides the option of specifying variable emission rate factors for individual sources or for groups of sources. The syntax, type and order of the EMISFACT keyword are summarized below:

Syntax:	SO EMISFACT SrcID or SrcRange Qflag Qfact(i), i=1,n
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the SrcID parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of using the SrcRange parameter for specifying a range of sources for which the emission rate factors apply, instead of identifying a single source.

This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. The use of the SrcRange parameter is explained in more detail in the description of the BUILDHGT keyword (see Section 3.3.9).

The parameter Qflag is the variable emission rate flag, and must be specified as one of the following secondary keywords (the number in parentheses indicates the number of values required for each option):

SEASON -	emission rates vary seasonally (n=4),
MONTH -	emission rates vary monthly (n=12),
HROFDY -	emission rates vary by hour-of-day (n=24),
WSPEED -	emission rates vary by wind speed (n=6),
SEASHR -	emission rates vary by season and hour-of-day (n=96),
HRDOW -	emission rates vary by hour-of-day, and day-of-week [M-F, Sat, Sun] (n=72),
HRDOW7 -	emission rates vary by hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=168),
SHRDOW -	emission rates vary by season, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=288),
SHRDOW7 -	emission rates vary by season, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=672),
MHRDOW -	emission rates vary by month, hour-of-day, and day-of-week [M-F, Sat, Sun] (n=864), and
MHRDOW7 -	emission rates vary by month, hour-of-day, and the seven days of the week [M, Tu, W, Th, F, Sat, Sun] (n=2,016).

The Qfact array is the array of factors, where the number of factors is shown above for each Qflag option. The seasons are defined in the following order: Winter (Dec., Jan., Feb.), Spring (Mar., Apr., May), Summer (Jun., Jul., Aug.), and Fall (Sep., Oct., Nov.). The wind speed categories used with the WSPEED option may be defined using the ME WINDCATS keyword. If the WINDCATS keyword is not used, the default wind speed categories are defined by the upper bound of the first five categories as follows (the sixth category is assumed to have no upper bound): 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The EMISFACT card may be repeated as many times as necessary to input all of the factors, and repeat values may be used for the numerical inputs. Examples for the more recent HRDOW and MHRDOW options are presented below, with column

headers to indicate the order in which values are to be to input:

```
SO EMISFACT STK1 HRDOW   enter 24 hourly scalars for each of the “days”, first for Weekdays
                         (Monday-Friday), then for Saturdays, and finally for Sundays, e.g.,
** Weekdays:          Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
** Saturdays:         Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
** Sundays:           Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW      5*0.3  0.5  11*1.0  0.5  6*0.3
```

```
SO EMISFACT STK1 HRDOW7  enter 24 hourly scalars for each of the “days”,
                         first for Mondays, then for Tuesdays, ..., then for Saturdays,
                         and finally for Sundays, e.g.,
** Mondays:            Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7      5*0.3  0.5  11*1.0  0.5  6*0.3
** Tuesdays:           Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7      5*0.3  0.5  11*1.0  0.5  6*0.3
       .
       .
       .
** Saturdays:          Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7      5*0.3  0.5  11*1.0  0.5  6*0.3
** Sundays:            Hrs:   1-5    6    7-17   18   19-24
SO EMISFACT STK1 HRDOW7      5*0.3  0.5  11*1.0  0.5  6*0.3
```

```
SO EMISFACT STK1 MHRDOW  enter 24 hourly scalars for each of the twelve months, first for Weekdays
                         (Monday-Friday), then for Saturdays, and finally for Sundays, e.g.,
** Weekdays              JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Saturdays:
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Sundays:
SO EMISFACT STK1 MHRDOW 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
```

```
SO EMISFACT STK1 MHRDOW7 enter 24 hourly scalars for each of the twelve months,
                         first for Mondays, then for Tuesdays, ..., then for Saturdays,
                         and finally for Sundays, e.g.,
** Mondays                JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Tuesdays               JAN    FEB    MAR    APR    MAY    JUN  . . .  NOV    DEC
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
       .
       .
       .
** Saturdays:
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
** Sundays:
SO EMISFACT STK1 MHRDOW7 24*1.0 24*0.8 24*0.6 24*0.8 24*1.0 24*0.8      24*0.6 24*0.8
```

3.3.12 Specifying an hourly emission rate file (HOUREMIS)

The source (SO) pathway includes an option for inputting hourly emission rates for the AERMOD model, controlled by the HOUREMIS keyword. AERMOD currently allows for a single hourly emission file to be used with each model run. The syntax, type and order for this keyword are summarized below:

Syntax:	SO HOUREMIS Emifil Srcid's (and/or Srcrng's)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Emifil parameter specifies the filename for the hourly emission file, and Srcid or Srcrng identify the source or sources for which hourly emission rates are included. The Emifil filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. Source ranges, which are described in more detail in Section 3.3.9, are input as two source IDs separated by a dash, e.g., STACK1-STACK10. The user may include more than one HOUREMIS card in a runstream file, if needed to specify additional sources, but there can be only one hourly emissions file, and therefore the filename must be the same on all HOUREMIS cards.

The format of each record of the hourly emissions file includes a pathway and keyword (SO HOUREMIS), followed by the Year, Month, Day, Hour, Source ID, and emission rate (in the appropriate units). For POINT sources, the stack gas exit temperature (K), and stack gas exit velocity (m/s) are also specified. Beginning with version 09292, the release heights and initial dispersion coefficients can also be varied on an hourly basis for AREA, AREAPOLY, AREACIRC, and VOLUME sources using the HOUREMIS option. The user selects this enhanced option by including the additional source parameters in the hourly emissions file. AERMOD determines whether hourly release heights and initial dispersion coefficients are being used based on the first HOUREMIS record for each source, and these additional parameters must be included on all HOUREMIS records unless the emissions are missing, which is indicated by leaving the emission rate and all fields beyond the source ID blank.

When hourly emissions are specified for a buoyant line source, each of the individual lines (BUOYLINE sources) that comprise the the buoyant line source must be represented in the hourly emissions file for every hour, and the buoyancy (m^4/s^3) of each line must be specified after the hourly emission rate. The buoyancy of each line can vary within an hour and from hour to hour. AERMOD computes an average buoyancy of the buoyant line source for each hour using the buoyancy values specified for each individual line that comprises the buoyant line source.

The hourly emissions file is processed using the same routines used to process the runstream input file, therefore each of the parameters must be separated by at least one space, but otherwise the format is flexible. It is also not necessary to include the SO HOUREMIS on each line, as long as the parameters (Year, Month, etc.) do not begin before column 13. The data in the hourly emission file must also include the exact same dates as are included in the meteorological input files, and the source IDs must correspond to the source IDs defined on the SO LOCATION cards and be in the same order as defined in the 'aermod.inp' file.

The model will check for a date mismatch between the hourly emissions file and the meteorological data, and also for a source ID mismatch. However, it is not necessary to process the entire hourly emissions file on each model run, i.e., the correct emissions data will be read if the ME DAYRANGE or the ME STARTEND cards (see Section 3.5.4) are used, as long as all the dates (including those that are processed and those that are skipped) match the meteorological data files.

An example of several lines from an hourly emissions file for two point sources is provided below:

```
SO HOUREMIS 88 8 16 1 STACK1  52.5  382.60  12.27
SO HOUREMIS 88 8 16 1 STACK2  44.3  432.33  22.17
SO HOUREMIS 88 8 16 2 STACK1  22.3  377.88   9.27
SO HOUREMIS 88 8 16 2 STACK2  42.2  437.68  19.67
SO HOUREMIS 88 8 16 3 STACK1  51.5  373.72  11.87
SO HOUREMIS 88 8 16 3 STACK2  41.3  437.28  18.77
SO HOUREMIS 88 8 16 4 STACK1  36.0  374.83   9.63
SO HOUREMIS 88 8 16 4 STACK2  43.7  437.68  18.23
```

The use of hourly varying release heights and initial dispersion coefficients for VOLUME and AREA sources is illustrated in the following example:

```
SO HOUREMIS 88  3  1   1   VOL1  500.0  2.0 2.0 2.0
SO HOUREMIS 88  3  1   1   AREA1 5.000  2.0 2.0
SO HOUREMIS 88  3  1   2   VOL1  500.0  2.0 2.0 3.0
SO HOUREMIS 88  3  1   2   AREA1 5.000  2.0 3.0
SO HOUREMIS 88  3  1   3   VOL1  500.0  2.0 2.0 4.0
SO HOUREMIS 88  3  1   3   AREA1 5.000  2.0 4.0
```

For POINT sources, the model will use the stack release height and stack inside diameter defined on the SO SRCPARAM card, but will use the emission rate, exit temperature and exit velocity from the hourly emission file. As noted above regarding VOLUME and AREA sources, if the emission rate, exit temperature and exit velocity are not included for a particular hour, i.e, any or all of those fields are blank, the model will interpret emissions data for that hour as missing and will set the parameters to zero. Since the emission rate will be zero, there will be no calculations made for that hour and that source.

3.3.13 Adjusting the emission rate units for output

The default emission rate units for the AERMOD model are grams per second for point and volume sources, and grams per second per square meter for area sources. By default, the model converts these input units to output units of micrograms per cubic meter for concentration calculations. This is accomplished by applying a default emission rate unit factor of 1.0E06 for concentration.

The EMISUNIT keyword on the SO pathway allows the user to specify a different unit conversion factor, and to specify the appropriate label for the output units for either concentration calculations. The syntax and type of the EMISUNIT keyword are summarized below:

Syntax:	SO EMISUNIT Emifac Emilbl Conlbl
Type:	Optional, Non-repeatable
Order:	Must follow the LOCATION card for each source input

where the parameter Emifac is the emission rate unit factor, Emilbl is the label for the emission units (up to 40 characters), and Conlbl is the output unit label (up to 40 characters) for concentration calculations. For example, to produce output concentrations in milligrams per cubic meter, assuming input units of grams per sec, the following card could be input:

```
SO EMISUNIT 1.0E3   GRAMS/SEC   MILLIGRAMS/M**3
```

since there are 1.0E3 milligrams per gram. The emission rate unit factor applies to all sources for a given run. Since the model uses one or more spaces to separate different fields on the input

runstream images, it is important that there not be any spaces within the label fields on this card. Thus, instead of entering 'GRAMS PER SECOND' for the emission label, a label of 'GRAMS/SECOND', or 'GRAMS-PER-SECOND' or an equivalent variation should be used.

3.3.14 Including source data from an external file

The user has the option of including source data from an external file by using the INCLUDED keyword on the source (SO) pathway. An SO INCLUDED card may be placed anywhere within the source pathway, after the STARTING card and before the FINISHED card (i.e., the SO STARTING and SO FINISHED cards cannot be included in the external file). The data in the included file will be processed as though it were part of the runstream file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	SO INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 40 characters that identifies the filename for the included file. The contents of the included file must be valid runstream images for the source pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX C). If more than one INCLUDED file is specified for the source pathway, the user will first need to determine which file the error occurred in. If the starting column of the main runstream input file is shifted from column 1 (see Section 2.4.8), then the runstream images in the included file must be offset by the same amount.

3.3.15 Using source groups

The AERMOD model allows the user to group contributions from particular sources together. Several source groups may be setup in a single run, and they may, for example, be used to model impacts from the source being permitted, the group of increment consuming PSD sources,

and the group of all sources for comparison to a NAAQS in a single run. There is always at least one source group in a run, which may consist of all sources, so the SRCGROUP keyword has been made mandatory in the AERMOD model unless the PSDGROUP is specified, which is mandatory when using the PSDCREDIT keyword with the PVMRM NO to NO_2 conversion option (See Section 3.3.7). The SRCGROUP keyword cannot be be used when the PSDGROUP keyword is used. The syntax, type and order of the SRCGROUP keyword are summarized below:

Syntax:	SO SRCGROUP Grpid Srcid's and/or Srcrng's
Type:	Mandatory (conditional), Repeatable
Order:	Must be the last keyword in the SO pathway before FINISHED

where the Grpid parameter is an alphanumeric string of up to eight characters that identifies the group name. The Srcid's and Srcrng's are the individual source IDs and/or source ranges that make up the group of sources. Source ranges, which are described in more detail in the description of the BUILDHGT keyword (Section 3.3.9), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway, keyword and group ID.

A special group ID has been reserved for use in specifying the group of <u>all</u> sources. When Grpid = <u>ALL</u>, the model will automatically setup a source group called <u>ALL</u> that includes all sources modeled for that particular run. If desired, the user can setup a group of all sources with a different group ID by explicitly specifying all sources on the input card(s).

As noted in Section 2.3, the number of source groups is allocated dynamically at the time AERMOD is run. This value, in concert with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

As discussed in Sections 1.2.3.6 and 3.2.12, it is sometimes important for a user to know the contribution of a particular source to the total result for a group. These source contribution analyses are facilitated for short term averages by the use the EVENT processing capabilities in the AERMOD model. EVENT processing uses the same source groups that are identified by

AERMOD (when the input file is generated using the CO EVENTFIL option), but the model is structured in a way that it retains individual source results for particular events. Refer to the sections noted above for a more complete description of EVENT processing and its uses.

With regard to buoyant line sources, note that the SRCGROUP keyword treats the individual lines (BUOYLINE) that comprise a buoyant line source as if they are individual sources. A SRCGROUP can consist of all or a subset of the indivual lines by specifying the source IDs from the LOCATION keyword for those lines that should make up the SRCGROUP.

3.4 Receptor pathway inputs and options

The **RE**ceptor pathway contains keywords that define the receptor information for a particular model run. The RE pathway contains keywords that allow the user to define Cartesian grid receptor networks and/or polar grid receptor networks, with either uniform or non-uniform grid spacing, as well as discrete receptor locations referenced to a Cartesian or a polar system. As noted in Section 2.3, the number of receptors and receptor networks are allocated dynamically at the time AERMOD is run. This value, in combination with the other dynamically allocated arrays and input requirements, is limited only by the amount of available memory.

All of the receptor options in AERMOD allow the user to input terrain elevations and hill height scales for each receptor, both of which are needed when applying AERMOD in an elevated terrain situation. To facilitate the generation of hill height scales for AERMOD, a terrain preprocessor, called AERMAP, has been developed (EPA, 2004c). The AERMAP terrain preprocessor, which can process U.S. Geological Survey (USGS) Digital Elevation Model (DEM) data and data from the National Elevation Dataset (NED), may also be used to generate the terrain elevations for the receptor locations. The AERMAP program generates an output file that contains the receptor pathway data for AERMOD in the format described below. This file may be cut and pasted into the AERMOD runstream file, or included as an external file using the RE INCLUDED card (see Section 3.4.4).

The default units for receptor elevations for the AERMOD model are in meters; however, the user may specify receptor elevations to be in units of feet by adding the RE ELEVUNIT FEET

card immediately after the RE STARTING card. Since the AERMAP terrain preprocessor outputs elevations in meters and includes the RE ELEVUNIT METERS card as the first record, the AERMAP data must be placed at the beginning of the receptor pathway.

3.4.1 Defining networks of gridded receptors

Two types of receptor networks are allowed by the AERMOD model. A Cartesian grid network, defined through the GRIDCART keyword, includes an array of points identified by their x (east-west) and y (north-south) coordinates. A polar network, defined by the GRIDPOLR keyword, is an array of points identified by direction and distance from a user-defined origin. Each of these keywords has a series of secondary keywords associated with it that are used to define the network, including any receptor elevations for elevated terrain and flagpole receptor heights. The GRIDCART and GRIDPOLR keywords can be thought of as "sub-pathways," since their secondary keywords include a STArt and an END card to define the start and end of inputs for a particular network.

3.4.1.1 Cartesian grid receptor networks

Cartesian grid receptor networks are defined by use of the GRIDCART keyword. The GRIDCART keyword may be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDCART keyword are summarized below:

Syntax:	RE GRIDCART Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta XPNTS Gridx1 Gridx2 Gridx3 .... Gridxn, and or YPNTS Gridy1 Gridy2 Gridy3 .... Gridyn ELEV Row Zelev1 Zelev2 Zelev3 ... Zelevn HILL Row Zhill1 Zhill2 Zhill3 ... Zhilln FLAG Row Zflag1 Zflag2 Zflag3 ... Zflagn END
Type:	Optional, Repeatable

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates the STArt of GRIDCART inputs for a particular network, repeated for each new Netid
XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta	Keyword identifying uniform grid network generated from x and y increments Starting x-axis grid location in meters Number of x-axis receptors Spacing in meters between x-axis receptors Starting y-axis grid location in meters Number of y-axis receptors Spacing in meters between y-axis receptors
XPNTS Gridx1 Gridxn	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with YPNTS) Value of first x-coordinate for Cartesian grid (m) Value of 'nth' x-coordinate for Cartesian grid (m)
YPNTS Gridy1 Gridyn	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with XPNTS) Value of first y-coordinate for Cartesian grid (m) Value of 'nth' y-coordinate for Cartesian grid (m)
ELEV Row Zelev	Keyword to specify that receptor elevations follow (optional) Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row) An Array of receptor terrain elevations (m) for a particular Row (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per row equals the number of x-coordinates for that network
HILL Row Zelev	Keyword to specify that hill height scales follow (optional) Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row) An Array of hill height scales (m) for a particular Row (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per row equals the number of x-coordinates for that network
FLAG Row Zflag	Keyword to specify that flagpole receptor heights follow (optional) Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row) An array of receptor heights (m) above local terrain elevation for a particular Row (flagpole receptors), number of entries per row equals the number of x-coordinates for that network
END	Indicates the END of GRIDCART inputs for a particular network, repeated for each new Netid

The ELEV, HILL, and FLAG keywords are optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If elevated terrain is being used, then both the

ELEV and HILL inputs are needed for each receptor. If the ELEV and HILL keywords are used and the model is being run with the flat terrain option (see Section 3.2.2), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

The order of cards within the GRIDCART subpathway is not important, as long as all inputs for a particular network are contiguous and start with the STA secondary keyword and end with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each runstream image (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords. Thus, the following two examples produce the same 8 X 4 Cartesian grid network:

```
RE GRIDCART CAR1 STA
RE GRIDCART CAR1 XPNTS  -500.  -400.  -200.  -100. 100.  200.  400.  500.
RE GRIDCART CAR1 YPNTS  -500.  -250.  250.  500.
RE GRIDCART CAR1 ELEV 1  10.  10.  10.  10.  10.  10.  10.  10.
RE GRIDCART CAR1 ELEV 2  20.  20.  20.  20.  20.  20.  20.  20.
RE GRIDCART CAR1 ELEV 3  30.  30.  30.  30.  30.  30.  30.  30.
RE GRIDCART CAR1 ELEV 4  40.  40.  40.  40.  40.  40.  40.  40.
RE GRIDCART CAR1 HILL 1  50.  50.  50.  50.  50.  50.  50.  50.
RE GRIDCART CAR1 HILL 2  60.  60.  60.  60.  60.  60.  60.  60.
RE GRIDCART CAR1 HILL 3  70.  70.  70.  70.  70.  70.  70.  70.
RE GRIDCART CAR1 HILL 4  80.  80.  80.  80.  80.  80.  80.  80.
RE GRIDCART CAR1 FLAG 1  10.  10.  10.  10.  10.  10.  10.  10.
RE GRIDCART CAR1 FLAG 2  20.  20.  20.  20.  20.  20.  20.  20.
RE GRIDCART CAR1 FLAG 3  30.  30.  30.  30.  30.  30.  30.  30.
RE GRIDCART CAR1 FLAG 4  40.  40.  40.  40.  40.  40.  40.  40.
RE GRIDCART CAR1 END
```

```
RE GRIDCART CAR1 STA
                 XPNTS -500. -400. -200. -100. 100. 200. 400. 500.
                 YPNTS -500. -250. 250. 500.
                 ELEV 1 8*10.
                 HILL 1 8*50.
                 FLAG 1 8*10.
                 ELEV 2 8*20.
                 HILL 2 8*60.
                 FLAG 2 8*20.
                 ELEV 3 8*30.
                 HILL 3 8*70.
                 FLAG 3 8*30.
                 ELEV 4 8*40.
                 HILL 4 8*80.
                 FLAG 4 8*40.
RE GRIDCART CAR1 END
```

The Row parameter on the ELEV, HILL, and FLAG inputs may be entered as either the row

number, i.e., 1, 2, etc., or as the actual y-coordinate value, e.g., -500., -250., etc. in the example above. The model sorts the inputs using Row as the index, so the result is the same. The above example could therefore be entered as follows, with the same result:

```
RE GRIDCART CAR1 STA
                 XPNTS  -500.  -400.  -200.  -100.  100.  200.  400.  500.
                 YPNTS  -500.  -250.  250.  500.
                 ELEV   -500.  8*10.
                 FLAG   -500.  8*10.
                 ELEV   -250.  8*20.
                 FLAG   -250.  8*20.
                 ELEV    250.  8*30.
                 FLAG    250.  8*30.
                 ELEV    500.  8*40.
                 FLAG    500.  8*40.
RE GRIDCART CAR1 END
```

Of course, one must use either the row number or y-coordinate value consistently within each network to have the desired result.

The following simple example illustrates the use of the XYINC secondary keyword to generate a uniformly spaced Cartesian grid network. The resulting grid is 11 x 11, with a uniform spacing of 1 kilometer (1000. meters), and is centered on the origin (0., 0.). No elevated terrain heights or flagpole receptor heights are included in this example.

```
RE GRIDCART CG1 STA
                XYINC  -5000.  11  1000.  -5000.  11  1000.
RE GRIDCART CG1 END
```

3.4.1.2 Polar grid receptor networks

Polar receptor networks are defined by use of the GRIDPOLR keyword. The GRIDPOLR keyword may also be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDPOLR keyword are summarized below:

Syntax:	RE GRIDPOLR Netid STA ORIG Xinit Yinit, or ORIG Srcid DIST Ring1 Ring2 Ring3 ... Ringn DDIR Dir1 Dir2 Dir3 ... Dirn, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... Zelevn HILL Dir Zhill1 Zhill2 Zhill3 ... Zhilln FLAG Dir Zflag1 Zflag2 Zflag3 ... Zflagn END
Type:	Optional, Repeatable

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates STArt of GRIDPOLR inputs for a particular network, repeat for each new Netid
ORIG Xinit Yinit Srcid	Keyword to specify the origin of the polar network (optional) x-coordinate for origin of polar network y-coordinate for origin of polar network Source ID of source used as origin of polar network
DIST Ring1 Ringn	Keyword to specify distances for the polar network Distance to the first ring of polar coordinates Distance to the 'nth' ring of polar coordinates
DDIR Dir1 Dirn	Keyword to specify discrete direction radials for the polar network First direction radial in degrees (1 to 360) The 'nth' direction radial in degrees (1 to 360)
GDIR Dirnum Dirini Dirinc	Keyword to specify generated direction radials for the polar network Number of directions used to define the polar system Starting direction of the polar system Increment (in degrees) for defining directions
ELEV Dir Zelev	Keyword to specify that receptor elevations follow (optional) Indicates which direction is being input An array of receptor terrain elevations for a particular direction radial (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per radial equals the number of distances for that network

HILL Dir Zelev	Keyword to specify that hill height scales follow (optional) Indicates which direction is being input An array of receptor hill height scales for a particular direction radial (default units of meters may be changed to feet by use of RE ELEVUNIT keyword), number of entries per radial equals the number of distances for that network
FLAG Dir Zflag	Keyword to specify that flagpole receptor heights follow (optional) Indicates which direction is being input An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors)
END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid

The ORIG secondary keyword is optional for the GRIDPOLR inputs. If omitted, the model assumes a default origin of (0.,0.) in x,y coordinates. The ELEV, HILL, and FLAG keywords are also optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If elevated terrain is being used, then both the ELEV and HILL inputs are needed for each receptor. If the ELEV and HILL keywords are used and the model is being run with the flat terrain option (see Section 3.2.2), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

As with the GRIDCART keyword described above, the order of cards within the GRIDPOLR subpathway is not important, as long as all inputs for a particular network are contiguous and start with the STA secondary keyword and end with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each runstream image (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords.

The following example of the GRIDPOLR keyword generates a receptor network consisting of 180 receptor points on five concentric distance rings centered on an assumed default origin of (0.,0.). The receptor locations are placed along 36 direction radials, beginning with 10. degrees and incrementing by 10. degrees in a clockwise fashion.

```
RE GRIDPOLR POL1 STA
                 DIST  100.  300.  500.  1000.  2000.
                 GDIR  36  10.  10.
RE GRIDPOLR POL1 END
```

Another example is provided illustrating the use of a non-zero origin, discrete direction radials and the specification of elevated terrain and flagpole receptor heights:

```
RE GRIDPOLR POL1 STA
                 ORIG  500.  500.
                 DIST  100.  300.  500.  1000.  2000.
                 DDIR   90.  180.  270.  360.
                 ELEV   90.  5. 10. 15. 20. 25.
                 ELEV  180.  5. 10. 15. 20. 25.
                 ELEV  270.  5. 10. 15. 20. 25.
                 ELEV  360.  5. 10. 15. 20. 25.
                 HILL   90. 50. 60. 75. 80. 95.
                 HILL  180. 50. 60. 75. 80. 95.
                 HILL  270. 50. 60. 75. 80. 95.
                 HILL  360. 50. 60. 75. 80. 95.
                 FLAG   90.  5. 10. 15. 20. 25.
                 FLAG  180.  5. 10. 15. 20. 25.
                 FLAG  270.  5. 10. 15. 20. 25.
                 FLAG  360.  5. 10. 15. 20. 25.
RE GRIDPOLR POL1 END
```

The user has the option of specifying the radial number (e.g. 1, 2, 3, etc.) on the ELEV, HILL, and FLAG inputs, or the actual direction associated with each radial.

For purposes of model calculations, all receptor locations, including those specified as polar, are stored in the model arrays as x, y and z coordinates and flagpole heights. For the purposes of reporting the results by receptor in the main print file, the tables are labeled with the polar inputs, i.e., directions and distances.

3.4.2 Using multiple receptor networks

For some modeling applications, the user may need a fairly coarsely spaced network covering a large area to identify the area of significant impacts for a plant, and a denser network covering a smaller area to identify the maximum impacts. To accommodate this modeling need, the AERMOD model allows the user to specify multiple receptor networks in a single model run. The user can define either Cartesian grid networks or polar networks, or both. With the use of the ORIG option in the GRIDPOLR keyword, the user can easily place a receptor network centered on the facility being permitted, and also place a network centered on another background source known to be a significant contributor to high concentrations. Alternatively, the polar network may be

centered on a receptor location of special concern, such as a nearby Class I area.

As noted in the introduction to this section (3.4), the model dynamically allocates array storage based on the number of receptors and receptor networks when the AERMOD model is run, up to the maximum amount of memory available on the computer.

3.4.3 Specifying discrete receptor locations

In addition to the receptor networks defined by the GRIDCART and GRIDPOLR keywords described above, the user may also specify discrete receptor points for modeling impacts at specific locations of interest. This may be used to model critical receptors, such as the locations of schools or houses, nearby Class I areas, or locations identified as having high concentrations by previous modeling analyses. The discrete receptors may be input as either Cartesian x,y points (DISCCART keyword) or as polar distance and direction coordinates (DISCPOLR keyword). Both types of receptors may be identified in a single run. In addition, for discrete polar receptor points the user specifies the source whose location is used as the origin for the receptor.

3.4.3.1 Discrete Cartesian receptors.

Discrete Cartesian receptors are defined by use of the DISCCART keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCCART Xcoord Ycoord (Zelev Zhill) (Zflag)
Type:	Optional, Repeatable

where the Xcoord and Ycoord parameters are the x-coordinate and y-coordinate (m), respectively, for the receptor location. The Zelev parameter is an optional terrain elevation (m) and Zhill is a corresponding hill height scale for the receptor for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain algorithms, and are referenced to the same reference elevation (e.g., mean sea level) used for source elevations. The Zflag parameter is the optional receptor height above ground (m) for modeling flagpole receptors. All of the parameters are in units of meters, except for Zelev and Zhill, which default to meters but may be specified in feet by use of the RE ELEVUNIT keyword.

If neither the elevated terrain option (Section 3.2.2) nor the flagpole receptor height option (Section 3.2.10) are used, then the optional parameters are ignored if present. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.10). Note: If both the elevated terrain and flagpole receptor height options are used, then the third parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.3.2 Discrete polar receptors

Discrete polar receptors are defined by use of the DISCPOLR keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCPOLR Srcid Dist Direct (Zelev Zhill) (Zflag)
Type:	Optional, Repeatable

where the Srcid is the alphanumeric source identification for one of the sources defined on the SO pathway which will be used to define the origin for the polar receptor location. The Dist and Direct parameters are the distance in meters and direction in degrees for the discrete receptor location. Degrees are measured clockwise from north. The Zelev parameter is an optional terrain elevation for the receptor and Zhill is the corresponding hill top elevation (m) for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain algorithms, and are referenced to the same reference elevation (e.g., mean sea level) used for source elevations. The units of Zelev and Zhill are in meters, unless specified as feet by the RE ELEVUNIT keyword. The Zflag parameter is the optional receptor height above ground (meters) for modeling flagpole receptors.

If neither the elevated terrain option (Section 3.2.2) nor the flagpole receptor height option

(Section 3.2.10) are used, then the optional parameters are ignored if present. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.10). Note: If both the elevated terrain and flagpole receptor height options are used, then fourth parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.3.3 Discrete Cartesian receptors for evalfile output

The EVALCART keyword is used to define discrete Cartesian receptor locations, similar to the DISCCART keyword, but it also allows for grouping of receptors, e.g., along arcs. It is designed to be used with the EVALFILE option, described later for the output pathway, which outputs arc maxima values to a separate file for evaluation purposes. The EVALCART keyword can be used without the use of the EVALFILE option, in which case the receptor groupings are ignored. The syntax and type for the modified EVALCART keyword are summarized below:

Syntax:	RE EVALCART Xcoord Ycoord Zelev Zhill Zflag Arcid (Name)
Type:	Optional, Repeatable

where the Xcoord and Ycoord parameters are the x-coordinate and y-coordinate (m), respectively, for the receptor location. The Zelev parameter is the terrain elevation (m) for the receptor and Zhill is the corresponding hill top elevation (m) for use in elevated terrain modeling. Both the Zelev and Zhill parameters must be specified for use with the elevated terrain algorithms, and are referenced to the same reference elevation (e.g., mean sea level) used for source elevations. The Zflag parameter is the receptor height above ground (m) for modeling flagpole receptors. All of the parameters are in units of meters, except for Zelev and Zhill, which default to meters but may be specified in feet by use of the RE ELEVUNIT keyword. The Arcid parameter is the receptor grouping identification, which may be up to eight characters long, and may be used to group

receptors by arc. The Name parameter is an optional name field that may be included to further identify a particular receptor location. The Name parameter is ignored by the model. Unlike the DISCCART keyword, all of the parameters (except for the Name) must be present on each card with the EVALCART keyword. The terrain height and flagpole height inputs are ignored if the appropriate options are not specified on the CO TERRHGHT and CO FLAGPOLE cards.

3.4.4 Including receptor data from an external file

The user has the option of including receptor data from an external file by using the INCLUDED keyword on the receptor pathway. An RE INCLUDED card may be placed anywhere within the source pathway, after the STARTING card and before the FINISHED card (i.e., the RE STARTING and RE FINISHED cards cannot be included in the external file). The data in the included file will be processed as though it were part of the runstream file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	RE INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 40 characters that identifies the filename for the included file. The contents of the included file must be valid runstream images for the receptor pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX C). If more than one INCLUDED file is specified for the receptor pathway, the user will first need to determine which file the error occurred in. If the starting column of the main runstream input file is shifted from column 1 (see Section 2.4.8), then the runstream images in the included file must be offset by the same amount. The INCLUDED option allows the user to include receptor data that have been generated by the AERMOD Terrain Preprocessor, AERMAP, in the runstream file without having to cut and paste the AERMAP output file. Since AERMAP generates terrain elevations in meters and includes the RE ELEVUNIT METERS card as the first record, an AERMAP file must be INCLUDED at the beginning of the receptor pathway, immediately following the RE STARTING card. If more than one AERMAP output file is INCLUDED on the receptor pathway, the RE ELEVUNIT METERS card must be deleted from all but the first one.

3.5 Meteorology pathway inputs and options

The **ME**teorology pathway contains keywords that define the input meteorological data for a particular model run.

3.5.1 Specifying the input data files and formats

The AERMOD model uses hourly meteorological data from separate surface and profile data files as one of the basic model inputs. These input meteorological data filenames for AERMOD are identified by the SURFFILE and PROFFILE keywords on the ME pathway. The syntax and type of these keywords are summarized below:

Syntax:	ME SURFFILE Sfcfil (Format) ME PROFFILE Profil (Format)
Type:	Optional, Repeatable

where the Srcfil and Profil parameters are character fields of up to 40 characters that identify the filenames for the input meteorological data files. For running the model on an IBM-compatible PC, the filename parameters may include the complete DOS pathname for the file, or will assume the current directory if only the filename is given. The optional Format parameter specifies the format of the meteorological data files. The default formats for the surface and profile data files corresponds with the format of the files generated by the AERMET meteorological preprocessor program. The user also has the option of specifying the Fortran read format for each of these files. The contents of the meteorological data files are described below, and the file formats are documented in APPENDIX D.

The surface meteorological data file consists of a header record containing information on the meteorological station locations, and one record for each hour of data. These data are delimited by at least one space between each element, i.e., the data may be read as free format. The contents of the surface file are as follows:

- Year
- Month (1 – 12)
- Day of Month (1 – 31)
- Julian Day (Day of Year) (1 – 366)

- Hour of Day (1 – 24)
- Heat Flux (W/m2)
- Surface Friction Velocity, u* (m/s)
- Convective Velocity Scale, w* (m/s)
- Lapse Rate above Mixing Height (K/m)
- Convective Mixing Height (m)
- Mechanical Mixing Height (m)
- Monin-Obukhov Length, L (m)
- Surface Roughness Length, zo (m)
- Bowen Ratio
- Albedo
- Reference Wind Speed (m/s)
- Reference Wind Direction (degrees)
- Reference Height for Wind (m)
- Ambient Temperature (K)
- Reference Height for Temperature (m)
- Precipitation Code (0-45)
- Precipitation Amount (mm)
- Relative Humidity (%)
- Surface Pressure (mb)
- Cloud Cover (tenths)
- Wind Speed Adjustment and Data Source Flag

The sensible heat flux, Bowen ratio and albedo are not used by the AERMOD model, but are passed through by AERMET for information purposes only.

The profile meteorological data file consists of one or more records for each hour of data. As with the surface data file, the data are delimited by at least one space between each element and may be read as Fortran free format. The contents of the profile meteorological data file are as follows:

- Year
- Month (1 – 12)
- Day (1 – 31)
- Hour (1 – 24)
- Measurement height (m)
- Top flag = 1, if this is the last (highest) level for this hour,
  0, otherwise
- Wind direction for the current level (degrees)
- Wind speed for the current level (m/s)

- Temperature at the current level (K)
- Standard deviation of the wind direction, σ_2 (degrees)
- Standard deviation of the vertical wind speed, σ_w (m/s)

The data in this file include the on-site meteorological data that are processed by AERMET. Since AERMET was designed to be able to perform dispersion parameter calculations with NWS data only, i.e., no on-site data, the profile data may consist of a one-level "profile" based on the NWS winds and temperature.

3.5.2 Specifying station information

Three keywords are used to specify information about the meteorological stations, SURFDATA for the surface meteorological station, UAIRDATA for the upper air station, and the optional SITEDATA for any on-site meteorological data that may be used. The syntax and type of these keywords are summarized below:

Syntax:	ME SURFDATA	Stanum Year	(Name) (Xcoord) (Ycoord)	
Syntax:	ME UAIRDATA	Stanum Year	(Name) (Xcoord) (Ycoord)	
Syntax:	ME SITEDATA Stanum	Year	(Name) (Xcoord) (Ycoord)	
Type:	Mandatory, Non-repeatable for SURFDATA and UAIRDATA Optional, Non-repeatable for SITEDATA			

where Stanum is the station number, e.g. the 5-digit WBAN number for NWS stations, Year is the year of data being processed (either 2 or 4 digits), Name is an optional character field (up to 40 characters with no blanks) specifying the name of the station, and Xcoord and Ycoord are optional parameters for specifying the x and y coordinates for the location of the stations. At the present time, the station locations are not utilized in the model. Therefore, no units are specified for Xcoord and Ycoord at this time, although meters are suggested in order to be consistent with the source and receptor coordinates. The AERMOD model compares the station numbers input using these keywords with the numbers included in the header record of the surface meteorological data file, and issues non-fatal warning messages if there are any mismatches.

3.5.3 Specifying the base elevation for potential temperature profile

The AERMOD model generates a gridded vertical profile of potential temperatures for use

in the plume rise calculations. Since potential temperature is dependent on the elevation above mean sea level (MSL), the user must define the base elevation for the profile with the PROFBASE keyword. The syntax and type for the PROFBASE keyword are summarized below:

Syntax:	ME PROFBASE BaseElev (Units)
Type:	Mandatory, Non-repeatable

where the BaseElev parameter specifies the base elevation above MSL for the potential temperature profile, and the optional Units parameter specifies the units of BaseElev. Valid inputs of Units are the secondary keywords METERS or FEET. The default units for BaseElev are in meters if Units is left blank. The base elevation should correspond with the base elevation of the primary meteorological tower.

3.5.4 Specifying a data period to process

There are two keywords that allow the user to specify particular days or ranges of days to process from the sequential meteorological file input for the AERMOD model. The STARTEND keyword controls which period within the meteorological data file is read by the model, while the DAYRANGE keyword controls which days or ranges of days (of those that are read) for the model to process. The default for the model is to read the entire meteorological data file (up to a full year) and to process all days within that period.

The syntax and type for the STARTEND keyword are summarized below:

Syntax:	ME STARTEND Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)
Type:	Optional, Non-repeatable

where the Strtyr Strtmn Strtdy parameters specify the year, month and day of the first record to be read (e.g., 87 01 31 for January 31, 1987), and the parameters Endyr Endmn Enddy specify the year, month and day of the last record to be read. The Strthr and Endhr are optional parameters that may be used to specify the start and end hours for the data period to be read. If either Strthr or Endhr is to be specified, then both must be specified. Any records in the data file that occur before the start date are ignored, as are any records in the data file that occur after the end date. In fact, once the end

date has been reached, the model does not read any more data from the meteorological file. If Strthr and Endhr are not specified, then processing begins with hour 1 of the start date, and ends with hour 24 of the end date, unless specific days are selected by the DAYRANGE card described below.

Any PERIOD averages calculated by the model will apply only to the period of data actually processed. Therefore, if someone wanted to calculate a six-month average, they could select PERIOD averages on the CO AVERTIME card, and then specify the period as follows:

```
ME STARTEND   87 01 01      87 06 30
```

for the period January 1, 1987 through June 30, 1987.

The syntax and type for the DAYRANGE keyword are summarized below:

Syntax:	ME DAYRANGE Range1 Range2 Range3 ... Rangen
Type:	Optional, Repeatable

where the Range parameters specify particular days or ranges of days to process. The days may be specified as individual days (e.g. 1 2 3 4 5) or as a range of days (e.g. 1-5). The user also has the option of specifying Julian day numbers, from 1 to 365 (366 for leap years), or specifying month and day (e.g., 1/31 for January 31). Any combination of these may also be used. For example the following card will tell the model to process the days from January 1 (Julian day 1) through January 31 (1/31):

```
ME DAYRANGE   1-1/31
```

The DAYRANGE keyword is also repeatable, so that as many cards as needed may be included in the ME pathway.

As with the STARTEND keyword, any PERIOD averages calculated by the model will apply only to the period of data actually processed. If the STARTEND keyword is also used, then only those days selected on the DAYRANGE cards that fall within the period from the start date to the end date will be processed. Thus, if the ME pathway included the following two cards:

```
ME STARTEND  87 02 01   87 12 31
ME DAYRANGE  1-31
```

then no data would be processed, since the days 1 through 31 fall outside the period 2/1 to 12/31.

3.5.5 Correcting wind direction alignment problems

The WDROTATE keyword allows the user to correct the input meteorological data for wind direction alignment problems. All input wind directions or flow vectors are rotated by a user-specified amount. Since the model results at particular receptor locations are often quite sensitive to the transport wind direction, this optional keyword should be used only with extreme caution and with clear justification.

The syntax and type of this keyword are summarized below:

Syntax:	ME WDROTATE Rotang
Type:	Optional, Non-repeatable

where the Rotang parameter specifies the angle in degrees to rotate the input wind direction measurements. The value of Rotang is subtracted from the wind direction measurements. It may be used to correct for known (and documented) calibration errors, or to adjust for the alignment of a valley if the meteorological station is located in a valley with a different alignment than the source location.

3.5.6 Specifying wind speed categories

Variable emission rate factors may be input to the model that vary by wind speed category. The model uses six wind speed categories, and these are defined by the upper bound wind speed for the first five categories (the sixth category is assumed to have no upper bound). The default values for the wind speed categories are as follows: 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The syntax and type of the WINDCATS keyword, which may be used to specify different category boundaries, are summarized below:

Syntax:	ME WINDCATS Ws1 Ws2 Ws3 Ws4 Ws5
Type:	Optional, Non-repeatable

where the Ws1 through Ws5 parameters are the upper bound wind speeds of the first through fifth categories in meters per second. The upper bound values are inclusive, i.e., a wind speed equal to the value of Ws1 will be placed in the first wind speed category.

3.5.7 Specifying SCIM parameters

The SCIM parameters on the SCIMBYHR card specify the starting hour and sampling interval for the regular sample and an optional file name. The syntax and type of the SCIMBYHR keyword are summarized below:

Syntax:	ME SCIMBYHR NRegStart NRegInt NwetStart NwetInt (SfcFilnam PflFilnam)
Type:	Optional, Non-repeatable

where the NRegStart and NRegInt parameters specify the first hour to be sampled and the sampling interval, respectively, when performing the regular sampling. The NWetStart and NWetInt parameters are used to specify the first wet hour (i.e., with non-zero precipitation) and the wet sampling interval for wet sampling. However, since the AERMOD model currently does not include wet deposition algorithms, the wet sampling option is not operational, and the user should enter a value of zero (0) for bot NWetStart and NWetInt. Optionally, the user can create output files containing the surface and profile meteorological data for the sampled hours by specifying the SfcFilnam and PflFilnam parameters. These output files are in the same format used in the summary of the first 24 hours of data included in the main output file.

In order to use the SCIM option, the user must specify the non-DFAULT SCIM option on the CO MODELOPT card. Although the ME SCIMBYHR is an optional card, it is required when using the SCIM option. NRegStart is required to have a value from 1 through 24, i.e., the first sampled hour must be on the first day in the meteorological data file. There are no restrictions for NRegInt; however, NRegInt would generally be greater than 1. For example, NRegInt could be based on the formula (24n+1), where "n" is the number of days to skip between samples, in order to ensure a regular diurnal cycle to the sampled hours (e.g., 25 or 49).

3.5.8 Specify the number of years to process

The NUMYEARS keyword on the ME pathway allows the user to specify the number of years of data being processed for purposes of allocating array storage for the MAXDCONT option (see Section 3.7.2.8), with a default value of five (5) years being assumed if the optional NUMYEARS keyword is omitted. The syntax of the optional NUMYEARS keyword is summarized below:

Syntax:	ME NUMYEARS NumYrs
Type:	Optional, Non-repeatable

where NumYrs specifies the number of (full) years of meteorological data being processed.

3.6 Event pathway inputs and options

EVENT processing is specifically designed to facilitate analysis of source contributions to specific events for short term averages (less than or equal to 24 hours). These events may be design concentrations generated by the AERMOD model, occurrences of violations of an air quality standard, or user-specified events. These events are input to the AERMOD model through the **EV**ent pathway. Each event is defined by an averaging period and specific data period, a source group, and a receptor location. Since the locations are only of interest in combination with particular averaging and data periods, the REceptor pathway is not used with EVENT processing.

There are two keywords that are used to define the events on the EV pathway. The EVENTPER keyword defines the averaging period, data period and source group, while the EVENTLOC keyword defines the receptor location for the event. Each event is also given an alphanumeric name that links the two input cards for that event.

The syntax and type of the EVENTPER and EVENTLOC keywords are summarized below:

Syntax:	EV EVENTPER Evname Aveper Grpid Date
Syntax:	EV EVENTLOC Evname XR= Xr YR= Yr (Zelev) (Zflag) Or Evname RNG= Rng DIR= Dir (Zelev) (Zflag)
Type:	Mandatory, Repeatable

where the parameters are as follows:

Evname - event name (an alphanumeric string of up to 8 characters),
Aveper - averaging period for the event (e.g. 1, 3, 8, 24 hr)
Grpid - source group ID for the event (must be defined on SO pathway),

Date - date for the event, input as an eight digit integer for the ending hour of the data period (YYMMDDHH), e.g. 84030324 defines a data period ending at hour 24 on March 3, 1984. The length of the period corresponds to Aveper.

XR= - X-coordinate (m) for the event location, referenced to a Cartesian coordinate system

YR= - Y-coordinate (m) for the event location, referenced to a Cartesian coordinate system

RNG= - distance range (m) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

DIR= - radial direction (deg.) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

Zelev - optional terrain elevation for the event location (m)

Zflag - optional receptor height above ground (flagpole receptor) for the event location (m)

Each event is defined by the two input cards EVENTPER and EVENTLOC, and these inputs are linked by the event name, which must be unique among the events being processed in a given run. There is no particular requirement for the order of cards on the EV pathway. Note that the location for the event may be specified by either Cartesian coordinates or by polar coordinates, however, the polar coordinates must be relative to an origin of (0,0).

3.6.1 Using events generated by the AERMOD model

The AERMOD model has an option (CO EVENTFIL described in Section 3.2.12) to generate an input file for the AERMOD EVENT processing. When this option is used, the AERMOD model copies relevant inputs from the AERMOD runstream input file to the Event processing input file, and generates the inputs for the EVent pathway from the results of the modeling run. These events are the design concentrations identified by the OU RECTABLE keyword (see Section 3.8.1.1), such as the highest and high-second-high 24-hour averages, etc., and any threshold violations identified by the OU MAXIFILE keyword (see Section 3.8.1.2). The inputs generated by the AERMOD model correspond to the syntax described above for the EVENTPER and EVENTLOC keywords. The locations for events generated by the AERMOD model are always provided as Cartesian coordinates.

To easily identify the events generated by the AERMOD model, and to provide a mechanism for the AERMOD model to manage the events generated from the model run, a naming convention is used for the EVNAME parameter. The following examples illustrate the event names used by the AERMOD model:

H1H01001 - High-first-high 1-hour average for source group number 1

H2H24003 - High-second-high 24-hour average for source group number 3

TH030010 - Threshold violation number 10 for 3-hour averages

TH240019 - Threshold violation number 19 for 24-hour averages

The high value design concentrations are listed first in the EVENT processing input file, followed by the threshold violations (grouped by averaging period). To make it easier for the user to review the EVENT processing input file generated by the AERMOD model, and determine which events are of most concern, the actual concentration value associated with the event is included as the last field on the EVENTPER card. This field is ignored by the AERMOD model, and is included only for informational purposes. The user should be aware that the same event may appear in the AERMOD model input file as both a design value and as a threshold violation, depending on the options selected and the actual results. Since the model processes the events by date sequence and

outputs the results for each event as it is processed, the order of events in the output file will generally not follow the order of events in the input file, unless all of the events were generated by the MAXIFILE option.

3.6.2 Specifying discrete events

The user can specify discrete events by entering the EVENTPER and EVENTLOC cards as described above. The averaging period and source group selected for the event must be among those specified on the CO AVERTIME and SO SRCGROUP cards. If the EVENT processing input file was generated by the AERMOD model, the user may include additional events for those averaging periods and source groups used in the original AERMOD model run. They may also add averaging periods or define new source groups in the Event processing input file in order to define additional events.

3.6.3 Including event data from an external file

The user has the option of including event data from an external file by using the INCLUDED keyword on the source (EV) pathway. An EV INCLUDED card may be placed anywhere within the event pathway, after the STARTING card and before the FINISHED card (i.e., the EV STARTING and EV FINISHED cards cannot be included in the external file). The data in the included file will be processed as though it were part of the runstream file. The syntax and type of the INCLUDED keyword are summarized below:

Syntax:	EV INCLUDED Incfil
Type:	Optional, Repeatable

where the Incfil parameter is a character field of up to 40 characters that identifies the filename for the included file. The contents of the included file must be valid runstream images for the event pathway. If an error is generated during processing of the included file, the error message will report the line number of the included file (see APPENDIX C). If more than one INCLUDED file is specified for the event pathway, the user will first need to determine which file the error occurred in. If the starting column of the main runstream input file is shifted from column 1 (see Section 2.4.8), then the runstream images in the included file must be offset by the same amount.

3.7 Output pathway inputs and options

The **OU**tput pathway contains keywords that define the output options for the model runs. Beginning with version 11059, a number of enhancements have been incorporated in AERMOD to more fully support the form of more recent 1-hour NO_2 and SO_2 standards, as well as the 24-hour PM2.5 standard. The form of these NAAQS are similar in that they are based on a ranked percentile value averaged over the number of years processed.

The options on the **OU**tput pathway have been divided into five categories: 1) options that control different types of tabular output in the main output files of the model; 2) output files for specialized purposes that that can be generated for any pollutant and averaging period; 3) options that are specific to more recent 24-hour PM2.5, 1-hour NO_2, and/or 1-hour SO_2 standards; 4) options related to EVENT processing; and 5) miscellaneous options. The user may select any combination of output option for a particular application.

3.7.1 Selecting options for tabular printed outputs

The three tabular printed output options are controlled by the following keywords:

RECTABLE: Controls output option for high value summary tables by receptor;

MAXTABLE: Controls output option for overall maximum value summary tables; and

DAYTABLE: Controls output option for tables of concurrent values summarized by receptor for each day processed.

The keywords are described in more detail in the order listed above.

The syntax and type for the RECTABLE keyword are summarized below:

Syntax:	OU RECTABLE Aveper FIRST SECOND ... SIXTH ... TENTH and/or 1ST 2ND ... 6TH .... 10TH and/or 1 2 ... 6 ... 10 .... *N* 999
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 1, 3, 8 or 24 hr or MONTH) for

which the receptor table is selected, and the secondary keywords, FIRST, SECOND, etc., indicate which high values are to be summarized by receptor for that averaging period. The RECTABLE card may be repeated for each averaging period. For cases where the user wants the same RECTABLE options for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter.

In order to support the implementation of recent guidance regarding modeling to demonstrate compliance with these NAAQS, the RECTABLE keyword had been modified to allow user-specified ranks of short-term averages (for all pollutants) up to the 999th highest value. The previous version of AERMOD was limited to the 10th-highest value and also restricted the rank for the 24-hour PM2.5 NAAQS to the 8th highest value (corresponding to the 98th percentile of daily values during a year).

The following example will select summaries of the highest, second highest and third highest values by receptor for all averaging periods:

```
OU RECTABLE ALLAVE FIRST  SECOND  THIRD
```

The model will also recognize a range of high values on the RECTABLE input card, and therefore the following card will have the effect:

```
OU RECTABLE ALLAVE FIRST-THIRD
```

The output file will include tables for only the high values selected. Tables for all source groups for a particular averaging period are grouped together, and the averaging periods are output in the order that they appear the CO AVERTIME card. For each averaging period and source group combination, the tables of high values for the receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, and any discrete polar receptors.

If the CO EVENTFIL keyword has been used to generate an input file for EVENT processing, then the design values identified by the RECTABLE options, e.g., the high-second-high 24-hour average, are included in the events that are defined in the EVENT processing input file.

The syntax and type for the MAXTABLE keyword are summarized below:

Syntax:	OU MAXTABLE Aveper Maxnum
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 1, 3, 8 or 24 hr or MONTH) for which the receptor table is selected, and the Maxnum parameter specifies the number of overall maximum values to be summarized for each averaging period. The MAXTABLE card may be repeated for each averaging period. As with the RECTABLE keyword, for cases where the user wants the same MAXTABLE options for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter. The following example will select the maximum 50 table for all averaging periods:

```
OU MAXTABLE   ALLAVE 50
```

A separate maximum overall value table is produced for each source group. The maximum value tables follow the RECTABLE outputs in the main print file. All source group tables for a particular averaging period are grouped together, and the averaging periods are output in the order that they appear on the CO AVERTIME card.

The syntax and type for the DAYTABLE keyword are summarized below:

Syntax:	OU DAYTABLE Avper1 Avper2 Avper3 . . .
Type:	Optional, Non-repeatable

where the Avper*n* parameters are the short term averaging periods (e.g. 1, 3, 8 or 24 hr or MONTH) for which the daily tables are selected. The DAYTABLE card is non-repeatable, but as with the RECTABLE and MAXTABLE keywords, for cases where the user wants daily tables for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the first parameter. The following example will select the daily tables for all averaging periods:

```
OU DAYTABLE    ALLAVE
```

For each averaging period for which the DAYTABLE option is selected, the model will print the concurrent averages for all receptors for each day of data processed. The receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, and any discrete polar receptors. Results for each source group are output. For example, if 1, 3, and 24-hour averages are calculated, and the OU DAYTABLE ALLAVE option is used, then for the first day of data processed, there will be 24 sets of tables of hourly averages (one for each hour in the day), eight sets of 3-hour averages (one for each 3-hour period in the day), and one set of 24-hour averages. The averages are printed as they are calculated by the model, but for hours where more than one averaging period is calculated (e.g., hour 24 is the end of an hourly average, a 3-hour average, and a 24-hour average), the order in which the averages are output will follow the order used on the CO AVERTIME card. Note: This option can produce very large output files, especially when used with a full year of data and very short period averages, such 1-hour and 3-hour. It should therefore be used with CAUTION.

3.7.2 Selecting options for special purpose output files

The AERMOD model provides options for seven types of output files for specialized purposes. These options are controlled by the following keywords that create the output file described:

MAXIFILE -	Occurrences of violations of user-specified threshold value;
POSTFILE -	Concurrent (raw) results at each receptor suitable for post-processing;
PLOTFILE -	Design values that can be imported into graphics software for plotting contours;
TOXXFILE -	Unformatted files of raw results above a threshold value with a special structure for use with the TOXX model component of TOXST;
RANKFILE -	Output values by rank for use in Q-Q (quantile) plots;
EVALFILE -	Output values, including arc-maximum normalized concentrations,

suitable for model evaluation studies;

SEASONHR - Output values by season and hour-of-day;

MAXDCONT - Ranked values for individual source groups to determine source contributions for 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 standards;

MAXDAILY - Daily maximu 1-hour concentrations for a specified source group, for each day in the data period processed, useful for analyzing the 1-hour NO2 and SO2 NAAQS; and

MAXDYBYYR - Summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword.

The keywords are described in more detail in the order listed above.

3.7.2.1 MAXIFILE

The syntax and type for the MAXIFILE keyword are summarized below:

Syntax:	OU MAXIFILE Aveper Grpid Thresh Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, or MONTH for monthly averages) and Grpid is the source group ID for which the MAXIFILE option is selected. The Thresh parameter is the user-specified threshold value, and Filnam is the name of the file where the MAXIFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. By specifying the same filename and unit for more than one MAXIFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.7.2).

The MAXIFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. The resulting maximum value file will

include several header records identifying the averaging period, source group and the threshold value for that file, and a listing of every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration value.

Each of the threshold violations, except for monthly averages, identify events that may be modeled for source contribution information with EVENT processing by selecting the CO EVENTFIL option (see Sections 3.2.12 and 3.8). Each of the threshold violations is included as an event on the EV pathway, and is given a name of the form THxxyyyy, where xx is the averaging period, and yyyy is the violation number for that averaging period. For example, an event name of TH240019 identifies the 19th threshold violation for 24-hour averages. Monthly average threshold violations are included in the file specified on the MAXIFILE card, but are not included in the EVENT processing input file since the AERMOD model currently handles only averaging periods of up to 24 hours.

