Emerging Models and Techniques: Direction and Needs

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Overview

- EPA and FLMs have engaged in various meetings to discuss the current issues related to long-range transport and chemistry related applications.
- Clear that our interests and needs are overlapping across our multiple programs and regulatory responsibilities
  - NEPA air quality analyses for energy development on federal lands: MOU between EPA/DOI/USDA
  - EPA grant of Sierra Club petition on O3 and secondary PM2.5 models in Appendix W
- EPA and FLMs will follow IWAQM process for conducting the necessary evaluations and reporting

From AWMA AB-3 Committee (2008) Comment Areas

- Need for regional (Eulerian) models
- Best uses for Lagrangian vs. Eulerian models
- Where does EPA go from here?

AWMA AB-3 (2008): Need for Regional Models

- ***Ozone and PM-2.5 are pollutants involving multiple precursors and complex chemistry and transport***
- ***Current models mentioned in 40 CFR Part 51 do not address these needs***
- These pollutants are important because of widespread and large nonattainment areas, and the scale of emission changes needed to address attainment
- ***EPA needs to provide procedures for modeling PM-2.5***

AWMA AB-3 (2008): Lagrangian Models

- These models, such as CALPUFF and SCIPUFF, compute the change of concentration following a parcel (puff) as it is advected by the wind
- ***They are most suitable for individual source applications, but could be run for hundreds of sources***
- ***Chemistry is limited: ozone cannot be modeled; PM-2.5 can be modeled***

AWMA AB-3 (2008): Eulerian Models

- The total concentration is obtained relative to a fixed grid, pollutant concentrations and met variables are defined at each grid point
- ***For individual sources, this approach causes instantaneous "pseudo dilution" of point source emissions into the entire grid cell volume***
- ***This overdilution effect becomes more pronounced with increasing horizontal grid sizes***
- ***Eulerian approaches are most suitable when complex emission and non-linear chemical conversions are involved for large distances***

AWMA AB-3 (2008): Approved Use of Regional Eulerian Models

- Use throughout the US: focusing upon CAMx and CMAQ
- ***There have been evaluation studies, but EPA should have a system to determine acceptable criteria for approving the models***
- The models are very complex and resource intensive; uncertainty/sensitivity needs review
- ***The models' accuracy is good in some areas and poor in others. Continued work on a consistent evaluation approach is recommended, similar to short-range models.***

Interagency Workgroup on Air Quality Modeling (IWAQM) Phase III Effort

- IWAQM was originally formed in 1991 to provide a focus for development of technically sound regional air quality models for regulatory assessments of pollutant source impacts on Federal Class I areas.
  - Phase 1 consisted of reviewing EPA guidance and recommending an interim modeling approach to meet the immediate need for a LRT model for ongoing permitting activity
  - Phase 2 report provided a series of recommendations concerning the application of the CALPUFF model for use in long range transport (LRT) modeling that informed EPA's promulgation in 2003 of CALPUFF.
- Phase 3 focus on next generation model to meet Federal program needs such as
  - Single source ozone and secondary PM2.5
  - AQRVs (visibility and deposition)
- Program needs and commitments have clearly made updating Appendix W to address LRT and chemistry a priority.

Initial Needs & Attributes for Models

- Multiple source treatments
  - Point/Area/Volume
  - Plume rise
  - Buoyant area/line
- Lagrangian/Eulerian Hybrid
  - Ability to utilize gridded emissions
  - Ability to interface as plume-in-grid (PiG) module for Eulerian models.
- State of science chemical transformation and removal mechanisms
  - particulate matter and ozone chemistry
  - Wet and dry deposition
- Use spatially and temporally varying meteorological fields

Historical Evaluation Efforts at a Glance

- 1986 8-model study
  - Savannah River & Oklahoma Mesoscale Experiments
- 1990 Rocky Mountain Acid Deposition Model Assessment Program
- 1993 Interagency Workgroup on Air Quality Modeling Phase I Evaluation
- 1998 Interagency Workgroup on Air Quality Modeling Phase II Evaluation

Lessons Learned from Prior Evaluation Efforts

- No USEPA recommended methodology for evaluation of LRT models. No consistent approach between efforts in 1980’s and 1990’s.
- Evaluation methodology used all published AMS metrics and data organizational strategies.
  - This did not take into consideration regulatory use of LRT models, weighting schemes not most appropriate for particular methods LRT models are used for.
- High sensitivity of LRT models to meteorological inputs.
- Need for more objective meteorological performance evaluation measures.
- No data sets available to evaluation chemical transformation mechanisms of LRT models

Defining Performance Objectives – Start with Regulatory Use of Model

- Current Regulatory Uses:
  - PSD Class I NAAQS and increment analyses
  - Visibility and deposition for Air Quality Related Values analysis for PSD
- Potential Future Uses:
  - Single source O3 NAAQS analyses
  - Single source PM2.5 NAAQS analyses

EPA/FLM Evaluation Framework

- Evaluation of LRT models within their defined regulatory niche requires an evaluation of three independent components of the AQ model system
  - Meteorological component
  - Advection and diffusion component
  - Chemical transformation

Meteorology and Model Intercomparisons

- LRT model performance is inherently linked to the suitability of the meteorological fields coupled to the AQ model.
- In model intercomparison studies, using a common source of meteorological data between all air quality modeling systems reduces the potential contribution of differences in meteorological data on dispersion model performance.
- Meteorological model performance by necessity is an integral part of any LRT model evaluation framework.

Single Source Chemistry Evaluations

- Application of LRT models for chemistry usually only involve an individual or small group of sources.
- Traditional photochemical grid model (PGM) evaluation techniques (chemistry evaluation) combined with inert tracer evaluation (advection and diffusion) are combined to examine the suitability of a model for use in single source chemistry applications.
- The best performing chemistry model will only be as good as its ability to treat advection and diffusion appropriately.