AERMOD Modeling System: Status and Updates

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Outline

- Recent* AERMOD modeling system developments
  - AERMOD dispersion model
  - AERMET meteorological preprocessor
  - AERMAP terrain preprocessor
- Future plans and priorities

* Since the 9th Modeling Conference

AERMOD Developments

- Two "major" updates to AERMOD model since 9th Modeling Conference, dated 09292 (MCB#3) and dated 11059 (MCB#4):
  - Version 09292 (10/19/2009) included:
    - Numerous bug fixes, enhancements and miscellaneous code cleanup, including OLMGROUP bug fix, explicit use of double precision for most computations, and clarifications of logic related to deposition options
  - Version 11059 (02/28/2011) included:
    - Important bug fixes related to PVMRM option for NO2 conversion, numerous enhancements to more fully support form of the 1-hr NO_2 and SO_2 NAAQS and 24-hr PM2.5 NAAQS, enhancements to allow inclusion of background concentrations in cumulative modeled concentrations

AERMOD Developments (cont.)

- Version 11059 (cont.):
  - "Miscellaneous" change to no longer ignore potential building downwash effects for stack heights that equal or exceed EPA formula height
    - Determination of whether building downwash effects apply is now based on the criterion implemented within the PRIME downwash algorithm;
    - This modification is the subject of a pending Clarification Memorandum
  - Addressed "formulation bug" for transition from nighttime urban boundary (with enhanced dispersion) to daytime convective boundary (with no memory of enhanced dispersion)
    - May result in spuriously high concentrations for first convective hour for low-level plumes, while underestimating concentrations for elevated plumes;
    - Could significantly affect 1-hr NO_2 and SO_2 NAAQS modeling given the form of the standards (annual distribution of daily maximum 1-hr values);
    - Appendix E of AERMOD User's Guide Addendum includes summary of the effect on model performance for Indianapolis SF_6 urban field study data and Atlanta NO_2 Risk and Exposure Assessment model-to-monitor comparisons

Evaluation of AERMOD Urban Transition "Bug" Fix Indianapolis SF$_6$ Data – Elevated Source


Indianapolis SF6 Eval - Morning Transition Hour 85092908

Indianapolis SF6 Eval - Morning Transition Hour 85100409
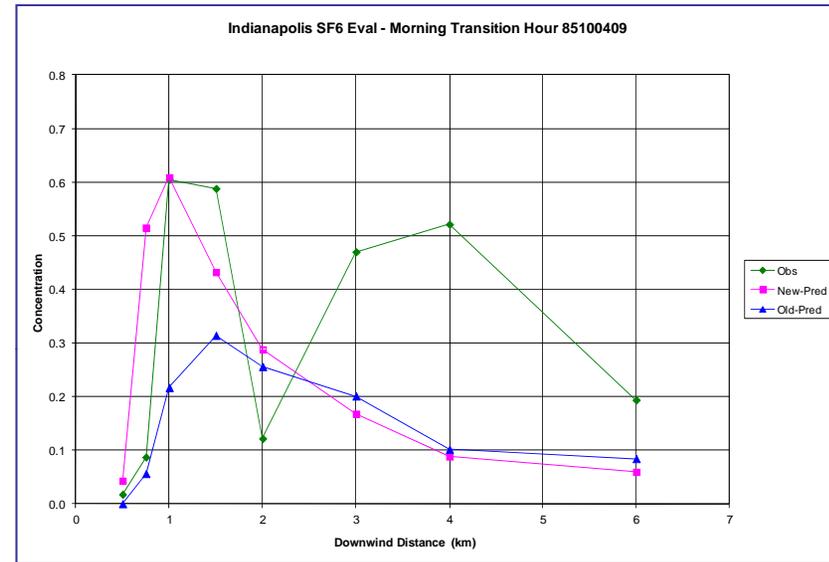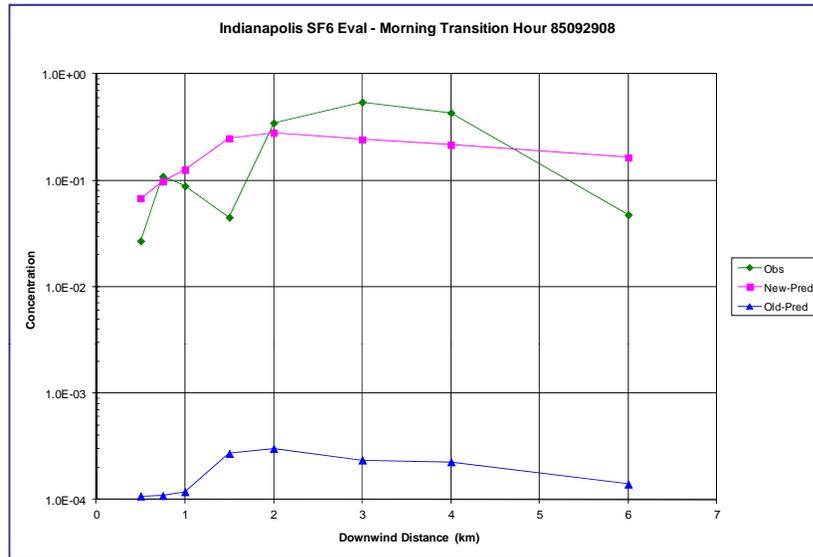
Top figures show arc-max concentrations vs. distance for 1st convective hour on two days, indicating underpredictions by old version and much better agreement for new version.