The following examples illustrate the use of the MAXIFILE option:

```
OU  MAXIFILE   24     ALL    364.0   MAX24ALL.OUT
OU  MAXIFILE   24     PSD     91.0   MAXPSD.OUT    50
OU  MAXIFILE   3      PSD    365.0   MAXPSD.OUT    50
OU  MAXIFILE   3      PLANT   25.0   C:\OUTPUT\MAXI3HR.FIL
OU  MAXIFILE   MONTH  ALL     10.0   MAXMONTH.OUT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The FILNAM parameter may be up to 40 characters in length. It should also be noted that only one MAXIFILE card may be used for each averaging period/source group combination. Note: The MAXIFILE option may produce very large files for runs involving a large number of receptors if a significant percentage of the results exceed the threshold value.

3.7.2.2 POSTFILE

The syntax and type for the POSTFILE keyword are summarized below:

Syntax:	OU POSTFILE Aveper Grpid Format Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, PERIOD for period averages, or ANNUAL for annual averages) and Grpid is the source group ID for which the POSTFILE option is selected. The Format parameter specifies the format of the POSTFILE output, and may either be the secondary keyword UNFORM for unformatted concentration files, or the secondary keyword PLOT to obtain formatted files of receptor locations (x- and y-coordinates) and concentrations suitable for plotting contours of concurrent values. The Filnam parameter is the name of the file where the POSTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. By specifying the same filename and unit for more than one POSTFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2).

The POSTFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. If UNFORM is specified for the Format parameter, then the resulting unformatted file includes a constant-length record for each of the selected averaging periods calculated during the model run. The first variable of each record is an integer variable (4 bytes) containing the ending date (YYMMDDHH) for the averages on that record. The second variable for each record is an integer variable (4 bytes) for the number of hours in the averaging period. The third variable for each record is a character variable of length eight containing the source group ID. The remaining variables of each record contain the calculated average concentration values for all receptors, in the order in which they were defined in the input runstream.

The following examples illustrate the use of the POSTFILE option:

```
OU POSTFILE  24   ALL   UNFORM  PST24ALL.BIN
OU POSTFILE  24   PSD   UNFORM  PST24PSD.BIN
OU POSTFILE  3    PLANT UNFORM  C:\BINOUT\PST3HR.FIL
OU POSTFILE  MONTH ALL  PLOT    PSTMONTH.PLT
OU POSTFILE  PERIOD ALL PLOT    PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The Filnam parameter may be up to 40 characters in length. The use of separate files for each averaging period/source group combination allows the user flexibility to select only those results that are needed for post-processing for a particular run, and also makes the resulting unformatted files manageable. Note: The POSTFILE option can produce very large files, and should be used with some caution. For a file of hourly values for a full year (8760 records) and 400 receptors, the resulting file will use about 14 megabytes of disk space. To estimate the size of the file (in bytes), use the following equation:

$$File\ Size\ (bytes) = \frac{\#\ Hrs/Yr}{\#\ Hrs/Ave} * (\#\ Rec + 4) * 4$$

Divide the result by 1000 to estimate the number of kilobytes (KB) and divide by 1.0E6 to estimate the number of megabytes (MB).

3.7.2.3 PLOTFILE

The syntax and type for the PLOTFILE keyword are summarized below:

Syntax:	OU PLOTFILE Aveper Grpid Hivalu Filnam (Funit), or OU PLOTFILE PERIOD Grpid Filnam (Funit) OU PLOTFILE ANNUAL Grpid Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, PERIOD for period averages, or ANNUAL for annual averages), Grpid is the source group ID for which the PLOTFILE option is selected, and Hivalu specifies which short term high values are to be output (FIRST for the first highest at each receptor,

SECOND for the second highest at each receptor, etc.) Note that the Hivalu parameter is not specified for PERIOD or ANNUAL averages, since there is only one period or annual average for each receptor. The Filnam parameter is the name of the file where the PLOTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. By specifying the same filename and unit for more than one PLOTFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2).

The PLOTFILE card may be repeated for each combination of averaging period, source group, and high value, and a different filename should be used for each file. The resulting formatted file includes several records with header information identifying the averaging period, source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number. The data are written to the file in the order of x-coord, y-coord, concentration so that the file can easily be imported into a graphics package designed to generate contour plots. Many such programs will read the PLOTFILEs directly without any modification, ignoring the header records, and produce the desired plots.

The following examples illustrate the use of the PLOTFILE option:

```
OU  PLOTFILE   24    ALL   FIRST   PLT24ALL.FST
OU  PLOTFILE   24    ALL  SECOND   PLT24ALL.SEC
OU  PLOTFILE   24    PSD     2ND   PLTPSD.OUT  75
OU  LOTFILE     3    PSD     2ND   PLTPSD.OUT  75
OU  PLOTFILE    3    PLANT   1ST   C:\PLOTS\PLT3HR.FIL
OU  PLOTFILE  MONTH  ALL  THIRD    PLTMONTH.OUT
OU  PLOTFILE  PERIOD  ALL          PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. As illustrated by the second and third examples, the high value parameter may also be input as secondary keywords using the standard abbreviations of 1ST, 2ND, 3RD . . . 10TH. The Filnam parameter may be up to 40 characters in length. The use of separate files for each averaging period, source group, high value combination allows the user flexibility to select only those results that are needed for plotting from a particular run.

3.7.2.4 TOXXFILE

The syntax and type for the TOXXFILE keyword are summarized below:

Syntax:	OU TOXXFILE Aveper Cutoff Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 1, 3, 8, 24 for 1, 3, 8 and 24-hour averages, or MONTH for monthly averages) for which the TOXXFILE option has been selected. The Cutoff (threshold) parameter is the user-specified threshold cutoff value in g/m^3, and Filnam is the name of the file where the TOXXFILE results are to be written. It is important to note that the units of the Cutoff parameter are g/m^3, regardless of the input and output units selected with the SO EMISUNIT card. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2). While the TOXXFILE option may be specified for any of the short term averaging periods that are identified on the CO AVERTIME card for a particular run, a non-fatal warning message will be generated if other than 1-hour averages are specified. This is because the TOXST model currently supports only 1-hour averages.

The TOXXFILE card may be repeated for each averaging period, but a different filename should be used for each file since the structure of the output file generated by the TOXXFILE option does not allow for a clear way to distinguish between results for different averaging periods. The resulting output file for the AERMOD model is an unformatted file with several header records identifying the title, averaging period, receptor information, and the threshold value for that file, followed by records listing every occurrence where the result for any source group for that averaging period equals or exceeds the threshold value. When one of the source groups exceeds the threshold value, the results for all source groups for that averaging period and receptor location are output. Each concentration that is output through the TOXXFILE option is paired with an integer ID variable that identifies the averaging period (hour number of the year), the source group number, and the receptor number corresponding to that value. The concentration values and corresponding ID variables are stored in buffer arrays, and the arrays are then written to the unformatted output file

when full. The size of the arrays is controlled by the NPAIR PARAMETER defined in MODULE MAIN1, and is initially set at 100. At the end of the modeling run, any values remaining in the buffer arrays are written to the file, padded to the right with zeroes. The structure of the output file generated by the TOXXFILE option is described in more detail in Section 3.8.2 and in APPENDIX D. When using the TOXXFILE option, the user will normally place a single source in each source group. The user should refer to the user's guide for TOXST for further instructions on the application of the TOXXFILE option of the AERMOD model.

The following examples illustrate the use of the TOXXFILE option:

```
OU TOXXFILE   1  1.0E-5  TOXX1HR.BIN
OU TOXXFILE  24  2.5E-3  TOXX24HR.BIN  50
```

The Filnam parameter may be up to 40 characters in length. It should be noted that only one TOXXFILE card may be used for each averaging period. Note: The TOXXFILE option may produce very large files for runs involving a large number of receptors if a significant percentage of the results exceed the threshold value.

3.7.2.5 RANKFILE

The RANKFILE keyword outputs values by rank for use in Q-Q (quantile) plots. The MAXTABLE option must be specified first in order to use the RANKFILE option for a particular averaging period. However, the RANKFILE output differs from the results in the MAXTABLE output in that duplicate date/hour occurrences are removed. The syntax and type for the RANKFILE keyword are summarized below:

Syntax:	OU RANKFILE Aveper Hinum Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g., 3, 8, 24 for 3, 8, and 24-hour averages, or MONTH for monthly averages), and Hinum is the number of high values to be ranked. The RANKFILE keyword cannot be used with PERIOD averages. As noted above, the MAXTABLE option must be specified first for the particular Aveper, and the Hinum parameter on the RANKFILE card must be less than or equal to the Maxnum parameter on the corresponding

MAXTABLE card. Since duplicate dates are removed from the RANKFILE output, the output file may contain less than the number of requested high values. The NMAX parameter, which controls the maximum number of values that can be stored, has been set initially to 400. The Filnam parameter is the name of the file (up to 40 characters) where the RANKFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. By specifying the same filename and unit for more than one RANKFILE card, results for different averaging periods may be combined into a single file. If the Funit parameter is omitted, the model will dynamically allocate a unique file unit for this file according to the following formula:

IRKUNT = 100 + IAVE

where IRKUNT is the Fortran unit number and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card).

3.7.2.6 EVALFILE

The EVALFILE option is specifically designed for use in generating residuals for model evaluation studies. The EVALFILE output consists of the arc-maximum normalized concentration values for each hour of meteorology and for each source specified. The arc groupings of the receptors must be specified using the RE EVALCART keyword described above. The syntax and type for the EVALFILE keyword are summarized below:

Syntax:	OU EVALFILE Srcid Filnam (Funit)
Type:	Optional, Repeatable

where the Srcid parameter is the source ID for which EVALFILE results are requested, the Filnam parameter is the name of the file (up to 40 characters) where the EVALFILE results are to be written, and the optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 26-100, inclusive. By specifying the same filename and unit for more than one EVALFILE card, results for different sources may be combined into a single file. If the Funit parameter is omitted, the model will dynamically allocate a unique file unit for this file according to the following formula:

IELUNT = 400 + ISRC*5

where IELUNT is the Fortran unit number and ISRC is the source number (the order of the source as specified on the SO pathway).

For each hour of meteorological data processed and for each receptor grouping (e.g., arc), the EVALFILE option outputs five records containing the source ID, date, arc ID, arc-maximum normalized concentration (P/Q), emission rate, and other plume dispersion and meteorological variables associated with the arc-maximum. Since the EVALFILE option looks at receptor groupings, it must be used in conjunction with the EVALCART keyword described above for the RE pathway, and a fatal error is generated if no receptor groups are identified.

3.7.2.7 SEASONHR

The SEASONHR option is used to output a file containing the average results by season and hour-of-day. To select this option, the user must include the SEASONHR keyword on the OU pathway. The syntax, type, and order for the SEASONHR keyword are summarized below:

Syntax:	OU SEASONHR GroupID Filenam (FUnit)
Type:	Optional, Repeatable

where the GroupID parameter specifies the source group to be output, FileName specifies the name of the output file, and the optional FileUnit parameter specifies an optional file unit and must be in the range 26-100, inclusive. If FileUnit is left blank, then the model will dynamically assign a file unit based on the formula 302+IGRP*10, where IGRP is the group index number. A sample from a SEASONHR output file is shown below:

```
* MODELING OPTIONS USED:
*  CONC                    WDEP   RURAL   FLAT        TOXICS
*         FILE OF SEASON/HOUR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   216 RECEPTORS.
*         FORMAT: (4(1X,F13.5),1X,F8.2,2X,A8,2X,I4,2X,I4,2X,I4,2X,A8)
*        X             Y      AVERAGE CONC   ZELEV     GRP     NHRS  SEAS  HOUR  NET ID
*  ___________   ____________   ___________   ______   ______  _____ _____ ____ _________
      8.68241       49.24039       0.00000     0.00   ALL        87     1     1  POL1
     17.36482       98.48077       0.00000     0.00   ALL        87     1     1  POL1
     86.82409      492.40387       0.18098     0.00   ALL        87     1     1  POL1
    173.64818      984.80774       2.52520     0.00   ALL        87     1     1  POL1
    868.24091     4924.03857       2.07470     0.00   ALL        87     1     1  POL1
   1736.48181     9848.07715       0.93252     0.00   ALL        87     1     1  POL1
     17.10101       46.98463       0.00000     0.00   ALL        87     1     1  POL1
     34.20201       93.96926       0.00000     0.00   ALL        87     1     1  POL1
    171.01007      469.84631       0.15772     0.00   ALL        87     1     1  POL1
    342.02014      939.69263       2.48554     0.00   ALL        87     1     1  POL1
   1710.10071     4698.46289       6.09119     0.00   ALL        87     1     1  POL1
   3420.20142     9396.92578       4.49830     0.00   ALL        87     1     1  POL1
     25.00000       43.30127       0.00000     0.00   ALL        87     1     1  POL1
     50.00000       86.60254       0.00000     0.00   ALL        87     1     1  POL1
    250.00000      433.01270       0.10114     0.00   ALL        87     1     1  POL1
    500.00000      866.02539       2.12970     0.00   ALL        87     1     1  POL1
   2500.00000     4330.12695       2.79993     0.00   ALL        87     1     1  POL1
   5000.00000     8660.25391       1.97200     0.00   ALL        87     1     1  POL1
```

The NHRS column in the output file contains the number of non-calm and non-missing hours used to calculate the season-by-hour-of-day averages. The SEAS column is the season index, and is 1 for winter, 2 for spring, 3 for summer and 4 for fall. The records loop through hour-of-day first, and then through the seasons.

3.7.2.8 MAXDCONT

Beginning with version 11059, three output options have been incorporated on the OU pathway to support the 1-hour NO_2 and SO_2 standards, especially the analyses that may be required to determine a source's (or group of sources) contributions to modeled violations of the NAAQS for comparison to the Significant Impact Level (SIL). The form of the standards, based on averages of ranked values across years, complicates this analysis, especially for the 1-hour NO_2 and SO_2 standards which are based on ranked values from the distribution of daily maximum 1-hour averages. One of the options (MAXDCONT) can also be used for the 24-hour PM2.5 NAAQS.

The MAXDCONT option, applicable to 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 standards, can be used to determine the contribution of each user-defined source group to the high ranked values for a target source group, paired in time and space. This is accomplished as an

internal post-processing routine after the main model run is completed. The user can specify the range of ranks to analyze, or can specify an upper bound rank, e.g., 8th-highest for 1-hour NO_2 (note that "upper bound" rank implies a higher concentration, while "lower bound" rank implies a lower concentration), and a threshold value, such as the NAAQS, for the target source group. The model will process each rank within the range specified, but will stop after the first rank (in descending order of concentration) that is below the threshold.

The syntax, type and order of the optional MAXDCONT keyword are summarized below:

Syntax:	OU MAXDCONT GrpID UpperRank LowerRank FileName (FileUnit) or OU MAXDCONT GrpID UpperRank <u>THRESH</u> ThreshValue FileName (FileUnit)
Type:	Optional, Repeatable

where GrpID is the target or reference source group toward which contributions are being determined, UpperRank and LowerRank are the upper bound and lower bound ranks (where upper bound rank implies higher concentrations and lower bound rank implies lower concentrations), <u>THRESH</u> indicates that the lower bound rank is determined based on a lower concentration threshold, ThreshValue is the user-specified concentration threshold for GrpID impacts which serves as a lower bound on the range of ranks analyzed, FileName is the output file name, and (FileUnit) is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. When the <u>THRESH</u> option is selected AERMOD will skip the contribution analysis for any receptor where the target GrpID impact is less than the threshold, and will stop processing completely after the first rank where the target GrpID values are below the threshold for all receptors. **<u>NOTE:</u> It is important note that the range of ranks that can be analyzed under the MAXDCONT option is limited to the range of ranks (not the individual ranks) specified on the OU RECTABLE keyword, even when the <u>THRESH</u> option is used in lieu of specifying a LowerRank value. AERMOD will issue a fatal error if the THRESH option is used and the range of ranks is less than or equal to 8 for the 1-hr SO_2 NAAQS, or less than or equal to 12 for the 1-hr NO2 and 24-hr PM2.5 NAAQS. Non-fatal warning messages will be generated if the THRESH option is used and the range of ranks is less than or equal to 24 for the 1-hr SO_2 NAAQS, or less than or equal to**

28 for the 1-hr NO2 and 24-hr PM2.5 NAAQS.

When the MAXDCONT option is specified, AERMOD stores all meteorological variables in memory for each hour during the initial stage of processing in order to optimize the model runtime during the post-processing stage. Any temporally-varying emissions and background concentrations, including background ozone concentrations for the OLM and PVMRM options, are also stored in memory for each hour. While optimizing runtime for the post-processing, this approach may also significantly increase the memory storage requirements of the model. In addition, since the MAXDCONT option extracts meteorological variables and other temporally-varying data stored in memory to optimize runtime, the MAXDCONT option cannot be used with the model "re-start" option using the INITFILE and SAVEFILE keywords (Section 3.2.13) on the CO pathway, or with the MULTYEAR option (Section 3.2.6) on the CO pathway.

3.7.2.9 MAXDAILY

The MAXDAILY option, introduced with version 11059, is applicable to 1-hour NO_2 and 1-hour SO_2 NAAQS and generates a file of daily maximum 1-hour concentrations for a specified source group, for each day in the data period processed. The MAXDAILY file provides an interim output that may be useful for analyzing the 1-hour NO_2 and SO_2 NAAQS. The syntax, type and order of the optional MAXDAILY keyword are summarized below:

Syntax:	OU MAXDAILY GrpID FileName (FileUnit)
Type:	Optional, Non-repeatable

where GrpID is the source group selected for daily maximum 1-hour values, FileName is the name of the MAXDAILY output file, and FileUnit is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

3.7.2.10 MAXDYBYYR

Another option applicable to 1-hour NO_2 and 1-hour SO_2 NAAQS introduced with version

11059, the MXDYBYYR keyword, generates a summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword. The ranks included in the MXDYBYYR file are the ranks used in the MAXDCONT postprocessing option. The syntax, type and order of the optional MXDYBYYR keyword are summarized below:

Syntax:	OU MXDYBYYR GrpID FileName (FileUnit)
Type:	Optional, Non-repeatable

where GrpID is the source group selected for daily maximum 1-hour values summarized by year, FileName is the name of the MXDYBYYR output file, and FileUnit is the optional file unit. The filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (“) at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces.

3.7.3 EVENT processing options

EVENT processing in the AERMOD model is designed specifically to perform source contribution analyses for short term average (less than or equal to 24-hour) events. The events may either be generated by the AERMOD model, or they may be user-specified events, or both. Because of this rather narrow focus of applications, the output options are limited to a single keyword. The EVENTOUT keyword controls the level of detail in the source contribution output from the EVENT model. The syntax and type of the EVENTOUT keyword are summarized below:

Syntax:	OU EVENTOUT SOCONT DETAIL
Type:	Mandatory, Non-repeatable

where the SOCONT secondary keyword specifies the option to produce only the source contribution information in the output file, and the DETAIL secondary keyword specifies the option to produce more detailed summaries in the output file. The SOCONT option provides the average concentration (or total deposition) value (i.e., the contribution) from each source for the period corresponding to the event for the source group. The basic source contribution information is also provided with the DETAIL option. In addition, the DETAIL option provides the hourly average concentration (or total deposition) values for each source for every hour in the averaging period,

and a summary of the hourly meteorological data for the event period. In general, the DETAIL option produces a larger output file than the SOCONT file, especially if there are a large number of sources. There is no default setting for the EVENTOUT options.

3.7.4 Miscellaneous output options

The optional SUMMFILE keyword can be used to generate a separate formatted output file containing the summary of high ranked values included at the end of the standard 'aermod.out' file. The optional FILEFORM keyword can be used to specify the use of exponential notation, rather than fixed format as currently used, for results that are output to separate result files. The optional NOHEADER keyword can be used to suppress file headers in formatted output file options. These new options are described below.

The syntax, type and order of the optional SUMMFILE keyword are summarized below:

Syntax:	OU SUMMFILE SummFileName
Type:	Optional, Non-repeatable

where the SummFileName is the name of the external file containing the summary of high ranked values. The SUMMFILE filename can be up to 200 characters in length based on the default parameters in AERMOD. Double quotes (") at the beginning and end of the filename can also be used as field delimiters to allow filenames with embedded spaces. In addition to the summary of high ranked values, the SUMMFILE also includes the "MODEL SETUP OPTIONS SUMMARY" page from the main 'aermod.out' file.

The syntax, type and order of the optional FILEFORM keyword are summarized below:

Syntax:	OU FILEFORM EXP or FIX
Type:	Optional, Non-repeatable

where the EXP parameter specifies that output results files will use exponential-formatted values, and the FIX parameter specifies that the output results files will use fixed-formatted values. The default option is to use fixed-formatted results, so use of FILEFORM = 'FIX' is extraneous. Note

that AERMOD only examines the first three characters of the input field, so that the full terms of 'EXPONENTIAL' or 'FIXED' can also be used. The format specified on this optional keyword is applicable to PLOTFILEs, plot-formatted POSTFILEs, MAXIFILEs, RANKFILEs, and SEASONHR files, but will not affect the format of results in the standard 'aermod.out' file or the optional SUMMFILE. The FILEFORM optional may be useful to preserve precision in applications with relatively small impacts, especially for the purpose of post-processing hourly concentrations using the POSTFILE option. The option may also be useful for applications with relatively large impacts that may overflow the Fortran format specifier of F13.5 used for fixed-formatted outputs. AERMOD will issue a warning message if values that exceed the range allowed for fixed-format are detected unless the FILEFORM EXP option has been selected.

The syntax, type and order of the optional NOHEADER keyword are summarized below:

Syntax:	OU NOHEADER FileType1 FileType2 FileType3 … FileTypeN or OU NOHEADER <u>ALL</u>
Type:	Optional, Non-repeatable

where FileTypeN identifies the keywords for formatted output files for which the file headers will be suppressed, which may include the includes the following file types: POSTFILE, PLOTFILE, MAXIFILE, RANKFILE, SEASONHR, MAXDAILY, MXDYBYYR, and MAXDCONT. The keyword <u>ALL</u> may be used to specify that header records will be suppressed for ALL applicable output file types.

3.8 Controlling input and output files

This section describes the various input and output files used by the AERMOD model, and discusses control of input and output (I/O) in the Microsoft Windows PC environment. Much of this discussion also applies to operating the model in other environments.

3.8.1 Description of AERMOD input files

The two basic types of input files needed to run all of the AERMOD model are the input runstream file containing the modeling options, source data and receptor data, and the two input meteorological data files. Each of these is discussed below, as well as a special file that may be used to initialize the AERMOD model with intermediate results from a previous run.

3.8.1.1 Input runstream file

The input runstream file contains the user-specified options for running the various AERMOD model (called AERMOD.INP), includes the source parameter data and source group information, defines the receptor locations, specifies the location and parameters regarding the meteorological data, and specifies the output options. Details regarding the keywords and parameters used in the input runstream file are provided in Section 3.0, and APPENDIX B.

For the PC-executable version of the model available on the SCRAM website, the runstream file is explicitly opened by the model using a Fortran OPEN statement, and the integer variable, INUNIT, specifies the unit number for the file. The variable INUNIT is initialized to a value of 7 in a DATA statement in MODULE MAIN1, and is therefore available to all of the necessary subroutines.

3.8.1.2 Meteorological data files

The input meteorological data is read into the AERMOD model from two separate data files, one corresponding to surface (scalar) parameters, and the other corresponding to multi-level profiles of data. The meteorological data filenames and format are specified within the input runstream file using the ME SURFFILE and PROFFILE keywords. The AERMOD model accepts meteorological data that has been preprocessed by the AERMET meteorological preprocessor program (EPA,

2004b). The data are read from formatted ASCII files of hourly sequential records.

The meteorological data files are explicitly opened by the model using Fortran OPEN statements, and the integer variables MFUNIT for the surface/scalar file and MPUNIT for the profile file are used to specify the unit numbers for the files. The variable MFUNIT is initialized to a value of 19 and MPUNIT is initialized to a value of 16 in a DATA statement in MODULE MAIN1, and are therefore available to all of the necessary subroutines.

3.8.1.3 Initialization file for model re-start

The AERMOD model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may therefore be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When initializing the model for the re-start option, the user specifies the name of the unformatted results file on the INITFILE keyword. The default filename used if no parameter is provided is TMP.FIL. The initialization file is explicitly opened by the AERMOD model, and the integer variable, IRSUNT, specifies the unit number for the file. The variable IRSUNT is initialized to a value of 15 in a DATA statement in MODULE MAIN1, and is therefore available to all of the necessary subroutines.

3.8.2 Description of AERMOD output files

The AERMOD model produce a variety of output files, including the main print file of model results, an unformatted file of intermediate results for later re-start of the model (AERMOD only), and several output data files for specialized purposes. These files are described in detail below.

3.8.2.1 Main output file

The AERMOD model produces a main output file of model results called AERMOD.OUT. The contents and organization of this file were shown in Figure 2-5. This file includes an echo of the input runstream images at the beginning of the file (up until a NO ECHO input is encountered). A summary of runstream setup messages and a summary of the inputs follow the echo of inputs. The input summary includes a summary of modeling options, source data, receptor data, and meteorological data, following the same order as the pathways in the runstream file. If model calculations are performed, then the model results are summarized next. The content and order of the model result summaries depend on the output options selected and on the particular model being run. Following the detailed model results are summary tables of the high values for each averaging period and source group. The final portion of the main output file is the summary of messages for the complete model run.

For the PC-executable version of the model available on the SCRAM website, the main output file is explicitly opened by the model using a Fortran OPEN statement, and the integer variable, IOUNIT, specifies the unit number for the file. The variable IOUNIT is initialized to a value of 8 in a DATA statement in MODULE MAIN1, and is therefore available to all of the necessary subroutines.

3.8.2.2 Detailed error message file

The user may select an option for the model to save a separate file of detailed error and other messages, through use of the CO ERRORFIL keyword. The format and syntax of these messages is described in APPENDIX C. The order of messages within the file is the order in which they were generated by the model. The file includes all types of messages that were generated.

The error message file is explicitly opened by the model using a Fortran OPEN statement, and the integer variable, IERUNT, specifies the unit number for the file. The variable IERUNT is initialized to a value of 10 in a DATA statement in MODULE MAIN1, and is therefore available to all of the necessary subroutines.

3.8.2.3 Intermediate results file for model re-start

The AERMOD model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may therefore be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When saving the intermediate results for the re-start option, the user specifies the name of the unformatted results file on the SAVEFILE keyword. The user has the option of specifying a single filename, two filenames (for alternate saves), or specifying no filename. The default filename used if no parameter is provided is TMP.FIL. If a single file is used, then the intermediate results file is overwritten on each successive dump, with the chance that the file will be lost if the interrupt occurs during the time that the file is opened. If two filenames are provided, then the model also saves to the second file on alternate dumps, so that the next most recent dump will always be available. The main save file is explicitly opened by the AERMOD model, and the integer variable, IDPUNT, specifies the unit number for the file. The variable IDPUNT is initialized to a value of 12 in a BLOCK DATA subprogram of the model. If a second save file is used, then it is also opened explicitly, and the integer variable IDPUN2, initialized to a value of 14, specifies the unit number.

3.8.2.4 Maximum value/threshold file

The user may select an option for the AERMOD model to generate a file or files of concentration values exceeding a user-specified threshold. The OU MAXIFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which a list of threshold violations may be needed. Each file includes several records with header information identifying the averaging period, source group and threshold value, and then a record for every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration value.

The structure of the threshold violation file is described in more detail in APPENDIX D. Each of the files selected by the user is opened explicitly by the model as a formatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the MAXIFILE card through the optional FUNIT parameter. User-specified units must be greater than or equal to 26, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formula:

$$IMXUNT = 100 + IGRP*10 + IAVE$$

where IMXUNT is the Fortran unit number, IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.2.5 Sequential results file for postprocessing

The user may select an option for the AERMOD model to generate a file or files of concentration values suitable for postprocessing. The OU POSTFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which postprocessing may be needed. For each file requested, the user has the option of specifying whether to use unformatted files suitable for postprocessing or to use a plot format which could allow for importing the x,y conc files into a graphics package for plotting. For the unformatted file option, each file consists of sequential unformatted records of values at each receptor location for every averaging period calculated. For the plot file format option, each file consists of formatted records listing the x-coordinate, y-coordinate and concurrent concentration values for each receptor and for all averaging periods calculated. For certain applications, these files may become quite large, and should only be used when needed, especially when using the plot format.

The structure of both types of postprocessing file is described in more detail in APPENDIX D. Each of the postprocessing files selected by the user is opened explicitly by the model as either an unformatted or a formatted file, depending on the option selected. The filenames are provided on the input runstream image. The user may specify the file unit on the POSTFILE card through

the optional FUNIT parameter. User-specified units must be greater than or equal to 26, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formulas:

IPSUNT = 200 + IGRP*10 + IAVE for short term averages
IAPUNT = 300 + IGRP*10 - 5 for PERIOD averages

where IPSUNT and IAPUNT are the Fortran unit numbers, IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.2.6 High value summary file for plotting

The user may select an option for the AERMOD model to generate a file or files of the highest concentration values at each receptor suitable for importing into a graphics package in order to generate contour plots. The OU PLOTFILE keyword controls this option. The user may select separate files for each averaging period, source group and high value combination for which a plot file may be needed. Each file includes several records with header information identifying the averaging period, source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number.

The structure of the plot file is described in more detail in APPENDIX D. Each of the plot files selected by the user is opened explicitly by the model as a formatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the PLOTFILE card through the optional FUNIT parameter. User-specified units must be greater than or equal to 26, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formulas:

IPLUNT = (IVAL+3)*100 + IGRP*10 + IAVE for short term averages
IPPUNT = 300 + IGRP*10 for PERIOD averages

where IPLUNT and IPPUNT are the Fortran unit numbers, IVAL is the high value number (1 for FIRST highest, 2 for SECOND highest, etc.), IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.2.7 TOXX model input files

The user may select an option for the AERMOD model to generate an unformatted file or files of concentration values exceeding a user-specified threshold for use with the TOXX model component of TOXST. The OU TOXXFILE keyword controls this option. The user may select separate files for each averaging period for which a threshold violation file may be needed. Each file includes several records with header information identifying the title, averaging period, threshold value, and receptor network information, and then records including every occurrence where the result of any source group for that averaging period equals or exceeds the threshold value. Records are also output that identify the averaging period (hour number of the year), source group number and receptor number corresponding to the concentration values.

The structure of the threshold exceedance file for use with the TOXX model component of TOXST is described in more detail in APPENDIX D. Each of the files selected by the user is opened explicitly by the model as an unformatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the TOXXFILE card through the optional Funit parameter. User-specified units must be greater than or equal to 26, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formula:

$$ITXUNT = 300 + IAVE$$

where ITXUNT is the Fortran unit number, and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 4 short term averaging periods.

The user may also select an option for the AERMOD model to generate an output for use with the RISK model component of TOXLT. The OU TOXXFILE keyword also controls this option. The user can specify a separate TOXXFILE for each long term averaging period and source group combination. The TOXXFILE option may also be used for PERIOD averages with the AERMOD model. The structure of the TOXXFILE output for AERMOD is very similar to the long term PLOTFILE output, except that results are output for each individual source in the specified source group. The structure of the long term TOXXFILE is described in more detail in APPENDIX D. Each of the files selected by the user is opened explicitly by the model as a formatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the TOXXFILE card through the optional Funit parameter. User-specified units must be greater than or equal to 26, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formulas:

ITXUNT = 500 + IAVE*10 + IGRP	for long term averages
IPXUNT = 700 + IGRP*10	for PERIOD averages

where ITXUNT and IPXUNT are the Fortran unit numbers, IAVE is the averaging period number (in the order of months, seasons or quarters, and annual), and IGRP is the source group number (in the order is which the groups are defined in the SO pathway). This formula will not cause any conflict with other file units used by the model for up to 9 source groups.

3.8.3 Controlling file inputs and outputs (I/O)

3.8.3.1 Controlling I/O on PCs.

The main input runstream file and the main output print file are specified internally by AERMOD as AERMOD.INP and AERMOD.OUT, respectively. Therefore, a standard command line to execute the AERMOD model might look something like this:

