Response to Comments on the Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter

December 20, 2016

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1.0 Introduction

The Environmental Protection Agency (EPA) on Wednesday, July 29, 2015 proposed to revise the *Guideline on Air Quality Models* (*Guideline*) (80 FR 45340). The *Guideline* is incorporated into the EPA's regulations, satisfying a requirement under the Clean Air Act (CAA) for the EPA to specify, with reasonable particularity, models to be used in the Prevention of Significant Deterioration (PSD) program. It provides the EPA-preferred models and other recommended techniques, as well as guidance for their use in estimating ambient concentrations of air pollutants. The proposed rule included enhancements to the formulation and application of the EPA's preferred near-field dispersion modeling system, AERMOD (American Meteorological Society (AMS)/EPA Regulatory Model), and the incorporation of a tiered demonstration approach to address the secondary chemical formation of ozone and fine particulate matter ($PM_{2.5}$) associated with precursor emissions from single sources. The EPA proposed to change the preferred status of and remove several air quality models from appendix A of the *Guideline*. The EPA also proposed to make various editorial changes to update and reorganize information throughout the *Guideline* to streamline the compliance assessment process.

A public hearing was conducted on the proposed rule in association with the Eleventh Conference on Air Quality Modeling, which was held on August 12-13, 2015 at the EPA Campus Auditorium in Research Triangle Park, NC. The public hearing was held on the second half of August 12th and on August 13th. A total of 26 public presentations were given at the public hearing. All of these presentations are included in the Docket (ID No. EPA-HQ-OAR-2015-0310) for the rule.[1]

Additionally, the EPA provided a 90-day public comment period that closed on October 27, 2015. A total of 101 public comments were received and are included in the Docket. Table 1 has a listing of the public comment Docket numbers and commenter names. There was one duplication of public comments received: EPA-HQ-OAR-2015-0310-0147 and EPA-HQ-OAR-2015-0310-0148. Additionally, one commenter provided supplemental information that was not appropriately received with their initial comment submission: EPA-HQ-OAR-2015-0310-0131 (original comment) and EPA-HQ-OAR-2015-0310-0153 (supplemental information). A list of acronyms and frequently used abbreviations are contained in Table 2.

The notice of final rulemaking signed by the Administrator presents the EPA's final regulatory conclusions and rule text, and includes summaries of and responses to several of the public comments received during the public comment period. This Response to Comments document presents further discussion of the public comments received and provides additional responses to those comments by the EPA. In some cases, the responses presented in this document provide more detail or elaboration than do corresponding responses in the notice of final rulemaking. In other cases, the responses in this document repeat or refer to the notice of final rulemaking as providing the EPA's complete response to the public comment at issue.

[1] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2015-0310-0001.

Table 1. Docket and Public Comments

Docket Number	Commenter
EPA-HQ-OAR-2015-0310-0028	Anonymous public comment
EPA-HQ-OAR-2015-0310-0031	N. N. Ahmedkhan
EPA-HQ-OAR-2015-0310-0052	American Iron and Steel Institute (AISI)
EPA-HQ-OAR-2015-0310-0053	Bob Paine, AECOM
EPA-HQ-OAR-2015-0310-0054	Bob Paine, AECOM
EPA-HQ-OAR-2015-0310-0055	Richard Hamel, Senior Air Dispersion Modeler, ERM
EPA-HQ-OAR-2015-0310-0056	Cathe Kalisz, API
EPA-HQ-OAR-2015-0310-0057	Bart Brashers and Ralph Morris, Ramboll Environ and Jason Maranche, Allegheny County Health Department
EPA-HQ-OAR-2015-0310-0058	David Heinold, AECOM on behalf of AF&PA and AWC
EPA-HQ-OAR-2015-0310-0059	Zachery Emerson, NCASI; Tim Hunt, AF&PA and Dave Heinold, AECOM
EPA-HQ-OAR-2015-0310-0060	Bob Paine, AECOM and Carlos Szembek, ERM
EPA-HQ-OAR-2015-0310-0061	Tom Wickstrom and Surya Ramaswamy, ERM
EPA-HQ-OAR-2015-0310-0062	David Long, Chair, Justin Walters Vice-Chair and Michael Hammer, Secretary, Air & Waste Management Association, Atmospheric Modeling and Meteorology (APM)
EPA-HQ-OAR-2015-0310-0063	David Long, Chair, Justin Walters, Vice-Chair, Michael Hammer, Secretary, Air & Waste Management Association and Atmospheric Modeling and Meteorology (APM)
EPA-HQ-OAR-2015-0310-0064	Christopher DesAutels et al., Exponent
EPA-HQ-OAR-2015-0310-0065	Biswanath Chowdhury, Sage Management - an Xator Company
EPA-HQ-OAR-2015-0310-0066	Ron Petersen, PhD, CCM, CPP, Inc.
EPA-HQ-OAR-2015-0310-0067	Sergio A. Guerra, CPP Inc.
EPA-HQ-OAR-2015-0310-0068	David J. Long, PE, American Electric Power Service Corporation (AEP)
EPA-HQ-OAR-2015-0310-0069	Chris Rabideau on behalf of the API Air Modeling Group
EPA-HQ-OAR-2015-0310-0070	Cindy Langworthy, Hunton & Williams LLP on behalf of UARG
EPA-HQ-OAR-2015-0310-0071	George J. Schewe, CCM, QEP, Trinity Consultants
EPA-HQ-OAR-2015-0310-0072	Jeffry D. Bennett, PE, Barr Engineering
EPA-HQ-OAR-2015-0310-0073	Rob Kaufmann, Koch Companies
EPA-HQ-OAR-2015-0310-0074	Mark Garrison, ERM
EPA-HQ-OAR-2015-0310-0075	Beth Barfield, ERM
EPA-HQ-OAR-2015-0310-0076	Eladio Knipping, and Naresh Kumar, Electric Power Research Institute (EPRI)
EPA-HQ-OAR-2015-0310-0077	Craig W. Butler, Director, Ohio Environmental Protection Agency (Ohio EPA)
EPA-HQ-OAR-2015-0310-0079	Bill Thompson, Chairman, National Tribal Air Association (NTAA)
EPA-HQ-OAR-2015-0310-0080	Jeffrey Kinder, Chief, Bureau of Air Pollution Control, Nevada Division of Environmental Protection (NDEP)
EPA-HQ-OAR-2015-0310-0081	Sean Alteri, Director, Kentucky Division for Air Quality

Docket Number	Commenter
EPA-HQ-OAR-2015-0310-0082	Arthur N. Marin, Executive Director, Northeast States for Coordinated Air Use Management (NESCAUM)
EPA-HQ-OAR-2015-0310-0083	Anda Ray, Vice President, Environment and Chief Sustainability Officer, Electric Power Research Institute (EPRI)
EPA-HQ-OAR-2015-0310-0084	Keith Baugues, Assistant Commissioner, Office of Air Quality, Indiana Department of Environmental Management (IDEM)
EPA-HQ-OAR-2015-0310-0085	Todd Parfitt, Director, Wyoming Department of Environmental Quality (WDEG)
EPA-HQ-OAR-2015-0310-0086	Bud Wright, Executive Director, American Association of State Highway and Transportation Officials (AASHTO)
EPA-HQ-OAR-2015-0310-0087	Catharine Fitzsimmons, Chief, Air Quality Bureau, Iowa Department of Natural Resources (DNR)
EPA-HQ-OAR-2015-0310-0088	Tamara L. McCandless, Chief, Branch of Air and Water Resources, U.S. Fish and Wildlife Service
EPA-HQ-OAR-2015-0310-0089	Richard A. Hyde, Executive Director, Texas Commission on Environmental Quality (TCEQ)
EPA-HQ-OAR-2015-0310-0090	Preston McLane, Program Administrator, Florida Department of Environmental Protection (DEP)
EPA-HQ-OAR-2015-0310-0091	Terri Lynn Sciarro, Owner/Member, Air Hub, LLC
EPA-HQ-OAR-2015-0310-0092	Leslie Sue Ritts, Counsel for National Environmental Development Association’s Clean Air Project (NEDA/CAP)
EPA-HQ-OAR-2015-0310-0093	Robert Opiela, Chief Executive Officer (CEO), NaviKnow, LLC
EPA-HQ-OAR-2015-0310-0094	Harold Gus Frank, Chairman, Forest County Potawatomi Community (FCPC)
EPA-HQ-OAR-2015-0310-0095	Paul E. Rosenfeld, Soil Water Air Protection Enterprise (SWAPE)
EPA-HQ-OAR-2015-0310-0096	Linda Geiser, Air Resource Management National Program Leader, USDA Forest Service
EPA-HQ-OAR-2015-0310-0097	Arthur N. Marin, Executive Director, Northeast States for Coordinated Air Use Management (NESCAUM)
EPA-HQ-OAR-2015-0310-0098	Myra C. Reece, Chief Bureau of Air Quality, South Carolina Department of Health and Environmental Control (DHEC)
EPA-HQ-OAR-2015-0310-0099	Denise Koch, Director, Division of Air Quality, Alaska Department of Environmental Conservation (ADEC)
EPA-HQ-OAR-2015-0310-0100	Jennifer Barclay, ModSIG Member, et al., Clean Air Society of Australia and New Zealand (CASANZ)
EPA-HQ-OAR-2015-0310-0101	Bradley C. Thomas, Supervisor, Environmental Permitting, Conoco Phillips
EPA-HQ-OAR-2015-0310-0102	Vipin K. Varma, Vice President, Air Quality and Director, Southern Region, and Zachery I. Emerson, Program Manager, National Council for Air and Stream Improvement (NCASI)
EPA-HQ-OAR-2015-0310-0103	Raymond L. Evans, Vice President, Environmental and Technologies, FirstEnergy (FE)
EPA-HQ-OAR-2015-0310-0104	Andrew J. Such, Director of Environmental and Regulatory Policy, Michigan Manufacturers Association (MMA)

Docket Number	Commenter
EPA-HQ-OAR-2015-0310-0105	David J. Long, Environmental Engineer - Principal, American Electric Power Service Corporation (AEPSC)
EPA-HQ-OAR-2015-0310-0106	David Thornton, Minnesota Co-Chair and Charlene Albee, Reno, Nevada Co-Chair, NACCA Emissions & Modeling Committee, National Association of Clean Air Agencies (NACAA)
EPA-HQ-OAR-2015-0310-0107	Patrick Coughlin, Senior Environmental Specialist, Duke Energy
EPA-HQ-OAR-2015-0310-0108	Steven M. Pirner, Secretary, South Dakota Department of Environmental and Natural Resources (DENR)
EPA-HQ-OAR-2015-0310-0109	Kyra L. Moore, Director, Missouri Department of Natural Resources Air Pollution Control Program (MDNR-APCP)
EPA-HQ-OAR-2015-0310-0110	Colin P. Carroll, Director, Environment, Health and Safety, American Iron and Steel Institute (AISI)
EPA-HQ-OAR-2015-0310-0111	Susan Haupt, Chief Environmental Officer, Oregon Department of Transportation (ODOT)
EPA-HQ-OAR-2015-0310-0112	Kimberly D. Mireles, Vice President, Environmental Services, Luminant Power
EPA-HQ-OAR-2015-0310-0113	Jayme Graham, Air Quality Program Manager, Allegheny County Health Department (ACHD), Pennsylvania
EPA-HQ-OAR-2015-0310-0114	Zachary M. Fabish, Staff Attorney, The Sierra Club
EPA-HQ-OAR-2015-0310-0115	Seth Johnson, Attorney, Earthjustice
EPA-HQ-OAR-2015-0310-0116	Jay Spehar, Manager, Environmental, Land and Sustainable Development, Freeport-McMoRan Miami, Inc. (FMMI)
EPA-HQ-OAR-2015-0310-0117	Shannon M. Lotthammer, Division Director, Environmental Analysis MS Outcomes Division, Minnesota Pollution Control (MPCA)
EPA-HQ-OAR-2015-0310-0118	Gail Good, Director, Air Management, Wisconsin Department of Natural Resources (WDNR)
EPA-HQ-OAR-2015-0310-0119	Debra J. Jezouit, et al., Baker Botts L.L.P. on behalf of Class of ’85 Regulatory Response Group
EPA-HQ-OAR-2015-0310-0120	Joshua M. Kindred, Environmental Counsel, Alaska Oil and Gas Association (AOGA)
EPA-HQ-OAR-2015-0310-0121	P. E. Rosenfeld
EPA-HQ-OAR-2015-0310-0122	Anonymous Public Comment
EPA-HQ-OAR-2015-0310-0123	Biswanath Chowdhury, Senior Engineer, Sage Management, Sage-Xator
EPA-HQ-OAR-2015-0310-0124	Lucinda Minton Langworthy, Counsel, Hunton Williams LLP for Utility Air Regulatory Group (UARG)
EPA-HQ-OAR-2015-0310-0125	Thomas A. Damiana, Air Quality Meteorologist/Engineer and Tiffany Samuelson, Air Quality Engineer, AECOM Environment
EPA-HQ-OAR-2015-0310-0126	Cathe Kalisz, Policy Advisor, Regulatory and Scientific Affairs, American Petroleum Institute (API)
EPA-HQ-OAR-2015-0310-0127	Erie C. Massey, Director, Air Quality Division, Arizona Department of Environmental Quality (ADEQ)

Docket Number	Commenter
EPA-HQ-OAR-2015-0310-0128	Company submitted by Jeffry D. Bennett, Senior Air Quality Engineer, Air Quality Modeling Practice Group Coordinator, Barr Engineering Company (Barr)
EPA-HQ-OAR-2015-0310-0129	Robin Ormerod, ModSIG Convenor, Clean Air Society of Australia and New Zealand, through its Modelling Special Interest Group (CASANZ ModSIG) et al.
EPA-HQ-OAR-2015-0310-0130	Mark Gebbia, Director, Environmental Services, The Williams Companies, Inc. (Williams)
EPA-HQ-OAR-2015-0310-0131	Tom Coulter, Coulter Air Quality Services
EPA-HQ-OAR-2015-0310-0132	Raymond L. Evans, Vice President, Environmental and Technologies, FirstEnergy (FE)
EPA-HQ-OAR-2015-0310-0133	John C. Vimont, Acting Chief, Air Resources Division, National Park Service Air Resources Division (NPS), Department of the Interior
EPA-HQ-OAR-2015-0310-0134	Zachary L. Craft, Baker Botts, L.L.P. on behalf of the Texas SO_2 Working Group
EPA-HQ-OAR-2015-0310-0135	Michael P. Lebeis, Principal Engineer, Environmental Management & Resources, DTE Energy Corporate Services, LLC
EPA-HQ-OAR-2015-0310-0136	Piotr Staniaszek, Director, Air and Acoustics, Prairies Region, SNC-Lavalin Inc.
EPA-HQ-OAR-2015-0310-0137	Tom Bachman for Terry L. O'Clair, Director Division of Air Quality, North Dakota Department of Health (NDDH)
EPA-HQ-OAR-2015-0310-0138	Laura J. Finley, Supervising Attorney, Air Quality Division, Oklahoma Department of Environmental Quality (ODEQ)
EPA-HQ-OAR-2015-0310-0141	Paul Noe, Vice President Public Policy, American Forest & Paper Association (AF&PA) and American Wood Council (AWC)
EPA-HQ-OAR-2015-0310-0142	Joseph C. Stanko Jr., Hunton & Williams LLP, Counsel for National Ambient Air Quality Standards (NAAQS)
EPA-HQ-OAR-2015-0310-0143	Barbara Sprungl, Manager, Salt River Project Agricultural Improvement & Power District (SRP)
EPA-HQ-OAR-2015-0310-0144	Michael F. Kennedy, Associate General Counsel, National Mining Association (NMA)
EPA-HQ-OAR-2015-0310-0145	Larry S. Monroe, Chief Environmental Officer, SVP Research and Environmental Affairs, Southern Company
EPA-HQ-OAR-2015-0310-0146	Carlos Swonke, Director of Environmental Affairs Director, Texas Department of Transportation (TxDOT)
EPA-HQ-OAR-2015-0310-0147	Joy Wiecks, Air Coordinator, Fond du Lac Band
EPA-HQ-OAR-2015-0310-0148	Joy Wiecks, Air Coordinator, Fond du Lac Band
EPA-HQ-OAR-2015-0310-0149	Quinlan J. Shea, III, Vice President, Environment, Edison Electric Institute (EEI)
EPA-HQ-OAR-2015-0310-0150	Lynn Fiedler, Division Chief, Air Quality Division, Michigan Department of Environmental Quality (MDEQ)

Docket Number	Commenter
EPA-HQ-OAR-2015-0310-0151	Karen D. Hays, Chief, Air Protection Branch, Georgia Environmental Protection Division (EPD)
EPA-HQ-OAR-2015-0310-0152	Seth Johnson, Attorney on behalf of Earthjustice
EPA-HQ-OAR-2015-0310-0153	Tom Coulter, Coulter Air Quality Services

Table 2. Explanation of Acronyms and Frequently Used Abbreviations

Acronym	Long Name
AEDT	Aviation Environmental Design Tool
AERMET	Meteorological data preprocessor for AERMOD
AERMINUTE	Pre-processor to AERMET to read 1-minute ASOS data to calculate hourly average winds for input into AERMET
AERMOD	American Meteorological Society (AMS)/EPA Regulatory Model
AERSURFACE	Land cover data tool in AERMET
AQRV	Air Quality Related Value
AQS	Air Quality System
ARM	Ambient Ratio Method
ARM2	Ambient Ratio Method 2
ASOS	Automated Surface Observing Stations
ASTM	American Society for Testing and Materials
Bo	Bowen ratio
BART	Best available retrofit technology
BID	Buoyancy-induced dispersion
BLP	Buoyant Line and Point Source model
BOEM	Bureau of Ocean Energy Management
BPIPPRM	Building Profile Input Program for PRIME
BUKLRN	Bulk Richardson Number
CAA	Clean Air Act
CAL3QHC	Screening version of the CALINE3 model
CAL3QHCR	Refined version of the CALINE3 model
CALINE3	CAlifornia LINE Source Dispersion Model
CALMPRO	Calms Processor
CALPUFF	Dispersion model
CALTRANS99	Field study, Highway 99, Sacramento, California
CAMx	Comprehensive Air Quality Model with Extensions
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality
CO	Carbon monoxide
CTDMPLUS	Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations
CTSCREEN	Screening version of CTDMPLUS
CTM	Chemical transport model
$d\theta/dz$	Vertical potential temperature gradient
DT	Temperature difference
EDMS	Emissions and Dispersion Modeling System
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FLAG	Federal Land Managers’ Air Quality Related Values Work Group Phase I Report
FLM	Federal Land Manager
GEP	Good engineering practice
GUI	Graphical user interface

