Challenges in Modeling Compliance for New NAAQS: 1-hour NO_2 & SO_2 and $PM_{2.5}$

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April 25, 2012

Clean Air Act Advisory Committee

Outline

- Applicability of EPA's Guideline on Air Quality Models (published as Appendix W) for new 1-hr NO_2 and SO_2 NAAQS
- Discussion of key issues addressed in March 1, 2011 guidance memo for new 1-hour NAAQS
- Draft guidance for $PM_{2.5}$ compliance demonstrations under PSD with the end of the PM_{10} Surrogate Policy
- 10^{th} Modeling Conference and Planned Next Steps by the Agency

Challenges to our current models

- States and sources reporting difficulty in demonstrating compliance with new 1-hour NO_2 and SO_2 NAAQS
  - New standards are <u>much</u> more stringent than previous
  - "Overly conservative" nature of model is often "blamed"
  - Necessitates new guidance to reconsider past practices, which often entail overly conservative approaches
- Probabilistic form of the new 1-hr standards complicates aspects of modeled compliance demonstrations
  - Based on %-ile of annual distribution of daily maximum 1-hr values, averaged across multiple years
  - Complicates key test of whether new source contributes significantly to modeled violations paired in time and space
  - Requires new model developments & regulatory use

Challenges to our current models

- Accuracy of models receiving much greater scrutiny, and common misconceptions lead to impression that models are "overly conservative" in all or most cases
- Lawsuit from Sierra Club requesting EPA to designate models under our Guideline on Air Quality Models (aka Appendix W) for O3 and PM2.5
  - Suggests photochemical models to address chemistry for these reactive pollutants
- Overall renewed tension between environmental protection and economic growth

Recent NO2/SO2 PSD Modeling Guidance

- Applicability of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard, June 28, 2010
  - *http://www.epa.gov/ttn/scram/ClarificationMemo_AppendixW_Hourly-NO2-NAAQS_FINAL_06-28-2010.pdf*
- Applicability of Appendix W Modeling Guidance for the 1-hour SO2 National Ambient Air Quality Standard, August 23, 2010
  - *http://www.epa.gov/ttn/scram/ClarificationMemo_AppendixW_Hourly-SO2-NAAQS_FINAL_08-23-2010.pdf*
- Additional Clarification Regarding Application of Appendix W Modeling Guidance for the 1-hour NO2 National Ambient Air Quality Standard, March 1, 2011
  - *http://www.epa.gov/ttn/scram/Additional_Clarifications_AppendixW_Hourly-NO2-NAAQS_FINAL_03-01-2011.pdf*

Modeling Guidance for 1-hr NO_2

- NO_2 NAAQS revised February 2010
- Standard is 100 ppb based on 3-year average of the 98th percentile of daily maximum 1-hour concentrations
- Monitored design values (see Appendix S to 40 CFR Part 50) are based on 3-year averages
- Monitoring guidance does not preempt or alter Appendix W requirement for use of 5 years of National Weather Service (NWS) meteorological data or at least 1 year of site-specific data

Modeling Guidance for NO_2

- Clarification memo on applicability of Appendix W guidance for new 1-hour NAAQS issued in June 2010
  - AERMOD is the preferred model for estimating NO_2 impacts in near-field applications (out to 50 km)
  - Three-tiered screening approach in Section 5.2.4 is generally applicable for 1-hour NO_2 modeling, with additional/different considerations:
    - Tier 1 assumes full conversion of NO to NO2;
    - Tier 2 applies ambient ratio to Tier 1 result (annual default ratio = 0.75);
    - Tier 3 “detailed screening methods” on a case-by-case basis, including OLM (ozone limiting method) and PVMRM (plume volume molar ratio method) options implemented in AERMOD

Modeling Guidance for NO_2

- Applicability of three-tiered screening approach for 1-hour NO_2 modeling:
  - Tier 1 applies to 1-hour NAAQS without additional justification;
  - Tier 2 may also apply to the 1-hour NAAQS in many cases, but additional consideration may be needed regarding appropriate ratio for peak hourly impacts since the current default ARM of 0.75 is representative of "area wide quasi-equilibrium conditions";
  - Tier 3 "detailed screening methods" such as OLM and PVMRM will be on a case-by-case basis, but representativeness of background O_3 data and in-stack NO_2/NO_x ratios will be more important for the 1-hour NAAQS.

Tier 3 Detailed Screening Methods

- OLM specifically mentioned in Appendix W under Tier 3; PVMRM is also considered in this category until more robust model evaluations can be completed
- OLM and PVMRM are available as non-regulatory-default options in AERMOD
  - Requires justification and approval from RO on case-by-case basis as alternative modeling techniques, in accordance with Section 3.2.2.e of Appendix W, but main focus should be on key input data
- Applications of OLM option in AERMOD (subject to Section 3.2.2.e) should routinely utilize the “OLMGROUP ALL” option for combining plumes

Tier 3 Detailed Screening Methods

- Several documents are available on the SCRAM website related to PVMRM and its implementation in AERMOD:
  - Sensitivity Analysis of PVMRM and OLM in AERMOD (2004)
  - Evaluation of Bias in AERMOD-PVMRM (2005)
  - Addendum to AERMOD Model Formulation Document provides technical description of implementation of PVMRM within AERMOD
- Evaluations of PVMRM show encouraging results, but the amount of data is too limited to justify categorizing PVMRM as a refined method for NO_2
- Evaluations have been updated and extended to include OLM and to examine model performance for predicting hourly NO_2 concentrations

Long-term Monitoring Studies 1-hr NO_2 Robust Highest Concentrations

	Observed	PVMRM	OLMGRP	OLM	FULL
New Mexico Abo North Monitor RHC	117.87	116.26	108.38	444.87	449.24
New Mexico Abo South Monitor RHC	70.10	218.98	104.81	440.96	454.68
Hawaii Palaau Monitor RHC	95.42	101.57	113.18	368.57	480.38
Geometric Mean Pred/Obs RHC	---	1.486	1.177	4.510	4.993

Figure A-1. AERMOD Model Evaluation - New Mexico North Monitor - Hourly NO2 Q-Q Plot

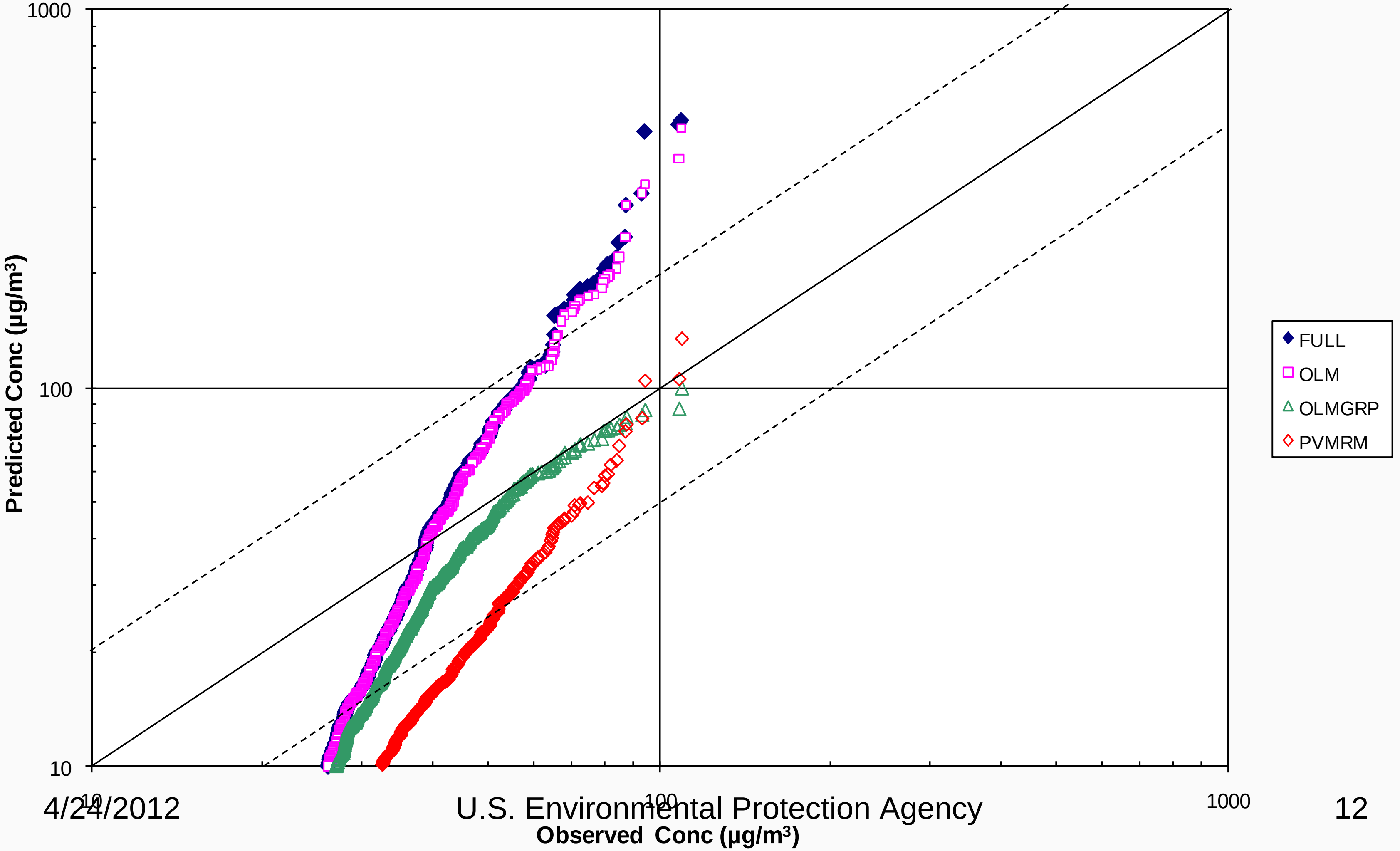


Figure A-2. AERMOD Model Evaluation - New Mexico South Monitor - Hourly NO2 Q-Q Plot

