93-TT-08

Wilson

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

JUL 22 1993

**MEMORANDUM**

**SUBJECT:** Draft Protocol for the Urban Airshed Model V (UAM-V)

**FROM:** Joseph A. Tikvart, Chief for JAT
Source Receptor Analysis Branch, TSD (MD-14)

**TO:** Brenda Johnson, Meteorologist
Air Programs Branch, Region IV

In response to the request in your June 22 memorandum, the Model Clearinghouse has reviewed the draft, "Protocol for Applying UAM-V to the Atlanta Area to Support the Development of the Ozone State Implementation Plan," prepared by Systems Applications International. We have also reviewed your proposed comments on this draft. In the attachment, we respond first to the draft protocol and then to your comments. If you would like to discuss any of our comments, or the report further, please contact Ned Meyer at (919) 541-5594.

Attachment

cc: J. Lewis, Region IV
D. Neeley, Region IV

## I. Comments on the Draft Protocol

**General.** Preparation of a protocol for a head to head comparison between UAMIV and UAMV breaks new ground. In general, we feel that a number of the concepts presented in this document are good ones. We also believe inclusion of tests which allow for some relaxation of spatial and temporal pairing (pp. 22-23) is a good idea. However, we believe the protocol needs to address or elaborate upon several additional issues.

In order for UAMV to be accepted for application in Atlanta, in place of UAMIV, the **Guideline on Air Quality Models (Revised)** requires that it be subjected to a statistical performance evaluation, and the results must show that it performs better than UAMIV. The **Guideline** indicates that the **Interim Procedures for Evaluating Air Quality Models** should be used, as appropriate, in designing the protocol for such an evaluation. However, we recognize that the **Interim Procedures** were not designed specifically for use with episodic models such as the UAM. Thus, not all of the individual stipulations in the **Interim Procedures** document necessarily apply even though the principles contained in that document should be followed.

One apparent conflict between the protocol and existing guidance is the protocol's provision that if performance of the two models is comparable, UAMV should be the model of choice for use in the State implementation plan (SIP). As previously noted, the normal procedure for determining the most appropriate model is that if the proposed model does not perform clearly better than the reference model, then the reference model (in this case, UAMIV) should be used. However, the **Interim Procedures** do allow for the use of other technical criteria to make a decision in the case of comparable performance. A legitimate criterion would be scientific merit of the two approaches. To be consistent with the guidance, the protocol should make a strong case that the UAMV is scientifically superior to the UAMIV. We believe that this point needs to be addressed more specifically in the draft protocol. For example, the first paragraph on p.2 contains a list of new features within the UAMV. However, most of these are unaccompanied by explanations as to why the UAMV treatment is superior.

The EPA also has guidance which applies specifically to the use of the Urban Airshed Model to demonstrate attainment of the ozone standard in an ozone SIP. This guidance, embodied in **Guideline for Regulatory Application of the Urban Airshed Model**, requires explanations/justification for deviations. Procedures which have merit for comparing UAMIV vs. UAMV may not necessarily be consistent with those recommended for use in SIP applications and vice versa. For example, it may make sense to use the SAIMM meteorological model for comparing the two models, but this method

of generating meteorological input is not the recommended procedure in the **Guideline for Regulatory Application of the UAM**. Conversely, use of technical and management committees to reach consensus is the procedure we recommend for SIP modeling, but the same committees may or may not be the most appropriate means for reaching a conclusion regarding use of a non-guideline model. For the reasons outlined above, we believe it would be more appropriate to have separate protocols for the UAMIV/UAMV comparison and for the application of the chosen model in the Atlanta SIP.

Finally, once a model is chosen, attention should be paid to a potential problem posed if the model predictions are biased low. As a working group at the May 12-14 Atlanta UAM workshop concluded, this problem should be addressed on a case by case basis. Our concern over this issue becomes even greater if UAMV were to be the chosen model, despite predicting a lower episodic peak concentration than UAMIV for one or more episodes (see pp.41-42 of the **Interim Procedures**).

