API Comments on EPA Air Dispersion Modeling

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Steve Hanna, PH.D, CCM – Hanna Consultants
Bruce Egan, Sc.D, CCM – Egan Environmental
Bob Paine, CCM - AECOM

Modeling Stakes Are High

Are the current regulatory models capable enough and suitable for demonstrating compliance with increasingly stringent NAAQS?

- **Some existing sources in areas currently attaining the 1-hour NO_2 NAAQS have been unable to model compliance with the standard.**
- **Using CALPUFF to assess PM and visibility impacts may produce erroneous results due to outdated chemistry.**
- **Substituting modeling instead of monitoring to determine attainment with the 1-hour SO_2 NAAQS potentially means more nonattainment areas and unnecessary controls. It is questionable whether states have adequate time and resources to model over 1600 100+ TPY sources as EPA has initially asked.**

How can we improve?

- ✓ ***Continue to develop and improve modeling science***
- ✓ ***Conduct additional model evaluations that consider a variety of source characteristics and atmospheric conditions***
  - E.g., low-level sources, low wind speed conditions
- ✓ ***Improve guidance on modeling use and model inputs***
  - Guidance should undergo peer review/public comment prior to issuance
  - Balance need for standardization and consistency against ability to use the best model for the source/conditions
  - More realistic inputs mean more realistic results
- ✓ ***Help policy makers, model users, and those evaluating model results better understand the limitations and uncertainties of modeling tools***
- ✓ ***Provide for better use of well-sited air quality monitoring***

Some of Our Previous Modeling Conference Comments Still Appropriate

- **Need for Complete Documentation and Guidance**
  - All codes should be in public domain
  - All documentation needs to be brought up to date and made publicly available
- **General need for more EPA guidance, workshops, and training for the modeling community**
- **Encourage development and use of science-based models through evaluation efforts and enhanced public involvement**
  - We appreciate EPA's efforts to enhance public involvement by providing for public participation in the 2011 R/S/L Modelers Workshop and via the Technical Modeling Workgroup for the 10th Conference

PM2.5 and SO_2 NAAQS Guidance

- **EPA should provide a minimum of 60 days for comments on PM2.5 Modeling Guidance**

- **We support EPA completing final SO_2 NAAQS implementation guidance and an implementation rule that provides for:**
  - Use of monitoring data as the preferred method for attainment determinations.
  - Non-attainment SIPs should:
    1) Use modeling recognizing accuracy limitations
    2) Use weight of evidence assessments (other data and analyses to supplement modeling)
    3) Use actual emissions, not potential to emit

Recent API-Sponsored Work to Improve Models

- OLM and PVMRM Code Review and Evaluation with Wainwright data (Epsilon Associates)
- AERMOD Ambient Ratio Method 2 – "ARM2" (RTP Environmental)
- AERMOD Low Wind Speed Study (AECOM; joint API/UARG project)

We appreciate EPA's willingness to work with the API on these projects

TECHNICAL COMMENTS
List of Topics

1. AERMOD
2. CALPUFF
3. Regional Chemistry Models (CMAQ and CAMx)
4. Prognostic meteorological models
5. Background concentrations
6. Model evaluation and data bases

AERMOD (1)

Low winds - Overpredictions in low winds during stable conditions are now found

- Anemometer lower thresholds have decreased and AERMINUTE is used. More model runs are made with low wind speeds (i.e., not "calm").
- At night, low winds result in low mixing depths and small turbulence and dispersion.
- Problems appear with the plume meandering module and wind and turbulence profiles.
- Field databases used in AERMOD evaluation had few low wind speed hours, but these portended problems (e.g., AGA).
- Possible fixes to the AERMOD low wind parameterizations have been suggested by several groups. EPA should implement the results of the API/UARG Low Wind Speed Project.