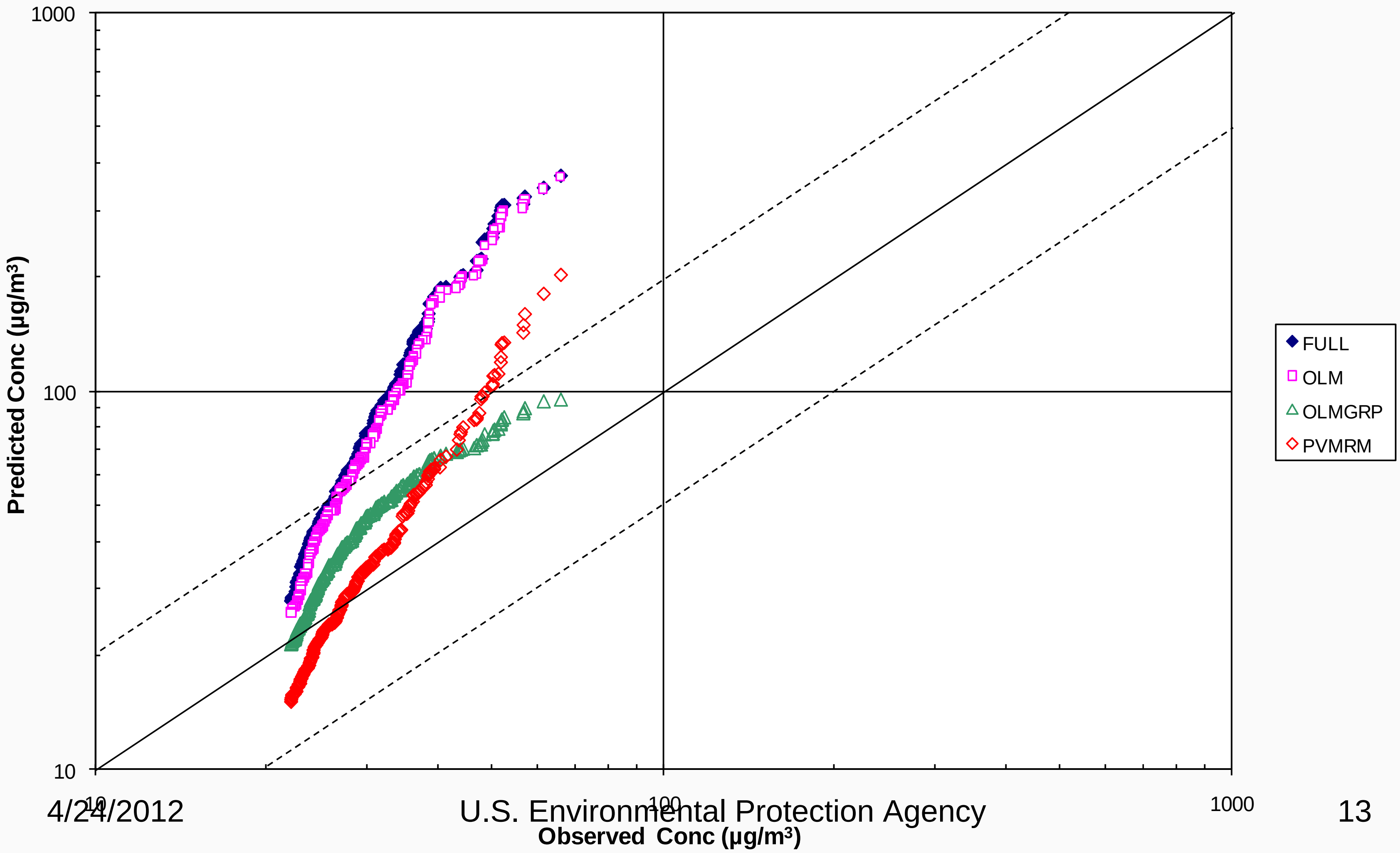
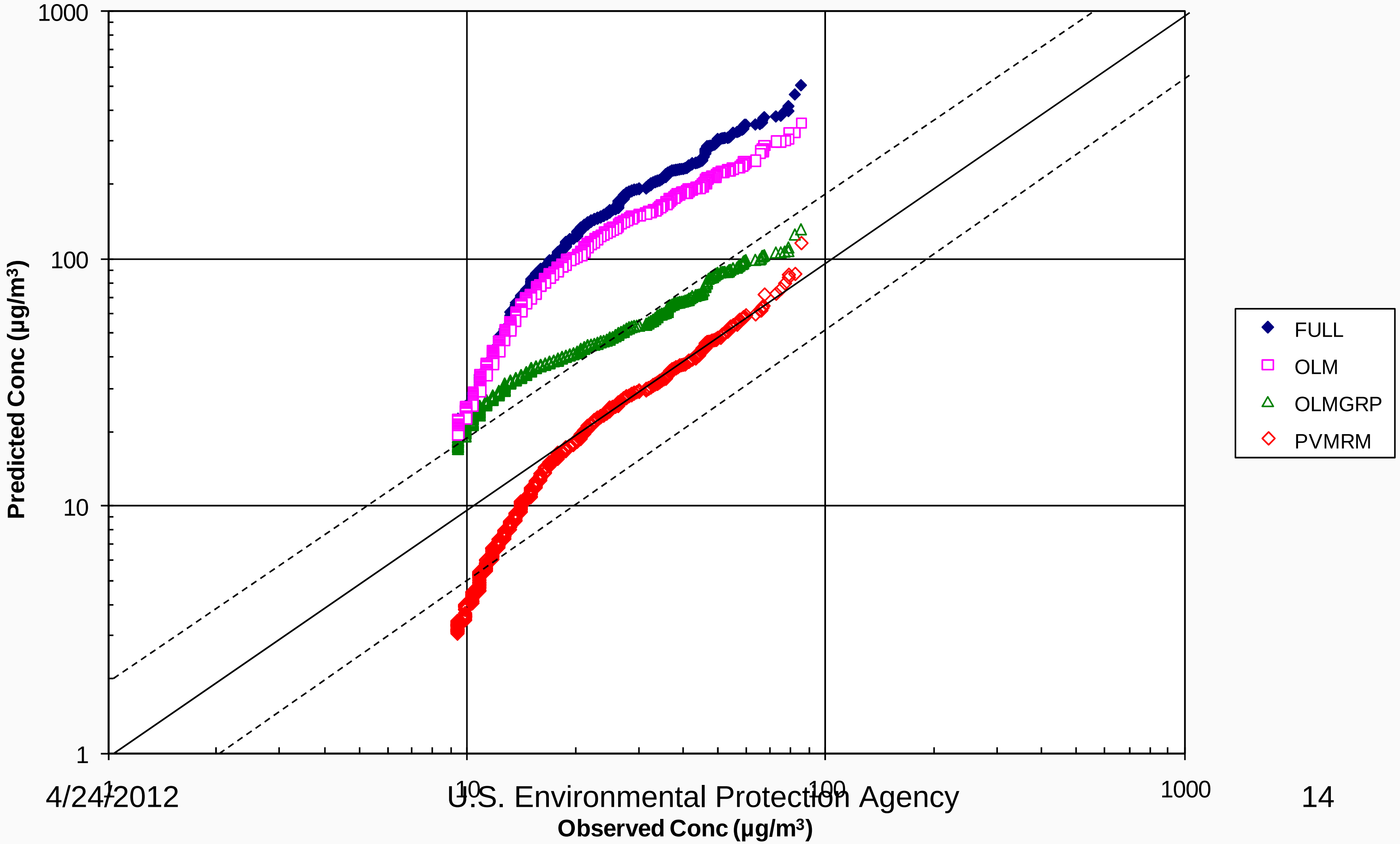


