<u>Attachment 5</u>

Model Change Bulletin #4,
 AERMOD 11059

 and

Model Change Bulletin #8,
AERMOD 12345

aermod_mcb4

Model Change Bulletin

MCB#4   02/28/2011

AERMOD (dated 11059)

This Model Change Bulletin (MCB) documents changes made to the AERMOD Dispersion Model. A brief description of the changes is provided below. Additional details are available in the Fortran source code. Changes to the user instructions associated with this update are documented in an updated AERMOD User's Guide Addendum.

This revised version of AERMOD (dated 11059) includes the following modifications relative to the previous version (dated 09292):

-- Bug Fixes:

1. Modified subroutines PVMRM_CALC, MAJOR_CONT, and MOLES_NOX to include calls to subroutine SETSRC for all source types, and modified subroutine SETSRC to initialize arrays for area source dimensions and initial sigmas to correct initialization problems with the PVMRM option. Also modified subroutine RELDISP to more appropriately account for initial sigmas for volume and area sources in the calculation of relative dispersion coefficients for determining plume volume.

2. Modified subroutines PVMRM_CALC and MOLES_NOX to include calls to subroutine EMFACT to apply emission factors, if appropriate, in order to use the EMISFACT-adjusted emission rates in the calculations of the moles of NOx. Previous versions used the emission rate specified on the SRCPARAM keyword to calculate the models of NOx.

NOTE: These bugs related to the PVMRM option could have significant impacts on modeled concentrations using the PVMRM option with the EMISFACT option and/or with mixed source types. The magnitude and bias of the differences associated with these bugs will depend on the specifics of the application, but there may be a tendency to overestimate NO2 concentrations for POINT sources due to the first item when the application also included VOLUME sources with large initial sigma values.

3. Modified subroutine HRLOOP to skip call to CHK_ENDYR to determine whether the end of the year has been reached if the NOCHKD or WARNCHKD options are specified, since the end-of-year processing is only applicable to sequential meteorological data. Since the NOCHKD option is invoked if the SCREEN option is specified, the call to CHK_ENDYR will also be skipped for screening met data with AERSCREEN.

4. Modified subroutine CHKDAT to correct problems with date sequence checks involving gaps of complete days or complete years. A gap of complete calendar years is allowed even without the NOCHKD or WARNCHKD options to account for missing years due to data completeness

issues for applications involving design values that
are based on multi-year averages (e.g., 1hr NO2/SO2
and 24hr PM2.5).

5. Modified subroutine TERRST to correct problems with
   determining the number of calm and/or missing hours
   only for the data period that is processed.

6. Modified subroutine EVLINI to include initializations
   for SZMAX(:) and HSBLMX(:) arrays used for EVALFILES.

7. Corrected subroutines OUMXFL, OUPOST, OUPLOT, PERPST,
   PERPLT, OUTOXX, OUSEAS, OURANK, and OUEVAL to set lower
   limit for acceptable user-specified file units to 31,
   in order to avoid potential conflicts with hardcoded
   file units. Previous version incorrectly used '.LT. 30'
   rather than '.LE. 30' for checks on user-specified file
   units, allowing for potential file units conflicts with
   the debug file for particle deposition velocities.

-- Enhancements:

1. A number of enhancements have been incorporated to more
   fully support the form of the new 1-hour NO2 and SO2
   NAAQS, as well as the 24-hour PM2.5 standard. The
   form of these standards are similar in that they are
   based on a ranked percentile value averaged over the
   number of years processed. To more fully support
   implementation of recent guidance on these NAAQS,
   the RECTABLE keyword has 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). Note that the range of ranks specified
   on the RECTABLE keyword (not the individual ranks) also
   determines the range of ranks that may be considered
   with the new MAXDCONT option, described below.

2. Added new MAXDAILY option on the OU pathway to output a
   summary of daily maximum 1-hour values for each day
   processed. These files provide an interim output product
   that may be used to analyze new 1-hour NO2 and SO2 NAAQS
   based on a specified percentile rank of daily maximum
   1-hour values.

3. Added new MXDYBYYR option on the OU pathway to output a
   summary of daily maximum 1-hour values by year and rank.
   These files provide an interim output product that may
   be used to analyze the new 1-hour NO2 and SO2 NAAQS based
   on a specified percentile rank of daily maximum 1-hour
   values.

4. Added new MAXDCONT option on the OU pathway to output a
   summary of source group contributions to high ranked values
   for a target group, averaged across the number of years
   processed and paired in time and space. The new MAXDCONT
   option is applicable to daily maximum values for the 24-hour
   PM2.5 NAAQS and the new 1-hour NO2 and SO2 standards, and
   can be used to determine whether a source or a group of
   sources contributes significantly to modeled violations of

the NAAQS, paired in time and space.