**Specific Comments**

1. **P.4--Schedule.** For devising the schedule, we would like to give you our latest estimates regarding availability of base case supporting ROM data. The July 7-8, 1988 episode should be available by the end of July. The July 29-August 1, 1987 episode should be available by the end of September. You should be advised however, that there are major unresolved contract uncertainties regarding ROM support and that these estimates are subject to change.

2. **P.5**--Are the technical working groups identified in the SIP demonstration protocol to be used in assessing/approving results and procedures in the UAMIV/UAMV comparisons? Their role is unclear. In any event, other participants should recognize Region IV representatives as the EPA spokespersons for decisions having to do with the model evaluation protocol.

3. **P.7--Episode Selection.** Are there not 5 rather than 3 primary episode days? Why aren't July 30, 31 and August 1, 1987 all considered to be primary days?

4. **P.10--Modeling Domain Specification.** The protocol mentions that it may be appropriate to use a fine mesh (2 km x 2 km) nested horizontal grid. Since this is a new feature of UAMV, it would seem appropriate to use the feature if the data base warrants. Where would this finer grid be located? The protocol is completely silent about the vertical resolution to be assumed in UAMV. Is it, like UAMIV, to be 5 cells, or will the resolution be finer to more closely reflect resolution available in the wind model? If fine

horizontal and vertical resolution are used in UAMV, some concern arises over costs. It would not be appropriate to use the fine resolution with UAMV to improve its performance over that of UAMIV, unless it were practical to take advantage of this capability in performing the SIP analysis.

**5. P.15--Input Procedures.** We agree that use of the mesoscale meteorological model with both UAMIV and UAMV is the best way to compare the models while at the same time taking advantage of new features offered by UAMV. However, the performance of prognostic models in photochemical modeling studies thus far has been less than overwhelming. What happens if both UAMIV and UAMV perform poorly as a result? Do the model comparisons with each other mean anything in such a case? The protocol should include a contingency plan to run UAMIV (and, if feasible, UAMV) with the Diagnostic Wind Model if performance of both models is poor.

**6. P.15--Input Procedures.** It is unclear whether four dimensional data assimilation or some other approach to use observed data to nudge SAIMM predictions is to be used. If so, would this be done consistently for UAMIV and UAMV? To what extent, if any, would diagnostic UAM analyses be used to revise the wind models? Remember our UAM applications guidance requires some physical justification for adjusting wind fields or other inputs, not just improved model performance.

**7. P.17--PTSOURCE.** The protocol needs to be more explicit about which sources it will treat as "major point sources" for plume-in-grid (PiG) treatment. Will PiG treatment apply to VOC sources as well as NOx? Are the cutoffs the same? Is there an upper limit to the number of sources which can practically be treated with the PiG algorithm in the Atlanta application?

**8. P.17--HEIGHT.** see comment #4 on vertical resolution.

**9. P.22--Statistical Measures of Performance.** The difference between observations and predictions should be computed by subtracting predictions from observations (Oi - Si), rather than as shown. This will provide signed numbers which are consistent with EPA Guidance and performance evaluations for other demonstrations.

**10. PP.22-23--Statistical Measures.** Greater effort needs to be made to be very precise about the definitions of these measures. This can be done by greater use of equations/subscripts in illustrating what is meant by tests 4-6. In addition, use of very simple examples might be made to illustrate the calculations for each of the tests (particularly (4) - (10)) so that the reader would have a clearer understanding of what these are. The

following are examples of the sorts of ambiguities arising from the current descriptions:

in tests (1)-(3), the protocol needs to explain more clearly what "N" is.

test (4): are we talking about 1 "S" and "O" per primary day per monitor, or 1 value of each for an entire episode?

test (5): is the bilinear interpolation used, or is the prediction used the one from the 9 cells which agrees most closely with the observation?

tests (7) - (10): pictures and illustrations would be immensely helpful.