```
C:\>AERMOD
```

where the "DOS prompt" has been given as "C:\>", but may look different on different systems, or may include a subdirectory specification. The output file generated by the DOS version includes page feeds that are written directly to the file as part of the header for each page, rather than using

the Fortran carriage control of '1'. This is accomplished by including a compiler- specific parameter to set CARRIAGECONTROL = ‘Fortran’ on the OPEN statement for the output file.

3.8.3.2 Controlling I/O on other computer systems

Since the main input runstream file and the main output print file are specified internally by AERMOD, control of I/O on other computer systems will be the same.

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Note: Many of the references listed can be found on the U.S. EPA SCRAM website at the following url: http://www.epa.gov/ttn/scram/

APPENDIX A. Alphabetical keyword reference

This appendix provides an alphabetical listing of all of the keywords used by the AERMOD model. Each keyword is identified as to the pathway for which it applies, the keyword type (either mandatory or optional, and either repeatable or non-repeatable), and with a brief description of the function of the keyword. For a more complete description of the keywords, including a list of associated parameters, refer to the Detailed Keyword Reference in Section 3.0 or the Functional Keyword/Parameter Reference in APPENDIX B.

Keyword	Path	Type	Keyword Description
AREAVERT	SO	M – R	Specifies location of vertices for an AREAPOLY source type (mandatory if AREAPOLY source is used)
ARMRATIO	CO	O - N	Option to override default minimum and maximum (equilibrium) ratios for the ARM or ARM2 options
AVERTIME	CO	M – N	Averaging time(s) to process
BACKGRND	SO	O – R	Option to specify temporally varying background concentrations
BACKUNIT	SO	O – N	Option to specify units for background concentrations
BGSECTOR	SO	O – N	Option to specify wind sectors for use in varying background concentrations of the pollutant being modeled by wind direction.
BUILDHGT	SO	O – R	Building height values for each wind sector
BUILDLEN	SO	O – R	Building projected length values for each wind sector
BUILDWID	SO	O – R	Building projected width values for each wind sector
CONCUNIT	CO	O – N	Optional conversion factors for emission input units and concentration output units
DAYRANGE	ME	O – R	Specifies days or ranges of days to process (default is to process all data)
DAYTABLE	OU	O – N	Option to provide summaries for each averaging period for each day processed.
DCAYCOEF	CO	O – N	Optional decay coefficient for exponential decay
DEBUGOPT	CO	O – N	Option to generate detailed result and meteorology files for debugging purposes
DEPOUNIT	SO	O – N	Optional conversion factors for emission input units and deposition output units
DISCCART	RE	O – R	Defines discretely placed receptors referenced to a Cartesian system
DISCPOLR	RE	O – R	Defines discretely placed receptors referenced to a polar system
ELEVUNIT	SO RE	O – N O – N	Defines input units for receptor elevations (RE path), or source elevations (SO path) (defaults to meters)
EMISFACT	SO	O – R	Optional input for variable emission rate factors
EMISUNIT	SO	O – N	Optional conversion factors for emission units and concentration units
ERRORFIL	CO	O – N	Option to generate detailed error listing file (error file is mandatory for CO RUNORNOT NOT case)
EVALCART	RE	O – R	Defines discretely placed receptor locations referenced to a Cartesian system, grouped by arc for use with the EVALFILE output option
EVALFILE	OU	O – R	Option to output file of normalized arc maxima for model evaluation studies

Keyword	Path	Type	Keyword Description
EVENTFIL	CO	O – N	Specifies whether to generate an input file for EVENT model
EVENTLOC	EV	M – R	Describes receptor location for an event
EVENTOUT	OU	M – N	Specifies level of output information provided by the EVENT model
EVENTPER	EV	M – R	Describes data and averaging period for an event
FILEFORM	OU	O – N	Specify fixed or exponential format for output results files
FINISHED	ALL	M – N	Identifies the end of inputs for a particular pathway
FLAGPOLE	CO	O – N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for a default flagpole height to be specified
GASDEPDF	CO	O – N	Option to override default parameters for gas dry deposition
GASDEPOS	SO	O – R	Specify source parameters for gas deposition algorithms
GASDEPVD	CO	O – N	Option to specify deposition velocity for gas dry deposition
GDLANUSE	CO	O – N	Specify land use categories by sector for gas dry deposition
GDSEASON	CO	O – N	Specify seasonal definitions for gas dry deposition
GRIDCART	RE	O – R	Defines a Cartesian grid receptor network
GRIDPOLR	RE	O – R	Defines a polar receptor network
HALFLIFE	CO	O – N	Optional half-life for exponential decay
HOUREMIS	SO	O – R	Option for specifying hourly emission rates in a separate file
INCLUDED	SO, RE, EV	O – R	Option to include input data from a separate file in the runstream for the SO and/or RE pathways, or for the EV pathway for EVENTs
INITFILE	CO	O – N	Option to initialize model from file of intermediate results generated by SAVEFILE option
LOCATION	SO	M – R	Identifies coordinates for particular source location
LOW_WIND	CO	O – N	Option for user-specified parameters for the LOWWIND1 and LOWWIND2 BETA options
MASSFRAX	SO	O – R	Optional input of mass fraction for each particle size category
MAXDAILY	OU	O – R	Option to output file of daily maximum 1-hour values for each day processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
MAXDCONT	OU	O – R	Option to output contributions of each source group to ranked values averaged across years for a reference source group, paired in time and space; only applicable for 24-hour PM2.5, 1-hour NO_2, and 1-hour SO_2 NAAQS
MAXIFILE	OU	O – R	Option to list events exceeding a threshold value to file (if CO EVENTFIL option is used, these events are included in the input file generated for the EVENT model)
MAXTABLE	OU	O – R	Option to summarize the overall maximum values

Keyword	Path	Type	Keyword Description
METHOD_2	SO	O – R	Specify optional source parameters for METHOD_2 option for particle deposition
MODELOPT	CO	M – N	Job control and dispersion options
MULTYEAR	CO	O – N	Specifies that run is part of a multi-year run, e.g., for PM-10 H6H in five years
MXDYBYYR	OU	O – R	Option to output file of daily maximum 1-hour values by year, for each year processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
NOHEADER	OU	O – N	Option to suppress file headers for output file options, e.g., POSTFILE, PLOTFILE, MAXDCONT, etc
NO2EQUIL	CO	O – N	Option to override default NO_2/NO_x equilibrium ratio for PVMRM or OLM
NO2RATIO	SO	O – R	Option to specify in-stack NO_2/NO_x equilibrium ratio for OLM and PVMRM options by source
NO2STACK	CO	O – N	Option to specify default in-stack NO_2/NO_x equilibrium ratio for OLM and PVMRM options; may be overridden by NO2RATIO
NUMYEARS	ME	O – N	Option to specify the number of years of meteorological data being processed for purposes of allocating array storage for the OU MAXDCONT option
OLMGROUP	SO	O – R	Specifies sources to combine for OLM option for merging plumes
OZONEFIL	CO	O – N	Specifies hourly ozone file for OLM and PVMRM options
OZONEVAL	CO	O – N	Specifies background value of ozone for OLM and PVMRM options
OZONUNIT	CO	O – N	Option to specify units for temporally-varying ozone concentrations for the O3VALUES keyword.
O3SECTOR	CO	O – N	Option to specify wind sectors for use in varying background ozone (O3) concentrations by wind direction for use with OLM and PVMRM options.
O3VALUES	CO	O – R	Option to specify temporally varying ozone concentrations for use with OLM and PVMRM options for estimating NO_2
PARTDENS	SO	O – R	Specifies particle density by size category for particle deposition
PARTDIAM	SO	O – R	Specifies particle diameters by size category for particle deposition
PLOTFILE	OU	O – R	Option to write certain results to a storage file suitable for input to plotting routines
POLLUTID	CO	M – N	Identifies pollutant being modeled
POSTFILE	OU	O – R	Option to write results to a mass storage file for postprocessing
PROFBASE	ME	M – N	Specifies the base elevation for the potential temperature profile
PROFFILE	ME	M – N	Describes input profile meteorological data file
PSDGROUP	SO	O – R	Specifies source groups for PSDCREDIT option with PVMRM

Keyword	Path	Type	Keyword Description
RANKFILE	OU	O – R	Option to produce output file of ranked values for Q-Q plots
RECTABLE	OU	O – R	Option to output high ranked value(s) by receptor
RUNORNOT	CO	M – N	Identifies whether to run model or process setup information only
SAVEFILE	CO	O – N	Option to store intermediate results for later restart of the model after user or system interrupt
SCIMBYHR	ME	O – N	Specifies sampling parameters for the SCIM option
SEASONHR	OU	O – R	Option to output values by season and hour-of-day
SITEDATA	ME	O – N	Describes on-site meteorological station
SRCGROUP	SO	M – R	Identification of source groups
SRCPARAM	SO	M – R	Identifies source parameters for a particular source
STARTEND	ME	O – N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file)
STARTING	ALL	M – N	Identifies the start of inputs for a particular pathway
SUMMFILE	OU	O – N	Option to output summary of high ranked values to separate file
SURFDATA	ME	M – N	Surface meteorological station
SURFFILE	ME	M – N	Describes input surface meteorological data file
TITLEONE	CO	M – N	First line of title for output
TITLETWO	CO	O – N	Optional second line of output title
TOXXFILE	OU	O – R	Creates output file for use with TOXX model component of TOXST
UAIRDATA	ME	M – N	Upper air meteorological station
URBANOPT	CO	O – R	Option to specify population for urban option
URBANSRC	SO	O – R	Option to specify use of urban option by source
WDROTATE	ME	O – N	Wind direction rotation adjustment
WINDCATS	ME	O – N	Upper bound of wind speed categories
XBADJ	SO	O – R	Along-flow distances from the stack to the center of the upwind face of the projected building
YBADJ	SO	O – R	Across-flow distances from the stack to the center of the upwind face of the projected building

Type: M - Mandatory
O – Optional
N - Non-repeatable
R - Repeatable

APPENDIX B. Functional keyword/parameter reference

This appendix provides a functional reference for the keywords and parameters used by the input runstream files for the AERMOD model. The keywords are organized by functional pathway, and within each pathway the order of the keywords is based on the function of the keyword within the model. The pathways used by the model are as follows, in the order in which they appear in the runstream file and in the tables that follow:

CO - for specifying overall job **CO**ntrol options;
SO - for specifying **SO**urce information;
RE - for specifying **RE**ceptor information;
ME - for specifying **ME**teorology information and options;
EV - for specifying **EV**ent information and options;
OU - for specifying **OU**tput options.

The pathways and keywords are presented in the same order as in the Detailed Keyword Reference in Section 3.0, and in the Quick Reference at the end of the manual.

Two types of tables are provided for each pathway. The first table lists all of the keywords for that pathway, identifies each keyword as to its type (either mandatory or optional and either repeatable or non-repeatable), and provides a brief description of the function of the keyword. The second type of table, which takes up more than one page for most pathways, presents the parameters for each keyword, in the order in which they should appear in the runstream file where order is important, and describes each parameter in detail.

The following convention is used for identifying the different types of input parameters. Parameters corresponding to secondary keywords which should be input "as is" are listed on the tables with all capital letters and are underlined, although none of the inputs to AERMOD are treated as case-sensitive. Other parameter names are given with an initial capital letter and are not input "as is." In all cases, the parameter names are intended to be descriptive of the input variable being represented, and they often correspond to the Fortran variable names used in the AERMOD code. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that parameter.

Table B-1. Description of Control Pathway Keywords

CO Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of CONTROL pathway inputs
TITLEONE	M – N	First line of title for output
TITLETWO	O – N	Optional second line of title for output
MODELOPT	M – N	Job control and dispersion options
AVERTIME	M – N	Averaging time(s) to process
URBANOPT	O – R	Specifies parameters for urban dispersion option
POLLUTID	M – N	Identifies type of pollutant being modeled
HALFLIFE[1]	O – N	Optional half life used for exponential decay
DCAYCOEF[1]	O – N	Optional decay coefficient
GASDEPDF	O – N	Option to override default parameters for gas dry deposition
GASDEPVD	O – N	Option to specify deposition velocity for gas dry deposition
GDLANUSE	O – N	Specify land use categories by sector for gas dry deposition
GDSEASON	O – N	Specify seasonal definitions for gas dry deposition
LOW_WIND	O – N	Option for user-specified parameters for the LOWWIND1 and LOWWIND2 BETA options
NO2EQUIL	O – N	Option to override default NO_2/NO_x equilibrium ratio for PVMRM or OLM
NO2STACK	O – N	Option to specify default in-stack NO_2/NO_x equilibrium ratio for OLM and PVMRM options; may be overridden by NO2RATIO option on SO pathway
ARMRATIO	O – N	Option to override default minimum and maximum (equilibrium) ratios for the ARM or ARM2 options
O3SECTOR	O – N	Specifies optional wind sectors for use in varying background ozone (O3) concentrations by wind direction for use with OLM and PVMRM options; can be used with the OZONEFIL, OZONEVAL, and O3VALUES options.
OZONEFIL	O – R	Specifies filename for hourly ozone file for use with OLM and PVMRM options
OZONEVAL	O – R	Specifies background value of ozone for use with OLM and PVMRM options
O3VALUES	O – R	Option to specify temporally varying ozone concentrations for use with OLM and PVMRM options for estimating NO_2
OZONUNIT	O – N	Option to specify units for temporally-varying ozone concentrations for the O3VALUES keyword
FLAGPOLE	O – N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for default flagpole height to be specified
RUNORNOT	M – N	Identifies whether to run model or process setup information only
EVENTFIL[2]	O – N	Specifies whether to generate an input file for EVENT model
SAVEFILE[3]	O – N	Option to store intermediate results for restart of model after user or system interrupt

INITFILE[3]	O – N	Option to initialize model from intermediate results generated by SAVEFILE option
MULTYEAR[3]	O – N	Option to process multiple years of meteorological data (one year per run) and accumulate high short term values across years
DEBUGOPT	O – N	Option to generate detailed result and meteorology files for debugging purposes
ERRORFIL	O – N	Option to generate detailed error listing file
FINISHED	M – N	Identifies the end of CONTROL pathway inputs

Type: M - Mandatory
O - Optional
N - Non-Repeatable
R - Repeatable

1) Either HALFLIFE or DCAYCOEF may be specified. If both cards appear a warning message will be issued and the first value entered will be used in calculations. The DFAULT option assumes a half-life of 4 hours for SO_2 modeled in urban mode.

2) The EVENTFIL keyword controls whether or not to generate an input file for EVENT processing. The primary difference between AERMOD "regular" processing and EVENT processing by AERMOD is in the treatment of source group contributions. The AERMOD model treats the source groups independently, whereas EVENT processing determines individual source contributions to particular events, such as the design concentrations determined from AERMOD, or user-specified events. By specifying the EVENTFIL keyword, an input runstream file will be generated that can be used directly for EVENT processing. The events included in the generated EVENT processing input file are defined by the RECTABLE and MAXIFILE keywords on the OU pathway, and are placed in the EVent pathway.

3) The SAVEFILE and INITFILE keywords work together to implement the model's re-start capabilities. Since the MULTYEAR option utilizes the re-start features in a special way to accumulate high short term values from year to year, it cannot be used together with the SAVEFILE or INITFILE keyword in the same model run.

Table B-2. Description of Control Pathway Keywords and Parameters

Keyword	Parameters	
TITLEONE	Title1	
where:	Title1	First line of title for output, character string of up to 68 characters (additional characters can be included on the TITLEONE keyword, but only the first 68 characters are printed in the output files).
TITLETWO	Title2	
where:	Title2	Optional second line of title for output, character string of up to 68 characters (any additional characters are not printed)
MODELOPT	DFAULT BETA CONC DEPOS DDEP and/or WDEP AREADPLT FLAT and/or ELEV NOSTD NOCHKD or WARNCHKD NOWARN SCREEN SCIM or OLM or ARM or ARM2 PVMRM PSDCREDIT FASTALL or FASTAREA DRYDPLT or NODRYDPLT WETDPLT or NOWETDPLT NOURBTRAN LOWWIND1 or LOWWIND2 or LOWWIND3 VECTORWS	
where:	DFAULT	Specifies that regulatory default options will be used; specification of DFAULT option will override non-DFAULT options that may be specified
	BETA	Non-DFAULT option that allows for draft, “Beta” test options to be used; includes PSDCREDIT option and capped and horizontal stack releases
	CONC	Specifies that concentration values will be calculated
	DEPOS	Specifies that total deposition flux values will be calculated
	DDEP	Specifies that dry deposition flux values will be calculated
	WDEP	Specifies that wet deposition flux values will be calculated
	AREADPLT	Specifies use of non-DFAULT method for optimized plume depletion due to dry removal mechanisms for area sources
	FLAT	Non-DFAULT option of assuming flat terrain will be used
	ELEV	Default option of assuming elevated terrain will be used; Note: Both FLAT and ELEV may be specified in the same model run to allow specifying the non-DFAULT FLAT terrain option on a source-by-source basis (see the SO LOCATION keyword for specifying FLAT sources)
	NOSTD	Non-DFAULT option of no stack-tip downwash will be used
	NOCHKD	Non-DFAULT option of suspending date checking will be used for non-sequential meteorological data files, also implemented when SCREEN option is specified
	WARNCHKD	Specifies option for issuing warning messages rather than fatal errors for non-sequential meteorological data files
	NOWARN	Option to suppress detailed listing of warning messages in the main output file will be used
	SCREEN	Non-DFAULT option for running AERMOD in a screening mode for AERSCREEN will be used

Keyword	Parameters	
	SCIM	Non-DFAULT Sampled Chronological Input Model (SCIM) option; applies to ANNUAL averages only; SCIM sampling parameters must be specified on the ME pathway
	PVMRM	DFAULT Plume Volume Molar Ratio Method (PVMRM) for NO_2 conversion will be used
	OLM	DFAULT Ozone Limiting Method (OLM) for NO_2 conversion will be used
	ARM	DFAULT Ambient Ratio Method (ARM) for NO_2 conversion will be used
	ARM2	DFAULT Ambient Ratio Method – 2 (ARM2) for NO_2 conversion will be used
	PSDCREDIT	Non-DFAULT BETA test option to calculate the increment consumption with PSD credits using the PVMRM option
	FASTALL	Non-DFAULT option to optimize model runtime for POINT, VOLUME and AREA sources (AREA optimizations formerly associated with TOXICS option)
	FASTAREA	Non-DFAULT option to optimize model runtime for AREA sources (formerly associated with TOXICS option)
	DRYDPLT	Option to incorporate dry depletion (removal) processes associated with dry deposition algorithms; dry depletion will be used by default if dry deposition algorithms are invoked
	NODRYDPLT	Option to disable dry depletion (removal) processes
	WETDPLT	Option to incorporate wet depletion (removal) processes associated with wet deposition algorithms; wet depletion will be used by default if wet deposition algorithms are invoked
	NOWETDPLT	Option to disable wet depletion (removal) processes.
	NOURBTRAN	Non-DFAULT option to revert to the urban option as implemented prior to version 11059 (see Section 3.2.2).
	LOWWIND1	Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions (see Sections 3.2.2 and 3.2.3). Cannot be used with LOWWIND2 or LOWWIND3 option.
	LOWWIND2	Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions (see Sections 3.2.2 and 3.2.3).. Cannot be used with LOWWIND1 or LOWWIND3 option.
	LOWWIND3	Non-DFAULT BETA option to address concerns regarding model performance under low wind speed conditions (see Sections 3.2.2 and 3.2.3). Cannot be used with LOWWIND1 or LOWWIND2 option.
	VECTORWS	Option to specify that input wind speeds are vector mean (or resultant) wind speeds, rather than scalar means (see Section 3.2.2). The VECTORWS option is not linked with the DFAULT option.
AVERTIME	Time1 Time2 . . . TimeN MONTH PERIOD or ANNUAL	

Keyword	Parameters	
where:	TimeN MONTH PERIOD ANNUAL	Nth optional averaging time (1, 2, 3, 4, 6, 8, 12, or 24-hr) Option to calculate MONTHly averages Option to calculate averages for the entire data PERIOD; for the MULTYEAR option, the summary of highest PERIOD averages is based on the highest PERIOD average across the individual years processed with MULTYEAR Option to calculate ANNUAL averages (assumes complete years); for multi-year meteorological data files, with and without the MULTYEAR option, the multi-year average of the ANNUAL values is reported
URBANOPT	For multiple urban areas: UrbanID Urbpop (Urbname) (UrbRoughness) For single urban area: Urbpop (Urbname) (UrbRoughness)	
where:	UrbanID UrbPop (UrbName) (UrbRoughness)	Specifies the alphanumeric urban ID (up to eight characters) Specifies the population of the urban area Specifies the name of the urban area (optional) Specifies the urban surface roughness length, meters (optional, defaults to 1.0m; value other than 1.0m treated as non-DFAULT)
POLLUTID	Pollut (H1H or H2H or INC)	
where:	Pollut	Identifies type of pollutant being modeled. Any name of up to eight characters may be used, e.g., SO2, NOX, CO, PM25, PM-2.5, PM10, PM-10, TSP or OTHER. NOTE: Some processing options are pollutant-specific, and require the user to specify the appropriate pollutant ID. For example, use of PM10, PM-10, PM25, PM2.5, PM-2.5, PM-25, LEAD, NO2, SO2, or OTHER allows for the use of the MULTYEAR option. Use of PM25, PM2.5, PM-2.5, or PM-25, triggers special processing for the PM-2.5 NAAQS, based on values averaged across the number of years processed (see Section 3.2.14.1). Use of NO2 or SO2 triggers special processing for their respective 1-hr NAAQS based on daily maximum 1-hr concentrations, averaged across the number of years modeled if the CO AVERTIME keyword includes 1-hr averages (see Section 3.2.15). Use of NO2 is required in order to use the OLM and PVMRM options for simulating conversion of NO to NO_2. Use of SO2 also triggers the use of a 4-hour half-life for SO_2 decay for urban applications under the regulatory default option.

Keyword	Parameters	
	H1H or H2H or INC	Use of the H1H or H2H or INC keyword (not case-specific) disables the special processing requirements associated the 1-hr NO2 and SO2 NAAQS and the 24-hr PM2.5 NAAQS. Specifying one of these keywords would allow for modeling PM2.5 24-hr increments which are based on the H2H value, and also allow evaluating NO2 options in AERMOD based on incomplete years of field measurements.
HALFLIFE	Haflif	
where:	Haflif	Half-life used for exponential decay (s)
DCAYCOEF	Decay	
where:	Decay	Decay coefficient for exponential decay (s^{-1}) = 0.693/HAFLIF
GASDEPDF	React F_Seas2 F_Seas5 (Refpoll)	
where:	React F_Seas2 F_Seas5 (Refpoll)	Value for pollutant reactivity factor (f_o) Fraction (F) of maximum green LAI for seasonal category 2 Fraction (F) of maximum green LAI for seasonal category 5 Optional name of reference pollutant
GASDEPVD	Uservd	
where:	Uservd	User-specified dry deposition velocity (m/s) for gaseous pollutants
GDLANUSE	Sec1 Sec2 ... Sec36	
where:	Sec1 Sec2 . . Sec36	Land use category for winds blowing toward sector 1 (10 degrees) Land use category for winds blowing toward sector 2 (20 degrees) Land use category for winds blowing toward sector 36 (360 degrees)
GDSEASON	Jan Feb ... Dec	
where:	Jan . . . . Dec	Seasonal category for January: 1 = Midsummer/Lush vegetation; 2 = Autumn/Unharvested cropland; 3 = Late autumn after harvest or Winter with no snow; 4 = Winter with continuous snow cover; or 5 = Transitional spring/partial green coverage/short annuals) Seasonal category for December
LOW_WIND	SVmin (WSmin) SVmin (WSmin (FRANmax)) SVmin (WSmin (FRANmax))	[for LOWWIND1] [for LOWWIND2] [for LOWWIND3]
where:	SVmin (WSmin) (FRANmax)	Minimum value of sigma-v, within a range of 0.01 to 1.0 m/s Minimum value of wind speed, within a range of 0.01 to 1.0 m/s Maximum value meander factor, within a range of 0.50 to 1.0 inclusive

Keyword	Parameters	
NO2EQUIL	NO2Equil	
where:	NO2Equil	Equilibrium ratio of NO_2/NO_x for the PVMRM and OLM options; between 0.1 and 1.0, inclusive (default is 0.9)
NO2STACK	NO2Ratio	
where:	NO2Ratio	Default in-stack ratio of NO_2/NO_x for PVMRM and OLM options, which may be overridden by NO2RATIO keyword on SO pathway. <u>NOTE:</u> Beginning with version 11059, AERMOD no longer assumes a default in-stack ratio of 0.1 for the OLM option.
ARMRATIO	ARM_1hr (ARM_Ann) For ARM Option or ARM2_Min ARM2_Max For ARM2 Option	
where:	ARM_1hr ARM_Ann ARM2_Min ARM2_Max	ARM ambient ratio for NO2/NOx applied for 1hr NO2 concentrations, with a default value of 0.80 ARM ambient ratio for NO2/NOx applied for Annual NO2 concentrations, with a default value of 0.75 Minimum ARM2 ambient ratio, with a default value of 0.50 Maximum ARM2 ambient ratio, with a default value of 0.90
O3SECTOR	StartSect1 StartSect2 . . . StartSectN, where N is ≤ 6	
where:	StartSect1 StartSect2 . . StartSectN	Starting direction for the first sector Starting direction for the second sector . . Starting direction for the last sector <u>NOTE:</u> The minimum sector width allowed is 30 degrees, and warning messages will be issued for sector widths less than 60 degrees. Sector-varying O3 concentrations will be selected based on the flow vector, i.e., the downwind direction based on the wind direction specified in the surface meteorological data file.
OZONEFIL	O3FileName (O3Units) (O3Format) (without O3SECTORs) or SECTn O3FileName (O3Units) (O3Format) (with O3SECTORs)	
where:	SECTn O3FileName (O3Units) (O3Format)	Applicable sector (n = 1 to 6) defined on the CO O3SECTOR keyword, if specified Filename for hourly ozone data file (YR, MN, DY, HR, O3Value) Units of ozone data (PPM, PPB, or UG/M3); default is UG/M3 Fortran format statement to read ozone file; default is FREE-format, i.e., comma or space-delimited data fields (Yr Mn Dy Hr O3Value). The O3Format parameter must include open and close parentheses, the date variables must be read as integers (Fortran I

Keyword	Parameters	
		format), and the O3Value must be read as real (Fortran F, E, or D format), e.g., '(4I2,F8.3)'. The year may be specified as a 2-digit or 4-digit year, and the data period in the OZONEFIL must match the data period in the meteorological data files.
OZONEVAL	O3Value (O3Units) (without O3SECTORs) or SECTn O3Value (O3Units) (with O3SECTOR)	
where:	SECTn O3Value (O3Units)	Applicable sector (n = 1 to 6) defined on the CO O3SECTOR keyword, if specified Background ozone concentration; also used to substitute for missing data in OZONEFIL Units of ozone value (PPM, PPB, or UG/M3); default is UG/M3
O3VALUES	O3Flag O3values(i), i=1,n) (without O3SECTORs) or SECTn O3Flag O3values(i), i=1,n) (with O3SECTORs)	
where:	SECTn O3Flag

Keyword	Parameters	
		default value of 0.0 m is used if this optional parameter is omitted
RUNORNOT	RUN or NOT	
where:	RUN NOT	Indicates to run full model calculations Indicates to process setup data and report errors, but to not run full model calculations
EVENTFIL	(Evfile) (Evopt)	
where:	(Evfile) (Evopt)	Identifies the filename to be used to generate a file for input to EVENT model (Default=EVENTFIL.INP) Optional parameter to specify the level of output detail selected for the EVENT model: either SOCONT or DETAIL (default is DETAIL if this parameter is omitted)
SAVEFILE	(Savfil) (Dayinc) (Savfl2)	
where:	(Savfil) (Dayinc) (Savfl2)	Specifies name of disk file to be used for storing intermediate results (default = SAVE.FIL); file is overwritten after each dump Number of days between dumps (optional: default is 1) Optional second disk filename to be used on alternate dumps - eliminates risk of system crash during the dump. If blank, file is overwritten each time.
INITFILE	(Inifil)	
where:	(Inifil)	Specifies name of disk file of intermediate results to be used for initializing run (default = SAVE.FIL)
MULTYEAR	(H6H) Savfil (Inifil)	
where:	(H6H) Savfil (Inifil)	Optional field formerly used to specify that High-Sixth-High is being calculated for use in PM10 processing; no longer required Specifies name of file to be used for storing results at the end of the year Optional name of file used for initializing the results arrays from previous year(s). The Inifil parameter is not used for the first year in the multi-year run.
DEBUGOPT	MODEL (Dbgfil) and/or METEOR (Dbmfil) and/or PRIME (Prmfil) and/or DEPOS and/or [AREA (AreaDbFil) or LINE (LineDbFil)] and/or [PVMRM (Dbpvfil) or OLM (OLMfil) or ARM (ARMfil) or ARM2 (ARM2fil)]	
where:	MODEL (Dbgfil) METEOR (Dbmfil) PRIME	Specifies that MODEL debugging output will be generated Optional filename for the model calculation debug file (a default filename of 'MODEL.DBG' will be used if omitted) Specifies that METEORological profile data file will be generated Optional filename for the meteorological profile data file (a default filename of 'METEOR.DBG' will be used if omitted) Specifies that PRIME debugging output will be generated

Keyword	Parameters	
	(Prmfil)	Optional filename for PRIME debug file (a default filename of 'PRIME.DBG' will be used if omitted)
	DEPOS	Specifies that DEPOSition debugging output will be generated, using default filenames of 'GDEP.DAT' for gas deposition and 'PDEP.DAT' for particle deposition.
	AREA or LINE	Specifies that AREA or LINE debugging output will be generated, including debugging outputs for OPENPIT sources, if included in the modeling.
	(AreaDbfil)	Optional filename for AREA debug file (a default filename of 'AREA.DBG' will be used if omitted)
	PVMRM	Specifies that PVMRM debugging output will be generated
	(Dbpvfil)	Optional filename for PVMRM debug file (a default filename of 'PVMRM.DBG' will be used if omitted)
	OLM	Specifies that OLM debugging output will be generated
	(OLMfil)	Optional filename for OLM debug file (a default filename of 'OLM.DBG' will be used if omitted)
	ARM	Specifies that ARM debugging output will be generated
	(ARMfil)	Optional filename for ARM debug file (a default filename of 'ARM.DBG' will be used if omitted)
	ARM2	Specifies that ARM2 debugging output will be generated
	(ARM2fil)	Optional filename for ARM2 debug file (a default filename of 'ARM2.DBG' will be used if omitted)
		Note: The user can specify any of the applicable debug options for a particular model run, and the options can be specified in any order. However, the optional filenames must be specified immediately after the keyword option associated with the filename. Also note that debugging information that was written to the main 'aermod.out' file for the MODEL debug option prior to version 13350 is now written to the applicable debug file (either MODEL or PRIME), and beginning with version 14134 debug information for AREA/LINE/OPENPIT sources is written to the AREA debug file.
ERRORFIL	(Errfil)	
where:	(Errfil)	Specifies name of detailed error listing file (default = ERRORS.LST)

Table B-3. Description of Source Pathway Keywords

SO Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of SOURCE pathway inputs
ELEVUNIT	O – N	Defines input units for source elevations (defaults to meters), must be first keyword after SO STARTING if used.
LOCATION	M – R	Identifies coordinates for particular source
SRCPARAM	M – R	Identifies source parameters for a particular source
BUILDHGT	O – R	Building height values for each wind sector
BUILDLEN	O – R	Building projected length values for each wind sector
BUILDWID	O – R	Building projected width values for each wind sector
XBADJ	O – R	Along-flow distances from the stack to the center of the upwind face of the projected building
YBADJ	O – R	Across-flow distances from the stack to the center of the upwind face of the projected building
AREAVERT	M – R	Specifies location of vertices for an AREAPOLY source type (mandatory if AREAPOLY source is used)
URBANSRC	O – R	Identifies which sources to model with urban effects
EMISFACT	O – R	Optional input for variable emission rate factors
EMISUNIT	O – N	Optional unit conversion factors for emissions, concentrations
CONCUNIT	O – N	Optional conversion factors for emissions and concentrations
DEPOUNIT	O – N	Optional conversion factors for emissions and depositions
PARTDIAM	O – R	Input variables for optional input of particle size (microns)
MASSFRAX	O – R	Optional input of mass fraction for each particle size category
PARTDENS	O – R	Optional input of particle density (g/cm^3) for each size category
METHOD_2	O – R	Optional input of parameters for METHOD_2 particle deposition
GASDEPOS	O – R	Optional input of gas deposition parameters
NO2RATIO	O – R	Option to specify in-stack NO2/NOx equilibrium ratio for OLM and PVMRM options by source
HOUREMIS	O – R	Option for specifying hourly emission rates in a separate file
BGSECTOR	O – N	Specifies optional wind sectors for use in varying background concentrations by wind direction for the pollutant being modeled, as specified on the BACKGRND keyword
BACKGRND	O – R	Option to specify temporally varying background concentrations
BACKUNIT	O – N	Option to specify units for background concentrations
INCLUDED	O – R	Option to include data from a separate file in the runstream

SO Keywords	Type	Keyword Description
OLMGROUP	O – R	Specifies sources to combine for OLM option to account for merging plumes
PSDGROUP[1]	O – R	Specifies source groups for PSDCREDIT option with PVMRM
SRCGROUP[1]	M – R	Identification of source groups
FINISHED	M – N	Identifies the end of SOURCE pathway inputs

1) The PSDGROUP or SRCGROUP keywords must be the last keyword within the SO pathway before the FINISHED keyword. The SRCGROUP keyword is mandatory, unless the PSDCREDIT option is used, which requires the PSDGROUP option instead.

Table B-4. Description of Source Pathway Keywords and Parameters

Keyword	Parameters	
ELEVUNIT	METERS or FEET	
where:	METERS FEET	Specifies input units for source base elevations of meters (default if ELEVUNIT is omitted) Specifies input units for source elevations of feet Note: This keyword applies to source base elevations only.
LOCATION	SrcID Srctyp Xs Ys (Zs) [for all Srctyp's except LINE] or (FLAT) [for 'FLAT & ELEV' option] or SrcID Srctyp Xs1 Ys1 Xs2 Ys2 (Zs) [for LINE Srctyp] or (FLAT) [for 'FLAT & ELEV' option]	
where:	SrcID Srctyp Xs Ys Xs1, Xs2 Ys1, Ys2 (Zs) (FLAT)	Source identification code (unique alphanumeric string of up to 12 characters) Source type: POINT, POINTCAP, POINTHOR, VOLUME, AREA, AREAPOLY, AREACIRC, OPENPIT, LINE, or BUOYLINE * x-coord of source location, corner for AREA, AREAPOLY, and OPENPIT, center for AREACIRC (m) y-coord of source location, corner for AREA, AREAPOLY, and OPENPIT, center for AREACIRC (m) x-coords of midpoint for start and end of LINE source (m) y-coords of midpoint for start and end of LINE source (m) Optional z-coord of source location (elevation above mean sea level, defaults to 0.0 if omitted) Optional keyword to indicate non-DFAULT option for identifying sources to model as FLAT terrain
SRCPARAM	SrcID Ptemis Stkhgt Stktmp Stkvel Stkdia (POINT, POINTCAP, POINTHOR source) Vlemis Relhgt Syinit Szinit (VOLUME source) Aremis Relhgt Xinit (Yinit) (Angle) (Szinit) (AREA source) Aremis Relhgt Nverts (Szinit) (AREAPOLY source) Aremis Relhgt Radius (Nverts) (Szinit) (AREACIRC source) Lnemis Relhgt Width (Szinit) (LINE source) Opemis Relhgt Xinit Yinit Pitvol (Angle) (OPENPIT source)	
where:	SrcID __Emis ___Hgt Stktmp Stkvel Stkdia	Source identification code Source emission rate: in g/s for Ptemis and Vlemis; g/(s-m^2) for Aremis, Lnemis, and Opemis Source physical release height above ground (center of height for VOLUME, height above base of pit for OPENPIT) Stack gas exit temperature (K) Stack gas exit velocity (m/s) Stack inside diameter (m)

Keyword	Parameters	
	Syinit Szinit Xinit Yinit Angle Nverts Radius Width Pitvol	Initial lateral dimension of VOLUME source (m) Initial vertical dimension of VOLUME, AREA, LINE source (m) Length of side of AREA source in X-direction (m) Length of side of AREA source in Y-direction (m) (optional parameter, assumed to be equal to Xinit if omitted) Orientation angle (deg) of AREA or OPENPIT source relative to N measured positive clockwise, rotated around the source location, (Xs,Ys) (optional parameter, assumed to be 0.0 if omitted) Number of vertices used for AREAPOLY or AREACIRC source (optional for AREACIRC sources) Radius of circular area for AREACIRC source (m) Width of LINE source (m) Volume of OPENPIT source (m^3)
BUILDHGT	SrcID (or SrcRange) Dsbh(i), i=1,36	
where:	SrcID SrcRange Dsbh	Source identification code Range of sources (inclusive) for which building dimensions apply, entered as two alphanumeric strings separated by a '-' Array of direction-specific building heights (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
BUILDLEN	SrcID (or SrcRange) Dsbl(i), i=1,36	
where:	SrcID SrcRange Dsbl	Source identification code Range of sources (inclusive) for which building dimensions apply Array of direction-specific building lengths (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
BUILDWID	SrcID (or SrcRange) Dsbw(i), i=1,36	
where:	SrcID SrcRange Dsbw	Source identification code Range of sources (inclusive) for which building dimensions apply Array of direction-specific building widths (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
XBADJ	SrcID (or SrcRange) Xbadj(i), i=1,36	
where:	SrcID SrcRange Xbadj(i)	Source identification code Range of sources (inclusive) for which XBADJ distances apply Array of direction-specific along-wind distances beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
YBADJ	SrcID (or SrcRange) Ybadj(i), i=1,36	
where:	SrcID SrcRange Ybadj(i)	Source identification code Range of sources (inclusive) for which YBADJ distances apply Array of direction-specific across-wind distances beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
AREAVERT	SrcID Xv(1) Yv(1) Xv(2) Yv(2) ... Xv(i) Yv(i)	
where:	SrcID	Source identification code

Keyword	Parameters	
	Xv(1) Yv(1) Xv(i) Yv(i)	X-coordinate of the first vertex of an AREAPOLY source (must be the same as the value of Xs for that source defined on the SO LOCATION card) Y-coordinate of the first vertex of an AREAPOLY source (must be the same as the value of Ys for that source defined on the SO LOCATION card) X-coordinate for the ith vertex of an AREAPOLY source Y-coordinate for the ith vertex of an AREAPOLY source
URBANSRC	<u>For multiple urban areas:</u> UrbanID SrcID's and/or SrcRng's <u>For single urban areas:</u> SrcID's and/or SrcRng's User may also specify 'ALL' for SrcID's to assign all sources as urban.	
where:	UrbanID SrcID SrcRange	Specifies the alphanumeric urban ID (up to eight characters) Specifies which source(s) will be modeled with urban effects Specifies a range of sources that will be modeled with urban effects
EMISFACT	SrcID (or SrcRange) Qflag Qfact(i), i=1,n	
where:	SrcID SrcRange Qflag

Keyword	Parameters	
		than one output type is generated (default is micrograms/m**3 for concentration and grams/m**2 for deposition)
CONCUNIT	Emifac Emilbl Conlbl	
where:	Emifac Emilbl Conlbl	Emission rate factor used to adjust units of output (default value is 1.0E06 for concentration for grams to micrograms) Label to use for emission units (default is grams/sec) Label to use for concentrations (default is micrograms/m^3)
DEPOUNIT	Emifac Emilbl Deplbl	
where:	Emifac Emilbl Deplbl	Emission rate factor used to adjust units of output for deposition (default value is 3600 for grams/sec to grams/m^2/hr) Label to use for emission units (default is grams/sec) Label to use for deposition (default is grams/m^2)
PARTDIAM	SrcID (or SrcRange) Pdiam(i), i=1,Npd	
where:	SrcID SrcRange Pdiam	Source identification code Range of sources (inclusive) for which size categories apply Array of particle diameters (microns)
MASSFRAX	SrcID (or SrcRange) Phi(i), i=1,Npd	
where:	SrcID SrcRange Phi	Source identification code Range of sources (inclusive) for which mass fractions apply Array of mass fractions for each particle size category
PARTDENS	SrcID (or SrcRange) Pdens(i), i=1,Npd	
where:	SrcID SrcRange Pdens	Source identification code Range of sources (inclusive) for which particle densities apply Array of particle densities (g/cm^3) for each size category
METHOD_2	SrcID (or SrcRange) FineMassFraction Dmm	
where:	SrcID FineMassFraction Dmm	Source identification code Fraction (between 0 and 1) of particle mass emitted in fine mode, less than 2.5 microns Representative mass mean particle diameter in microns
GASDEPOS	SrcID (or SrcRange) Da Dw rcl Henry	
where:	SrcID Da Dw rcl Henry	Source identification code Diffusivity in air for the pollutant being modeled (cm^2/s) Diffusivity in water for the pollutant being modeled (cm^2/s) Cuticular resistance to uptake by lipids for individual leaves (s/cm) Henry's Law constant (Pa m^3/mol)
NO2RATIO	SrcID (or SrcRange) NO2Ratio	
where:	SrcID SrcRange NO2Ratio	Source identification code Source ID range for specified ratio In-stack ratio of NO_2/NO_x

Keyword	Parameters	
HOUREMIS	Emifil SrcID's SrcRange's	
where:	Emifil SrcID's SrcRange's	Specifies name of the hourly emission rate file Discrete source IDs that are included in the hourly emission file Source ID ranges that are included in the hourly emission file
BGSECTOR	StartSect1 StartSect2 . . . StartSectN, where N is ≤ 6	
where:	StartSect1 StartSect2 . . StartSectN	Starting direction for the first sector Starting direction for the second sector . . Starting direction for the last sector <u>NOTE:</u> The minimum sector width allowed is 30 degrees, and warning messages will be issued for sector widths less than 60 degrees. Sector-varying background concentrations will be selected based on the flow vector, i.e., the downwind direction, based on the wind direction specified in the surface meteorological data file.
BACKGRND	BGflag BGvalue(i), i=1,n and/or (without BGSECTORs) <u>HOURLY</u> BGfilnam (BGformat) or SECTn BGflag BGvalue(i), i=1,n and/or (with BGSECTORs) SECTn <u>HOURLY</u> BGfilnam (BGformat)	
where:	SECTn BGflag

Keyword	Parameters	
		SHRDOW7, n=672; MHRDOW, n=864; MHRDOW7, n=2016
	HOURLY	Flag indicating that hourly background concentrations are specified in a separate data file; data period must match the meteorological data period being processed; no missing values are allowed in the hourly file, unless temporally-varying background concentrations are also specified through the BGflag parameter, which are used to substitute for missing hourly values.
	BGfilnam	Filename for hourly background concentrations
	(BGformat)	Optional Fortran format of hourly background concentration file; the default format is FREE format, i.e., comma or space-delimited data fields (Yr Mn Dy Hr BGvalue). The BGformat parameter must include open and close parentheses, the date variables must be read as integers (Fortran I format), and the BGvalue must be read as real (Fortran F, E, or D format), e.g., '(4I2,F8.3)'. The year may be specified as a 2-digit or 4-digit year, and the data period in the HOURLY background file must match the data period in the meteorological data files. The BGformat parameter cannot include any blank spaces, unless the field in enclosed by double quotes. NOTE: Background concentrations specified on the BACKGRND keyword are currently assumed to be in units of PPB for NO_2 and SO_2, PPM for CO, and UG/M3 for all other pollutants, unless otherwise specified on the SO BACKUNIT keyword. Background concentrations can be included with any source group, including group 'ALL', by including a "SrcID" of 'BACKGROUND' on the SRCGROUP keyword. **Note that background concentrations are automatically included with group ALL by default; however, background concentrations can be excluded from group ALL by including NOBACKGROUND (or NOBACKGRND) on the SRCGROUP ALL keyword.**
BACKUNIT	BGunits	
where:	BGunits	Background concentration units, specified as PPB for parts-per-billion, PPM for parts-per-million, or UG/M3 for micrograms/cubic-meter. Background concentrations input in units of PPB or PPM are converted to micrograms/cubic-meter based on reference temperature (25 C) and pressure (1013.25 mb).
INCLUDED	Incfil	
where:	SrcIncFile	Filename for the included source file, up to 200 characters in length; double quotes (") may be used as delimiters for the filename to

Keyword	Parameters	
		allow for embedded spaces; and quotes don't count toward the limit of 200
OLMGROUP	OLMGrpID SrcID's SrcRange's or ALL	
where:	OLMGrpID SrcID's SrcRange's	Group ID (Grpid = ALL specifies group including all sources) Discrete source IDs to be included in group Source ID ranges to be included in group Note: Card may be repeated with same Grpid if more space is needed to specify sources
PSDGROUP	PSDGrpID SrcID's SrcRange's	
where:	PSDGrpID SrcID's SrcRange's	PSD GrpID for PSDCREDIT option, must be one of the following: INCRCONS – increment-consuming sources, NONRBASE – non-retired baseline sources, or RETRBASE – retired (increment-expanding) baseline sources. Discrete source IDs to be included in group Source ID ranges to be included in group Note: Card may be repeated with same PSDGrpID if more space is needed to specify sources
SRCGROUP	SrcGrpID SrcID's SrcRange's	
where:	SrcGrpID SrcID's SrcRange's	Group ID (Grpid = ALL specifies group including all sources) Discrete source IDs to be included in group; a "SrcID" of 'BACKGROUND' (or 'BACKGRND') can be used to include background concentrations, based on the BACKGRND keyword. Also note that background concentrations are automatically included with group ALL; however, background concentrations can be excluded from group ALL by specifying 'NOBACKGROUND' on the SRCGROUP ALL keyword. Source ID ranges to be included in group Note: Card may be repeated with same Grpid if more space is needed to specify sources

Table B-5. Description of Receptor Pathway Keywords

RE Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of RECEPTOR pathway inputs
ELEVUNIT	O – N	Defines input units for receptor elevations (defaults to meters), must be first keyword after RE STARTING if used.
GRIDCART	O[1] – R	Defines a Cartesian grid receptor network
GRIDPOLR	O[1] – R	Defines a polar receptor network
DISCCART	O[1] – R	Defines the discretely placed receptor locations referenced to a Cartesian system
DISCPOLR	O[1] – R	Defines the discretely placed receptor locations referenced to a polar system
EVALCART	O[1] – R	Defines discrete Cartesian receptor locations for use with EVALFILE output option
INCLUDED	O – R	Identifies an external file containing receptor locations to be included in the inputs
FINISHED	M - N	Identifies the end of RECEPTOR pathway inputs

1) At least one of the following must be present: GRIDCART, GRIDPOLR, DISCCART, DISCPOLR, or EVALCART, unless the INCLUDED keyword is used to include receptor inputs from an external file. Multiple receptor networks can be specified in a single run, including both Cartesian and polar.

Table B-6. Description of Receptor Pathway Keywords and Parameters

Keyword	Parameters	
ELEVUNIT	METERS or FEET	
where:	METERS FEET	Specifies input units for receptor elevations of meters Specifies input units for receptor elevations of feet Note: This keyword applies to receptor elevations only.
GRIDCART	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta or XPNTS Gridx1 Gridx2 Gridx3 .... GridxN, and YPNTS Gridy1 Gridy2 Gridy3 .... GridyN ELEV Row Zelev1 Zelev2 Zelev3 ... ZelevN HILL Row Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Row Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta XPNTS Gridx1 GridxN YPNTS Gridy1 GridyN ELEV Row Zelev HILL Row Zhill FLAG Row Zflag END	Receptor network identification code (up to eight alphanumeric characters) Indicates STArt of GRIDCART subpathway, repeat for each new Netid Keyword identifying grid network generated from x and y increments Starting local x-axis grid location in meters Number of x-axis receptors Spacing in meters between x-axis receptors Starting local y-axis grid location in meters Number of y-axis receptors Spacing in meters between y-axis receptors Keyword identifying grid network defined by series of x and y coordinates Value of first x-coordinate for Cartesian grid Value of 'nth' x-coordinate for Cartesian grid Keyword identifying grid network defined by series of x and y coordinates Value of first y-coordinate for Cartesian grid Value of 'nth' y-coordinate for Cartesian grid Keyword to specify that receptor elevations follow Indicates which row (y-coordinate fixed) is being input An array of receptor terrain elevations for a particular Row Keyword to specify that hill height scales follow Indicates which row (y-coordinate fixed) is being input An array of hill height scales for a particular Row Keyword to specify that flagpole receptor heights follow Indicates which row (y-coordinate fixed) is being input An array of receptor heights above local terrain elevation for a particular Row (flagpole receptors) Indicates END of GRIDCART subpathway, repeat for each new Netid
GRIDPOLR	Netid STA ORIG Xinit Yinit, or ORIG Srcid	

Keyword	Parameters	
	DIST Ring1 Ring2 Ring3 ... RingN DDIR Dir1 Dir2 Dir3 ... DirN, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... ZelevN HILL Dir Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Dir Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid	Receptor network identification code (up to eight alphanumeric characters)
	STA	Indicates STArt of GRIDPOLR subpathway, repeat for each new Netid
	ORIG	Optional keyword to specify the origin of the polar network (assumed to be at x=0, y=0 if omitted)
	Xinit	local x-coordinate for origin of polar network (m)
	Yinit	local y-coordinate for origin of polar network (m)
	Srcid	Source ID of source used as origin of polar network
	DIST	Keyword to specify distances for the polar network
	Ring1	Distance to the first ring of polar coordinates (m)
	RingN	Distance to the 'nth' ring of polar coordinates (m)
	DDIR	Keyword to specify discrete direction radials for the polar network
	Dir1	First direction radial in degrees (1 to 360)
	DirN	The 'nth' direction radial in degrees (1 to 360)
	GDIR	Keyword to specify generated direction radials for the polar network
	Dirnum	Number of directions used to define the polar system
	Dirini	Starting direction of the polar system
	Dirinc	Increment (in degrees) for defining directions
	ELEV	Keyword to specify that receptor elevations follow
	Dir	Indicates which direction is being input
	Zelev	An array of receptor terrain elevations for a particular direction radial
	HILL	Keyword to specify that hill height scales follow
	Row	Indicates which row (y-coordinate fixed) is being input
	Zhill	An array of hill height scales for a particular Row Keyword to specify that flagpole receptor heights follow
	FLAG	Keyword to specify that flagpole receptor heights follow
	Dir	Indicates which direction is being input
	Zflag	An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors)
	END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid
DISCCART	Xcoord Ycoord (Zelev Zhill) (Zflag)	
where:	Xcoord	local x-coordinate for discrete receptor location (m)
	Ycoord	local y-coordinate for discrete receptor location (m)
	(Zelev)	Elevation above sea level for discrete receptor location (optional), used only for ELEV terrain
	(Zhill)	Hill height scale (optional)
	(Zflag)	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword
DISCPOLR	Srcid Dist Direct (Zelev Zhill) (Zflag)	

Keyword	Parameters	
where:	Srcid	Specifies source identification for which discrete polar receptor locations apply (used to define the origin for the discrete polar receptor)
	Dist	Downwind distance to receptor location (m)
	Direct	Direction to receptor location, in degrees clockwise from North
	(Zelev)	Elevation above sea level for receptor location (optional), used only for ELEV terrain
	(Zhill)	Hill height scale (optional)
	(Zflag)	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword
EVALCART	Xcoord Ycoord Zelev Zhill Zflag Arcid (Name)	
where:	Xcoord	Local x-coordinate for discrete receptor location (m)
	Ycoord	Local y-coordinate for discrete receptor location (m)
	Zelev	Elevation above sea level for discrete receptor location (optional), used only for ELEV terrain
	Zhill	Hill height scale (m)
	Zflag	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword
	Arcid	Receptor arc ID used to group receptors along an arc or other grouping (up to eight characters)
	(Name)	Optional name for receptor (up to eight characters)
INCLUDED	RecIncFile	
where:	RecIncFile	Identifies the filename for the included receptor file, up to 200 characters in length; double quotes (“) may be used as delimiters for the filename to allow for embedded spaces; quotes don’t count toward the limit of 200

Table B-7. Description of Meteorology Pathway Keywords

ME Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of METEOROLOGY pathway inputs
SURFFILE	M – N	Describes input meteorological surface data file
PROFFILE	M – N	Describes input meteorological profile data file
SURFDATA	M – N	Describes surface meteorological station
UAIRDATA	M – N	Describes upper air meteorological station
SITEDATA	O – N	Describes on-site meteorological station
PROFBASE	M – N	Specifies the base elevation for the potential temperature profile
STARTEND	O – N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file)
DAYRANGE	O – R	Specifies days or ranges of days to process (default is to process all data)
SCIMBYHR	O – N	Specifies the parameters for the SCIM (Sampled Chronological Input Model) option (see CO MODELOPT)
WDROTATE	O – N	May be used to correct for alignment problems of wind direction measurements, or to convert wind direction from to flow vector
WINDCATS	O – N	Input upper bounds of wind speed categories, five values input - sixth category is assumed to have no upper bound (used for WSPEED option on the EMISFACT keyword)
FINISHED	M – N	Identifies the end of METEOROLOGY pathway inputs

Table B-8. Description of Meteorology Pathway Keywords and Parameters

Keyword	Parameters	
SURFFILE	Sfcfil	
where:	Sfcfil	Specify filename for surface meteorological input file Note: FREE format is used for all SURFFILE reads beginning with version 09292.
PROFFILE	Profil	
where:	Profil	Specify filename for profile meteorological input file Note: FREE format is used for all PROFFILE reads beginning with version 09292.
SURFDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number, e.g. 5-digit WBAN number for NWS station Year of data being processed (four digits) Station name (optional) x-coordinate of station location (m) (optional) y-coordinate of station location (m) (optional)
UAIRDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number, e.g. 5-digit WBAN number for NWS station Year of data being processed (four digits) Station name (optional) x-coordinate of station location (m) (optional) y-coordinate of station location (m) (optional)
SITEDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum Year (Name) (Xcoord) (Ycoord)	Station number for on-site meteorological data station Year of data being processed (four digits) Station name (optional) x-coordinate of station location (m) (optional) y-coordinate of station location (m) (optional)
PROFBASE	BaseElev (Units)	
where:	BaseElev (Units)	Base elevation (above MSL) for the potential temperature profile Units of BaseElev: METERS or FEET (default is METERS)
STARTEND	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)	
where:	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)	Year of first record to be read Month of first record to be read Day of first record to be read Hour of first record to be read (optional) Year of last record to be read Month of last record to be read Day of last record to be read Hour of last record to be read (optional)

Keyword	Parameters	
		Note: File read begins with hour 1 of the start date and ends with hour 24 of the end date if Stahr and Endhr are omitted.
DAYRANGE	Range1 Range2 Range3 ... RangeN	
where:	Range1 RangeN	First range of days to process, either as individual day (XXX) or as range (XXX-YYY); days may be input as Julian dates (XXX) or as month and day (XX/YY) The 'N-th' range of days to process
NUMYEARS	NumYrs	
where:	NumYrs	Specifies the number of years of meteorological data being processed for purposes of allocating array storage for the OU MAXDCONT option. A default value of 5 years is assumed if the optional NUMYEARS keyword is omitted.
SCIMBYHR	NRegStart NRegInt (SfcFilnam PflFilnam)	
where:	NRegStart NRegInt (SfcFilnam) (PflFilnam)	Specifies the first hour to be sampled with the SCIM option; required to have a value from 1 to 24 Specifies the sampling interval, in hours Optional output file name to list the surface meteorological data for the sampled hours Optional output file name to list the profile meteorological data for the sampled hours
WDROTATE	Rotang	
where:	Rotang	Specifies angle (in degrees) to rotate wind direction measurements to correct for alignment problems; value of Rotang is subtracted from WD measurements, i.e., rotation is counterclockwise
WINDCATS	Ws1 Ws2 Ws3 Ws4 Ws5	
where:	Ws1 Ws2 Ws3 Ws4 Ws5	Upper bound of first wind speed category (m/s) Upper bound of second wind speed category (m/s) Upper bound of third wind speed category (m/s) Upper bound of fourth wind speed category (m/s) Upper bound of fifth wind speed category (m/s) (sixth category is assumed to have no upper bound)

Table B-9. Description of Event Pathways and Keywords

EV Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of EVENT pathway inputs
EVENTPER	M – R	Describes data and averaging period for an event
EVENTLOC	M – R	Describes receptor location for an event
INCLUDED	O – R	Identifies an external file containing EVENT data to be included in the inputs
FINISHED	M – N	Identifies the end of EVENT pathway inputs

Table B-10. Description of Event Pathway Keywords and Parameters

Keyword	Parameters	
EVENTPER	Evname Aveper Grpid Date Conc	
where:	Name Grpid Aveper Date Conc	Specify name of event to be processed (e.g. H002H24ALL), (up to ten alphanumeric characters) Specify source group ID for event Specify averaging period for event Specify data period for event (ending YYMMDDHH for averaging period) Specifies the concentration value generated during the initial non-EVENT processing
EVENTLOC	Evname XR= Xr YR= Yr (Zelev Zhill) (Zflag) or RNG= Rng DIR= Dir (Zelev Zhill) (Zflag)	
where:	Evname XR= YR= RNG= DIR= (Zelev) (Zhill) (Zflag)	Specify name of event to be processed (e.g. H002H24ALL), (up to ten alphanumeric characters) X-coordinate for event (discrete Cartesian receptor) Y-coordinate for event (discrete Cartesian receptor) Distance range for event (discrete polar receptor) Radial direction for event (discrete polar receptor) Terrain elevation for event (optional) Hill height scale (optional) Receptor height above ground for event (optional)
INCLUDED	EventIncFile	
where:	EventIncFile	Identifies the filename for the included EVENT file, up to 200 characters in length; double quotes (“) may be used as delimiters for the filename to allow for embedded spaces; and quotes don’t count toward the limit of 200

Note: EVENT locations can be input as either discrete Cartesian receptors (XR=, YR=) or as discrete polar receptors (RNG=, DIR=). Events that are specified in the file generated by the AERMOD model (CO EVENTFIL card) are always given as discrete Cartesian coordinates. Discrete polar receptors are assumed to be relative to an origin of (0,0).

Table B-11. Description of Output Pathway Keywords

OU Keywords	Type	Keyword Description
STARTING	M – N	Identifies the start of OUTPUT pathway inputs
RECTABLE	O – R	Option to specify value(s) by receptor for output
MAXTABLE	O – R	Option to summarize the overall maximum values
DAYTABLE	O – N	Option to print summaries for each averaging period for each day processed.
MAXIFILE	O – R	Option to list events exceeding a threshold value to file (if CO EVENTFIL option is used, these events are included in the input file generated for the EVENT model).
POSTFILE[1]	O – R	Option to write results to a mass storage file for postprocessing.
PLOTFILE[1]	O – R	Option to write certain results to a storage file suitable for input to plotting routines
TOXXFILE	O – R	Option to write results to a storage file suitable for input to the TOXX model component of TOXST or the RISK
RANKFILE	O – R	Option to output file of ranked values for Q-Q plots (must be used with the MAXTABLE keyword)
EVALFILE	O – R	Option to output file of normalized arc maxima from EVALCART receptors for model evaluation studies
SEASONHR	O – R	Option to output results by season and hour-of-day
MAXDAILY	O – R	Option to output file of daily maximum 1-hour values for each day processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
MXDYBYYR	O – R	Option to output file of daily maximum 1-hour values by year, for each year processed; only applicable for 1-hour NO_2 and 1-hour SO_2 NAAQS
MAXDCONT	O – R	Option to output contributions of each source group to ranked values averaged across years for a reference source group, paired in time and space; only applicable for 24-hour PM2.5, 1-hour NO_2, and 1-hour SO_2 NAAQS
SUMMFILE	O – N	Option to output summary of high ranked values to separate file
FILEFORM	O – N	Specify fixed or exponential format for output results files
NOHEADER	O – N	Option to suppress file headers for output file options, e.g., POSTFILE, PLOTFILE, MAXDCONT, etc.
EVENTOUT	M – N	Specifies the level of output information provided for EVENT Processing [EVENT Only]
FINISHED	M – N	Identifies the end of OUTPUT pathway inputs

1) POSTFILE is used to output concurrent concentration values for particular source groups and averaging times across the receptor network suitable for postprocessing. PLOTFILE is used to output specific design values, such as second high concentrations, across the receptor network, suitable for plotting concentration contours.

Table B-12. Description of Output Pathway Keywords and Parameters

Keyword	Parameters	
RECTABLE	Aveper FIRST SECOND . . . SIXTH . . . TENTH and/or Aveper 1ST 2ND . . . 6TH . . . 10TH and/or Aveper 1 2 . . . 6 . . . 10 . . . *N* . . . 999	
where:	Aveper FIRST SECOND SIXTH 1ST 2ND 6TH *N*	Averaging period to summarize with high values (keyword ALLAVE specifies all short-term averaging periods) Select summaries of FIRST highest values by receptor Select summaries of SECOND highest values by receptor Select summaries of SIXTH highest values by receptor Select summaries of 1ST highest values by receptor Select summaries of 2ND highest values by receptor Select summaries of 6TH highest values by receptor Select summaries of *N*-th highest values by receptor (up to 999-th highest values) Note: If two parameters are input separated by a dash (e.g. FIRST-THIRD or 4-12), then summaries of all high ranked values within that range (inclusive) are provided. If the CO EVENTFIL keyword is exercised, then the events generated by the RECTABLE keyword are included in the input file for EVENT model. The range of ranks specified on the RECTABLE keyword (but not the individual ranks specified) also determines the range of ranks that may be considered with the MAXDCONT option.
MAXTABLE	Aveper Maxnum	
where:	Aveper Maxnum	Averaging period to summarize with overall maximum values (keyword ALLAVE specifies all averaging periods) Specifies number of overall maximum values to summarize
DAYTABLE	Avper1 Avper2 Avper3 . . .	
where:	Avper1	Averaging period, e.g., 24 for 24-hr averages, to summarize with values by receptor for each day of data processed (keyword ALLAVE for first parameter specifies all averaging periods)
MAXIFILE	Aveper GrpID Thresh Filnam (Funit)	
where:	Aveper GrpID Thresh Filnam Funit	Specifies averaging period for list of values equal to or exceeding a threshold value Specifies source group to be output to file Threshold value (e.g. NAAQS) for list of exceedances Name of disk file to store maximum values Optional parameter to specify the file unit

Keyword	Parameters	
		Note: If the CO EVENTFIL keyword is exercised, then the events generated by the MAXIFILE keyword are included in the input file for EVENT processing.
POSTFILE	Aveper GrpID Format Filnam (Funit)	
where:	Aveper GrpID Format Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages Specifies source group to be output to file Specifies format of file, either UNFORM for unformatted files or PLOT for formatted files for plotting Specifies filename for output file Optional parameter to specify the file unit
PLOTFILE	Aveper GrpID Hivalu Filnam (Funit) (Short Term values) Aveper GrpID Filnam (Funit) (PERIOD or ANNUAL averages)	
where:	Aveper GrpID Hivalu Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages, etc. Specifies source group to be output to file Specifies rank to be included in high value summary (e.g. FIRST, SECOND, 1ST, 2ND, etc.) to be output to file (the rank must be included on the RECTABLE card) Specifies filename for output file Optional parameter to specify the file unit
TOXXFILE	Aveper Cutoff Filnam (Funit)	
where:	Aveper Cutoff Filnam Funit	Specifies averaging period to be output to file, e.g., 1 for 1-hr averages. Specifies cutoff (threshold) value in g/m^3 for outputting results for AERMOD model Specifies filename for output file Optional parameter to specify the file unit
RANKFILE	Aveper Hinum Filnam (Funit)	
where:	Aveper Hinum Filnam Funit	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages Specifies the number of high values to be ranked Specifies filename for output file Optional parameter to specify the file unit
EVALFILE	SrcID Filnam (Funit)	
where:	SrcID Filnam Funit	Specifies the source ID to be output to file Specifies filename for output file Optional parameter to specify the file unit
SEASONHR	GrpID FileName (FileUnit)	
where:	GrpID	Specifies the source group ID to be output to file

Keyword	Parameters	
	FileName (FileUnit)	Specifies filename for output file Optional parameter to specify file unit
MAXDAILY	GrpID FileName (FileUnit)	
where:	GrpID FileName (FileUnit)	Specifies the source group ID to be output to file Specifies filename for output file Optional parameter to specify file unit
MXDYBYYR	GrpID FileName (FileUnit)	
where:	GrpID FileName (FileUnit)	Specifies the source group ID to be output to file Specifies filename for output file Optional parameter to specify file unit
MAXDCONT	GrpID UpperRank LowerRank FileName (FileUnit) or GrpID UpperRank THRESH ThreshValue FileName (FileUnit)	
where:	GrpID UpperRank LowerRank THRESH ThreshValue FileName (FileUnit)	Specifies the source group ID to be output to file Upper bound of ranks to evaluate for contributions Lower bound of ranks to evaluate for contributions (note that lower rank refers to lower concentrations and higher rank refers to higher concentrations) NOTE: The UpperRank and LowerRank values must be within the range of ranks specified on the RECTABLE keyword. AERMOD will analyze each rank within the range, regardless of whether the rank is specified explicitly on the RECTABLE keyword. Indicates that a threshold concentration (ThreshValue) will be specified as a limit on the lower bound rank to process Lower threshold value for evaluating contributions; processing will stop after the first ranked value that is below ThreshValue NOTE: The ThreshValue analysis will be limited to the range of ranks specified on the RECTABLE keyword (but not the individual ranks that are specified). A warning message is generated if the ThreshValue is not reached within the range of ranks analyzed. Specifies filename for output file Optional parameter to specify file unit Note: The range of ranks specified on the RECTABLE keyword (but not the individual ranks specified) also determines the range of ranks that may be considered with the MAXDCONT option, even with the THRESH option.
SUMMFILE	SummFileName	
where:	SummFileName	Specifies filename of output summary file
FILEFORM	EXP or FIX	

Keyword	**Parameters**	
where:	EXP FIX	Specifies that the output results files will use EXPonential-formatted values Specifies that the output results files will use FIXed-formatted values (fixed-formatted values will be used if FILEFORM is omitted)
NOHEADER	FileType1 FileType2 FileType3 . . . FileType*N* or ALL	
where:	FileType*N* ALL	Specifies the output file type(s) for which header records will be suppressed; includes the following file types: POSTFILE, PLOTFILE, MAXIFILE, RANKFILE, SEASONHR, MAXDAILY, MXDYBYYR, and MAXDCONT Specifies that header records will be suppressed for ALL applicable output file types
EVENTOUT	SOCONT or DETAIL	[EVENT Only]
where:	SOCONT DETAIL	Provide source contribution information only in the event output Include hourly concentrations for each source and hourly meteorological data in the event output

APPENDIX C. Explanation of error message codes

C.1 Introduction

The AERMOD input runstream is checked to identify parameters that are missing or potentially in error, and the input source and meteorological data are checked and flagged for possible erroneous values.

The AERMOD model uses a "defensive programming" approach to eliminate as much as possible of the user's work in debugging the input runstream file. Also, a great deal of effort has been made to eliminate the possibility of run time errors, such as "divide by zero," and to point out questionable input data. Error messages are reported to the user in two ways. A summary of messages is provided in the main output result file, and the user can also request a detailed message listing file.

Message Summary: Whether the user selects a detailed error listing file or not, the AERMOD model output a summary of messages within the output result file. This message table gives the number of messages of each type, together with a detailed list of all the fatal errors and warning messages. During setup processing, if no errors or warnings are generated, then the model simply reports to the user that "SETUP Finishes Successfully."

Detailed Message Listing File: The AERMOD model provide the option of saving a detailed list of all messages generated by the model in a separate output file. The user can select this option by specifying the keyword "ERRORFIL" followed by a filename inside the COntrol pathway. For example, the following statements will save all the error messages to an ASCII text file named "errormsg.out":

```
CO  STARTING
    ERRORFIL  errormsg.out
CO  FINISHED
```

C.2 Output message summary

There are two message summaries provided in the standard output file of the AERMOD model. The first one is located after the echo of input runstream file images and before the input data summary. This summary will take one of two forms, depending on whether any fatal error or non-fatal warning messages were generated, and also depending on whether the option to RUN or NOT to run was selected on the CO RUNORNOT card. If there are no errors or warnings generated during the setup processing, and the RUN option was selected, then the model simply reports that "SETUP Finishes Successfully." If any fatal errors or warning messages were generated during the setup processing, or if the option NOT to run was selected, then a more detailed summary is provided. This summary provides a message count for each type of message, and a detailed listing of each fatal error and warning message generated. The second message summary table is located at the very end of the standard output result file, and it sums up the messages generated by the complete model run - both setup processing and run-time processing.

An example of a setup processing message summary is shown in Figure C-1.

```
*** Message Summary For The AERMOD Model Setup ***

  --------- Summary of Total Messages ---------
A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 0 Information Message(s)


   ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***

   ********   WARNING MESSAGES   ********
               ***  NONE  ***

************************************
*** SETUP Finishes Successfully ***
************************************
```

Figure C-1. Example of an AERMOD Message Summary

C.3 Description of the message layout

Three types of messages can be produced by the model during the processing of input runstream images and during model calculations. These are described briefly below:

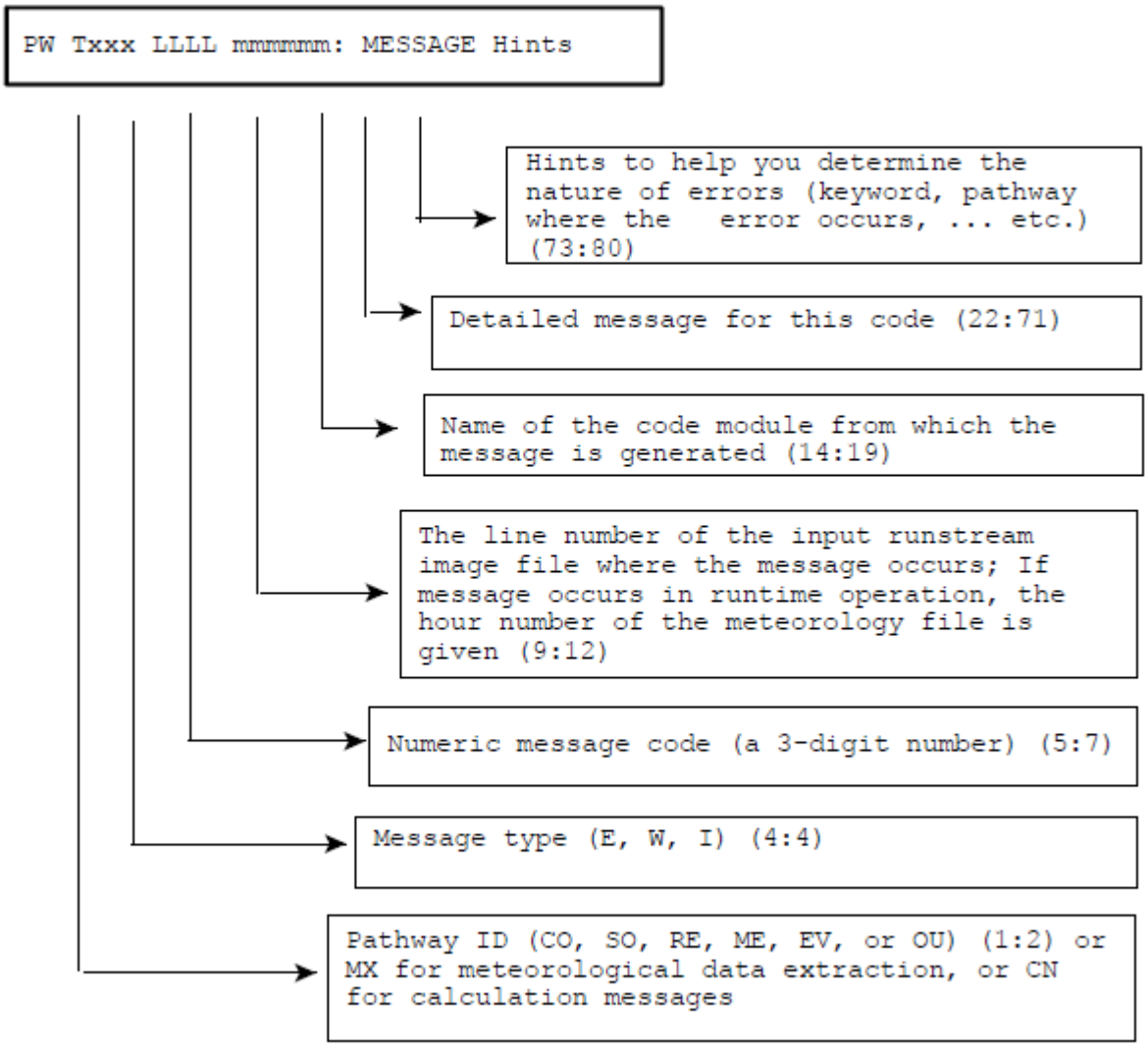
- Errors that will halt any further processing, except to identify additional error conditions (type E);
- Warnings that do not halt processing but indicate possible errors or suspect conditions (type W); and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results (type I).

The messages have a consistent structure which contains the pathway ID, indicating which pathway the messages are generated from; the message type followed by a three-digit message number; the line number of the input runstream image file for setup messages (or the meteorology hour number for runtime messages); the name of the module (e.g. the subroutine name) from which the message is generated; a detailed message corresponding to the message code; and an 8-character simple hint to help the user spot the possible source of the problem.

The following is an example of a detailed message generated from the CO pathway:

