Revisions to the Guideline on Air Quality Models and Future Directions

Tyler Fox/George Bridgers, EPA/OAQPS

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OAR - OAQPS - AQAD
Air Quality Modeling Group

- Conducts air quality modeling for Agency regulatory and policy assessments
  - e.g., NOx SIP Call, Heavy Duty Diesel, Nonroad Rule, CAIR, CAMR, NAAQS RIAs
- Provides guidance for the use of air quality models for SIP demonstrations and NSR/PSD permitting
  - $O_3$/PM/RH Guidance
  - Guideline on Air Quality Models (aka Appendix W)
- Partners and coordinates w/ others (e.g., ORD, NOAA, scientific community, etc) on model evaluations and development efforts
Final Rule to Revise to the
Guideline on Air Quality Models
(Appendix W to 40 CFR Part 51)

Revised Guideline & AERMOD version

Original Effective Date

2016
Dec 20
Jan 17
Feb 16

FRM Published Federal Register

2017
May 22

Updated Effective
Background

• The *Guideline on Air Quality Models* (Guideline or “Appendix W” to 40 CFR Part 51) is used by the EPA, states, tribes, and industry to prepare and review permits for new sources of air pollution. State and tribal air agencies also use the Guideline to revise their plans detailing strategies for reducing emissions and improving air quality known as State or Tribal Implementation Plans.

• On December 20, 2016, the EPA...
  – finalized several additions and changes to its *Guideline*.
  – released a revised regulatory version of the preferred near-field modeling system, AERMOD, reflective of the final rule.

• The EPA expects the *Guideline* revisions and associated model enhancements will increase the efficiency and accuracy of regulatory modeling demonstrations.
Final Revisions to Appendix W

• The final rule was published in the Federal Register on January 17, 2017.
  - Federal Register Version of Final Rule is available on SCRAM.
  - Response to Comments Document can be found in the rule docket.

• 2017 Appendix W final rule information and supporting material / documentation is available via EPA’s SCRAM website:
  - [https://www3.epa.gov/ttn/scram/appendix_w-2016.htm](https://www3.epa.gov/ttn/scram/appendix_w-2016.htm)

• At publication, the effective date for the final rule was February 16, 2017.

• Per Presidential directives, the effective date for the Appendix W final rule was delayed until May 22, 2017.
  • No changes to PSD and Transportation Conformity transition periods of 1 and 3 years, respectively, from publication.
Appendix W: Main Final Actions

• Science improvements to AERMOD Modeling System
  – ADJ_U* options to address technical concerns and improve model performance under extremely light winds and stable conditions
  – Enhanced treatment of horizontal and capped stacks
  – Addition of a buoyant line source option
  – Updates to the NO2 screening techniques, including a new Tier 2 Ambient Ratio Method (ARM) and revised Tier 3 Plume Volume Molar Ratio Method (PVMRM)
  – AERSCREEN as the recommended screening model for simple and complex terrain for single sources

• Long Range Transport (LRT) screening approach
• Single-Source Impacts on Ozone and Secondary PM$_{2.5}$
• Removal of BLP, CALINE, and CALPUFF as EPA preferred models
Appendix W: Main Final Actions (cont)

• Provide for use of prognostic met data in dispersion modeling for PSD compliance demonstrations
  – Effort to provide more flexibility
  – Improve meteorological inputs for areas where:
    • No representative NWS station
    • Prohibitive or infeasible to collect adequate site-specific data
  – EPA provided the Mesoscale Model InterFace Program (MMIF) that post-processes WRF simulation data for input to AERMOD
    • Also, made publicly available both national, 12km raw WRF data and MMIF processed data for 2013-2015.
    • Coordinated with Multi-Jurisdictional Organizations (MJOs) in an effort to most effectively distribute this data to the states.
Information & Outreach