**11. PP.23-24**--While we concur with the basic approach for selecting a model, we feel that there is merit in comparing the performance of models based on the use of the fractional bais. Since we are not specifically asking that you incorporate measures based on fractional bias, we would like to obtain a copy of the final data set so that we may independently evaluate other comparative techniques based on the fractional bias. In particular, we would like to obtain (electronic), all of the hourly observed and predicted concentrations for each model being evaluated for each day used in the evaluation.

**12. PP.23-24--Determination of Acceptable Performance.** We recommend that the two models be scored by combining (i.e., summing) the scores from each of the 5(?) primary days, so that there is one test score for each model. We also recommend dropping the notion that if the difference in scores is less than "1.5", it is too close to call. We feel that a better interpretation is, "if the score for UAMV is the same as or better than that for UAMIV, UAMV is the model of choice". (This assumes that the protocol contains a convincing argument that UAMV is scientifically superior). Our underlying rationale for these changes is that they enable one to take account of and weight an episode where one model performs very much better than the other. Further, we feel that the scores on many of the individual measures are likely to be zero. Thus, any non-zero difference in the test scores reflects one or more decisive differences in the performance of the two models.

## II. Reaction to B. Johnson's Comments

A number of the comments reflect conce
between procedures which are appropriate fo
but not for the SIP application prot
justification is provided. We agree with
The one issue that we think deserves furthe

last sentence on to next page is part in question but as this revision be replaced. see Aug 17, 93 memo Pete

one raised in comment 8. We believe that the ability of UAMV to consider nested grids is an improved feature of the model. As such, it is legitimate to see whether this "improvement" helps improve model performance. Thus, from the point of view of comparing models, it is similar to the different treatment of vertical exchange in UAMV and the plume-in-grid treatment.

**FY-93 MODEL CLEARINGHOUSE MEMORANDA**

| Date | Region | Subject |
|---|---|---|
| 10/7/92 | IV | Response to Proposal to Allow Credit for a Stack Height Increase at the Dade County Resource Recovery Facility, Dade County, Florida |
| 10/28/92 | V | Demonstrating Attainment of the Ozone National Ambient Air Quality Standards (NAAQS) with the Urban Airshed Model (UAM) for Detroit |
| 10/28/92 | VII | Demonstrating Attainment of the Ozone National Ambient Air Quality Standards (NAAQS) with the Urban Airshed Model (UAM) for St. Louis |
| 10/28/92 | IV | Attainment Demonstrations using the Empirical Kinetics Modeling Approach (EKMA) |
| 11/5/92 | I | Proposal to Use ISCRDT to Model Intermediate Terrain (Boise Cascade, Rumford, Maine) |
| 11/12/92 | VIII | Denver PM-10 State Implementation Plan (SIP) Modeling Issues |
| 12/10/92 | V | Proposal for Resolving Part D Sulfur Dioxide State Implementation Plan Revision for Rhinelander, Wisconsin |
| 12/15/92 | IV | The Ozone Attainment Test in the State Implementation Plan (SIP) Modeling Demonstrations |
| 2/18/93 | II | AES Guayama, Puerta Rico Proposal to Use the Rough Terrain Dispersion Model with Off-Site Meteorological Data |
| 2/22/93 | VIII | Carbon Monoxide State Implementation Plan Attainment Demonstrations |
| 2/23/93 | II | AES Guayama, Puerta Rico Proposal to Use the Rough Terrain Dispersion Model with Off-Site Meteorological Data |