```
CO E1008 EXPATH: Invalid Pathway Specified. The Troubled Pathway is FF
```

The message syntax is explained in more detail below (values in parentheses give the column numbers within the message line for each element):



If an error occurs during processing of an included file (either SO INCLUDED or RE INCLUDED), the line number will represent the line number of the included file. The line number of the runstream file is saved before processing the included data, and then restored when processing returns to the main runstream file.

The three message types are identified with the letters E (for errors), W (for warnings), and I (for informational messages). The 3-digit message codes are grouped into general categories corresponding to the different stages of the processing. Theses categories are:

100 - 199 Input Runstream Image Structure Processing

200 - 299 Parameter Setup Processing

300 - 399 Data and Quality Assurance Processing

400 - 499 Run Time Message Processing

500 - 599 Input/Output Message Processing

A listing of each of the message codes currently used in the model is provided in the next section.

C.4 Listing of the error/message codes

Message Number	Error/Warning Message
100	Invalid Pathway Specified. The Troubled Pathway is
105	Invalid Keyword Specified. The Troubled Keyword is
109	Too many fields specified on runstream image; MAX=
110	Keyword is Not Valid for This Pathway. Keyword is
111	LOW_WIND Keyword specified without LOWWIND Options
112	User-specified minimum Sigma-V on LOW_WIND Keyword
113	User-specified minimum WindSpeed on LOW_WIND Keywd
114	User-specified maximum FRAN on the LOW_WIND Keywrd
115	STARTING or FINISHED Out of Sequence: Pathway =
116	Vector Wind Speeds specified on MODELOPT Keyword
120	Pathway is Out of Sequence: Pathway =
121	LowWind1 Beta Option specified on MODELOPT Keyword
122	LowWind2 Beta Option specified on MODELOPT Keyword
125	Missing FINISHED-Runstream File Incomplete: ISTAT=
130	Missing Mandatory Keyword. The Missing Keyword is
131	Minimum sigmav value (SVmin) for LowWind1 Beta Opt
132	Minimum sigmav value (SVmin) for LowWind2 Beta Opt
133	Maximum FRAN value (FRANmax) for LowWind2 Beta Opt
135	Nonrepeatable Keyword or Recursed INCLUDED: Keywrd
136	Conflicting Beta Option - LowWind1 and LowWind2
140	Invalid Order of Keyword. The Troubled Keyword is
141	Conflicting Options for NO2 conversion specified:
142	Following Keyword Invalid Without PVMRM or OLM:
143	Following Keyword Invalid Without PVMRM Option:
144	Following Keyword Invalid Without OLM Option:

Message Number	Error/Warning Message
145	Following Keyword Invalid Without ARM or ARM2:
146	PSDGROUP Keyword Specified without PSDCREDIT Opt.
147	Following Option is Invalid with PSDCREDIT Option:
148	Both OZONEVAL and O3VALUES keywords are specified
149	Conflicting options specified on MODELOPT keyword:
150	Conflicting Options: MULTYEAR Option with
151	Non-DFAULT NoUrbTran option selected on MODELOPT
152	ELEVUNIT card must be first for this Pathway:
153	Conflicting Opts: MAXDCONT with Re-Start or MULTYR
154	Conflicting options: SCIM cannot be used with
155	Conflicting Decay Keyword. Inputs Ignored for
156	Option ignored - not valid with SCIM. Option =
157	Wet SCIM Not Supported - Wet SCIM Inputs Ignored
158	EMISUNIT Keyword Used With More Than 1 Output Type
159	EMISUNIT Keyword Used With the Following Keyword:
160	Duplicate ORIG Secondary Keyword for GRIDPOLR:
161	MAXDCONT option already defined for source group:
162	Option only applies to 1-hr NO2 or 1-hr SO2 NAAQS:
163	Option only applies to 24h PM25, 1h NO2 or 1h SO2:
164	NOHEADER selected for non-specified output option:
165	Inconsistent temporally-varying BACKGRND options:
166	BGSECTOR/O3SECTOR option invalid w/o BG/O3 Inputs:
167	Inconsistent temporally-varying O3VALUES options:
168	Hourly BACKGRND already specified for this sector:
170	Invalid Secondary Keyword for Receptor Grid:
171	Sector ID specified without Sector-varying Option:
175	Missing Secondary Keyword END for Receptor Grid:

Message Number	Error/Warning Message
180	Conflicting Secondary Keyword for Receptor Grid:
181	BULKRN Delta-T & SolarRad option for SBL was used
182	MMIF-generated meteorological inputs were used
183	Non-DFAULT option for MMIF-generated data without
184	PROFFILE heights > 999m; inputs could be from MMIF
185	Either No Sources or No Receptors are specified!!!
186	THRESH_1MIN 1-min ASOS wind speed threshold used
187	ADJ_U* Beta Option for Low Winds used in AERMET
188	Non-Default ADJ_U* Option used in AERMET
189	No Keywords for OU Path and No PERIOD/ANNUAL Aves.
190	Incompatible Option Used With SAVEFILE or INITFILE
191	PM25, 1h NO2 or SO2 w/o MAXIFILE incompatible with
192	FASTALL option also implies use of FASTAREA option
193	Units keyword specified without appropriate option
194	DEBUGOPT input option is invalid or not applicable
195	Incompatible Keyword used with GASDEPVD option
196	Gas deposition algorithms are non-DFAULT options
197	METHOD_2 for particulates is a non-DFAULT option
198	TOXICS Option obsolete; see Users Guide Addendum
199	Non-DFAULT BETA Option Required for
200	Missing Parameter(s). No Options Specified For
201	Not Enough Parameters Specified For the Keyword of
202	Too Many Parameters Specified For the Keyword of
203	Invalid Parameter Specified. Troubled Parameter:
204	Regulatory DFAULT Conflicts with Non-DFAULT Option
205	No Option Parameter Setting. Forced by Default to
206	Regulatory DFAULT Overrides Non-DFAULT Option For

Message Number	Error/Warning Message
207	No Parameters Specified. Default Values Will Used.
208	Illegal Numerical Field Encountered in
209	Negative Value Appears For Non-negative Variable.
211	Duplicate Averaging Period Specified for Keyword
212	END Encountered Without (X,Y) Points Properly Set
213	ELEV Input Inconsistent With Option: Input Ignored
214	ELEV Input Inconsistent With Option: Defaults Used
215	FLAG Input Inconsistent With Option: Input Ignored
216	FLAG Input Inconsistent With Option: Defaults Used
217	More Than One Delimiter In A Field for Keyword
218	Number of (X,Y) Points Does Not Match Number of
219	Urban ID field is too long (>8); first 12 char:
220	Missing Origin (Use Default = 0,0) In GRIDPOLR
221	Missing Dist or Direction Setting In Polar Network
222	O3SECTOR or BGSECTOR Value is out of order:
223	Missing Distance or Degree Field in
224	SrcID specified on SRCGROUP keyword not defined:
225	SrcID specified on OLMGROUP keyword not defined:
226	SrcID specified on PSDGROUP keyword not defined:
227	O3SECTOR or BGSECTOR Width is out of range:
228	Default(s) Used for Missing Parameters on Keyword
229	Too Many Parameters - Inputs Ignored on Keyword
230	Source ID field is too long (>12); first 12 chars:
231	Too Many Numerical Values Specified for
232	OLMGroup ID field is too long (>8); first 12 char:
233	Building Dimensions Specified for Non-POINT Source
234	Too Many Sectors Input for

Message Number	Error/Warning Message
235	Num of SRCGRPs exceeds limit for EVT name; Set=999
236	Not Enough BUILDHGTs Specified for SourceID
237	Not Enough BUILDWIDs Specified for SourceID
238	Not Enough BACKGRND Concentration Values Specified
239	Not Enough QFACTs Specified for SourceID
240	Inconsistent Number of Particle Categories for
241	Not Enough BUILDLENs Specified for SourceID
242	No Particle Cat. or Gas Depos. Specified for SRCID
243	Wet depos (DEPOS, WDEP, WETDPLT) incompatible with
244	Source parameters are missing or incomplete for
245	SrcGroup ID field is too long (>8); first 12 char:
246	Not Enough XBADJs Specified for SourceID
247	Not Enough YBADJs Specified for SourceID
248	Either BGVALs or BGFILE missing for this sector:
249	Source elevation is missing (-9999.0); SRCID =
250	Duplicate XPNT/DIST or YPNT/DIR Specified for GRID
252	Duplicate Receptor Network ID Specified. NETID =
253	PSDGROUP ID field is too long (>8); first 12 char:
256	EVALFILE Option Used Without EVALCART Receptors
259	Receptor elevation is missing (-9999.0); IREC =
260	Number of EMISFACT/O3VALUES/BACKGRND values > max:
261	Not Enough O3VALUES Ozone Concentrations Specified
262	First Vertex Does Not Match LOCATION for AREAPOLY
264	Too Many Vertices Specified for AREAPOLY Source
265	Not Enough Vertices Specified for AREAPOLY Source
266	Invalid shape defined (area=0) for AREAPOLY source
271	O3FILE w/o O3VALs; full conv for hrs with miss O3

Message Number	Error/Warning Message
272	Upper bound rank > Lower bound rank for MAXDCONT:
273	Range of ranks for MAXDCONT THRESH Opt is limited:
276	Special proc for 1h-NO2/SO2 24hPM25 NAAQS disabled
277	Specified option not applicable for this pollutant
279	Multiple URBANOPT/URBANSRC inputs not allowed for:
280	Number of Output Types Specified Exceeds Max:NTYP=
282	Following SRCID Included in Multiple OLMGROUPs:
283	OZONEVAL, O3VALUES or OZONEFIL Keyword Needed for
284	Invalid POLLUTID Specified for PVMRM/OLM; Must Use
285	BACKGROUND and BACKGRND are invalid as Source IDs
286	Following SRCID Included in Multiple PSDGROUPs:
287	PSDGROUP ID Must be INCRCONS, RETRBASE or NONRBASE
288	Use of "*" for repeated values not meaningful for
289	Source defined as both particulate and gaseous
290	This array limit exceeded; possible coding error:
291	Filename specified is too long. Maximum length =
292	Potential problem with Fortran format specifier:
293	User-specified met data format not used; use FREE
294	PERIOD and ANNUAL averages are both selected for
295	Invalid Averaging Period Specified for SCREEN Mode
296	Averaging Period .NE. 1-Hr for TOXXFILE Option
297	Aver. Period must be .LE. 24 for EVENT Processing
298	Results reported for source group ALL include
299	SRCGROUP ALL is missing, but is NOT required for
300	Specified SRCID Has Not Been Defined Yet: KEYWORD=
301	Urban Area ID Has Not Been Defined. URBID =
302	Following SRCID Included in Multiple Urban Areas:

Message Number	Error/Warning Message
303	Urban ID has already been defined. URBID =
305	Stack height > or = EPA formula height for SRCID:
310	Attempt to Define Duplicate LOCATION Card for SRC:
313	Attempt to Define Duplicate EVENTPER card for
315	Attempt to Define Duplicate SRCPARAM Card for SRC:
317	Specified SRCID not included in any PSD/SRCGROUP:
318	No Sources Defined for Urban Area. URBID =
319	No Sources Included in Specified Source Group:
320	Input Parameter May Be Out-of-Range for Parameter
321	BACKGROUND concs are NOT included in any SRCGROUP!
322	Release Height Exceeds Effective Depth for OPENPIT
323	BACKGRND included w/o BACKGRND keyword for SrcGrp:
324	Release Height Exceeds 3000 Meters for SRCID:
325	Negative Exit Velocity (Set=1.0E-5) for SRCID:
330	Mass Fraction Parameters Do Not Sum to 1. for Src
332	Mass Fraction Parameter Out-of-Range for Source
334	Particle Density Out-of-Range for Source
335	Particle Diameter Out-of-Range for Source
336	NO2RATIO Missing or Invalid for OLM/PVMRM - SrcID:
338	Neg Emis Rate Cannot be Used with OLM/PVMRM. Src:
340	Possible Error in PROFBASE Input: Value is < 0
341	Emissions in HOUREMIS file < -90; set to 0.0 for
342	Src ID Mismatch in Hourly Emissions File for ID =
344	Missing HOUREMIS fields; EmisRate set = 0. KURDAT=
345	Problem processing the HOUREMIS file. KURDAT =
346	Too many fields for HOUREMIS file. KURDAT =
350	Julian Day Out Of Range at

Message Number	Error/Warning Message
352	The "H6H" field is no longer required for MULTYEAR
353	Urban Roughness Length (m) May Be Out-of-Range:
360	2-Digit Year Specified: Valid for Range 1950-2049
361	Multiyear PERIOD/ANNUAL values for NO2/SO2 require
362	Multiyear 1h NO2/SO2 processing not applicable for
363	Multiyr 24h/Ann PM25 processing not applicable for
365	Year Input is Greater Than 2147
370	Invalid Date: 2/29 In a Non-leap Year.
380	This Input Variable is Out-of-Range:
381	Latitude in Surface File Is Not Valid:
382	Error Decoding Latitude:
384	Not enough fields specified for HOUREMIS; KURDAT =
386	PARTDIAM and METHOD_2 specified for same SRCID:
387	METHOD_2 option already specified for this SRCID:
389	Rotated buoyant line sources not in correct order:
390	Aspect ratio (L/W) of LINE source greater than 100
391	Aspect ratio (L/W) of AREA source greater than 100
392	Aspect ratio (L/W) of OPENPIT is greater than 10
394	Met data may be from outdated version of AERMET:
395	Met. Data Error; Incompatible Version of AERMET:
396	Met data from outdated version of AERMET, version:
397	SCREEN option used without use of SCREEN Met Data
398	SCREEN met used without specifying SCREEN option
399	EXP format specified with no applicable file types
400	Output values exceed format limit; use OU FILEFORM
405	Value of PHEE Exceeds 1.0 on KURDAT =
406	Number of Vertices Exceeds Max (NVMAX) for SRCID:

Message Number	Error/Warning Message
409	Error Allocating Storage for Setup/Result Arrays!
410	Wind Direction Out-of-Range. KURDAT =
413	Number of Threshold Events > 999999 for Ave Period
415	MAXDCONT THRESH not reached within range of ranks
420	Wind Speed Out-of-Range. KURDAT =
430	Ambient Temperature Data Out-of-Range. KURDAT =
432	Friction Velocity Out-of-Range. KURDAT =
435	Surface Roughness Length Out-of-Range. KURDAT =
438	Convective Velocity Data Out-of-Range. KURDAT =
439	Monin-Obukhov Length Out-of-Range. KURDAT =
440	Calm Hour Identified in Meteorology Data File at
441	Vert Pot Temp Grad abv ZI set to min .005, KURDAT=
442	Vert Pot Temp Grad abv ZI exceeds 0.1 K/m, KURDAT=
450	Record Out of Sequence in Meteorological File at:
452	Missing hourly BACKGRND w/o BGSUB, KURDAT/Sector =
453	BGSUB for missing hourly BACKGRND, KURDAT/Sector =
454	Date/time Mismatch: BACKGRND File, KURDAT/Sector =
455	Date/time Mismatch: Hourly Emission File, KURDAT =
456	Date/time Mismatch on Surface & Profile. KURDAT =
457	Date/time Mismatch: OZONEFIL File, KURDAT/Sector =
458	O3SUB for missing hourly O3 value, KURDAT/Sector =
459	No Hrly O3 & No Sub; Use Full Conversion, KURDAT =
460	Missing Hour Identified in Meteor. Data File at
465	Number of Profile Levels Exceeds Max: MXPLVL =
470	Mixing Height Value is < or = 0.0. KURDAT =
474	WS RefHt invalid (<0.001); Not msg or clm: KURDAT=
475	WS reference height is higher than 100m. KURDAT =

Message Number	Error/Warning Message
480	Less than 1yr for MULTYEAR, MAXDCONT or ANNUAL Ave
481	Data Remaining After End of Year. Number of Hours=
482	Too many years modeled for 24h-PM25 1h-NO2 1h-SO2:
483	User Start Date is Earlier Than Start of Met File
484	Restart Date < STARTEND date or start of Met File
485	MULTYR DataGap; Restart Date < STARTEND or MetFile
486	MULTYR Date Overlap; STARTEND Date < Restart Date
487	MULTYR Date Overlap; MetFile Start < Restart Date
488	First met HR.ne.1; ST results may not be valid
489	First met HR.ne.1; EV results may not be valid for
490	Problem reading SURFFILE date for EVENTS; MNDYHR =
491	MAXDCONT option requires 1st Hr of met data = 01;
492	SURFDATA YR .NE. 1st YR of file, adj to match file
493	SURFDATA YR must match 1st YR of file for DAYRANGE
495	Surface met file does not include enough variables
496	Total precipitation in SURFFILE is zero (0.0) with
497	Possible code ERROR!!! EVENT mismatch for EVENTID:
498	Possible code ERROR! MAXDCONT mismatch GRP/RNK/REC
499	PRIME plume rise error; check stack parameters for
500	Fatal Error Occurs Opening the Data File of
501	Dup Filename! Fatal Error Opening the Data File of
510	Fatal Error Occurs During Reading of the File of
520	Fatal Error Occurs During Writing to the File of
530	CAUTION! Met Station ID Mismatch with SURFFILE for
531	CAUTION! Met Station ID Missing from SURFFILE for
540	No RECTABLE/MAXTABLE/DAYTABLE for Average Period
550	File Unit/Name Conflict for the Output Option:

Message Number	Error/Warning Message
555	File Unit/Name conflict across options: GRP# AVE
560	User Specified File Unit .LE. 30 for OU Keyword:
565	Possible Conflict With Dynamically Allocated FUNIT
570	Problem Reading Temporary Event File for Event:
580	End of File Reached Trying to Read the File of
585	Output data file for INITFILE option was not found
590	The INITFILE filename matches a SAVEFILE filename
592	MAXIFILE includes data past start of MULTYEAR run
593	POSTFILE includes data past start of MULTYEAR run

APPENDIX D. Description of file formats

D.1 AERMET meteorological data

Two files are produced for input to the AERMOD dispersion model by the AERMET meteorological preprocessor. The surface OUTPUT contains observed and calculated surface variables, one record per hour. The PROFILE file contains the observations made at each level of an on-site tower, or the one level observations taken from NWS data, one record per level per hour. The contents and format of each of these files is described below:

<u>SURFACE OUTPUT</u>

<u>Header record:</u>

READ( ) *latitude, longitude, UA identifier, SF identifier, OS identifier, Version date*

FORMAT (2(2X,A8), 8X,' UA_ID: ',A8, ' SF_ID: ',A8, ' OS_ID: ',A8, T85, 'VERSION:', A6)

where *latitude* = latitude specified in Stage 1 for primary surface station

longitude = longitude specified in Stage 1 for primary surface station

UA identifier = station identifier for upper air data; usually the WBAN number used to extract the data from an archive data set

SF identifier = station identifier for hourly surface observations; usually the WBAN number used in extracting the data

OS identifier	=	site-specific identifier
Version date	=	AERMET version date; this date also appears in the banner on each page of the summary reports

Note that the ‘ ??_ID: ’ fields in the FORMAT statement above include two spaces before the 2-character pathway ID and one space after the colon.

Data records:

READ( ) *year, month, day, j_day, hour, H,* u_* , w_* , *VPTG, Zic, Zim, L,* z_o , B_o , *r,* W_s , W_d , z_{ref}, *temp,* z_{temp}, *ipcode, pamt, rh, pres, ccvr, WSADJ*

FORMAT (3(I2,1X), I3,1X, I2,1X, F6.1,1X, 3(F6.3,1X), 2(F5.0,1X), F8.1,1X, F7.4,1X, 2(F6.2,1X), F7.2,1X, F5.0, 3(1X,F6.1), 1X,I5, 1X,F6.2, 2(1X, F6.0), 1X, I5, 1X, A7)

where

j_day	=	Julian day
H	=	sensible heat flux (W/m^2)
u_*	=	surface friction velocity (m/s)
w_*	=	convective velocity scale (m/s)
VPTG	=	vertical potential temperature gradient above *Zic* (K/m)
Zic	=	height of convectively-generated boundary layer (m)
Zim	=	height of mechanically-generated boundary layer (m)
L	=	Monin-Obukhov length (m)
z_0	=	surface roughness length (m)
B_0	=	Bowen ratio
r	=	Albedo
W_s	=	reference wind speed (m/s)
W_d	=	reference wind direction (degrees)
z_{ref}	=	reference height for wind (m)
temp	=	reference temperature (K)
z_{temp}	=	reference height for temperature (m)
ipcode	=	precipitation type code (0=none, 11=liquid, 22=frozen, 99=missing)
pamt	=	precipitation amount (mm/hr)
rh	=	relative humidity (percent)
pres	=	station pressure (mb)
ccvr	=	cloud cover (tenths)
WSADJ	=	wind speed adjustment and data source flag

When site-specific data are included in the data base, the definition of the reference height wind speed and direction are subject to the following restrictions:

- the wind speed, W_s, must be greater than or equal to the site-specific data threshold wind speed;
- the measurement height must be at or above $7*z_0$, where z_0 is the surface roughness length;
- the height must be less than or equal to 100 meters;

If AERMET is run only with NWS data, i.e. no site-specific data are in the data base, then the restrictions above do not apply and the reference winds are taken to be the NWS winds independent of the height at which the winds were measured.

Ambient air temperature is subject to a similar, but less restrictive, selection process:

- the measurement height must be above z_0; and
- the height must be less than or equal to 100 meters.

The sensible heat flux, Bowen ratio and albedo are not used by AERMOD, but are passed through by AERMET for information purposes only.

PROFILE OUTPUT

READ( ) *year*, *month*, *day* , *hour*, height, top, WD*nn*, WS*nn*, TT*nn*, SA*nn*, SW*nn*

FORMAT (4(I2,1X), F7.1,1X, I1,1X, F7.1,1X, F8.2,1X, F8.2,1X, F8.2,1X, F8.2)

where, height = measurement height (m)
top= 1, if this is the last (highest) level for this *hour*, or 0 otherwise
WD*nn* = wind direction at the current level (degrees)
WS*nn* = wind speed at the current level (m/s)
TT*nn* = temperature at the current level (°C)
SA*nn* = σ_θ (degrees)
SW*nn* = σ_w (m/s)

D.2 Threshold violation files (MAXIFILE option)

The OU MAXIFILE card for the AERMOD model allows the user the option to generate a file or files of threshold violations for specific source group and averaging period combinations. The file consists of several header records, each identified with an asterisk (*) in column one. The

header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the threshold value. Any value equal to or exceeding the threshold value will be included in the file. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the averaging period, the source group ID, the date (YYMMDDHH) for the end of averaging period, the X and Y coordinates of the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, and the concentration value that violated the threshold. The following example from a threshold file identifies the contents of the MAXIFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                         17:03:34
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         MAXI-FILE FOR  3-HR VALUES >= A THRESHOLD OF    50.00
*         FOR SOURCE GROUP: ALL
*         FORMAT: (1X,I3,1X,A8,1X,I8.8,2(1X,F13.5),3(1X,F7.2),1X,F13.5)
*AVE   GRP     DATE           X             Y        ZELEV   ZHILL   ZFLAG  AVERAGE CONC
*___ ________ ________  ____________  ____________  ______  ______  ______  ____________
   3 ALL      88030112     344.68271     -60.77686    0.00    0.00    0.00      71.36678
   3 ALL      88030112     492.40388     -86.82409    0.00    0.00    0.00      73.20689
   3 ALL      88030112     984.80775    -173.64818    0.00    0.00    0.00      50.65556
   3 ALL      88030112     164.44621     -59.85353    0.00    0.00    0.00     112.74896
```

D.3 Postprocessor files (POSTFILE option)

The OU POSTFILE card for the AERMOD model allows the user the option of creating output files of concurrent concentration values suitable for postprocessing. The model offers two options for the type of file generated - one is an unformatted file, and the other is a formatted file of X, Y, CONC values suitable for inputting to plotting programs.

The unformatted POSTFILE option generates a separate unformatted data record of concurrent values for each averaging period and source group specified. The averaging period and source group combinations may be written to separate files, or combined into a single file. Each record begins with the date variable for the end of the averaging period (an integer variable of the form YYMMDDHH), the averaging period (e.g., an integer value of 3 for 3-hour averages), and the source group ID (eight characters). Following these three header variables, the record includes the

concentration values for each receptor location, in the order in which the receptors are defined on the RE pathway. The results are output to the unformatted file or files as they are calculated by the model.

The formatted plot file option for the POSTFILE keyword includes several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the number of receptors included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for that location, receptor terrain elevation, hill height scale, flagpole receptor height, the averaging period, the source group ID, the date variable for the end of the averaging period (in the form of YYMMDDHH) for short term averages or the number of hours in the period for PERIOD averages, and the receptor network ID. The following example from a formatted postprocessor file for PERIOD averages identifies the contents of the POSTFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                         16:58:19
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         POST/PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP      NUM HRS   NET ID
* ________ ___________ ____________ _______ _______ _______ ______ ________ ________ ________
     30.38843     172.34136       0.21576     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     60.77686     344.68271       0.53162     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     86.82409     492.40388       0.85993     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    173.64818     984.80775       1.39778     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     59.85353     164.44621       0.20861     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    119.70705     328.89242       0.67388     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    171.01007     469.84631       1.27452     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    342.02014     939.69262       2.45702     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
     87.50000     151.55445       0.20576     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    175.00000     303.10889       0.64322     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    250.00000     433.01270       1.20422     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    500.00000     866.02540       2.28880     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    112.48783     134.05778       0.20172     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    224.97566     268.11556       0.48027     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    321.39380     383.02222       0.76067     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
    642.78761     766.04444       1.19405     0.00     0.00     0.00  PERIOD  ALL       00000096  POL1
```

D.4 High value results for plotting (PLOTFILE option)

The OU PLOTFILE card for the AERMOD model allows the user the option of creating output files of highest concentration values suitable for importing into graphics software to generate

contour plots. The formatted plot files generated by the PLOTFILE include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, the high value (e.g. 2ND highest) included for plotting, and the number of receptors included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for that location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, the high value included for short term averages or the number of hours in the period for PERIOD averages, and the receptor network ID. For short term averages, the PLOTFILE also includes the date variable for the end of the averaging period (in the form of YYMMDDHH). The PERIOD average PLOTFILE uses the same format for the data records as the PERIOD average formatted POSTFILE shown in the previous section. The following example from a plot file for high second highest 24-hour averages identifies the contents of the PLOTFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                         17:07:58
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         PLOT FILE OF  HIGH   2ND HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),3X,A5,2X,A8,2X,A5,5X,A8,2X,I8)
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP       RANK     NET ID   DATE(CONC)
* ____________  ____________  ____________  ______   ______   ______  ______  ________  ________  ________  ________
     30.38843     172.34136       0.34726     0.00     0.00     0.00   24-HR  ALL         2ND      POL1      88030324
     60.77686     344.68271       0.75187     0.00     0.00     0.00   24-HR  ALL         2ND      POL1      88030124
     86.82409     492.40388       1.18649     0.00     0.00     0.00   24-HR  ALL         2ND      POL1      88030124
    173.64818     984.80775       1.19837     0.00     0.00     0.00   24-HR  ALL         2ND      POL1      88030124
```

The PLOTFILE output also includes a flag ('**') identifying the receptor with the highest concentration. For short term averages, the flag precedes the date field. For period averages, the flag precedes the field with the number of hours in the period.

D.5 TOXX model input files (TOXXFILE option)

The OU TOXXFILE card for the AERMOD model allows the user the option to generate an unformatted file or files of threshold violations for a specific averaging period for use with the TOXX model component of TOXST. The file consists of three header records, including the first line of the title information for the run, the number of source groups, receptors and averaging

periods, information on the type of receptor network, and the threshold cutoff value. Following the header records are pairs of records identifying the specific averaging period, source group and receptor location and corresponding concentration value for the values exceeding the user- specified threshold. If any source group exceeds the threshold for a given averaging period and receptor location, then the concentrations for all source groups are output for that period and receptor. The structure of the unformatted file for the AERMOD model TOXXFILE option is described below:

Record #	Description
1	Title (80 characters)
2	IYEAR, NUMGRP, NUMREC, NUMPER, ITAB, NXTOX, NYTOX, IDUM1, IDUM2, IDUM3
3	CUTOFF, RDUM1, ..., RDUM9

where:

TITLE = First line of title (80 characters)
IYEAR = Year of simulation NUMGRP = No. of source groups
NUMREC = Total no. of receptors
NUMPER = No. of averaging periods (e.g., number of hours in the year)
ITAB = 1 for polar grid; 2 for Cartesian grid; 0 for discrete receptors or mixed grids
NXTOX = No. of x-coordinates (or distances) in receptor network
NYTOX = No. of y-coordinates (or directions) in receptor network
IDUM1, IDUM2, IDUM3 = dummy integer variables, arbitrarily set equal to zero
CUTOFF = User-specified threshold for outputting results (g/m^3)
RDUM1, ..., RDUM9 = Dummy real variables (nine) arbitrarily set equal to zero

Following the header records, the file consists of pairs of records including an ID variable identifying the data period, source group number and receptor number, and the corresponding concentration values. The number of values included in each record is controlled by the NPAIR PARAMETER, which is initially set at 100 in MODULE MAIN1. The identification variable is determined as follows:

IDCONC = IPER*100000 + IGRP*1000 + IREC

where:

IPER = the hour number for the year corresponding to the concentration value
IGRP = the source group number (the order in which the group was defined on the SO pathway)
IREC = the receptor number (the order in which the receptor was defined on the RE pathway)

D.6 Maximum values by rank (RANKFILE option)

The OU RANKFILE card for the AERMOD model allows the user the option of creating output files of the maximum concentration values by rank, suitable for generating Q-Q or quantile plots. The data contained in the RANKFILE output is based on the MAXTABLE arrays, except that only one occurrence per data period is included. The formatted data files generated by the RANKFILE include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period included in the file, and the number of ranked values included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the rank, concentration value, X and Y coordinates of the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, and the source group ID. Each RANKFILE includes results for all of the source groups for a particular averaging period. Since the RANKFILE only include one occurrence per data period, the file may not include the number of ranked values requested, especially for evaluation data bases of limited duration. The following example identifies the contents of the RANKFILE:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 15181):                                                                         17:11:08
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         RANK-FILE OF UP TO    40 TOP  3-HR VALUES FOR     1 SOURCE GROUPS
*         INCLUDES OVERALL MAXIMUM VALUES WITH DUPLICATE DATA PERIODS REMOVED
*         FORMAT: (1X,I6,1X,F13.5,1X,I8.8,2(1X,F13.5),3(1X,F7.2),2X,A8)
*  RANK  AVERAGE CONC   DATE          X             Y        ZELEV   ZHILL   ZFLAG     GRP
*_______ ____________ ________  ____________  ____________  ______  ______  ______  ________
      1     329.96009 88030112     433.01270    -250.00000    0.00    0.00    0.00  ALL
      2     278.47891 88030115     469.84631    -171.01007    0.00    0.00    0.00  ALL
      3     124.30430 88030118     433.01270    -250.00000    0.00    0.00    0.00  ALL
```

D.7 Arc-maximum values for evaluation (EVALFILE option)

The OU EVALFILE card for the AERMOD model allows the user the option of creating output files of the arc-maximum concentration values for individual sources suitable for use in model evaluation studies. The data contained in the EVALFILE output is based on the maximum value along arcs of receptors, identified using the RE EVALCART card. Receptors may be grouped on arcs based on their distance from the source, or other logical grouping. The formatted

EVALFILE output includes five records of information for each selected source and each hour of meteorological data. The information provided is as follows:

Record 1:	Source ID (eight characters) Date variable (YYMMDDHH) Arc ID (eight characters) Arc maximum P/Q Emission rate for arc maximum (including unit conversions) Crosswind integrated concentration based on true centerline concentration Normalized non-dimensional crosswind integrated concentration
Record 2:	Downwind distance corresponding to arc maximum (m) Effective wind speed corresponding to arc maximum (m/s) Effective F_v corresponding to arc maximum (m/s) Effective F_w corresponding to arc maximum (m/s) F_y corresponding to arc maximum (m) Effective plume height corresponding to arc maximum (m)

Record 3: Monin-Obukhov length for current hour (m)
Mixing height for current hour (m)
Surface friction velocity for current hour (m/s)
Convective velocity scale for current hour if unstable (m/s), or
F_z for current hour if stable
(Buoyancy flux for current hour
(m^4/s^3) Momentum flux for
current hour (m^4/s^2)

Record 4: Bowen ratio for current hour
Plume penetration factor for current hour
Centerline P/Q for direct plume
Centerline P/Q for indirect plume
Centerline P/Q for penetrated plume
Nondimensional downwind distance

Record 5: Plume height/mixing height ratio
Non-dimensional buoyancy flux
Source release height (m)
Arc centerline P/Q
Developmental option settings place holder (string of 10 zeroes)
Flow vector for current hour (degrees)
Effective height for stable plume reflections (m)

The following Fortran WRITE and FORMAT statements are used to write the results to the EVALFILE output:

```
      WRITE(IELUNT(ISRC),9000) SRCID(ISRC), KURDAT, ARCID(I),
     &                         ARCMAX(I), QMAX(I), CWIC, CWICN,
     &                         DXMAX(I), UOUT, SVMAX(I),
     &                         SWMAX(I), SYOUT, HEMAX(I),
     &                         OBULEN, ZI, USTAR, PWSTAR, FB, FM,
     &                         BOWEN, PPF, CHIDML(I), CHINML(I), CHI3ML(I),
     &                         XNDIM, HEOZI, FSTAR, AHS(ISRC), ARCCL(I),
     &                         AFV, HSBLMX(I)

9000  FORMAT(1X,A8,1X,I8,1X,A8,4(1X,G12.6),
     &       /,9X,6(1X,G12.4),/,9X,6(1X,G12.4),
     &       /,9X,6(1X,G12.4),/,9X,4(1X,G12.4),1X,'0000000000',
     &       1X,G12.4,1X,G12.4)
```

D.8 Results by season and hour-of-day (SEASONHR option)

The SEASONHR option is used to output a file containing the average results by season and hour-of-day. The formatted data files generated by the SEASONHR option include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the source group included in the file, and the number of receptors. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the average concentration value, receptor terrain elevation, hill height scale, flagpole receptor height, source group ID, number of non-calm and non-missing hours used to calculate the season-by-hour-of-day averages (the NHRS column), season index (the SEAS column with 1 for winter, 2 for spring, 3 for summer, and 4 for fall), the hour-of-day for the concentration value, and the receptor network ID. A sample from a SEASONHR output file is shown below:

```
* AERMOD ( 15181): A Simple Example Problem for the AERMOD-PRIME Model                    06/09/16
* AERMET ( 14134):                                                                         17:27:43
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         FILE OF SEASON/HOUR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   144 RECEPTORS.
*         FORMAT: (2(1X,F13.5),1(1X,F13.8),3(1X,F7.2),2X,A8,2X,3(I4,2X),A8)
*        X             Y      AVERAGE CONC   ZELEV   ZHILL   ZFLAG    GRP      NHRS  SEAS  HOUR   NET ID
* ___________  ___________  ____________  ______  ______  ______  ________  ____  ____  ____  ________
     30.38843     172.34136   34.14568783    0.00    0.00    0.00  ALL         65     1     1  POL1
     60.77686     344.68271   39.19676801    0.00    0.00    0.00  ALL         65     1     1  POL1
     86.82409     492.40388   34.59785413    0.00    0.00    0.00  ALL         65     1     1  POL1
    173.64818     984.80775   16.14253303    0.00    0.00    0.00  ALL         65     1     1  POL1
     59.85353     164.44621   32.93762092    0.00    0.00    0.00  ALL         65     1     1  POL1
    119.70705     328.89242   41.97750583    0.00    0.00    0.00  ALL         65     1     1  POL1
```

D.9 Source group contribution for ranked averaged maximum daily values (MAXDCONT)

The OU MAXDCONT card of the AERMOD model allows the user to create output files that provide source contributions for the 24-hour PM2.5, 1-hour NO_2 and 1-hour SO_2 standards in which the design value is based on averages of ranked values across multiple years. Ranked concentrations and source contributions are based on a target source group specified by the user. The user can define the ranks to include or a range of ranks and an optional minimum threshold concentration value. The MAXDCONT output file includes several lines of header information, each identified with an asterisk (*) in column one, ncluding: the model name and version number,

the first line of the title information, the list of modeling option keywords, the highest rank specified, the averaging period, target source group, and threshold value if applicable. The header also includes the total number of receptors and source groups and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, rank, receptor network ID, and the source contribution for each source modeled. The data records are grouped by rank in ascending order. Concentrations are displayed for all receptors for the highest rank, then the next highest rank, etc. The following example is a partial MAXDCONT file with a minimum threshold value of 35 $\mu g/m^3$ was specified for ranks 1 through 50. Results for the first two ranks are displayed for four the source groups that were modeled.

```
* AERMOD ( 15181):  PM-2.5 Test Case for the AERMOD Model using single met file            07/30/15
* AERMET ( 13350):                                                                          13:50:57
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         MAXDCONT FILE OF   1ST-HIGHEST 24-HR VALUES AVERAGED OVER   5 YEARS FOR SOURCE GROUP: ALL      ; ABOVE THRESH =      35.00000
*         FOR A TOTAL OF     16 RECEPTORS AND    3 SOURCE GROUPS;  WITH CONTRIBUTIONS FROM OTHER SOURCE GROUPS PAIRED IN TIME & SPACE
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,A5,5X,A8,2X,   3(F13.5,2X:))
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP       RANK     NET ID   CONT STACK1    CONT STACK2    CONT ALL
*  ___________  ___________  ____________  ______  ______  ______  ______  ________  ______  ______  _____________  _____________  _____________
     200.00000       0.00000       9.76902    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
     500.00000       0.00000      25.61401    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
    1000.00000       0.00000      26.86548    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
    3000.00000       0.00000       8.85979    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
       0.00000    -200.00000      20.50162    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
       0.00000    -500.00000      51.65594    0.00    0.00    0.00   24-HR  ALL        1ST     POL1           21.15838       30.49757       51.65594
       0.00000   -1000.00000      52.82753    0.00    0.00    0.00   24-HR  ALL        1ST     POL1           13.99357       38.83396       52.82753
       0.00000   -3000.00000      19.91409    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
    -200.00000      -0.00000       8.64428    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
    -500.00000      -0.00000      14.58084    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
   -1000.00000      -0.00000      11.59131    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
   -3000.00000      -0.00000      12.28970    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
      -0.00000     200.00000      67.53734    0.00    0.00    0.00   24-HR  ALL        1ST     POL1           67.53733        0.00002       67.53734
      -0.00000     500.00000      67.83252    0.00    0.00    0.00   24-HR  ALL        1ST     POL1           64.45844        3.37408       67.83252
      -0.00000    1000.00000      52.28291    0.00    0.00    0.00   24-HR  ALL        1ST     POL1           28.94476       23.33815       52.28291
      -0.00000    3000.00000      29.08609    0.00    0.00    0.00   24-HR  ALL        1ST     POL1            0.00000        0.00000        0.00000
* AERMOD ( 15181):  PM-2.5 Test Case for the AERMOD Model using single met file            07/30/15
* AERMET ( 13350):                                                                          13:50:57
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      RURAL
*         MAXDCONT FILE OF   2ND-HIGHEST 24-HR VALUES AVERAGED OVER   5 YEARS FOR SOURCE GROUP: ALL      ; ABOVE THRESH =      35.00000
*         FOR A TOTAL OF     16 RECEPTORS AND    3 SOURCE GROUPS;  WITH CONTRIBUTIONS FROM OTHER SOURCE GROUPS PAIRED IN TIME & SPACE
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,A5,5X,A8,2X,   3(F13.5,2X:))
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP       RANK     NET ID   CONT STACK1    CONT STACK2    CONT ALL
*  ___________  ___________  ____________  ______  ______  ______  ______  ________  ______  ______  _____________  _____________  _____________
     200.00000       0.00000       7.91782    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
     500.00000       0.00000      22.53064    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
    1000.00000       0.00000      24.26451    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
    3000.00000       0.00000       8.10584    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
       0.00000    -200.00000      16.96505    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
       0.00000    -500.00000      43.25276    0.00    0.00    0.00   24-HR  ALL        2ND     POL1           14.36197       28.89079       43.25276
       0.00000   -1000.00000      43.82672    0.00    0.00    0.00   24-HR  ALL        2ND     POL1           10.92254       32.90417       43.82672
       0.00000   -3000.00000      17.32480    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
    -200.00000      -0.00000       6.77421    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
    -500.00000      -0.00000      11.56687    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
   -1000.00000      -0.00000       9.72229    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
   -3000.00000      -0.00000       8.03098    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
      -0.00000     200.00000      51.19765    0.00    0.00    0.00   24-HR  ALL        2ND     POL1           51.19763        0.00002       51.19765
      -0.00000     500.00000      59.15581    0.00    0.00    0.00   24-HR  ALL        2ND     POL1           57.67153        1.48428       59.15581
      -0.00000    1000.00000      41.49519    0.00    0.00    0.00   24-HR  ALL        2ND     POL1           18.49276       23.00243       41.49519
      -0.00000    3000.00000      23.24160    0.00    0.00    0.00   24-HR  ALL        2ND     POL1            0.00000        0.00000        0.00000
```

D.10 Daily maximum 1-hour values (MAXDAILY)

The OU MAXDAILY card of the AERMOD model generates a file of daily maximum 1-hour concentrations for a specified source group, useful for analyzing the 1-hour NO_2 and SO_2 NAAQS. The MAXDAILY file includes several lines of header information, each identified with an asterisk (*) in column one, including: the model name and version number, the first line of the title information, the list of modeling option keywords, and the source group. The header also includes the total number of receptors and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, averaging period, the source group ID, day of the year, hour, date, and receptor network ID. The following example is a sample from a MAXDAILY output file.

```
* AERMOD ( 15181): AERMOD OLM/OLMGROUP ALL Test Case, with BACKGROUND                    07/30/15
* AERMET ( 13350):                                                                       13:50:48
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      OLM       RURAL
*         MAXDAILY FILE OF DAILY MAXIMUM 1-HR VALUES BY DAY FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF    16 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I4,2X,I3,2X,I8.8,2X,A8)
*        X             Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    AVE     GRP      JDAY   HR    DATE     NET ID
* ____________  ____________  ____________  ______   ______   ______  ______  ________  ____   ___  ________  ________
    100.00000       0.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
    300.00000       0.00000      50.00159    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
   1000.00000       0.00000      50.20117    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
   3000.00000       0.00000      50.12314    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
      0.00000    -100.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
      0.00000    -300.00000      50.00259    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
      0.00000   -1000.00000      50.22100    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
      0.00000   -3000.00000      68.29389    35.00    35.00     0.00    1-HR  ALL          1    7  99010107  POL1
   -100.00000      -0.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
   -300.00000      -0.00000      50.00258    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
  -1000.00000      -0.00000      50.20079    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
  -3000.00000      -0.00000      50.12262    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
     -0.00000     100.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
     -0.00000     300.00000      50.00159    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
     -0.00000    1000.00000      50.20117    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
     -0.00000    3000.00000      50.12314    35.00    35.00     0.00    1-HR  ALL          1   13  99010113  POL1
    100.00000       0.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
    300.00000       0.00000      50.00001    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
   1000.00000       0.00000      50.00008    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
   3000.00000       0.00000      50.00280    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
      0.00000    -100.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
      0.00000    -300.00000      50.00001    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
      0.00000   -1000.00000      50.00009    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
      0.00000   -3000.00000      50.00285    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
   -100.00000      -0.00000      50.00000    35.00    35.00     0.00    1-HR  ALL          2   13  99010213  POL1
```

D.11 Maximum daily 1-hour concentration by year (MAXDYBYYR)

The OU MAXDYBYYR card of the AERMOD model generates a file with a summary of daily maximum 1-hour concentrations by year for each rank specified on the RECTABLE keyword for a specified source group. This is another output file type that is applicable to the 1-hour NO_2 and 1-hour SO_2 NAAQS. The ranks included in the MXDYBYYR file are the ranks used in the MAXDCONT postprocessing option. The MAXDYBYYR file includes several lines of header information, each identified with an asterisk (*) in column one, including: the model name and version number, the first line of the title information, the list of modeling option keywords, and the source group. The header also includes the total number of receptors and the Fortran format statement used to write the data records. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration value for the target source group at the receptor location, receptor terrain elevation, hill height scale, flagpole receptor height, rank, the source group ID, day of the year, hour, date, and receptor network ID. The data records are grouped by rank in ascending order. Concentrations are displayed for all receptors for the highest rank, then the next highest rank, etc. The following example is a sample from a MAXDAILY output file for which ranks 4, 8 12, and 50 were specified on the MAXDCONT keyword.