Acronym	Long Name
Guideline	*Guideline on Air Quality Models*
ISC	Industrial Source Complex model
IWAQM	Interagency Workgroup on Air Quality Modeling
L	Monin-Obukhov length
MAKEMET	Program that generates a site-specific matrix of meteorological conditions for input to AERMOD
MAR	Minimum ambient ratio
MCH	Model Clearinghouse
MCHISRS	Model Clearinghouse Information Storage and Retrieval System
MERPs	Model Emissions Rates for Precursors
MM5	Mesoscale Model 5
MMIF	Mesoscale Model Interface
NAAQS	National Ambient Air Quality Standards
NCEI	National Centers for Environmental Information
NH_3	Ammonia
NO	Nitric oxide
NOAA	National Oceanic and Atmospheric Administration
NO_X	Nitrogen oxides
NO_2	Nitrogen dioxide
NSR	New Source Review
NTI	National Technical Information Service
NW	National Weather Service
OCD	Offshore and Coastal Dispersion Model
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OLM	Ozone Limiting Method
PCRAMMET	Meteorological Processor for dispersion models
P-G stability	Pasquill-Gifford stability
$PM_{2.5}$	Particles less than or equal to 2.5 micrometers in diameter
PM_{10}	Particles less than or equal to 10 micrometers in diameter
PRIME	Plume Rise Model Enhancements algorithm
PSD	Prevention of Significant Deterioration
PVMRM	Plume Volume Molar Ratio Method
r	Albedo
RHC	Robust Highest Concentration
RLINE	Research LINE source 33 model for near-surface releases
SCICHEM	Second-order Closure Integrated Puff Model
SCRAM	Support Center for Regulatory Atmospheric Modeling
SCREEN3	A single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources
SDM	Shoreline Dispersion Model
SILs	Significant impact levels
SIP	State Implementation Plan

Acronym	Long Name
SMAT	Software for Model Attainment Test
SO_2	Sulfur dioxide
SRDT	Solar radiation/delta-T method
TSD	Technical support document
u	Values for wind speed
u*	Surface friction velocity
VOC	Volatile organic compound
w*	Convective velocity scale
WRF	Weather Research and Forecasting model
zi	Mixing height
Zo	Surface roughness
Zic	Convective mixing height
Zim	Mechanical mixing height
σv, σw	Standard deviation of horizontal and vertical wind speeds

2.0 Final Action

2.1 Clarifications to Distinguish Requirements from Recommendations

Support of proposal

Comment:

Commenters (0080 and 0106) stated their support, overall, for the proposed changes to the *Guideline*. NDEP (0080) stated the proposed *Guideline* is well organized and clear. A commenter (0106) stated that the changes will improve clarity for both air regulators and the regulated community.

A commenter (0109) supports the use of mandatory language to establish requirements for modeling procedures when conducting air quality analyses. The commenter further stated the introduction of mandatory language should promote consistency within the modeling community and should reduce confusion over which modeling practices are acceptable. In addition, the retention of recommendations within the *Guideline* promotes flexibility and allows states to determine how to appropriately characterize industrial facilities within the air quality model.

A commenter (0128) stated the concept of providing additional clarity that some modeling paradigms should be considered "requirements" is acceptable. This is especially true given the case-by-case nature of many of the approaches considered throughout the revised *Guideline* as it promotes additional certainty for project proposers, while still allowing the best technical choices to be made in each circumstance.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*.

Recommendations vs. Requirements

Comment:

One commenter (0098) does not believe the revisions from "recommended" language (replacing "should" or "may" with "shall" or "must") is warranted at this time.

Response:

As discussed in the preamble to the proposed rule, the EPA's PSD permitting regulations specify that "[a]ll applications of air quality modeling involved in this subpart shall be based on the applicable models, data bases, and other requirements specified in appendix W of this part (Guideline on Air Quality Models)." 40 CFR 51.166(l)(1); see also 40 CFR 52.21(l)(1). The "applicable models" are the preferred models listed in appendix A to appendix W to 40 CFR part 51. However, there was some ambiguity in the past with respect to the "other requirements" specified in the *Guideline* that must be used in PSD permitting analysis and other regulatory modeling assessments.

Ambiguity could arise because the *Guideline* generally contains "recommendations" and these recommendations are expressed in non-mandatory language. For instance, the *Guideline* frequently uses "should" and "may" rather than "shall" and "must." This approach is generally preferred throughout the *Guideline* because of the need to exercise expert judgment in air quality analysis and the reasons discussed in the *Guideline* that “dictate against a strict modeling ‘cookbook’.” 40 CFR part 51, appendix W, section 1.0(c).

Considering the non-mandatory language used throughout the *Guideline*, the EPA’s Environmental Appeals Board observed:

“Although appendix W has been promulgated as codified regulatory text, appendix W provides permit issuers broad latitude and considerable flexibility in application of air quality modeling. Appendix W is replete with references to “recommendations,” “guidelines,” and reviewing authority discretion.”

In Re Prairie State Generating Company, 13 E.A.D. 1, 99 (EAB 2005) (internal citations omitted).

Although this approach appears throughout the *Guideline*, there are instances where the EPA does not believe permit issues should have broad latitude. Some principles of air quality modeling described in the *Guideline* must always be applied to produce an acceptable analysis. Thus, to promote clarity in the use and interpretation of the revised *Guideline*, we are finalizing the specific use of mandatory language, as proposed, along with references to “requirements,” where appropriate, to distinguish requirements from recommendations in the application of models for regulatory purposes.

Comments on Requirements in the Guideline

Comment:

A commenter (0138) stated that Section 4.2 should not broadly be titled “Requirements” when it mainly includes discussion related to models under Sections 4.2.1, 4.2.1.1, 4.2.1.2, 4.2.1.3, 4.2.2, 4.2.2.1, 4.2.2.2, 4.2.2.3, and the actual requirements are contained in Section 4.2.3 Pollutant Specific Modeling Requirements.

Response:

The EPA believes the title of Section 4.2 “Requirements” is appropriate. Section 4.2, including subsections listed by the commenter, specifies applicable requirements and limitations, while also listing and briefly describing recommended screening models and techniques and preferred refined models.

Comment:

A commenter (0138) stated that all statements in appendix A of appendix W are requirements that must be met, otherwise the model is determined to be an “Alternative Model” requiring approval of the Regional Administrator and the Modeling Clearinghouse.

Response:

The EPA agrees that all statements in appendix A of appendix W are applicable requirements for the listed models, and, as stated in the final revisions to the *Guideline*, the preferred models listed in appendix A of appendix W do not require additional approval by the Regional Administrator as is required for an alternative model under Section 3.2.

2.2 Updates to the EPA's AERMOD Modeling System

2.2.1 Incorporation of the ADJ_U* Option into AERMET

Support for Proposed Changes

Comment:

Multiple commenters (0077, 0081, 0083, 0084, 0089, 0092, 0098, 0099, 0103, 0132, 0106, 0107, 0109, 0110, 0113, 0118, 0119, 0120, 0127, 0124, 0126, 0128, 0134, 0135, 0141, 0142, 0144, 0145, 0149, 0150, and 0151) support the incorporation of ADJ_U* into AERMET as a regulatory option.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline* to incorporate the ADJ_U* option into AERMET as a regulatory option.

Clarify the Status of ADJ_U as a Regulatory Default*

Comment:

A number of commenters (0077, 0081, 0089, 0098, 0103, 0132, 0109, 0110, 0113, 0118, 0119, 0120, 0127, 0124, 0126, 0135, 0142, 0149, and 0150) stated ADJ_U* should be incorporated as a regulatory default option, though one commenter (0113) stated there may be circumstances where it may not be applicable.

Response:

Based on the results of a detailed evaluation submitted by a commenter (0114) and further evaluation by the EPA, and MCH request memoranda received after proposal that noted the potential for underprediction when the ADJ_U* option is used in combination with measured turbulence, the EPA is adopting the proposed ADJ_U* option in AERMET as a regulatory option but not a regulatory default option. The EPA is adopting the proposed ADJ_U* option as a regulatory option for use in AERMOD for sources using standard NWS airport meteorological data, site-specific meteorological data without turbulence parameters, or prognostic meteorological inputs derived from prognostic meteorological models.

Comment:

Commenters (0124 and 0119) stated that the proposed rule was not clear whether ADJ_U* was a regulatory default, and the EPA should clarify this in the final rule. Commenter 0119 stated that if the EPA does not make ADJ_U* a regulatory default option, then guidance should be provided to determine when the option should be used.

Response:

See the EPA's response to these comments in the preamble to the final rule and appendix A of this document. The status of the ADJ_U* option as a regulatory option has been clarified in the final rule. Based on the results of a detailed evaluation submitted by a commenter (0114) and further evaluation by the EPA to related comments, and MCH request memoranda received after proposal that noted the potential for underprediction when the ADJ_U* option is used in combination with measured turbulence, the EPA is adopting the proposed ADJ_U* option in AERMET as a regulatory option for use in

AERMOD for sources using standard NWS airport meteorological data, site-specific meteorological data without turbulence parameters, or prognostic meteorological inputs derived from prognostic meteorological models.

Comment:

Commenter 0119 stated that if the EPA does not make ADJ_U* a regulatory default option, then guidance should be provided to determine when the option should be used.

Response:

Based on the EPA's further evaluation of the Beta options in response to public comments, the EPA has determined that ADJ_U* should not be used in AERMET in combination with turbulence data. The EPA is adopting the proposed ADJ_U* option in AERMET as a regulatory option, but **not** a regulatory default. In a regulatory application of AERMOD, the ADJ_U* can be applied and is preferred when using standard NWS airport meteorological data, site-specific meteorological data **without** turbulence parameters, or prognostic meteorological inputs derived from prognostic meteorological models. The EPA's evaluation, as presented in appendix A of this Response to Comments document, shows that ADJ_U* has a tendency to underpredict when the ADJ_U* option is used in combination with site-specific turbulence measurements.

Low Wind Options Underpredict Impacts

Comment:

Multiple commenters (0114, 0121, 0095, and 0128) stated that the low wind options underpredict impacts and need further evaluation. Commenter 0114 stated that applying these options to the original validation studies performed for AERMOD erratically and in some cases quite significantly reduce modeled impacts, particularly so in the case of the Tracy validation study data. The commenter also submitted a technical analysis to demonstrate that the proposed changes to AERMOD decrease model accuracy.

Response:

As discussed in the preamble to the final rule, through further evaluation of the Tracy and the 1974 Idaho Falls field studies, to evaluate public comments, the EPA found that underprediction can occur when the ADJ_U* option is used in combination with site specific turbulence measurements, *i.e.*, sigma-theta (the standard deviation of horizontal wind direction fluctuations) and/or sigma-w (the standard deviation of the vertical wind speed fluctuations). The results of the EPA's evaluation of the low wind options (ADJ_U* and LOWWIND3) are provided in appendix A of this of this Response to Comments document.

The results of the EPA's further evaluation of the low wind options (ADJ_U* and LOWWIND3) in appendix A of this of this Response to Comments document confirm good performance for the Tracy field study using the full set of meteorological inputs with the default options (*i.e.*, without the ADJ_U* option in AERMET and without any LOWWIND option in AERMOD). Including the ADJ_U* option in AERMET with full meteorological data results in an underprediction of about 40 percent. On the other hand, AERMOD results without the ADJ_U* option in AERMET and without the observed profiles of temperature and turbulence (*i.e.*, mimicking standard airport meteorological inputs) results in significant overprediction by about a factor of 4. However, using the ADJ_U* option with the degraded meteorological data for the Tracy field study shows good agreement with observations, comparable to or slightly better than the results with full meteorological inputs. Full results from this EPA assessment on the use of the ADJ_U* option with various levels of meteorological data inputs is detailed in appendix A of this Response to Comments document. There is also evidence of this potential bias toward underprediction when the ADJ_U* option is applied for applications that also include site-specific meteorological data with turbulence parameters based on the 1974 Idaho Falls study. As with the Tracy field study, the Idaho Falls field study results with site-specific turbulence data do not show a bias toward underprediction without the ADJ_U* option, but do show a bias toward underprediction using turbulence data with the ADJ_U* option.

The EPA is adopting the proposed ADJ_U* option in AERMET as a regulatory option for use in AERMOD for modeling applications using standard NWS airport meteorological data, site-specific meteorological data without turbulence parameters, or prognostic meteorological inputs derived from prognostic meteorological models.

Flawed, Outdated, and Inappropriate Study Databases

Comment:

One commenter (0114) stated that the study databases that the EPA used to evaluate performance for low winds (Oak Ridge, Idaho Falls, and Cordero) are flawed, outdated, and not appropriate. The commenter provided an evaluation of the ADJ_U* and LOWWIND3 options using the Baldwin, Kincaid, Lovett, Tracy, and Prairie Grass to support their position that these options can underpredict and should not be made regulatory options in the revised *Guideline.* In the evaluation document, the commenter provided separate discussions of the Oak Ridge, Idaho Falls, and Cordero study databases providing specific reasons to support the position that the databases are flawed and inappropriate to evaluate the ADJ_U* and LOWWIND3 options. In addition, the commenter (0114) stated that these three databases precede the promulgation of AERMOD but have not been included in the standard set of databases used to evaluate AERMOD performance.

Response:

The EPA appreciates this comment but respectfully disagrees with the commenter. However, despite these potential issues and concerns regarding these databases, we believe that they provide valuable information in assessing and supporting the EPA's model evaluations and final action. Please see appendix A of this Response to Comments document for more details about each study, including insights on their value in assessing these low wind options. The EPA will continue to evaluate the low wind options against more recent, suitable databases as they become available.

2.2.2 Incorporation of the LOWWIND3 Option into AERMOD

Comment:

Multiple commenters (0077, 0081, 0083, 0084, 0089, 0092, 0098, 0099, 0103, 0132, 0106, 0107, 0109, 0110, 0113, 0118, 0119, 0120, 0127, 0124, 0126, 0128, 0134, 0135, 0141, 0142, 0144, 0145, 0149, 0150, and 0151) support the incorporation of LOWWIND3 into AERMOD as a regulatory option.

Further, many of the commenters (0077, 0081, 0089, 0098, 0103, 0132, 0109, 0110, 0113, 0118, 0119, 0120, 0127, 0124, 0126, 0135, 0142, 0149, and 0150) stated that LOWWIND3 should be incorporated as a regulatory default option.

Two commenters (0124 and 0119) stated that it is not clear in the proposed rule whether LOWWIND3 was proposed as a regulatory default, and the EPA should clarify this in the final rule.

A commenter (0119) requested that if the EPA did not make LOWWIND3 a regulatory default option, then guidance should be provided to determine when the option should be used.

Response:

As a result of public comment and further evaluation, we are deferring action on the LOWWIND3 option pending further analysis and evaluation in conjunction with the modeling community. The LOWWIND3 option, along with the LOWWIND1 and LOWWIND2 options, will remain in AERMOD as "beta" options to facilitate their continued evaluation by the EPA and the modeling community.

Low Wind Options Underpredict Impacts

Comment:

Multiple commenters (0114, 0121, 0095, and 0128) stated that the low wind options underpredict impacts and need further evaluation. One commenter (0114) stated that applying these options to the original validation studies performed for AERMOD erratically and in some cases quite significantly reduce modeled impacts, particularly so in the case of the Tracy validation study data. The commenter submitted a technical analysis to demonstrate that the proposed changes to AERMOD decrease model accuracy.

Response:

In consideration of the technical analysis submitted by the commenter and the EPA's reassessment of the Tracy and other databases led us to conclude that the commenter was correct in pointing out the mixed results with some tendency to underpredict impacts per the Baldwin, Kincaid, Prairie Grass, and in particular, the Tracy study. Further evaluation by the EPA, presented in appendix A of this Response to Comments document, demonstrates a tendency of the LOWWIND3 toward underprediction when applied in combination with the ADJ_U* option in AERMET, consistent with Sierra Club's evaluation. The LOWWIND3 option sets a minimum value of sigma-v higher than the default 0.2 m/s. A higher value tends to increase lateral dispersion during low wind conditions and reduce predicted impacts. However, it goes beyond the specification of the minimum sigma-v parameter to address the horizontal meander component in AERMOD that also contributes to lateral plume spread, especially during low wind, stable conditions. Since the horizontal meander component is a function of the "effective" sigma-v value, lateral plume dispersion may be further enhanced under the LOWWIND3 option by increased meander, beyond the influence of the minimum sigma-v value alone.

Another aspect of the AERMOD model formulation that may contribute to an increasing bias toward underprediction with distance is the treatment of the "inhomogeneous boundary layer" (IBL) that accounts for changes in key parameters such as wind speed and temperature with height above ground. The IBL approach determines "effective" values of wind speed, temperature, and turbulence that are averaged across a layer of the plume between the plume centerline height and the height of the receptor. The extent of this layer depends on the vertical dispersion coefficient (*i.e.*, sigma-z). Therefore, as the plume grows downwind of the source, the extent of the layer used to calculate the effective parameters will increase (up to specified limits). The potential influence of this aspect of AERMOD formulation on modeled concentrations will depend on several factors, including source characteristic, meteorological condition, and the topographic characteristics of the modeling domain.

As a result of the reassessment of the LOWWIND3 option, the EPA is deferring action on the LOWWIND3 option in pending further analysis and evaluation in conjunction with the modeling community.

Expand Databases and Continued Evaluation

Comment:

While several commenters (0128, 0134, 0106, and 0092 stated their support for LOWWIND3 as a regulatory option, they expressed that additional evaluation was necessary as the low wind options would not fix all issues with low winds and the EPA should continue to make improvements. One commenter (0092) also urged the EPA to expand the datasets used to evaluate the low wind options.

Response:

The EPA will continue to work with Regional, State, and Local agencies and the modeling community to improve the future performance of the AERMOD system in stable, low wind conditions. Through this rulemaking process, in response to comments, the EPA was prompted to further evaluate the Beta options which resulted in adopting the ADJ_U* regulatory option with limitations that were not originally proposed (refer to appendix A of this Response to Comments document and the *Guideline*). In addition, we have not promulgated our proposed action to incorporate LOWWIND3 in the regulatory version of AERMOD, and we are deferring action on the LOWWIND options in general pending further analysis and evaluation in conjunction with the modeling community.