## FY-93 MODEL CLEARINGHOUSE MEMORANDA (Cont'd)

| Date | Region | Subject |
|---|---|---|
| 3/2/93 | VIII | E. Helena Lead SIP Attainment Demonstration |
| 3/30/93 | V | Nonmethane Organic Compound (NMOC) and Nitrogen Oxides ($NO_x$) Monitoring Required for the Empirical Kinetics Modeling Approach (EKMA) for Nonattainment Areas in Ohio |
| 4/5/93 | V | Nonmethane Organic Compounds (NMOC) and Nitrogen Oxides (NOx) Monitoring Required for the Empirical Kinetics Modeling Approach (EKMA) for Nonattainment Areas in Ohio |
| 5/18/93 | VI | Technical Comparison Document--Phelps Dodge Smelter |
| 6/7/93 | VII | Wind Field Development for the Urban Airshed Model (UAM) |
| 6/10/93 | V | Draft Protocol for Modeling a Sewage Sludge Incinerator |
| 6/22/93 | II | Proposal for Calculating Plume Rise for Stacks with Horizontal Releases or Rain Caps for Cookson Pigment, Newark, New Jersey |
| 6/28/93 | VII | Stack-Structure Relationships--Further clarification of our memoranda dated May 11, 1988 and June 28, 1989 |
| 7/6/93 | IV | Draft Protocol for the Urban Airshed Model V (UAM-V) |

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET, N.E.
ATLANTA, GEORGIA 30365

MEMORANDUM

DATE: JUN 2 2 1993

SUBJECT: Draft Protocol for Urban Airshed Model - V

FROM: Brenda Johnson, Regional Meteorologist
EPA Region IV

THRU: Douglas Neeley, Chief
Air Programs Branch

TO: Joseph Tikvart, Chief
Source Receptor Analysis Branch (MD-14)
OAQPS/TSD

The draft Urban Airshed Model (UAM) V protocol, developed by the Southern Company, for use in Georgia's State Implementation Plan photochemical grid modeling demonstration for the Atlanta ozone nonattainment area has been reviewed. This model is proposed as an alternative model to the EPA-recommended UAM IV model, which is the current regulatory model. In the May 11, 1993, meeting with the representatives from the State of Georgia, Southern Company, SAI, EPA Region IV and OAQPS, we agreed to provide comments on this protocol and its acceptability for use in developing the State's ozone SIP revision. Please include my comments in your review of this protocol. My comments are as follows:

1. The last sentence of page 1 would read better if the phrase, "Prescription of," was replaced with "The".

2. The third sentence at the top of page 2, needs to be supported by a reference. What is this statement based on, past SIP modeling demonstrations or research? Are there any supporting published papers to this effect?

3. The word "plume" in the sixth sentence on page 2 is redundant.

4. Page 3, item 1 states that the UAM-IV protocol for the Atlanta area has been approved by EPA. This protocol is still undergoing revisions and has not been approved.

5. On page 5, Stuart Perry should be replaced with Kay Prince as the EPA representative to the Policy Oversight Group.

6. The second paragraph of the **Technical Work Group** section (p.5) should modify the phrase, "work performed by SAI" to "work performed by SAI and the State", since the State will be assisted by SAI (see p.4) in performing the modeling work.

7. Yasmin Yorker should be replaced with Joey Levasseur as the Region IV representative to the Emission Inventory Work Group.

8. The last sentence in the **Modeling Domain Specification** section (p.10) states that an additional higher resolution nested grid (e.g., 2km x 2km) may be added in certain high emission density areas near Atlanta for the UAM V grid. In order for a side-by-side model comparison to be creditable, the models should be run in as similar a manner as possible (i.e., same model dimensions and grid spacings, same answers for same or similar inputs). Adding this higher density grid in the urban scale domain gives an unfair advantage to UAM V model. This will not be allowed. However, you may caveat this section by stating that if the model performance indicates that UAM V out performs UAM IV then, modeling with this higher nested grid may be considered for the SIP submittal. Of course, this will involve a new model performance on the base case episodes.

9. The first paragraph of page 14 could be rewritten to state that:

> The 1990 modeling emission inventory which is under development for the UAM IV domain will form the basis for both UAM IV and UAM V modeling. Those counties in the regional domain of UAM V will use the EPA interim inventory.