```
* AERMOD ( 15181): AERMOD OLM/OLMGROUP ALL Test Case, with BACKGROUND                    07/30/15
* AERMET ( 13350):                                                                       13:50:48
* MODELING OPTIONS USED:  NonDFAULT CONC      FLAT      OLM       RURAL
*         MXDYBYYR FILE OF RANKED DAILY MAXIMUM 1-HR  VALUES BY YEAR FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF    16 RECEPTORS.
*         FORMAT: (3(1X,F13.5),3(1X,F8.2),2X,A6,2X,A8,2X,I4,2X,I3,2X,I8.8,2X,A8)
*        X            Y      AVERAGE CONC    ZELEV    ZHILL    ZFLAG    RANK    GRP     JDAY   HR    DATE     NET ID
* ___________  ___________  ___________  _______  _______  _______  _______  ________  ____  __  ________  ________
     100.00000      0.00000      76.74205    35.00    35.00     0.00     4TH  ALL        236   14  99082414  POL1
     300.00000      0.00000     174.62886    35.00    35.00     0.00     4TH  ALL        136   14  99051614  POL1
    1000.00000      0.00000     146.90191    35.00    35.00     0.00     4TH  ALL        147   14  99052714  POL1
    3000.00000      0.00000      91.97719    35.00    35.00     0.00     4TH  ALL        104   13  99041413  POL1
       0.00000   -100.00000      99.52361    35.00    35.00     0.00     4TH  ALL        252   15  99090915  POL1
       0.00000   -300.00000     171.76063    35.00    35.00     0.00     4TH  ALL        107   11  99041711  POL1
       0.00000  -1000.00000     152.93801    35.00    35.00     0.00     4TH  ALL         65   13  99030613  POL1
       0.00000  -3000.00000     111.73167    35.00    35.00     0.00     4TH  ALL        293   16  99102016  POL1
    -100.00000     -0.00000      91.59388    35.00    35.00     0.00     4TH  ALL         62   14  99030314  POL1
    -300.00000     -0.00000     154.65265    35.00    35.00     0.00     4TH  ALL         62   15  99030315  POL1
   -1000.00000     -0.00000     131.73020    35.00    35.00     0.00     4TH  ALL        360   13  99122613  POL1
   -3000.00000     -0.00000      86.11262    35.00    35.00     0.00     4TH  ALL        312   16  99110816  POL1
      -0.00000    100.00000      80.06381    35.00    35.00     0.00     4TH  ALL        203    8  99072208  POL1
      -0.00000    300.00000     166.86210    35.00    35.00     0.00     4TH  ALL        139   16  99051916  POL1
      -0.00000   1000.00000     156.54681    35.00    35.00     0.00     4TH  ALL        110   15  99042015  POL1
      -0.00000   3000.00000     102.04635    35.00    35.00     0.00     4TH  ALL         23   15  99012315  POL1
     100.00000      0.00000      65.46639    35.00    35.00     0.00     8TH  ALL        250   17  99090717  POL1
     300.00000      0.00000     164.95260    35.00    35.00     0.00     8TH  ALL        147   14  99052714  POL1
    1000.00000      0.00000     137.02622    35.00    35.00     0.00     8TH  ALL        145   16  99052516  POL1
    3000.00000      0.00000      79.71649    35.00    35.00     0.00     8TH  ALL        102   19  99041219  POL1
       0.00000   -100.00000      90.20572    35.00    35.00     0.00     8TH  ALL        175    9  99062409  POL1
       0.00000   -300.00000     167.99537    35.00    35.00     0.00     8TH  ALL         81   14  99032214  POL1
       0.00000  -1000.00000     147.76997    35.00    35.00     0.00     8TH  ALL        107   18  99041718  POL1
       0.00000  -3000.00000     108.50074    35.00    35.00     0.00     8TH  ALL        272   17  99092917  POL1
    -100.00000     -0.00000      86.21569    35.00    35.00     0.00     8TH  ALL        251   12  99090812  POL1
    -300.00000     -0.00000     147.43347    35.00    35.00     0.00     8TH  ALL         63   13  99030413  POL1
   -1000.00000     -0.00000     113.23071    35.00    35.00     0.00     8TH  ALL        144    8  99052408  POL1
   -3000.00000     -0.00000      80.46493    35.00    35.00     0.00     8TH  ALL        251   12  99090812  POL1
      -0.00000    100.00000      62.77470    35.00    35.00     0.00     8TH  ALL        213   15  99080115  POL1
      -0.00000    300.00000     164.12251    35.00    35.00     0.00     8TH  ALL        212   12  99073112  POL1
      -0.00000   1000.00000     147.60345    35.00    35.00     0.00     8TH  ALL         84   15  99032515  POL1
      -0.00000   3000.00000      92.37244    35.00    35.00     0.00     8TH  ALL        264   19  99092119  POL1
     100.00000      0.00000      63.04954    35.00    35.00     0.00    12TH  ALL        213   15  99080115  POL1
     300.00000      0.00000     158.05318    35.00    35.00     0.00    12TH  ALL        182   15  99070115  POL1
    1000.00000      0.00000     132.45210    35.00    35.00     0.00    12TH  ALL        123   15  99050315  POL1
    3000.00000      0.00000      75.06520    35.00    35.00     0.00    12TH  ALL         56   14  99022514  POL1
       0.00000   -100.00000      81.79820    35.00    35.00     0.00    12TH  ALL        230   14  99081814  POL1
       0.00000   -300.00000     163.58691    35.00    35.00     0.00    12TH  ALL        150   13  99053013  POL1
       0.00000  -1000.00000     143.66477    35.00    35.00     0.00    12TH  ALL         63   11  99030411  POL1
       0.00000  -3000.00000     103.84510    35.00    35.00     0.00    12TH  ALL        359   10  99122510  POL1
    -100.00000     -0.00000      66.87945    35.00    35.00     0.00    12TH  ALL        210   13  99072913  POL1
    -300.00000     -0.00000     134.34226    35.00    35.00     0.00    12TH  ALL        192   11  99071111  POL1
   -1000.00000     -0.00000     112.42027    35.00    35.00     0.00    12TH  ALL         90   10  99033110  POL1
   -3000.00000     -0.00000      69.14045    35.00    35.00     0.00    12TH  ALL         70   12  99031112  POL1
      -0.00000    100.00000      57.29793    35.00    35.00     0.00    12TH  ALL         80   13  99032113  POL1
      -0.00000    300.00000     161.46688    35.00    35.00     0.00    12TH  ALL         46   12  99021512  POL1
      -0.00000   1000.00000     141.04997    35.00    35.00     0.00    12TH  ALL        165   14  99061414  POL1
      -0.00000   3000.00000      89.51271    35.00    35.00     0.00    12TH  ALL        109   19  99041919  POL1
     100.00000      0.00000      51.04396    35.00    35.00     0.00    50TH  ALL        132   13  99051213  POL1
     300.00000      0.00000     126.14782    35.00    35.00     0.00    50TH  ALL        175   15  99062415  POL1
    1000.00000      0.00000     105.50261    35.00    35.00     0.00    50TH  ALL        267   17  99092417  POL1
    3000.00000      0.00000      56.90880    35.00    35.00     0.00    50TH  ALL        236   14  99082414  POL1
       0.00000   -100.00000      56.69467    35.00    35.00     0.00    50TH  ALL        287   13  99101413  POL1
       0.00000   -300.00000     137.18380    35.00    35.00     0.00    50TH  ALL        204   13  99072313  POL1
       0.00000  -1000.00000     120.65746    35.00    35.00     0.00    50TH  ALL        268   13  99092513  POL1
       0.00000  -3000.00000      85.42463    35.00    35.00     0.00    50TH  ALL        156    1  99060501  POL1
    -100.00000     -0.00000      51.20790    35.00    35.00     0.00    50TH  ALL        169   14  99061814  POL1
    -300.00000     -0.00000      72.61516    35.00    35.00     0.00    50TH  ALL         32   13  99020113  POL1
   -1000.00000     -0.00000      72.14476    35.00    35.00     0.00    50TH  ALL        270   10  99092710  POL1
   -3000.00000     -0.00000      52.15505    35.00    35.00     0.00    50TH  ALL        265   13  99092213  POL1
      -0.00000    100.00000      50.39602    35.00    35.00     0.00    50TH  ALL        180   14  99062914  POL1
      -0.00000    300.00000     125.74471    35.00    35.00     0.00    50TH  ALL        247   14  99090414  POL1
      -0.00000   1000.00000     117.67662    35.00    35.00     0.00    50TH  ALL        143    1  99052301  POL1
      -0.00000   3000.00000      70.84420    35.00    35.00     0.00    50TH  ALL        127    2  99050702  POL1
```

APPENDIX E. Quick reference for AERMOD

SUMMARY OF CONTROL PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters
TITLEONE	Title1
TITLETWO	Title2
MODELOPT	DFAULT BETA CONC AREADPLT FLAT NOSTD NOCHKD NOWARN SCREEN SCIM PVMRM PSDCREDIT DEPOS and/or or or OLM DDEP ELEV WARNCHKD or ARM and/or or ARM2 WDEP FASTALL DRYDPLT WETDPLT NOURBTRAN LOWWIND1 VECTORWS or or or or FASTAREA NODRYDPLT NOWETDPLT LOWWIND2 or LOWWIND3
AVERTIME	Time1 Time2 . . . TimeN MONTH PERIOD or ANNUAL
URBANOPT	UrbanID Urbpop (Urbname) (UrbRoughness) [For multiple urban areas] or Urbpop (Urbname) (UrbRoughness) [For single urban areas]
POLLUTID	Pollut (H1H or H2H or INC)
HALFLIFE	Haflif
DCAYCOEF	Decay
GASDEPDF	React F_Seas2 F_Seas5 (Refpoll)
GASDEPVD	Uservd
GDLANUSE	Sec1 Sec2 ... Sec36
GDSEASON	Jan Feb ... Dec
LOW_WIND	SVmin (WSmin) [for LOWWIND1] or SVmin (WSmin (FRANmax)) [for LOWWIND2] or SVmin (WSmin (FRANmax)) [for LOWWIND3]
NO2EQUIL	NO2Equil
NO2STACK	NO2Ratio
ARMRATIO	ARM_1hr (ARM_Ann) [for ARM Option] or ARM2_Min ARM2_Max [for ARM2 Option]
O3SECTOR	StartSect1 StartSect2 . . . StartSectN, where N is ≤ 6
OZONEFIL	O3FileName (O3Units) (O3Format) [without O3SECTORs] or SECTn O3FileName (O3Units) (O3Format) [with O3SECTORs]
OZONEVAL	O3Value (O3Units) [without O3SECTORs] or SECTn O3Value (O3Units) [with O3SECTOR]
O3VALUES	O3Flag O3values(i), i=1,n) [without O3SECTORs] or SECTn O3Flag O3values(i), i=1,n) [with O3SECTORs]

Keyword	Parameters
OZONUNIT	(OzoneUnits)
FLAGPOLE	(Flagdf)
RUNORNOT	RUN or NOT
EVENTFIL	(Evfile) (Evopt)
SAVEFILE	(Savfil) (Dayinc) (Savfl2)
INITFILE	(Inifil)
MULTYEAR	(H6H) Savfil (Inifil)
DEBUGOPT	MODEL (Dbgfil) and/or METEOR (Dbmfil) and/or PRIME (Prmfil) and/or DEPOS and/or [AREA (AreaDbFil) or LINE (LineDbFil)] and/or [PVMRM (Dbpvfil) or OLM (OLMfil) or ARM (ARMfil) or ARM2 (ARM2fil)]
ERRORFIL	(Errfil)

SUMMARY OF SOURCE PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters
ELEVUNIT	METERS or FEET
LOCATION	SrcID Srctyp Xs Ys (Zs) [All except LINE or BUOYLINE source] or (FLAT) [for 'FLAT & ELEV' option] SrcID Srctyp Xs1 Ys1 Xs2 Ys2 (Zs) [LINE or BUOYLINE source]
SRCPARAM	SrcID Ptemis Stkhgt Stktmp Stkvel Stkdia [POINT,POINTCAP, POINTHOR source] Vlemis Relhgt Syinit Szinit [VOLUME source] Aremis Relhgt Xinit (Yinit) (Angle) (Szinit) [AREA source] Aremis Relhgt Nverts (Szinit) [AREAPOLY source] Aremis Relhgt Radius (Nverts) (Szinit) [AREACIRC source] Opemis Relhgt Xinit Yinit Pitvol (Angle) [OPENPIT source] BLemis Relhgt [BUOYLINE source]
BLPINPUT	blavgblen blavgbhgt blavgbwid blavglwid blavgbsep blavgfprm
BUILDHGT	SrcID (or SrcRange) Dsbh(i), i=1,36
BUILDLEN	SrcID (or SrcRange) Dsbl(i), i=1,36
BUILDWID	SrcID (or SrcRange) Dsbw(i), i=1,36
XBADJ	SrcID (or SrcRange) Xbadj(i), i=1,36
YBADJ	SrcID (or SrcRange) Ybadj(i), i=1,36
AREAVERT	SrcID Xv(1) Yv(1) Xv(2) Yv(2) ... Xv(i) Yv(i)
URBANSRC	UrbanID SrcID's and/or SrcRng's [For multiple urban areas] or SrcID's and/or SrcRng's [For single urban areas]
EMISFACT	SrcID (or SrcRange) Qflag Qfact(i), i=1,n
EMISUNIT	Emifac Emilbl Outlbl
CONCUNIT	Emifac Emilbl Conlbl
DEPOUNIT	Emifac Emilbl Deplbl
PARTDIAM	SrcID (or SrcRange) Pdiam(i), i=1,Npd
MASSFRAX	SrcID (or SrcRange) Phi(i), i=1,Npd
PARTDENS	SrcID (or SrcRange) Pdens(i), i=1,Npd
METHOD_2	SrcID (or SrcRange) FineMassFraction Dmm
GASDEPOS	SrcID (or SrcRange) Da Dw rcl Henry
NO2RATIO	SrcID (or SrcRange) NO2Ratio
HOUREMIS	Emifil SrcID's SrcRange's
BGSECTOR	StartSect1 StartSect2 . . . StartSectN, where N is ≤ 6
BACKGRND	BGflag BGvalue(i), i=1,n and/or [without BGSECTORs] HOURLY BGfilnam (BGformat) or SECTn BGflag BGvalue(i), i=1,n and/or [with BGSECTORs] SECTn HOURLY BGfilnam (BGformat)
BACKUNIT	BGunits
INCLUDED	Incfil
OLMGROUP	OLMGrpID SrcID's SrcRange's
PSDGROUP	PSDGrpID SrcID's SrcRange's

Keyword	Parameters
BLPGROUP	BLPGrpID SrcID's and/or SrcRange's [for BUOYLINE sources only] or ALL
SRCGROUP	SrcGrpID SrcID's SrcRange's

SUMMARY OF RECEPTOR PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters
ELEVUNIT	METERS or FEET
GRIDCART	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta, or XPNTS Gridx1 Gridx2 Gridx3 .... GridxN, and YPNTS Gridy1 Gridy2 Gridy3 .... GridyN ELEV Row Zelev1 Zelev2 Zelev3 ... ZelevN HILL Row Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Row Zflag1 Zflag2 Zflag3 ... ZflagN END
GRIDPOLR	Netid STA ORIG Xinit Yinit, or ORIG Srcid DIST Ring1 Ring2 Ring3 ... RingN DDIR Dir1 Dir2 Dir3 ... DirN, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... ZelevN HILL Dir Zhill1 Zhill2 Zhill3 ... ZhillN FLAG Dir Zflag1 Zflag2 Zflag3 ... ZflagN END
DISCCART	Xcoord Ycoord (Zelev Zhill) (Zflag)
DISCPOLR	Srcid Dist Direct (Zelev Zhill) (Zflag)
EVALCART	Xcoord Ycoord Zelev Zhill Zflag Arcid (Name)
INCLUDED	RecIncFile

SUMMARY OF METEOROLOGY PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters
SURFFILE	Sfcfil
PROFFILE	Profil
SURFDATA	Stanum Year (Name) (Xcoord Ycoord)
UAIRDATA	Stanum Year (Name) (Xcoord Ycoord)
SITEDATA	Stanum Year (Name) (Xcoord Ycoord)
PROFBASE	BaseElev (Units)
STARTEND	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)
DAYRANGE	Range1 Range2 Range3 ... RangeN
SCIMBYHR	NRegStart NRegInt (SfcFilnam PflFilnam)
WDROTATE	Rotang
WINDCATS	Ws1 Ws2 Ws3 Ws4 Ws5

SUMMARY OF EVENT PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters
EVENTPER	Evname Aveper Grpid Date
EVENTLOC	Evname XR= Xr YR= Yr (Zelev Zhill) (Zflag) or RNG= Rng DIR= Dir (Zelev Zhill) (Zflag)
INCLUDED	EventIncFile

Note: EVENT locations can be input as either discrete Cartesian receptors (XR=, YR=) or as discrete polar receptors (RNG=, DIR=). Events that are specified in the file generated by the AERMOD model (CO EVENTFIL card) are always given as discrete Cartesian coordinates. Discrete polar receptors are assumed to be relative to an origin of (0,0).

SUMMARY OF OUTPUT PATHWAY KEYWORDS AND PARAMETERS

Keyword	**Parameters**
RECTABLE	Aveper FIRST SECOND . . . SIXTH . . . TENTH and/or Aveper 1ST 2ND . . . 6TH . . . 10TH and/or Aveper 1 2 . . . 6 . . . 10 . . . *N* . . . 999
MAXTABLE	Aveper Maxnum
DAYTABLE	Avper1 Avper2 Avper3 . . .
MAXIFILE	Aveper GrpID Thresh Filnam (Funit)
POSTFILE	Aveper GrpID Format Filnam (Funit)
PLOTFILE	Aveper GrpID Hivalu Filnam (Funit) [Short Term values] Aveper GrpID Filnam (Funit) [PERIOD or ANNUAL averages]
TOXXFILE	Aveper Cutoff Filnam (Funit)
RANKFILE	Aveper Hinum Filnam (Funit)
EVALFILE	SrcID Filnam (Funit)
SEASONHR	GrpID FileName (FileUnit)
MAXDAILY	GrpID FileName (FileUnit)
MXDYBYYR	GrpID FileName (FileUnit)
MAXDCONT	GrpID UpperRank LowerRank FileName (FileUnit) or GrpID UpperRank THRESH ThreshValue FileName (FileUnit)
SUMMFILE	SummFileName
FILEFORM	EXP or FIX
NOHEADER	FileType1 FileType2 FileType3 . . . FileType*N* or ALL
EVENTOUT	SOCONT or DETAIL [EVENT Only]

APPENDIX F. Evaluation of modified urban option

The urban option in AERMOD was modified, beginning with version 11059, to address potential issues associated with the transition from the nighttime urban boundary layer to the daytime convective boundary layer. Prior to version 11059, the enhanced dispersion associated with the urban nighttime heat island effect was ignored once the boundary layer turned convective. This could result in an unrealistic drop in the mixed layer height during early morning hours for urban applications, which could contribute to unrealistically high concentrations for low-level plumes. This effect was observed in the application of AERMOD for the Risk and Exposure Assessment (REA) in support of the NO_2 NAAQS review in association with mobile source emissions (EPA, 2008). Beginning with version 11059 the urban option in AERMOD continues application of the urban boundary layer approach for urban sources until the daytime convective mixing height exceeds the urban nighttime mixing height, based on the user-specified population (EPA, 2004a)). This revision to AERMOD will generally reduce concentrations during the early morning transition to convective conditions for low-level urban sources, but may increase daytime concentrations for elevated urban sources.

The modified implementation of the urban option was evaluated using data from the 1985 Indianapolis SF_6 urban field study (Perry, et al, 2005), and model-to-monitor comparisons at four ambient monitors for 2002 from the Atlanta NO_2 REA (EPA, 2008). The Indianapolis study involved an elevated buoyant release and the Atlanta REA study involved mostly low-level mobile source emissions. Results from the Indianapolis study are presented in the form of Q-Q plots of ranked 1-hour modeled vs. observed concentrations, unpaired in time and space. Figure E-1 shows model performance for all stabilities and Figure E-2 shows model performance for convective conditions only. The revised urban option does not affect results under stable conditions. Results from the Atlanta NO_2 REA are also presented in the form of Q-Q plots of 1-hour ranked modeled vs. observed concentrations, unpaired in time, for each of the four ambient NO_2 monitors, shown in Figures E-3 through E-6. Both of these evaluations show improved model performance with the modified urban option in AERMOD.

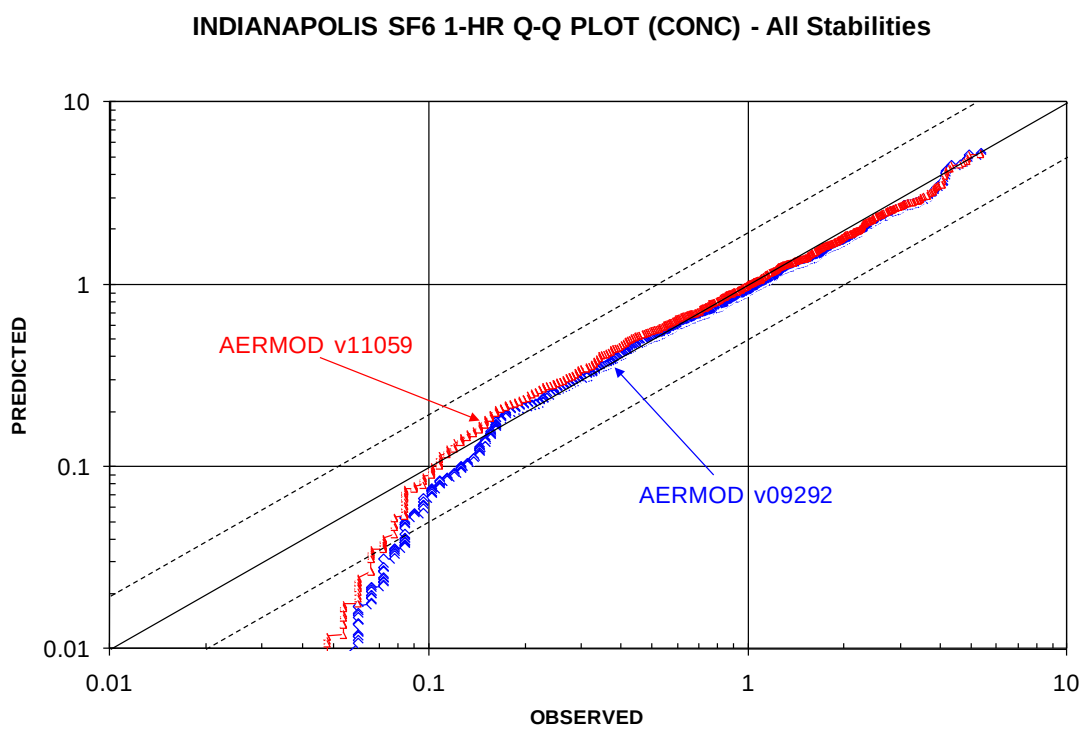


Figure E-1. 1-hour Q-Q Plot for Indianapolis SF_6 Study for All Stabilities

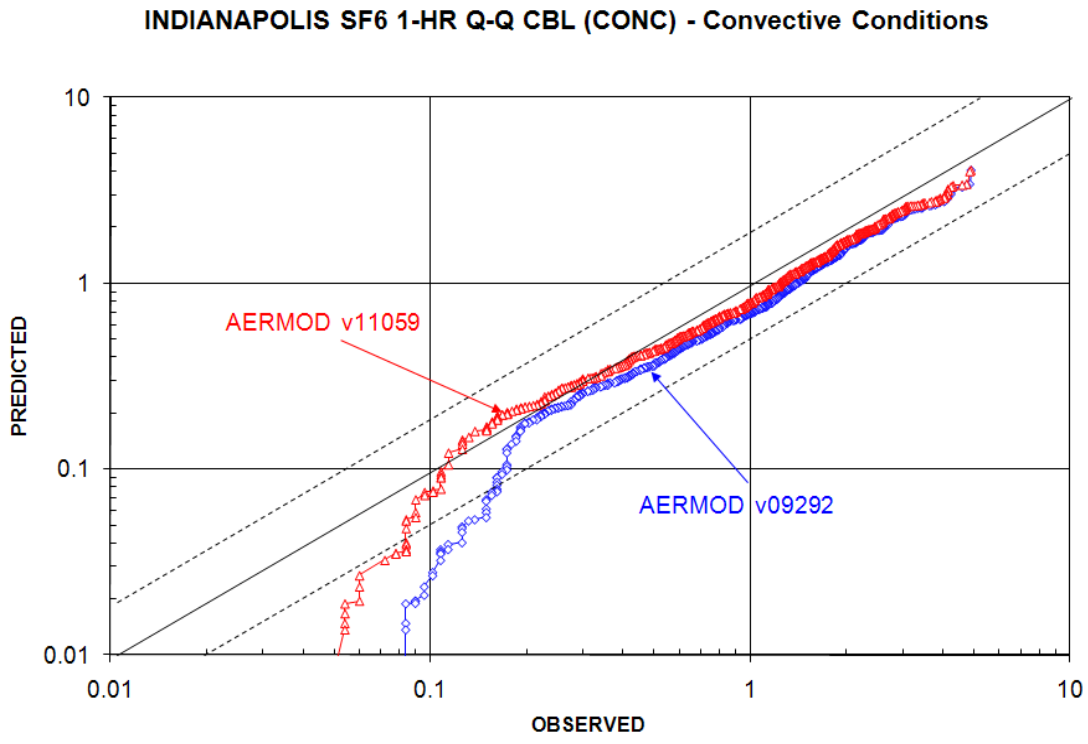


Figure E-2. 1-hour Q-Q Plot for Indianapolis SF_6 Study for Convective Conditions

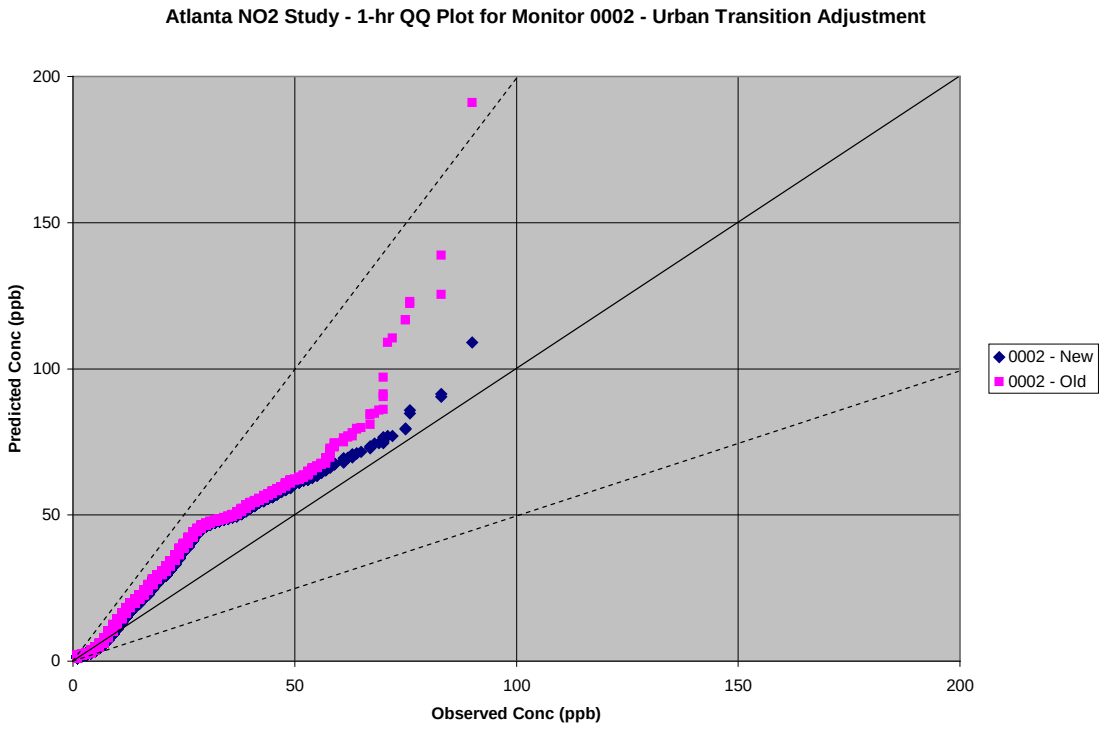


Figure E-3. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 0002

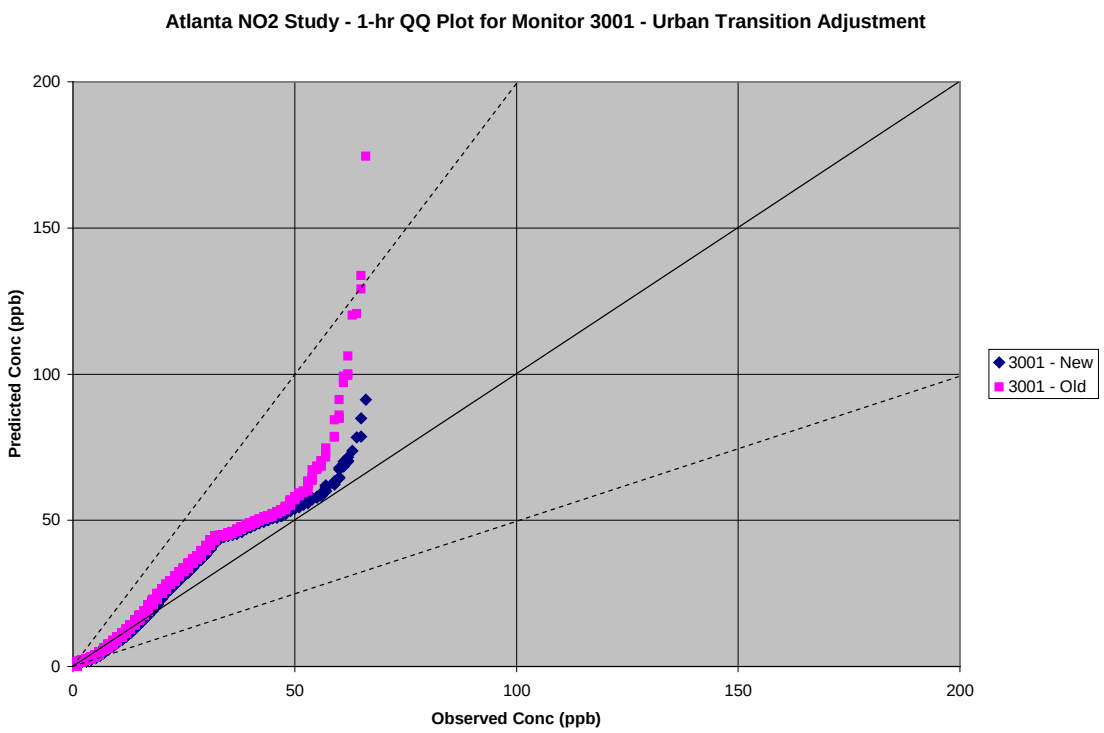


Figure E-4. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 3001

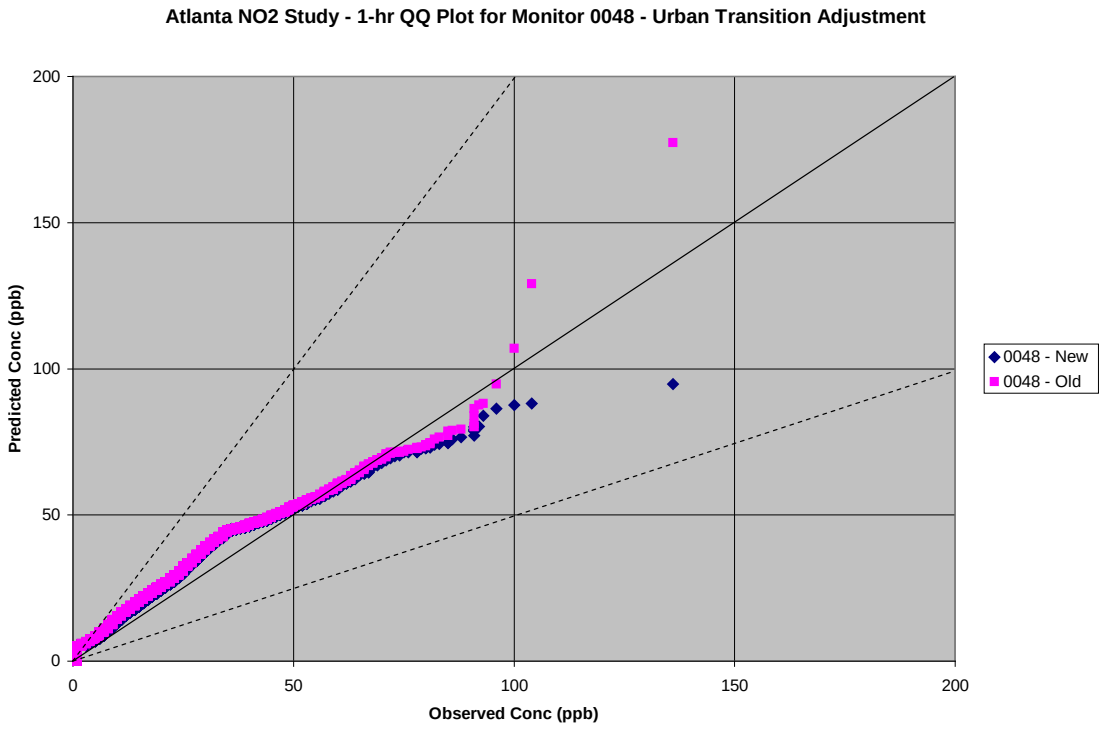


Figure E-5. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor 0048

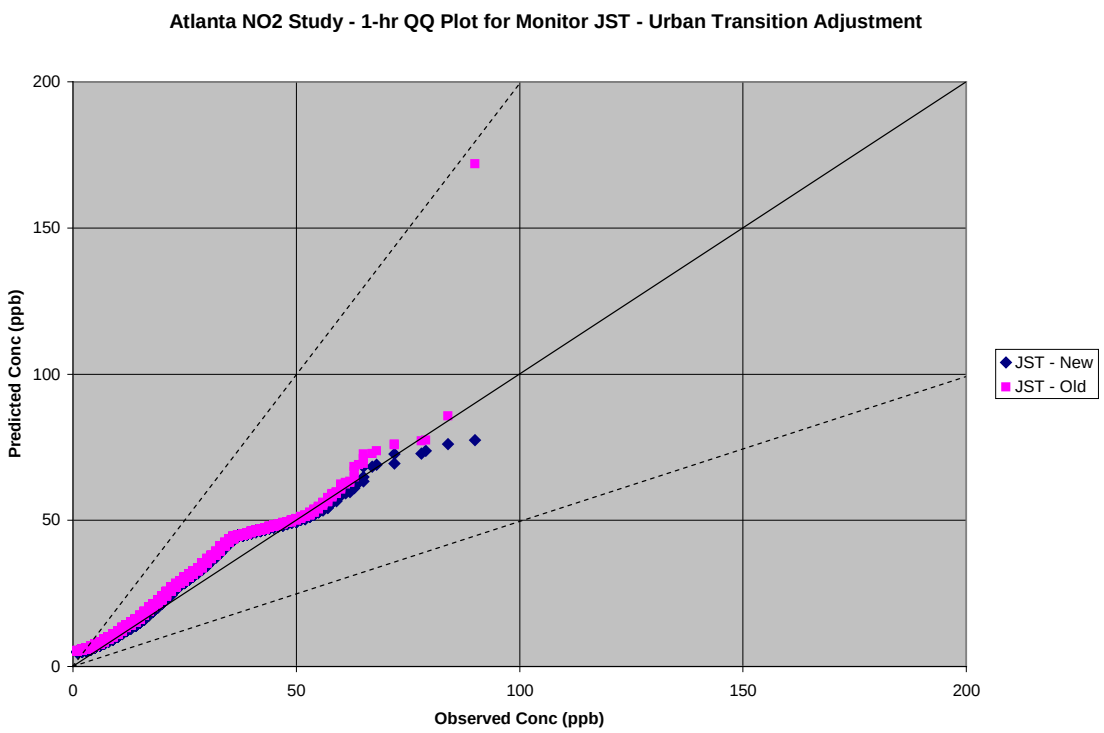


Figure E-6. 1-hour Q-Q Plot for Atlanta NO_2 Study for Monitor JST

APPENDIX G. Evaluation of low wind beta options

Beginning with version 12345, AERMOD includes non-default BETA options to address concerns regarding model performance under low wind speed conditions. This included the LOWWIND1 and LOWWIND2 BETA options on the MODELOPT keyword in AERMOD, and the ADJ_U* option included in Stage 3 of the AERMET meteorological processor. Beginning with version 15181 a new LOWWIND3 BETA option was incorporated into AERMOD. The LOWWIND3 option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, consistent with the LowWind2 option, but eliminates upwind dispersion, consistent with the LowWind1 option. The LowWind3 option uses an "effective" sigma-y value that replicates the centerline concentration accounting for meander, but sets concentrations to zero (0) for receptors that are more than 6*sigma-y off the plume centerline, similar to the FASTALL option.