Figure A-3. AERMOD Model Evaluation - Palaau, HI - Hourly NO2 Q-Q Plot



SO_2 NAAQS

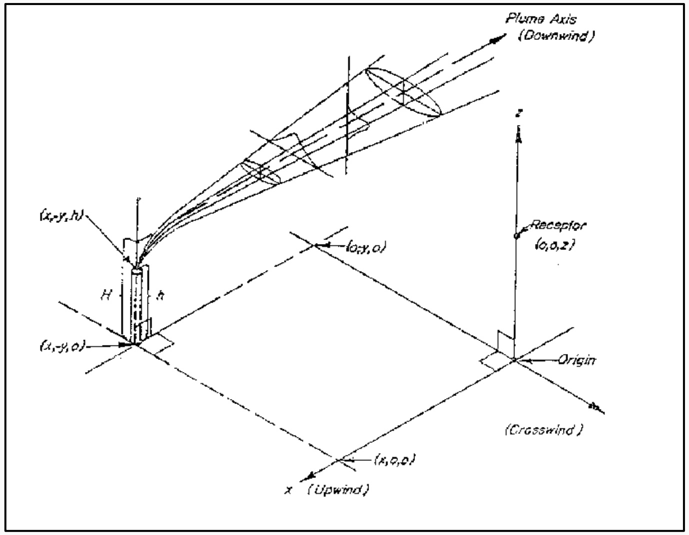
- SO_2 NAAQS revised June 2010
- Standard is 75 ppb based on 3-year average of the 99^{th} percentile of daily maximum 1-hour concentrations
- The 3 year averaging time for the NAAQS does not preempt or alter Appendix W to 40 CFR Part 51 requirement for use of 5 years of National Weather Service (NWS) meteorological data or at least 1 year of site-specific data.

Modeling Guidance for SO_2

- Clarification memo on applicability of Appendix W guidance for new 1-hour NAAQS issued in August 2010
  - The current guidance in Appendix W regarding SO2 modeling in the context of the previous 24-hour and annual primary SO2 NAAQS and the 3-hour secondary SO2 NAAQS is generally applicable to the new 1-hour SO2 standard.
  - AERMOD is the preferred model for estimating SO_2 impacts in near-field applications (out to 50 km)

SO_2: Nature of the Problem

- Ambient SO_2 is predominantly associated with source-oriented impacts, especially for coal-fired EGUs and other industrial sources
- Thus, dispersion models have historically been used to characterize ambient SO2 levels under PSD and SIP regulations



Can AERMOD Estimate 1-hr SO_2 Impacts?

- This question has been posed frequently in the context of the new 1-hr SO_2 NAAQS
- The potential role of modeling in 1-hr SO_2 SIPs (and designations) has also highlighted the importance of this question
- Since AERMOD uses an hourly time-step, all modeled concentrations (i.e., 1-hr, 3-hr, 24-hr and ANNUAL) are based on 1-hr estimates
- The answer to the question also depends on how the model is applied
  - In PSD modeling for comparison to the NAAQS we are interested in the peak of the concentration distribution unpaired in time and space
- Fortunately, the extensive model validation conducted to support promulgation of AERMOD provides relevant information

AERMOD Performance Evaluation

- Evaluated on total of **17 Field Study Databases**
  - 10 without Building Downwash, 7 with Downwash
  - 13 with Flat or Rolling Terrain, 4 with Complex Terrain
- Included Developmental and Independent Evaluations
  - Developmental evaluations conducted during development of model, with evaluation results informing model formulation
  - Independent evaluations conducted on separate data bases not included in developmental stage
- Included short-term and long-term studies
  - Short-term studies typically included controlled tracer releases with intensive monitoring network
  - Long-term studies based on SO_2 impacts from operating power plants

AERMOD Performance Evaluation

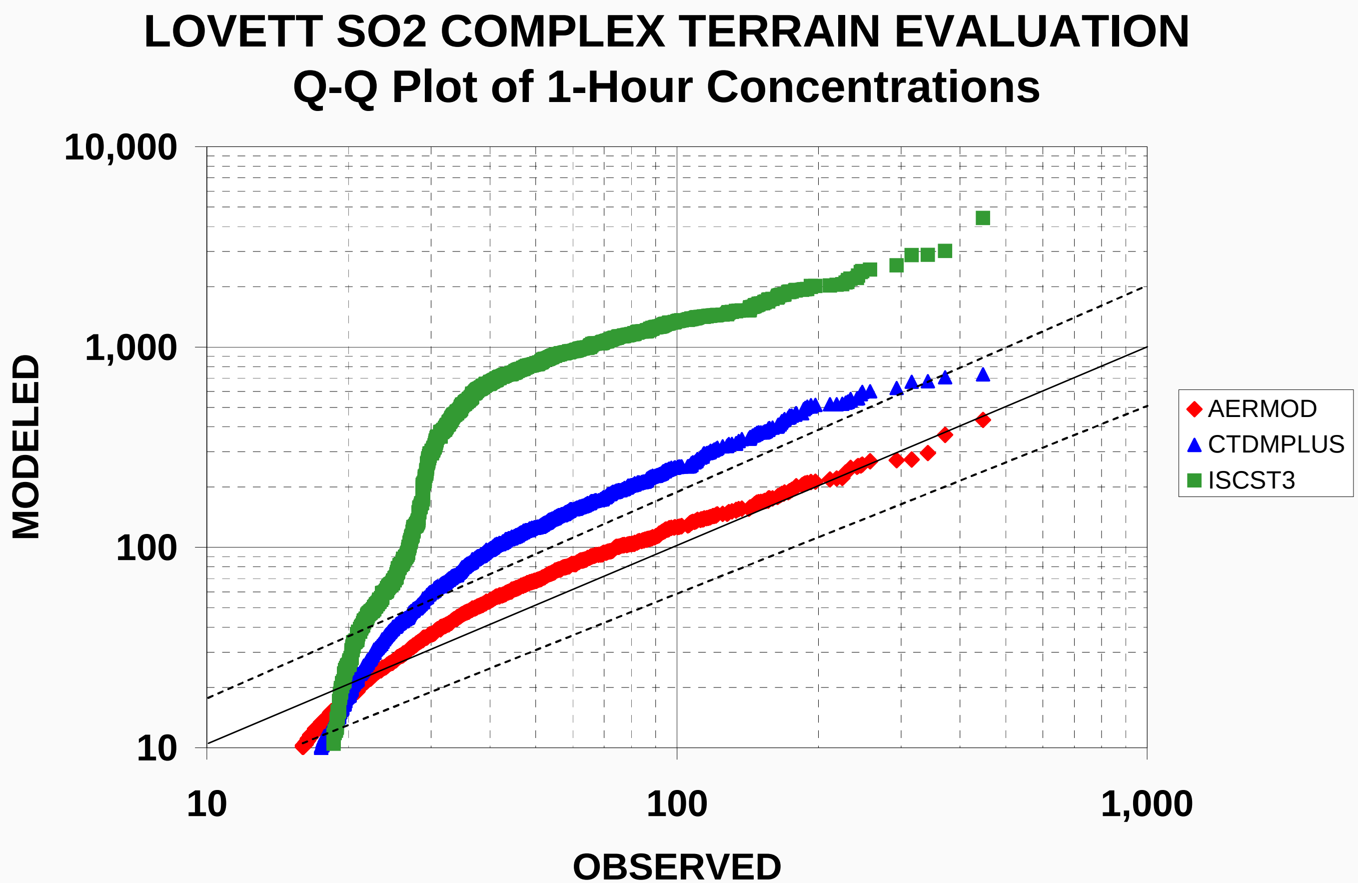
- Performance evaluation included a range of methods and metrics depending on the type of data available
  - Evaluation for long-term studies at operating power plants was based on EPA's Cox-Tikvart "Protocol for Determining Best Performing Model"
- AERMOD performance compared to other refined models:
  - ISC3 for non-downwash/non-complex-terrain databases
  - CTDMPLUS for complex terrain databases
  - ISC-PRIME for downwash databases
- AERMOD outperformed ISC3, ISC-PRIME and CTDMPLUS
- Average ratio of Pred/Obs 1-hr and 3-hr RHC* values across all field studies for AERMOD was 0.995.