Flawed, Outdated, and Inappropriate Study Databases

Comment:

One commenter (0114) stated that the study databases that the EPA used to evaluate performance for low winds (Oak Ridge, Idaho Falls, and Cordero) are flawed, outdated, and not appropriate. The commenter provided an evaluation of the ADJ_U* and LOWWIND3 options using the Baldwin, Kincaid, Lovett, Tracy, and Prairie grass to support their position that these options can underpredict and should not be made regulatory options in the revised *Guideline.* In the evaluation document, the commenter provided separate discussions of the Oak Ridge, Idaho Falls, and Cordero study databases providing specific reasons to support the position that the databases are flawed and inappropriate to evaluate the ADJ_U* and LOWWIND3 options. In addition, the commenter (0114) stated that these three databases precede the promulgation of AERMOD but have not been included in the standard set of databases used to evaluate AERMOD performance.

Response:

The EPA appreciates this comment but respectfully disagrees with the commenter. However, despite these potential issues and concerns regarding these databases, we believe that they provide valuable information in assessing and supporting the EPA's model evaluations and final action. Please see appendix A of this Response to Comments document for more details about each study, including insights on their value in assessing these low wind options. The EPA will continue to evaluate the low wind options against more recent, suitable databases as they become available.

Minimum Sigma-v Level

Comment:

A commenter (0119) urged the EPA to incorporate additional input from the latest modeling research to better enhance AERMOD's ability to handle low wind speed conditions. The commenter cited recent studies and stated the EPA should raise the minimum sigma-v level to 0.4. Another commenter (0128) stated that minimum sigma-v should be raised to 0.5.

Response:

The EPA appreciates this comment and will consider the published literature and new research for future updates to the model as appropriate. Adhering to the existing procedures under CAA section 320, which requires the EPA to conduct a conference on air quality modeling at least every 3 years, the Twelfth Conference on Air Quality Modeling will occur within the next 2 years to provide a public forum for the EPA and the stakeholder community to engage on technical issues, introduce new air quality modeling research and techniques, and discuss recommendations on future areas of air quality model development and subsequent revisions to the *Guideline.* A formal notice announcing the next Conference on Air Quality Modeling will be published in the *Federal Register* at the appropriate time and will provide information to the stakeholder community on how to register to attend and/or present at the conference. In addition, the EPA regularly attends related specialty conferences that are sponsored by the various industrial stakeholders where current research is presented and relevant topics are discussed.

2.2.3 Modifications to AERMOD Formulation for Tall Stack Applications near Small Urban Areas

Support of Proposal

Comment:

Multiple commenters (0084, 0119, 0134, 0151, 0110, 0126, 0141, and 0150) expressed their support for the modifications in AERMOD to address over prediction for applications involving relatively tall stacks located near urban areas.

Response:

The EPA appreciates the stated support for the modifications in AERMOD to address over prediction for applications involving relatively tall stacks located near urban areas.

Request for Detailed Information and Updated Guidance

Comment:

A commenter (0097) requested a more detailed explanation in the final *Guideline* for how to account for a tall stack in an urban area that has been approved for exclusion from application of the urban option. The commenter also requested that the EPA describe in greater detail what justification would suffice to show that the rural option is more appropriate than the urban option when comparing modeled impacts to observed monitored data in an urban area.

Response:

The AERMOD User's Guide provides instruction on how to apply urban effects to all or a subset of sources using the URBANOPT and URBANSRC options, which would exclude urban effects for those not identified with the URBANSRC keyword. The EPA takes under advisement the request for guidance to determine if a source in an urban area should be excluded from urban effects. In the interim, the EPA will consider adding a discussion to the AERMOD Implementation Guide (U. S. EPA, 2016h). Regardless, model users should make that determination in consultation with the appropriate reviewing authority.

Effective Population Calculation

Comment:

A commenter (0097) requested an explanation of the method to be used to calculate an effective population of the modeling domain.

Response:

For non-population oriented urban areas, or areas influenced by both population and industrial activity, a method to estimate an equivalent population for input to AERMOD has not been prescribed. As stated in the *Guideline*, estimate of an equivalent population should be determined in consultation with the appropriate reviewing authority (paragraph 3.0(b)) and the latest version of the AERMOD Implementation Guide (U.S. EPA, 2016h).

Plume Penetration Formulation

Comment:

Commenters 0110 and 0110 stated that the EPA should review the plume penetration formulation and consider changes to address the over prediction that occurs in some applications.

Response:

The EPA recognizes that for tall stacks located within or adjacent to small or moderate sized urban areas, the stack height or effective plume height may extend above the urban boundary layer and, therefore, may be more appropriately modeled using rural coefficients. Model users should consult with the appropriate reviewing authority (paragraph 3.0(b)) and the latest version of the AERMOD Implementation Guide (U.S. EPA, 2016h) when evaluating this situation. The EPA takes this comment under advisement and will review and further evaluate the plume penetration formulation in AERMOD. If it is determined that a bug fix is needed, then the EPA will address the issue in the AERMOD code in a future release of the model. Otherwise, if an enhancement to the model is needed, a Beta option will be made available in a future release for evaluation. When appropriate, the EPA will pursue a regulatory update to the modeling system.

2.2.4 Address plume rise for horizontal and capped stacks in AERMOD

Support for Proposed Changes

Comment:

Several commenters (0084, 0099, 0106, 0109, 0118, 0119, 0135, 0135, 0142, 0134, and 0151) stated their support for the proposed changes that include the horizontal and capped stack options as regulatory options.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline* that reclassify the horizontal and capped stack beta options as regulatory options in AERMOD.

Horizontal Stacks and Building Downwash

Comment:

A commenter (0113) stated that the POINTHOR option for horizontal stacks can lead to extremely high concentrations for sources with building downwash in complex terrain, up to a factor of 10, compared to impacts from the same sources with building parameters excluded. ACHD further commented that the downwash algorithms and/or inclusion of building parameters for horizontal stacks should be more closely related.

Response:

Despite the noted improved performance of the proposed option in the case of building downwash, the EPA recognizes the ongoing issues with this option in the presence of building downwash and with its inherent complexities and its particular application in such situations with complex terrain. The EPA also recognizes that the appropriateness of this option for that particular situation would be a matter of consultation with the appropriate reviewing authority as is stated in the preamble to the proposed rule. However, given the broad support stated in public comments for the improved treatment, the EPA is finalizing this formulation update, as proposed, as a regulatory option within AERMOD.

2.2.5 Incorporation of the BLP Model into AERMOD

The purpose of this first release of a buoyant line source algorithm in AERMOD is to incorporate the algorithms found in BLP without change and to verify that the two models (BLP and AERMOD) are producing comparable results. The Technical Support Document (TSD), "AERMOD_BLP development and Testing," provides more information on the implementation and testing of the buoyant line algorithms in AERMOD.

Support of proposal

Comment:

Commenters 0113, 0119, 0127, and 0128 stated their support for the implementation of the buoyant line source as a much-needed component of AERMOD.

Response:

The EPA appreciates the stated support for the addition of the buoyant line source into AERMOD.

Buoyant line source should remain a non-default Beta option

Comment:

Commenters 0089, 0116, 0127, 0110, and 0141 recommended making the buoyant line source a non-default Beta option until further investigations can be conducted regarding the discrepancies and unexplained differences between AERMOD and BLP. Two commenters (0089 and 0099) recommended that BLP model remain as the preferred model.

Response:

As recommended by the reviewers, the EPA reviewed the stated differences between the two models. As a result, updates were applied to the implementation of BLP in AERMOD to resolve the majority of the modeled differences (remaining differences in modeled concentrations are either within bounds of equivalency or due to appropriate updates to the model code, correcting limitations that existed in BLP) – see also the response to the "AERMOD estimates higher than BLP estimates" comment below and the updated TSD provided for this model update (U. S. EPA, 2016c).

Additional testing

Comment:

Commenters noted that there has been no equivalency demonstration (0099); there is no published performance evaluation or consequence analysis (0131); and AERMOD was not evaluated against data provided in BLP development documentation (*e.g.*, 1979 SF6 tracer study) (0116). Two commenters (0100 and 0129) indicated that additional supporting documentation and further comparative studies are necessary.

Response:

With the further updates to the BLP implementation in AERMOD and the updated TSD (U. S. EPA, 2016c), a complete model equivalency demonstration has been provided. The equivalency test in the TSD show that the top 10 values for the 1-hour,3-hour, 8-hour, 24-hour, period, and annual averages agree (with no difference). In addition to the top 10 concentrations, the high-1st-high through high-4th-high ranks are presented in the TSD, with similar results as the top 10 concentrations. Additionally, several source configurations have been modeled and are presented in the TSD. These comparisons of short-term averages show modeled equivalency within the constraints set forth in section 3.2.2.c in the *Guideline*. Thus, the EPA that the model equivalency in individual hours was clearly demonstrated. Since AERMOD will be replacing BLP on the basis of model equivalency (*i.e.*, we have simply integrated the BLP algorithms into AERMOD rather than a new model formulation) there is no need for a comparison of modeled concentrations to observations so that evaluation has not been undertaken. However, it should be noted that there are not sufficient databases available to make an appropriate model-to-monitor comparison.

Differences in the meteorology

Comment:

A commenter (0116) expressed concern over differences in underlying meteorology, and that there was no sensitivity analysis of MPRM P-G classes vs AERMET calculated stability.

Response:

The EPA recognizes that there should be no differences between the meteorological data set for AERMOD and the data for BLP to ensure that any differences in the results are due to differences in the algorithms and not the meteorology. In the original testing, one year of meteorology from one of the AERMOD evaluation databases (Lovett) was used for testing. To obtain the meteorology for BLP, AERMOD was modified slightly to output the necessary parameters each hour in a format that BLP could read (see documentation and analysis in the updated TSD) (U. S. EPA, 2016c). However, the meteorological data were not completely consistent between the two models. Since BLP cannot process calm winds (see "Handling of calm wind conditions" below) nor a missing data indicator, the data needed to be 'cleaned up'. While the meteorological data for BLP were 'cleaned up' (*i.e.*, 187 hours of missing required parameters were filled by interpolation or persistence; there were no calm hours to change), the met data were not cleaned up for AERMOD. The differences in the meteorology could contribute to some of the differences in concentration, but an examination of the output from AERMOD suggests it likely was not a significant factor.

To eliminate the differences in meteorology between the two models in more recent testing, a program was written to convert the meteorology from the AERMET format (the 'surface' file) to the format readable by BLP. However, because of the limitations in BLP regarding calm winds and missing data, rather than try to 'clean up' an entire year, subsets of the data from each season of the year were used for the model runs. Subsets were selected to limit the number of calm or missing winds to no more than two consecutive hours so that the data could be filled easily by persisting the data from the hour before or after to replace the calm or missing hour. Refer to the TSD for additional details related to meteorological data processing for testing and the equivalency evaluation.

Handling of calm wind conditions

Comment:

Commenters 0100 and 0129 questioned if the handling of calm wind conditions was the same between AERMOD and BLP.

Response:

The two models handle calm winds differently. Whereas AERMOD does not perform calculations when the winds are calm, BLP will try to make the calculations, reach the maximum number of iterations for a receptor, then go to the next receptor. BLP eventually fails with the message TOO MANY EXCEEDENCES OF LINE SOURCE ITERATION MAXIMUM -- EXECUTION TERMINATING. To overcome this limitation in BLP, one of two options are available when attempting to run both models and compare results: 1) select only those periods in which there are no calm winds or 2) replace the calm winds with non-calm values for wind speed and direction.

Although not explicitly mentioned by commenters, the EPA notes that BLP cannot handle an omitted hour of meteorology either, *i.e.*, physically not present in the meteorology file. The message MET DATA SEQUENCE ERROR is generated and displayed on the monitor and BLP stops execution. Likewise, a field that has a missing data indicator will be used and most likely fail. BLP also cannot process missing data indicators (*e.g.*, -999.0) in the manner AERMOD can.

AERMOD algorithms do not appear to correctly follow the BLP algorithms

Comment:

A commenter (0105) suggested that the buoyant line source in AERMOD does not appear to be implemented correctly.

Response:

The EPA disagrees with the commenters and has gone through a detailed QA process to insure implementation of BLP algorithms was correctly ported to AERMOD. The buoyant line source algorithms in BLP's main program and subroutines, *i.e.*, the actual calculations, were ported to AERMOD without modification. However, input for the buoyant line source follows the AERMOD requirements, *e.g.* use of keywords. Some of the changes to the BLP algorithms incorporated into the AERMOD source code include:

- adding input control keywords specific to a buoyant line source (additional keywords and parameters added to AERMOD to process buoyant lines),
- updating the processing of the input information (*e.g.*, defining source and receptor data),
- updating BLP algorithms to current Fortran coding structures - *e.g.*, BLP follows old Fortran coding standards and used GO TO statements extensively for branching and conditional processing,
- adding or changing variable names in BLP algorithms as needed to match AERMOD variable names,
- adding a new module to AERMOD, BOUYANT_LINE, to centralize the global variables associated with the buoyant line processing, and
- declaring real variables and constants in the module and routines as double precision.

To see if the data were being read correctly, print statements were placed throughout the AERMOD code during development. This included source locations, receptor locations and the average buoyant line source parameters (*e.g.*, buoyancy parameter). Print statements were inserted in to both BLP and AERMOD to confirm that translations and rotations of receptor and source coordinates were the same. Please note that there can be very small differences in the rotated coordinates due to the precision of the calculations (single in BLP versus double in AERMOD). In addition to confirming the input data, print statements were scattered throughout to confirm that data were being passed between routines properly. If a difference was identified, it was fixed.

A verification on variable naming is 'built in' to AERMOD. The use of "IMPLICIT NONE" in the main program, modules, subroutines, and functions in AERMOD forces the declaration of <u>all</u> variables. Therefore, if a variable name was misspelled or omitted from the declarative statements, the compiler would catch that as an error and require it to be declared before creating an executable.

The dispersion code was not updated, so limitations in BLP remain in AERMOD

Comment:

A commenter (0116) noted that the dispersion algorithms were not updated so the limitations that appear in the BLP algorithms are also in the AERMOD algorithms for a buoyant line source.

Response:

Since the buoyant line source algorithms in BLP were ported unchanged into AERMOD (as noted above), it is true that any limitations of the dispersion algorithms originally in BLP are in the code in AERMOD. We recognize the need to improve upon the limitations and science of the BLP algorithms now in AERMOD once the appropriate databases become available for proper development and testing. However, the purpose was to replicate BLP capabilities within AERMOD to allow for removal of BLP from appendix A so as to streamline the modeling process and better allow for science improvements for buoyant line sources within AERMOD.

Downwash algorithms not consistent

Comment:

A commenter (0126) noted inconsistencies between the downwash algorithms in BLP and AERMOD.

Response:

Since the buoyant line source algorithms were not changed when implemented in AERMOD, BLP and AERMOD are consistent with regard to downwash for buoyant line sources. The EPA notes, however, that the downwash algorithm for point sources do differ between the two models, but the point source algorithms in BLP were not ported to AERMOD since point sources are already a part of the AERMOD system and take full advantage of the state-of-the-science algorithms in AERMOD, including the PRIME downwash algorithm implemented in AERMOD.

Treatment of dispersion rates not consistent

Comment:

Commenter 0126 noted inconsistencies between the treatment of dispersion rates in BLP and AERMOD.

Response:

Since the buoyant line source algorithms were not changed when implemented in AERMOD, BLP and AERMOD are consistent with regard to the treatment of dispersion rates for buoyant line sources. The EPA notes, however, that the dispersion rates for point sources differ between the two models because the point source algorithms in BLP were not ported to AERMOD.

Boundary layer parameterizations not consistent

Comment:

One commenter (0056) noted inconsistencies between the boundary layer parameterizations in BLP and AERMOD.

Response:

As stated previously, the buoyant line source algorithms were implemented, unchanged, in AERMOD. BLP and AERMOD are consistent with regard to the boundary layer parameterizations for buoyant line sources. The EPA notes, however, that the boundary layer parameterizations for point sources differ between the two models because the point source algorithms in BLP were not ported to AERMOD.

Dispersion in complex terrain

Comment:

A commenter (0126) noted that there are inconsistences between the plume response to terrain in BLP and AERMOD. Another commenter (0116) noted that the BLP algorithms, and hence, AERMOD, do not adequately address dispersion in complex terrain.

Response:

Since the buoyant line source algorithms from BLP were not changed when implemented in AERMOD, BLP and AERMOD are consistent with regard to the treatment of terrain for buoyant line sources. The EPA notes, however, that the plume response for point sources differs between the two models because the point source algorithms in BLP were not ported to AERMOD.

The EPA agrees that the BLP algorithms do not adequately address dispersion in complex terrain. However, the purpose of this first release of a buoyant line source algorithm in AERMOD is to incorporate the BLP algorithms without change and to verify that the two models (BLP and AERMOD) are producing comparable results. The EPA anticipates that the buoyant line source algorithms will be updated with AERMOD's terrain algorithms in a future release.

AERMOD estimates higher than BLP estimates

Comment:

A commenter (0056) noted that the concentration estimate from AERMOD were occasionally higher than the estimates from BLP.

Response:

The EPA agrees that for the initial testing and comparisons, AERMOD would produce higher concentrations, although it was not always the case. One case in particular had the highest AERMOD concentration that was orders of magnitude larger than the highest BLP concentration. The case in question had three lines at a 45-degree angle to the receptors and were embedded in the receptor network. The reasons for the large difference could be due to: 1) not excluding the receptors inside or on the boundary defined by the minimum and maximum extents of the lines (exclusion zone) in AERMOD, resulting in a receptor very near or on a source line, and 2) the particular configuration of sources and receptors in the example.

To address this issue, the exclusion zone has now been incorporated into AERMOD and the EPA’s assessment of additional examples have demonstrated that the problem had to do with the configuration. In fact, it was demonstrated that the large concentration could be reproduced with BLP by recompiling it as 64-bit code (using a compiler option) which treats real variables as double precision.

The updated TSD (U. S. EPA, 2016c) demonstrates that there are effectively no differences in concentrations between the updated implementation of BLP in AERMOD and the original BLP model, with any observed changes simply due to the different precision of the calculations, *i.e.*, single precision in BLP versus double precision in AERMOD.

Non-parallel vents and non-uniform building configurations

Comment:

A commenter (0116) recommended that the capability to process non-parallel vents and non-uniform building configurations be implemented in AERMOD.