5. For applications addressing the 24-hour PM2.5 standard
    or the 1-hour NO2 and SO2 standards, which are based on
    ranked values averaged across the number of years modeled,
    the PLOTFILE option has been enhanced to include values
    for each of the years processed based on the specified
    rank, in addition to the multi-year average.

6. Added new BACKGRND option on the SO pathway to allow
    users to specify background concentrations, which can
    be added to impacts from modeled emission sources to
    determine cumulative impacts. Background concentrations
    can be varied temporally using options similar to the
    EMISFACT keyword for temporally-varying source emissions.
    The new BACKGRND keyword also allows an option to use
    a separate file of background concentrations on an hourly
    basis. Applications with hourly background concentrations
    can also include temporally-varying background values
    based on the EMISFACT options, such as SEASHR for season
    by hour-of-day, which are used to substitute for missing
    hourly values.

7. For applications using the OLM or PVMRM options for NO2,
    a new option for specifying background ozone concentrations
    has been incorporated. Similar to the new BACKGRND keyword,
    the new O3VALUES keyword on the CO pathway allows the user
    to specify temporally-varying background O3 concentrations
    using many of the same options available on the EMISFACT
    keyword for source emission factors. The O3VALUES keyword
    can be used by itself or in conjunction with an hourly
    ozone file. In the latter case, the O3VALUES are used to
    fill in for missing values in the hourly ozone file.
    A separate OZONUNIT keyword is also available on the CO
    pathway to specify units for the concentrations input
    through the O3VALUES keyword.

8. Incorporated the equilibrium NO2/NOx ratio component of the
    PVMRM option into the OLM option for estimating conversion
    from NOx emissions to ambient NO2 concentrations. The same
    NO2EQUIL keyword on the CO pathway can be used to specify
    the equilibrium ratio for either option, and a default
    ratio of 0.90 is assumed for both options if the NO2EQUIL
    option is omitted.

9. Modified subroutine DEBOPT to allow user to specify
    debug output only for PVMRM or deposition options
    on the DEBUGOPT keyword, avoiding large output files
    under the MODEL debug option. Debug output for deposition
    options will still be generated if the MODEL debug option
    is selected. See AERMOD User's Guide Addendum for details
    on the DEBUGOPT keyword. Also assigned file unit 9 to
    variable PVMDBG for the PVMRM debug file, and adjusted
    the PVMRM debug output to report total PercentNO2,
    including in-stack NO2/NOx contribution.

10. A modification to the urban option has been implemented
    to address issues with the transition from the nighttime
    urban boundary layer to the daytime convective boundary
    layer. Under the new default urban option, the model will
    continue to apply the urban boundary layer approach for
    urban sources until the daytime convective boundary layer
    exceeds the population-dependent urban boundary layer

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height. This enhancement is desribed in more detail in
Appendix E of the updated AERMOD User's Guide Addendum.
A non-DFAULT option has also been included to allow
users to revert to the original urban implementation.

11. Increased the maximum length of source IDs from 8 to 12
characters, and increased the length of EVENT names from
8 to 10 characters, involving modifications to several
subroutines.

12. Included a new NOHEADER keyword on the OU pathway to allow
users to suppress the file header records for formatted
output files.

-- Miscellaneous:

1. Modified subroutines CHK_ENDYR, PRTPM25, PRTPM25SUM,
OUHIGH, and PRTOPT to allow for user-specified rank for
processing PM2.5 24-hour averages to accommodate current
recommendations for PM2.5 modeling. Also changed the
name of array used to store these values from SUMH8H
to SUMHNH.

2. The table of distances used in calculating the dominant
plume volume for the PVMRM option (in subroutine PLUME_VOL)
was adjusted to use a more logical progression of distance
intervals and to reduce the total number of intervals. This
change may affect results slightly, but will also reduce
model runtime.

3. Subroutine WAKFLG was modified to no longer ignore potential
downwash effects for stack heights that equal or exceed the
EPA formula height. The determination of whether building
downwash effects apply is based on the criterion implemented
within the PRIME downwash algorithm.

4. Modified subroutine URBPOP to adjust the limit for issuing
a warning for urban population out-of-range from 10,000 to
21,206, which corresponds to a population density of
750/sq-km for an area within a 3km radius, consistent with
the Appendix W criterion for urban/rural determination based
on the population density.

5. Several miscellaneous changes to address output formatting
issues, replace DO loops with array assignments for array
initializations, and other minor code cleanup.