* RHC=robust highest concentration, a metric proposed in Cox-Tikvart Protocol

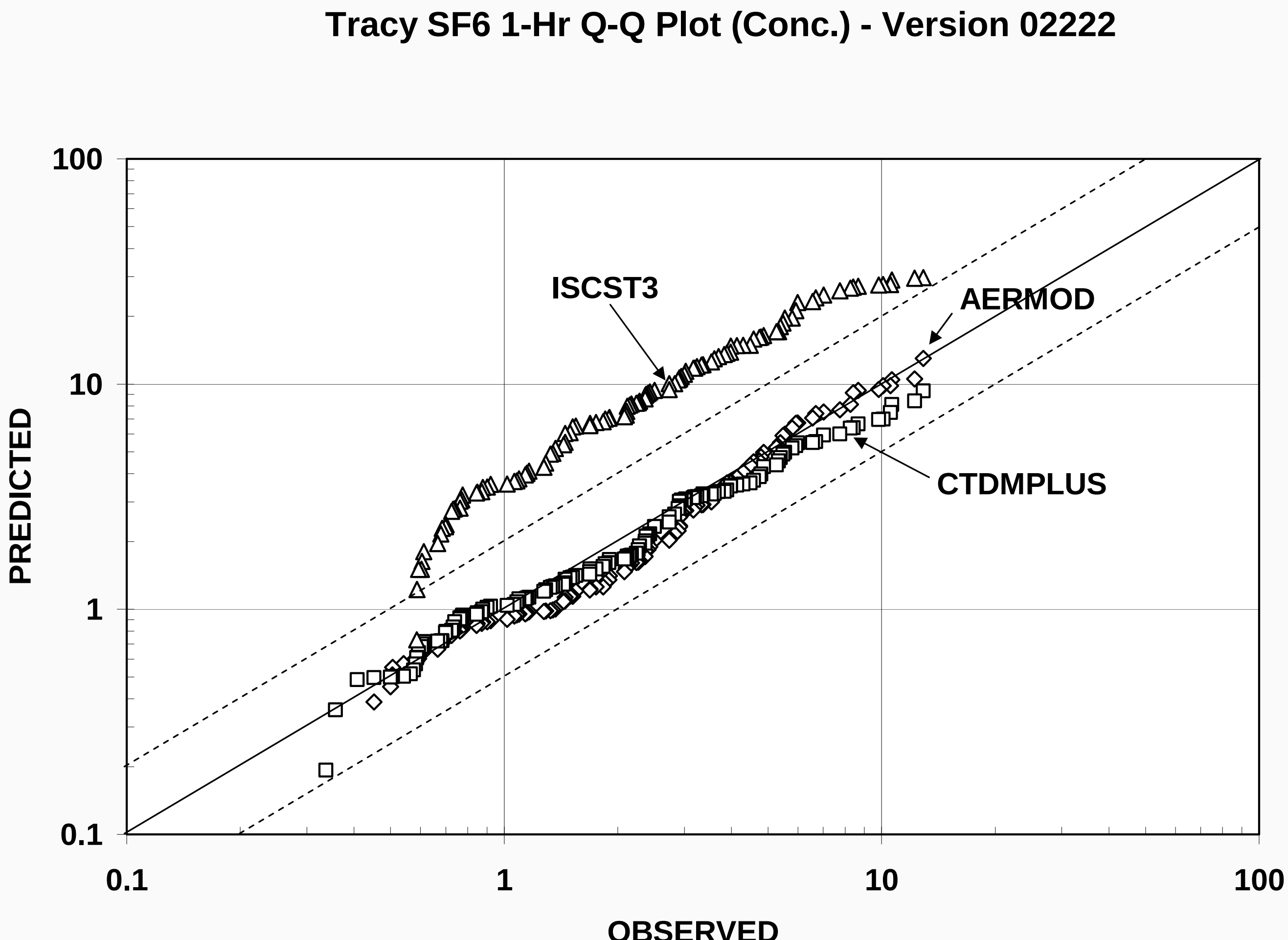
AERMOD Performance Evaluation

- The following slides document AERMOD model performance for estimating hourly concentrations from several field studies
- Results are summarized in Q-Q plots of highest ranked modeled vs. highest ranked observed concentrations, unpaired in time and space
- Solid diagonal line shows 1:1 (perfect agreement) and dashed lines show plus/minus factor of 2 agreement
- AERMOD exhibits consistently unbiased performance for estimating the distribution of peak hourly concentrations across a wide range of scenarios
- Performance of other models is included for comparison, demonstrating that model performance has significantly improved with AERMOD relative to models used in the past