Updated evaluation results for these BETA options based on version 15181 of AERMOD are presented below for two field studies conducted in 1974 by the Air Resources Laboratory of the National Oceanic and Atmospheric Administration (NOAA) to investigate diffusion under low wind speed conditions at Idaho Falls (NOAA, 1974) and Oak Ridge (NOAA, 1976). These two field studies were used in the API-sponsored evaluations of AERMOD conducted by AECOM (AECOM, 2009), that were subsequently submitted as part of API's public comments on EPA's 10th Conference on Air Quality Models held in March 2012. Each of these studies used tracer releases with three arcs of samplers located at 100m, 200m, and 400m from the release point. Diagrams for each of the study areas are presented below.

In addition, since the ADJ_U* option in AERMET and the LowWind option in AERMOD are focused on improving model performance during periods of stable/low-wind conditions, additional evaluations are presented below for the Lovett evaluation database, a tall stack located in complex terrain where stable/low-wind conditions can also be important.

The evaluation results presented here for the Idaho Falls and Oak Ridge studies were based in part on the information included in the AECOMs 2009 report and data files subsequently provided by AECOM. However, some adjustments to inputs were made based on an independent assessment of the surface roughness for each of the study locations, an

adjustment to the effective tracer release height at Idaho Falls from 1.5 to 3m based on information provided on page 24 of the NOAA Technical Memorandum for Idaho Falls (NOAA, 1974), and adjustments to the wind measurement height for Oak Ridge based on the discussion in Section 2.2 and information provided in Table 1 of the NOAA Technical Memorandum for Oak Ridge (NOAA, 1976).

The AECOM evaluation for Oak Ridge assumed a 2m wind measurement height, whereas page 8 of the NOAA report for Oak Ridge indicated that the wind measurements were "accomplished by laser anemometry" because wind speeds were "below the threshold of standard cup anemometers." Footnotes in Table 1 also confirm that wind speeds were "measured by laser anemometers" for all tests, except for Test 11 where the wind speed was measured at the 30.5m level on one of meteorological towers included in the study. Given that the transmitters and receivers for the laser anemometer were located on the hills on either side of the valley where the tracer was released, at elevations between 50 to 100 feet higher than the elevation at the release point (based on Figure 2b of the NOAA report), a 2m wind measurement height may not be appropriate. However, the NOAA report does not indicate an "effective" measurement height above ground for the wind speeds measured by the laser anemometers. Another aspect of the use of laser anemometry that complicates the determination of an appropriate measurement height is that the "measured" wind speeds may represent more of a volume average than a point measurement. Since the wind speeds estimated by laser anemometry are likely to be more representative of vector averaged wind speeds than scalar averages the VECTORWS option in AERMOD was used for the Oak Ridge evaluations.

Based on these considerations, the evaluation results presented here were based on an "effective" wind measurement height of 10m, and the winds were also assumed to represent vector mean wind speeds. In addition to the different assumptions regarding the appropriate measurement height to assign to the observed wind speeds at Oak Ridge, the results presented below are based on a surface roughness length of 0.6m, consistent with the forest covering most of the study area at the time. The AECOM study assumed a much smaller roughness length of 0.2m.

A series of figures is provided below for each site, starting with the Oak Ridge study

followed by the Idaho Falls study. For each site a series of Q-Q plots (results paired by rank), plots of concentrations paired in time, and residual plots showing the distribution of predicted/observed concentration ratios versus downwind distance are provided. Results are shown for the following scenarios:

- Current regulatory default options, i.e., no adjustments (No ADJ_U*/No LowWind)
- U* adjustment with no low wind options (ADJ_U*/No_LowWind)
- U* adjustment with LOWWIND1 (ADJ_U*/LowWind1)
- U* adjustment with LOWWIND2 (ADJ_U*/LowWind2)
- U* adjustment with LOWWIND3 (ADJ_U*/LowWind3)

Based on the limited meteorological data available for the Oak Ridge study, a single set of model comparisons is presented. Given the more robust meteorological data available from the Idaho Falls study, including multiple levels of wind speed, direction, temperature, and sigma-theta, several sets of meteorological inputs are evaluated, including the use of delta-T data with the Bulk Richardson Number (BULKRN) option available in AERMET.

Another important difference between these two field studies is that the Oak Ridge site was located in a hilly area on the Oak Ridge peninsula, with terrain elevations varying about 40m across the study area, with the tracer release point located near the center of the valley that cuts across the peninsula. Given the very low wind speeds during the study period, drainage flows and valley channeling may have influenced plume dispersion. The influence of terrain on low-level non-buoyant releases in AERMOD has not been assessed, and neither the AECOM nor EPA results for Oak Ridge have incorporated terrain elevations in their respective evaluations. As a result, the evaluations based on the Idaho Falls are likely to be more robust than the evaluations based on Oak Ridge.

As noted above, the Oak Ridge evaluations are based on a single set of meteorological inputs, whereas the Idaho Falls evaluation are based on a range of options given the more robust data available. These various sets of meteorological inputs for Idaho Falls are referred to in the figure captions as follows:

1. Base 1-level: no delta-T or turbulence (i.e., sigma-theta) data included;
2. Full 1-level: no delta-T data with sigma-theta data;

3. Base 2-level: delta-T data used with BULKRN option without sigma-theta;
4. Full 2-level: delta-T data used with BULKRN option with sigma-theta

Each of these data sets were used with and without the ADJ_U* option in AERMET and also with and without the LowWind options. For purposes of assessing the proposed BETA options, including the ADJ_U* option in AERMET and the LowWind options in AERMOD, the comparisons below are limited to the current default options, i.e., without ADJ_U* and without the LowWind option (labeled as NoADJ and NoLW), and the proposed options of ADJ_U* and LowWind3 (labeled as ADJ and LW3).

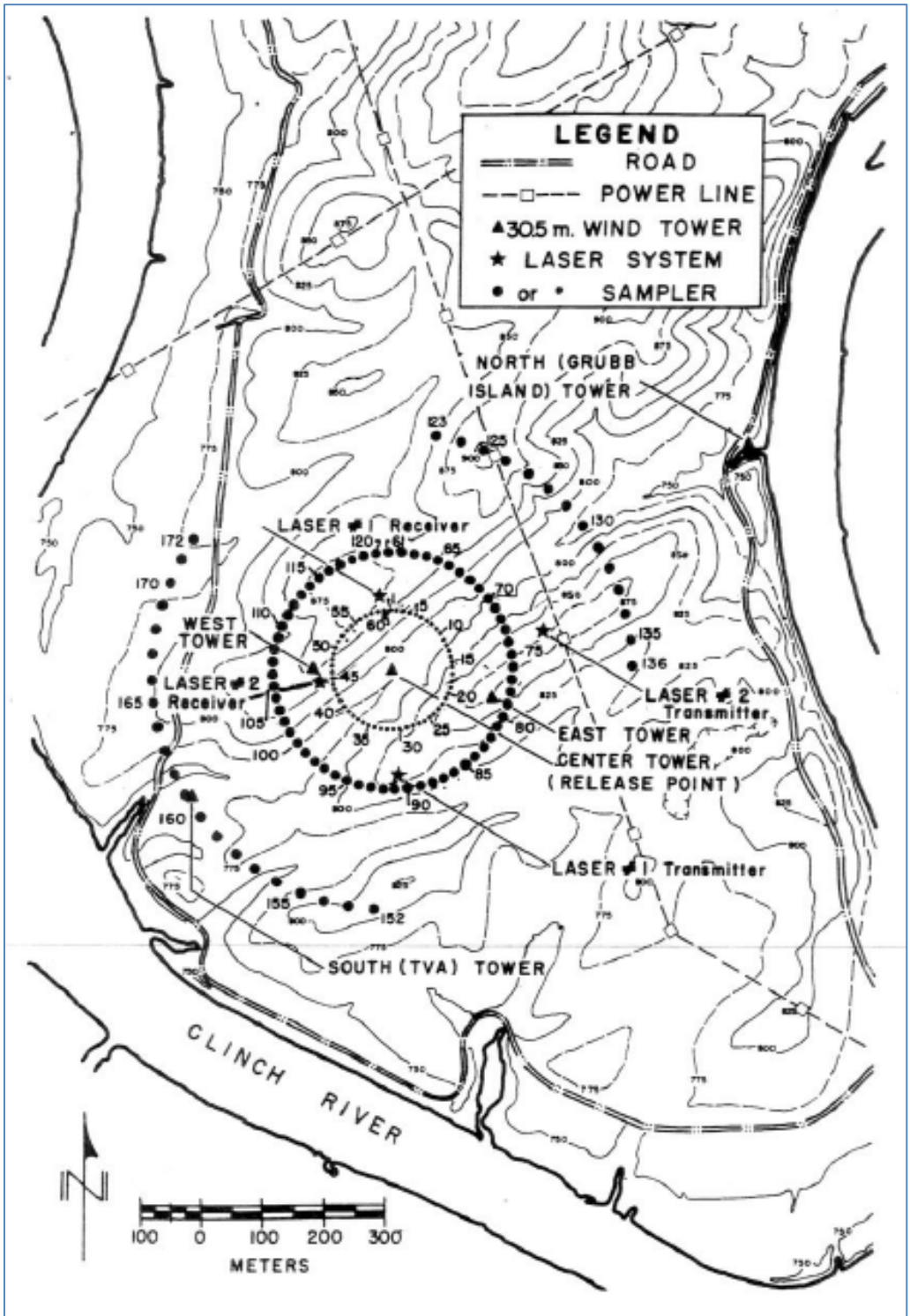
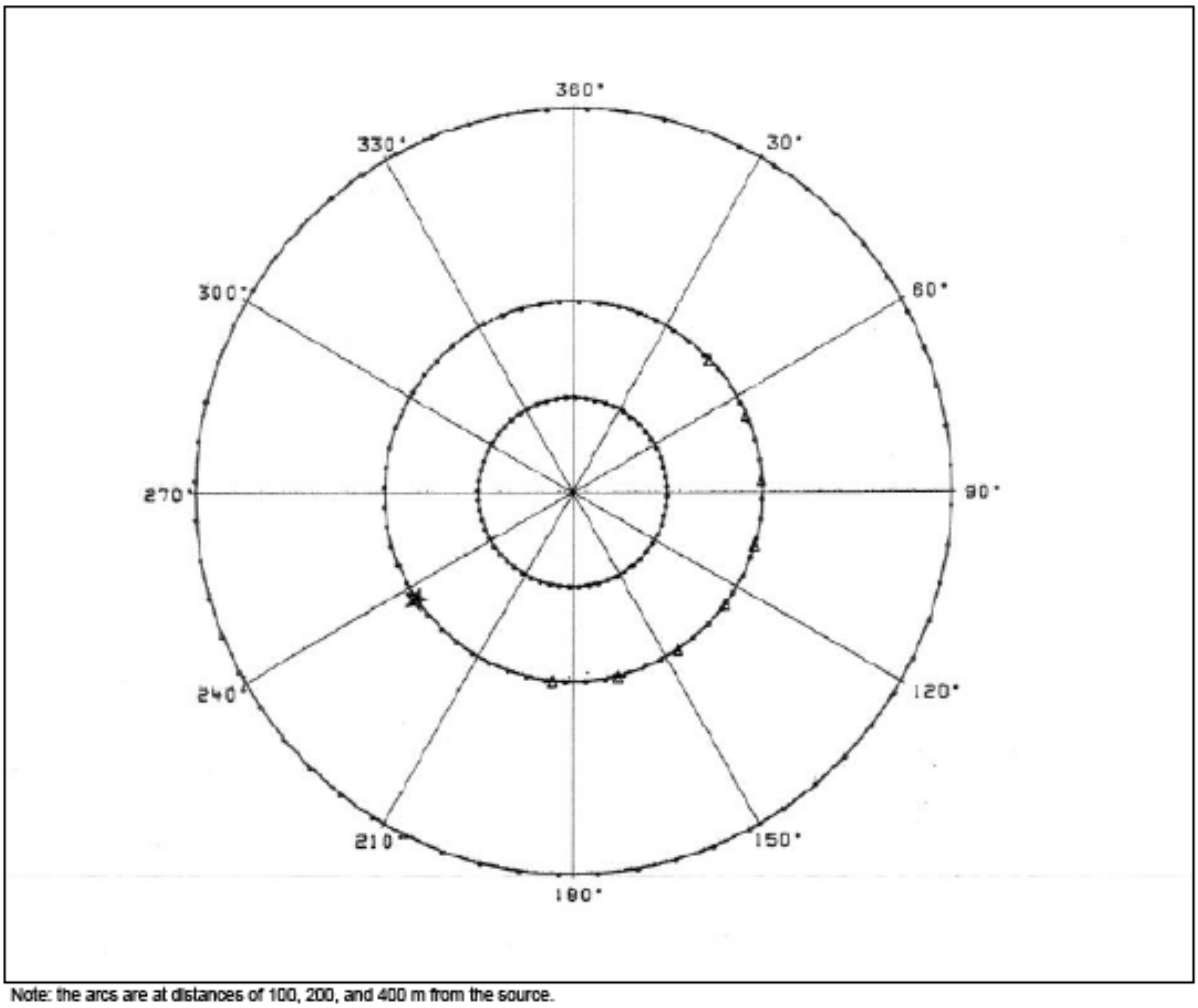


Figure 2b. Detail of inner sampling arcs showing location of meteorological towers and laser transmitters and receivers. (Contour heights are in feet above sea level).

Figure 9-4: Depiction of Sampler Array for Idaho Falls



Note: the arcs are at distances of 100, 200, and 400 m from the source.

A series of figures is provided below for each site, starting with the Oak Ridge study followed by the Idaho Falls study. For each site, a series of **Q-Q plots** (i.e., results paired by rank and arc distance), **paired plots** (i.e., results paired in time and arc distance), and **residual plots** (showing the distribution of Pred/Obs ratios by distance) are shown in the following order:

No ADJ_U* / No LowWind Option;

No ADJ_U* / LowWind1 Option;

No ADJ_U* / LowWind2 Option;

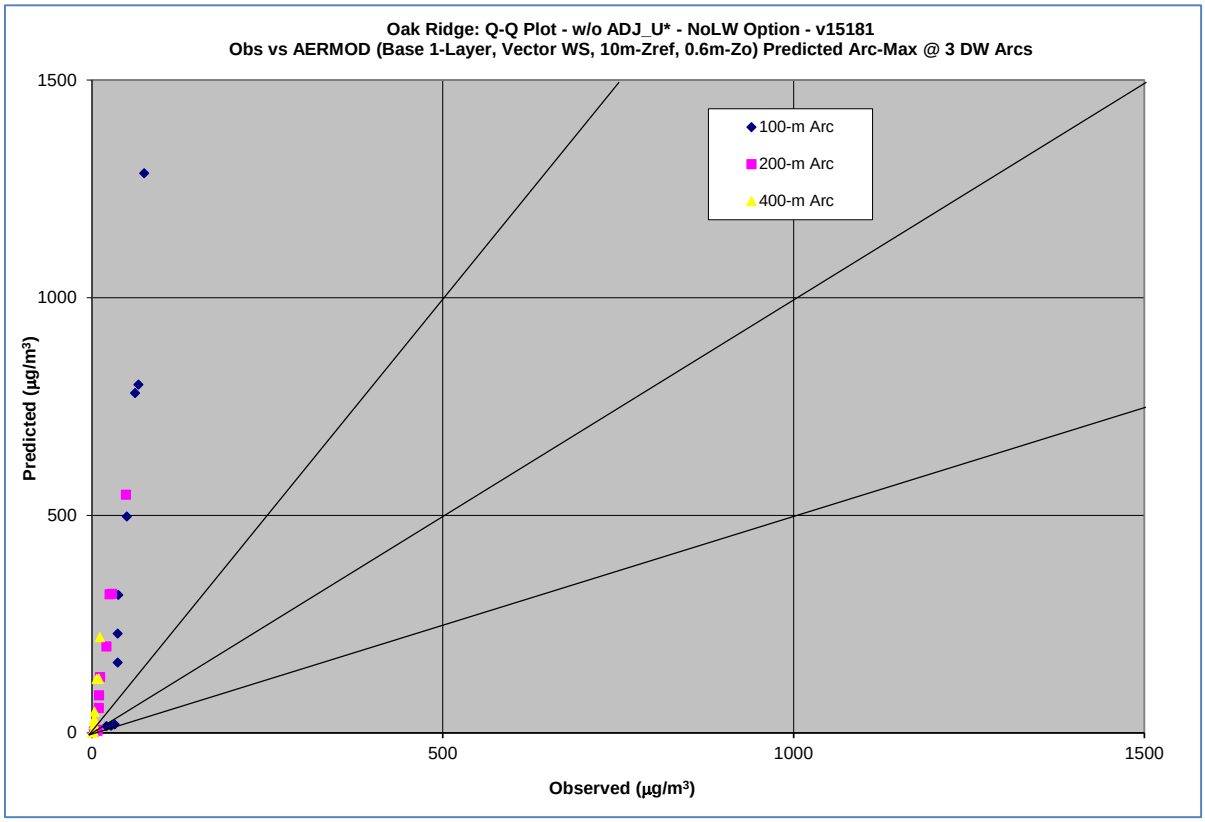
No ADJ_U* / LowWind3 Option;

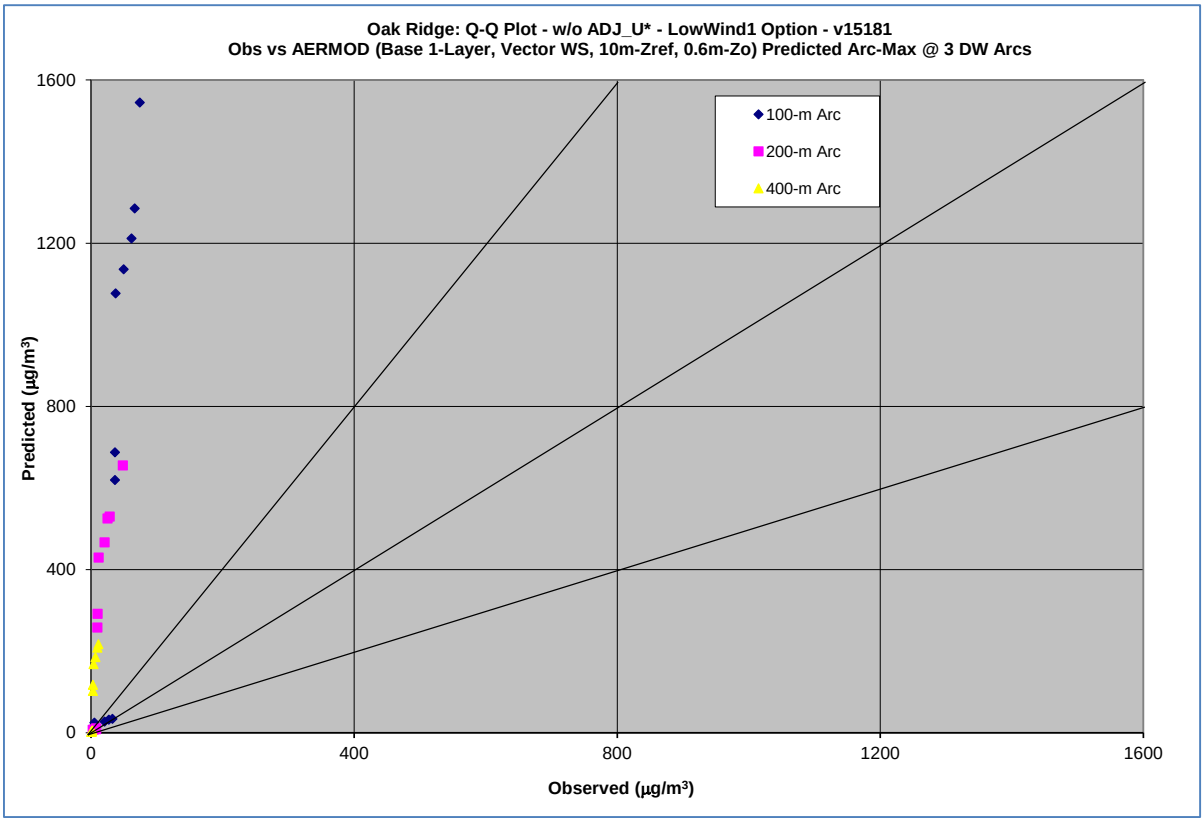
ADJ_U* / No LowWind Option;

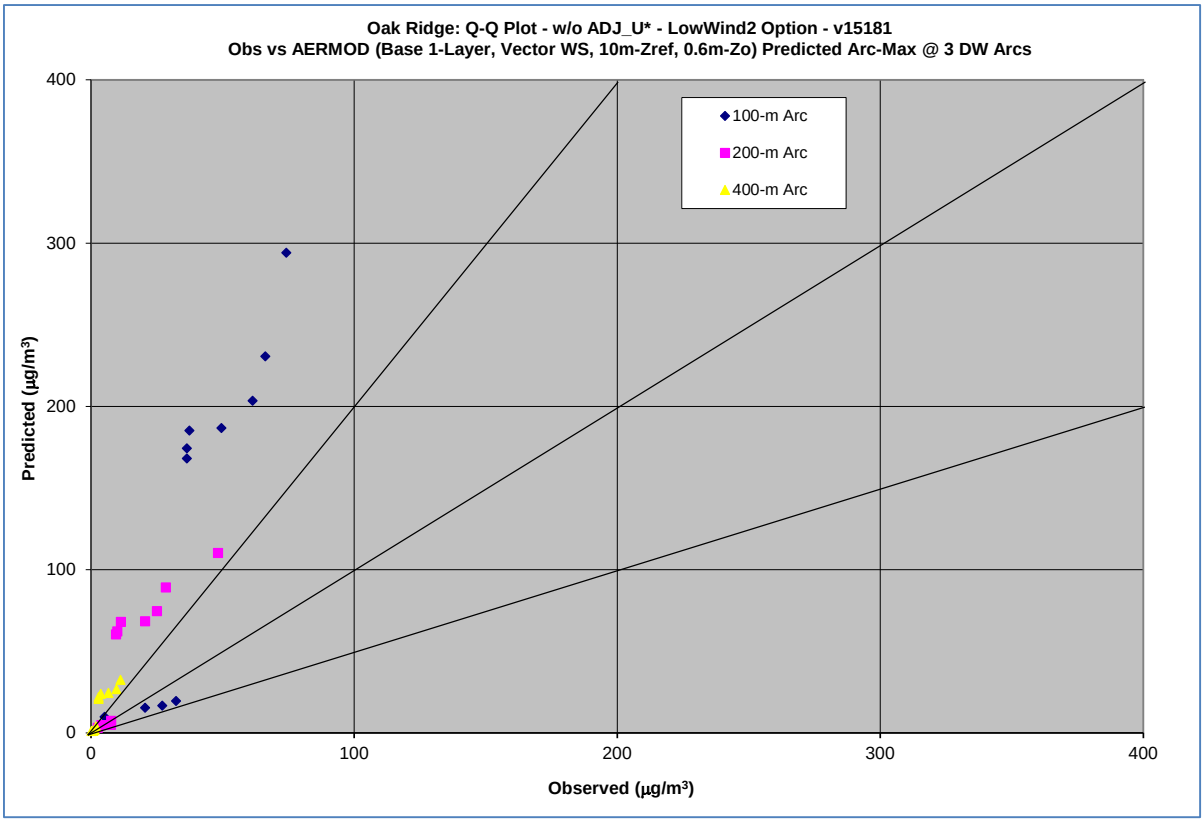
ADJ_U* / LowWind1 Option;

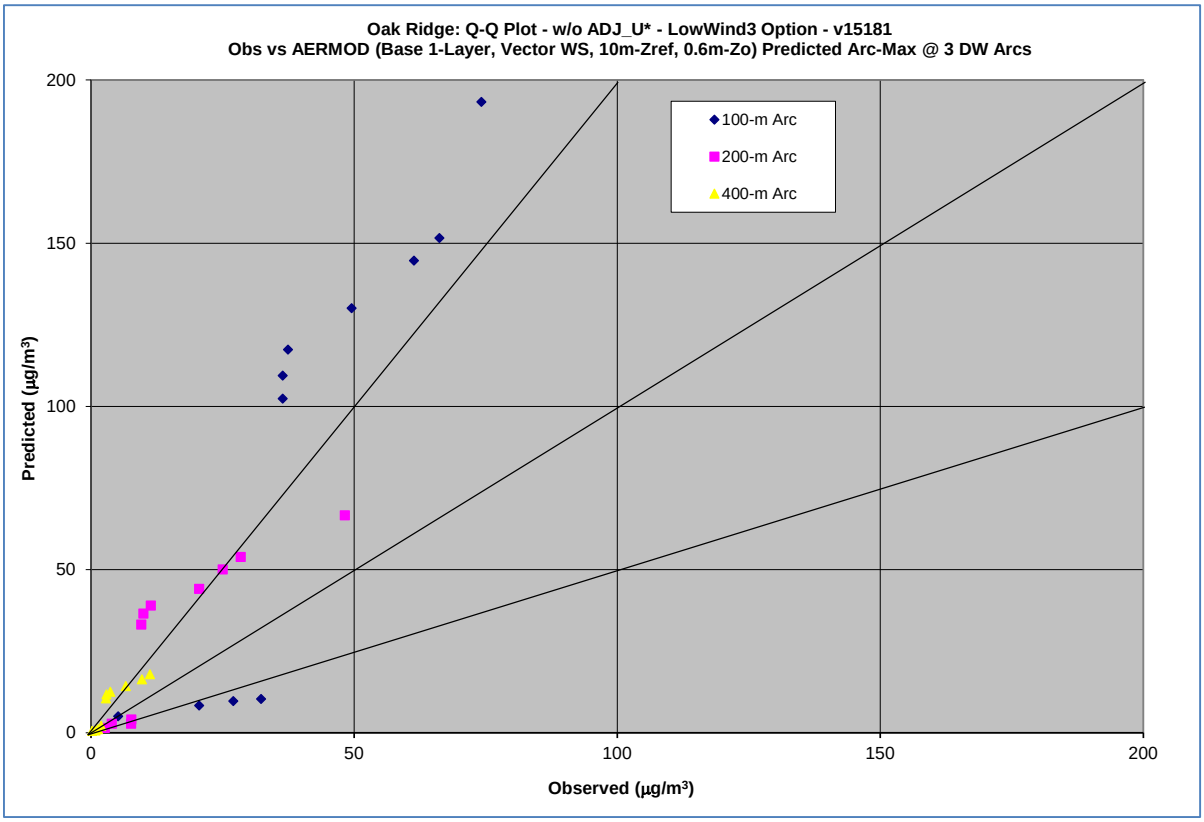
ADJ_U* / LowWind2 Option; and

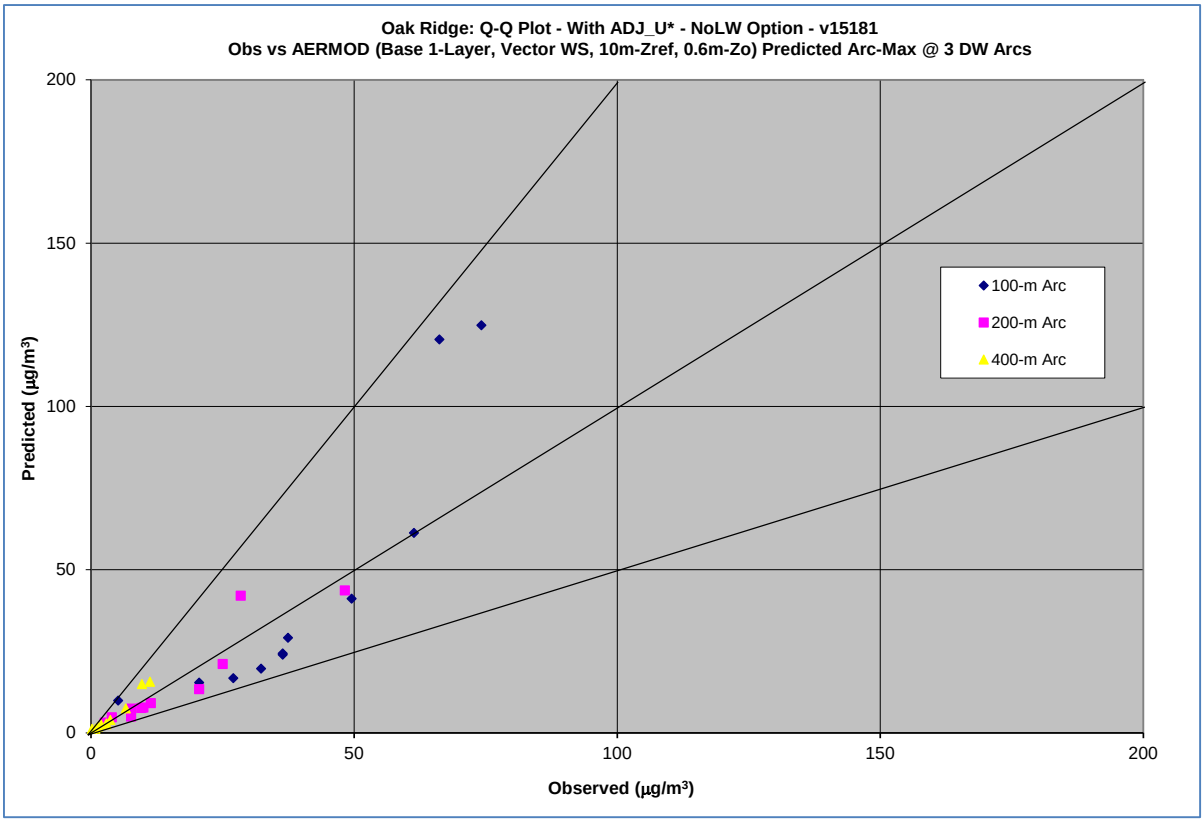
ADJ_U* / LowWind3 Option.

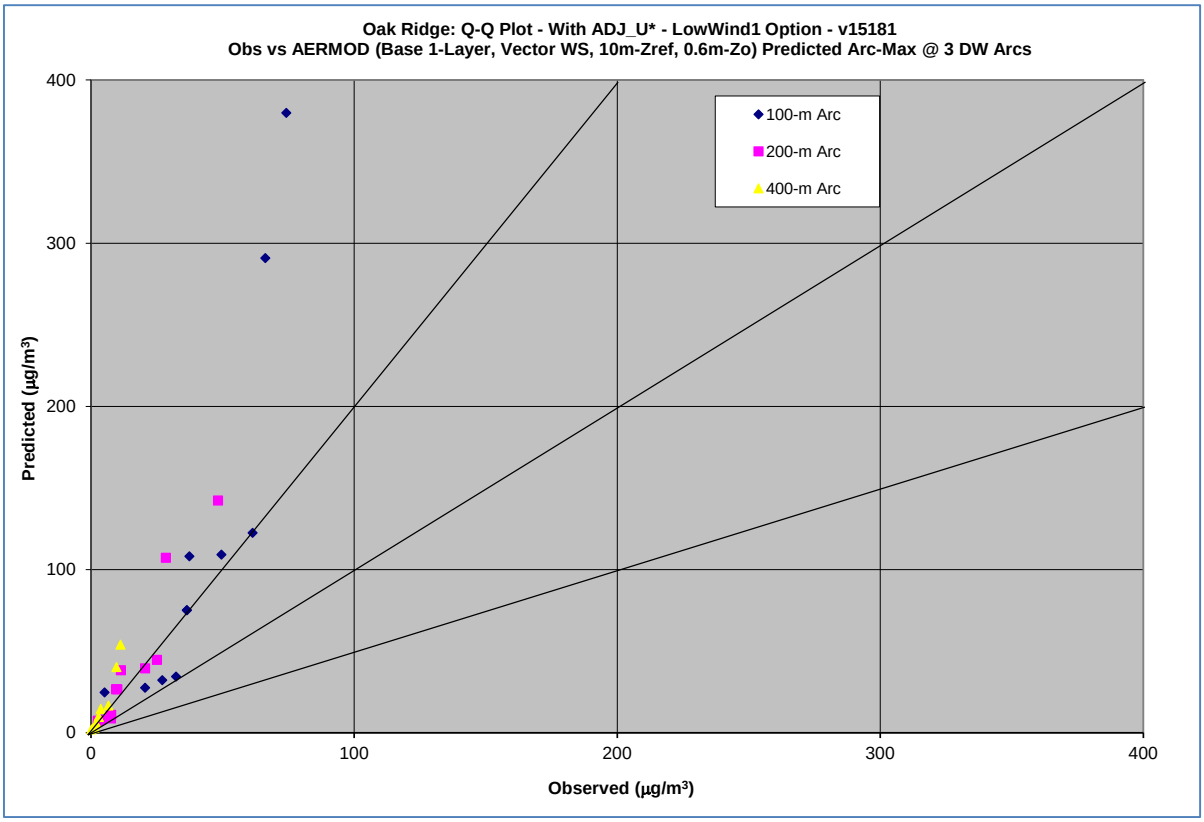


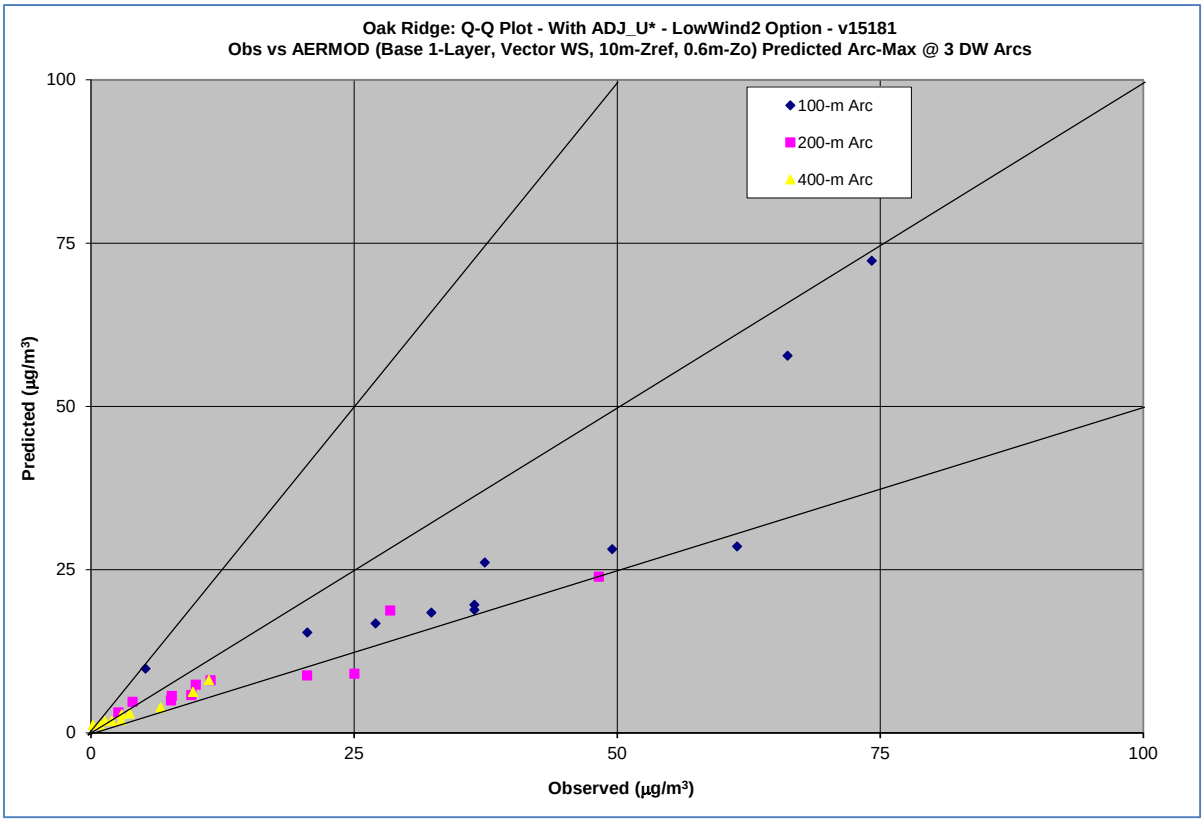

Oak Ridge: Q-Q Plot - w/o ADJ_U* - LowWind1 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
400
800
1200
1600

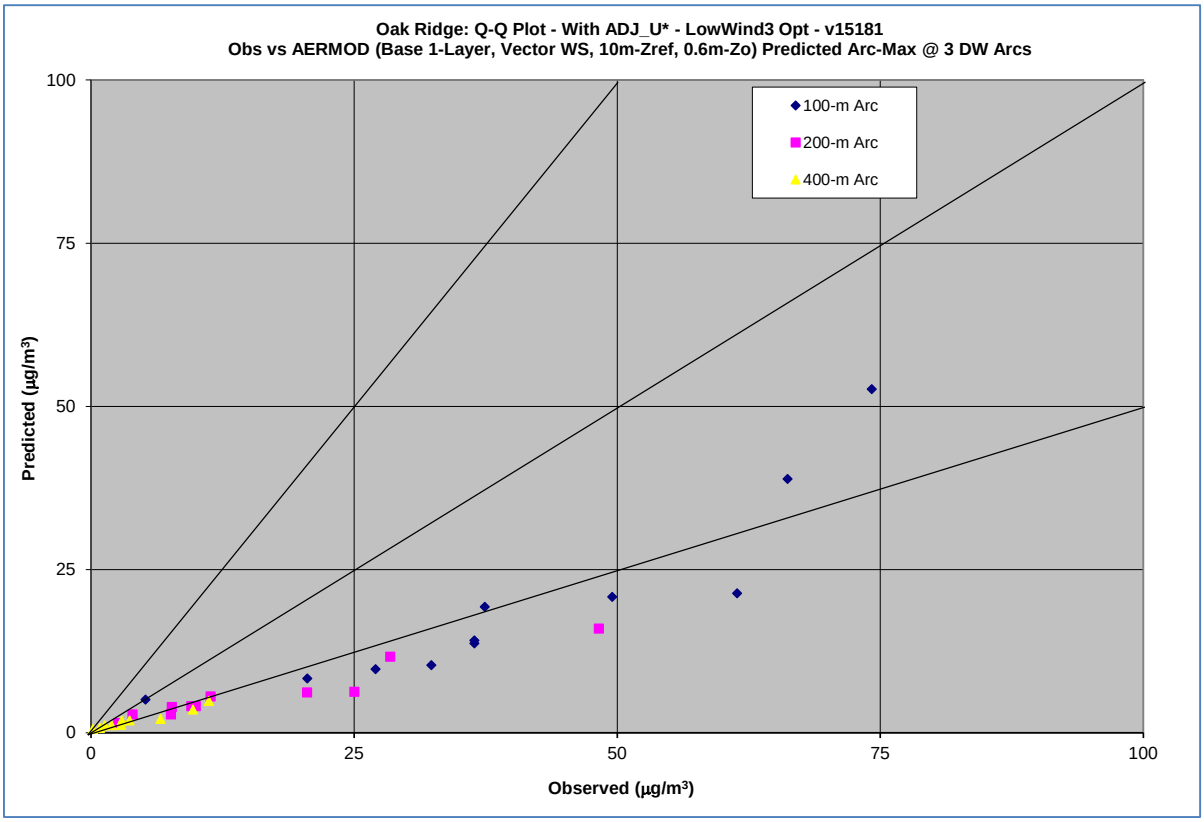

Oak Ridge: Q-Q Plot - w/o ADJ_U* - LowWind2 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
100
200
300
400

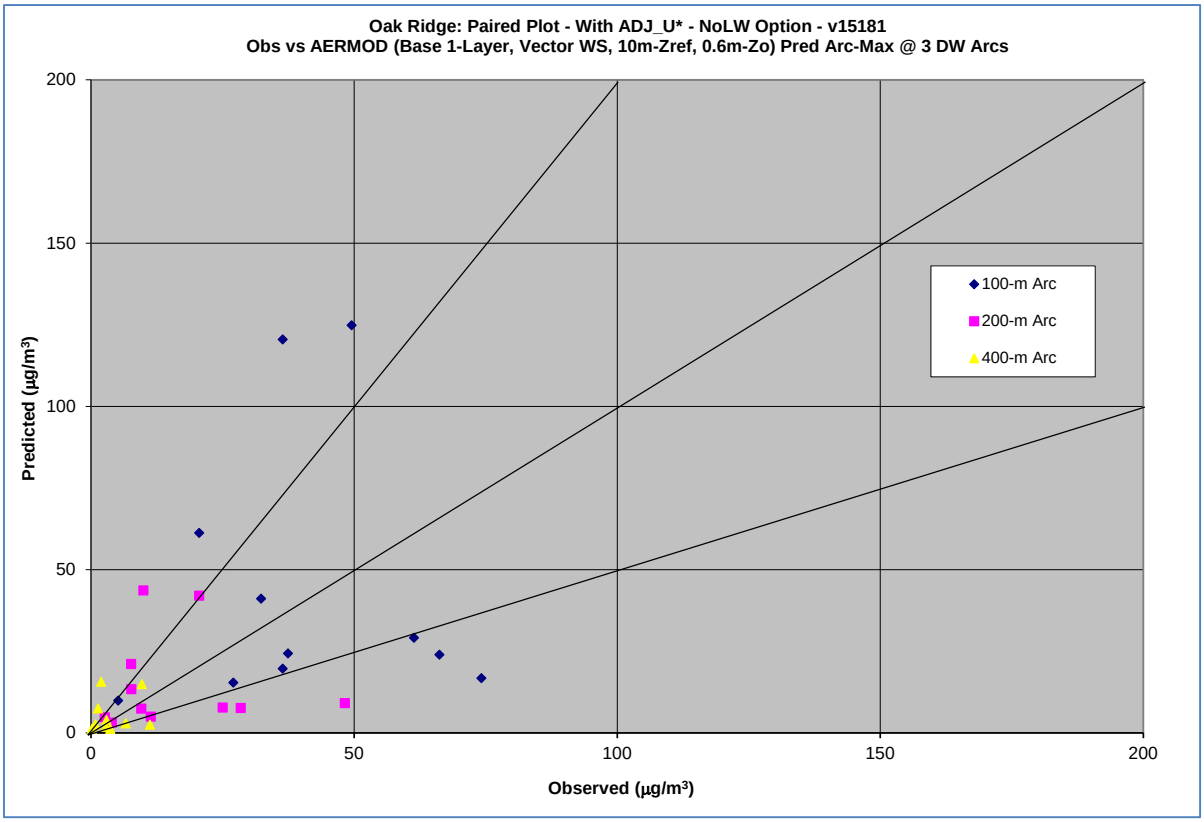

Oak Ridge: Q-Q Plot - w/o ADJ_U* - LowWind3 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200

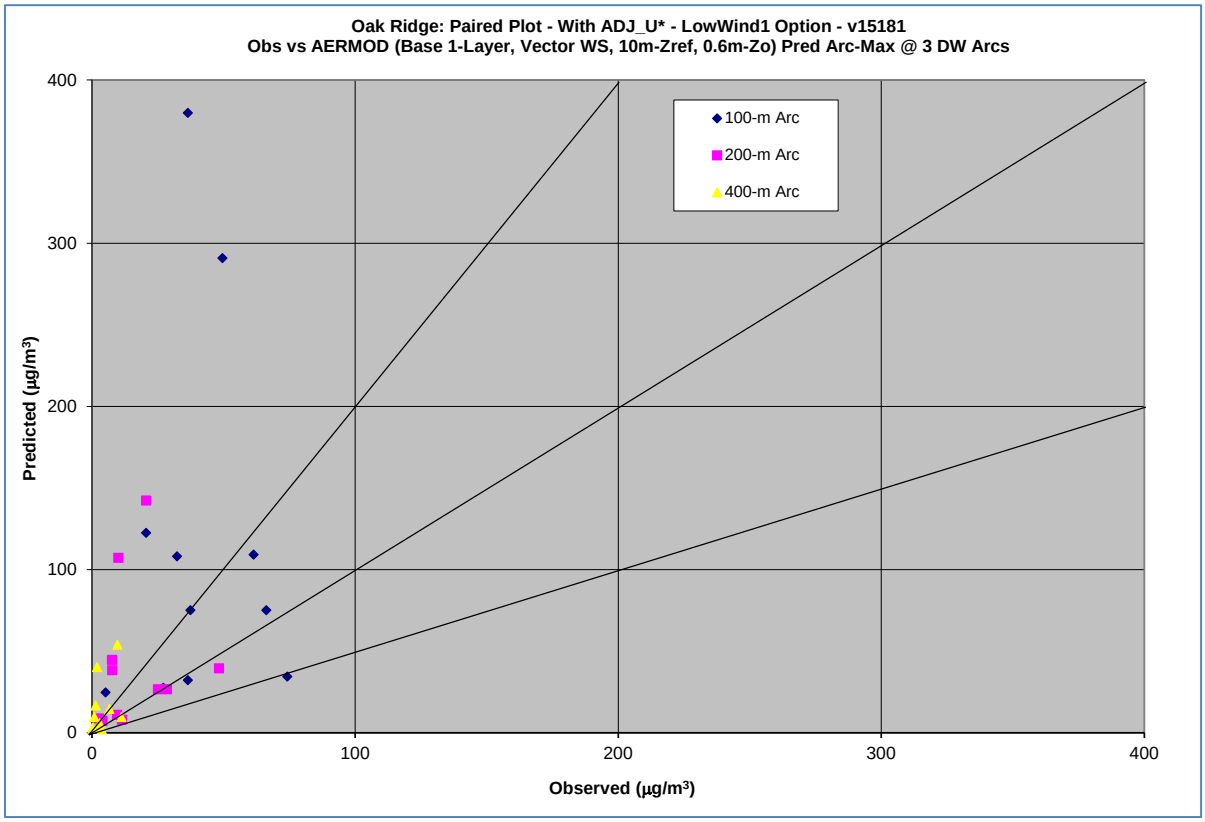

Oak Ridge: Q-Q Plot - With ADJ_U* - NoLW Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200

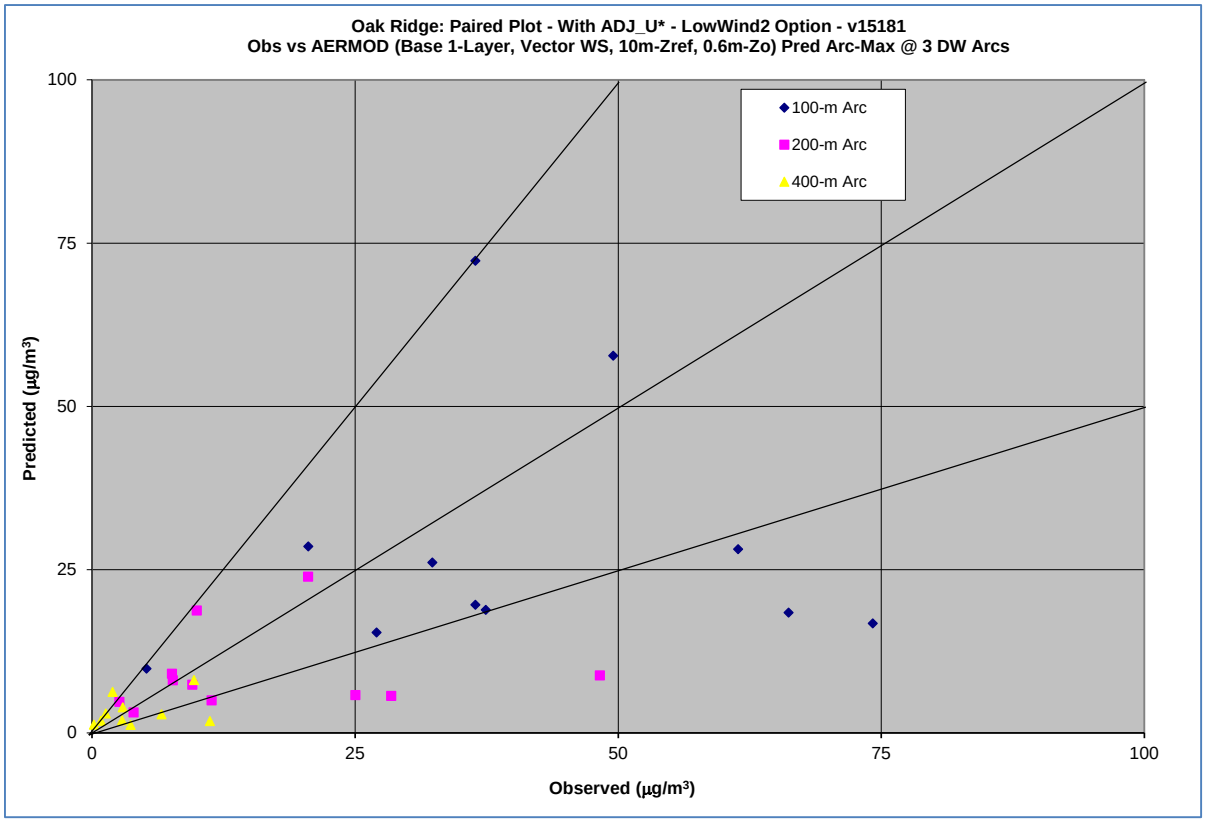

Oak Ridge: Q-Q Plot - With ADJ_U* - LowWind1 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
100
200
300
400

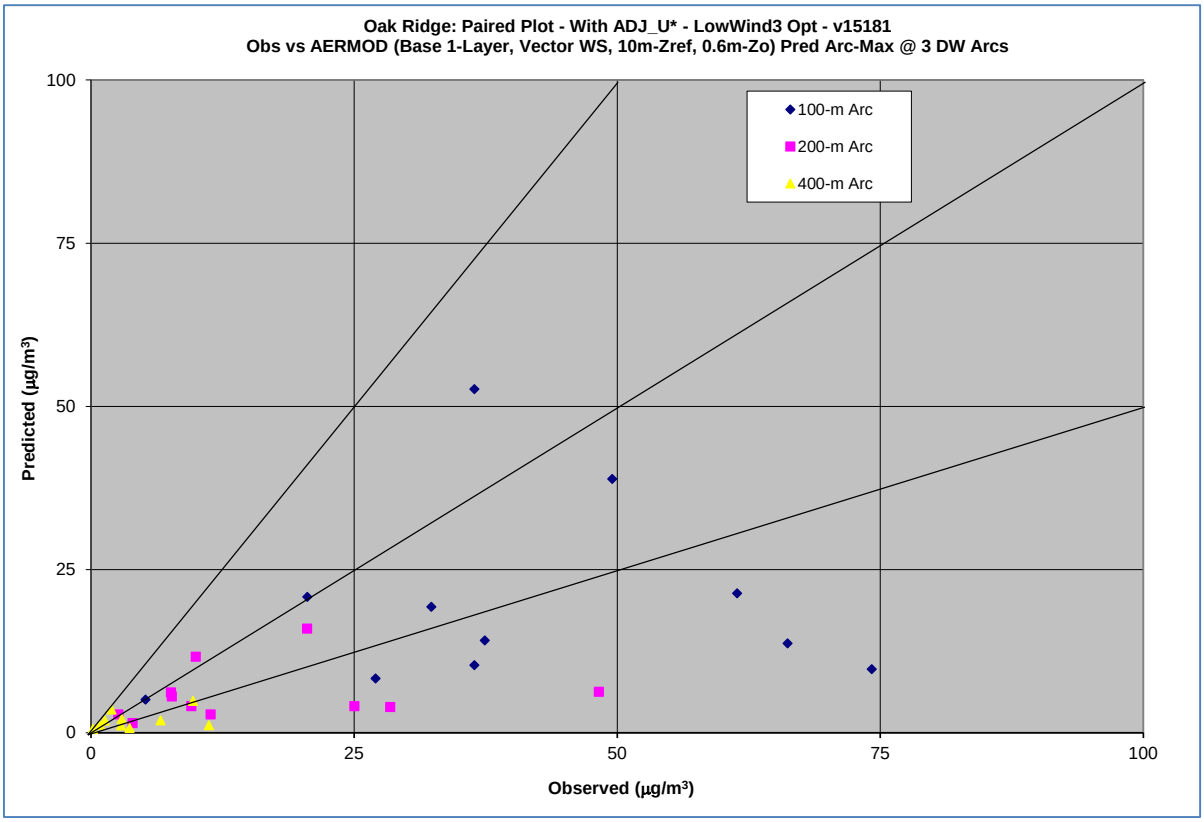

Oak Ridge: Q-Q Plot - With ADJ_U* - LowWind2 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
25
50
75
100

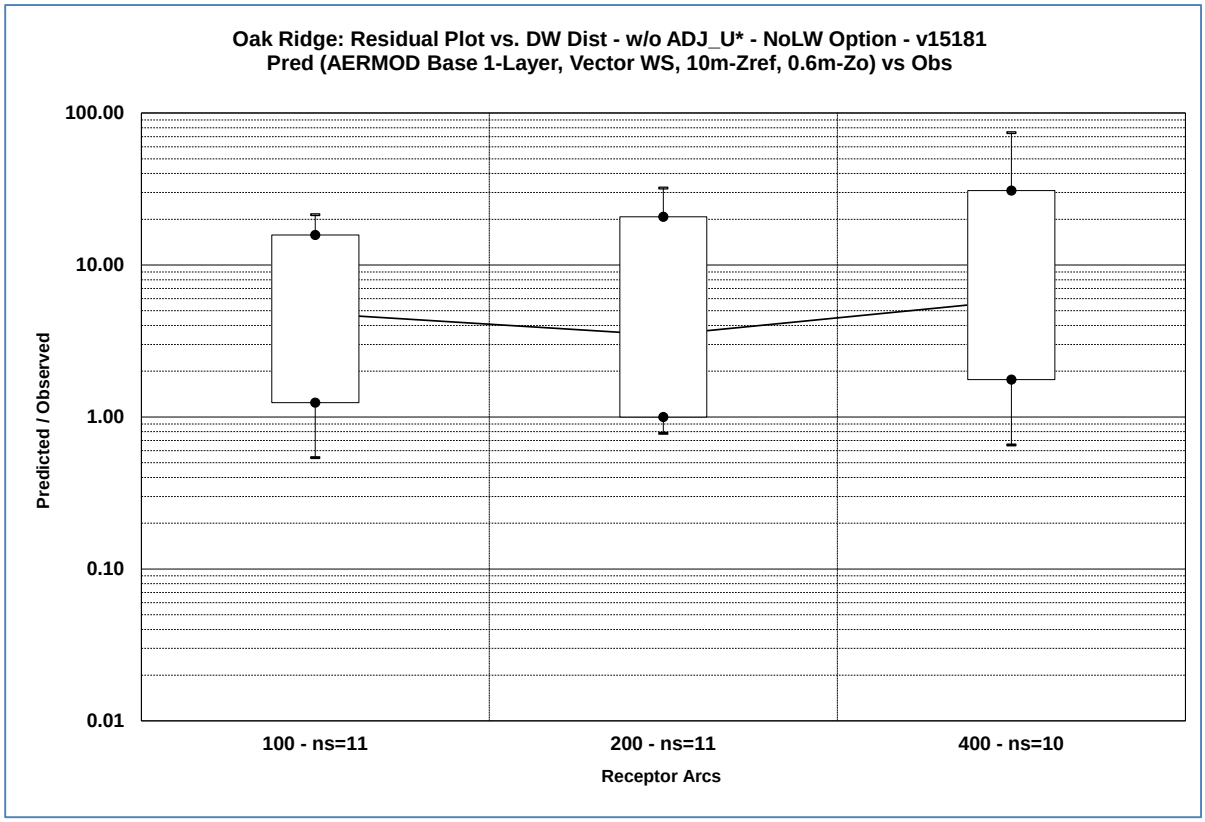

Oak Ridge: Q-Q Plot - With ADJ_U* - LowWind3 Opt - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Predicted Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
25
50
75
100

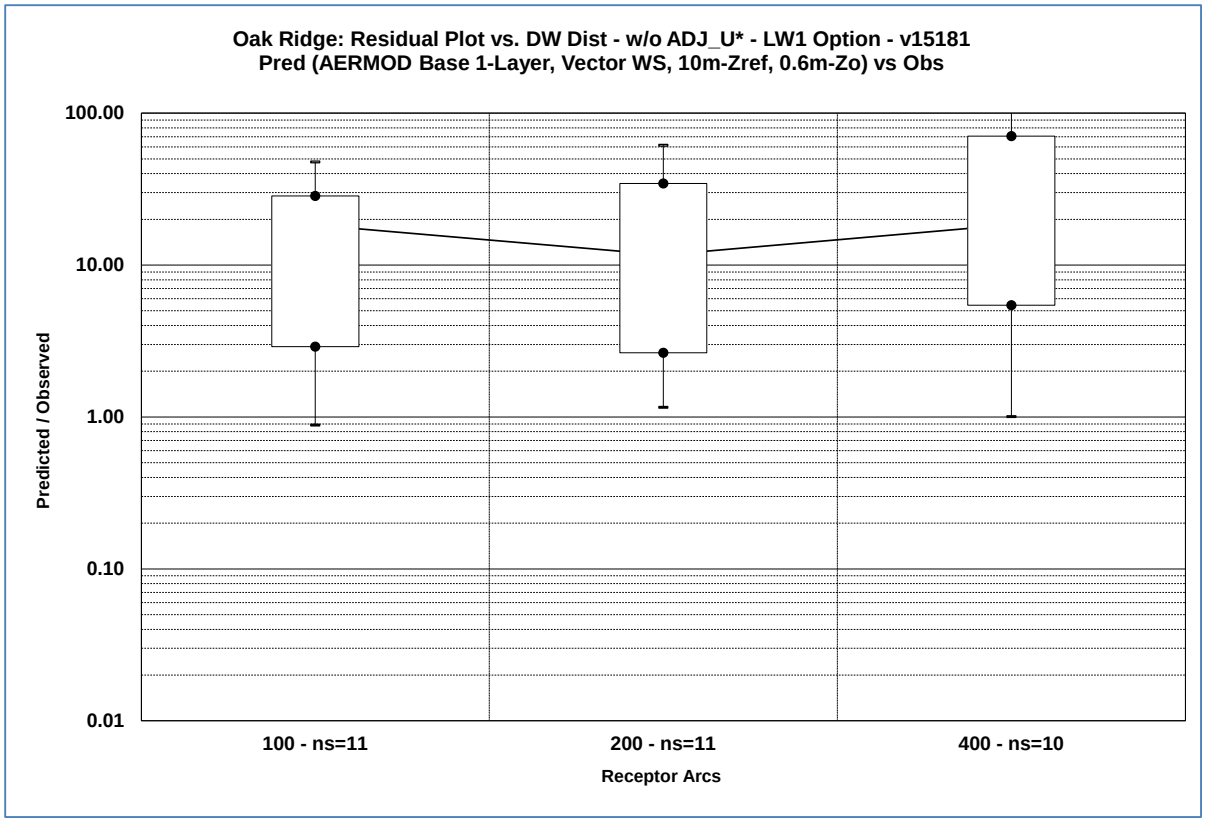

Oak Ridge: Paired Plot - With ADJ_U* - NoLW Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Pred Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200

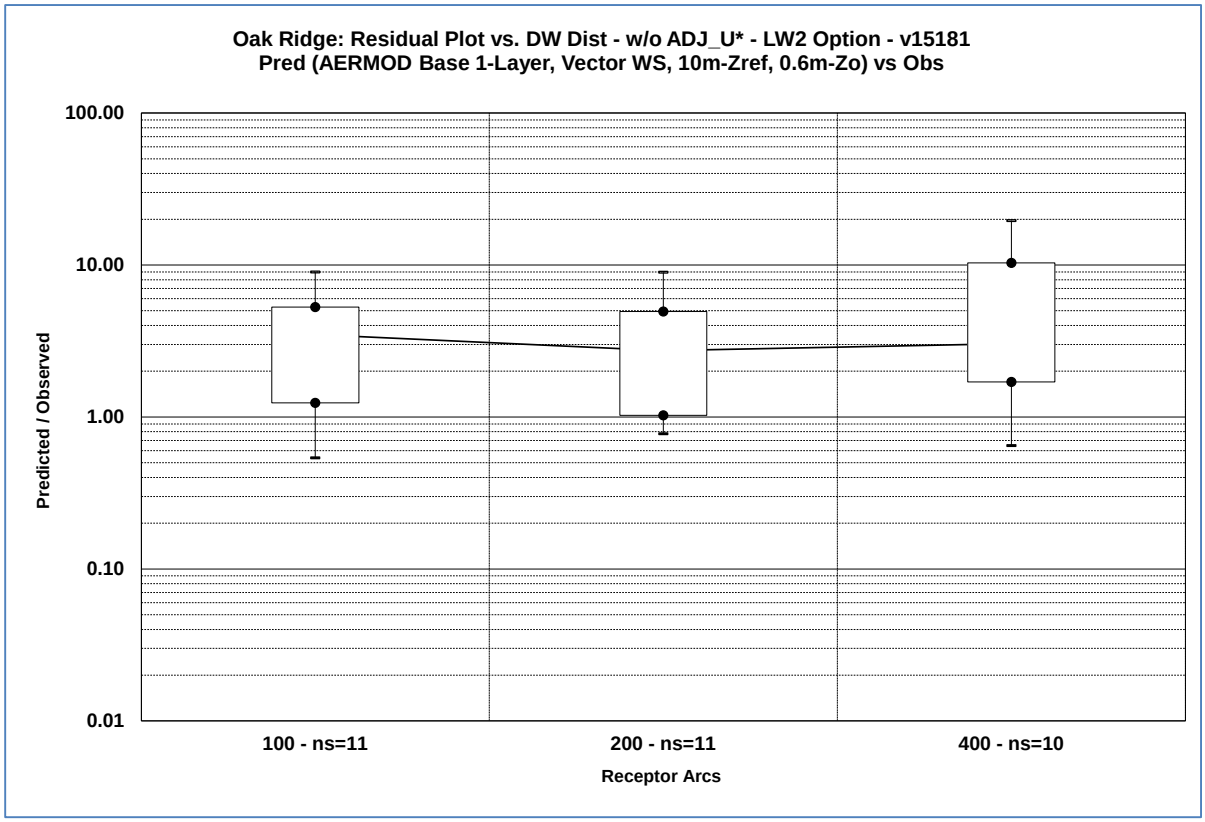

Oak Ridge: Paired Plot - With ADJ_U* - LowWind1 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Pred Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
100
200
300
400

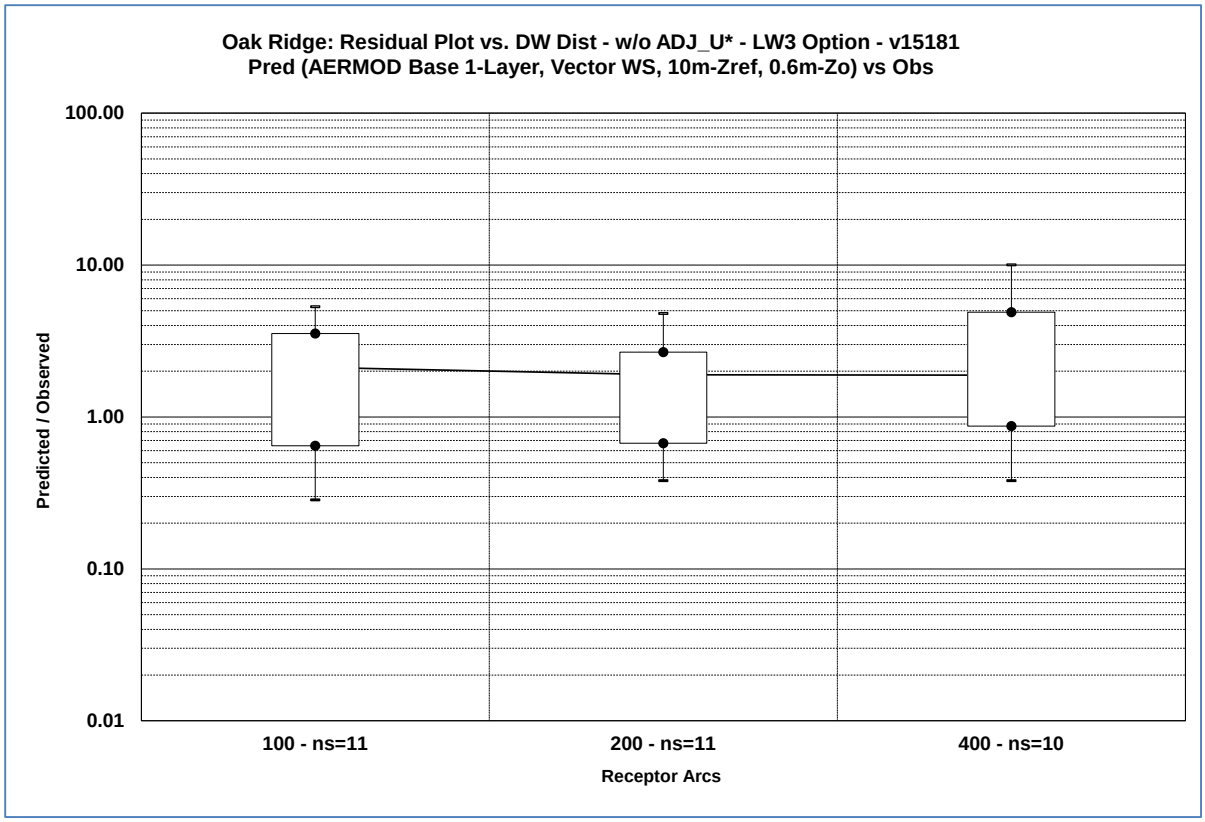

Oak Ridge: Paired Plot - With ADJ_U* - LowWind2 Option - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Pred Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
25
50
75
100

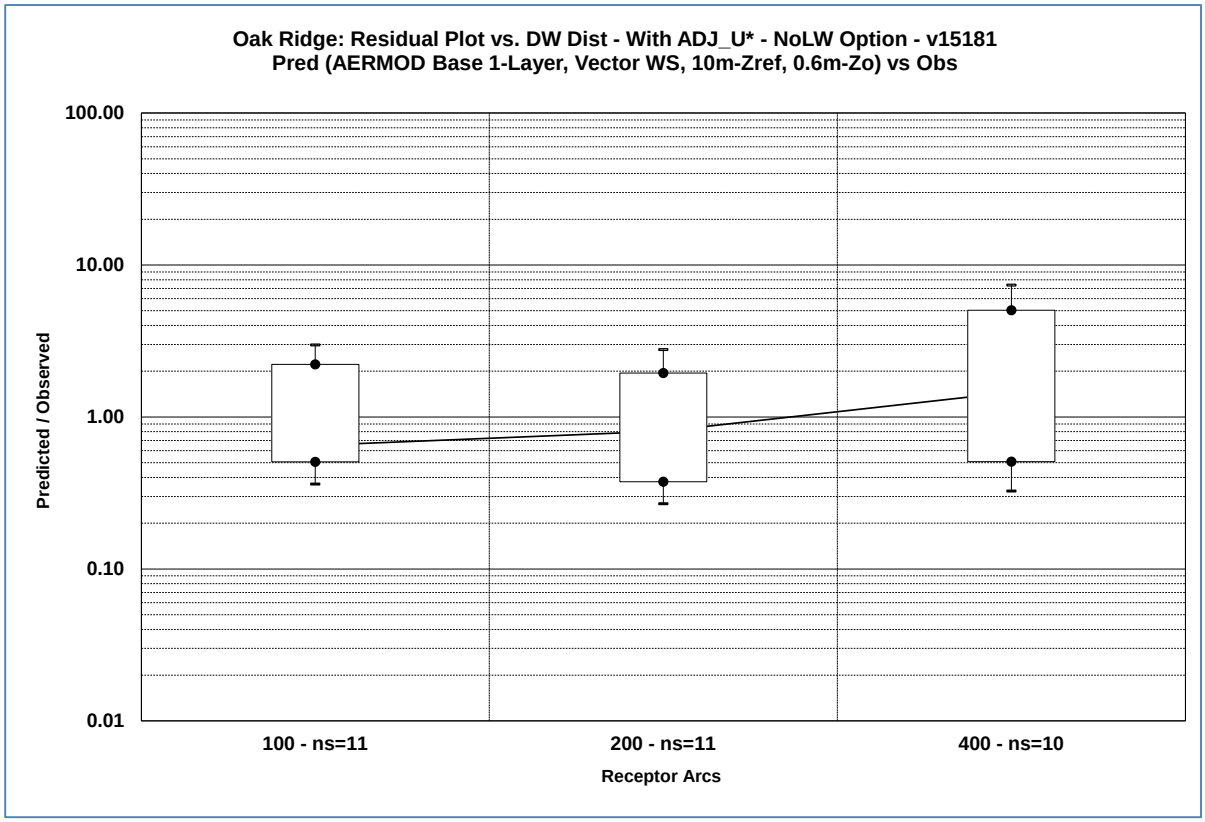

Oak Ridge: Paired Plot - With ADJ_U* - LowWind3 Opt - v15181
Obs vs AERMOD (Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) Pred Arc-Max @ 3 DW Arcs
100-m Arc
200-m Arc
400-m Arc
Predicted (µg/m³)
Observed (µg/m³)
0
25
50
75
100

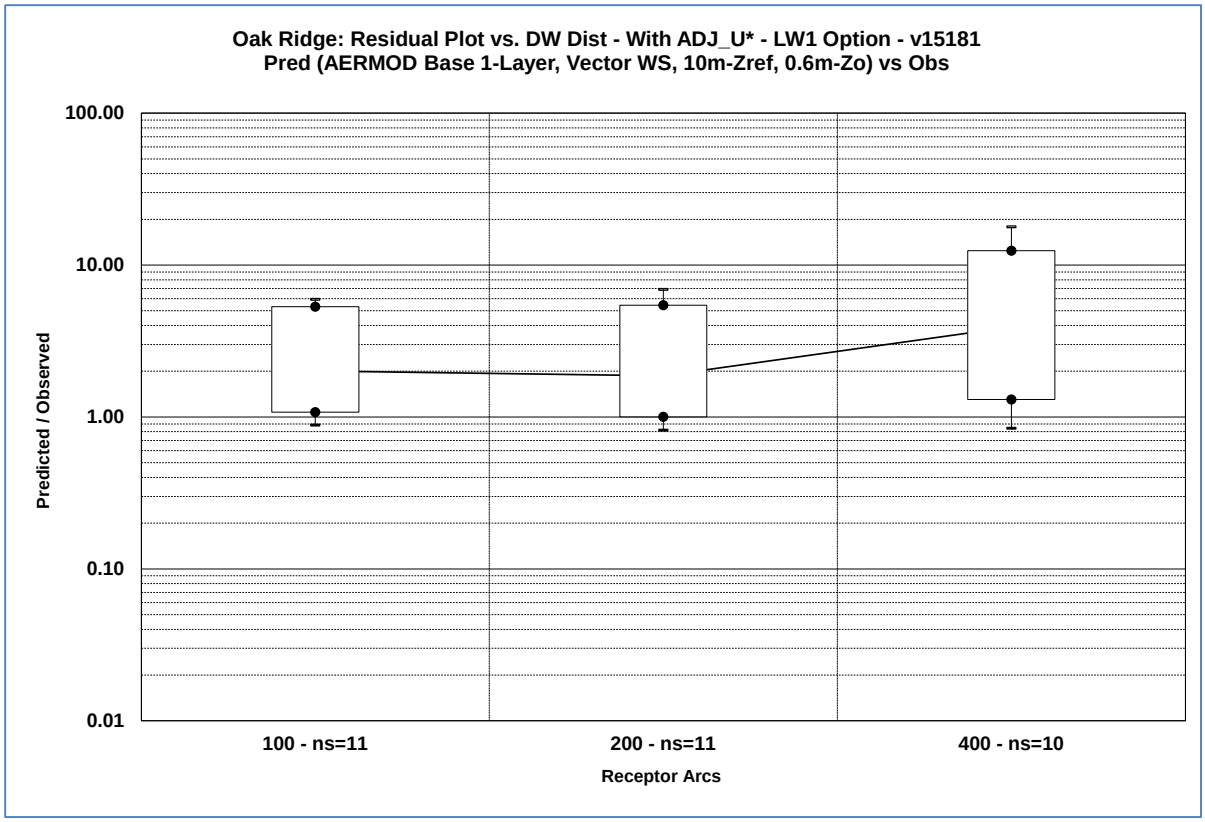

Oak Ridge: Residual Plot vs. DW Dist - w/o ADJ_U* - NoLW Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
Predicted / Observed
100.00
10.00
1.00
0.10
0.01
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs

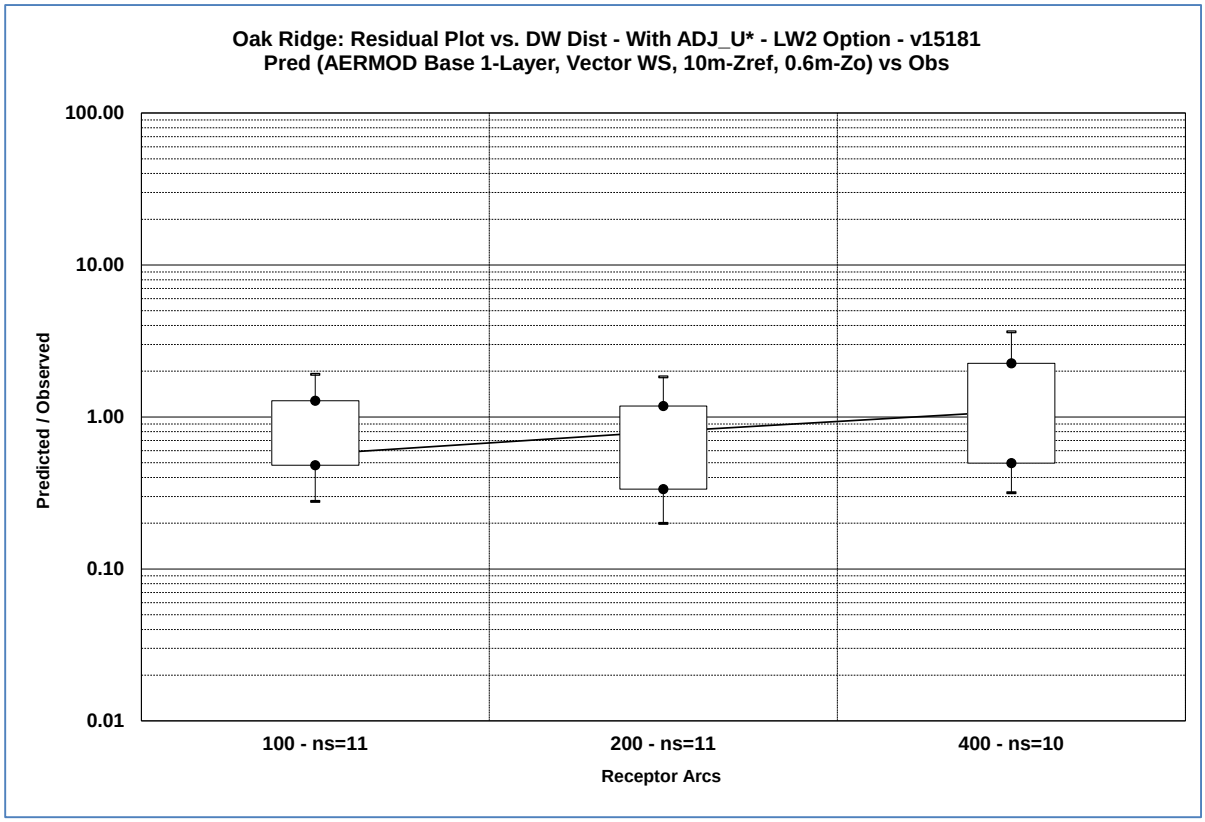

Oak Ridge: Residual Plot vs. DW Dist - w/o ADJ_U* - LW1 Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs

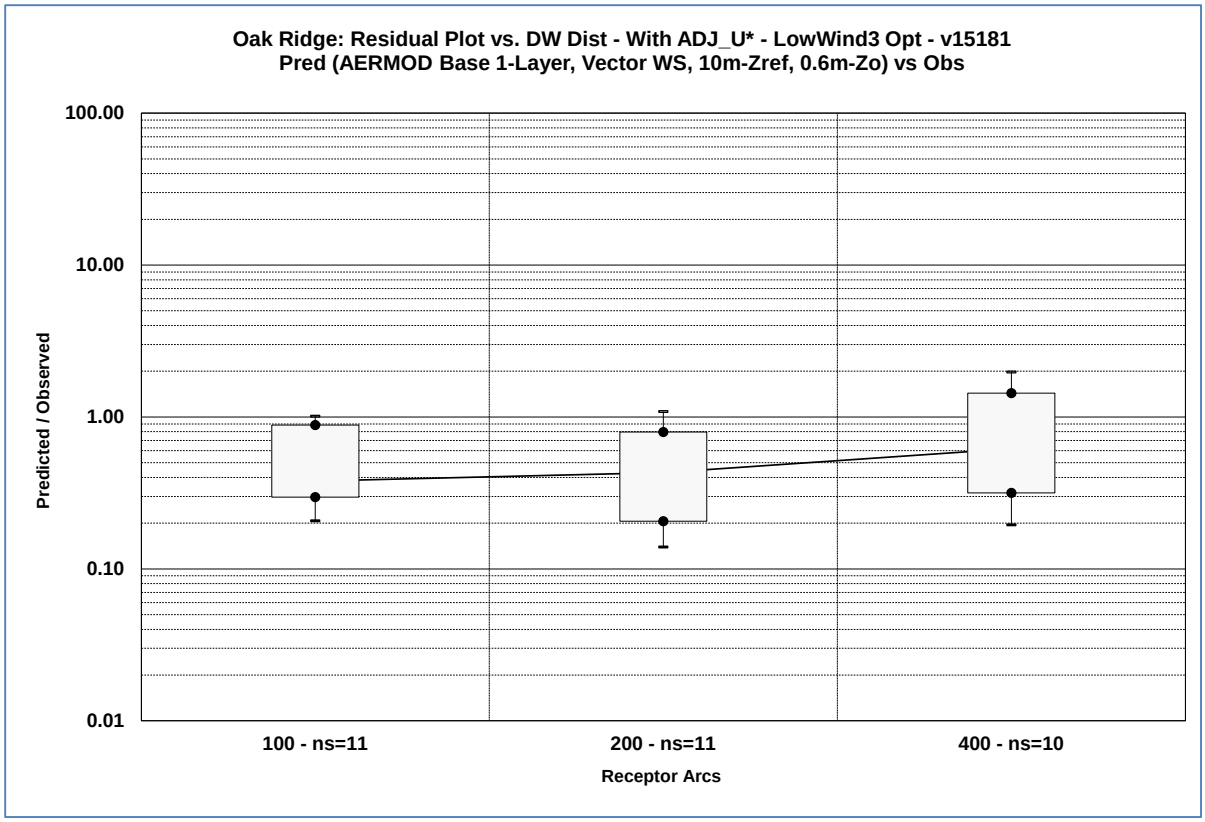

Oak Ridge: Residual Plot vs. DW Dist - w/o ADJ_U* - LW2 Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs


Oak Ridge: Residual Plot vs. DW Dist - w/o ADJ_U* - LW3 Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs


Oak Ridge: Residual Plot vs. DW Dist - With ADJ_U* - NoLW Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs


Oak Ridge: Residual Plot vs. DW Dist - With ADJ_U* - LW1 Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs


Oak Ridge: Residual Plot vs. DW Dist - With ADJ_U* - LW2 Option - v15181
Pred (AERMOD Base 1-Layer, Vector WS, 10m-Zref, 0.6m-Zo) vs Obs
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=10
Receptor Arcs



The figures shown above for the Oak Ridge field study show significant overprediction with the current default options in AERMET and AERMOD. The LowWind2 and LowWind3 options without the ADJ_U* option exhibit much better performance, with LowWind3 showing the best results, but both options still show significant overpredictions. The LowWind1 option actually degrades model performance relative to the default options. These figures also show significant improvement in model performance with the ADJ_U* option in AERMET with and without the LowWind options. The LowWind2 option with ADJ_U* appears to show the best overall performance, with the LownWind3/ADJ_U* option showing some bias toward underprediction. However, as noted above, the evaluation results presented here do not account for the potential influence of terrain on modeled concentrations. Given the potential for valley channeling and drainage flows one might expect modeling results based on an assumption of flat terrain to underestimate concentrations for this study. Figure 7 from the NOAA Technical Memorandum shows horizontal isopleths of concentrations for Test #6 which appears to be stretched along the axis of the valley where the tracer was released. A similar pattern shows up with other tests.

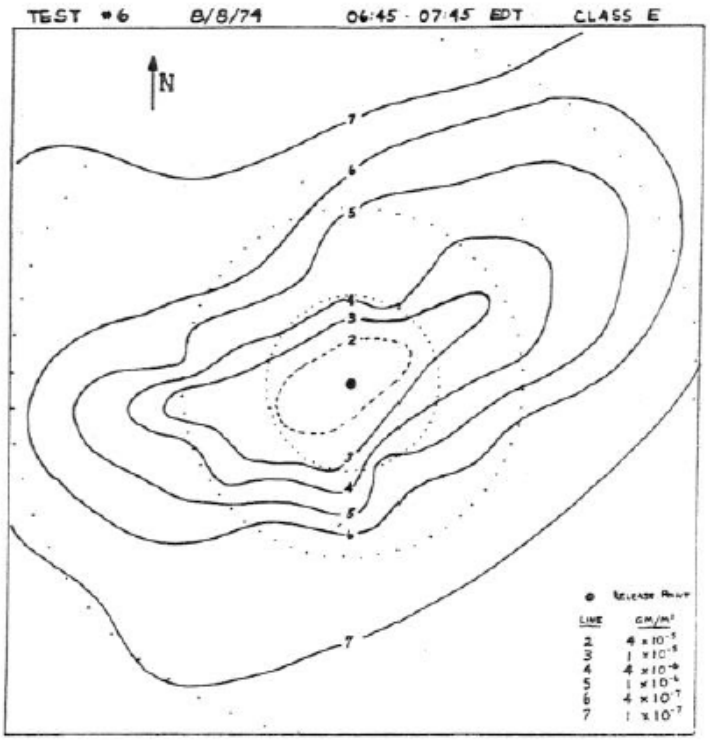
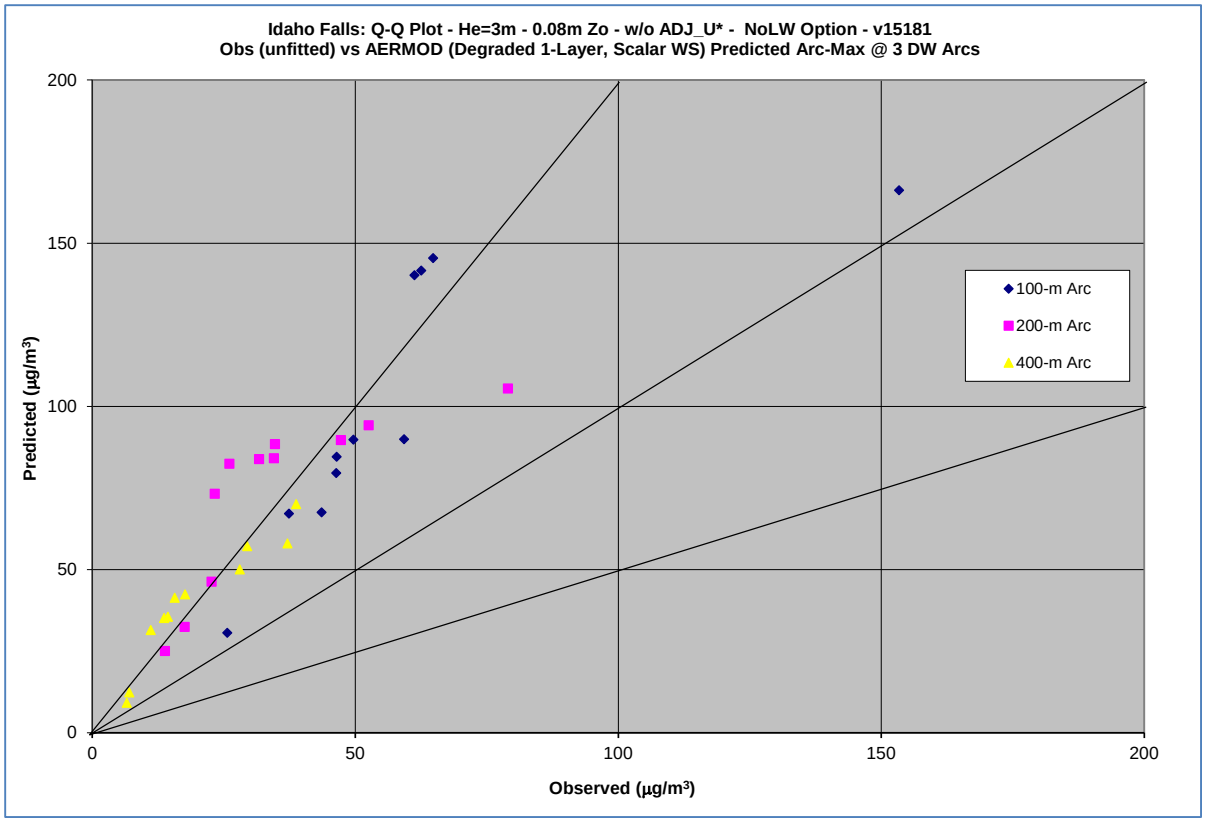
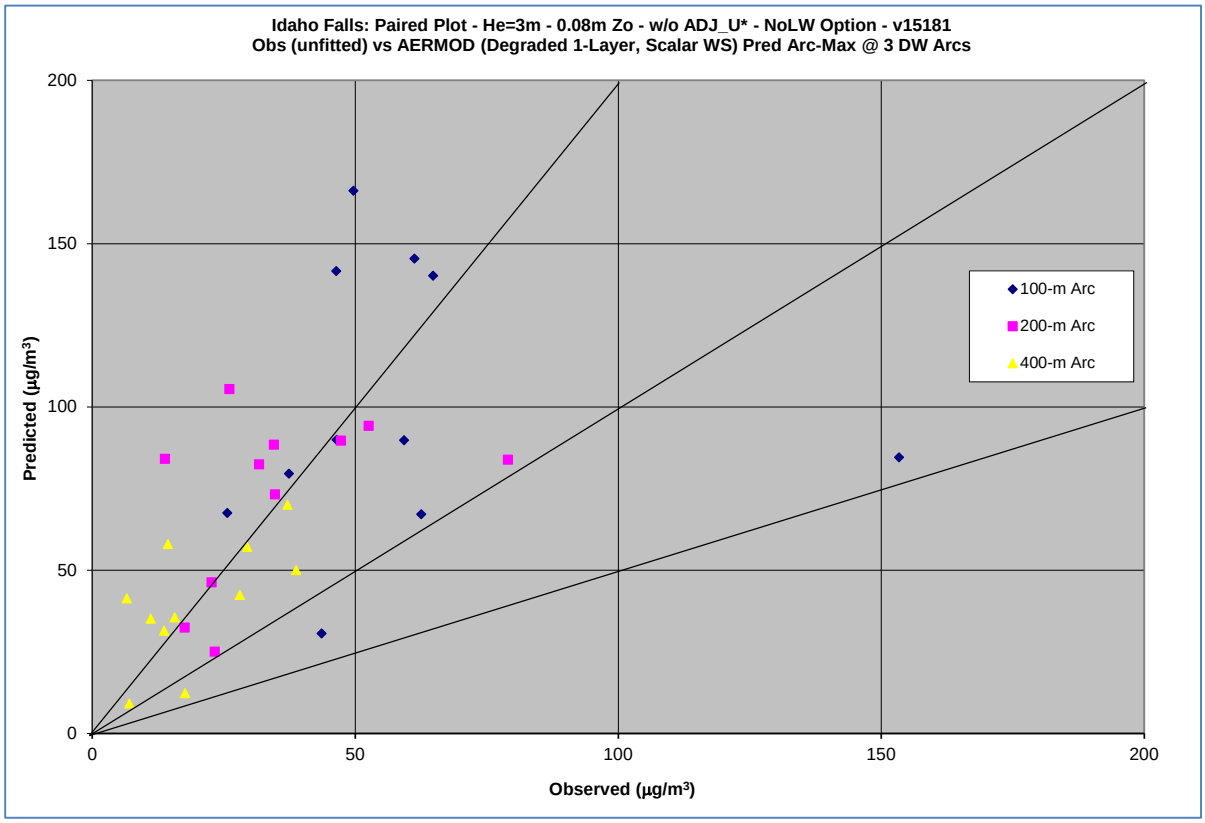
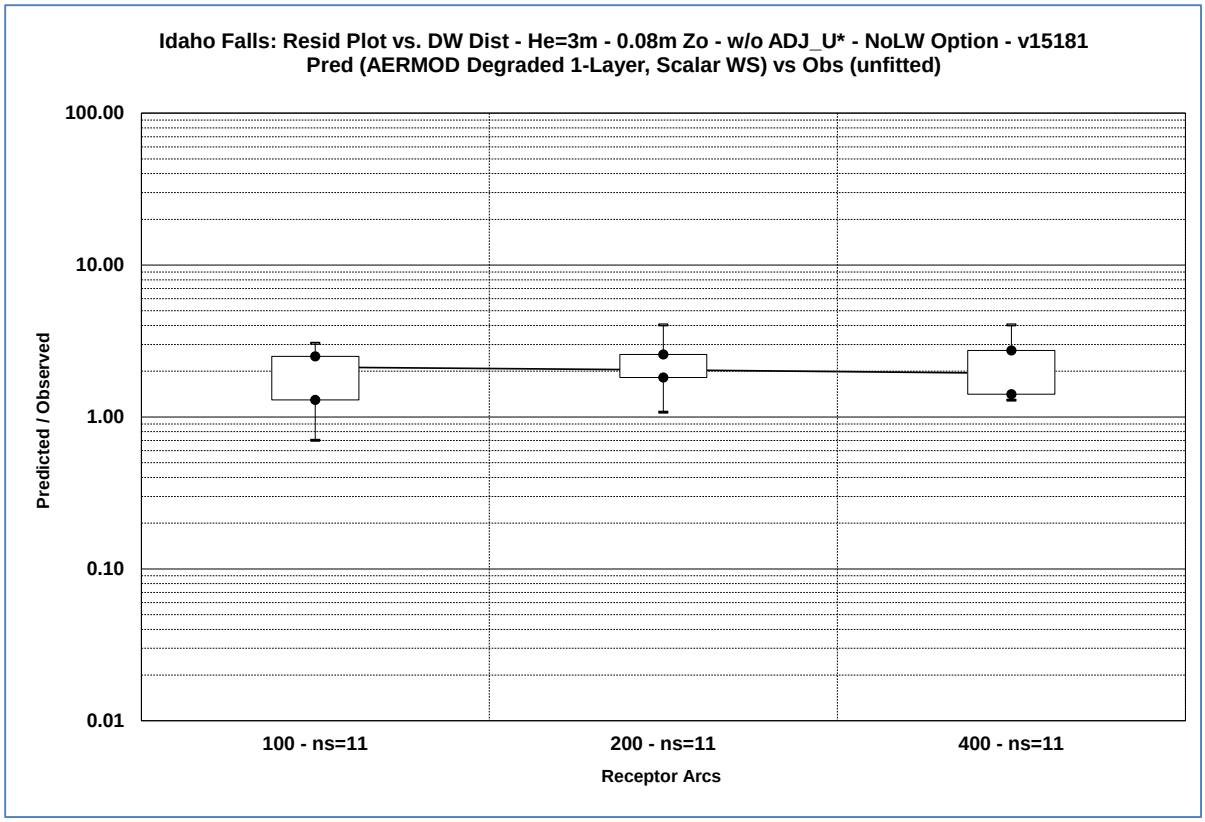


Figure 7. Horizontal isopleths of concentration for test 6 showing the typical 360° spread of gaseous tracer.

The next series of figures shows evaluation results for Idaho Falls based on the degraded 1-layer meteorological data (i.e., no delta-T data for the BULKRN option and no sigma-theta data, starting with the DFAULT option (without ADJ_U* and NoLW), followed by the LowWind1, LowWind2, and LowWind3 option, followed by the results with the ADJ_U* option.

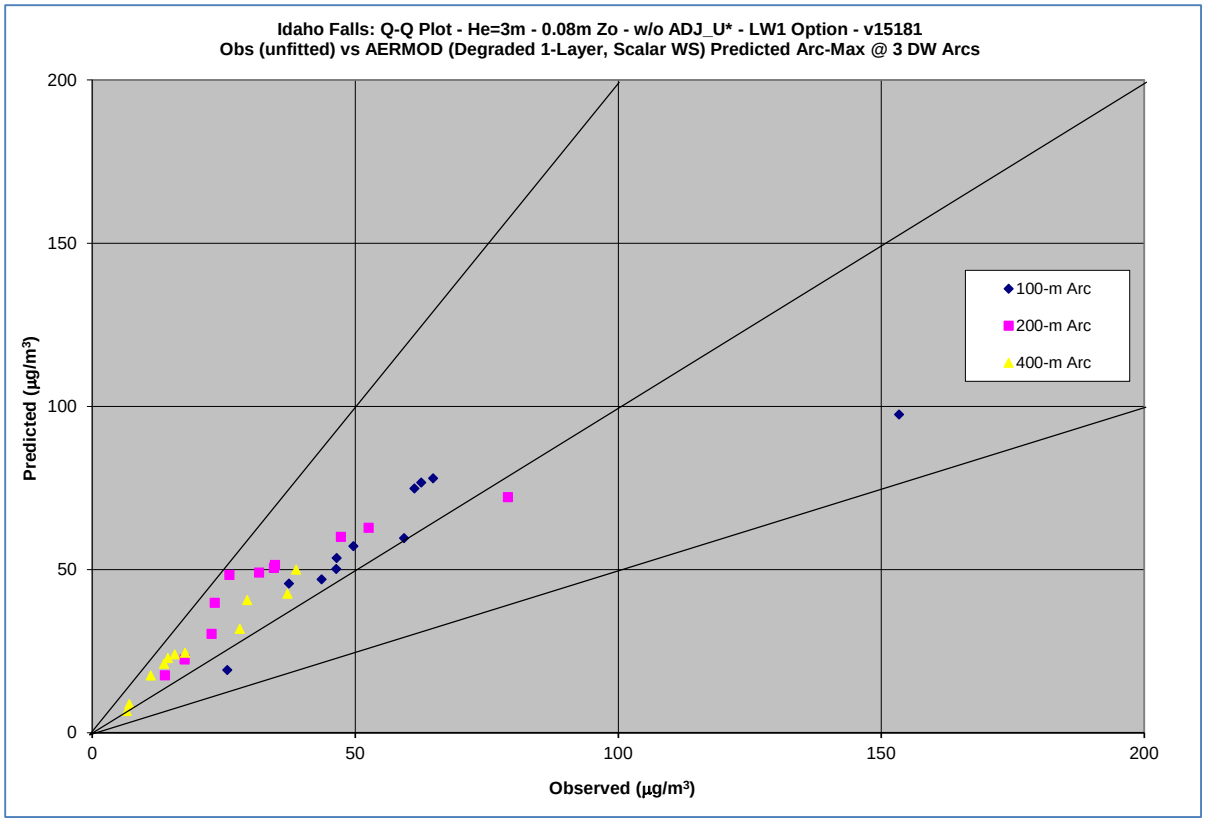

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - w/o ADJ_U* - NoLW Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

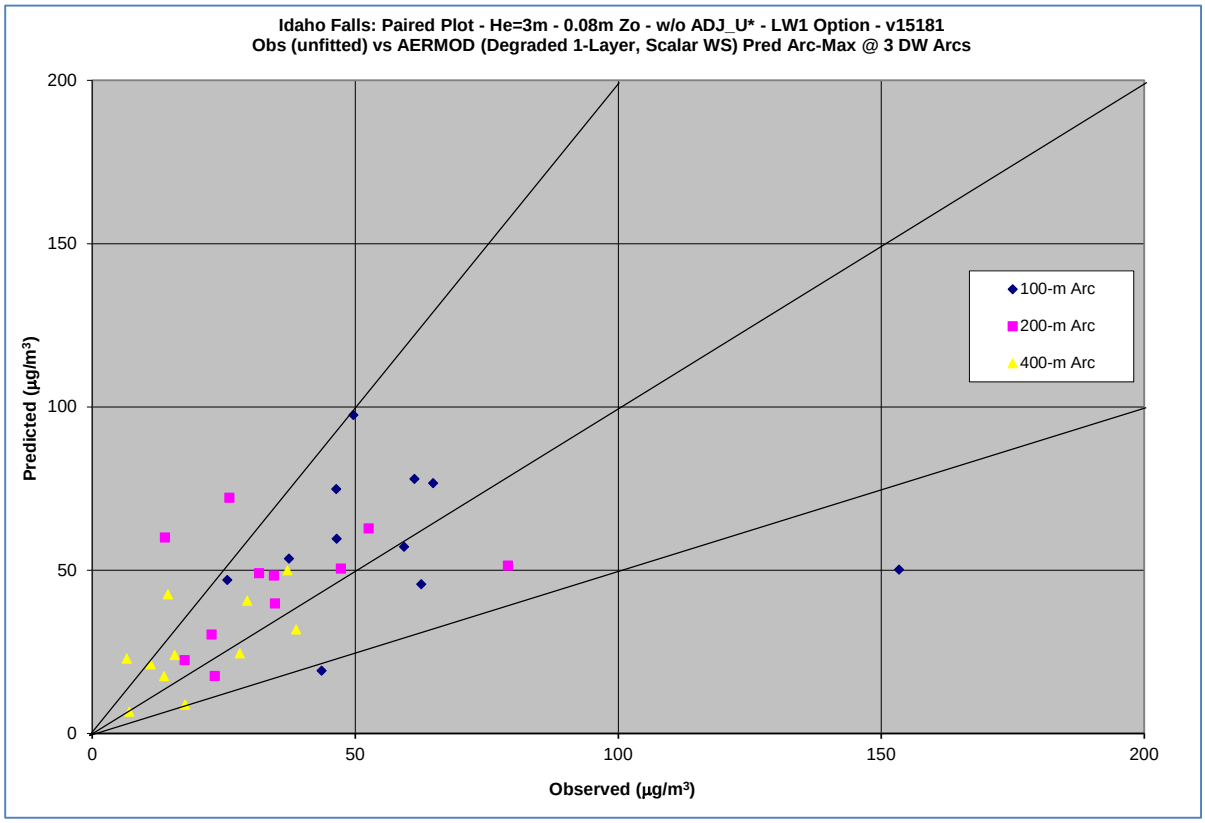

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - w/o ADJ_U* - NoLW Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

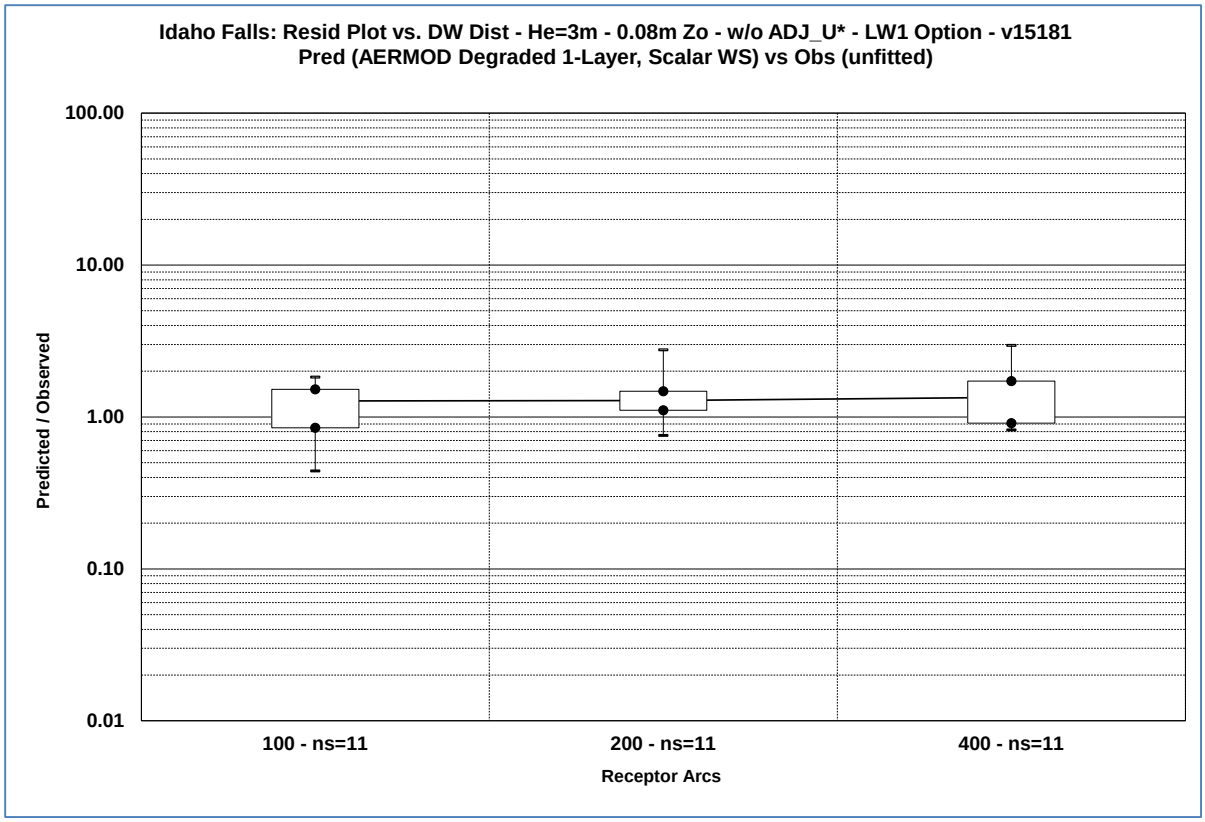


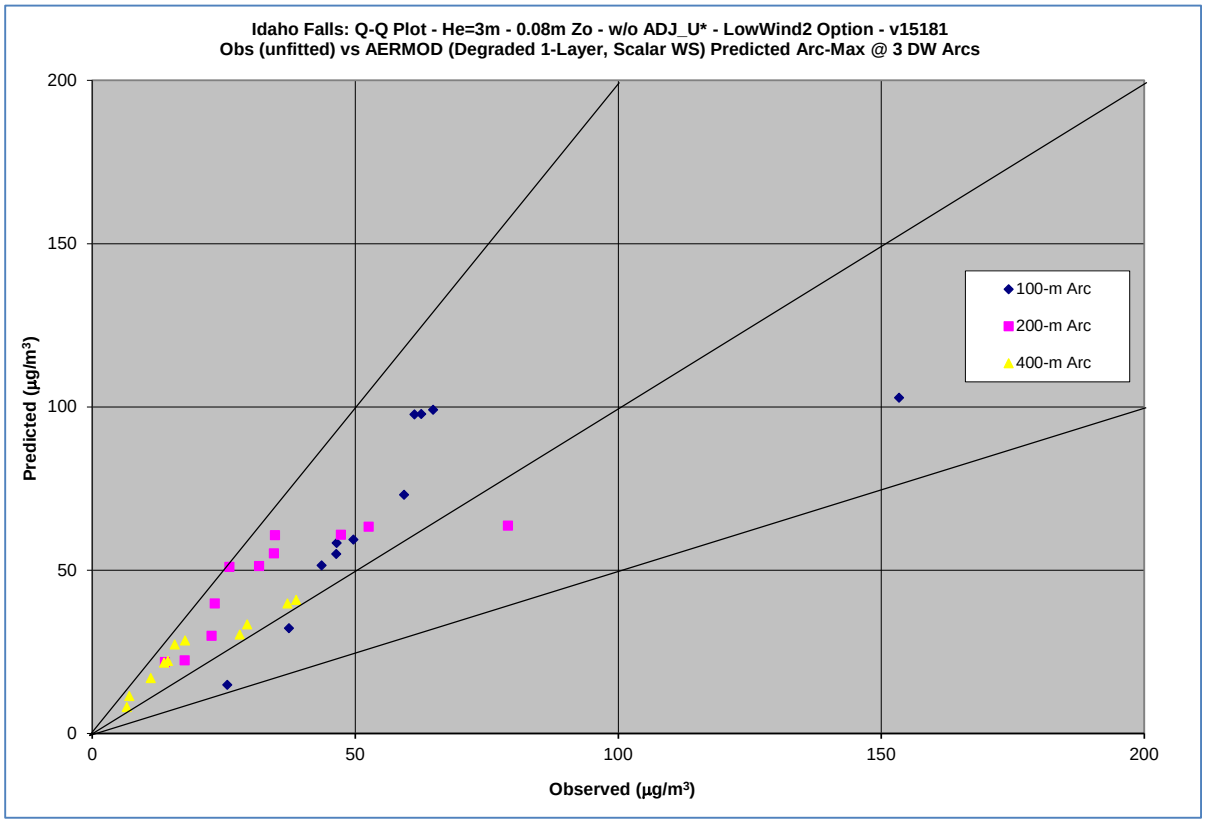
The results for Idaho Falls based on the default options in AERMET and AERMOD exhibit overprediction of the observed concentrations of approximately a factor of 2, with is a much smaller bias than for the Oak Ridge study. As shown below, the bias toward overprediction is largely eliminated with the LowWind options in AERMOD, without the ADJ_U* option in AERMET. The average Pred/Obs concentration ratios are also generally consistent with downwind distance.

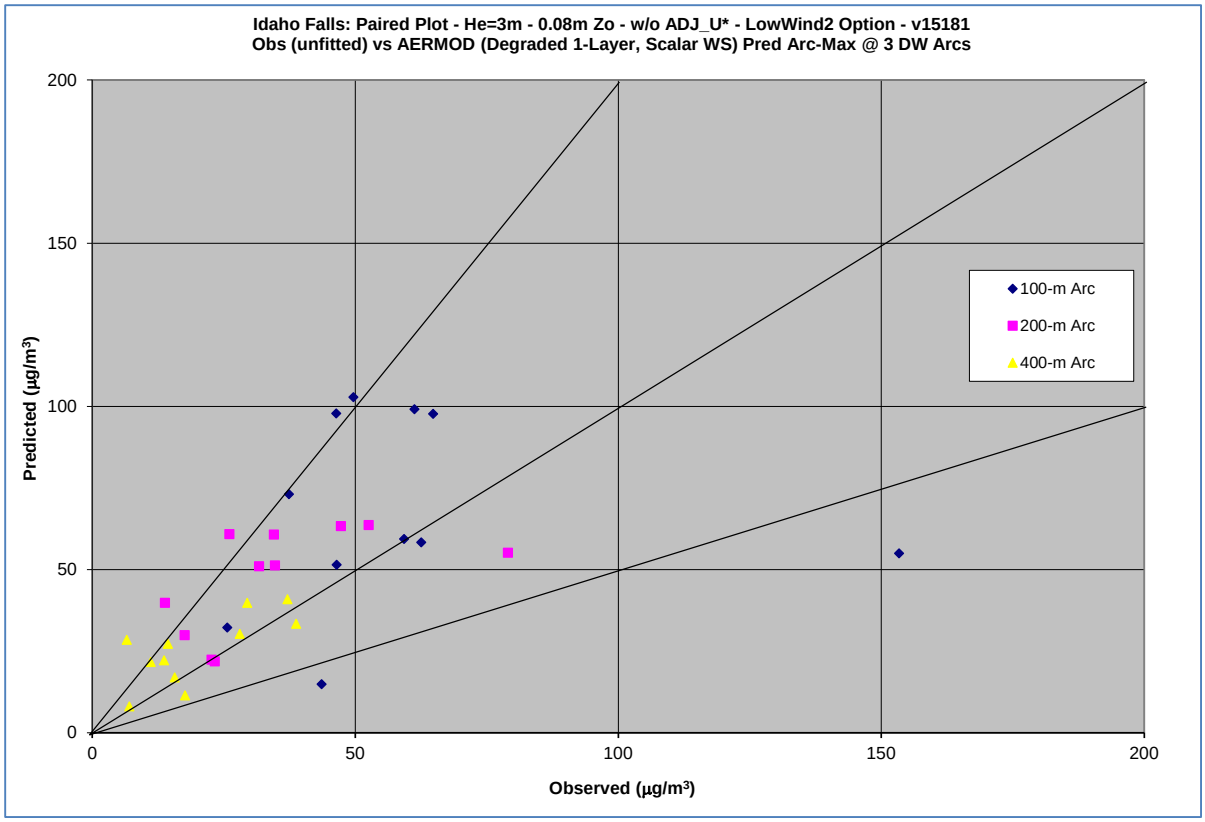
The results for Idaho Falls with the ADJ_U* option in AERMET also show generally good performance at the first arc of receptors at 100m downwind, with some tendency toward underprediction further downwind, especially when the LowWind options are also used. For this type of source, i.e., a non-buoyant, ground-level or low-level source (e.g., fugitive emission), the maximum ambient impacts are likely to occur at the fenceline.

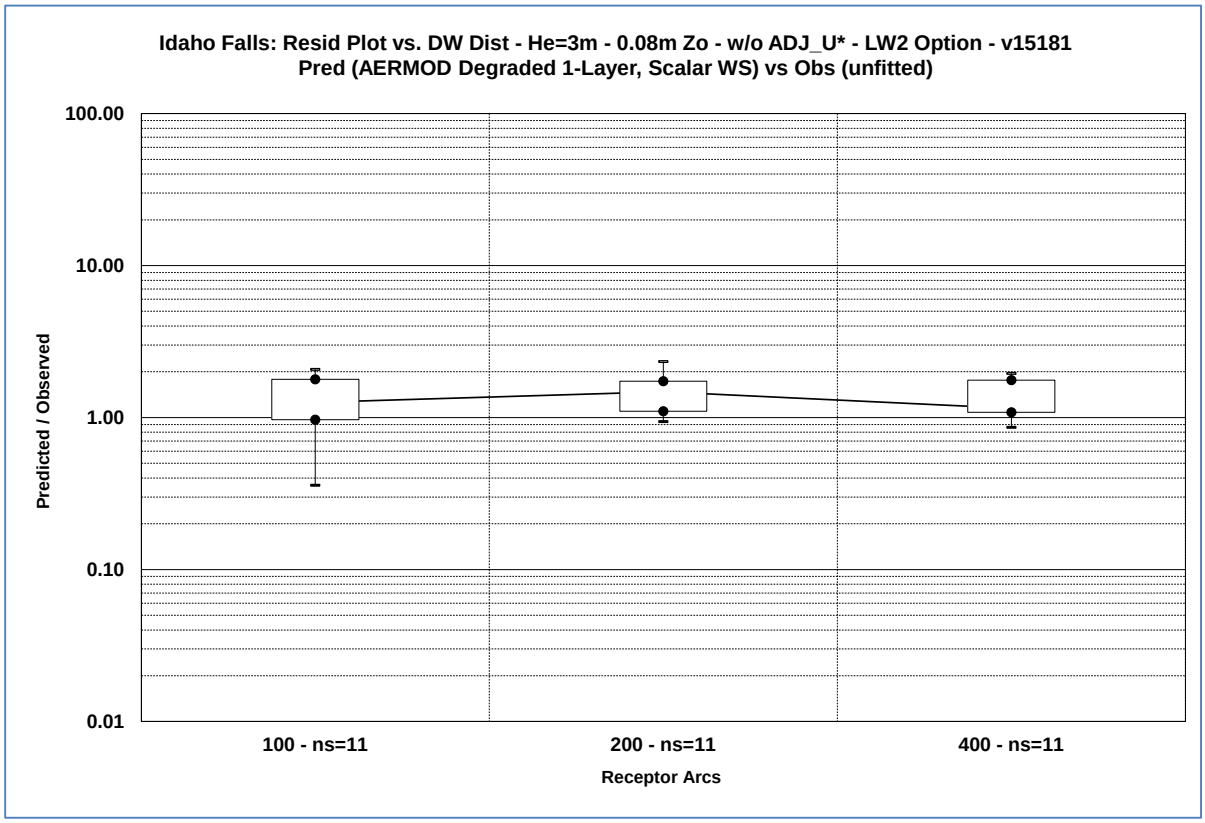

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - w/o ADJ_U* - LW1 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

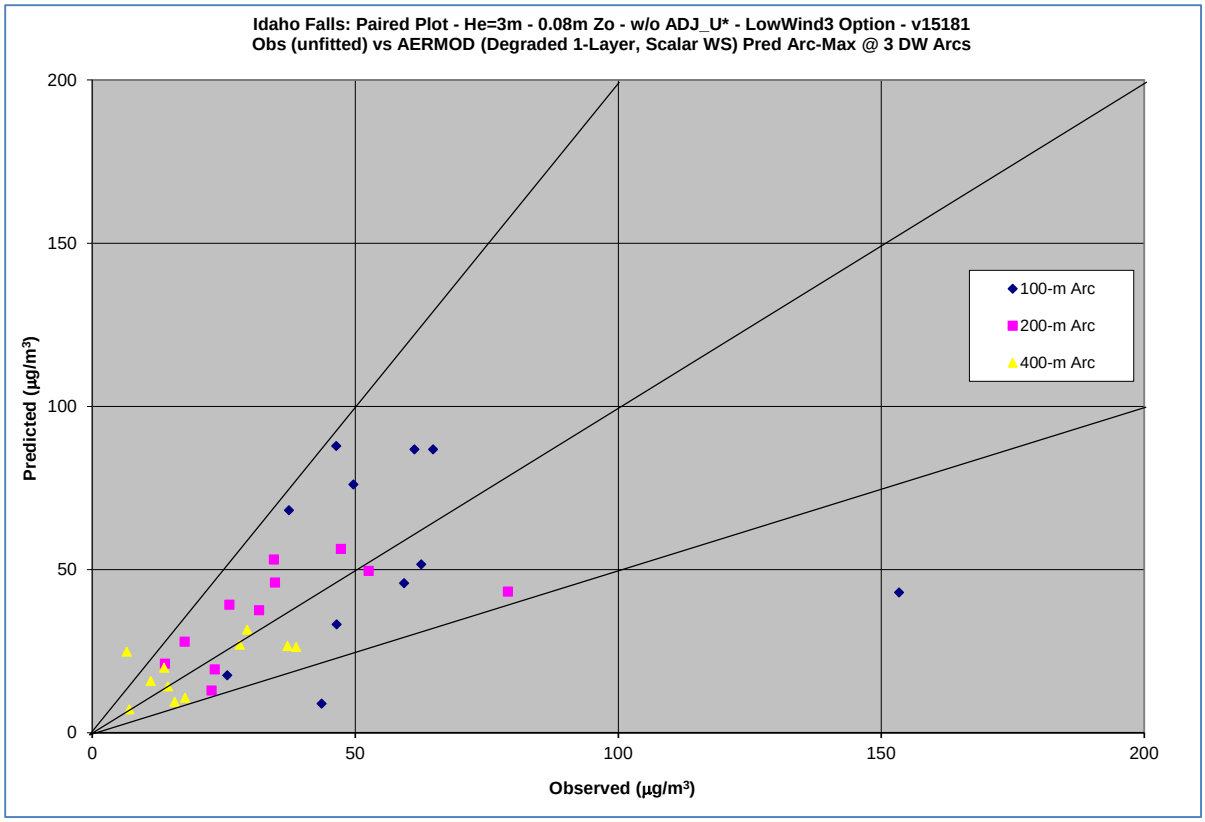

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - w/o ADJ_U* - LW1 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

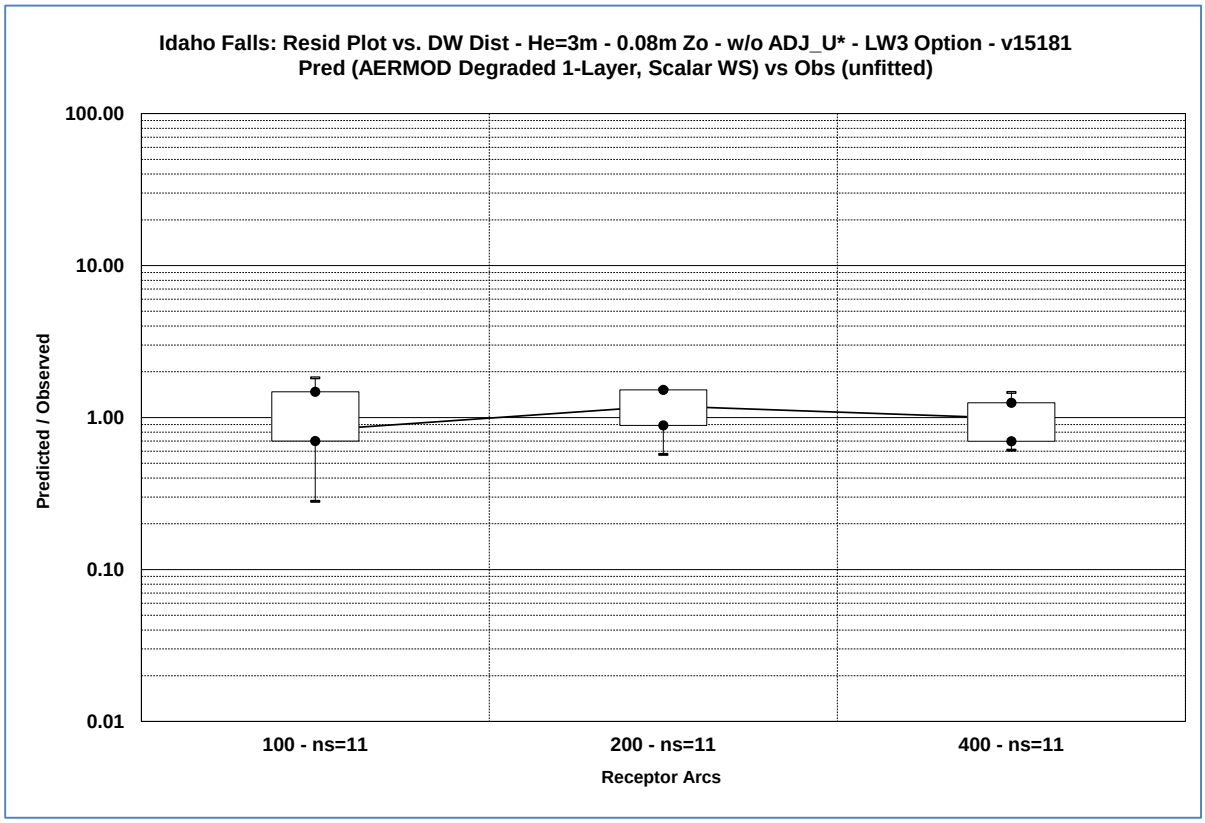

Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - w/o ADJ_U* - LW1 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

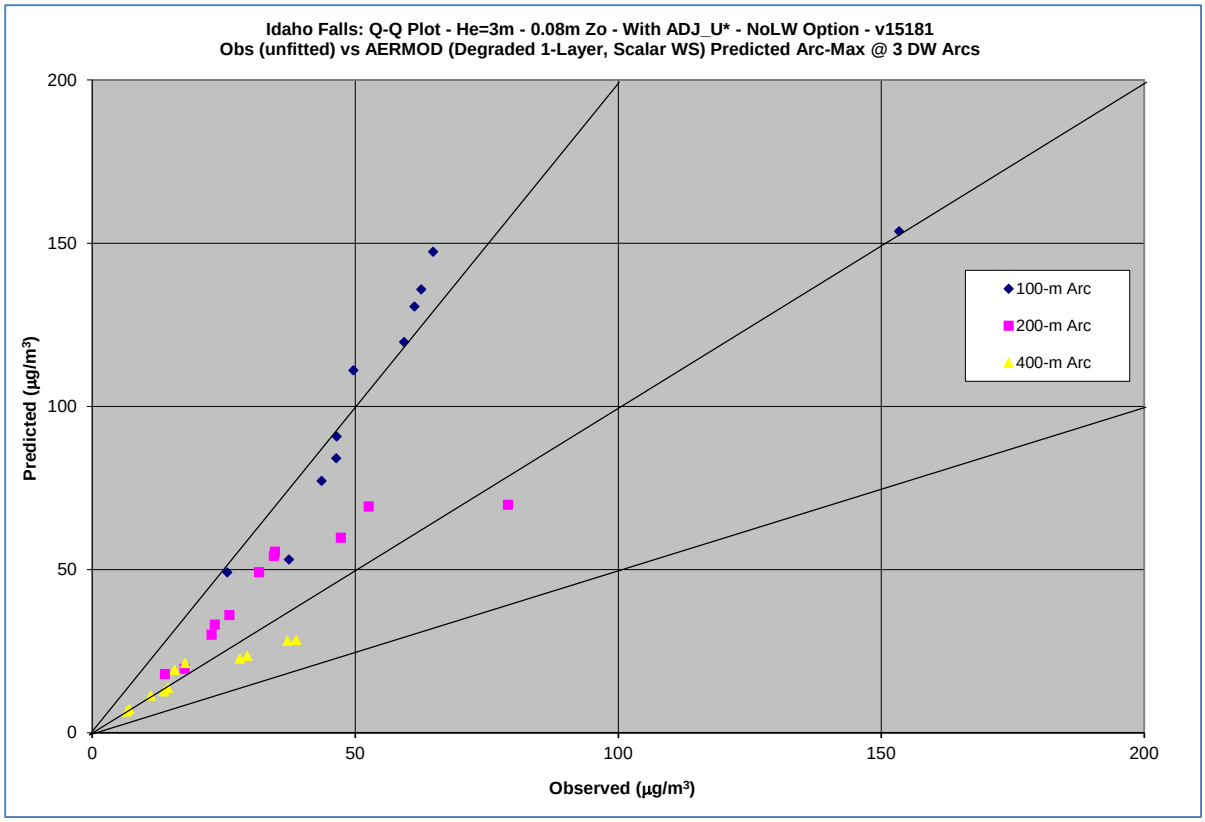

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - w/o ADJ_U* - LowWind2 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
200
150
100
50
0
Predicted (µg/m³)
0
50
100
150
200
Observed (µg/m³)
100-m Arc
200-m Arc
400-m Arc

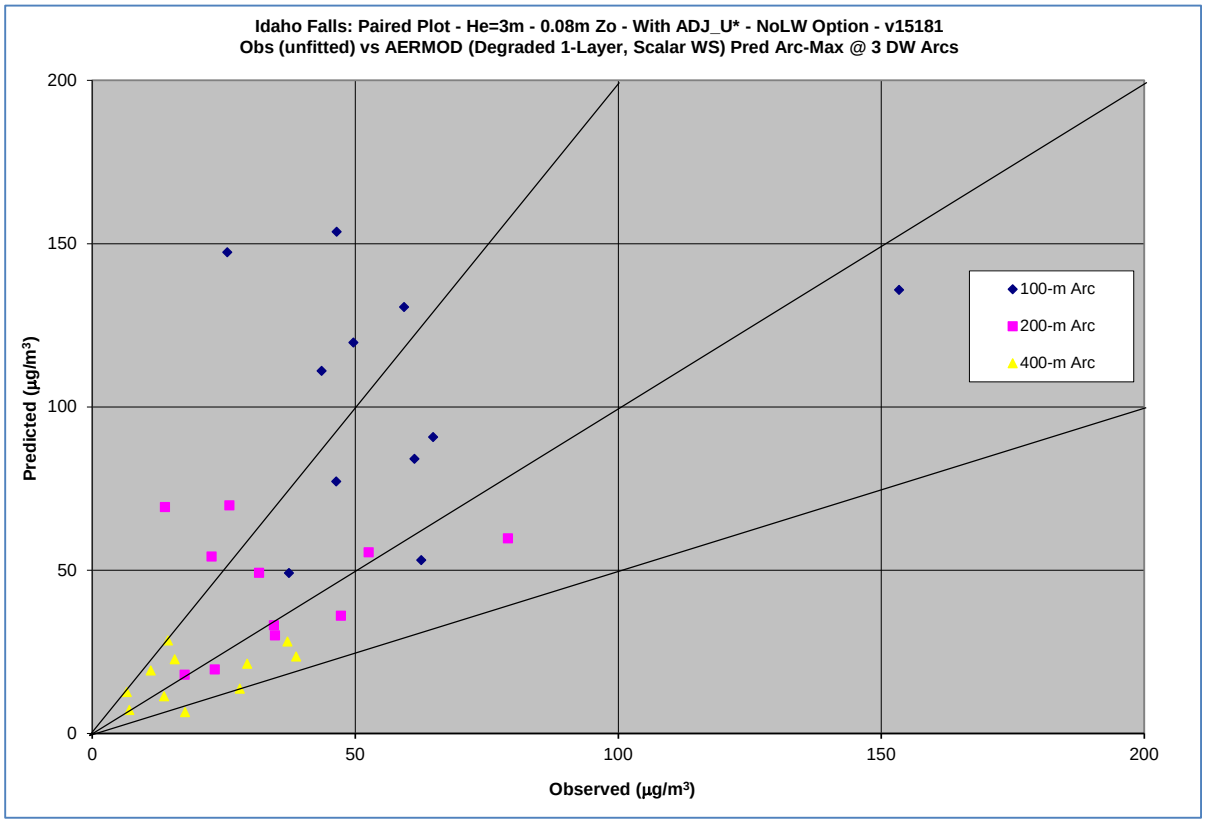

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - w/o ADJ_U* - LowWind2 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

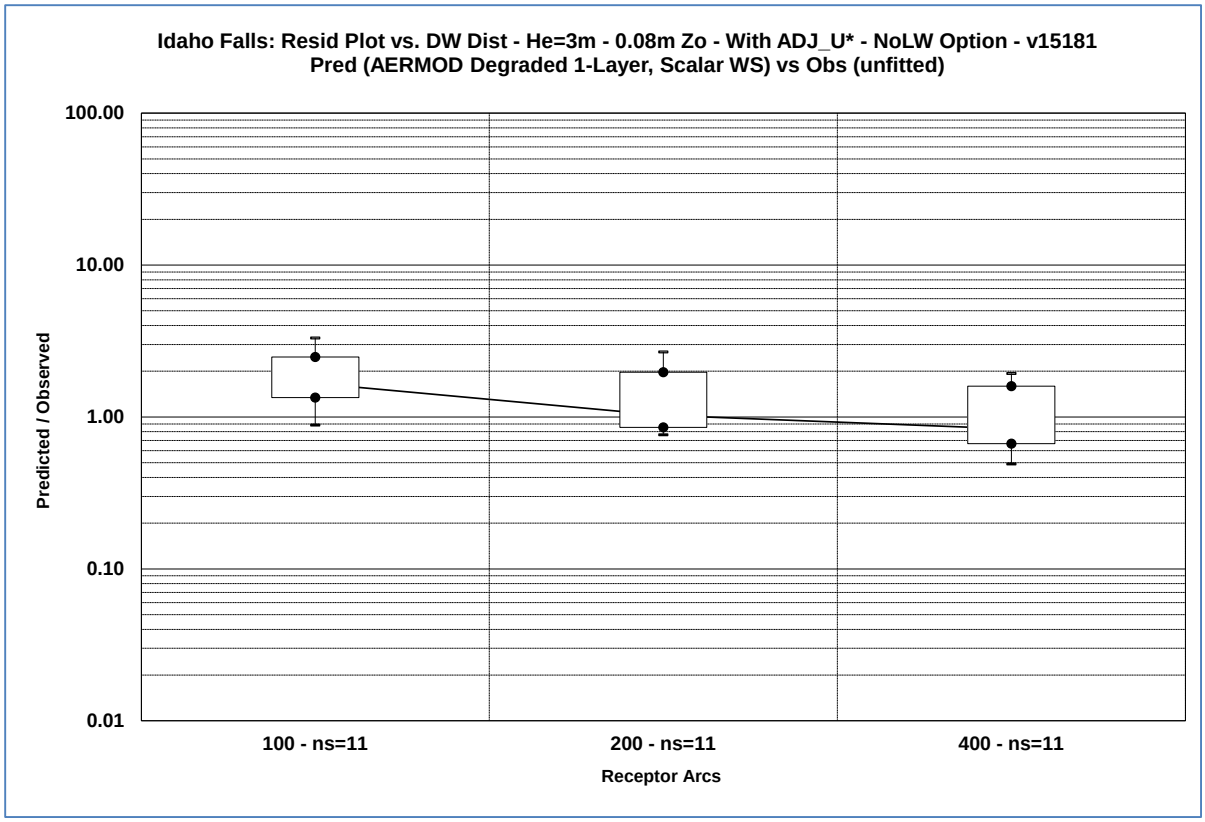

Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - w/o ADJ_U* - LW2 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
Predicted / Observed
100.00
10.00
1.00
0.10
0.01
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

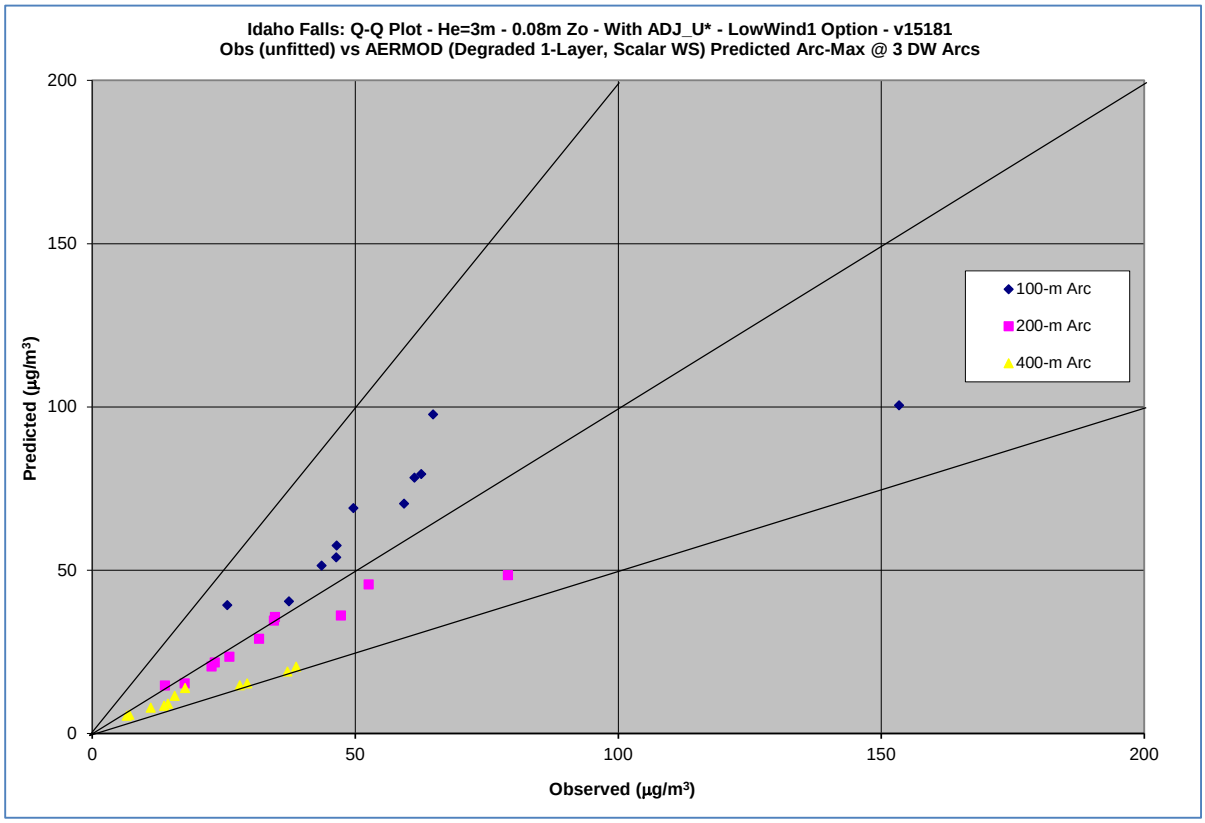

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - w/o ADJ_U* - LowWind3 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

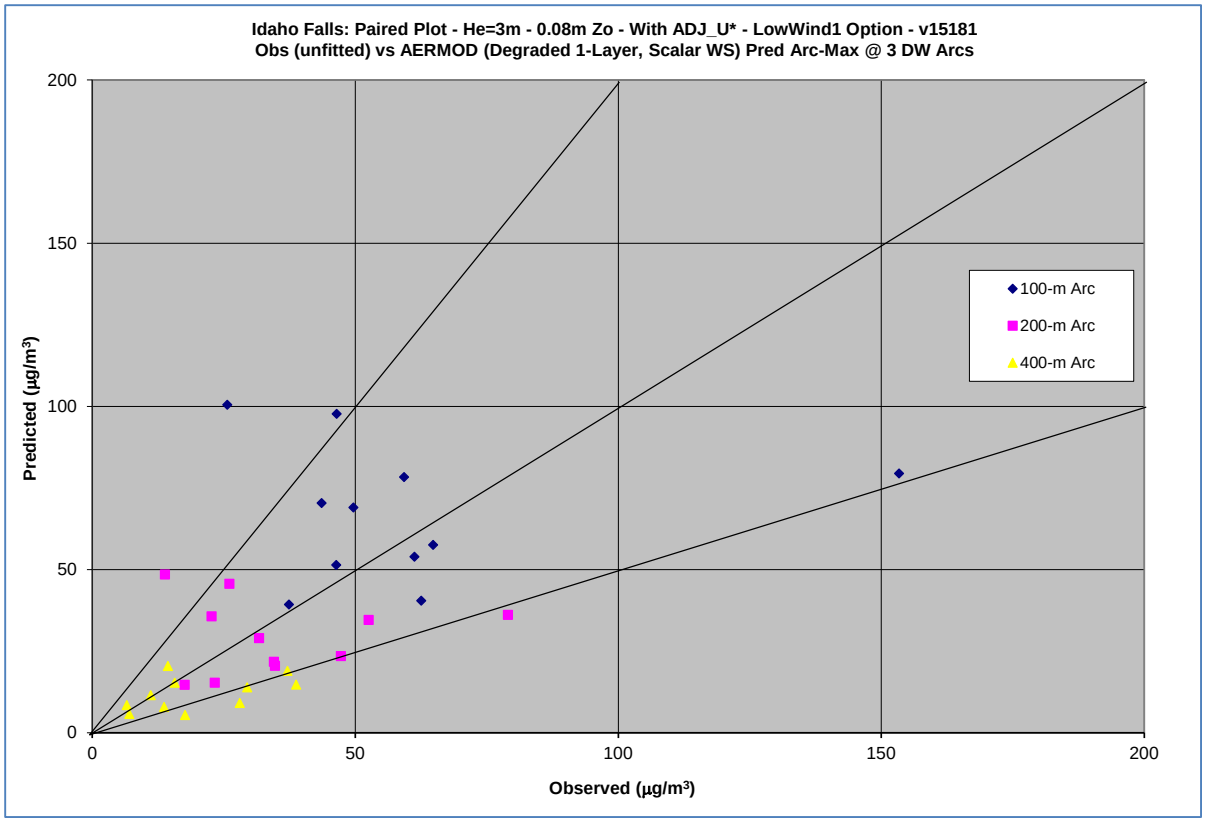

Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - w/o ADJ_U* - LW3 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
Predicted / Observed
100.00
10.00
1.00
0.10
0.01
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

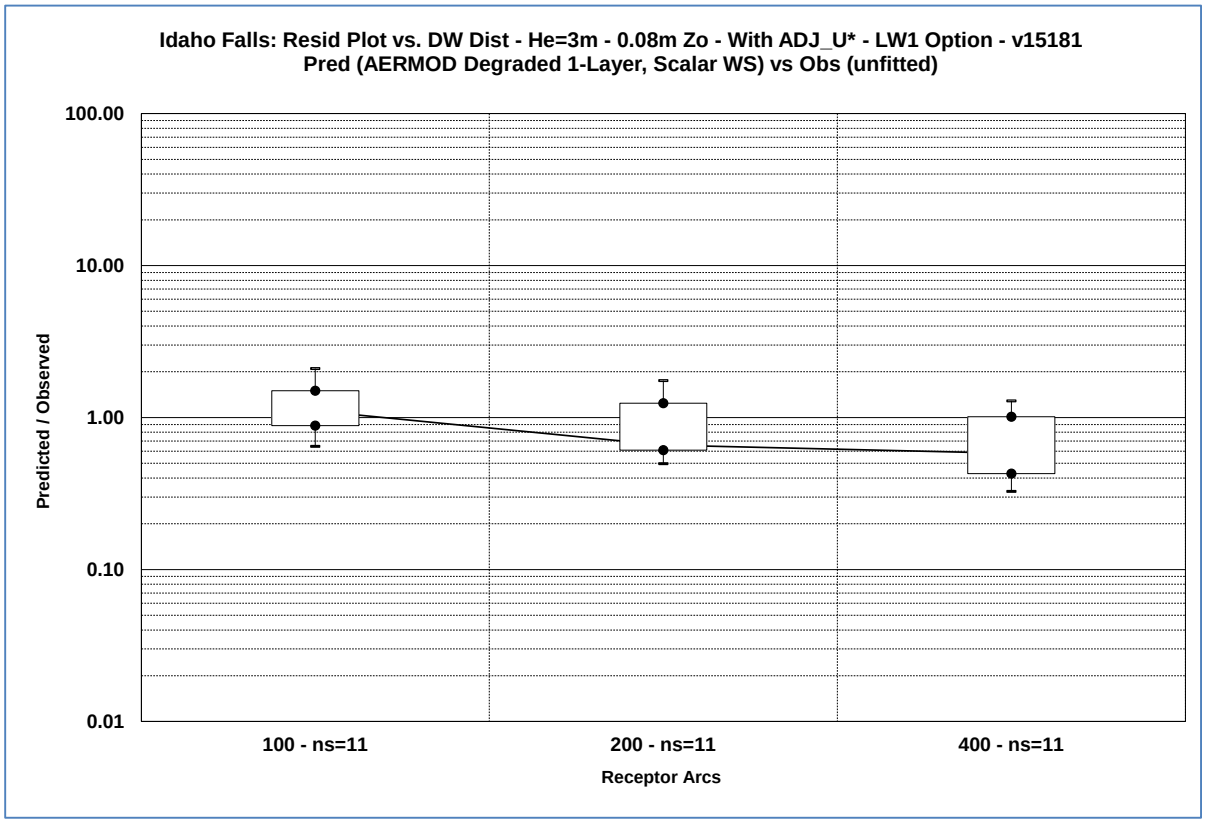

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

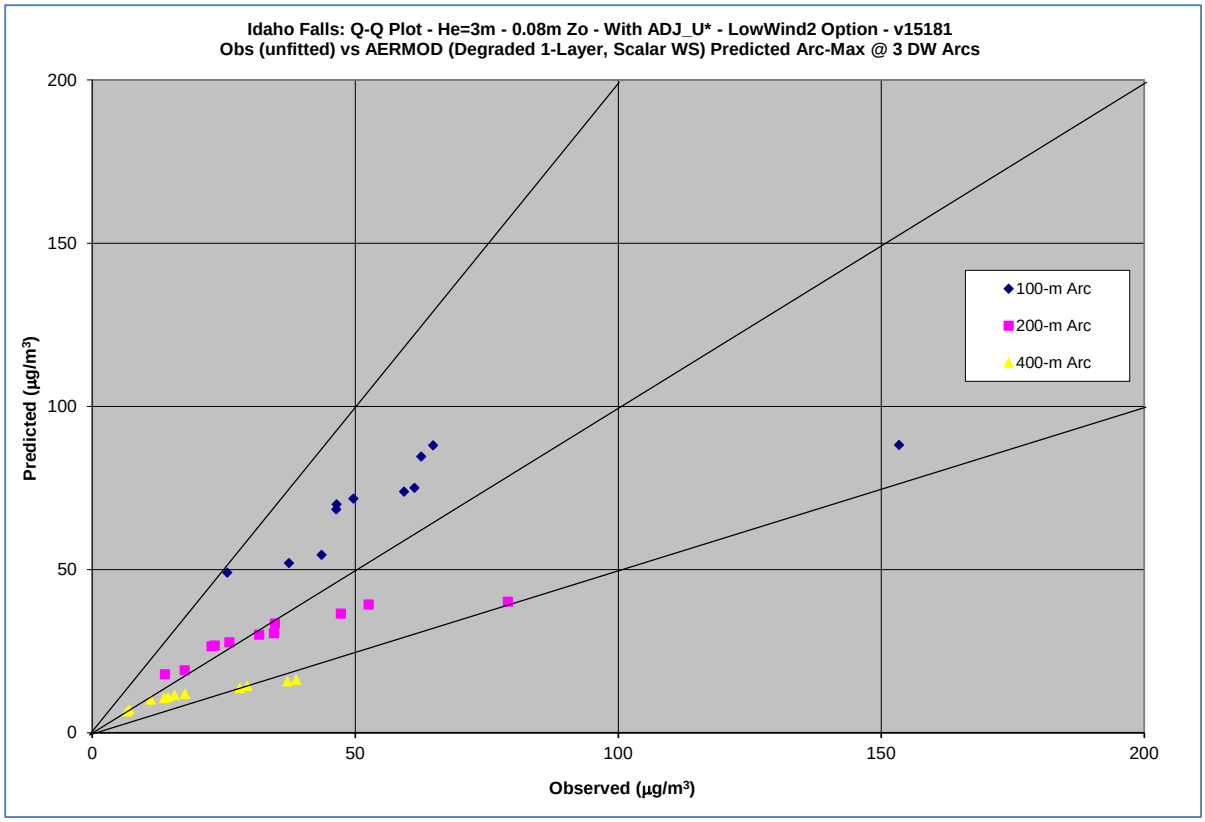

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

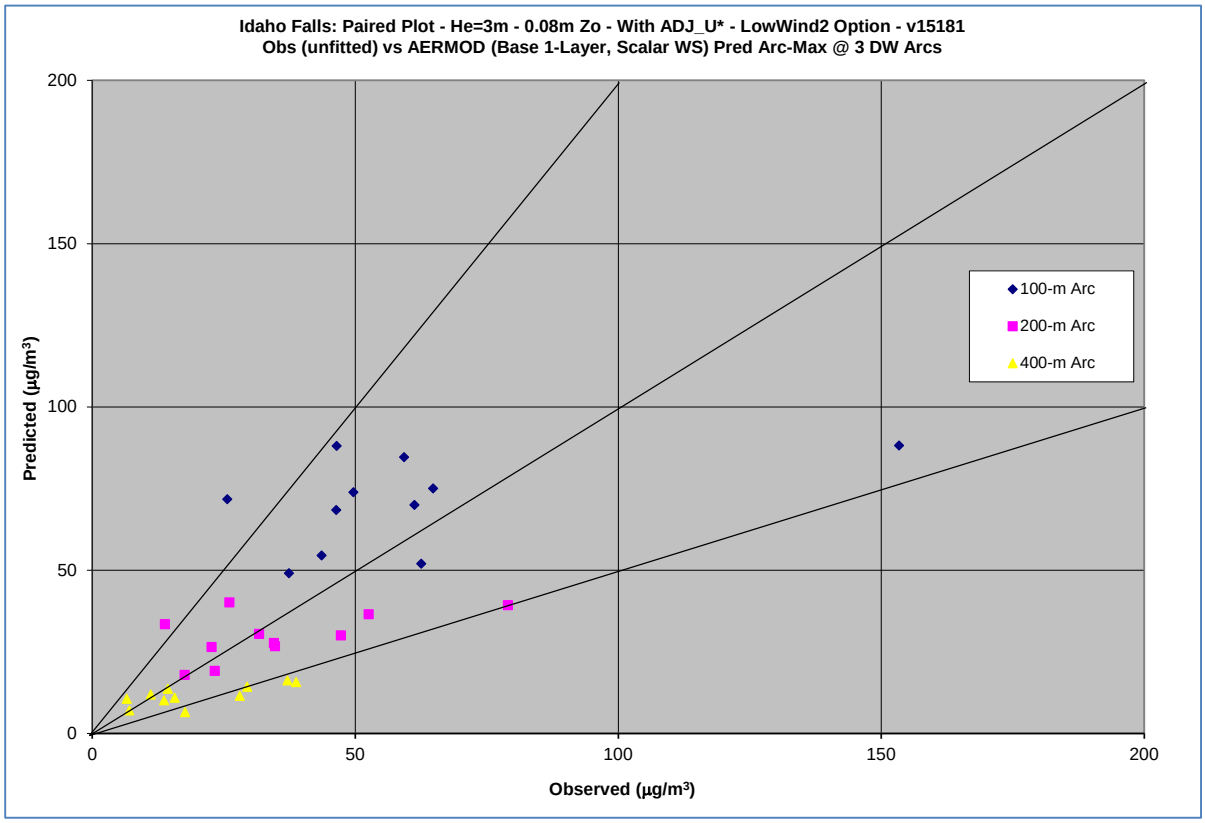

Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - With ADJ_U* - NoLW Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

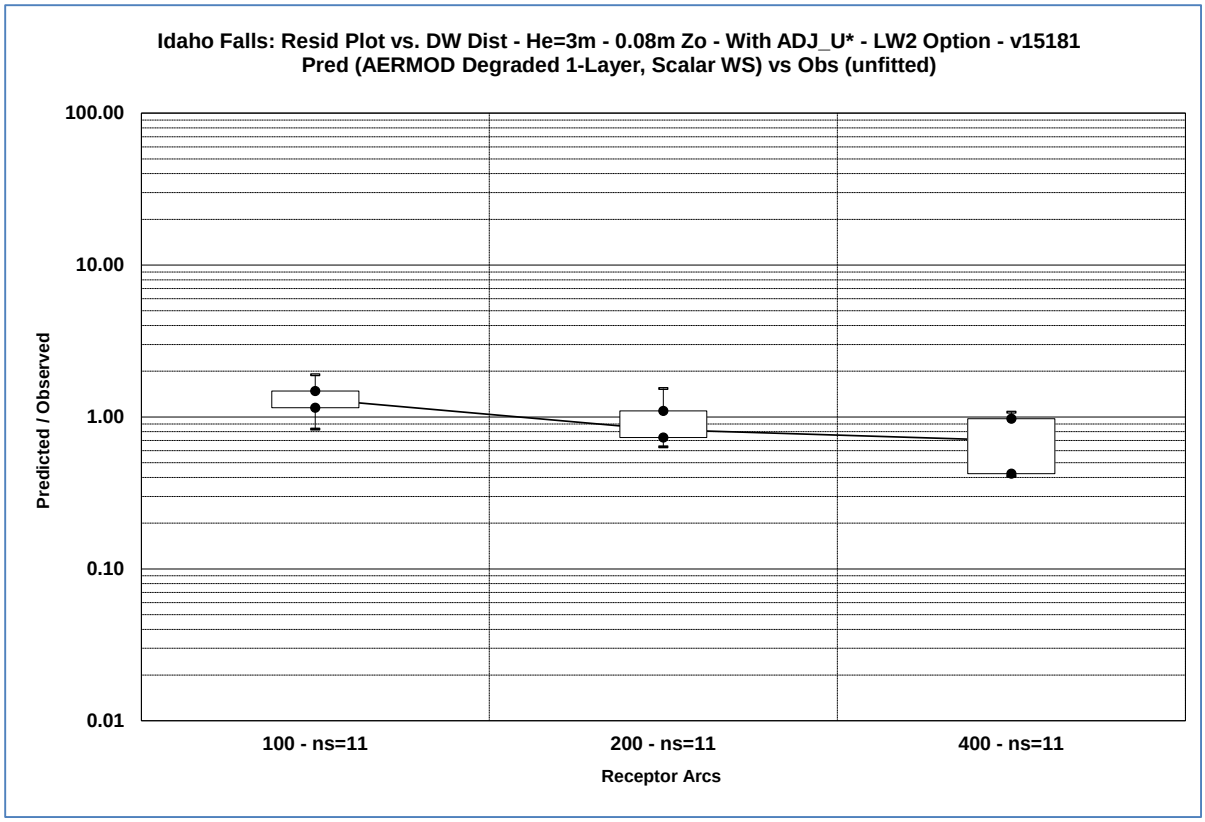

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind1 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
200
150
100
50
0
Predicted (µg/m³)
0
50
100
150
200
Observed (µg/m³)
100-m Arc
200-m Arc
400-m Arc

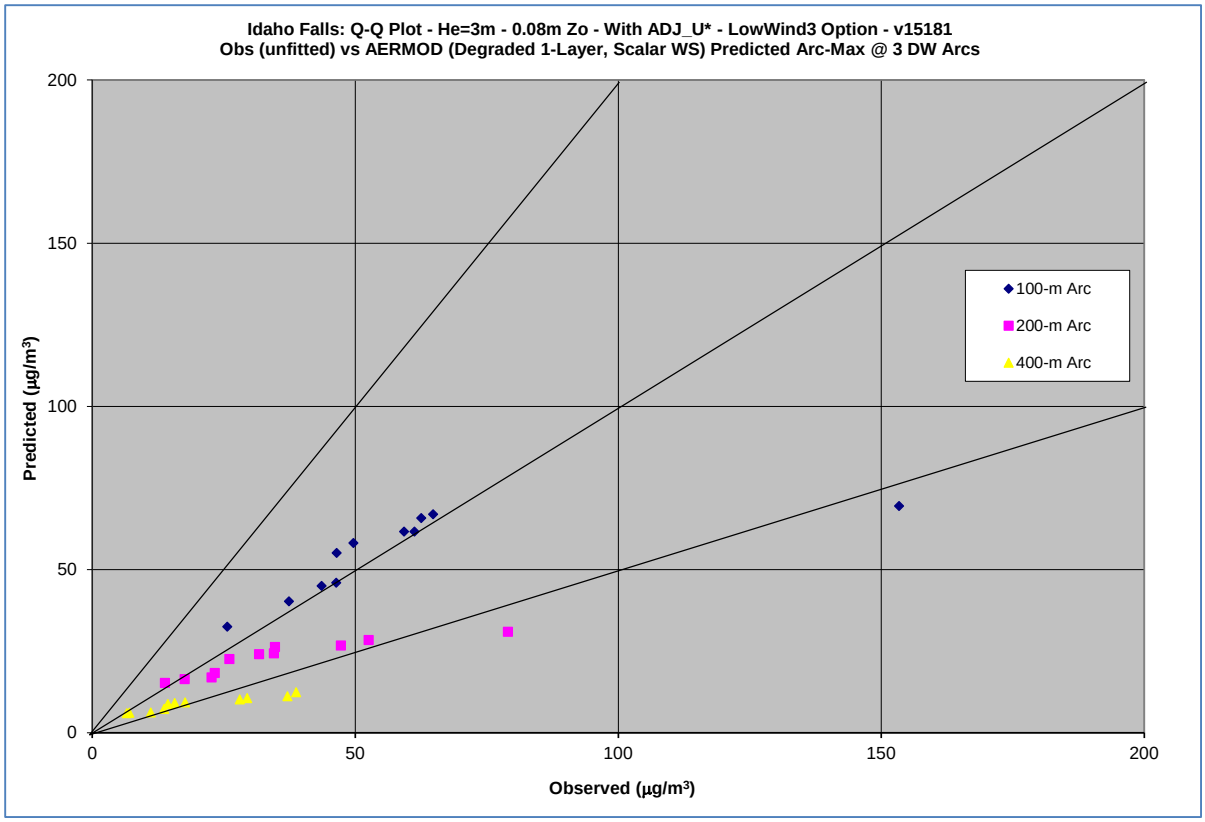

Idaho Falls: Paired Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind1 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc

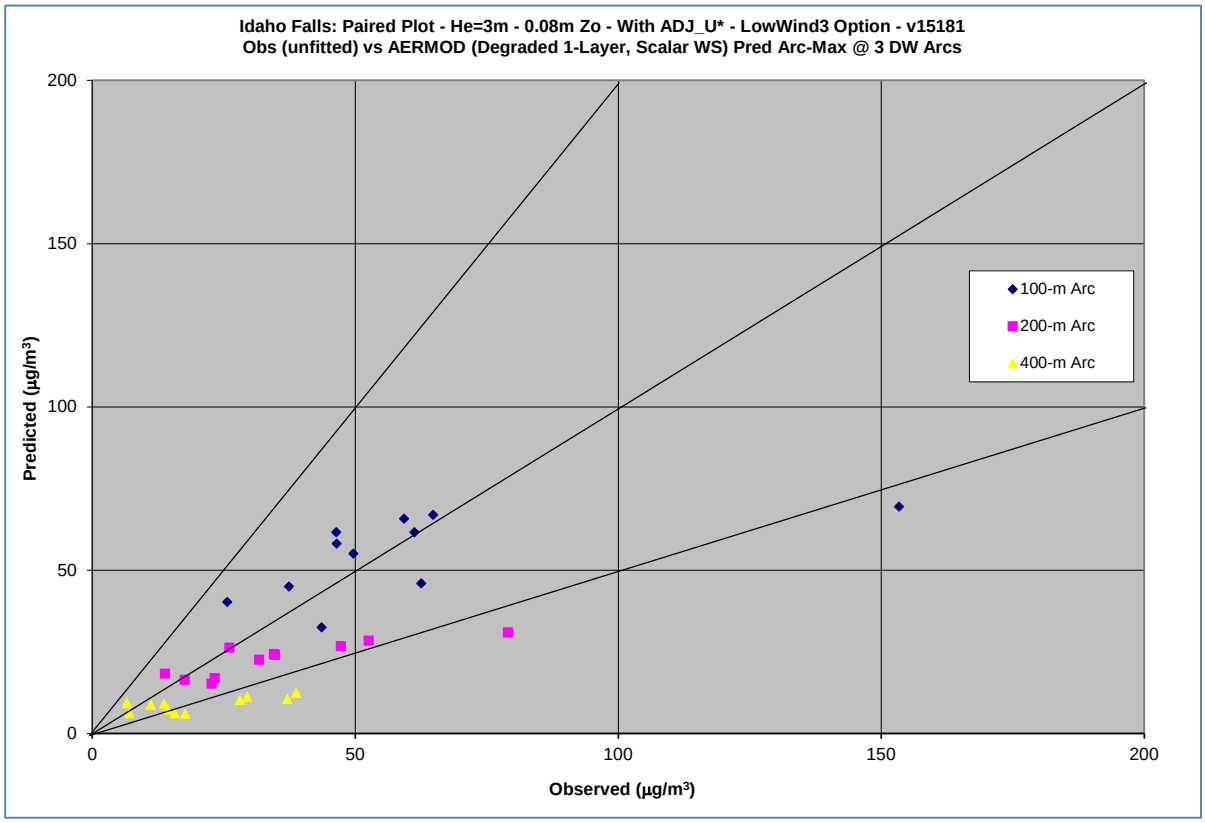

Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - With ADJ_U* - LW1 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
Predicted / Observed
100.00
10.00
1.00
0.10
0.01
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

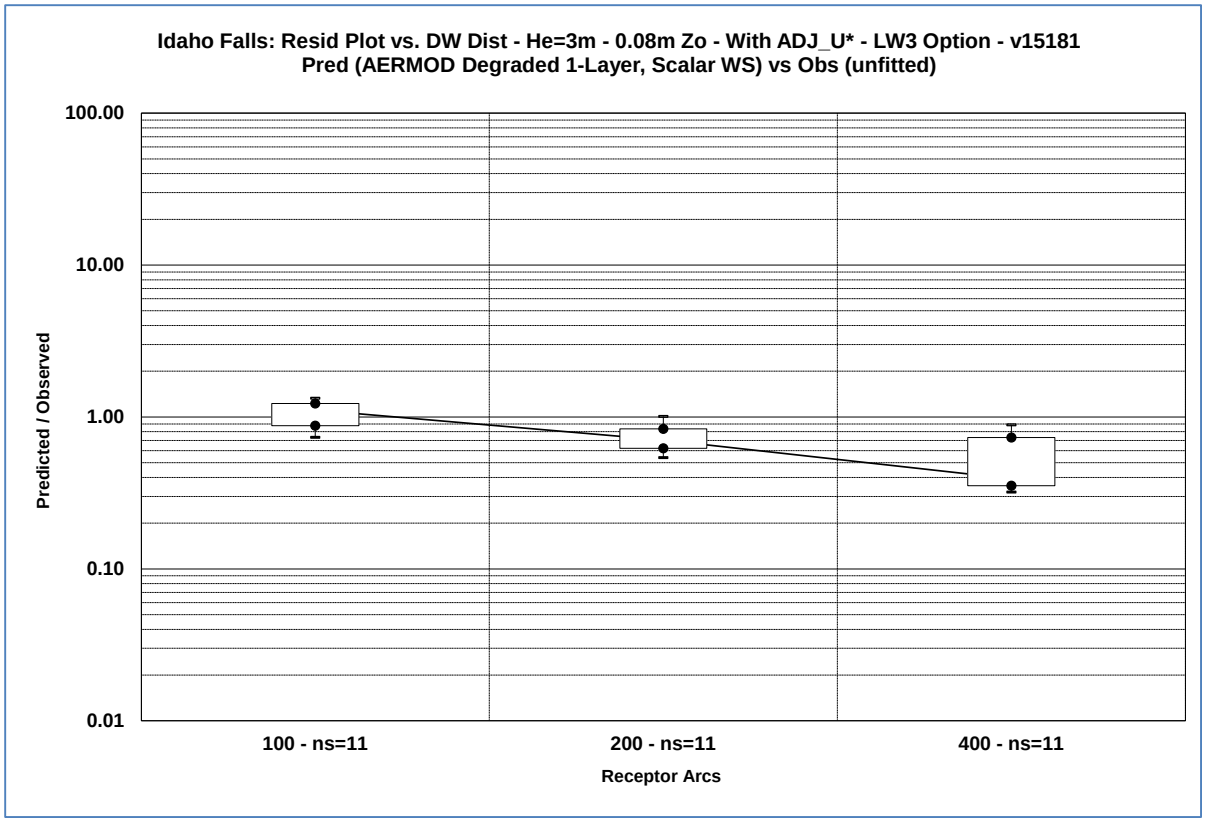

Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind2 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc


Idaho Falls: Paired Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind2 Option - v15181
Obs (unfitted) vs AERMOD (Base 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc


Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - With ADJ_U* - LW2 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs


Idaho Falls: Q-Q Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind3 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Predicted Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc


Idaho Falls: Paired Plot - He=3m - 0.08m Zo - With ADJ_U* - LowWind3 Option - v15181
Obs (unfitted) vs AERMOD (Degraded 1-Layer, Scalar WS) Pred Arc-Max @ 3 DW Arcs
Predicted (µg/m³)
Observed (µg/m³)
0
50
100
150
200
100-m Arc
200-m Arc
400-m Arc


Idaho Falls: Resid Plot vs. DW Dist - He=3m - 0.08m Zo - With ADJ_U* - LW3 Option - v15181
Pred (AERMOD Degraded 1-Layer, Scalar WS) vs Obs (unfitted)
100.00
10.00
1.00
0.10
0.01
Predicted / Observed
100 - ns=11
200 - ns=11
400 - ns=11
Receptor Arcs

The Lovett data base includes a single 145m stack located within a few kilometers of complex terrain. The site area is shown below:

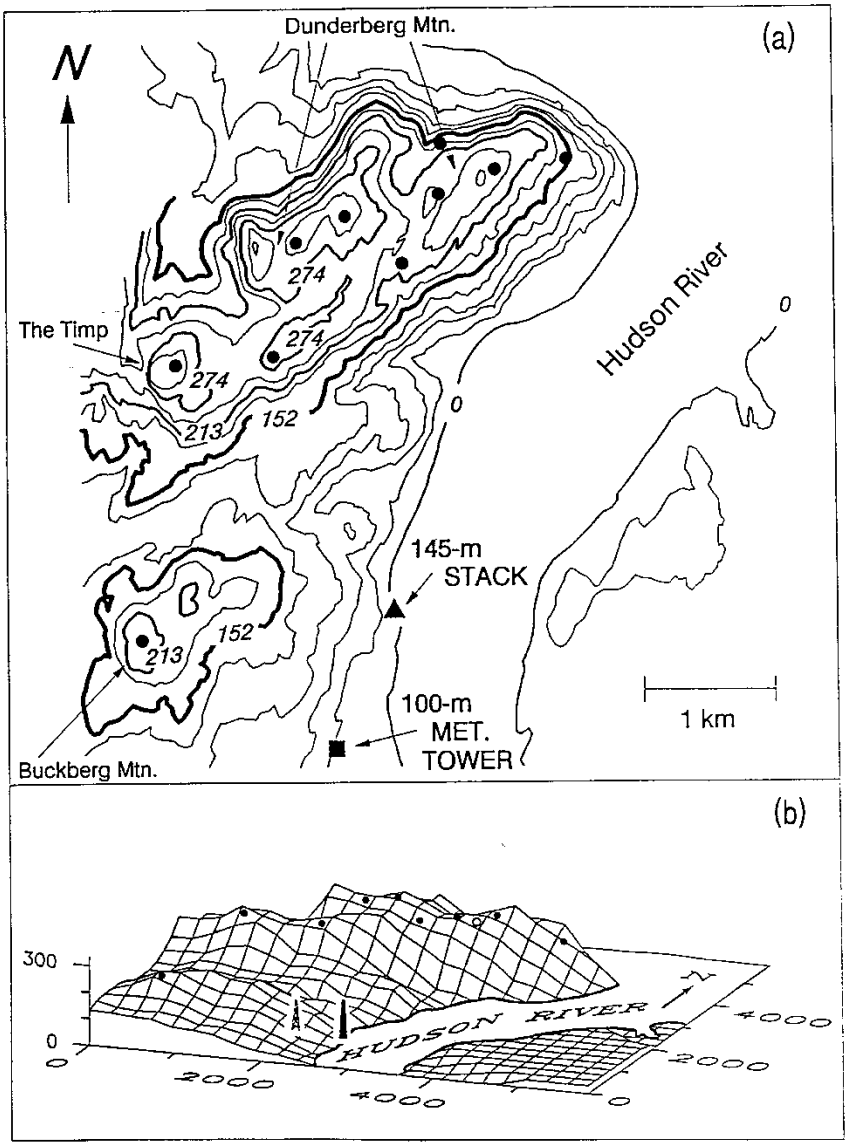
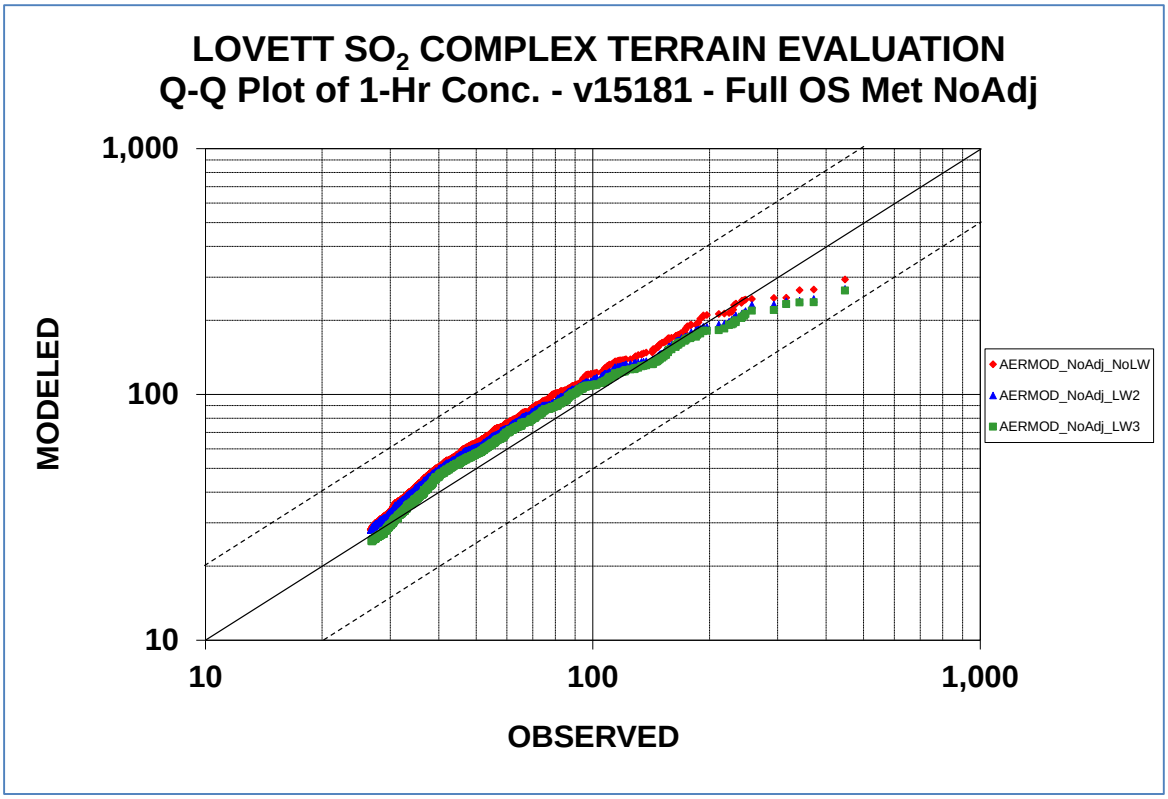


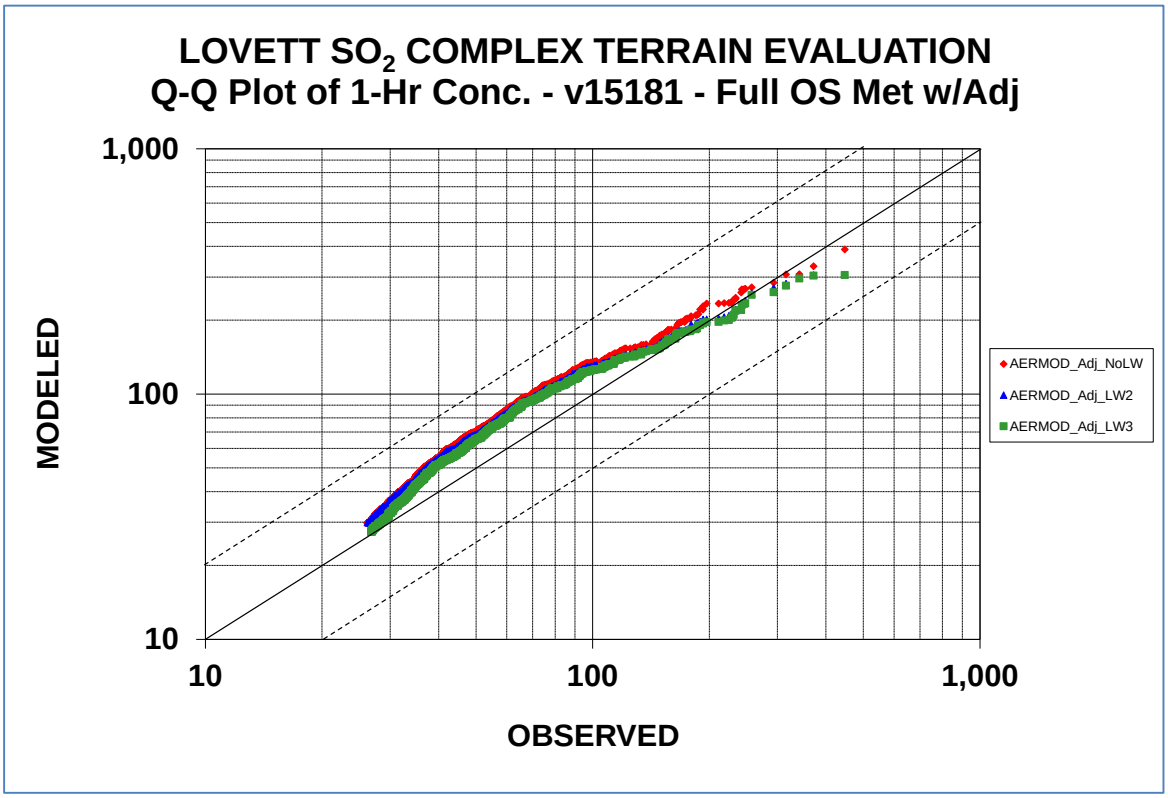
Figure 7 **Depiction of the Monitoring Network Used for the Lovett Complex Terrain Model Evaluation Study**

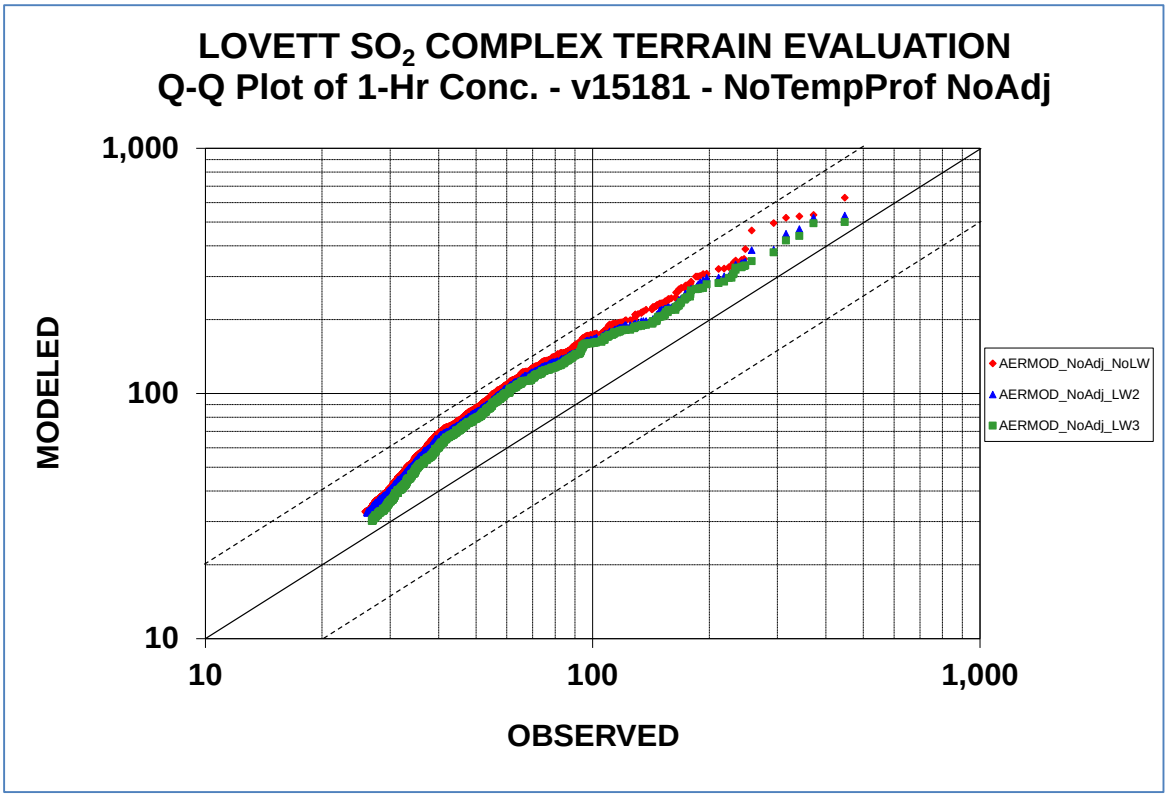
The Lovett data base includes a 100m meteorological tower with wind speed, wind direction, sigma-theta and temperature collected at the 10m, 50m, and 100m levels. In addition, sigma-w was also collected at the 10m and 100m levels. Past evaluations of AERMOD have

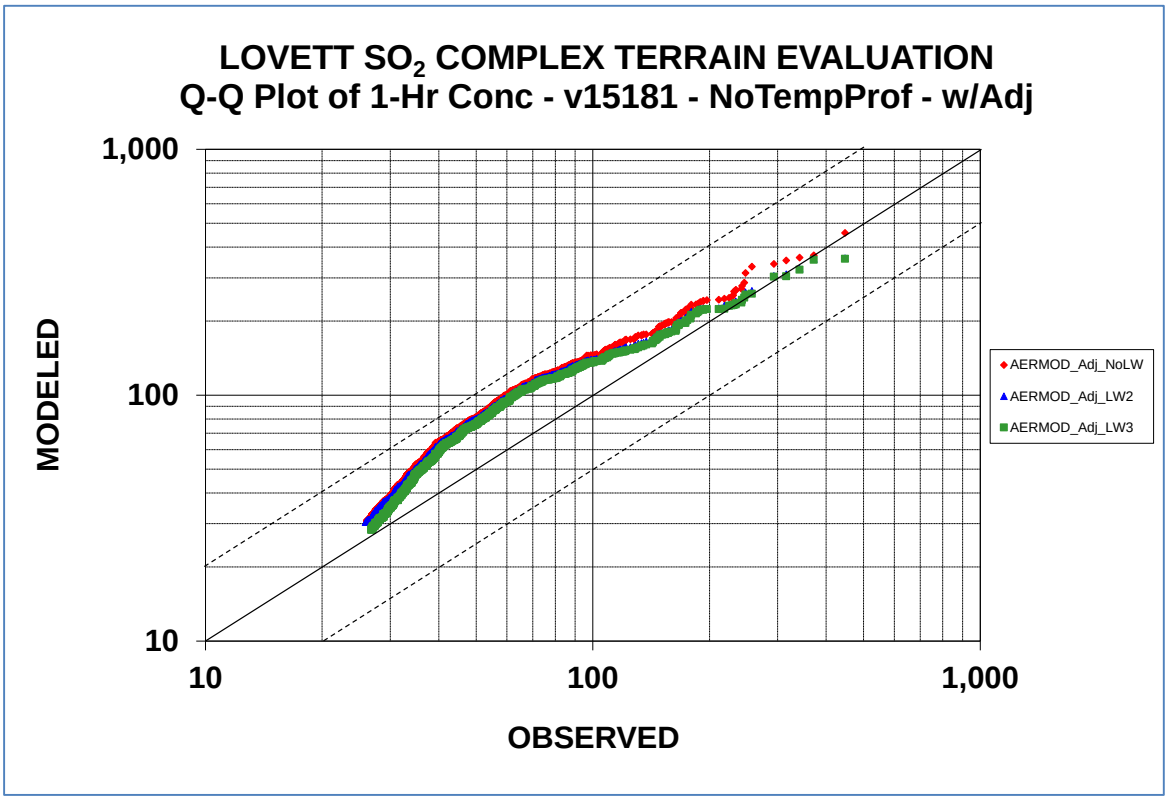