A low wind stable natural cloud

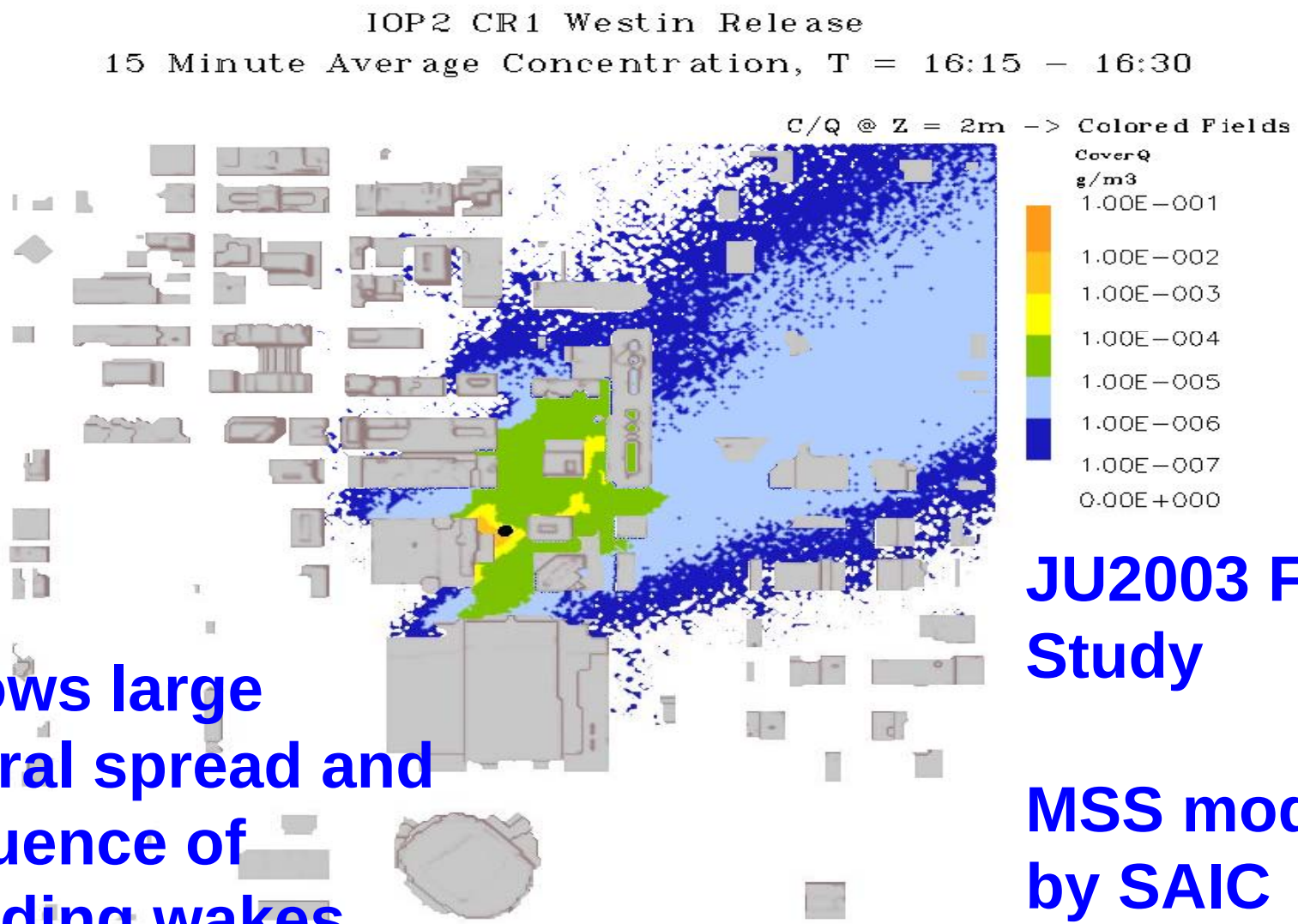
Photo courtesy of Larry Mahrt

AERMOD (2)

Urban dispersion - The AERMOD modules rely on PRIME, which is intended for downwash scenarios with only a few buildings

- For urban areas with several blocks of many buildings, a new urban dispersion module is needed. There are several well-tested urban dispersion modules that are available. These have been evaluated with data from four recent (since 2000) large new urban tracer data bases.
- An urban canopy wind and turbulence profile is used by models such as SCIPUFF. Profiles above the canopy are based on standard models with assumed larger surface roughness z_o. Dispersion coefficients reflect the much larger turbulence and the tendency towards neutral stability.
- The EPA AMAG is developing an urban dispersion model system that could be directly implemented in AERMOD.

Modeled C/Q contours for continuous point source release (at black dot) in Oklahoma City



JU2003 Field Study

MSS model by SAIC

Shows large lateral spread and influence of building wakes

AERMOD (3)

NO_2 chemistry is not adequately accounted for in AERMOD via PVMRM or OLM.

- Outside groups have suggested improved chemical formulations, including those in SCICHEM, ADMS, and RPM2. These should be tested.
- The ARM2 method is a revised ambient ratio approach based on extensive observations, and should be implemented as an interim approach.
- Since the previous NOx datasets (Empire Abo, Palaau, and Arellano/Bange) have all had missing aspects, it is essential that a new comprehensive NOx plume field experiment be carried out and used for model testing.

AERMOD (4)

Use of airport met observations for sites many km away

- Methods should be developed to better extrapolate the airport observations to the local site. Use of the airport data can result in significant AERMOD biases.
- Various improved extrapolation methods are available , such as the “up-over-and-down” method used in SCIPUFF, or the Blackadar resistance formulas. These better account for the differences in surface roughness z_o and the resistance formulas can account for the lower wind speed at the reference height at the site of interest.
- Prognostic meteorological models may also be useful for extrapolation, but they should be carefully tested.