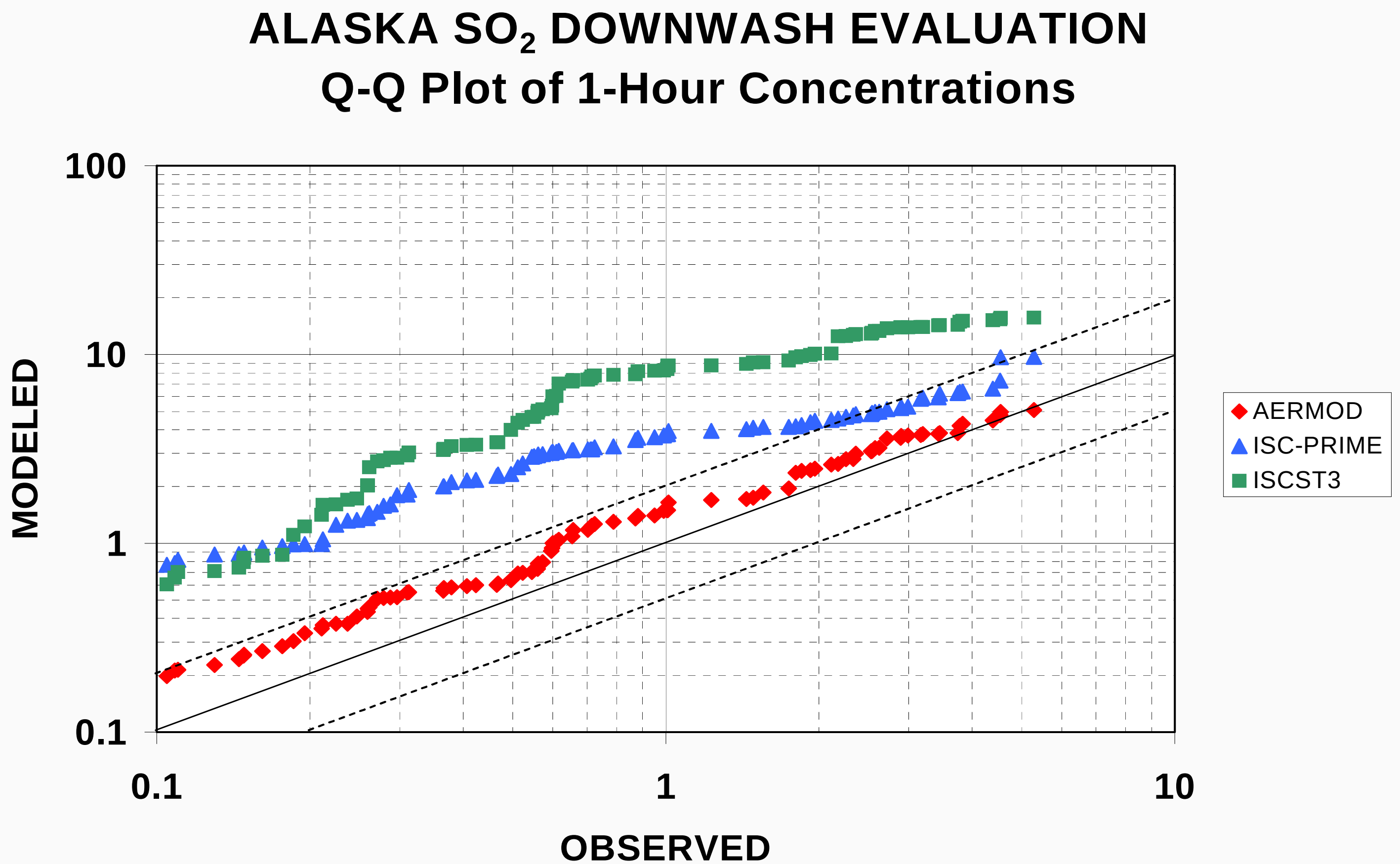
AERMOD Performance: Complex Terrain



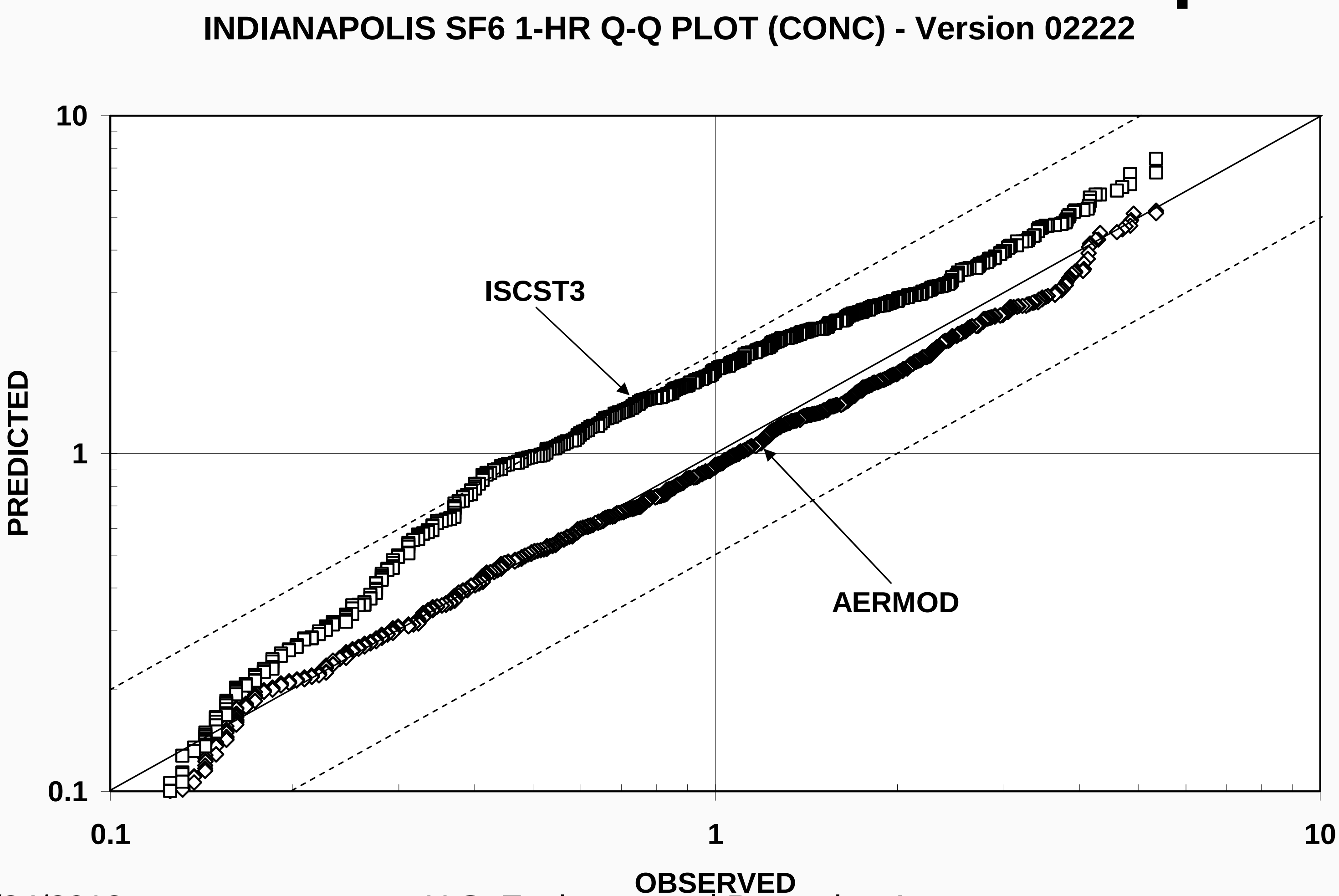
AERMOD Performance: Complex Terrain



AERMOD Performance: Building Downwash



AERMOD Performance: Urban Dispersion



Performance Evaluation Caveats

- Model performance evaluations typically include robust site-specific meteorological data and hourly actual emissions, removing as much uncertainty or bias associated with these key model inputs as possible
- Regulatory modeling applications for PSD permits are based on maximum allowable emissions, and typically use the most representative airport meteorological data
- Model evaluation field studies also include multiple monitoring sites designed to adequately capture ambient impacts; intensive field studies typically use arcs of receptors designed to capture the full plume, minimizing the sensitivity to errors in wind direction
- As a result of these factors, comparisons of PSD permit modeling results with observed concentrations at a single monitor are subject to misinterpretation and generally are not good indicators of model performance

Modeling Guidance for NO_2 & SO_2

- Additional guidance issued March 1, 2011
  - Clarifies procedures for analyzing results given form of NAAQS
  - For NO_2, recommends default 1-hour Tier 2 ambient ratio of 0.80, and default in-stack NO_2/NO_x ratio for OLM and PVMRM Tier 3 options of 0.50, **in the absence of more appropriate information**
  - Addresses treatment of intermittent emissions (e.g., emergency generators) in PSD modeling demonstrations, a key issue with implementation of the new 1-hour NAAQS
  - Discussion/recommendations regarding nearby background sources to include in modeling and combining modeled+monitored contributions for cumulative analysis

Form of 1-hour NO_2 & SO_2 Standards

- Form of the new 1-hour NAAQS complicates aspects of modeled compliance demonstrations
  - Comparison of project impacts to interim significant impact level (SIL) is based on multiyear average of highest 1-hour concentrations at each receptor, which is consistent with the maximum contribution that a source could make at that receptor
  - Significant contribution analysis examines whether project impacts contribute significantly to modeled violations paired in time and space, including all cases where cumulative impact exceeds the NAAQS at or below the 98^{th}-percentile for NO2 or 99^{th}-percentile for SO2
  - Recent AERMOD updates support these analyses

Modeling Guidance for NO_2 & SO_2

- Treatment of intermittent emissions
  - Intermittent emission sources may present challenge for demonstrating compliance with 1-hour NO_2 NAAQS assuming continuous operation
  - Given implications of the probabilistic form of the 1-hour NO_2 NAAQS, the March 1, 2011 memo highlights a concern that "*assuming continuous operations for intermittent emissions would effectively impose an additional level of stringency beyond that intended by the level of the standard itself*."
  - Recommends that "*compliance demonstrations for the 1-hour NO_2 NAAQS be based on emission scenarios that can logically be assumed to be relatively continuous or which occur frequently enough to contribute significantly to the annual distribution of daily maximum 1-hour concentrations*."
  - May be appropriate to address emergency/unscheduled operation separately from routine testing operations which may be scheduled

Modeling Guidance for NO_2 & SO_2

- Determining background concentrations
  - Cumulative analyses of ambient impacts is required if emissions from new or modified source exceed the interim SIL
  - March 1, 2011 memo addresses components of cumulative impact analysis, including identification of nearby sources to include in modeled inventory and combining modeled results with monitored background concentrations
  - Reiterates caution expressed in the June 2010 memo against the “literal and uncritical application of very prescriptive procedures” such as the 1990 draft NSR Workshop Manual:
    - Use of such prescriptive procedures will generally be acceptable for permit modeling, but may be overly conservative in many cases
    - Challenge will be to find the proper balance of competing factors that contribute to the analysis, considering the degree of conservatism associated with key assumptions – more conservative assumptions are likely to be less controversial during the review process, and vice versa.
    - March 1 memo also offers suggestions on key elements of documentation to facilitate the review of modeling demonstrations.

Modeling Guidance for NO_2 & SO_2

- Significant concentration gradient criterion
  - Appendix W identifies "*a significant concentration gradient in the vicinity of the source*" as the sole criterion for identifying which nearby sources to model
    - A concentration gradient is the rate of change of concentration with distance, and has two components, a longitudinal (along-wind) gradient and a lateral (cross-wind) gradient.
    - Both components are important, but the lateral gradient may be more important for this purpose.
  - Appendix W did not "*comprehensively define*" the term "*owing to both the uniqueness of each modeling situation and the large number of variables involved in identifying nearby sources*."
  - Significant concentration gradients in the vicinity of the source imply that the nearby source's potential interaction with the proposed source's impacts will not be represented well by monitored concentrations at a specific location

Modeling Guidance for NO_2 & SO_2

- Significant concentration gradient criterion
  - Concentration gradients are generally largest between the source and the location of maximum ground-level impacts, nominally about 10 times the release height in relatively flat terrain
  - This suggests focusing on nearby sources within about 10 kilometers of the project source in most cases
  - Every application entails case-specific considerations based on the dispersion characteristics of the project location (e.g., terrain influences), the location and characteristics of nearby sources, and the availability and representativeness of ambient monitoring data

Modeling Guidance for NO_2 & SO_2

- Combining modeled and monitored concentrations
  - The issues of which nearby sources to include in the modeled inventory and what monitored concentration to include in the cumulative assessment are interrelated, and depend on the circumstances of the specific case
  - If a demonstrably complete inventory of background sources is included in the modeling, then less conservative assumptions regarding the monitored component may be justified to avoid double counting of modeled and monitored impacts
  - Conversely, if a demonstrably conservative monitored concentration is used, then a less extensive (i.e., less conservative) modeled inventory may be justified
  - In either case, some assessment of what sources are contributing to the monitored concentrations should be included in the justification