shown good performance. Updated 1-hour results are presented below comparing model performance with full onsite meteorological data with and without the ADJ_U* and LowWind options, followed by comparisons with and without the ADJ_U* and LowWind options using degraded meteorological data inputs. Including the ADJ_U* option with full onsite meteorological data shows a slight improvement in model performance without the LowWind options, and little difference in performance for the LowWind2 compared to LowWind3 (the LowWind1 option was not included in this study.

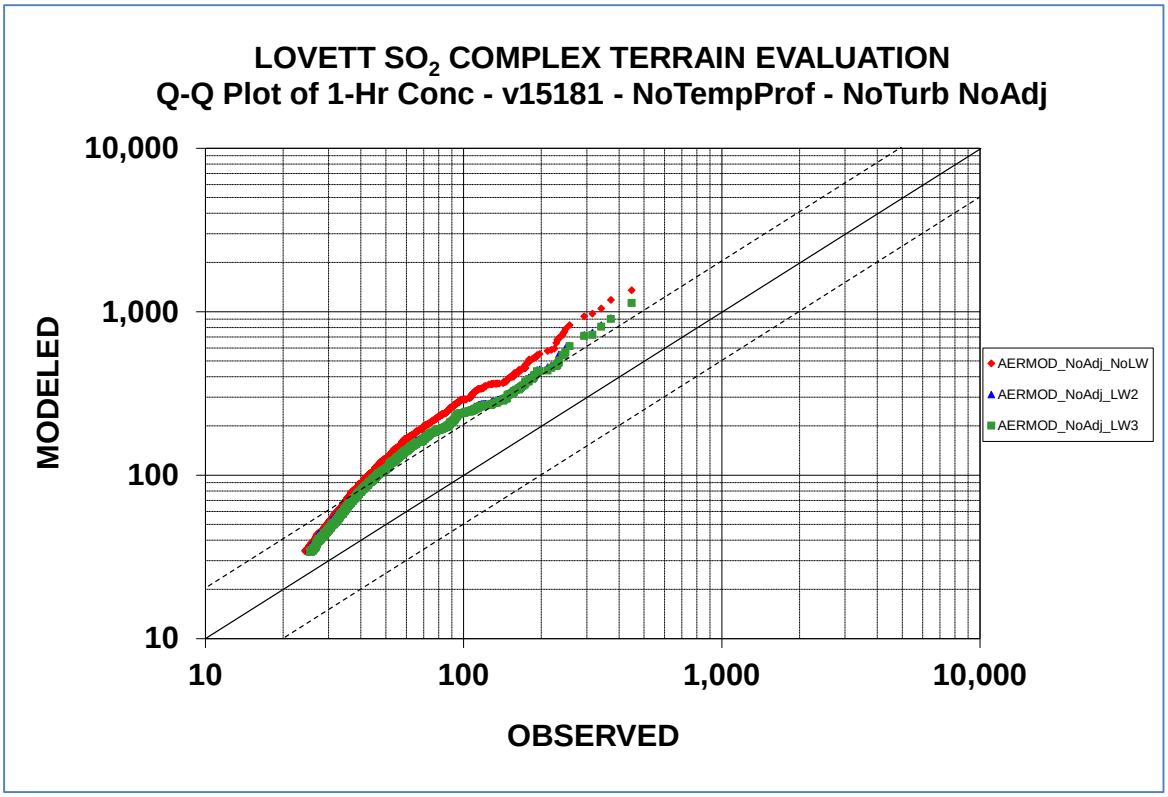
The next set of comparisons are based on no temperature profile in the Lovett site-specific meteorological data. The model shows some overprediction without the temperature profile and without the ADJ_U* option, especially without the LowWind options. The model overprediction without the temperature profile is noticeably reduced when the ADJ_U* option is used. The modeled results shows more significant overprediction when the meteorological data is further degraded by eliminating the turbulence data (i.e., sigma-theta and sigma-w), with the overprediction bias exceeding a factor of 2. The overprediction without the temperature profile and turbulence data is significantly reduced when the ADJ_U* and LowWind options are used. It’s also worth noting that results for the LowWind2 (LW2) and LowWind3 (LW3) options are nearly indistinguishable in this case.

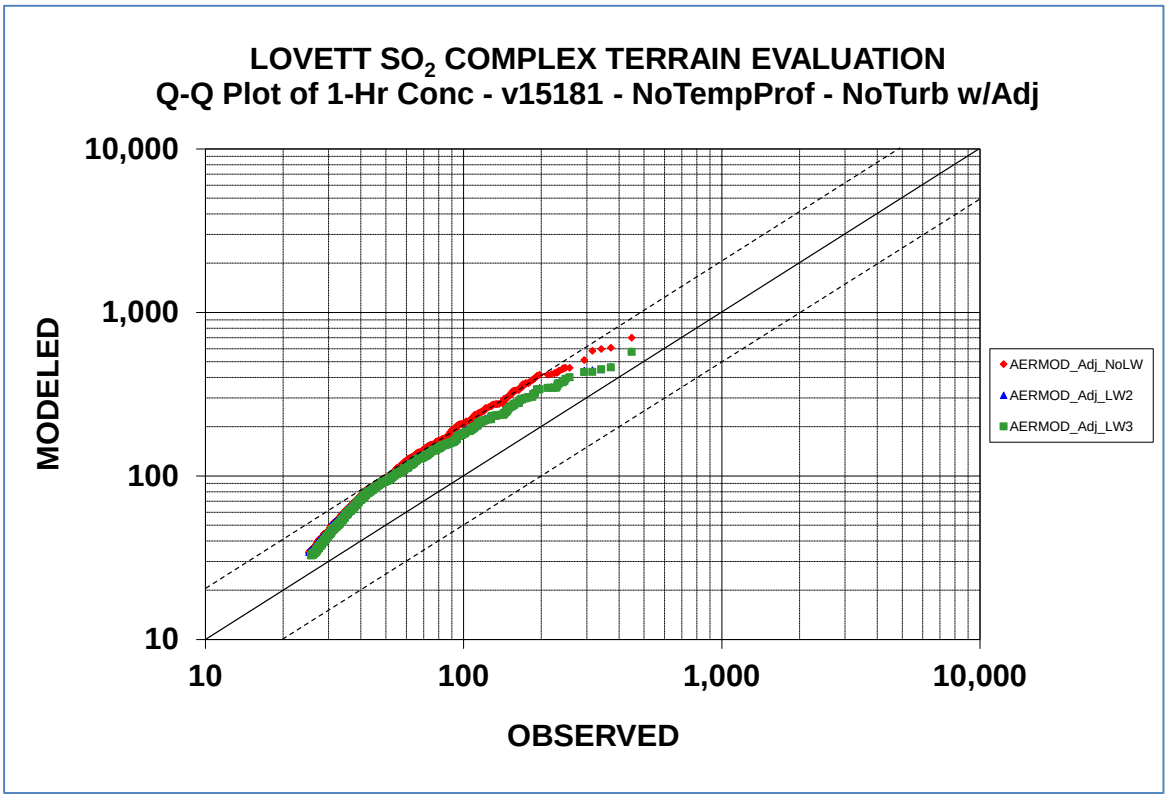

LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc. - v15181 - Full OS Met NoAdj
1,000
100
10
MODELED
10
100
1,000
OBSERVED
AERMOD_NoAdj_NoLW
AERMOD_NoAdj_LW2
AERMOD_NoAdj_LW3


LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc. - v15181 - Full OS Met w/Adj
1,000
100
10
MODELED
10
100
1,000
OBSERVED
AERMOD_Adj_NoLW
AERMOD_Adj_LW2
AERMOD_Adj_LW3


LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc. - v15181 - NoTempProf NoAdj
1,000
100
10
MODELED
10
100
1,000
OBSERVED
AERMOD_NoAdj_NoLW
AERMOD_NoAdj_LW2
AERMOD_NoAdj_LW3


LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc - v15181 - NoTempProf - w/Adj
1,000
100
10
MODELED
10
100
1,000
OBSERVED
AERMOD_Adj_NoLW
AERMOD_Adj_LW2
AERMOD_Adj_LW3


LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc - v15181 - NoTempProf - NoTurb NoAdj
10,000
1,000
100
10
MODELED
10
100
1,000
10,000
OBSERVED
AERMOD_NoAdj_NoLW
AERMOD_NoAdj_LW2
AERMOD_NoAdj_LW3


LOVETT SO2 COMPLEX TERRAIN EVALUATION
Q-Q Plot of 1-Hr Conc - v15181 - NoTempProf - NoTurb w/Adj
10,000
1,000
100
10
MODELED
10
100
1,000
10,000
OBSERVED
AERMOD_Adj_NoLW
AERMOD_Adj_LW2
AERMOD_Adj_LW3

APPENDIX H. Overview of AERMOD revisions

1. The first set of revisions, first introduced with version 03273 of AERMOD, includes dry and wet deposition algorithms for both particulate and gaseous emissions (see Sections 3.2.2.5, 0, and 3.3.3 for more details), and the OPENPIT source option, originally incorporated in the ISCST3 model (EPA, 1995a), for modeling particulate emissions from open pit (below grade) sources, such as surface coal mines and rock quarries;

2. The second set of revisions, first introduced with version 04300 of AERMOD, includes two non-DFAULT options for modeling conversion of NO to NO_2: 1) the Plume Volume Molar Ratio Method (PVMRM) (Hanrahan, 1999a and 1999b); and 2) the Ozone Limiting Method (OLM);

3. The third set of revisions, first introduced with version 06341 of AERMOD, includes the following (additional information is provided in Model Change Bulletin (MCB) #1 provided on the SCRAM AERMOD webpage):
   a. A new "BETA" option on the CO MODELOPT card to allow for new features to be added to AERMOD that are still in BETA-test status;
   b. A BETA option for incorporating NO/NO_2 chemistry for NO_2 increment consumption calculations with PSD credits using the PVMRM option;
   c. BETA options for capped and horizontal stack releases;
   d. An option to specify an initial default in-stack NO_2/NO_x ratio for the PVMRM and OLM options;
   e. New options for varying emissions by month, hour-of-day, and day-of-week (MHRDOW and MHRDOW7);
   f. An option to allow multiple urban areas to be defined in a single model run;
   g. Updated processing to support modeling demonstrations for the National Ambient Air Quality Standards (NAAQS) for PM, including the 24-hour average design value for PM-2.5 impacts; and
   h. Use of dynamic array allocation for AREAPOLY sources to allocate array limits for the maximum number of vertices at model runtime, replacing the previous fixed array limit of 20 vertices.

4. The fourth set of revisions, first introduced with version 09292 of AERMOD, includes the following (additional information is provided in MCB#3 provided on the SCRAM AERMOD webpage):
   a. New options for varying emissions by hour-of-day and day-of-week (HRDOW and HRDOW7);
   b. Modification of the regulatory default option (DFAULT) on the CO MODELOPT card to impose a restriction on the urban roughness length parameter to be 1 meter for regulatory default applications. Any value other than 1 meter for the urban roughness length option on the CO URBANOPT card will be treated as a non-DFAULT option;

c. Removal of the TOXICS option from the MODELOPT keyword. Options formerly associated with the TOXICS option are still considered non-DFAULT options within AERMOD. The area source optimizations formerly associated with the TOXICS option are now selected using the new non-DFAULT FASTAREA option on the MODELOPT keyword;

d. A new non-DFAULT option for optimizing runtime for POINT and VOLUME sources based on an alternative implementation of the horizontal meander algorithm has been incorporated through the FASTALL option on the MODELOPT keyword. The FASTALL option also includes the FASTAREA optimizations if area sources are included in the model inputs;

e. The option for specifying hourly emissions from a separate file through the HOUREMIS keyword has been enhanced to allow the use of hourly varying release heights and initial dispersion coefficients for VOLUME and AREA/AREAPOLY/AREACIRC sources;

f. The OPENPIT source option has been modified to allow for use of the OPENPIT source for gaseous (non-particulate) emissions and with METHOD_2 for particulate emissions;

g. The non-DFAULT option of FLAT terrain can now be specified on a source-by-source basis, allowing both FLAT and ELEV terrain treatments within the same model run (see Section 4.1 of the *AERMOD Implementation Guide* regarding modeling of sources with terrain-following plumes in sloped terrain);

h. A non-DFAULT option for a user-specified dry deposition velocity for gaseous emissions has been added under the GASDEPVD keyword on the CO pathway;

i. A new SUMMFILE option has been included on the OU pathway to output the summary of high ranked values to a separate file;

j. An option to use scientific notation for output result files has been added through the FILEFORM keyword on the OU pathway. The FILEFORM option is applicable to PLOTFILEs, plot-formatted POSTFILEs, MAXIFILEs, RANKFILEs, and SEASONHR files;

k. An option (WARNCHKD) has been added to the MODELOPT keyword to allow issuing of warning messages rather than fatal errors for non-sequential meteorological data files, in order to allow use of multi-year meteorological data files that may contain gaps between years of data under the DFAULT option; and

l. The maximum length of filenames specified in the ‘aermod.inp’ file has been increased to 200 (controlled by the ILEN_FLD parameter in modules.f), and the maximum input string length to 512 (controlled by the ISTRG parameter in modules.f). Double quotes (") are also allowed as field delimiters in the 'aermod.inp' file to support filenames with embedded spaces.

5. The fifth set of revisions, first introduced with version 11059 of AERMOD, includes the following (additional information is provided in MCB#4 provided on the SCRAM AERMOD webpage):

a. Revisions to the processing options available for 24-hour averages of PM2.5 to support implementation of recommendations regarding appropriate modeling procedures for demonstrating compliance the PM2.5 NAAQS;

b. Enhancements to support processing for the 1-hour NO_2 and SO_2 NAAQS, based on the annual distribution of daily maximum 1-hour values, averaged across the number of years processed, including three new output file options, MAXDAILY, MXDYBYYR, and MAXDCONT, and revisions to the RECTABLE keyword to support user-specified ranks up the 999th highest value to support significant contribution analyses;

c. A new option to specify uniform or temporally-varying background concentrations, using the BACKGRND keyword on the SO pathway;

d. A new option to specify temporally-varying background ozone concentrations, using the O3VALUES keyword on the CO pathway;

e. Incorporation of the default equilibrium ratio 0.90 for NO_2/NO_x for the OLM option, which was previously associated only with the PVMRM option (the CO NO2EQUIL option can also be used to specify a non-default equilibrium ratio for the OLM option);

f. Increasing the maximum length for source IDs from 8 to 12 characters;

g. An option to suppress file headers for formatted output files, using the NOHEADER keyword on the OU pathway;

h. A modification to the urban option to address issues with the transition from the nighttime urban boundary layer to the daytime convective boundary layer (a non-DFAULT option has been included to allow users to revert to the original implementation); and

i. Corrections to several bugs related to the PVMRM algorithm and modifications to the DEBUGOPT keyword to allow user to specify only PVMRM or deposition (DEPOS) debug output, without the MODEL debug file, which can be very large.

6. The sixth set of revisions, first introduced with version 11103 of AERMOD, includes the following (additional information is provided in MCB#5 provided on the SCRAM AERMOD webpage):

   a. Correction to a bug that resulted in all short-term values being 0.0 if only the 1st-highest rank was selected for applications involving the special processing for daily maximum values (24hr PM25, 1hr NO2 and 1hr SO2); and

   b. Additional error handling to identify potential problems with the Fortran format specifier for hourly ozone files and hourly background files specified on the CO OZONEFIL and SO BACKGRND keywords, respectively. The hourly ozone and/or background concentrations may have been assigned values of zero (0) in previous versions of AERMOD if the user-specified Fortran format included an integer (I) format to read the concentration values. The requirements for user-specified Fortran formats with these options has been clarified in the appropriate sections below.

7. The seventh set of revisions, first introduced with version 12060 of AERMOD, includes the following (additional information is provided in MCB#7 provided on the SCRAM AERMOD webpage):

   a. Corrections to bugs associated with the MAXDCONT option for determining source contributions for the 1hr NO2, 1hr SO2 and 24hr PM25 NAAQS based on a distribution of daily maximum values for applications including a day-of-week component on the EMISFACT, O3VALUES, or BACKGRND keywords, and for applications using an

hourly emission file (SO HOUREMIS keyword) for at least one source, but not all sources, in a particular run;

b. Corrected a bug for applications with the OLM and PVMRM options under the EVENT processing mode when only the CO OZONEVAL keyword is used to specify a background ozone value, without an hourly ozone file through the CO OZONEFIL keyword or varying ozone values through the CO O3VALUES keyword;

c. Replaced subroutine LTOPG for determining PG stability class based on Monin-Obukhov length and surface roughness used in the FASTAREA option with code from the CTDMPLUS model that more closely matches the Golder (1972) figure;

d. Incorporated an option for users to indicate that all sources in a particular model run are to be treated as URBAN sources, by specifying 'ALL' on the SO URBANSRC keyword. The URBANSRC ALL option is only applicable for applications that include a single urban area;

e. Included a new option for users to specify the number of years of meteorological data being processed for multi-year applications of the MAXDCONT option, using the new NUMYEARS keyword on the ME pathway. This allows users with less than 5 years of site-specific met data to specify the number of years being processed in order to minimize memory storage requirements. Consistent with previous versions, the default number of years absent the NUMYEARS option is five (5); and

f. Includes checks of the range of ranks specified on the OU RECTABLE keyword when the THRESH option on the MAXDCONT keyword is being used, since the analysis of contributions for MAXDCONT is limited to the range of ranks specified on the RECTABLE keyword. A fatal error message will be generated if the range of ranks specified is less than or equal to the design value rank for the specified pollutant plus 4, i.e., a fatal error will be generated if the range of ranks is less than or equal to 8 for 1-hr SO2, or less than or equal to 12 for 1-hr NO2 or 24-hr PM2.5. A non-fatal warning message is also generated if the range of ranks is less than or equal to the design value rank plus 20, i.e., if the range of ranks is less than or equal to 24 for 1-hr SO2, or less than or equal to 28 for 1-hr NO2 or 24-hr PM2.5.

8. The eighth set of revisions, first introduced with version 12345 of AERMOD, includes the following (additional information is provided in MCB#8 provided on the SCRAM AERMOD webpage):

a. Adjustments to wind speeds based on the assumption that input wind speeds are vector (or resultant) mean winds (see Eq. 112 on page 79 of the AERMOD Model Formulation Document (EPA, 2004a)) have been removed. This is considered a formulation bug fix since current EPA guidance for site-specific meteorological monitoring (EPA, 2000) recommends that scalar mean wind speeds be used in steady-state Gaussian dispersion models. Furthermore, all wind speeds derived from NWS or FAA airport data represent scalar mean wind speeds. An option has also been included on the MODELOPT keyword on the CO pathway (VECTORWS) that allows users to specify that input wind speeds are vector means, in which case the previous adjustments will be included. The new VECTORWS option is not linked with the DFAULT option, but users should be able to confirm that input speeds are vector means in order to justify use of the option. However, scalar mean wind speeds, if available, should be used based on the current guidance.

b. Modifications to check for large negative hourly emissions (< -90), which may be used as missing indicators. Since AERMOD allows inputs of negative emissions for use in emission credit calculations, negative values used as missing indicators in the HOUREMIS file result in negative hourly concentrations in the previous versions. Warning messages are generated and the emission rate is set to zero (0) for these cases.

c. Two new BETA (non-Default) options have been included to address concerns regarding model performance under low wind speed conditions. The LOWWIND1 option increases the minimum value of sigma-v from 0.2 to 0.5 m/s and "turns off" the horizontal meander component. The LOWWIND2 option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, and incorporates the meander component, with some adjustments to the algorithm, including an upper limit on the meander factor (FRAN) of 0.95. A new LOW_WIND keyword has been added to the CO pathway that allows users to adjust the minimum sigma-v value (within a range of 0.01 to 1.0 m/s), and the minimum wind speed value (within a range from 0.01 to 1.0 m/s), with a default value of 0.2828 m/s, consistent with the default applied in previous versions based on SQRT(2*SVmin*SVmin) with SVmin=0.2. The new LOW_WIND keyword also allows users to adjust the maximum value for the meander factor (FRAN) within a range of 0.50 to 1.0, inclusive, when the LOWWIND2 option is used. These new LowWind BETA options can also be used in conjunction with the new option in AERMET (v12345) to adjust the surface friction velocity (U*) under low-wind/stable conditions (ADJ_U*), based on Qian and Venkatram (2011). More details regarding these LowWind BETA options is provided in Section 3.2.3.

d. A new LINE source type has been included that allows users to specify line-type sources based on a start-point and end-point of the line and the width of the line, as an alternative to the current AREA source type for rectangular sources. The LINE source type utilizes the same routines as the AREA source type, and will give identical results for equivalent source inputs. The LINE source type also includes an optional initial sigma-z parameter to account for initial dilution of the emissions. As with the AREA source type, the LINE source type does not include the horizontal meander component in AERMOD.

e. Additional range checks on hourly stack exit velocities and exit temperatures input through the SO HOUREMIS option. A fatal error is generated if the hourly exit temperature is less than 200K (about -100F), unless the hourly emissions are zero (0) for that hour. This may indicate that incorrect units for exit temperature have been used, or that the order of exit temperature and exit velocity may have been reversed in the HOUREMIS file. Also added a new warning message for exit velocities larger than 250 m/s. Comparable changes were incorporated in subroutine PPARM for inputs on the SRCPARAM keyword.

f. Modified the acceptable AERMET version date from 06341 to 11059. AERMOD will no longer run with met data based on version 06341 of AERMET. AERMOD will run using met data based on version 11059. However, a warning message will be generated, and users are strongly encouraged to update their meteorological data to version 12345 of AERMET due to the scope of changes included in that update.

9. The ninth set of revisions, first introduced with version 13350 of AERMOD, includes the following (additional information is provided in MCB#9 provided on the SCRAM AERMOD webpage):

a. Incorporated new options for modeling NO2, including a Default Ambient Ratio Method (ARM) option and non-Default BETA Ambient Ratio Method - 2 (ARM2);

b. Incorporated options to vary background ozone (O3) data by wind sector (new CO O3SECTOR keyword) for use with the OLM and PVMRM options, and options to vary background concentrations for the pollutant being modeled by wind sector (new SO BGSECTOR keyword). Any of the existing options for specifying background data can be used with the new sector-varying options, and will continue to work as before if no sectors are defined. The applicable sector is determined by the flow vector (downwind) based on the wind direction in the surface meteorological data file;

c. Added new "debug" output file options for the OLM option and for the new ARM and ARM2 options for NO2. Also added a new PRIME debug option to separate the debug information associated with the PRIME downwash algorithm from the non-PRIME related information provided under the MODEL debug option. Also removed all debug information from the main 'aermod.out' file.