Response:

The EPA recognizes that not all buoyant line source applications fit the simple configuration of two or more parallel lines on a single building in one model run. BLP overcomes this to some extent by post-processing multiple BLP model runs using the BLPSUM program, *i.e.*, this option is not native to BLP, but requires post-processing separate BLP runs. Since this functionality is not native to BLP, it was not implemented in AERMOD at the current time. To provide this functionality will require implementing the post-processing options available in BLPSUM into AERMOD. This functionality may be added in a future release of AERMOD when there is shown a need for such inclusion in the modeling system. However, the EPA will work with permit applicants and reviewing authorities with these types of situations to work towards a solution to such modeling needs, should they arise.

Tier 3 NO_2 modeling

Comment:

A commenter (0126) requested the capability to run Tier 3 NO_2 modeling in AERMOD.

Response:

The buoyant line source is a unique source type in that one source consists of multiple lines. The interaction of the plumes from these lines is one of the key concepts of the buoyant line source. Implementing the Tier 3 NO_2 modeling that is currently available for other source types in AERMOD will require a fairly intensive investigation on how the Tier 3 algorithms would need to be implemented and applied to the individual lines. The issue is further complicated by the request to add the capability to process multiple configurations in a single AERMOD model run.

The EPA anticipates adding this capability in a future release of AERMOD when there is shown a need for such inclusion in the modeling system.

2.2.6 Updates to the NO_2 Tier 2 and Tier 3 Screening Techniques in AERMOD

Support of proposal

Comment:

Commenters 0077, 0084, 0089, 0092, 0098, 0102, 0103, 0109, 0110, 0112, 0118, 0119, 0120, 0214, 0126, 0127, 0132, 0135, 0137, 0141, 0142, 0144, 0145, and 0150 stated their support for the proposed changes to AERMOD and the *Guideline* associated with NO_2 modeling.

Response:

The EPA appreciates the stated support for the proposed replacement and the recognition of the technical and programmatic reasons behind this change.

Request for additional modeling guidance

Comment:

Multiple commenters (0097, 0077 and 0130) request that the EPA develop modeling guidance for NO_2 to aid in the application and evaluation of the Tier 3 methods as well as the methods for performing net benefit and increment modeling (*e.g.*, the use of negative emissions rates).

Response:

The EPA takes this comment under advisement and will consider developing a single NO_2 modeling guidance document, similar to the one provided for ozone and $PM_{2.5}$. However, the EPA notes that several guidance documents and clarifications memos are already publically available for guidance with respect to implementing the NO_2 screening options in AERMOD.

Request to remove consultation requirements for NO_2 options in AERMOD

Comment:

Multiple commenters (0099, 0117, 0129, 0137, and 0150) requests that the EPA remove the consultation requirement associated with the NO_2 modeling methods in AERMOD or request that the status of the consultation/approval process be clarified for the Tier 3 options.

Response:

The Tier 3 methods require additional considerations and inputs that go beyond the requirements for all other inert pollutants in the New Source Review (NSR) program. Indeed, other commenters have asked for additional guidance in applying and evaluating the Tier 3 methods. Until such guidance is available based on experience gained in model applications of these techniques, it is appropriate to keep the consultation requirement in place. However, the EPA notes that the consultation requirement is not meant to be onerous and emphasizes that as a screening modeling approach, alternative model approval is not needed, as was previously required for these options in the 2005 version of the *Guideline*.

Status of PVMRM2 versus PVMRM

Comment:

A commenter (0112) noted that the specific version of PVMRM2 intended for regulatory use was not entirely clear.

Response:

Version 15181 of AERMOD included both PVMRM and PVMRM2 with the proposal preamble text indicating that we would be promulgating PVMRM2; however, the proposed regulatory text identified PVMRM, which caused confusion. The methodology employed in the “PVMRM2” option in AERMOD version 15181 is now the “PVMRM” option in the regulatory version of AERMOD, and the methodology employed in the “PVMRM” option in AERMOD version 15181 has been removed entirely from the model. The basis for this decision is that the updated PVMRM2 is a more complete implementation of the PVMRM approach outlined by Hanrahan (1999) than the original PVMRM implementation in AERMOD.

Therefore, the EPA is updating the regulatory version of the AERMOD modeling system to reflect these changes for NO_2 modeling and has updated the related descriptions of the AERMOD modeling system in section 4.2.3.4 of the *Guideline* as proposed.

Request to retain ARM and ARM2

Comment:

Commenters 0089, 0126, and 0128 requested that the EPA retain both ARM and ARM2 for use as a Tier 2 screening method for NO_2 and request clarification on the status of ARM.

Response:

ARM2 is believed to be more accurate than ARM or short- and long-term averaging of NO_2 concentrations. Additionally, ARM was initially developed exclusively for use with annual concentrations. Though the EPA adopted an approach for ARM to use with short-term averages, the less conservative nature of ARM versus ARM2 for lower concentrations relative to the more accurate information now available through the ARM2 approach make it inappropriate to maintain for future usage. For increased accuracy and to maintain an appropriate degree of conservatism, only ARM2 will be retained as a regulatory option.

Request to retain PVMRM2 and PVMRM

Comment:

Commenters 0097 and 0126 requested that the EPA retain both PVMRM and PVMRM2 for an extended period for additional comparison and model evaluation.

Response:

The methodology employed in the "PVMRM2" option in AERMOD version 15181 is now the "PVMRM" option in the regulatory version of AERMOD, and the methodology employed in the "PVMRM" option in AERMOD version 15181 has been removed entirely from the model. The basis for this decision is that the updated PVMRM2 is a more complete implementation of the PVMRM approach outlined by (Hanrahan, 1999) than the original PVMRM implementation in AERMOD.

Default minimum ambient ratio in the ARM2 method

Comment:

Multiple commenters (0110, 0120, 0124, 0126, 0128, 0103, 0135, and 0141) provided comment that they believe the minimum ambient ratio of 0.5 implemented as the regulatory default is too conservative.

Response:

While the ARM2 development paper (Podrez, 2015) estimated a minimum ambient ratio of 0.2 from data from ambient monitors, these data were not shown to be representative of near-source impacts from sources that are known to have high NO_2/NO_X in-stack ratios. As outlined in (Owen & Brode, 2014), the ambient NO_2/NO_X ratio is a direct function of the in-stack NO_2/NO_X ratio and the ambient ratio only increases from the in-stack ratio. Thus, a stack with a high total NO_X impact and a high NO_2/NO_X in-stack ratio could have an ambient NO_2/NO_X ratio higher than the values reflected in the data used to develop ARM2. In order to provide an appropriately conservative national default value to be used by all sources, the ARM2 minimum ambient ratio should reflect the minimum in-stack ratio provided for the Tier 2 methods (0.5). The *Guideline* encourages the use of site-specific data to more appropriately represent the specifics of the facility.

Near-field impacts

Comment:

Two commenters (0110 and 0126) offered suggested language changes in section 4.2.4.3(f) to help accommodate situations where maximum modeled NO_X concentrations occur in the near-field (*e.g.*, fence line) when transport time that is insufficient for oxidation (reaction of ozone with NO) to fully take place.

Response:

The EPA appreciates these suggestions. We realize that there is a limitation with PVMRM and OLM in this respect. However, the specifics of this limitation are not well characterized and not appropriate for addition to the *Guideline* at this time. However, we will consider adding suggestions to address this issue in guidance in the near term. When an approach to address this issue has been fully validated from a scientific perspective, we will consider adding to AERMOD as appropriate.

New Tier 3 methods

Comment:

A commenter (0126) requested that the EPA incorporate a new Tier 3 method based on Atmospheric Dispersion Modelling System (ADMS).

Response:

Unfortunately, the ADMS-based addition to AERMOD does not currently have sufficient documentation to pass the requirements for an alternative or preferred model under the *Guideline*. However, we look forward to evaluating this option as more testing, evaluation, and documentation becomes available. When that information becomes available, then the ADMS-based approach could be considered for use as an alternative model.

Negative emissions restrictions

Comment:

A commenter (0128) stated that the restriction on negative emissions is too strict and should be allowed in some circumstances.

Response:

The EPA has modified section 4.2.3.4(b) in the *Guideline* to now limit the usage of negative emissions only after consultation with the Regional Office rather than a complete restriction on the usage of negative emissions.

2.2.7 EPA Preferred Version of the AERMOD Modeling System

Clarifications on Regulatory Options

Comment:

A commenter (0117) stated they were unable to provide specific comment on the proposed AERMOD modifications and approaches (*e.g.*, ADJ_U*, LOWWIND3, POINTCAP, and POINTHOR) as more specific definitions are needed for each application, along with a clearer understanding of the conditions under which each approach should be considered for use in a regulatory modeling demonstration.

Response:

In the preamble and regulation text of the final rule, the EPA has expanded the discussions of the new regulatory options to provide more definition and clarity with regard to their application. Detailed information about how to specify each option in the model is provided in the updated AERMOD system user's guides for AERMET and AERMOD, as applicable.

Comment:

One commenter (0087) stated that additional clarity is needed to indicate that regulatory options do not require additional approval.

Response:

The EPA has provided clarity on regulatory options in the regulation text for preferred models listed in appendix A of the *Guideline* with details for each preferred model in the associated model user guide. Section 3.2 provides the process to be followed for the use of alternative models.

Comment:

Multiple commenters (0087, 0124, 0142) said that it is unclear in the proposed rule which AERMOD Beta options will become regulatory default options in the final rule making package.

Response:

In the final version of the rule, the EPA has clearly identified those Beta options that are now regulatory options and, therefore, do not require approval as an alternative model. Those Beta options that are now regulatory options include ADJ_U* (for site-specific date without turbulence, NWS data, and prognostic data), ARM2, PVMRM, and OLM.

2.3 Status of AERSCREEN

AERSCREEN is too complicated, needs simplifying and keep SCREEN3

Comments:

Several commenters (0089, 0098, 0110, 0124, 0126, 0135 and 0141) stated that AERSCREEN was either too complicated or costly to use and that SCREEN3 should be retained until AERSCREEN has been simplified for more general use. Commenter 0089 did not agree that screening models should be referred to as preferred/recommended screening models. Listing AERSCREEN as a preferred/recommended model may limit the use of simpler models like SCREEN3, resulting in costly, refined modeling that would not be necessary if SCREEN3 was used.

Response:

The EPA strongly believes that AERSCREEN represents the state of the science as it runs the EPA's preferred near-field dispersion model, AERMOD in screening mode, rather than the outdated algorithms of ISC, which is the basis of SCREEN3. The EPA does not agree that AERSCREEN is too complicated or costly to run. Many of the inputs into AERSCREEN such as source parameters (stack height, stack diameter, etc.), urban/rural determination, and receptor height are similar to SCREEN3. AERSCREEN takes advantage of the improved algorithms of AERMOD by allowing the user to specify site-specific meteorological variables such as ambient temperatures, wind speeds, and surface characteristics. We recognize that the analysis of surface characteristics can necessitate professional judgment but AERSCREEN does allow the user to take advantage of pre-calculated surface characteristics in AERSCREEN via land use type and climatological variability based on AERMET surface characteristics. AERSCREEN also allows the user to input building parameters for building downwash either as simple building dimensions, similar to SCREEN3, and stack orientation, which can be determined from aerial photographs or site plans.

AERSCREEN has a bug related to downwash

Comment:

Commenters 0110 and 0126 commented there was a bug related to BPIPPRM output reported in AERSCREEN. The commenters stated that AERSCREEN outputs a value of zero for some reported dimensions.

Response:

AERSCREEN allows the user to input building parameters either as a simple rectangular building or via BPIPPRM for more complicated building structures or multiple buildings. When using the simple rectangular building inputs, AERSCREEN outputs the user-entered values as the maximum building height, and minimum and maximum horizontal dimensions. When using BPIPPRM output, AERSCREEN loops through the 36 sectors to determine the maximum building height and minimum and maximum horizontal dimensions. We have determined that there is not a bug in AERSCREEN rather the reported zeros are the outcome of a bug related to BPIPPRM. To ease concerns, AERSCREEN has been modified to only output nonzero values for building dimensions when using a BPIPPRIME input file.

Fumigation options

Comment:

Two commenters (0110 and 0141) expressed concerns over the conservatism of the fumigation options in AERSCREEN and commented that the Shoreline Dispersion Model (SDM) may be suitable starting point for coastal fumigation. The EPA inserted the fumigation algorithms used by SCREEN3 into AERSCREEN but the algorithms use the updated similarity theory for parameters such as the horizontal and vertical dispersion parameters.

Response:

The EPA recognizes that the fumigation algorithms may be outdated and, now that AERSCREEN is the recommended screening model, we will work with the modeling community to improve the calculations for fumigation, including investigating the use of the SDM algorithms.

Comment:

A commenter (0090) recommended that the EPA incorporate the inversion break-up and coastal fumigation features into AERMOD. Another commenter (0099) recommended that shoreline fumigation be incorporated into AERMOD so that it can eventually replace OCD.

Response:

Given that the fumigation option calculations are performed outside of the normal Gaussian plume equations, the EPA feels it is more reasonable to keep the fumigation options inside the AERSCREEN program rather than bring them into the AERMOD modeling system. AERSCREEN does allow the user to output fumigation options only, without running through the entire screening modeling procedure normally performed in AERSCREEN. The EPA will continue to update the fumigation options, including the use of the SDM algorithms described above. The EPA will also look into the use of standard AERMOD-ready surface and profile files from site-specific, NWS, or prognostic data for use with the fumigation options instead of the MAKEMET generated data in AERSCREEN. In the long term, the EPA looks forward to working with the modeling community to investigate fumigation options for incorporation into AERMOD.

Support AERSCREEN

Comment:

Commenters (0109 and 0119) stated they support the use of AERSCREEN.

Response:

The EPA appreciates the stated support for the use of AERSCREEN.

Consideration of AERSCREEN and SCREEN3

Comment:

One commenter (0112) suggested that the EPA consider including SCREEN3 and AERSCREEN for screening use, especially at sites not previously modeled with AERMOD for permitting purposes.

Response:

The EPA agrees that AERSCREEN should be considered for modeling. However, the EPA feels that AERSCREEN should be used over SCREEN3 based on the reasons stated in the proposed rulemaking particularly its basis in the state of the science reflected in AERMOD. The EPA has recommended the use of AERSCREEN for SO_2 modeling in the sense of attainment demonstrations and designations. The EPA strongly believes that AERSCREEN has a valuable role in permit modeling to serve as an effective and credible screening tool to determine if refined modeling is needed.

Scaling factors applied to area sources

Comment:

A commenter (0128) commented that the scaling factors used in AERSCREEN to scale maximum 1-hour concentrations to other averaging times, 3-hour, 8-hour, 24-hour, and annual, should apply to area sources in addition to the point source types processed in AERSCREEN. The commenter points out the 1992 screening guidance to not apply the factors to area sources is subject to debate and has found that for elevated sources, there is a variation in concentrations among the time scales. The commenter points out that the use of area sources in a screening analysis would be conservative, but the treatment of those sources with no adjustment for variable winds is overly conservative, and therefore the EPA should include the conversion factors for all short-term averaging periods. The commenter also pointed out that text from the AERSCREEN user's guide denoting that scaling factors are not used for area sources should be included in the text in the *Guideline* that refers to the scaling factors, regardless of whether scaling factors for area sources are included.

Response:

Currently, AERSCREEN does not apply the scaling factors to 1-hour concentrations for area type sources. This is based on recommendations from the 1992 screening guidance for area sources. Based on this comment, the EPA will investigate in the future whether changes to the screening guidance is warranted based on additional modeling of area source types.

Errors and Clarifications

Comment:

Commenters 0089 and 0124 identified a discrepancy in the AERSCREEN scaling factors in the *Guideline* compared with what was reported in the user's guide. Other commenters (0112 and 0137) reported a typo in Section 4.2.1(c) for BPPIPRM. Commenter (0097) stated that the term "unresolvable problems" in Section 4.1.1.3(c) implies a problem cannot be solved and suggested the language be changed to "unforeseen." A commenter (0099) requested that the definition of "source" be clarified when referring to screening modeling stating single source can refer to a single facility or single emission unit. The commenter also recommended stating in the final rule that are no current screening models for overwater applications. Another commenter (0113) recommended listing the surface characteristics in the discussion of MAKEMET in Section 4.2.1.1(b).

Response:

The EPA has corrected the errors in the final version of the *Guideline* and incorporated the edit suggested by commenter 0097 in what is now Section 4.2.1.3(c). For the purposes of AERSCREEN, the term source refers to a single emission point. We have also listed the surface characteristics in Section 4.2.1.1(b).

Why is CTSCREEN still used?

Comment:

A commenter (0128) questioned why CTSCREEN still used if AERSCREEN is the recommended screening model.

Response:

CTSCREEN is used for applications that involves a well-defined hill or ridge. We still feel it is appropriate to use CTSCREEN in such situations, given that the basis of CTSCREEN, CTDMPLUS, is a preferred model for such applications.

Discrepancy between AERSCREEN and CTSCREEN scaling factors

Comment:

One commenter (0128) pointed out discrepancies between AERSCREEN and CTSCREEN scaling factors for converting 1-hour concentrations to other time periods, and that is an inconsistency given that the models are designed to give similar results.

Response:

AERSCREEN uses factors of 1, 0.9, 0.6, and 0.1 to scale 1-hour concentrations to 3-hour, 8-hour, 24-hour, and annual concentrations respectively. CTSCREEN factors are 0.7, 0.15, and 0.03 for scaling to 3-hour, 24-hour, and annual concentrations respectively. AERSCREEN scaling factors are based on the upper end of the SCREEN3 scaling factors. CTSCREEN factors are based on extreme results from comparing CTSCREEN and CTDMPLUS values. Based on the comment, the EPA will work with the modeling community to investigate the scaling factors for both models to determine if changes should be made to the screening factors.

2.4 Status of CALINE3

Support of proposal

Comment:

Multiple commenters (0106, 0109, and 0151) stated their support of the replacement of CALINE3 with AERMOD, citing one or more of the reasons set forth in the proposal. Another commenter (0129) stated that CALINE3 has been incorporated into AERMOD and noted that New Zealand has also moved away from CALINE3 and now uses Lagrangian models for roadway sources.