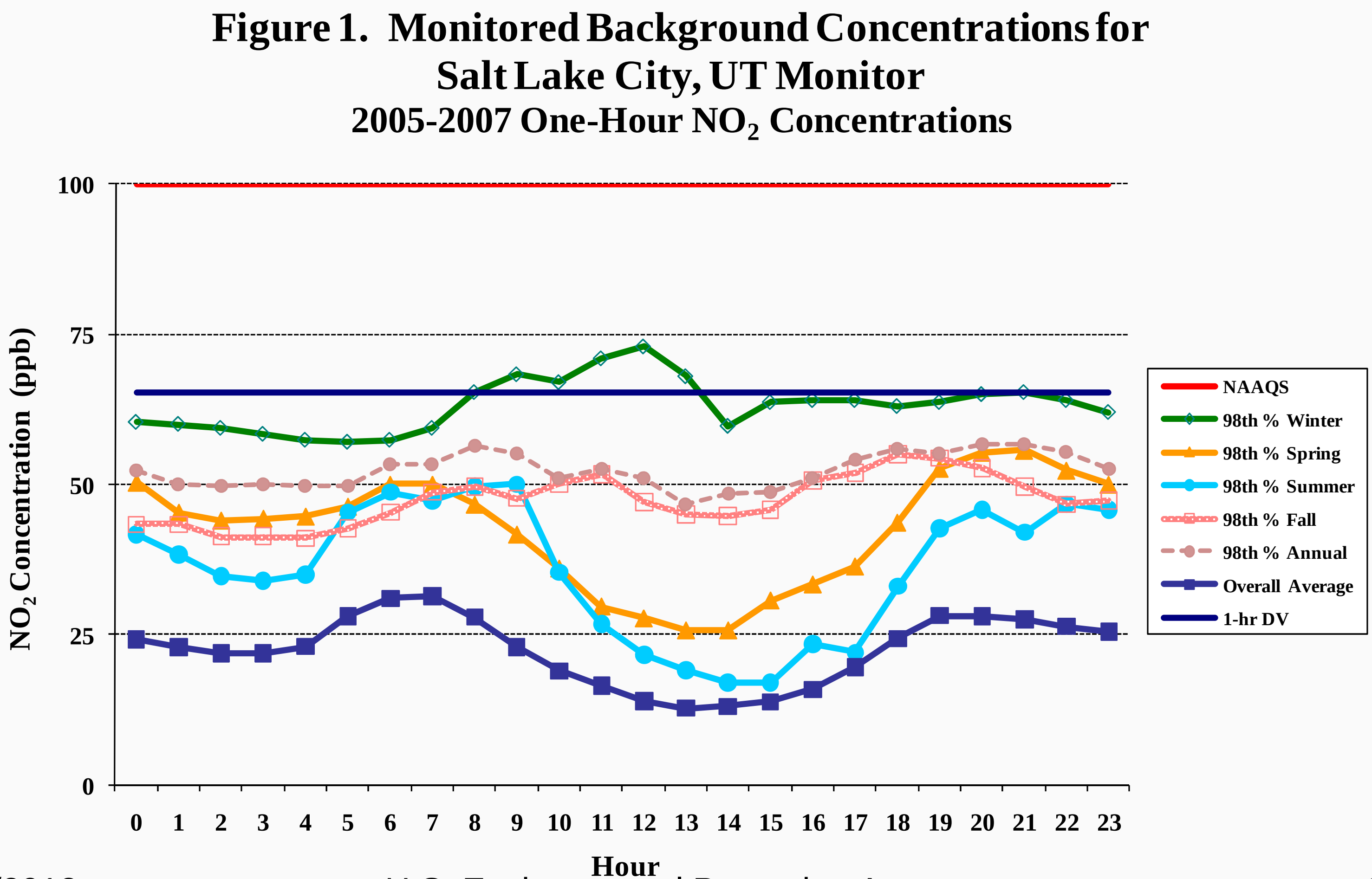
Modeling Guidance Example for NO_2

- Combining modeled and monitored concentrations
  - The June 29, 2010 memo identified the overall highest 1-hour monitored background NO_2 concentration as a “first tier” that should be acceptable without further justification
  - The March 1, 2011 memo suggests that the monitored design value (3-year average of the 98^{th}-percentile of the annual distribution of daily maximum 1-hour concentrations) should be acceptable as a less conservative “first tier” in most cases
  - Given the form of the 1-hour NO_2 NAAQS, and the role of background ozone concentrations in the Tier 3 OLM and PVMRM options, diurnal and seasonal patterns of concentrations, which reflect diurnal and seasonal patterns of both emissions and dispersion, may play a significant role in determining how best to combine modeled and monitored concentrations

Modeling Guidance Example for NO_2

- Combining modeled and monitored concentrations
  - Appendix W recommends that *"[f]or shorter averaging periods, the meteorological conditions accompanying the concentrations of concern should be identified*" and that *"[c]oncentrations for meteorological conditions of concern . . . should be averaged for each separate averaging time to determine the average background concentration*." (see Section 8.2.2.b)
  - Based on this guidance, the March 1, 2011 memo suggests that the use of "multiyear averages of the 98th-percentile of the available background concentrations by season and hour-of-day" is an appropriate methodology for the 1-hour NO_2 standard (see example on next slide)
    - The March 1, 2011 memo recommends using the 3rd-highest value by season and hour-of-day to represent the 98th-percentile of the monitored data
    - Use of the 98th-percentile values by season and hour-of-day is a simple surrogate for identifying the meteorological conditions of concern. Use of the overall average by hour-of-day (also shown on the next slide) is not recommended as it will also reflect concentrations during periods not of concern.

Background Concentration Example: NO_2



Technical Outreach Efforts for NO_2 & SO_2

- Modeling webinars
  - 1-Hour NO2
    - www.epa.gov/ttn/scram/webinar/1-Hour_NO2/NO2_Webinar_16June2011.pdf
  - 1-Hour SO2
    - http://www.epa.gov/ttn/scram/webinar/1-Hour_SO2/so2_implementation_webinar_1019.pdf
- AERMOD Implementation Workgroup (AIWG)
  - http://www.epa.gov/ttn/scram/10thmodconf/review_material/AIWG_Summary_v2.pdf

AERMOD Implementation Workgroup (AIWG)

- Re-aligned our AIWG to better understanding and address the permit modeling issues that we face under the new 1-hour NO2 and SO2
  - Workgroup composed of over 30 state/local/tribal agency modelers across 5 subgroups by Regional Office(s)
  - Based on workgroup input, modeling example scenarios of NO_2 and SO_2 to understand issues within existing EPA guidance
- Reported out initial findings at June 2011 R/S/L modelers workshop and shared at public session
- Provided findings at 10th Modeling Conference (March 2012)
- Report out findings at 2012 R/S/L modelers workshop next week (including new cumulative impact scenarios)

Draft $PM_{2.5}$ Permit Modeling Guidance

- We still intend to release the Draft $PM_{2.5}$ Permit Modeling Guidance in the near future for review and comment from the modeling community.
  - Discuss at 2012 R/S/L modelers workshop next week and release public review draft by mid-May
- The comments and feedback on the draft guidance are not directly connected to the 10^{th} Modeling Conference and will be welcome after the comment period / Docket for the Conference have officially closed.

Draft $PM_{2.5}$ Permit Modeling Guidance

- The final rules governing the implementation of the NSR program for $PM_{2.5}$ was promulgated on May 16, 2008.
  - Establishment of the Significant Emissions Rate (SER) for $PM_{2.5}$ and for the $PM_{2.5}$ Precursors which define the rates at which a net emissions increase will trigger major NSR permitting requirements. Any lower emissions increases are considered *de minimis*.
    - Direct $PM_{2.5}$ SER = 10 tpy
    - $PM_{2.5}$ Precursor – NO_x = 40 tpy and $PM_{2.5}$ Precursor – SO_2 = 40 tpy
  - This rule also included a “grandfathering provision” that allowed applicants for federal PSD permits to continue relying upon the PM_{10} Surrogate Policy.
- On February 11, 2010, the U.S. EPA published a proposal to repeal the grandfathering provision and an early end to the PM_{10} Surrogate Policy which occurred in May 2011

Draft $PM_{2.5}$ Permit Modeling Guidance

- To assist sources and permitting authorities in carrying out the required air quality analysis for $PM_{2.5}$ compliance demonstrations, a guidance memorandum entitled "Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS" was released on March 23, 2010.
  - Often referred to as the "Page Memo."
  - Addressed interim procedures to address the probabilistic form of the NAAQS.
  - Acknowledged that there are technical complications associated with the ability of existing models to estimate the impacts of secondarily formed $PM_{2.5}$.
  - Recommended special attention be given to the evaluation of monitored background air quality data since this data readily accounts for the contribution of both primary and secondarily formed $PM_{2.5}$.