AERMOD (5)

The **straight-line assumption** in AERMOD is assumed to extend to 50 km, which is much beyond the travel distance in one hour for most wind speeds encountered.

- The EPA should either better justify the current arbitrary 50 km limit or provide guidance for reducing the distance limits during lighter winds.

- It may be necessary to use a Lagrangian puff model (CALPUFF or SCIPUFF) at distances beyond where the straight-line assumption breaks down.

AERMOD (6)

Use of realistic emissions - The air quality model is intended by the EPA to provide realistic predictions

- But the use of maximum allowable emissions all year in modeling is not realistic and is overly conservative.
- It would be better to use observed emissions if available.
- In case observations are not available, it may be appropriate to allow a Monte Carlo random value that provides agreement with the known average and scatter of emissions. For multiple sources, the correlation of emissions between sources should be accounted for.

CALPUFF (1)

- **The 50 km minimum distance limit** should be reduced, since puff models are scientifically valid at much shorter distances. CALPUFF may need some modifications, though, to assure that it provides similar predictions to AERMOD at the overlap distances.

- **Several other high-quality widely-used Lagrangian puff and particle models are available** in the U.S. (e.g., SCIPUFF and LODI) and abroad (e.g., RIMPUFF and Flexpart). Some were recently evaluated by EPA using long-range field data, found to provide similar results to CALPUFF, and should be considered by the EPA.

CALPUFF (2)

The chemistry in the current version of CALPUFF and similar models should be (and is being) improved to account for more chemicals, for non-linear reactions, and for heterogeneous conversions (such as gas to particle).

- Increased emphasis on PM and visibility.
- Improved chemistry in CALPUFF is being discussed at this conference.
- SCICHEM contains improved chemistry and is also being discussed.
- Improved CALPUFF chemistry that has been carefully tested with field data should be incorporated into the regulatory version of CALPUFF.

Regional Chemistry Models (CMAQ and CAMx)

- **Regulatory applications of CMAQ and CAMx should take a more prominent role in the present conference**, since the other conferences regarding these models (such as the annual CMAS) are technical forums and provide no formal way for the public to comment.
- CAMx already has its own **plume-in-grid model** but CMAQ does not. We encourage the current EPA effort to incorporate the SCICHEM plume-in-grid model in CMAQ . This should more realistically treat a large point source plume rather than unrealistically mixing the emissions from a point source uniformly through the grid square in which it is located.

Prognostic Meteorological Models (1)

- We are pleased that the EPA is investigating linking their dispersion models with the outputs of prognostic meteorological models, since this is a world-wide trend as the models improve and have higher spatial resolution.

- The EPA has been testing the Mesoscale Interface (MMIF) program, which provides an interface between the met model outputs and the required dispersion model inputs. This is a good first step.

Prognostic Meteorological Models (2)

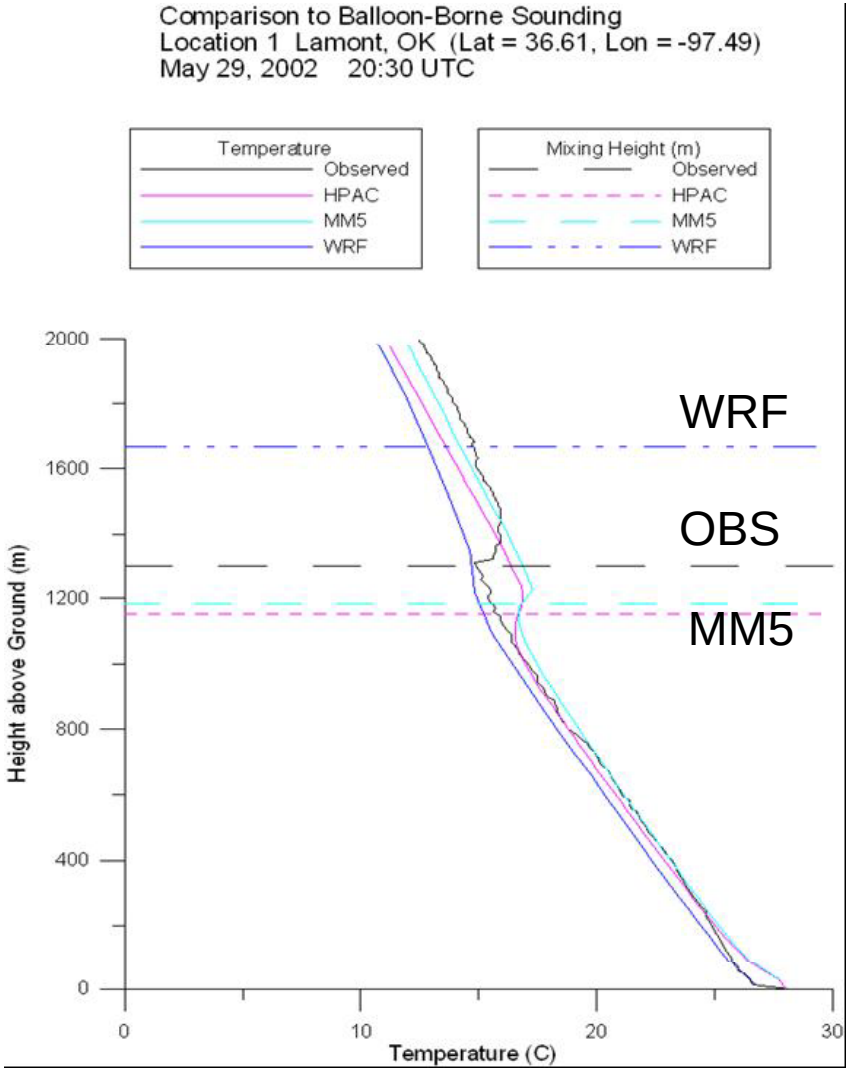
Uncertainties - Many studies (including the EPA's LRT model evaluation report and the papers discussed by Hanna at this conference) find that the use of the met models does not necessarily improve the dispersion model predictions. Met models have inherent uncertainty themselves.