• EPA Webinars
  – Appendix W Overview: Feb 16, 2017
  – Prognostic Met Data: Mar 21, 2017
  – Draft MERPs Guidance: Jan 19, 2017
  – Single Source O3 & PM2.5: July 25, 2017

• Regional calls/mtgs with states
  – Region 5: Single Source O3 & PM2.5
  – OAQPS strongly recommended that EPA Regions conduct such calls to engage with states
Updates to EPA’s AERMOD Modeling System
Regulatory version of AERMOD

- The regulatory versions of the AERMOD dispersion model and AERMET meteorological processor have been updated;
  - AERMET updated to v16216, with Model Change Bulletin (MCB) MCB 7.
  - AERMOD updated to v16216r, with MCB 12.
- AERMOD and AERMET options NOT finalized in v16216
  - LOWWIND3 was proposed as a regulatory option in AERMOD but was not promulgated as a regulatory option in v16216 because it was found to have a potential for under prediction of concentrations, especially if used with ADJ_U* and/or with observed turbulence data.
AERMOD and AERMET options that were finalized in v16216

- Options now part of the regulatory default version (DFAULT)
  - ADJ_U* option in AERMET
    - Regulatory option when site-specific turbulence is not used, but NonDFAULT if turbulence data is used
  - Prognostic Met
    - Mesoscale Model Interface Program (MMIF)
    - POINTCAP, POINTHOR options
  - BLP fully integrated into AERMOD
AERMOD and AERMET options that were finalized in v16216 (cont.)

– NO2 Conversion:
  • ARM2 (replaced ARM);
  • PVMRM (known as PVMRM2 in v15181);
  • OLM (with OLMGROUP ALL);
  • NO2 options are “screening”. While these do not require alternative model approval, they do require approval by the appropriate reviewing authority;
  • Tier 3 methods require consultation with the regional office
Regulatory version of AERMOD (Cont.)

- December release of AERMOD v16216 was found to have bugs that did not affect concentrations:
  - BETA flag requirements, compilation issues on certain platforms
- Bug was identified that affected concentrations for AREACIRC sources in some cases;
- Need to retain 16216 version number for clarity related to versions with App W, but need to differentiate from original release of 16216 with bug fixes:
  - Output files will report “16216r” for clarity.
- EPA released Clarification Memo on March 8, 2017 regarding the use of AERMOD modeling system for SO2 implementation efforts
Status of AERSCREEN
AERSCREEN 16216

- AERSCREEN incorporated into Appendix W as recommended screening model
- Changes since 15181
  - Bug fix related to surface meteorological file when performing AERMOD screening and fumigation options
  - When using a BPIPPRIME building input file, AERSCREEN outputs the min dimensions that are greater than zero.
    - Dimensions of zero are still used in AERMOD runs in AERSCREEN
  - Allow the use of adjusted u* in AERSCREEN runs
    - Modified MAKEMET u* adjustment equations to match those in 16216 AERMET
Updates to 3-Tiered Demonstration Approach for NO$_2$
NO$_2$ Tier 2 and 3 Screening Techniques

- The EPA is finalizing several modifications to the NO$_2$ Tier 2 and 3 screening techniques incorporated into AERMOD as proposed.
- For the Tier 2 approach, the EPA is replacing the existing Ambient Ratio Method (ARM) option with a revised ARM2 option.
- Because ARM2 is based on hourly measurements of the NO$_2$ to NO$_X$ ratios and provides more detailed estimates of this ratio based on the total NO$_X$ present, the EPA is incorporating a modified version of ARM2 as the new second tier NO$_X$ modeling approach.
- As proposed, the default NO$_2$/NO$_X$ minimum ambient ratio (MAR) is revised to 0.5, but alternative MARs should not be overly difficult to justify when appropriate justification can be made.
- The EPA reaffirms that site specific data are always preferred, but provides nation default model inputs when these data are not available.
For the Tier 3 approach, the EPA is incorporating the existing detailed screening options of the Ozone Limiting Method (OLM) and Plume Volume Molar Ratio Method (PVMRM) into the regulatory version of AERMOD as regulatory (or DFAULT) options.