NACAA $PM_{2.5}$ Modeling Implementation Workgroup

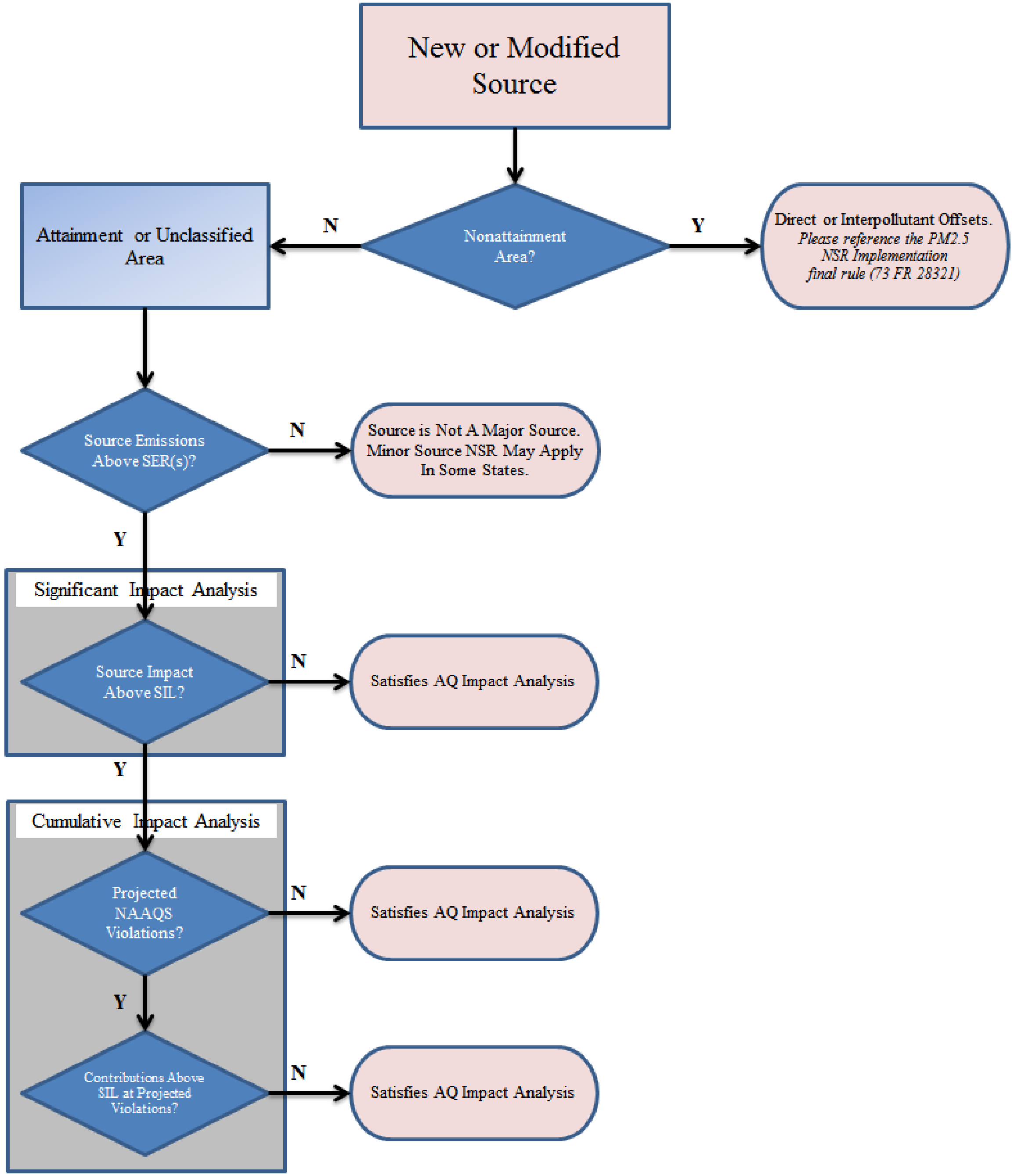
- Formed in Spring of 2010 at the request of the U.S. EPA to provide technical recommendations to the agency to aid in further development of $PM_{2.5}$ permit modeling guidance with focus on:
  - Emissions Inventories;
  - Secondary Formation from Project Source; and
  - Representative Background Concentrations
- On January 7, 2011, a final report was shared with the U.S. EPA with a compilation of these efforts and recommendations.
- This report is available for review on the 10th Modeling Conference web page on the SCRAM website:
  - http://www.epa.gov/ttn/scram/10thmodconf.htm

PSD Modeling of $PM_{2.5}$: Screening Nature, Consultation, & Protocol

- Given the potential contribution of secondary formation of $PM_{2.5}$ (not explicitly accounted for by dispersion models) and prominent role of background concentrations in the cumulative impact analysis, certain aspects of standard modeling practices used for other criteria pollutants may not be appropriate.
- As such, PSD modeling of $PM_{2.5}$ should be viewed as screening-level analysis analogous to the screening nature of Section 5.2.4 of App W for NO_2 impacts.

PSD Modeling of $PM_{2.5}$: Screening Nature, Consultation, & Protocol

- As stated in Section 5.2.2.1.c of Appendix W, the “[c]hoice of methods used to assess the impact of an individual source depends upon the nature of the source and its emissions. Thus, model users should consult with Regional Office to determine the most suitable approach on a case-by-case basis.”
- A modeling protocol should be developed and approved by the EPA Regional Office, the state/local agency, and the applicant to ensure that the analysis conducted will conform to the recommendations, requirements, and principles of Appendix W Section 3.2.2.


New or Modified Source
Nonattainment Area?
N
Y
Attainment or Unclassified Area
Direct or Interpollutant Offsets. Please reference the PM2.5 NSR Implementation final rule (73 FR 28321)
Source Emissions Above SER(s)?
N
Source is Not A Major Source. Minor Source NSR May Apply In Some States.
Y
Significant Impact Analysis
Source Impact Above SIL?
N
Satisfies AQ Impact Analysis
Y
Cumulative Impact Analysis
Projected NAAQS Violations?
N
Satisfies AQ Impact Analysis
Y
Contributions Above SIL at Projected Violations?
N
Satisfies AQ Impact Analysis

$PM_{2.5}$ Compliance Demonstration: Assessment Cases

- Case 1: If $PM_{2.5}$ emissions < 10 tpy and NO_x & SO_2 emissions < 40 tpy, then no $PM_{2.5}$ compliance demonstration is required.

- Case 2: If $PM_{2.5}$ emissions > 10 tpy and NO_x & SO_2 emissions < 40 tpy, then $PM_{2.5}$ compliance demonstration is required for direct $PM_{2.5}$ emission based on dispersion modeling, but no analysis of precursor emissions from the project source is necessary.

$PM_{2.5}$ Compliance Demonstration: Assessment Cases

- Case 3: If $PM_{2.5}$ emissions > 10 tpy and NO_x &/or SO_2 emissions > 40 tpy, then $PM_{2.5}$ compliance demonstration is required for direct $PM_{2.5}$ emission based on dispersion modeling, <u>AND</u> the applicant must account for impact of precursor emissions from the project source.
  - The assessment of the precursor emissions on the secondary formation of $PM_{2.5}$ could be completely qualitative in nature, could be a hybrid qualitative / quantitative approach, or may be a full photochemical modeling exercise.
  - We anticipate that only a handful of situations would require explicit photochemical modeling.

$PM_{2.5}$ Compliance Demonstration: Assessment Cases

- Case 4: If $PM_{2.5}$ emissions < 10 tpy and NO_x &/or SO_2 emissions > 40 tpy, then $PM_{2.5}$ compliance demonstration not required for direct $PM_{2.5}$ emissions and no analysis of precursor emissions from project source necessary (based on presumption that primary NO_2 and SO_2 NAAQS are controlling).
  - This case is still under review and consultation with the Policy Division and OGC.
  - Compliance with the NO_2 and SO_2 NAAQS are still required.

Modeling of Directly Emitted $PM_{2.5}$

- Cases 2 & 3 both require compliance demonstration for the direct $PM_{2.5}$ through dispersion modeling.
- Typical significant impact and cumulative impact analysis approach.
- Model Selection:
  - AERMOD, *EPA's preferred near-field dispersion model.*
- Model Considerations:
  - Modeling domain.
  - Source inputs.
  - Meteorological inputs.
  - Monitored background *(cumulative impact analysis)*

Assessment of Secondarily Formed $PM_{2.5}$

- Case 3 is the only case that requires some level of assessment of precursor emissions from a new or modified source on the secondary formation of $PM_{2.5}$.
- As stated previously, the assessment of the precursor emissions on the secondary formation of $PM_{2.5}$ could be completely qualitative in nature, could be a hybrid qualitative / quantitative approach, or may be a full photochemical modeling exercise.
- Consultation with the EPA Regional Office is paramount, including the approval of a modeling protocol that includes a well constructed conceptual description of the $PM_{2.5}$ for the region surrounding the project source.

Assessment of Secondarily Formed $PM_{2.5}$

- Qualitative only approach:
  - Situations where precursor emissions levels are marginally higher than the level of the SERs, monitored background levels are very low, and the primary $PM_{2.5}$ impacts are also very low such that the combination of the background and primary impacts are still well below the level of the NAAQS.
  - It is already a fair assessment that the primary $PM_{2.5}$ and the secondarily formed $PM_{2.5}$ concentrations will not be co-located in time and space.
  - Potentially augment with additional weight-of-evidence style discussion from recent SIP related photochemical modeling exercises in the region.
  - Recent Region 10 OCS drill ship permits are an example.

Assessment of Secondarily Formed $PM_{2.5}$

- Hybrid qualitative / quantitative approach:
  - In most situations, background concentrations in addition to the primary $PM_{2.5}$ impacts from the project source are already going to be relatively close to the NAAQS.
  - If a facility has sizable precursor emissions in such an environment, additional pseudo-quantitative analysis will be required beyond a weight-of-evidence style discussion.
  - The development of region specific offset ratios that can be applied to the precursor emissions to determine a related $PM_{2.5}$ concentration is one option.
  - Other techniques such as the development of a PM2.5 Impacts Screening Tool based on region specific photochemical modeling could be explored.