Response:

The EPA appreciates the stated support for the proposed replacement and the recognition of the technical and programmatic reasons behind this change. The EPA's technical support document details a number of reasons for the replacement (U. S. EPA, 2016a), including:

- The dispersion modeling science used in CALINE3 is very outdated (30 years old) as compared to AERMOD, RLINE and other state-of-the-science dispersion models. CALINE3 is based on the same dispersion science underlying the ISCTS3 model, which the EPA replaced with AERMOD in 2005 as the preferred regulatory dispersion model for inert pollutants.
- The model performance evaluations presented by (Heist, et al., 2013) represent the best model comparison for AERMOD, CALINE3 and CALINE4 to date. This study used metered emissions of an SF6 tracer and concurrent near-road measurements to serve explicitly as a platform for evaluating mobile source models. The results showed that CALINE3 and CALINE4 were the worst performing models of the 5-model comparison for the two available field studies (Idaho Falls and CALTRANS 99) when considering all modeled and monitored concentrations, paired in time and space.
- Additional analysis of the data from (Heist, et al., 2013) was conducted by the EPA in the context of regulatory use of models (see the updated TSD for the CALINE replacement (U. S. EPA, 2016a). This analysis focused on the highest concentrations (*i.e.*, top 25 concentrations), which

are most relevant for regulatory purposes, and typically the focus of performance evaluations of regulatory models. This additional analysis showed that not only were CALINE3 and CALINE4 the worst performers, but that AERMOD was the best performing model of the group.

- As described in more detail in the CALINE TSD (U. S. EPA, 2016a), CALINE3 is insensitive to changes in mixing height which provides further support for the replacement of this model with AERMOD. For surface releases like roadways, low winds, stable conditions and a low mixing height are expected to result in the worst case concentrations because they are kept close to the ground. The recommendations in the 1995 CAL3QHC User's Guide result in assumptions that are somewhat contradictory and unrealistic.

In addition to the evidence about model performance, CALINE3, CAL3QHC, and CAL3QHCR have several limitations related to the model input that make them more difficult than AERMOD to use for refined modeling:

- Meteorological pre-processors for the CALINE3 models are only available for older meteorological data sets. As a result, newer, higher resolution meteorological data, that is more representative of actual wind conditions cannot readily be used. In contrast, pre-processed meteorological data from AERMET is available from state air agencies for use in AERMOD.

- For CAL3QHCR, only 1 year of meteorological data can be used in each model run. For refined PM_{10} and $PM_{2.5}$ analyses, this requires multiple model runs to cover a 5-year modeling period with resulting model output data from up to 20 model runs that must be separately post-processed to obtain the necessary results.

- In contrast, the EPA provides significant support for AERMOD, including the continuous updates and developments in order to improve its performance for particular source types, meteorological conditions, and terrain features as well as to keep the model up to date with state of the science parameterizations for dispersion modeling. The EPA is committed to continuing to update the AERMOD modeling system to keep it a state of the science dispersion model and to incorporate updates and advancements, as scientifically appropriate, in accordance with the needs of regulatory stakeholders and the broader modeling community. The preamble for the final revised appendix W and the supporting technical support documents describe the numerous modifications that have been made to AERMOD over the last decade as well as provide details on the scientific basis and model evaluations that have been conducted to continually improve the AERMOD modeling system.

The EPA clarifies that CALINE3 has not been incorporated into AERMOD, but appreciates the acknowledgement one of the commenters (0129) that roadway sources require more advanced techniques than the science represented by CALINE3. The EPA adds that we have initiated a formal workgroup, the Interagency Workgroup on Air Quality Modeling (IWAQM) with the US DOT, including FHWA and FTA, to continue to improve the modeling science associated with these source types and update and expand implementation approaches, as needed and appropriate.

AERMOD improvements for transportation

Comment:

One commenter (0086) asked what improvements to AERMOD have been made that are associated with transportation applications.

Response:

The EPA added the "LINE" source option to AERMOD specifically to aid in the design of transportation projects, simplifying the definition of the location of area sources in AERMOD, such that the definition of the location is similar to that input in CALINE3. The adjusted u* update is focused on improving model performance for low-level releases under low-wind conditions and thus is highly relevant for transportation applications. These improvements are in addition to the underlying options that are available for mobile sources with traditional AREA and VOLUME source options, which can also be used to model mobile sources with a great degree of flexibility. The EPA will continue to consider future improvements in AERMOD for transportation applications.

Enhanced stakeholder involvement and coordination

Comment:

Several commenters (0086, 0111, and 0109) requested that the EPA increase stakeholder involvement in the model development and selection process, and provided suggestions about stakeholder training, implementation work groups, and future conferences as many of the commenter's members could not make the 11th Modeling Conference.

Response:

The EPA appreciates the suggestion to increase stakeholder involvement. Since all of the EPA's preferred models are open source, the EPA has a long history of cooperating with other federal, state, and private entities in the model development process. Thus, federal, state, and local stakeholders are welcome to work on model development and updates, including developing new models, for consideration as preferred appendix A models. The EPA has begun additional outreach programs to the transportation stakeholder community with this rulemaking and plans to initiate engagement in the future. The EPA hopes that this increased engagement can indeed lead to informed model updates and developments. Additionally, as noted above, the EPA has initiated a formal workgroup (IWAQM) with the US DOT, including FHWA and FTA, to continue to improve the modeling science associated with these source types and update and expand implementation approaches, as needed and appropriate

The EPA has had a long-standing history of engagement with FHWA with respect to the conformity program, which will continue into the foreseeable future. The EPA is also working with FHWA to establish regular communication with the transportation stakeholders to both provide updates to the community as well as get input and feedback from the community on dispersion modeling needs and issues.

The 11th Modeling Conference served as the public hearing for the proposed revisions to the *Guideline* and the EPA presented an overview of the proposal, but otherwise, the EPA was only accepting comments at this meeting and not responding to comments. The EPA subsequently participated in a webinar with AASHTO member DOTs to present the overview material that was presented at the 11th Modeling Conference. Thus, DOTs were able to get the same information provided by the EPA to the public at the Modeling Conference. Additionally, the 90-day public comment period provided full opportunity for AASHTO and member state DOTs to provide comment.

Transition period

Comment:

Commenters 0086 and 0111 requested an extended transition period for the replacement of CALINE3 with AERMOD. The commenters cited a need for additional time and for state DOTs to obtain additional training.

Response:

The EPA acknowledges that the implementation of the AERMOD modeling system for all refined modeling may take time, as many state transportation departments are not yet experienced with this modeling system. Many states may have attended one of the EPA's multiple training classes but have not been involved in a quantitative PM hot-spot analysis to date. Thus, as a result of these implementation concerns, we are providing an extended 3-year transition period before AERMOD is required as the sole dispersion model for refined modeling in transportation conformity determinations. As such, any refined analyses for which the air quality modeling was begun before the end of this 3-year period with a CALINE3-based model can be completed after the end of the transition period with that model, similar to the way the transportation conformity grace period for new emissions models is implemented.

Retain CALINE3

Comment:

Commenters (0086, 0111, and 0146) requested that the EPA retain CALINE3. The commenters stated that CALINE3 has been more fully evaluated than AERMOD for roadway sources, CALINE3 algorithms are developed specifically for roadway sources, and CAL3QHCR has been improved to address some of the limitations the EPA cited as the basis for the replacement of CALINE3.

Response:

The EPA's position is that the available evaluation data clearly shows that AERMOD is the better performing air quality model. As part of the proposal, the EPA undertook a review of literature documenting performance evaluations of AERMOD and CALINE3. There were few studies that undertook such a review and only one of those studies (Heist, et al, 2013) was based on tracer studies. In response to the comments received on the proposal, the EPA expanded its literature review. The EPA conducted an independent, unbiased literature search for all articles from 2005 to present that used CALINE3, CAL3QHC, CAL3QHCR, or CALINE4. The results of this search are detailed in appendix C of this Response to Comments document. The search returned 68 articles or reports, 4 of which were in a foreign language, leaving 64 articles that were reviewed for additional information to inform the EPA's decision. Of these 64 articles, 39 did not actually have any model performance evaluation (*i.e.*, a comparison of modeled concentrations to equivalent ambient measurements), while 27 had some form of model performance evaluation. Of the 27 studies that contained some sort of model evaluation, only one study met the standard s long-standing approach used by the EPA in established preferred models under the *Guideline*, which was the (Heist, et al, 2013) study on which the EPA already based its decision.

The standard for determining the best performing model is that the model evaluation be based on known emissions (*i.e.*, deliberative emissions of a known tracer mass) and not estimated or modeled emissions (*e.g.*, emissions determined from a combination of traffic counts and an emissions model). Model evaluations based on estimated emissions introduce a significant level of uncertainty in the accuracy of the model estimates. For example, one study included traffic counts based on a manual count of vehicles by individuals who stood at the roadside of one of the busiest intersections in the city; the MOBILE5a emissions model was then used to estimate emissions for specific speeds and three vehicle classes (heavy duty, light duty gasoline and light duty diesel, as counted by the roadside surveyors) (Kho, 2007). Many other studies did not even document how vehicle counts were determined. As noted, this study, along with several others, used the MOBILE model, which the EPA has previously determined has significant limitations which make it unsatisfactory for use in microscale analysis of $PM_{2.5}$ and PM_{10}. Furthermore, in many of the studies, an emissions model was not used to determine case-specific emissions (*i.e.*, emissions were not based on actual vehicle speeds or local meteorology).

The CALINE developers used a similar standard for evaluating model performance when updating CALINE3 to CALINE4 in relying on tracer data with known emissions rather than modeled data emissions [REF CALINE4 manual and paper] used the following 4 field studies to evaluate CALINE4 and CALINE3: 1) the 1980 CALTRANS99 tracer study, which was also used by (Heist, et al, 2013); 2) the 1975 General Motors tracer study; 3) the 1978 Illinois EPA CO field study; and 4) the 1978 EPA NO_2 study in Los Angeles, CA. The model statistics indicated that CALINE4 performed distinctly better for the two tracer studies, while the statistics indicated CALINE3 performed better than CALINE4 for the other two studies based on modeled emissions. The CALINE model developers concluded that the uncertainties in the modeled emissions factors made it “difficult to attach any significance” to the apparently better model performance of CALINE3, particularly when the tracer studies clearly indicated that CALINE4 was the best performing model. Fundamentally, the EPA used the same standard in evaluating AERMOD comparisons with CALINE3 that the CALINE developers used for determining CALINE4 was better than CALINE3, and the modeling results comparing AERMOD and CALINE were even more dramatically in favor of AERMOD than was found by the developers for CALINE4 over CALINE3.

CALINE3 has some other weaknesses, revealed in part by the chronology of CALINE3 and CALINE4. CALINE3 was released in 1979 (Benson, 1979), with the release of CALINE4 just 5 years later (CALTRANS, 1984). The two CALINE3 reports published by CALTRANS were published as "interim" reports and never finalized, though the CALINE4 reports were finalized, suggesting that the model developers never intended CALINE3 to be used long-term. The updates to CALINE3 from CALINE4 include changes to both the horizontal and vertical dispersion curves, modifications to the underlying source parameterizations, and updates to the built-in "mixing zone model." These were necessary because of issues in CALINE3: for example, the model dispersion curves in CALINE3 were stated in the CALINE3 documentation to be unreliable at wind speeds less than 1 m/s, which can occur at night and when mixing heights are expected to be quite low (Benson, 1979). The user's guide recommends that, because the model is unreliable in these situations, "site specific field measurements (should) be made" instead of using the model. The mixing height algorithms in CALINE3 and CAL3QHC are partly based on ISCST2, with stability classes A-C corresponding to ISCST2 (U. S. EPA, 1995). The mixing heights algorithms for D, E, and F were further updated in CAL3QHCR. (It may be noted that the fact that CAL3QHCR has different model algorithms than CALINE3 somewhat brings into question CALINE’s appropriateness as a preferred regulatory model, as the formulation of CAL3QHCR is different than the appendix A model, CALINE3. Additionally, ISCST2 is the predecessor to ISCST3. ISCST3 was the preferred appendix A model that AERMOD replaced (70 FR 68218, Nov. 9, 2005). Thus, the algorithms in CALINE3 are even outdated when compared to the model AERMOD replaced.) Furthermore, since the CALINE3 sensitivity tests presented in the user's guide show that the mixing height must be very low before the model will show a response, the user's guide recommends that users bypass the mixing height algorithm entirely except for special nocturnal simulations.

As a general matter, modeled concentrations are very sensitive to the initial plume parameters, *e.g.*, the initial sigma-z. In CALINE3, the initial sigma-z is determined by the "mixing zone model" incorporated in CALINE3 and is a function of the wind speed and the width of the roadway (Benson, 1979). The parameterization of sigma-z in CALINE3 was based on observations from a single field study, the GM sulfate tracer experiment (Benson, 1980). The study used a 5 km track at the GM testing grounds in Milford, MI with 352 vehicles with a sulfate-spiked gasoline fuel and 8 vehicles with a SF6 tracer (Cadle, et al, 1977; Wilson, et al, 1977). The results from the SF6 tracer measurements were used to develop an empirical relationship to estimate the initial sigma-z of the roadway emissions. The research that led to the development of CALINE4 showed that the parameterization of sigma-z in CALINE3 was flawed and the "mixing zone model" was updated to also be a function of the angle of the wind relative to the roadway segment. Thus, not only is the parameterization of the initial sigma-z flawed in CALINE3, it is not based on any scientific theory, but was instead based on fitting data from a single field study with no variation in traffic activity or composition on an artificial track in rural Michigan, and the approach implemented in CALINE3 was found to be flawed and updated just a few years later in CALINE4 (CALTRANS, 1984).

The EPA's current guidance for $PM_{2.5}$ and PM_{10} (U. S. EPA, 2015a) for AERMOD bases the initial sigma-z and plume release heights on the vehicle type, *i.e.*, passenger vehicle or heavy-duty trucks, based on the assumption that the initial plume characteristics are a function of size and shape of the vehicles on the roadway. However, while AERMOD would allow for these additional parameterizations, as discussed above, CALINE3's method is not only known to be flawed, it is also not accessible to the user as a variable that can be modified as appropriate for the application.

The question of the overall scientific credibility of CALINE3 is further informed by the results of the literature search, which showed that CALINE3 (or CAL3QHC or CAL3QHCR) was used in only 19 of the returned 62 references, with CALINE4 being used in 45 of those studies. The performance of the CALINE models ranged from apparently poor performance to apparently good performance. In some cases, simple auxiliary models based on land use (land use regression models) or simple linear regressions (regressions based on a single site parameter such as number of vehicles) performed as well or better at predicting CO and PM concentrations. All of these facts point towards the outdated model science underlying CALINE3 as well as the inconsistencies in the regulatory needs for a roadway dispersion model versus the capabilities and accuracy of CALINE3. Thus, the EPA's assessment is that CALINE3 is no longer justifiable as a preferred model for modeling the near-source impacts from roadways.

In 2013 (*i.e.*, several years prior to the proposed rulemaking), FHWA attempted to address some of the limitations of the CAL3QHCR model by submitting to the EPA an updated version of the model code. Even though the updated code was only meant to address limitations of the model (*e.g.*, number of meteorological hours) and not affect model concentrations, the code submitted to the EPA did not pass the basic test of model equivalency, *i.e.*, the revised code from FHWA had drastically different concentrations than the base model. However, even if these improvements had been adapted, they did nothing to address the fundamental questions about the model science or many of the other model limitations (*e.g.*, source characterization). Thus, the FHWA's proposed code does not alter the assessment of the value and capabilities of the CALINE3 model discussed here.

Overall, there is clearly a case for questioning the scientific and technical merits and capabilities of CALINE3. Meanwhile, AERMOD has been successfully used for many years for refined PM analyses for a variety of types of projects and facilities and is the EPA's preferred model for refined analyses. AERMOD has been used by the dispersion modeling community for over a decade, with many resources available for training, consultation services, and support from the regulatory community (*e.g.*, many states process meteorological data so that individual facilities do not need to do this part of a model demonstration). AERMOD has far greater flexibility for refined applications: it can model more source types with greater control over the source parameterizations, more options for emissions profiles, more options for incorporating background data, more options for computing design concentrations based on the current form of the standards, and more options for meteorological inputs than any of the CALINE3-based models. The weight of evidence makes clearly supports the EPA in proceeding with the replacement of CALINE3 as a preferred model in appendix A of the *Guideline* for refined analyses of mobile source emissions.

Retain CAL3QHC for CO screening

Comment:

Two commenters (0086 and 0111) emphasized the retention of CAL3QHC for CO screening over the retention of CALINE3 or CAL3QHCR. The commenters suggested that there is a need for an easy to use screening model for CO, particularly since the majority of CO applications are for screening. The commenters also noted that AERSCREEN, the proposed recommended screening model, is limited to a single source. The commenters suggested that MAKEMET is too complicated and labor intensive to use with AERMOD for screening purposes. The commenters provided information on the monitoring network and background levels of CO across the country, suggesting that CO analyses are a low priority. The commenters also stated that CAL3QHC has been used for a long time for CO applications, suggesting that longevity is a reason to not replace a model.

Response:

The EPA reiterates that appendix A of the *Guideline* sets forth preferred models for refined analyses rather than screening assessments. While section 4.2.1 of the *Guideline* does specify preferred screening models (AERSCREEN and CTSCREEN) and in general states a preference for screening approaches to be based on the preferred refined model, the decision to remove CALINE3 from appendix A of the *Guideline* is specifically a decision about its use in refined applications. The EPA originally developed CAL3QHC in 1995 to reflect the latest science at that time and to provide a CO screening model for state and local agencies. The EPA continues that commitment in this final rule by retaining the use of CAL3QHC for CO screening, and through its current evaluation, the EPA is finalizing AERMOD to reflect the latest science for refined modeling. As stated in the preamble of this final rule, CAL3QHC can still be used for CO project-level screening.

The EPA acknowledges that there are limited demonstrations of using AERMOD for multi-source screening and that additional development work is necessary to develop an AERMOD-based screening approach for CO that satisfies the need for this type of analysis. As such, there is no preferred screening model for CO hot-spot analyses. Thus, we have modified section 4.2.3.1(b) of the *Guideline* to reference the EPA's CO guidance for CO screening analysis. The existing guidance from 1992 that employs CAL3QHC (U. S. EPA, 1992) will remain in place as the recommended approach for CO screening until such time that the EPA develops a new CO screening approach based on AERMOD or another appropriate model, without needing to undergo the review process discussed in the *Guideline* section 2.2(d). That review and process is not necessary for CAL3QHC because its use is already well-established for CO hot-spot analyses and the review criteria have already been met.