The EPA is replacing the previous PVMRM option with a revised PVMRM option (proposed with the option name PVMRM2), that utilizes relative dispersion coefficients to estimate plume volume during convective conditions and total dispersion coefficients during stable conditions.

Because of the additional input data requirements and complexities associated, the Tier 3 options shall be used for regulatory application in consultation (not approval as previous) with the EPA Regional Office and appropriate reviewing authority.
Status of CALINE3 Models
Summary of EPA Final Actions for Mobile Source Modeling

• Replaced CALINE3 with AERMOD as the Appendix A preferred dispersion model for mobile source modeling of inert pollutants

• 3-year grace period from CALINE3 to AERMOD
  – Proposed a 1 year transition period after final rule
  – Based on comments from external stakeholders, we extended period to 3 years

• While CALINE3 was replaced for refined modeling, CAL3QHC still allowed for screening modeling for CO
Addressing Single-Source Impacts on Ozone and Secondary PM$_{2.5}$
Final Action: Single-Source Impacts on Ozone and Secondary PM$_{2.5}$

- The EPA believes photochemical grid models are generally most appropriate for addressing ozone and secondary PM$_{2.5}$, because they provide a spatially and temporally dynamic realistic chemical and physical environment for plume growth and chemical transformation.
- Lagrangian models (e.g. SCICHEM) applied with a realistic 3-dimensional field of chemical species could also be used for single source O$_3$ or PM$_{2.5}$ assessments.
- The EPA has finalized in Section 5 of revised Guideline a two-tiered demonstration approach for addressing single-source impacts on ozone and secondary PM$_{2.5}$.
  - Tier 1 demonstrations involve use of technically credible relationships between emissions and ambient impacts based on existing modeling results or studies deemed sufficient for evaluating a project source’s impacts.
  - Tier 2 demonstrations would involve case-specific application of chemical transport modeling (e.g., with an Eulerian grid or Lagrangian model).
- Section 5 does not provide a requirement for chemical transport modeling.
Tier 1 Demonstration Tools

• For Tier 1 assessments, EPA generally expects that applicants would use existing empirical relationships between precursors and secondary impacts based on modeling systems appropriate for this purpose.

• The use of existing credible technical information that appropriately characterize the emissions to air quality relationships will need to be determined on a case-by-case basis.

• Examples of existing relevant technical information that may be used by a permit applicant, in consultation with the appropriate permitting authority, include
  – air quality modeling conducted for the relevant geographic area reflecting emissions changes for similar source types as part of a State Implementation Plan (SIP) demonstration, other permit action, or similar policy assessment
  – air quality modeling of hypothetical industrial sources with similar source characteristics and emission rates of precursors that are located in similar atmospheric environments and for time periods that are conducive to the formation of $O_3$ or secondary PM$_{2.5}$. 
MERPs as a Tier 1 Demonstration Tool

• EPA has provided technical guidance that will provide a framework for development of Tier 1 demonstration tools under Appendix W for PSD permitting.
  – Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program (EPA-454/R-16-006 December 2016)

• The draft guidance provides a framework on how to arrive at values for MERPs based on existing relevant modeling or newly developed area specific modeling that source/states can utilize in their PSD compliance demonstrations.
  – The guidance does not endorse a specific MERP value for each precursor.
  – Public comments made available on SCRAM on May 26, 2017

• Currently reviewing comments and plan to provide a revised version of the guidance in late 2017 that addresses public comments with emphasis on:
  – More clarity on use of MERPs at national, regional and local level with more detail in the examples provided in the guidance
Tier 2 Demonstrations: Case-Specific Modeling

• EPA anticipates few situations where a Tier 2 demonstration would be necessary, we expect most situations could be demonstrated under Tier 1

• No EPA preferred model so case-specific modeling conducted consistent with EPA guidance in consultation with the appropriate permitting authority
  – No alternative model approval but documentation should generally follow criteria in Section 3.2.2(e)
  – EPA issued clarification memorandum on 8/4/17 that provides for the general applicability of the CMAQ and CAMx photochemical models for permit related program demonstrations and NAAQS attainment demonstrations.