(Similar to the Environ Presentation on an ozone screening tool developed for Australia)

Assessment of Secondarily Formed $PM_{2.5}$

- Chemical transport modeling:
  - As described in the NACAA $PM_{2.5}$ Implementation Workgroup recommendations for their Tier III and Tier IV cumulative impact assessments, the use of a Lagrangian or Eulerian model may be required for very large sources with a tremendous net increase of $PM_{2.5}$ precursor emissions.
  - We anticipate this being the rare case, especially in light of compliance requirements of the recently revised 1-hour NO_2 and SO_2 NAAQS.
  - The Lagrangian models (e.g., SCICHEM) are an emerging technical resource that could meet needs for assessment of secondarily formed $PM_{2.5}$.
    (Discussed in greater detail at the 10th Modeling Conference by both EPA in terms of testing and evaluation and EPRI in terms of new release and open-source nature of code)

Assessment of Secondarily Formed $PM_{2.5}$

- Chemical transport modeling:
  - The Eulerian models (e.g. CAMx & CMAQ) are widely used for SIP attainment modeling purposed but have limited application thus far for single source impacts. (Discussed in greater detail at the 10th Modeling Conference by EPA in terms of testing and evaluation)
  - Several single source application techniques for the Eulerian photochemical models
    - Brute Force “Zero-Out”
    - Source Apportionment Techniques
    - Direct Decoupled Method (DDM)
    - Sub-Grid Treatment
  - Please note there are still a number of outstanding issues to resolve regarding use of photochemical models for single-source assessments

Monitored Background *(Cumulative Impact)*

- Representative background monitored concentrations of $PM_{2.5}$ will entail different considerations from those for other criteria pollutants.
- Monitored background $PM_{2.5}$ concentrations:
  - Should account for the contribution of secondary $PM_{2.5}$ formation associated with existing sources represented in the modeling domain.
  - Consideration should be given to the potential for double-counting the impacts from modeled emissions that may be reflected in the background monitoring
    - Likely not as important for secondary contributions.
    - There could be some issues if the monitor is located relatively close to a nearby source of primary $PM_{2.5}$.

Monitored Background *(Cumulative Impact)*

- It may be appropriate to account for seasonal variation in background $PM_{2.5}$ levels which may not be correlated with seasonal patterns of the modeled primary $PM_{2.5}$ levels.
  - Primary $PM_{2.5}$ of fugitive or low-level emission sources likely occur during winter months due to longer periods of stable atmospheric conditions.
  - Maximum levels of secondary $PM_{2.5}$ (in the eastern U.S.) typically occur during the spring and summer months due to high levels of sulfates.
  - Relative composition of $PM_{2.5}$ and temporal patterns associated with the highest daily $PM_{2.5}$ levels may differ significantly from that associated with the annual average $PM_{2.5}$ levels, especially in western states.

Comparison to the $PM_{2.5}$ NAAQS

- Combining the modeled and monitored concentrations of $PM_{2.5}$ for comparison to the NAAQS also entails considerations different from those for other criteria pollutants.
- The probabilistic form of the $PM_{2.5}$ NAAQS requires additional careful considerations.
- The representative monitored $PM_{2.5}$ design value should be used as a component of the cumulative analysis rather than the overall maximum monitored background concentration.
  - Annual $PM_{2.5}$ design value is based on a 3-year average of the annual average $PM_{2.5}$ concentrations.
  - Daily $PM_{2.5}$ design value is based on the 3-year average of the 98^{th} percentile 24-hour average $PM_{2.5}$ concentrations.
    - 8^{th} highest based on 365 daily samples in a year.
    - Reference Appendix N to 40 CFR Part 50 for other ranks.

Regulatory Status of CALPUFF

- April 15, 2003 promulgation for NAAQS and PSD increment
  - Distances from 50-km to 200-km, 300-km maximum (40 CFR 51, Appendix W, Section 6.2.3)
  - Complex Wind situation (40 CFR 51, Appendix W, Section 7.2.8)
- NOT approved for chemistry
  - 40 CFR Part 51 Appendix W does not identify a “preferred model” for use in attainment demonstrations of the NAAQS for ozone or PM2.5 or uniform rate of progress assessments for regional haze. Models used for these purposes should meet requirements for “alternative models” as defined under Section 3.2.
  - May be used for visibility (Appendix W, Section 6.2.1)
- Regulatory Status Under 40 CFR 51.308 (e)
  - Appendix Y (“BART Guidelines”) states “you may use CALPUFF or other appropriate model to predict the visibility impacts from a single source at a Class I area.”
  - Appendix Y does not confer status as EPA ‘preferred model’ for either secondary particulate matter or visibility

Status of CALPUFF v6.4

- V6.4 updates specific to chemistry do not allow the Agency to go through previous CALPUFF update process because it is outside of “approved regulatory use”.
- Such approval necessitates a regulatory update to Appendix W through notice and comment rulemaking that includes required public review and comment.
- Case by case approval as alternative model based on criteria given in Section 3.2 of Appendix W
- EPA informed model developer of that fact in Feb 2011 and that Interagency Workgroup on Air Quality Modeling (IWAQM) will be forum and process to inform that rulemaking process

Need for Agency to Address Chemistry under Appendix W

- Sierra Club filed a lawsuit against EPA on August 31, 2011 alleging that EPA is unreasonably delayed in :
  - responding to an administrative petition for rulemaking to identify air quality models for ozone and PM2.5 to use in evaluating applications for PSD permits under the Clean Air Act, and
  - taking action required under the Clean Air Act § 165(e)(3)(D) to designate such models through rulemaking.
- Gina McCarthy letter on January 4, 20121 granting Sierra Club petition . . .
  - to engage in rule making to evaluate updates to Appendix W and, as appropriate, incorporate new analytical techniques or models for ozone and secondary PM2.5.
  - use the existing process and procedures under Section 320 of the Clean Air Act (CAA) to complete the appropriate rulemaking process to update Appendix W.

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)
- Latest efforts by EPA and FLMs reported during 10th Modeling Conference session on "Emerging Models and Techniques"

IWAQM Phase 3: Initial Products

- Complete development, documentation and evaluation of the Mesoscale Model Interface (MMIF) program
  - Converts MM5 or WRF meteorological output to CALPUFF, AERMOD, and SCICHEM-ready meteorological inputs
- Document LRT model evaluation against tracer test data for CALPUFF (CALMET & MMIF), HYSPLIT, FLEXPART, SCIPUFF/SCICHEM, CMAQ and CAMx
  - 1992 European Tracer Experiment (ETEX)
  - 1983 Cross-Appalachian Tracer Experiment (CAPTEX)
  - 1980 Great Plains Tracer Experiment (GR80)
  - 1975 Savannah River Laboratory (SRL75)
- Comparison of single-source estimation techniques for O3 & AQRV
  - 2006 Eastern Utah and western Colorado (UT-CO) 12 m domain
  - 2005 Four Corners Air Quality Task Force (FCAQRF) 12/4 km domain
- Plume chemistry model evaluation (SCICHEM, CMAQ, etc)
  - TVA Cumberland Plume 1999 Southern Oxidant Study
  - 2000 TexAQS Aircraft Measurements

10^{th} Modeling Conference

- Held March 13-15, 2012 in Research Triangle Park, NC
- Formal public meeting mandated by CAA regulations every 3 years
- Public and private input on potential changes to EPA's Guideline on Air Quality Models
  - Status and update on current preferred air quality models (AERMOD and CALPUFF)
  - Modeling for compliance demonstrations for new 1-hour NAAQS and PM2.5
  - Review of new/emerging models and techniques for future consideration under Appendix W to address LRT and chemistry
- For agenda and materials please see EPA's SCRAM website at: http://www.epa.gov/ttn/scram/10thmodconf.htm

Current Action Items: AERMOD

- Clarification memo on AERMINUTE/AERMET to establish minimum wind speed threshold
- Follow up on low wind speed and downwash issues with stakeholder community (including EPA's ORD) to determine possible model formulation updates
- Consider near-term options for updates to NO2 Tier 2 ambient ratio method based on API sponsored approach, i.e., ARM2.
- Continue work with community on evaluation of NO2 Tier 3 techniques (OLM and PVMRM) and discuss potential for new field studies
- Work with modeling community on development of NO/NO2 in-stack ratio database

Current Action Items: CALPUFF

- Discussed ‘bug fixes’ with FLMs in early April and now working to address them in updated regulatory version of modeling system
  - Conduct assessment with update tool to determine implications
  - Document assessment and work with TRC (model developer) to formally release updated model code and documentation

Ongoing Agency Activities

- Emphasize flexibility in existing guidance (e.g., post-construction monitoring) and issue new guidance as necessary for new 1-hour NAAQS permitting and implementation and to address reactive pollutants
- Continue working with co-regulators and stakeholders especially through workgroups:
  - AERMOD implementation workgroup (AIWG) focusing on issues with model demonstrations of compliance for NO_2 and SO_2
  - Technical Workgroup of stakeholders that assisted EPA in planning agenda and speakers for 10^{th} Modeling Conference with plans to continue for improved communication/coordination
  - Interagency Workgroup on Air Quality Models (IWAQM) focusing on next generation model(s) to meet Federal program needs

Web Links of Interest

- Support Center for Regulatory Atmospheric Modeling (SCRAM)
    - http://www.epa.gov/scram001/
  - Links to AERMOD modeling system
    - http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod
  - SIP modeling guidance
    - http://www.epa.gov/ttn/scram/guidance_sip.htm
  - Guideline on Air Quality Models
    - http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf
  - Clarification memorandum
    - http://www.epa.gov/ttn/scram/guidance_clarificationmemos.htm

Contact Information

- For follow-up questions, please contact:

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