Bottom figure shows 1-hr Q-Q plot for convective conditions, showing somewhat better agreement with new version.

INDIANAPOLIS SF6 1-HR Q-Q CBL (CONC) - Convective Conditions

3/13/2012

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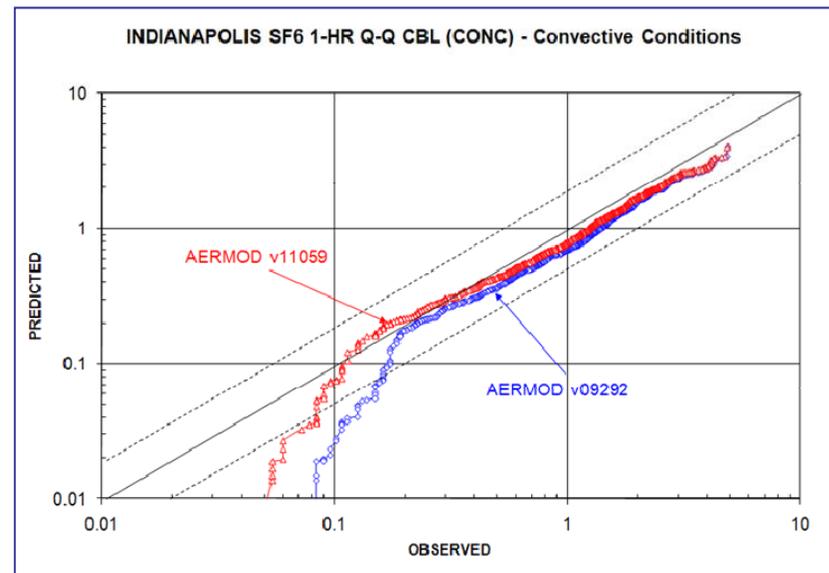
Evaluation of AERMOD Urban Transition "Bug" Fix Atlanta 1-hr NO_2 REA Data – Low-level Sources
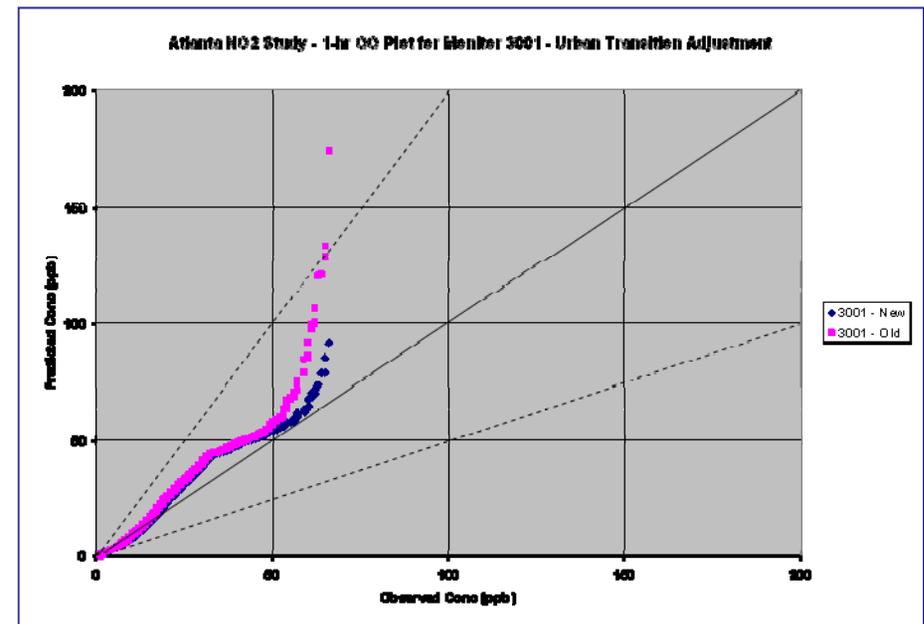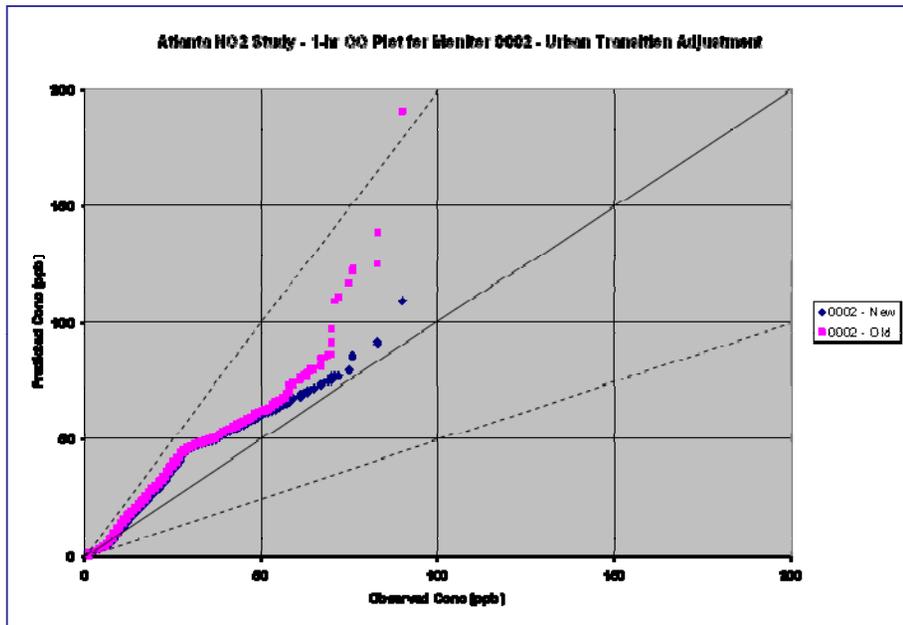
Figures show 1-hr Q-Q plots for 2002 for two ambient NO_2 monitors in Atlanta, with significant reductions in peak values for new version (blue curve) compared to old version (magenta curve).

Recent AERMOD Developments

- Three "minor" (or at least less "major") updates, dated 11103 (MCB#5), 11353 (MBC#6), and 12060 (MCB#7):

  – Version 11103:

  - Bug fix for MAXDAILY file option and miscellaneous changes to flag potential issues with format of hourly ozone data

  – Version 11353:

  - A few bug fixes including problem with MAXDCONT applications with URBAN sources

Recent AERMOD Developments

- Version 12060:
    - Bug fixes for MAXDCONT applications with variable emissions (EMISFACT), background ozone (O3VALUES) or background concentrations (BACKGRND) that vary by day-of-week, e.g., SHRDOW, SHRDOW7, etc.;
    - Includes checks to identify potential issues with the MAXDCONT option;
    - Miscellaneous changes, including reducing/optimizing the memory requirements for the MAXDCONT option.