CALINE3 as an alternative model

Comment:

AASHTO (0086) commented that the EPA should allow CALINE3 to be an "approved alternative model" in addition to AERMOD in the *Guideline*.

Response:

The *Guideline* has always allowed for alternative models when there is no preferred model, with specific steps required to meet the criteria for an alternative model to be approved and the subsequent approval steps consistent with the criteria and approach detailed in section 3.2 of the *Guideline*. This route remains available for modeling applications covered by the *Guideline* where appropriate. However, as evidenced by the information the EPA provided in the final rulemaking to support replacement of CALINE3 with AERMOD, CALINE3 would not seem to satisfy the alternative model criteria for the same reasons outlined in this final rule. Please refer to the EPA's documentation and other responses in this document for why CALINE3 would not be considered an appropriate model for project analyses.

Lack of queuing algorithm in AERMOD

Comment:

Multiple commenters (0086, 0130, 0109, and 0063) believe that AERMOD does not contain the queuing algorithms and, is thus, not a sufficient replacement for CAL3QHC and CAL3QHCR.

Response:

First, the EPA notes that the preferred model (*i.e.*, the appendix A model) for mobile sources in the 2005 version of *Guideline* was CALINE3, rather than CAL3QHC or CAL3QHCR. CALINE3 does not have any queuing algorithms, and thus in this respect, AERMOD has the same capacity as CALINE3.

The models that do include queuing are CAL3QHC and CAL3QHCR. CAL3QHC was mentioned in section 5.2.3 for CO screening and the regulatory text was explicit in stating that CAL3QHC is a combination of CALINE3 (the previous appendix A model) with a traffic model. CAL3QHCR is also mentioned in this section for refined analyses "on a case-by-case basis." The *Guideline* sets forth preferred air quality models and does not include development or updates to traffic modeling approaches.

Based on available information, the specifics of the queuing algorithm in CAL3QHC have not received much scrutiny, largely due to the reliance on CO screening analyses with an acknowledged reduced level of accuracy. However, this information suggests that the queuing algorithms in CAL3QHC and CAL3QHCR are both outdated and the resulting queue information may be inconsistent with the other traffic information determined from the traffic modeling done for the project that specifies the emissions for the dispersion model. Commenters did not supply any additional documentation that demonstrates that the queuing algorithm reflects the current best practice for modern day traffic models. In addition, for $PM_{2.5}$ and PM_{10} refined analyses, the current EPA guidance (U. S. EPA, 2015a) specifies that users should not use the queuing algorithm in CAL3QHCR, as emissions that occur during queuing are included in the results of the emissions model, based on the traffic information that is input to those models. Thus, the state of practice for $PM_{2.5}$ and PM_{10} is to use the traffic information, including queue information, from the traffic model used to develop the project rather than the limited queuing algorithms in CAL3QHCR. Therefore, when AERMOD is used for CO screening, this same information should be sufficient for those purposes. However, as discussed in the preamble, since the EPA is retaining the current practice using CAL3QHC for CO screening, there is no additional need for queuing information beyond the current state of practice.

Approach to model evaluation

Comment:

Commenters (0086 and 0111) suggested that the EPA should implement the model development and approval protocols outlined in the report from the National Research Council (NRC) on the development of regulatory models (NRC, 2007). The commenters cited several specific components from this report, specifically 1) comparing model results to known test cases, 2) reviewing model code and documentation, and 3) running the models for several types of problems for which the model might be used. The commenters also suggested that the (Heist, et al, 2013) study does not meet these requirements. The commenters further stated that the NRC protocols should be followed to determine preferred models based on their usage, *i.e.*, models for CO projects do not need to be accurate but should be very simple to run. The commenters also stated that the evaluation of the model should consider the "modeling chain," *i.e.*, the data inputs such as emissions and traffic data and that model uncertainties should be part of the model evaluation. Additionally, the commenters recommended that model comparisons should be based on the new near-road monitoring network. Finally, the commenters stated that the NRC report requires adequate documentation for the model selection and that the data justifying the proposed replacement of CALINE3 was not available on the EPA's SCRAM website or on the docket website.

Response:

The EPA has developed a protocol for determining the best performing model. These requirements have been part of the *Guideline* since it was first published. These requirements are given in section 3.1.1 of the *Guideline*, with the requirements for an alternative model for refined applications given in section 3.2. With respect to the analysis approaches suggested from the NRC report, the EPA believes that these steps have been part of the EPA's evaluation of AERMOD and CALINE3 to date: 1) the (Heist, et al, 2013) paper compared model results to known test cases, including one case that was used by the model developers to validate the update from CALINE3 to CALINE4, 2) the model code and documentation for AERMOD are readily available and have been for some time, and 3) AERMOD has been used for some time for a wide variety of transportation projects and, in fact, has more options for sources and can handle a wider variety of projects than any of the CALINE3 models. Thus, the EPA has not only satisfied the requirements set forth in the *Guideline*, but also the requirements suggested by the commenters. Again, appendix A of the *Guideline* recommends preferred models for refined analyses rather than screening analyses. Thus, while the recommendations for alternative evaluation techniques for screening models is appreciated, they are not applicable to the revisions in this rulemaking.

As discussed in the "Retain CALINE3" section, the EPA's emphasis on the (Heist, et al, 2013) paper was specifically to overcome the uncertainties in the "modeling chain." The EPA recognizes that there are significant uncertainties in the traffic data and other inputs needed in the models used to estimate emission rates leading to uncertainty in model evaluations. When these two are combined to estimate hourly emission rates for dispersion modeling there is even greater uncertainty. Thus, field studies based on traffic counts will have a significant amount uncertainty when attempting to replicate individual hours of monitoring data for use in model to monitor comparisons.

The EPA anticipates that future analyses will employ the results from the near road network. The network currently collects data for NO_2, which adds to the complexity and uncertainty of the modeling results due to the need to consider NO/NO_2 chemistry. CO and $PM_{2.5}$ near-road monitors are still coming online, and little or no data was available for these pollutants at the time of proposal.

Though it is not standard practice to provide data from journal articles cited in a proposal, the EPA provided contact information for requesting modeling files and model output from the (Heist, et al, 2013) paper. These files were provided to the FHWA and one state DOT that made requests. No other requests for files were received.

AERMOD performance and project timelines

Comment:

Two commenters (0086 and 0111) provided a number of comments suggesting that AERMOD (and other components of the AERMOD modeling system) is much more difficult to use and that model setup and runtimes take much longer than CALINE3. Fairly specific comments were given by AASHTO stating that the use of AERMOD would increase the project timelines by multiple months, with specific estimates for time to complete individual components of the modeling demonstrations with AERMOD, including model set up, compilation of meteorological data, running the model, and rerunning it after QC efforts that indicated hundreds of days and man-hours to complete each of these individual steps.

Response:

The EPA disagrees that AERMOD is fundamentally more complicated to set up and use compared to CALINE3.

If the effort to run one model over another is characterized as a function of the specific model inputs, then the following compares AERMOD, CAL3QHC, and CAL3QHCR (the base model CALINE3 is not actually used for any regulatory analysis):

- Source geometry - each model requires one or two lines of model input for each source, including the x and y coordinates of the link start and end point, the link height, and the source width or initial plume characteristics (using the LINE source option in AERMOD).
- Receptor geometry - each model requires one line of model input for each receptor, with the x, y, and z coordinates of the receptor. The EPA provides the AERMAP tool to determine receptor

height information when needed, though most projects can assume flat terrain and do not need this processing step.

- Meteorological data - each model has one line of model input for each hour of data for surface characteristics, though AERMOD met input includes a profile of met data, which in most projects is identical to the surface meteorology. This profile input is generated simultaneously as the surface data in AERMET.
- Time-varying emissions - AERMOD and CAL3QHCR can vary emissions data. CAL3QHCR can only vary the data on a 24-hour cycle, AERMOD has a number of variation options, though the 24-hour cycle has the same amount of input as CAL3QHCR

This comparison is based on the assumption that the fundamental input data, *i.e.*, the link locations, associated emissions, etc., are already compiled, which is required for all three models. Overall, the three models have effectively the same input requirements, only with variation in the formatting between all three models.

When comparing an AERMOD to CAL3QHC and CAL3QHCR run, the increased number of sources and receptors that AERMOD can process can ultimately make an AERMOD-based analysis less complicated. Consider the following examples:

FHWA completed a categorical CO hotspot finding, analyzing a large intersection with CAL3QHC to exempt similar projects from needing to conduct such an analysis. The FHWA project required 44 separate CAL3QHC model runs as opposed to a single AERMOD model run that would be required to complete the same analysis. Thus, the user must post-process the 44 separate model runs to determine the overall project impact and manage all the extra input and output files. If a modification must be made to the project, this can represent a significant amount of extra work over AERMOD. Additionally, the EPA has estimated that if this project could be run as a single CAL3QHC model run, it would take about 15 seconds to complete, while the estimate to complete in AERMOD ranged from 1-2 minutes, depending on the AERMOD configuration (see appendix B of this Response to Comments document for more information). While this does represent a factor of 4-8 times the CAL3QHC runtime, a model runtime of a few minutes is still negligible.

For refined PM hotspot analyses, AERMOD has many more options for hourly emission rates and allows for multiple years of meteorology, while CAL3QHCR can only process a single quarter of meteorology at a time. Thus, a single conformity analysis with 5 years of meteorological data can be consolidated into a single AERMOD run, which can include background concentrations and automatically calculate the project design values, while CAL3QHCR takes 20 separate model runs (4-quarters multiplied by 5 years) along with the additional post-processing required to calculate design values. The EPA did not test model run times, as was done with CAL3QHC, but we generally expect similar run times for each meteorological condition for the CALINE3 models.

It is difficult to respond to the specific comments on the project timetable presented by AASHTO without more information. The fact that AERMOD was chosen by the particular DOT over CAL3QHCR suggests that CAL3QHCR was not capable of modeling the project. If this is the case, then the project must have been quite complicated, with more sources and/or receptors than CAL3QHCR can handle, while AERMOD effectively has an unlimited number of sources and receptors (within the limits of the computer system used to run the model). However, the EPA notes that it is not reasonable to compare the project lead time for a simple project with CAL3QHCR to a very complicated project with AERMOD, which seems to be the case when the increased project lead times are discussed in AASHTO's comments with the implementation of AERMOD. Additionally, it should be noted that AERMOD has been successfully used for at least 7 hot-spot conformity analyses[2] and that the FHWA has listed an example of a hot-spot analysis using AERMOD (this example shows the use of AERMOD in the first hot-spot analysis in IN). Thus, clearly the record shows that AERMOD is not only capable of being used for hot-spot analyses, but that the community is able to use it in an appropriate time frame and that the implementation methods provided in the hot-spot guidance (U. S. EPA, 2015a) are sufficient for demonstrating its use for this application.

With respect to the meteorological data process, the EPA notes that an experienced dispersion modeler can prepare 5 years of meteorological data from scratch and have AERMOD-ready files on timescales of one day. The commenter's estimate of the hours necessary to compile meteorological data is excessive. The EPA also notes that most state air programs provide current meteorological data that has already been processed with AERMET for their stakeholders. Preprocessed meteorological data is also available from several commercial vendors that sell readily processed data, along with perhaps hundreds of consultants who can process meteorological data in a short period of time. Thus, there is a plethora of meteorological data already available for usage and many routes to obtaining meteorological data in far less time than quoted by AASHTO.

AASHTO references an internal CALTRANS report for much of this information. The EPA has been unable to locate the text of this document, as it does not appear to be public information. Thus, any further response to the comments based on this report is not possible.

Request to develop a model interface

Comment:

Two commenters (0086 and 0111) requested that the EPA develop a "user friendly interface for AERMOD."

Response:

The EPA does not currently plan to develop an AERMOD user's interface. We note that several commercial vendors sell packages that include a graphical user interface (GUI). The EPA has also provided training for applying AERMOD without a GUI (U. S. EPA, 2016b). The availability of a GUI does not impact the determination of a best performing model or the EPA's decision-making process in the course of this rulemaking.

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[2] According to FHWA's project tracker website, the following projects have completed modeling analysis with AERMOD: I-69 $PM_{2.5}$ Quantitative Hot-spot Analysis, Indianapolis2013; FRA-71.5.29 (Project ID#84868), Franklin County, OH, 2013; High Desert Corridor, Los Angeles and San Bernardino Counties, CA, 2014; I-15 Express Lanes, San Bernardino County, CA, 2015; I-170, (710 South) Los Angeles, CA; SR-710 (710 North), Los Angeles, CA; I-70, Denver, CO

Request to provide screening option

Comment:

A commenter (0086) requested that the EPA provide a screening option with detailed inputs that are needed with AERMOD.

Response:

As discussed elsewhere in this response (see comments on the retention of CAL3QHC for CO screening), the EPA has retained CAL3QHC for CO screening until an appropriate screening option can be developed for CO and AERMOD. Additionally, an example of a possible screening approach for CO using AERMOD is provided in the CALINE3 replacement TSD (U. S. EPA, 2016a).

Source characterization in AERMOD

Comment:

A commenter (0062) posed questions regarding model performance for low-wind situations with many low-level releases and the approach to modeling sources at various elevations.

Response:

As discussed elsewhere, AERMOD has been used extensively for conformity analyses for PM_{10} and $PM_{2.5}$ for many years (see footnote[2] above that includes the 7 hot-spot conformity analyses that AERMOD have been successfully used). The model has proven performance for these low-wind situations and is expected to show improved performance with the adoption of the adjust-u* option. The approach for modeling various source geometries and elevations can be found in the appropriate modeling guidance (U. S. EPA, 2015a).

Impact on NEPA analyses

Comment:

Two commenters (0086 and 0111) have provided a number of comments regarding the impact of the changes to the *Guideline* on NEPA analyses.

Response:

As stated in section 1.0, the *Guideline* provides modeling techniques applicable to NSR, conformity, and other air quality assessments required under CAA regulations and does not specify requirements for analyses under NEPA.

Request for a phased approach for model demonstrations

Comment:

Commenters (0086 and 0111) requested that the EPA develop a phased approach for using models for transportation projects, specifically requesting that the EPA provide multiple levels of demonstration similar to those provided for PSD (*e.g.*, SILs).

Response:

This comment is beyond the scope of the *Guideline*.

Support for AASHTO's comments

Comment:

One commenter (0146) submitted comments simply stating that commenter 0146 participated in another commenter's (0086) survey and that they fully support the comment letter submitted by commenter 0086.

Response:

The EPA appreciates commenter's participation in the effort to collect comments from state DOTs. The bulk of the EPA's response to the CALINE3 replacement is in response commenter 0086's comments.

2.5 Addressing Single-Source Impacts on Ozone and Secondary $PM_{2.5}$

Tier 1 Demonstration Tools / Modeled Emission Rates for Precursors (MERPs)

Comment:

Numerous commenters (0077, 0081, 0084, 0085, 0089, 0090, 0104, 0109, 0118, 0127, 0137, 0138, 0203, 0110, 0126, 0142, and 0128) expressed support for the two-tiered approach for estimating single source secondary impacts for permit related programs. Flexibility in the initial Tier is desired to allow for area specific demonstrations while avoiding the second Tier assessments where chemical transport modeling may be part of the demonstration. Commenters support the idea of MERPs as a Tier 1 demonstration tool but do not want MERPs more stringent than existing Significant Emissions Rates (SERs) which would thereby put all permit applicants that enter the PSD program directly into the Tier 2 demonstration. Commenters desire more specific information about Tier 1 demonstration tools and MERPs and generally felt the level of information provided in the proposed rulemaking was insufficient. One commenter (0114) states that the EPA should develop specific guidance for performing first tier assessments (*i.e.*, for emissions greater than any established MERP) and that for such assessments, any empirical relationships between precursor pollutants and secondary impacts must be based on methods that protect PSD increments in all Class I and II impact areas affected by the subject source. One commenter (0128) further suggests more guidance is needed about how to relate existing source-receptor relationships to source-receptor relationships in other places for Tier 1 demonstrations to adequately cover the range of chemical and physical environment differences that could exist.

Multiple commenters (0098, 0099, 0109) do not support the proposed Tier 1 approach MERPs demonstration tool until specific MERPs are proposed. Multiple commenters (0106, 0119, 0117, 0143, 0145) do not express support or opposition to the two-Tier approach for estimating single source secondary impacts but do desire more specific information about Tier 1 demonstration tools and MERPs and generally felt the level of information provided in the proposed rulemaking was insufficient. The same commenters prefer requiring only the largest sources to apply chemical transport models for estimating secondary impacts.

A commenter (0115) stated that the EPA should halt any development of additional loopholes, including MERPs, which would rely on SILs, for MERPs would measure the amount of precursors that the EPA anticipates would result in $PM_{2.5}$ or ozone impacts below the level of the relevant SIL. SILs are unlawful and arbitrary; therefore, MERPS would be unlawful and arbitrary. The EPA fails to account for a "causation" violation in its new discussion of SILs; it similarly fails to account for that in its discussion of MERPs. The EPA must also make sure that sources address both primary and secondary formation of $PM_{2.5}$. Further, the EPA's conception of MERPs as "a level of emissions of precursors that is not expected to contribute significantly to concentrations of ozone" is flawed because different areas may have different characteristics that lead to different precursors having greater or lesser impacts. For example, ozone levels in some areas may be more sensitive to changes in VOC emissions, whereas in other areas, NO_X emissions may be the dominant factor. As a result, if the EPA were to continue with the MERPs concept, it would need to establish them based on the most conservative, most-ozone- or $PM_{2.5}$-forming circumstance. Regardless of the existence of MERPs, the EPA cannot allow a qualitative approach to secondary pollutants, and it certainly cannot encourage the qualitative (or a hybrid qualitative-quantitative) approach as the default. Because the NAAQS and increments (and SILs, which are unlawful) are all expressed numerically, compliance needs to be determined numerically, too.

A commenter (0114) asserts that any MERPs developed must be based on levels that protect PSD increments in all Class I and II impact areas affected by the evaluated source, and should further be considered on a location-specific basis, based on both near-field and long-range transport impacts.