6. Moved setup-related subroutines for EVENT processing option
from the 'evcalc.f' source file to the 'evset.f' source file.

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*   IMPORTANT   *
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i.e.: AERMOD (dated 11059). Future changes to this model will be identified
by an updated Julian date found at the beginning of the model source code
and followed by a reference to a SCRAM Model Change Bulletin (MCB#n)
which will explain the nature and content of the changes. All Model Change
Bulletins for this program will always be available for back reference on
this website. In the future, notification of changes (MCBs) to this program

will be made in the Recent Additions section of the SCRAM website.

aermod_mcb8

Model Change Bulletin

MCB#8   12/10/2012

AERMOD (dated 12345)

This Model Change Bulletin (MCB) documents changes made to the AERMOD
Dispersion Model. A brief description of the changes is provided
below. Additional details are available in the Fortran source code.
Changes to the user instructions associated with this update are
documented in an updated AERMOD User's Guide Addendum.

This revised version of AERMOD (dated 12345) includes the following
modifications relative to the previous version (dated 12060):

-- Bug Fixes:

   1. Adjustments to wind speeds based on the assumption that input
       wind speeds are vector (or resultant) mean winds have been
       removed (see Eq. 112 on page 79 of the AERMOD Model Formulation
       Document, EPA-454/R-03-004). This is considered a formulation bug
       fix since current EPA guidance for site-specific meteorological
       monitoring (EPA-454/R-99-005) 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.
       This change affected several subroutines.

   2. Modified subroutine HRLOOP to correct a problem associated
       with missing hourly ozone data during MAXDCONT post-processing
       when no O3 values have been specified for substitution through
       the OZONEVAL or O3VALUES keywords on the CO pathway. The
       MAXDCONT results in those cases were invalid and may have
       shown up as negative concentrations.

   3. Modified subroutines DAYRNG, METEXT, and SET_DATES to correct a
       bug associated with use of the DAYRANGE keyword for multiple years
       of meteorological data, where the YR/MN/DY conversion to Julian
       may be incorrect. Also included checks of the year specified on
       the SURFDATA keyword with the first year included in the surface
       meteorological data file. The ISYEAR variable is now adjusted to
       match the first year of the data file, unless the DAYRANGE keyword
       is being used. In that case, a fatal error is generated since the
       ISYEAR variable is used to determine leap vs. non-leap years for
       the YR/MN/DY conversion to Julian day for the DAYRANGE option.

   4. Modified subroutine HRQREAD 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

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generated and the emission rate is set to zero (0) for these cases.

5. Modified subroutine EVALFL to address a potential problem
    with URBAN applications where the L_MorningTrans logical
    variable was not defined.

6. Modified MAIN program and subroutine PRESET to check for
    duplicate STARTING keywords on the SO or RE pathways, since
    that would reset the array limits for setup arrays to zero
    during the PRESET phase, resulting in array subscript
    out-of-bounds runtime errors.

-- Enhancements:

1. Incorporated two new BETA (non-Default) options 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. Both of the new
    LowWind BETA options also modify the the adjustment of vector
    mean wind speeds (based on Eq. 112, p. 79, of the AERMOD Model
    Formulation Document) to use the original values of sigma-
    v before they are adjusted based on SVmin. The new LOWWIND1
    and LOWWIND2 options are mutually exclusive and the model will
    issue a fatal warning message if both options are specified.

    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, W., and A. Venkatram, 2011: "Performance of Steady-
    State Dispersion Models Under Low Wind-Speed Conditions", Boundary-
    Layer Meteorology, 138, 475-491. The ADJ_U* option in AERMET is
    also considered a non-Default option, and users must also specify
    the BETA option on the MODELOPT keyword in AERMOD in order to
    process meteorological inputs derived using the new ADJ_U* option.
    See the AERMET Model Change Bulletin (MCB) #3 and AERMET User's
    Guide Addendum for additional details regarding the ADJ_U* option
    in AERMET.

    The new LowWind BETA options in AERMOD and the new ADJ_U*
    option in AERMET 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.

2. 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. This change affected several subroutines
and also includes a new LPARM subroutine.

-- Miscellaneous:

1. Modified subroutine HRQEXT to include additional range checks
    on hourly stack exit velocities and exit temperatures input
    through the HOUREMIS option. A fatal error is generated if
    the hourly exit temperature is less than 200K (about -100F)
    and the exit velocity is greater than 200m/s, 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 also in subroutine PPARM for inputs on the
    SRCPARAM keyword.

2. Modified subroutine MEOPEN to adjust 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.


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