- The wind speed uncertainty is at a minimum 1 m/s
- The uncertainty in wind directions is inversely proportional to wind speed
- The mixing depth uncertainty is, at best, ±20% during the day and as much as 100% at night
- Vertical temperature gradients tend to be underpredicted

WRF, MM5 and Observed Daytime T Profile and Mixing Depth Comparison with IHOP Data

OBS and MM5 Agree,

WRF is 30 % high



Prognostic Meteorological Models (3)

- The met models can typically resolve flows around terrain features (e.g., valleys) if the model's grid size is 3 or 4 times smaller than the size of the terrain feature.

- No major changes in the use of met models should be made until extensive testing is done over a wide range of scenarios, in order to demonstrate that the changes produce improved or at least similar performance compared to current methods (such as use of single met sites in AERMOD or diagnostic met models in CALPUFF).

Background Concentrations

- As the gap between hourly NAAQS and background gets smaller, it becomes more important to accurately specify the background concentrations.
- If a local monitor is used to establish background, there is the potential to double-count the contribution of sources. This could potentially be avoided by using more than one monitor and adding background determined from the lowest monitored concentration each hour in a paired-in-time procedure with the modeled concentrations.
- The background should conform to the averaging times (e.g., one hour, one day, annual) and the spatial domain (e.g., 10 km, 100 km, 500 km) of the scenario being modeled.

Model Evaluation and Data Bases

- The EPA model evaluation methods are inconsistent and rely too much on the Quantile-Quantile (Q-Q) plots. No estimates of statistical significance are given.
- The EPA should revisit their model evaluation method derived 15 years ago and included by John Irwin (from OAQPS) in an ASTM guideline. These are similar to the Hanna and Chang BOOT model evaluation methodology, which determines whether differences between performance measures are significant for two different models (see the presentation by Hanna on this topic at this conference).
- There is a need for the EPA to put all of their dispersion field data sets into a single data archive for easy public access.

Model Evaluation and Data Bases (2)

- The Chang and Hanna suggestions of **model acceptance criteria** should be considered, since they have been tested using many field experiments and are in wide use.
- Separate criteria are suggested for performance measures such as FB and NMSE for rural and urban areas.
- Additional OAQPS-specific acceptance criteria could be developed for measures such as "2nd-high" and for routine sampling networks (i.e., not research-grade).
- Together with significance tests, the model acceptance criteria allow quantitative comparisons of models.

Recommendations

- The NO_2 Modeling Guidance Tier 2 methods should include ARM2.
- PVMRM has some deficiencies that need to be corrected and evaluated with field data.
- EPA should implement the results of the API/UARG Low Wind Speed project.
- The regulatory version of CALPUFF should be the improved chemistry version.
- The Hanna and Chang BOOT model evaluation methodology should be considered in addition to Q-Q plots.

Recommendations

- Well-placed monitors should be used for SO_2 NAAQS attainment determinations.
- If SO_2 SIP modeling is needed, it should use actual emissions, not potential emissions.
- EPA/OAQPS should continue increasing their communications and collaborations with the many groups studying modeling issues and include the wider community in planning, model development and evaluation, and analysis and review of results.

API welcomes your feedback or partnership in modeling studies

For more information about air modeling projects supported by API go to

http://mycommittees.api.org/rasa/amp/default.aspx

Contact: Cathe Kalisz at kaliszc@api.org 202.682.8318