AERMET Changes

- Only one update to AERMET since 9th Modeling Conference, dated 11059 (MCB#2):
  - Bug fixes, including several problems with averaging of sub-hourly inputs for site-specific data
  - Incorporated several enhancements, including:
    - Increased flexibility in selecting most appropriate upper air sounding, improves portability of AERMET/AERMOD to other countries;
    - Allow use of hourly-averaged wind speed & direction derived from 1-minute ASOS data processed through new AERMINUTE program;
    - Adjustments to account for ASOS wind speeds being truncated, rather than rounded, to whole knots;
    - Improved error handling and reporting for processing of ONSITE data;
    - Option to specify secondary set of surface characteristics for use when NWS winds are substituted for missing site-specific wind data, and option to specify an external file, such as AERSURFACE output, for surface characteristics;
    - Make broader use of SURFACE station elevations from data files (ISHD & SAMSON) and/or user-specified elevations to substitute for missing pressure

AERMET Changes – UA Data

- Enhanced the default upper air sounding window (currently based on 12Z +/- 1hr):
  - selects 12Z or 00Z sounding from "current day" or 12Z sounding from "previous day" (± 1 hour) depending on latitude of upper air station; 12Z from "previous day" used for Eastern Hemisphere time zones

- Option for user-specified upper air sounding window to expand default range of obs times relative to three primary soundings
  - e.g., 'UAWINDOW -4 +2' would accept soundings between 08Z and 14Z, inclusive

- Additional option to allow AERMET to select "optimal" sounding based on local sunrise for upper air station location:
  - Enhances portability of AERMET for non-US applications
  - Accommodates potential use of more frequent pseudo-soundings derived from NARR or gridded met models in the future beyond standard twice-daily observations
  - May result in no acceptable sounding at high latitudes in summer with standard twice-daily soundings