As written in the protocol, it is implied that only a 1990 SIP inventory for the nonattainment counties is being developed and this inventory will have to be expanded to cover those attainment counties in the modeling domain.

10. The non-road mobile emissions were not addressed on page 14. These emissions are being developed and uploaded into the AIRS database by EPA for the UAM IV domain. These emissions for the urban and regional domains should be reviewed and quality assured by the Emissions Inventory Work Group prior to modeling.

11. The **EMISSIONS** section concerning input preparation (p.27) should state that the EPA UAM IV Emissions Preprocessor System 2.0 will be used to process (back-cast, project, seasonally and temporally adjust) all the emission inventory data for the modeling.

12. In the **PTSOURCE** section (p.17), it is stated that "all major point sources will be treated by plume-in-grid formulation" for the UAM V inputs. The emissions cut-off that is used to determine a major VOC and $NO_x$ point source should be stated in this section.

13. The comments in item 8 of this letter should be referred to with respect to the last sentence of the first paragraph of the "Other issues" subsection on page 15.

14. The **Deliverables** section (p.4) states that documentation for different stages of the modeling demonstration will be provided to EPA at appropriate times during the analyses. If possible, this should be incorporated into the **Schedules** section.

15. The last sentence of page 15 states that the SAI Mesoscale Model (SAIMM), a prognostic model, will be used to develop some input files. The SAIMM is an alternative model as opposed to the diagnostic wind model and RAMMET which are the EPA regulatory tools recommended to develop some UAM IV files. Therefore, a justification which addresses the representativeness of the SAIMM model as opposed to the EPA methods should be included in the protocol.

16. Pages 16 (BOUNDARY) and 18 (TOPCONC) refer to background concentrations/estimates. The method that will be used to determine these values should be addressed (i.e., EPA default values, ROM, or monitored data).

17. The description of the TEMPERATURE file would better represent the UAM IV and V models by stating that this file contains the hourly temperatures and vary spatially. The UAM V description could be written as the three-dimensional array of temperatures will be obtained from the SAIMM.

18. Diagnostic experiments are briefly mentioned in the **Quality Assurance of UAM Inputs** section. This discussion should be expanded to explicitly state the minimum diagnostic and sensitivity tests that will be performed to ensure discrepancies between simulated and observed data are minimized. Chapter 4 of the Guideline for Regulatory Application of the Urban Airshed Model should be followed in revising this section. If other data are available (i.e., $NO_2$, NO, speciated VOC data), time-series plots of this data should be reviewed per this chapter. Also, the protocol should address how modifications or corrections to the input data will be handled following such analyses.

19. Any alternatives to EPA guidance or suggested default values should be addressed in the protocol along with a justification for their use.

20. The "i" subscript is missing from $S_{max}$ and $O_{max}$ in the equation for unpaired accuracy of the peak concentration.

21. The top of p.23 proposes a constant temporal and spatial shift of the observed and simulated values for optimization. Will this constant remain the same for all episodes models or be episode specific?

22. Ranges for each measure that would be "too close to call" are given in the **Determination of Acceptable Model Performance for UAM-V**, The ranges or values to determine whether the model comparisons are "clearly better" or "clearly worse" should also be stated (e.g., if EPA goal for measures 1,2 and 3 are met then the comparison is clearly better for a given model).

23. The proposed scoring technique appears to be acceptable and easily applicable if all three episodes were modeled. If the enhanced SOS data are not available in time, the protocol should address an alternative to the last sentence of p.23 in determining model acceptability.

Please review my comments on the protocol. Any comments from the State of Georgia will be forwarded to your office as soon as they are received by Region IV. The Southern Company has requested comments on the protocol by June 1993. I would appreciate your comments by June 25th so that we can comment back to the Southern Company. If questions arise, please contact me or Jackie Lewis at (404) 347-2864.

cc: Ellen Baldridge (MD-14)
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