

## **A Revised Modeling Protocol for Air Quality Impact Assessment to the Class I areas in the Nescaum Region in Refined (FLAG Level II) Analysis**

Tentative Outline :

(Where a \* indicates that this issue has yet to be finalized in our decision-making process. See the footnotes for additional discussion.)

### **Introduction:**

- Introduction describing what the protocol is for (consistency in long range transport modeling for PSD increment tracking, regional haze, and visibility in New Source Review across the NESCAUM region),
- what regulatory needs have prompted this effort,
- what guidance documents this protocol relies upon (IWAQM, FLAG),
- any important key interpretations of these guidance documents that dictate the procedure in this protocol (i.e. how inclusive is a cumulative modeling exercise),
- when the protocol procedures at the phase II level will be initiated (i.e. after Level I analyses).

### **General Approach:**

- A brief description of the general procedural steps necessary to satisfying the related needs of PSD increment tracking, regional haze, and visibility analysis. In defining these steps, for PSD analysis, it is assumed that available increment at the baseline date has not increased. Verification of this assumption will occur as described in (3). Consequently it is not necessary that the cumulative source inventory for steps one and two include all increment-consuming sources.

1) A performance of Calpuff runs with an emissions inventory determined to be sufficient for multi-source sensitive functions to calculate impacts at sensitive receptor points (i.e. Class I area receptors). If it is concluded that an inventory primarily of major point sources is sufficient *chemically* then the Calpuff run may be utilized for *all* needs - visibility impairment, deposition, and increment consumption.

2) After the first step has occurred, during New Source Review process, run Calpuff using the inventory used in number (1), but also including the proposed new source emissions. Subtract impacts from step (1) at sensitive receptor locations from number (2) to calculate increment consumption and deposition from the new source. A possible alternative to an entire re-run including the proposed new source would be use of *postutil* which allows you to rerun *only the new source* by retaining gridded predictions of chemical concentrations from a cumulative run. For visibility (i.e. best for uniform haze impairment), use of *postutil* would also be ideal in calculating the single source contribution, which may subsequently require a cumulative analysis if it fails.

3) Independent assessment of available increment: A demonstration of any changes in available increment since the baseline date (this will occur as regional growth dictates to ensure area source growth is accounted for). This demonstration may rely on monitored data, or other, *entirely*

cumulative modeling exercises of *all* PSD increment consuming sources..

### **Regional Modeling Domain**

- A description of the area the domain encompasses\* (See the research needs,\*1.).  
Consequently, a listing of the Class I areas and any other sensitive receptors the domain will allow analysis for.

### **Regional Modeling Approach:**

- Choice of meteorological data and associated temporal length for production of the Calmet windfield\*2.
- Choice of Calmet model options for most accurate windfield production in chosen domain\*3.
- Choice of Calpuff Options for most accurate chemistry handling, other physics in chosen domain\*4.

### **Emissions Inventory Inputs:**

- Source of region-wide emissions inventory that is considered sufficient for atmospheric chemistry, etc., as handled in Calpuff\*4. Possible choices include: the 1996 NET inventory, or state-by-state data submission as specified in the Calpuff Inputs Survey.
- Description of conversion routines necessary to prepare input format for Calpuff.

### **Interactive Procedure With FLAG Phase I report**

- In the New Source Review process, after performing the Calpuff runs consistently with this protocol, references to the necessary procedure for final determination of visibility or deposition impacts (by page number).

## Footnoted Research Needs

**\*1) Determination of the domain size and geographical orientation.** This crucial decision is based on

- a) Class I areas which this effort will work for,
- b) Source regions we wish to include in a cumulative modeling exercise (i.e., can we *exclude* the Ohio river valley and still successfully simulate atmospheric chemistry?
- C) windfield accuracy at chosen model resolution.
- D) runtime constraints.

**\*2) Determination of the best meteorological set to use for CALMET runs.** Choices include: MM4 or 5 (limited to one year), rawinsonde data (up to 5 years if runtimes allow), other diagnostic model such as RAMS. (Vermont has established a dataset to evaluate model accuracy when Calmet is run in different modes, so far these results only compare calmet performance using rawinsonde data to RAMS windfield predictions. These evaluation methods quantify absolute error, bias, and temporally independent accuracy (i.e. climatologically). Other met data that may be included would be over-water obs. For lake-breeze effects.

**\*3) Determination of model options in Calmet (affecting interpolation, terrain handling, setting of barriers, all other physics).** (The method used above to evaluate model accuracy for various meteorological data sets can also be utilized to choose model options). However, on a *domain-wide basis*, the divergence minimization routine in CALMET corrects any grid-wide bias in windfield predictions that is computed using the physics for terrain effects. Comparison of windfield accuracy in trial runs with different parameter settings has indicated that, with respect to domain-wide model accuracy, different parameter settings handling terrain effects and variations in barriers scenarios minimally affects overall accuracy. If you are concerned with windfield accuracy for a specific point or area within the grid however, the model evaluation analysis would be useful. Therefore, for sensitive Class I receptors, it may be useful to examine the windfield produced by CALMET keeping in mind that final ground level concentrations or deposition will be affected by the CALPUFF routines accounting for terrain effects.

**\*4) Determination of Calpuff model options and modeling approach to correctly simulate atmospheric chemistry.**

In general in our region we are concerned with generation of aerosols for visibility and deposition analysis, where these aerosols are primarily sulfate and nitrate compounds. Nitrate aerosol affecting visibility only forms when ammonia is present in the atmosphere, where the ammonia preferentially reacts with sulfate. If more sulfate on a mass basis is available than ammonia, sulfate will completely deplete the ammonia concentrations allowing little or no conversion to nitrate aerosol. This is a common situation in the northeast (especially in high sulfate events). If you have a subset inventory which doesn't completely deplete ammonia in Calpuff, whereas in reality ammonia is depleted, *nitrate aerosol will be predicted incorrectly*. The solution to this problem, with some trial and error examination of results, is to artificially reduce the background ammonia in Calpuff (IWAQM may have some recommendations). Another solution to this problem is to attempt a more entirely cumulative modeling exercise utilizing an option in Calpuff which represents emissions transported into the domain (for our situation from the Ohio valley). Absolute concentrations of ammonia could then be used in this effort, a possible source being the recent ammonia inventory

available for the northeast.

Accounting for all forms of sulfate (with and without ammonia), an absolute estimate of sulfate mass *does not rely on ammonia concentrations*.

Another concern to be evaluated is the lack of an aqueous phase conversion estimate for sulfate. In Calpuff, the recommended chemistry module from Mesopuff II only accounts for 3% SO<sub>2</sub> to SO<sub>4</sub>-conversion at 100% RH (other factors in mountain situations make act to offset this underestimate). At high elevations in the northeast this component of the sulfate conversion can be very large, especially for terrain often experiencing fog or low clouds. Consequently deposition in these conditions will be underestimated. However, for class I areas where it has been established that acid buffering capacity is saturated, a non-zero underestimated sulfate deposition prediction could be a warning flag that deposition may in fact be much higher (with experience a corrective rule of thumb for aqueous phase conversion based on otherwise predicted sulfate may be formulated and used).