Response:

In the preamble to the 2015 proposed rule, we expressed our intent to pursue a separate rulemaking concerning MERPs. 80 Fed. Reg. at 45347-48. Since then, we have altered our plans. Instead of developing generally-applicable MERPs in a future rulemaking, we believe it is preferable for permit applicants and permitting authorities to consider site-specific conditions when deriving MERPs and to obtain experience with the development and application of locally and regionally appropriate values in the permitting process. In response to requests by multiple commenters for additional information regarding Tier 1 demonstration tools such as MERPs, the EPA has developed (and made available on the web for informal public comment) a draft guidance document on the development and use of MERPs as a Tier 1 demonstration tool by permitting authorities and permit applicants on a case-by-case basis under the PSD program in assessing the effects of precursors of $PM_{2.5}$ and ozone. The Agency is no longer planning a rulemaking to establish a single set of national MERPs and is instead providing this guidance document intended to provide a framework for area-specific levels that provides the flexibility and consideration of area-specific conditions requested by many commenters with respect to Tier 1 demonstration tools.

The draft MERPs guidance document (U. S. EPA, 2016e) is intended to provide information about how to use chemical transport models to estimate single source impacts on O_3 and secondary $PM_{2.5}$ and how that type of information can be used to develop empirical relationships for specific areas that may be appropriate for use as a Tier 1 demonstration tool. This type of approach allows for the development of area specific Tier 1 demonstration tools that better represent the chemical and physical characteristics and secondary pollutant formation. This draft guidance and the "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f) provide additional information about the types of chemical and physical characteristics of the project source and key receptor areas that should be addressed as part of the PSD compliance demonstration.

The EPA notes that this concept of the MERP framework for use as a Tier 1 demonstration tool is consistent with the comment that impacts should reflect the physical and chemical environment of the project source and key receptors in order to be used to support a PSD compliance demonstration. Through this process, the EPA believes it has provided sufficient information regarding Tier 1 demonstration tools, such as MERPs. The draft MERP technical guidance document illustrates how permitting authorities may appropriately develop MERPs for specific areas and use them as a Tier 1 demonstration tool for permit-related programs. This draft guidance also explicitly addresses the commenter's concern regarding the appropriate use of MERPs such that their use reflects the combined ambient impacts across precursors and, in the case of $PM_{2.5}$, the combined primary and secondary ambient impacts. This approach also provides the flexibility requested by many commenters with respect to Tier 1 demonstration tools, such as MERPs, to generate information relevant for specific regions or areas rather than a single, national level that may not be representative of secondary formation in a particular region or area.

The draft MERP technical guidance provides information about how to use CTMs to estimate single-source impacts on ozone and secondary $PM_{2.5}$ and how these model simulation results can be used to develop empirical relationships for specific areas that may be appropriate as a Tier 1 demonstration tool. It also provides results from the EPA photochemical modeling of multiple hypothetical situations across geographic areas and source types that may be used by a permit applicant, in consultation with the appropriate permitting authority, in providing a Tier 1 demonstration consistent with the guidance or with supplemental modeling in situations where the EPA's modeling may not be representative. The draft guidance also states that a permit applicant seeking to use MERPs as part of their modeling protocol should include a narrative that provides a technical justification that the existing information is relevant for their project source scenario. This flexible and scientifically credible approach allows for the development of area-specific Tier 1 demonstration tools that better represent the chemical and physical characteristics and secondary pollutant formation within that region or area.

The draft MERPs technical guidance and the EPA's single-source modeling guidance (U. S. EPA, 2016f) provide information to stakeholders about how to appropriately address the variety of chemical and physical characteristics regarding a project scenario and key receptor areas that should be addressed in conducting additional modeling to inform development of MERPs. As stated in section 5.2 of the revised *Guideline*, "the appropriate tier for a given application should be selected in consultation with the appropriate reviewing authority (paragraph 3.0(b)) and be consistent with EPA guidance." The EPA expects that such selection would be discussed early in the process during the development of a modeling protocol. The development of MERPs for ozone and secondary $PM_{2.5}$ precursors is just one example of a suitable Tier 1 demonstration tool. The EPA will continue to engage with the modeling community to identify credible alternative approaches for estimating single-source secondary pollutant impacts, which provide flexibility and are less resource intensive for permit demonstrations.

The comment questioning the legality of SILs is out of the scope of this rulemaking so no response is provided here. See the EPA's response under "Multi-stage Compliance Demonstration and Use of SILs" in Section 2.9, below, for a detailed response with respect to the use of SILs for PSD compliance demonstrations.

Comment:

A commenter (0115) suggested a change in text in the *Guideline* at 80 Fed. Reg. 45, 358/1 that states "simplified or conservative models" such that these are not mutually exclusion options for permit projects.

Response:

The EPA has made the suggested change to the regulatory text to insure that "simplified or conservative" text has been modified to "simplified and conservative" as they are not mutually exclusive options.

Comment:

A commenter (0114) states that because using MERPs as a screening method in $PM_{2.5}$ and ozone nonattainment areas is likely to interfere with progress towards attaining national ambient air quality standards (NAAQS) for these pollutants, $PM_{2.5}$ emissions as well as $PM_{2.5}$ and ozone precursor emissions that impact unclassified and nonattainment areas should be offset by a ratio greater than 1:1. Similarly, the EPA should develop specific guidance for performing second tier assessments: allowing facilities or local permitting authorities which modeling system (and which inputs) to use allows "model-shopping," and is no improvement over the current situation.

Response:

Under this final rulemaking, MERPs are intended as a Tier 1 "demonstration tool" for the PSD permitting program and not a "screening method," and we agree that any use of MERPs should reflect the combined ambient impacts across precursors and, in the case of $PM_{2.5}$, the combined primary and secondary ambient impacts. We also note that MERPs as currently envisioned are not for nonattainment area or SIP attainment purposes. To remove any confusion, the EPA's single source guidance, "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f) was revised to move information to an appendix on how to use such modeling for interprecursor trading ratios covered under separate guidance.

Regarding specific guidance for second tier assessments, the EPA's single-source guidance provides information relevant to the application of chemical transport models for the purposes of completing a Tier 2 type of assessment.

Comment:

Commenters 0107 and 0141 request clarity in the *Guideline* regarding when a Tier 1 demonstration is needed and when a Tier 2 demonstration would be needed. The commenters further indicate opposition to the flexibility afforded under the Tier 1 approach and prefers a stricter mandated single tool be developed by the EPA.

Response:

The EPA has revised the $PM_{2.5}$ Modeling Guidance document to be inclusive of both O_3 and $PM_{2.5}$ and provides the framework that permit applicants can use to determine which types of analysis and tiers of analysis are appropriate for their particular situation. The EPA believes that the complex nature of estimating O_3 and $PM_{2.5}$ impacts will necessitate flexibility in the approaches and has offered draft guidance on development and use of MERPs as a Tier 1 demonstration tool by permit applicants and state or local air agencies. The EPA will work with stakeholders and the modeling community as other tools or approaches are applied and can be leveraged or used by others.

Comment:

Two commenters (0097 and 0142) requested that the EPA not finalize the *Guideline* revisions until the MERPs proposal is released. One of the commenters (0097) also stated that MERPs should not be the sole decision criteria for permit approval or need for more refined analysis. The commenter (0097) suggested other corroborative information should be provided along with a MERPs Tier 1 demonstration.

Response:

The draft MERPs guidance (U. S. EPA, 2016e), instead of a rulemaking, has been made available on the web as discussed above. This draft guidance document provides information about Tier 1 demonstration tools and recognizes that project sources need to provide corroborating information (such as describing how the existing empirical information is relevant to the source/receptor relationships part of the permit application) to ensure an assessment protective of the environment.

Comment:

A commenter (0092) stated that "peer reviewed reduced-form models" is vague and would result in deliberation for each permit assessment. The commenter states MERPs as a Tier 1 demonstration tool could reduce this case-by-case deliberation but note that MERPs have not been proposed.

Response:

The draft MERPs guidance (U. S. EPA, 2016e) has been made available on the web as discussed above. The EPA anticipates most permit applicants will use information similar to the approach presented in that draft guidance document but flexibility is still afforded for applicants seeking to use other credible approaches.

The use of photochemical grid models for Tier 2 refined O_3/secondary $PM_{2.5}$ permit related assessments

Comment:

Multiple commenters (0085, 0090, 0097, 0098, 0099, 0107, 0108, 0124, 0127, 0137, and 0092) state that requiring chemical transport modeling as a Tier 2 demonstration tool places undue burden financially on States; States do not have the expertise to run or review such models; the regulated community does not have the expertise to run such models. A commenter (0097) requests that the EPA provide resources to state agencies to assist in performing single-source photochemical grid modeling and in reviewing the model protocols and project source impacts. Another commenter (0092) recommends the EPA not proceed with the appendix W revisions that require the use of photochemical grid models for Tier 2 assessments without specific rationale for that recommendation.

Response:

The EPA expects that a number of sources will be able to use Tier 1 demonstration tools, such as MERPs, to provide a PSD compliance demonstration under the Tier 1 approach in the *Guideline*. This would mean that not all permit applications will need to do a Tier 2 demonstration. Further, the EPA disagrees with the assertion that States do not have expertise related to chemical transport models. The EPA has attended numerous modeling conferences and workshops that include extensive representation by

State and Local air agencies that are focused on the application of chemical transport models. These meetings include the annual CMAS conference (www.cmascenter.org) and meetings held by multi-jurisdictional agencies such as Lake Michigan Air Directors Consortium, Western Regional Air Partnership, Mid-Atlantic Regional Air Management Association, and Central States Air Resource Agencies to name a few.

Comment:

A commenter (0115), states that chemical transport models such as SCICHEM and photochemical grid models (*e.g.* CAMx and CMAQ) are appropriate for estimating single source secondary impacts for permit related programs and the application of such models does not pose an undue resource burden on states or the regulated community. Two commenters (0085 and 0089) request the EPA designate a single modeling system with preferred status for O_3 and secondary impacts. Commenter 0089, requests The EPA provide the Comprehensive Air Quality Model with Extensions (CAMx) and the Community Multiscale Air Quality (CMAQ) models with preferred status. A commenter (0128) supports the choice of a photochemical model rather than Lagrangian model for estimating single source O_3 and secondary $PM_{2.5}$ impacts for permit projects. Another commenter (0085) further requests the EPA develop the preferred model to run on non-Linux based computer operating systems and capture cold-pool events associated with elevated O_3 levels.

Response:

Based on assessments of models used for estimating O_3 and secondary $PM_{2.5}$ for single source impacts, The EPA continues to recommend in the final revisions to the *Guideline* that chemical transport models (such as photochemical or Lagrangian transport models) be used where a more refined Tier 2 demonstration for O_3 or secondary $PM_{2.5}$ may be necessary. Given the community's interest in different types of chemical transport models for the purposes of estimating single source O_3 and secondary $PM_{2.5}$ impacts from single sources and the fact that there are multiple models where applied appropriately are fit for this purpose, a single model selected by the EPA for preferred status under the *Guideline* would impede sources from using a tool deemed most appropriate for specific situations recognizing the diversity in chemical and physical environments across the United States.

The EPA will continue to work with stakeholders and the modeling community to make continued improvements in the science and the computational efficiency of chemical transport models to meet the needs for regulatory modeling; however, we have sufficiently demonstrated that these models are currently capable of quantifying single-source impacts for use in the PSD permitting program.

Specific Modeling Systems for Tier 1 and 2 Demonstrations

Comment:

One commenter (0142) note the IWAQM report states that it is not clear that robust reduced form models exist for O_3 or secondary $PM_{2.5}$ impacts from single sources. The commenter notes that the EPA does not provide a clear modeling approach for estimating O_3 and secondary $PM_{2.5}$ from single source for permit related programs.

Response:

In response to this commenter, the EPA has changed the text in the "Interagency Workgroup on Air Quality Modeling Phase 3 Summary Report: Near-Field Single Source Secondary Impacts" document to provide additional clarity that screening tools (*e.g.* reduced-form models) have been identified for O_3 and secondary $PM_{2.5}$ that could be used as a Tier 1 demonstration tool. One such tool is outlined in recently released EPA draft guidance, "Guidance on the use of modeled emission rates for precursors (MERPs) as a Tier 1 demonstration tool for permit related programs". The intent of the "Interagency Workgroup on Air Quality Modeling Phase 3 Summary Report: Near-Field Single Source Secondary Impacts" was only to recognize that screening models that estimate very specific source-receptor relationships accurately representing the range of chemical and physical environments in the U.S. have not been clearly identified. However, the framework for development and use of MERPs represents a viable and credible option for a Tier 1 demonstration tool, while chemical transport models represent viable and credible options as Tier 2 demonstration tools. The MERP approach for a Tier 1 demonstration tool is detailed in the draft "Guidance on the use of modeled emission rates for precursors (MERPs) as a Tier 1 demonstration tool for permit related programs." The modeling approach using chemical transport models for a Tier 2 demonstration tool is detailed in "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f) documents.

Comment:

Commenters (0110 and 0126) request the EPA consider Tier 1 demonstration tools that do not require the application of more sophisticated modeling tools such as chemical transport models to determine relationships between precursors and O_3 or secondary $PM_{2.5}$. The commenter suggests a photochemical box model (*e.g.* OZIP-R) for O_3 assessments and using AERMOD with assumptions about project source precursor emissions conversion to secondary $PM_{2.5}$ for $PM_{2.5}$ assessments.

Response:

Under the revised *Guideline*, a permit applicant may provide a documented justification for approval to the appropriate reviewing authority that a photochemical box model, the inputs used for that tool, and the application of that tool provide a credible estimate of single source secondary impacts for meteorological periods conducive to O_3 and secondary $PM_{2.5}$ formation. If such a tool were put forth for this purpose, it is critically important that inputs reflect the meteorology, surface layer mixing height, and ambient concentrations of key oxidants and neutralizing agents (for $PM_{2.5}$) for the range of conditions known to result in elevated O_3 and $PM_{2.5}$ in the area between the source and key receptors. It is also critically important that information is clearly identified in a modeling protocol. Photochemical box models were not included as part of the discussion of potential tools since they are not designed to provide a 3-D representation of the chemical and physical processes at the source, receptors, and area between the source and receptors through time and space.

Comment:

A commenter (0083) proposes that SCICHEM can provide an alternative modeling platform for all single source regulatory applications including O_3 and secondary $PM_{2.5}$ impacts. Two commenters (0083 and 0110) note that SCICHEM does not suffer from limitations of other Lagrangian puff models with respect to overlapping puffs having similar access to background species as noted in the draft Single Source Modeling Guidance. Multiple commenters (0083, 0107, 0124, 0135, 0145, and 0110) request the EPA consider Lagrangian chemical transport models for use in assessing single source secondary impacts.

Response:

The EPA has clearly indicated in the final rulemaking package and related guidance that chemical transport models are appropriate for estimating single source impacts on O_3 and secondary $PM_{2.5}$ as a Tier 2 demonstration tool or as a tool to develop a Tier 1 demonstration tool. Thus, both Lagrangian models and photochemical transport models may be appropriate for this purpose under the *Guideline* where those models fulfill alternative model criteria detailed in Section 3 of the *Guideline*. The EPA has updated the single-source modeling guidance (U.S. EPA, 2016f) to reflect the difference in treatment of overlapping puffs and background in SCICHEM compared to other Lagrangian puff models. Specifically, new text has been added to section 4.7 of this guidance, *i.e.*, "Due to the existence of overlapping puffs in many Lagrangian puff models, multiple puffs can occupy the same location at a given time. These overlapping puffs interact with background concentrations independently unless special treatment (*e.g.* SCICHEM) of puff access to background is implemented."

Miscellaneous Comments on Secondary O_3/PM impacts

Comment:

Two commenters (0017 and 0115) request clarification about how secondary $PM_{2.5}$ impacts are combined with primary $PM_{2.5}$ impacts for comparison to the SIL or NAAQS. Clarification is needed as to whether a project source $PM_{2.5}$ precursor emissions are below the level of an accepted Tier 1 demonstration tool such as MERPs then those amounts do not need to be added to primary impacts and the analysis for primary $PM_{2.5}$ using AERMOD is a completely separate analysis.

Response:

The EPA has clearly indicated in the final rulemaking package and related guidance that a project source that emits primary $PM_{2.5}$ emissions and also precursors for $PM_{2.5}$ need to include some estimate of the secondary $PM_{2.5}$ impacts along with the impacts from the primarily emitted $PM_{2.5}$. The EPA has added text to the "Ozone and $PM_{2.5}$ Permit Modeling Guidance" (U. S. EPA, 2016n) as well as the MERPs guidance (U. S. EPA, 2016e) and the single-source modeling guidance (U. S. EPA, 2016f) to provide clarity regarding this situation and options that sources have for combining primary and secondary $PM_{2.5}$ impacts.

Comment:

A commenter (0128) states that the EPA should provide clearer guidance with respect to VOC speciation of project source emissions for the purposes of assessing single source O_3 impacts as part of permit related programs.

Response:

The EPA has updated the "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f) to state that project source VOC emissions should be speciated to match the actual speciation of emissions when a Tier 2 demonstration is necessary. Specifically, new text has been added to section 4.1.1 of this guidance, *i.e.*, "VOC and NO_X emissions should be assessed using a VOC and NO_X speciation profile matching the specific project source where feasible or otherwise the source type assessed in the permit assessment. "

Comment:

Commenter (0109) requests a clearly presented procedure for applying chemical transport models for the purposes of estimating single source secondary impacts for permit programs. Commenter (0126) requests additional guidance and examples. Another commenter (0110) contends the EPA does not provide an approach for using chemical transport models to estimate single source secondary pollutant impacts for permit related programs.

Response:

The EPA disagrees with the commenters because a detailed procedure for estimating single source secondary impacts from project sources is provided in the single-source modeling guidance (U.S. EPA, 2016f). This guidance has been updated in response to public comments and includes details on how to use chemical transport models in a variety of credible ways to inform PSD compliance demonstrations including brute-force simulations, source apportionment, and other instrumented modeling techniques.

Comment:

The commenters (0084, 0104, 0107) do not feel that photochemical grid models can adequately assess single source impacts. Commenter (0110) recognizes that photochemical grid model evaluations using in-plume traverses are encouraging as documented in the IWAQM reports, more work is needed to generate additional confidence in the technique. Commenter (0110) further requests the EPA use newer field study data from 2013 (*e.g.* SENEX 2013 field campaign) to evaluate chemical transport model performance against in-plume transects of secondary O_3 and $PM_{2.5}$.