10. The ninth set of revisions, first introduced with version 14134 of AERMOD, includes the following (additional information is provided in MCB#10 provided on the SCRAM AERMOD webpage):

a. Modified subroutine POLLID to allow for an additional user-specified field to disable the special processing associated with the 1-hr NO2, 1-hr SO2 and 24-hr PM2.5 NAAQS, which are based on a multi-year average of ranked maximum daily values (1-hr values in the case of NO2 and SO2 and 24-hr values in the case of PM2.5). The optional field allowed after the pollutant ID can be ‘H1H’, ‘H2H’, or ‘INC’ (without the single quotes), indicating that the results will be processed consistent with a deterministic standard, such as the original 3-hr and 24-hr SO2 standards, which could be exceeded once per year, and consistent with PSD increments, which can also be exceeded once per year. These options are intended to provide a mechanism for modeling to demonstrate compliance with the 24-hr PM2.5 increments, and also to provide a mechanism to evaluate the various NO2 chemistry options incorporated in AERMOD without the requirement for modeling complete years of meteorological data.

b. Modified subroutine DEBOPT to include a new AREA/LINE debug option, which is output to a separate file, including an optional user-specified file name. This includes additional information regarding AREA/LINE (and OPENPIT) calculations as compared to the AREA-related debug information included under the previous DEBUG option. Also modified subroutines ACALC and PSIDE to output AREA/LINE debug information under the new AREA/LINE debug option. Debug information is no longer included in the main ‘aermod.out’ file.

c. Modified subroutine MEOPEN to check for flags in the header record of the input SURFFILE indicating that MMIF-generated meteorological inputs were used, which is currently treated as non-DFAULT/BETA option, and for use of BULKRN option, which is treated as a DFAULT option. Subroutine MEOPEN also checks for measurement heights in the input PROFFILE file and issues a warning if heights exceed 999m, which could indicate that inputs were based on MMIF or other gridded meteorological data that were processed in a manner that did not include identifying information in the surface file header record (e.g., processing MMIF-generated pseudo- surface and upper air data with user-defined surface characteristics rather than the AERSURF file generate by MMIF. Subroutine MEOPEN was also modified to include checks for blank/missing

upper air, surface and/or onsite station IDs in the surface file header record, and issues warning messages if the respective station IDs specified on the ME pathway in the aermod input file are not zero (0).

d. Modified subroutine PRTSRC to include a table of SrcIDs for sources identified as urban sources under the URBANSRC keyword.

e. Modified subroutine PRTDET to include the original GrpVal concentration from the Non-EVENT run in the header information for the DETAIL output option under EVENT processing.

f. Modified subroutine PRTOPT to include additional information on the initial input summary page of the 'aermod.out' file related to the use of NO2 options, and to identify which debug options have been selected on the CO DEBUGOPT keyword.

g. The "acceptable" AERMET version date has been modified to version 12345, and AERMOD will not run if meteorological data generated by earlier versions of AERMET are input. AERMOD will run if meteorological data from versions 12345 or later are used, but a warning message will be issued if meteorological data from other than the current version of AERMET are used.

11. The tenth set of revisions, first introduced with version 15181 of AERMOD, includes the following (additional information is provided in MCB#11 provided on the SCRAM AERMOD webpage):

a. Included a new Plume Volume Molar Ration Method 2 non-DFAULT/BETA option that uses total dispersion coefficients instead of relative dispersion coefficients for stable conditions and relative dispersion coefficients for unstable conditions. The new PVMRM2 option incorporates additional modifications relative to the PVMRM option, including the use of downwind distance instead of radial distance from source to receptor to calculate the plume volume and moles of NOx. See the modified Model Formulation Document Addendum for additional details.

b. Incorporated a new LOWWIND3 BETA option to address concerns regarding model performance under low wind speed conditions. The LOWWIND3 option increases the minimum value of sigma-v from 0.2 to 0.3 m/s, consistent with the LowWind2 option, but eliminates upwind dispersion, consistent with the LowWind1 option. The LowWind3 option uses an "effective" sigma-y value that replicates the centerline concentration accounting for meander, but sets concentrations to zero (0) for receptors that are more than 6*sigma-y off the plume centerline, similar to the FASTALL option.

c. Included a source type option, BUOYLINE, to model buoyant line sources based on the BLP model.

12. The eleventh set of revisions, first introduced with 16126 of AERMOD, include the following (additional information is provided in MCB #12 provided on the SCRAM AERMOD webpage):

a. Replaced PVMRM option with the PVMRM2 option, retaining PVMRM as the option name and removing PVMRM2 as a valid option name. Refer to the Model Formulation Document for more details about the implementation of PVMRM in AERMOD.

b. Removed the requirement for specifying the BETA option on the CO pathway for applications of the ARM2 Tier 1 screening option for NO_X-to-NO_2 conversion, PVMRM and OLM Tier 2 screening options for NO_X-to-NO_2 conversion, and the POINTCAP and

POINTHOR source types used to characterize capped and horizontal point sources, respectively.

c. Removed the requirement for specifying the BETA option on the CO pathway when the ADJ_U* option is applied in AERMET and turbulence measurements (Sigma-Theta and/or Sigma-W) are not included in the processing of site-specific meteorological data. Note that the BETA option in AERMOD must still be specified when turbulence measurements are processed with site-specific data that includes turbulence in AERMET.

d. Updated subroutines related to the buoyant line source type (BUOYLINE) introduced in version 15181 of AERMOD. Modifications to BUOYLINE include:

    i. Added a receptor exclusion zone in which receptors within the maximum extents of a buoyant line source are omitted from calculations;

    ii. Modified SRCGROUP keyword so than an individual line in a buoyant line source can be included in a SRCGROUP;

    iii. Modified processing hourly emissions file for buoyant lines so that the hourly emissions fle requires a buoyancy flux parameter for each line of a buoyant line source; and

    iv. Added buoyant line sources to EVENT processing capabilities on the EV pathway.

Glossary

AERMAP -- AMS/EPA Regulatory Model (AERMOD) Terrain Preprocessor.
AERMET -- AMS/EPA Regulatory Model (AERMOD) Meteorological Preprocessor. AERMOD -- AMS/EPA Regulatory Model.
ASCII -- American Standard Code for Information Interchange, a standard set of codes used by computers and communication devices. Sometimes used to refer to files containing only such standard codes, without any application-specific codes such as might be present in a document file from a word processor program.

CD-144 Format -- Card Deck-144 data format available from NCDC for National Weather Service surface observations commonly used for dispersion models. Each record represents an 80-column "card image".

CO -- **CO**ntrol, the 2-character pathway ID for input runstream images used to specify overall job control options.

CO Pathway -- Collective term for the group of input runstream images used to specify the overall job control options, including titles, dispersion options, terrain options, etc.

Directory -- A logical subdivision of a disk used to organize files stored on a disk.

Dispersion Model -- A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

DOS -- Disk Operating System. Software that manages applications software and provides an interface between applications and the system hardware components, such as the disk drive, terminal, and keyboard.

Echo of inputs -- By default, the AERMOD model will echo the input runstream images, character by character, into the main printed output file. This serves as a record of the inputs as originally entered by the user, without any rounding of the numerical values. The echoing can be suppressed with the NO ECHO option.

EOF -- End-of-File.

EPA -- U. S. Environmental Protection Agency.

Error message -- A message written by the model to the error/message file whenever an error is encountered that will inhibit data processing.

Error/Message File -- A file used for storage of messages written by the model.

EV -- **EV**ent, the 2-character pathway ID for input runstream images used to specify event inputs for the Short Term EVENT model.

EV Pathway -- Collective term for the group of input runstream images used to specify the event periods and location for the Short Term EVENT model.

EVENT Processing -- An option in the AERMOD model specifically designed to provide source contribution (culpability) information for specific events of interest, e.g., design values or threshold violations.

Extended Memory -- Additional memory on 80386 and 80486 PCs that allows programs to address memory beyond the 640 KB limit of DOS. Special software is required to utilize this extra memory.

Fatal Error -- Any error which inhibits further processing of data by the model. Model continues to read input images to check for errors during setup, and will continue to read input meteorological data during calculation phase.

Flow Vector -- The direction towards which the wind is blowing. GMT -- Greenwich Mean Time, the time at the 0° meridian.

Informational Message -- Any message written to the error/message file that may be of interest to the user, but which have no direct bearing on the validity of the results, and do not affect processing.

Input Image -- User supplied input, read through the default input device, controlling the model options and data input. A single card or record from the input runstream file. Each input image consists of a pathway ID (may be blank indicating a continuation of the previous pathway), a keyword (may also be blank for continuation of a keyword), and possibly one or more parameter fields.

Input Runstream File -- The basic input file to the AERMOD model controlling the modeling options, source data, receptor locations, meteorological data file specifications, and output options. Consists of a series of input images grouped into functional pathways.

Julian Day -- The number of the day in the year, i.e., Julian Day = 1 for January 1 and 365 (or 366 for leap years) for December 31.

KB -- Kilobyte, 1000 bytes, a unit of storage on a disk

Keyword -- The 8-character codes that follow immediately after the pathway ID in the input run stream data.

LST -- Local Standard Time.

Math Co-processor -- A computer chip used to speed up floating point arithmetic in a personal computer.

MB -- Megabyte, one million bytes, a unit of storage on a disk

ME -- **ME**teorology, the 2-character pathway ID for input runstream images used to specify meteorological data options

ME Pathway -- Collective term for the group of input runstream images used to specify the input meteorological data file and other meteorological variables, including the period to process from the meteorological file for the AERMOD model.

Meteorological Data File -- Any file containing meteorological data, whether it be mixing heights, surface observations or on-site data.

Missing Value -- Alphanumeric character(s) that represent breaks in the temporal or spatial record of an atmospheric variable.

Mixing Height -- The depth through which atmospheric pollutants are typically mixed by dispersive processes.

NCDC -- National Climatic Data Center, the federal agency responsible for distribution of the National Weather Service upper air, mixing height and surface observation data.

NO ECHO -- Option to suppress echoing of the runstream input images to the main printed output file.

NWS -- National Weather Service.

On-site Data -- Data collected from a meteorological measurement program operated in the vicinity of the site to be modeled in the dispersion analysis.

OU -- **OU**tput, the 2-character pathway ID for input runstream images used to specify output options.

OU Pathway -- Collective term for the group of input runstream images used to specify the output options for a particular run.

Overlay -- One or more subprograms that reside on disk and are loaded into memory only

when needed.

Pasquill Stability Categories -- A classification of the dispersive capacity of the atmosphere, originally defined using surface wind speed, solar insolation (daytime) and cloudiness (nighttime). They have since been reinterpreted using various other meteorological variables.

Pathway -- One of the six major functional divisions in the input runstream file for the AERMOD model. These are **CO**ntrol, **SO**urce, **RE**ceptor, **ME**teorology, **EV**ent, and **OU**tput (see these entries in this section for a description).

PC -- Personal Computer, a wide ranging class of computers designed for personal use, typically small enough to fit on a desktop.

Quality Assessment -- Judgment of the quality of the data.

Quality Assessment Check -- Determining if the reported value of a variable is reasonable (see also Range Check).

Quality Assessment Message -- Message written to the error/message file when a data value is determined to be suspect.

Quality Assessment Violation -- Occurrences when data values are determined to be suspect (see also Range Check Violation).

RAM -- Random Access Memory on a personal computer.

RAMMET -- Meteorological processor program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 format) and hourly surface weather observations (CD-144 format) for use in dispersion models such as AERMOD, CRSTER, MPTER and RAM.

Range Check -- Determining if a variable falls within predefined upper and lower bounds.

Range Check Violation -- Determination that the value of a variable is outside range defined by upper and lower bound values (see also Quality Assessment Violation).

RE -- **RE**ceptor, the 2-character pathway ID for input runstream images used to specify receptor locations.

RE Pathway -- Collective term for the group of input runstream images used to specify the receptor locations for a particular run.

Regulatory Applications -- Dispersion modeling involving regulatory decision-making as described in the Guideline on Air Quality Models, which is published as Appendix W of 40 CFR Part 51 (as revised).

Regulatory Model -- A dispersion model that has been approved for use by the regulatory offices of the EPA, specifically one that is included in APPENDIX A of the Guideline on Air Quality Models, (as revised), such as the AERMOD model.

Runstream File -- Collectively, all input images required to process input options and input data for the AERMOD model.

SCRAM -- Support Center for Regulatory Air Models - part of EPA's website on the internet, used by EPA for disseminating air quality dispersion models, modeling guidance, and related information.

Secondary Keyword -- A descriptive alphabetical keyword used as a parameter for one of the main runstream keywords to specify a particular option.

SO -- **SO**urce, the 2-character pathway ID for input runstream images used to specify input source parameters and source groups.

SO Pathway -- Collective term for the group of input runstream images used to specify the source input parameters and source group information.

Station Identification -- An integer or character string used to uniquely identify a station or site as provided in the upper air (TD-5600 and TD-6201), mixing height (TD-9689), and surface weather (CD-144 and TD-3280) data formats available from NCDC. There are no standard station numbers for on-site data or card image/screening data, and the user may include any integer string

Subdirectory -- A directory below the root, or highest level, directory or another subdirectory, used for organization of files on a storage medium such as a PC hard disk.

Surface Weather Observations -- A collection of atmospheric data on the state of the atmosphere as observed from the earth's surface. In the U.S. the National Weather Service collect these data on a regular basis at selected locations.

Surface Roughness Length -- Height at which the wind speed extrapolated from a near-surface wind speed profile becomes zero.

Syntax -- The order, structure and arrangement of the inputs that make of the input runstream file, specifically, the rules governing the placement of the various input elements including pathway IDs, keywords, and parameters.

TD-1440 Format -- A format available from NCDC for summarizing NWS surface observations in an 80-column format; the CD-144 format is a subset of this format. This format has been superseded by the TD-3280 format.

TD-3280 Format -- The current format available from NCDC for summarizing NWS surface weather observations in an elemental structure, i.e., observations of a single atmospheric variable are grouped together for a designated period of time.

TD-5600 Format -- A format available from NCDC for reporting NWS upper air sounding data. This format has been superseded by the TD-6201 format.

TD-6201 Format -- The current format available from NCDC for reporting NWS upper air data. The file structure is essentially the same as the TD-5600 format except that there is more quality assurance information.

TD-9689 Format -- The format available from NCDC for mixing heights estimated from morning upper air temperature and pressure data and hourly surface observations of temperature.

Unformatted File -- A file written without the use of a FORTRAN FORMAT statement, sometimes referred to as a binary file.

Upper Air Data (or soundings) -- Meteorological data obtained from balloon- borne instrumentation that provides information on pressure, temperature, humidity, and wind away from the surface of the earth.

Vertical Potential Temperature Gradient -- The change of potential temperature with height, used in modeling the plume rise through a stable layer, and indicates the strength of the stable temperature inversion. A positive value means that potential temperature increases with height above ground and indicates a stable atmosphere.

Warning Message -- A message written by the model to the error/message file whenever a problem arises that <u>may</u> reflect an erroneous condition, but does not inhibit further processing.

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