• Applicable guidance:
  – Guidance on the Use of Models for Assessing the Impacts of Emissions from Single Sources on the Secondarily Formed Pollutants: Ozone and PM2.5 (EPA-454/R-16-005 December 2016)
Status of CALPUFF and Assessing Long-Range Transport for PSD Increment and Regional Haze
Background

• The 2003 Guideline recommended CALPUFF as the preferred model for long-range transport (i.e., source receptor distances of 50 km to several hundred km) for primary criteria pollutants.
  – Largely applied to address PSD increment.

• CALPUFF also considered on case-by-case basis as an alternative model subject to approval under Section 3.2 for near-field applications where complex winds or terrain warranted use of a puff model.
Long-Range Transport Assessments: Section 4

- EPA has finalized the removal of CALPUFF as a preferred model for long-range transport and now considers it a screening technique along with other Lagrangian models for addressing PSD increment beyond 50 km from a new or modifying source without alternative model approval (per Section 4.2.1).

- For NAAQS demonstrations: Near-field modeling is sufficient to address whether a source will cause of contribute to a NAAQS violation so EPA does not consider a LRT assessment beyond 50 km necessary for inert pollutants.
  - CALPUFF or other Lagrangian models still available for use in near-field as an alternative model subject to approval under Section 3.2 for situations of complex terrain or complex winds (per Section 7.2.1.2).
Screening Approach for PSD Increment: Section 4

- EPA recognizes that LRT assessments may be necessary in limited situations so recommends a screening approach for PSD increment and for NAAQS where near-field compliance is not required or receptors of concern > 50 km (e.g., Outer-continental shelf).
  - First step: Based on near-field application of appropriate model, determine significance of ambient impact at or about 50 km from new/modifying source.
  - Second step: In consultation with EPA Regional Office, determine appropriate screening technique using CALPUFF or other Lagrangian model to determine significance of impacts at specific receptors such as Class I areas of concern.

- For very limited situations where a cumulative impact assessment is necessary, then selection and use of an alternative model by applicant with appropriate approval under Section 3.2.2(e).
Regional Haze Program

- In 2005, EPA issued guidelines for implementing BART requirements under Regional Haze Rule and recommended the use of CALPUFF for single-source assessments despite the lack of full evaluation for secondary pollutant formation.
- States could use alternative approaches, including photochemical model, if done in consultation with EPA Regional Office.
- Final revisions to the Guideline do not affect the EPA’s recommendation in the 2005 BART Guidelines to use CALPUFF in the BART determination process.
Summary

• EPA has removed CALPUFF as a preferred model for long-range transport and now considers it a screening technique along with other Lagrangian models without alternative model approval (per Section 4.2.1) for addressing PSD increment beyond 50 km from a new or modifying source.

• For NAAQS demonstrations, EPA does not consider a LRT assessment necessary beyond 50 km for inert pollutants except for situations where near-field compliance is not required (e.g., OCS source).

• No change in ability to use CALPUFF in the near-field as an alternative model if appropriately approved under Section 3.2.

• Flexibility to the user community in estimating single-source secondary pollutant impacts with emphasis on chemical transport models that include Lagrangian puff models and Eulerian grid (e.g., photochemical transport) models.
Role of EPA's Model Clearinghouse
EPA’s Model Clearinghouse

- In the final revisions to the *Guideline*, the EPA is codify the long-standing process of the Regional Offices consulting and coordinating with the Model Clearinghouse (MCH) on all approvals of alternative models and techniques.