Default Sounding Times
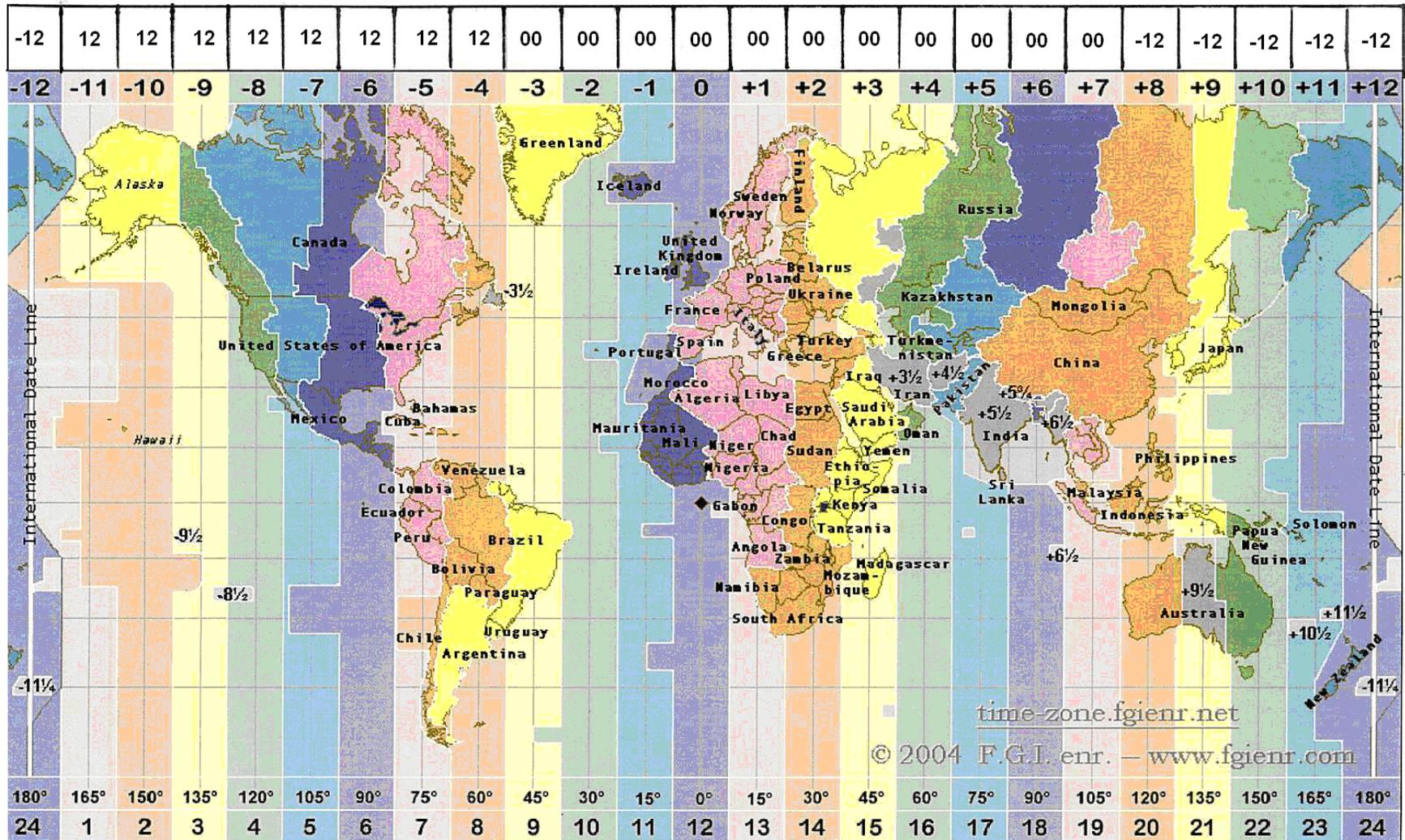
AERMAP Changes

- Two updates to AERMAP since 9th Modeling Conference, dated 09040 (MCB#2) and 11103 (MCB#3):
  - Version 09040 incorporated numerous bug fixes, enhancements and miscellaneous changes, including:
    - Corrections to problems with processing Alaska DEM files (1-deg, 15-min and 7.5-min data; non-uniform longitude spacing of nodes);
    - Support for National Elevation Dataset (NED), available from USGS Seamless Data Server in GeoTIFF format;
    - Allow "mixed" DEM files (1-deg, 7.5-min, and 15-min for AK); can be used to fill gaps in 7.5-min coverage, such as over-water grids;
    - DOMAINXY/DOMAINLL keywords now optional; uses all available data if omitted;
    - Allocatable array storage at runtime;
    - Support for INCLUDED keyword on RE and SO pathways; and
    - Improved handling/reporting of non-standard terrain data, including identification of receptors located in "gaps" between terrain files or inside terrain files
  - Version 11103 included minor bug fix and support for 12-char SrcID

Future Plans and Priorities

- AERMOD dispersion model:
  - Buoyant line source option, based on BLP model;
  - Buoyant area source option;
  - Enhancements to PVMRM option to address concerns regarding relative dispersion coefficients for stable conditions, per comments submitted by API;
  - MAXDCONT "Event" post-processing option:
    - Eliminate additional memory requirements associated with MAXDCONT option;
    - Provide more flexibility for users to analyze source contributions for 1-hr NO_2, 1-hr SO_2 and 24-hr PM2.5 NAAQS analyses
  - Address portability issues related to different operating systems, including 32-bit vs. 64-bit, and possibly support/distribute multiple processor-dependent executables
  - Further memory and runtime optimizations, possibly including parallelizing the code

Future Plans and Priorities

- AERMET meteorological processor:
  - Pending/imminent release to include:
    - Bug fix for processing ASOS cloud cover codes for HUSWO surface data, especially for data reformatted to HUSWO format;
    - Bug fix for convective mixing height calculation, which may lead to underestimates of convective mixing heights, especially for upper air soundings with coarser vertical resolution - AERMOD Implementation Guide cautions against use of soundings that include mandatory levels only;
    - Enhancement to allow user-specified threshold for 1-minute ASOS wind data from AERMINUTE, as discussed in Clarification Memo presentation;
  - Considering options to substitute for missing cloud cover
    - Appears to be a significant problem for some non-US data, but also showing up for some non-NWS US stations

- Evaluate use of meteorological inputs derived from prognostic meteorological models based on MMIF tool

- Update APTI 423 training course to reflect AERMOD