- Restated… while the Regional Administrators are the delegated authority to issue such approvals under Section 3.2.2 of the *Guideline*, all alternative model approvals will be issued only after consultation with the EPA’s MCH and formal documentation through a concurrence memorandum that indicates that the alternative model requirements in section 3.2.2 have been met.
EPA’s Model Clearinghouse (Cont)

• The 1988 Model Clearinghouse Operational Plan was substantially revised and reissued (2016) with the Appendix W final rule.
  - Model Clearinghouse: Operational Plan - [EPA-454/B-16-008]

• It is anticipated that the action in the final rule along with the revision and public dissemination of the MCH Operational Plan will further streamline the MCH process and alternative model and technique approvals by clarifying it for the regulatory modeling community.

• Additionally, the revisions will ensure fairness, consistency, and transparency in modeling decisions across all EPA Regional Offices.
Updates to Modeling Procedures for Cumulative Impact Analysis
The EPA continues to caution against the literal and uncritical application of very prescriptive procedures for conducting NAAQS and PSD increments modeling compliance demonstrations as described in Chapter C of the 1990 draft New Source Review Workshop Manual. Following such procedures in a literal and uncritical manner has led to practices that are overly conservative and unnecessarily complicate the permitting process.

The EPA provided a renewed emphasis on the development and vetting of a modeling protocol with the appropriate reviewing authority to discuss aspects of the input data and assessment technique, to identify potential issues, and to help streamline the entire compliance demonstration process.

To assist with model protocol development, we revised the Air Quality Analysis Checklist and will continue to update based on Regional Office and reviewing authority feedback.
Source/Cumulative Impact Analyses

• The EPA updated the recommendations in Section 9.2.3 (NAAQS and PSD Increment Compliance Demonstrations for New or Modifying Sources) to more clearly and accurately reflect the longstanding practice of performing:
  – a Source Impact Analysis (SIA) as a first stage of the NAAQS and PSD increments compliance demonstration and, as necessary,
  – conducting a more comprehensive Cumulative Impact Analysis (CIA) as the second stage.

• Each stage should involve increasing complexity and details, as required, to fully demonstrate that a new or modifying source will not cause or contribute to a violation of any NAAQS or PSD increment.

• The appropriate considerations and applications of screening and/or refined model are described in each stage throughout Section 9.2.3.
- Source Impact Analysis (SIA) is the first stage of the NAAQS and PSD increments compliance demonstration.

- As necessary, the permit applicant may conduct a more comprehensive Cumulative Impact Analysis (CIA) as the second stage.
Modeling Domain

- Over the years, the EPA observed that modeling domains for compliance demonstrations had been expanding and often reaching well beyond 50km… sometimes including sources over 100km away with representative ambient monitoring between the distant source and the project location.
  - The EPA no longer endorses the overly conservative practices described in Chapter C, IV.B (Determining the Impact Area) of the draft Puzzle Book.

- The inclusion of larger and larger domains and more and more “nearby” sources added unnecessary burden and was/is inappropriate.
  - What may have “worked” under older and much less stringent NAAQS does not “work” with the implementation of the 2010 1-hour NO$_2$ and SO$_2$ NAAQS.
Modeling Domain (Cont)

• The **modeling domain** or proposed project’s impact area is defined as an area with a radius extending from the new or modifying source to:
  
  (1) The most distant location where air quality modeling predicts a significant ambient impact will occur, or
  
  (2) the nominal 50 km distance considered applicable for Gaussian dispersion models, *whichever is less*.

  - In most situations, the extent to which a significant ambient impact could occur from a new or modifying source likely will be *considerably less* than 50 km, i.e., no more than 10-20km.

  - The intent is to focus the source and cumulative impact analyses on addressing the real air quality issues of the new or modifying source under PSD and other CAA programs.
The discussion of design concentrations was substantially updated and unified from the previous version of the Guideline.

- For many cases, the best starting point would be use of the current design value for the applicable NAAQS as a uniform monitored background contribution across the project area. However, there are cases in which the current design value may not be appropriate.
- EPA does not recommend hourly or daily pairing of monitored background and modeled concentrations except in rare cases.
- The seasonal (or quarterly) pairing of monitored and modeled concentrations should sufficiently address situations to which the impacts from modeled emissions are not temporally correlated with background monitored levels.
- In all situations, additional considerations for the calculation of design concentrations should be discussed with the appropriate reviewing authority.
Receptor Sites & Background Concentrations

- As proposed, an expanded discussion on the establishment of receptor sites (density and location) in the modeling domain is provided in Section 9 to prevent issues with numerous and unreasonable successive revisions of the receptor network.

- In the final rule, there is an increased emphasis on understanding background concentrations, defined in Section 8.3 as including:
  - Nearby sources: “These are individual sources located in the vicinity of the source(s) under consideration for emissions limits that are not adequately represented by ambient monitoring data.”
  - Other sources: “That portion of the background attributable to natural sources, other unidentified sources in the vicinity of the project, and regional transport contributions from more distant sources (domestic and international).”
Background Concentrations: Nearby Sources

• Identification of “few” nearby sources to model
  – The discussion of significant concentrations gradient is expanded to help better identify the “nearby” source(s) that should also be explicitly modeled in the compliance demonstration.
  – The EPA signaled in the preamble of the final rule that it would continue to work with the stakeholder community to clarify and improve upon the existing technical guidance with respect to the development and analysis of significant concentration gradients from nearby sources.

• Characterizing nearby sources
  • Tables 8-1 and 8-2 have been amended as proposed with typographical error corrections to allow modeling of nearby sources using average actual emissions (operating level) based on the most recent 2-years of normal source operation.
Background Concentrations: Other Sources

- In the final rule, there is an increased emphasis on understanding and appropriately accounting for background concentrations.
  - In many cases, numerous “other” sources in proximity to the new or modifying source are represented with background monitoring data.
  - In many cases, the design value for the applicable NAAQS set as an uniform monitored background contribution is the best starting point for defining the appropriate metric to characterize background.
  - There should be considerations and/or appropriately justified adjustments made to the ambient monitoring data for times when the project source is impacting the ambient monitor or other circumstances when the ambient monitor is impacted by activities that are not typical or not expected to occur again in the future.
Background Concentrations: Other Sources

- That portion of the background attributable to all other sources (e.g., natural sources, minor and distant major sources) should be accounted for through use of ambient monitoring data and determined by procedures found in Section 8.3.2 in keeping with eliminating or reducing the source-oriented impacts from nearby sources to avoid potential double-counting of modeled and monitored contribution.
Updates on Use of Meteorological Input Data for Regulatory Dispersion Modeling
Prognostic Meteorology

• EPA Finalized Use of Prognostic Data
  – Effort to provide more flexibility
  – Improve meteorological inputs for areas where:
    • No representative NWS station
    • Prohibitive or infeasible to collect adequate site-specific data
  – Requires best professional judgement and consultation with reviewing authority.
  – Observed site-specific or adequately representative NWS data still preferred

• Mesoscale Model InterFace Program (MMIF)
  – Translates meteorological model output into dispersion model inputs
  – Generates inputs for AERMET/AERMOD, SCICHEM, etc.
  – Works on Linux and Windows-based systems
Next Steps & Future Directions

• SILs Guidance: Pacing item for release of MERPs guidance and PM2.5 Precursor Demo guidance

• This workshop emphasizes discussions with stakeholder community on the continued science improvement in AERMOD with ultimate release of an AERMOD Development Plan reflecting EPA priority areas (white papers):
  – LOWWIND options & saturated plumes
  – Downwash algorithms (updates and/or replace PRIME)
  – Mobile source modeling (RLINE)
  – NO2 modeling updates (Tier 3 methods)
  – Replacement of Offshore & Coastal Dispersion Model (OCD)

• Continued engagement with the stakeholder community leading up to the 12th Conference on Air Quality Models in late 2018.