Response:

The EPA has sufficiently documented that photochemical grid modeling of single source impacts has been compared with near-source downwind in-plume measurements and shown to adequately capture secondary pollutant impacts and those impacts can clearly be differentiated from other sources (Baker and Kelly, 2014; Zhou et al., 2012). Other peer-reviewed research has shown that photochemical grid models are able to simulate impacts from single sources on secondarily formed pollutants (Baker et al., 2015; Bergin et al., 2008; Kelly et al., 2015). Further, single source secondary impacts have been provided in technical reports and the information supports the scientific and regulatory assessments (ENVIRON, 2012a, b; Yarwood et al., 2011). The EPA will continue to work with the modeling community to evaluate and improve modeling capabilities as evidenced by the additional work underway to compare photochemical grid model estimates of single source impacts with in-plume aircraft measurements made as part of the 2013 SENEX field campaign based on these comments.

Comment:

The commenters (0089 and 0110) support the characterization of "sub-grid plume treatment" within photochemical grid models relevant for single source O_3 and secondary $PM_{2.5}$ for permit related assessments. Commenter 0110 states the EPA should consider the benefits of using "sub-grid plume treatment" in photochemical grid models related to the characterization of inhibition of O_3 and secondary $PM_{2.5}$ in plumes near source release points.

Response:

The EPA allows for the consideration of "sub-grid plume treatment within photochemical grid modeling for secondary impacts as detailed in its "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f). Previous research has shown that photochemical grid models applied without "sub-grid plume treatment" do capture the initial stage of plume chemistry (*e.g.* O_3 titration) based on single source sensitivity simulations at multiple grid resolutions (Cohan et al., 2005) and also when comparing modeled single source impacts against near-source in-plume measurements (Baker and Kelly, 2014; Zhou et al., 2012). While "sub-grid plume treatment" is not prohibited, it is also not clear that it is necessary to adequately resolve near-source impacts in typical photochemical grid model configurations.

Comment:

A commenter (0089) states that using absolute impacts from single sources from photochemical grid model is appropriate at distances generally greater than 20 km from the source but where impacts are nearby (nearby defined as nominally ~20 km or closer) the model impacts should be adjusted up or down based on the model's prediction of O_3 or $PM_{2.5}$ from all sources compared to ambient measurements. Another commenter (0110) requests more guidance for making bias adjustments to project source contributions when photochemical models are used to assess impacts.

Response:

The *Guideline* does not provide any accommodation for adjusting model output to match monitored values, as described in section 4.1(d). Further, the relationship between bulk (total predicted, not just single source impacts) photochemical model predictions of O_3 and secondary $PM_{2.5}$ species and project source impacts are not obvious and model performance may be the result of other emissions sources (*e.g.*, not the project source which is well characterized). Therefore, conflating or deflating project source impacts so that bulk model estimates match observation data could result in unrealistic estimates of source impacts. The commenter does not provide any evidence that single source impacts are better characterized at distances greater than 20 km from a project source or that impacts closer to the source need to be adjusted with ambient data or how to make adjustments with ambient data where no ambient data is available within 20 km of a source for the period being modeled. The emissions and emissions release characteristics of the project source should be well known to the permit applicant such that when the new and/or modifying source is placed in a realistic chemical and physical environment (*e.g.* and chemical transport model such as CMAQ, CAMx, or SCICHEM) the downwind secondary impacts when a source plume interacts with the surrounding environment will be appropriately estimated.

Comment:

A commenter (0138) states that peak secondary $PM_{2.5}$ impacts from a project source will happen outside the model domain.

Response:

The EPA provided information with the proposed revisions to the *Guideline* showing that for hypothetical sources emitting SO_2 and NO_X in the Atlanta and Detroit areas that the peak secondary $PM_{2.5}$ impacts are in close proximity to the project source and usually within 50 km of the project source (U.S. Environmental Protection Agency, 2015). Additionally, a more robust assessment of secondary $PM_{2.5}$ peak impacts from hypothetical project sources also shows that the peak impacts are usually in proximity to the project source and are often within 50 km for $PM_{2.5}$ sulfate ion and 100 km for $PM_{2.5}$

nitrate ion (Baker et al., 2015). Peak impacts of $PM_{2.5}$ nitrate ion between 50 and 150 km are small and shown to be well below a concentration related to the most conservative Tier 1 demonstration tool emission rate meaning modeling out to these distances is not typically necessary. Similarly, peak impacts of O_3 from NO_X and VOC emitted by single sources are typically within 50 km and those beyond that distance are small and shown to be well below a concentration related to the most conservative Tier 1 demonstration tool emission rate meaning modeling out to these distances is not typically necessary.

Comment:

Multiple commenters (0104, 0089, and 0128) seek clarification from the EPA in the Single Source Modeling Guidance about whether photochemical grid modeling is required for all new sources under the Nonattainment New Source Review (NNSR) program. One of the commenters, (0089), seeks clarification in the Single Source Modeling Guidance related to interpollutant trading ratios and whether alternative ratios are allowable as technical demonstrations become increasingly complex and area-specific.

Response:

The EPA intended for the single-source modeling guidance (U.S. EPA, 2016f) to be applicable to PSD compliance demonstrations and, in response to this comment, text has been revised within this guidance to clearly state that modeling is not required for the NNSR program. Information has been placed in an appendix to the Guidance that informs stakeholders about air quality modeling that may be conducted to inform obtain precursor offsets and is relevant only to the technical approach taken for modeling project source and credit source(s) impacts. This guidance is strictly technical in nature and does not address whether alternative trading ratios are allowed or how one would go about using model estimating single source impacts from a project and credit source(s) to estimate a trading ratio.

Comment:

A commenter (0101) requests the EPA add text to the *Guideline* to state that future projects in Alaska have a negligible impact on O_3 and no modeling should be required. Another commenter (0125) requests the EPA add text to the *Guideline* to state that future projects in Alaska have a negligible impact on secondary $PM_{2.5}$ and no modeling should be required.

Response:

The commenter's request is not appropriate to add to the *Guideline* as such projects, like all others across the nation, are required to conduct PSD compliance demonstrations on a case-specific basis. The EPA has provided technical guidance wherein area-specific information about the nature of secondary pollutants may be used as part of a Tier 1 demonstration or in conducting case-specific modeling as part of a Tier 2 demonstration. Where concurred by the reviewing authority, a technical demonstration consistent with the *Guideline* showing that meteorological or chemical conditions in a certain area are not conducive to any secondary pollutant formation could be part of a Tier 1 demonstration or shown by case-specific modeling as part of a Tier 2 demonstration.

Comment:

A commenter (0128) states that the EPA should allow project source impact demonstrations for O_3 and secondary $PM_{2.5}$ to either use a current representation of air quality or a projected future year representation of air quality. The commenter suggests the future year representation of air quality is likely a better representation of the chemical environment of the source post-construction.

Response:

For PSD compliance demonstrations, CFR 52.21 (m)(1)(iii) is clear that such pollutants for which a standard exist, shall contain continuous air quality monitoring data gathered for purposes of determining whether emissions of that pollutant would cause or contribute to a violation of the standard. CFR 52.21 (m)(1)(iv) specifically states that, in general, the continuous monitoring data shall be gathered over a period of at least one year and shall represent at least the year preceding receipt of the application, except in certain situations where a shorter time period can be justified.

There is no regulatory avenue within PSD to use a projected future year as representative data in determining project source impacts. In conducting the compliance demonstration, a determination about whether emissions and other aspects of a modeling exercise adequately represent current conditions should be done in consultation with the appropriate reviewing authority.

Comment:

A commenter (0128) states that the EPA should consolidate the SIL and NAAQS demonstrations for situations where the single source impacts are being demonstrated with a photochemical grid model.

Response:

It is not clear what the commenter means by “consolidate” in this context. The use of a SIL in the context of PSD compliance demonstration using a photochemical model for ozone and secondary $PM_{2.5}$ is no different than past and current demonstrations using dispersion models for SO_2 or other criteria pollutants without chemistry.

Comment:

A commenter (0128) states that for Tier 2 demonstrations single source O_3 impacts should be assessed on high modeled days with the definition of high modeled days being a day where the 8-hr O_3 maximum value is equal to the level of the NAAQS.

Response:

The EPA has provided the single-source modeling guidance (U.S. EPA, 2016f) with recommendations for source impacts to be aggregated on “high” modeled days for cumulative 8-hr ozone and daily $PM_{2.5}$ NAAQS demonstrations. The definition of “high” modeled days is chosen to be consistent with the EPA modeling guidance for O_3 and $PM_{2.5}$ SIP demonstrations (U.S. EPA, 2014b) and no alternatives were considered superior or more appropriate for permit related demonstrations.

Comment:

A commenter (0128) states that the EPA should provide additional language to the IWAQM report stating that emission thresholds used to generate illustrative examples do not reflect an official Agency position on the thresholds for requiring project sources to perform Tier 2 demonstrations for O_3 or secondary $PM_{2.5}$.

Response:

In response to this comment, the EPA has added text to the document, "Interagency Workgroup on Air Quality Modeling Phase 3 Summary Report: Near-Field Single Source Secondary Impacts," that indicates the emission rates used for illustrating single source secondary pollutant impacts do not reflect official Agency policy regarding emissions thresholds for determining whether or what type of PSD compliance demonstration is necessary for secondary pollutant impacts.

Comment:

A commenter (0128) states that the EPA should use tons per ozone season for emission rates relevant for single source O_3 assessments for permit related programs to be consistent with other state and federal NO_X control programs intended to reduce ozone formation.

Response:

Air quality management programs under the Clean Air Act have specific emission rate expressions so those rates are directly comparable to thresholds that define a source's classification within the program and subsequent requirements. Therefore, the emission rates to inform compliance demonstrations for PSD permitting programs should be consistent with that program as opposed to seeking consistency with other Federal programs.

Comment:

A commenter (0089) suggests the EPA change the description of modeled episodes for single source O_3 and secondary $PM_{2.5}$ assessments in the Single Source Modeling Guidance to be consistent with the Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.

Response:

The EPA believes that because permit related program demonstrations are different from projected attainment of NAAQS demonstrations, the periods for modeling do not need to directly correspond. However, guidance provided in "Guidance on the use of models for assessing the impacts of emissions from single sources on the secondarily formed pollutants ozone and $PM_{2.5}$" (U.S. EPA, 2016f) is generally consistent with that provided in "Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze" such that periods with meteorology conducive to O_3 and $PM_{2.5}$ formation are recommended for both types of demonstrations. Both guidance documents are also consistent in not specifying a minimum number of days or episodes.

Comment:

One commenter (0115) states that photochemical models such as CAMx and CMAQ have the tendency to underestimate both primary and secondary $PM_{2.5}$ formation due to limitations in domain grid size and inaccuracies in model inputs. Another commenter (0137) suggests photochemical grid modeling done for permit assessments of secondary pollutants should be done at grid resolutions less than 4 km and use small model domains. The commenter further recommends photochemical grid models be applied at horizontal grid scales of "hundreds of meters" for permit related assessments of secondary pollutant impacts.

Response:

The EPA has documented that its review of photochemical model performance metrics reported in peer-reviewed literature (Simon et al., 2012) for both O_3 and secondary $PM_{2.5}$ species for CAMx and CMAQ does not show a systematic over or under-estimation tendency of photochemical grid models for predicting O_3 or $PM_{2.5}$. Since chemical transport models include a representation of chemical inflow into the model domain, the size of the domain should not introduce any specific positive or negative bias in pollutant estimates. The commenters do not provide any technical demonstration that a specific grid resolution is most appropriate for single source demonstrations. The application of chemical transport models using horizontal grid resolutions of "hundreds of meters" would likely be computationally burdensome without any clear showing of improved performance and therefore the EPA has not included such recommendations in its technical guidance.

Tribal Omissions from Proposed Guideline

Comment:

Two commenters (0079 and 0147) recognize that the Proposed *Guideline* includes mention of Indian Tribes and Tribal agencies. However, the commenter 0079 finds that there are a number of other places throughout section 6 in the Proposed *Guideline* where the EPA must add reference to Tribes and Tribal agencies to recognize the role that they have in managing air quality within their reservation boundaries. The commenters provided, as an example, a list of 10 recommended edits to sections 6.1 and 6.2.

Several commenters (0079, 0094, and 0147) note that the Proposed *Guideline* acknowledges the use of air dispersion models, referenced under appendix W of 40 C.F.R. Part 51, in fulfilling the requirements of non-EPA air quality programs. The Proposed *Guideline* gives particular attention to the authority of FLMs to protect areas listed as Class I under the PSD program including the air quality related values (AQRVs) associated with such areas. Not once does the Proposed *Guideline* make reference to any of the Indian Tribes that have redesignated portions of their reservations to Class I status, and at least one such Tribe, the Forest County Potawatomi Community, has also adopted AQRVs within its Class I area. One of the commenters (0079) expects that additional Tribes may also elect to adopt AQRVs in the future. Tribal air agencies, much like FLMs, have an affirmative responsibility to protect air quality and AQRVs, where applicable, within lands under their jurisdiction, including those land areas that have been redesignated to Class I status.

Response:

The EPA has revised section 6.1 and 6.2 to reflect that some tribal agencies may have air quality and land management responsibilities, including that of Air Quality Related Values. Where state or tribal agencies have successfully petitioned the EPA and lands have been redesignated to Class I status, these agencies may have equivalent responsibilities to that of the FLMs for these non-federal Class I areas as described throughout the remainder of section 6.2. More generally, we have added clarifying language in the *Guideline* that indicates that other federal, state, local, or tribal agencies with air quality and land management responsibilities may also have specific modeling approaches for their own regulatory or other requirements.

Recommended Models and Approaches for Ozone

Comment:

Two commenters (0079 and 0094) appreciate the discussion under Section 5.0 of the *Guideline* about air quality modeling for ozone.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*.

Comment:

Multiple commenters (0079, 0094, and 0147) recommend that the EPA expedite the development of technical tools to support the two-tiered approach for determining ozone from individual emission sources for use by regulatory agencies, including Tribal agencies, given the immediate need for such tools to assess and manage single-source impacts to listed AQRVs such as ozone.

Response:

The EPA has released for review and comment the draft MERPs technical guidance (U. S. EPA, 2016d). The development and use of MERPs are to meet PSD compliance demonstration requirements as a Tier 1 “demonstration tool.” The draft MERPs technical guidance document illustrates how permitting authorities may appropriately develop MERPs for specific areas and use them as a Tier 1 demonstration tool for permit-related programs. Where a refined Tier 2 demonstration is necessary, the EPA has provided detailed single-source modeling guidance (U. S. EPA, 2016e) with clear and credible procedures for estimating single-source secondary impacts from sources doing permit related assessments. The EPA has future plans to provide a module as part of its *Software for Model Attainment Test* (SMAT) tool, a publicly available, Windows-based program, that will allow users to work with output generated from CTMs to provide a consistent approach for estimating single-source ozone or secondary $PM_{2.5}$ impacts consistent with EPA guidance and the *Guideline*.

Timeline for Development of Tools and Rulemaking

Comment:

A commenter (0114) states that the EPA needs to establish expedient time frames for developing the proposed tools and rulemaking for assessing single-source impacts on ozone and secondary $PM_{2.5}$.

Response:

The EPA has released for review and comment the draft MERPs technical guidance (U. S. EPA, 2016e). The development and use of MERPs are to meet PSD compliance demonstration requirements as a Tier 1 “demonstration tool.” The draft MERPs technical guidance document illustrates how permitting authorities may appropriately develop MERPs for specific areas and use them as a Tier 1 demonstration tool for permit-related programs. Where a refined Tier 2 demonstration is necessary, the EPA has provided detailed single-source modeling guidance (U. S. EPA, 2016f) with clear and credible procedures for estimating single-source secondary impacts from sources doing permit related assessments. The EPA has future plans to provide a module as part of its *Software for Model Attainment Test* (SMAT) tool, a publicly available, Windows-based program, that will allow users to work with output generated from CTMs to provide a consistent approach for estimating single-source ozone or secondary $PM_{2.5}$ impacts consistent with EPA guidance and the *Guideline*.

Half-life Growth Option

Comment:

A commenter (0082) stated the EPA should consider adding a half-life "growth" option to AERMOD to estimate $PM_{2.5}$ formation from NO_X and SO_2 emissions.

Response:

The EPA encourages the use of chemical transport models to appropriately capture the complex spatial and temporal heterogeneity of meteorology and chemical transformation in source plumes. Lagrangian models such as SCICHEM exist as a potential option for applicants as an alternative to photochemical transport models. These approaches provide the most appropriate and credible estimates of single source secondary impacts that involve atmospheric chemistry. We do not believe that the platform of a Gaussian dispersion model is appropriate for attempts to account for such complex chemical reactions.

Emission Thresholds

Comment:

A commenter (0082) recommends that the EPA perform photochemical modeling to develop emissions thresholds that more accurately reflect the emission levels at which precursor emissions may be important for near-source impacts. The commenter further encourages the EPA to work with the states to develop state-specific or region-specific analyses that will indicate the importance of local conditions to the formation of secondary $PM_{2.5}$ and possibly set state- or region-specific thresholds based on these analyses.

Response:

The EPA has developed an entire draft guidance document (open for informal public comment) focused on illustrating how MERPs can be appropriately developed for specific areas and used as a Tier 1 demonstration tool under the *Guideline*. The Agency is no longer planning a rulemaking to establish a single set of national MERPs and is instead providing this guidance document that is intended to provide a framework for area-specific levels that provides the flexibility requested by many commenters with respect to Tier 1 demonstration tool such as MERPs. The document “Guidance on the use of modeled emission **rates** for precursors (MERPs) as a Tier 1 demonstration tool for permit related programs” is intended to provide information about how to use chemical transport models to estimate single source impacts on O_3 and secondary $PM_{2.5}$and how that type of information can be used to develop empirical relationships for specific areas that may be appropriate as a Tier 1 demonstration tool. This type of approach allows for the development of area specific Tier 1 demonstration tools that better represent the chemical and physical characteristics and secondary pollutant formation. This guidance provides the framework for areas to generate similar information relevant to sources and features in their particular area.

Comment:

A commenter (0082) recommends that the EPA set clear guidance and thresholds describing when the qualitative, hybrid, and quantitative assessment is appropriate.

Response:

The EPA has revised the $PM_{2.5}$ Modeling Guidance document to be inclusive of both O_3 and $PM_{2.5}$ and provides details about to use existing source-receptor relationships and how that will evolve as experience and examples are provided as part of future single source assessments. Further, it provides the framework for which sources can use to determine which types of analysis and tiers of analysis are appropriate for their particular situation. The EPA believes that the complex nature of estimating O_3 and $PM_{2.5}$ impacts will necessitate flexibility in the approaches and has offered draft guidance on development and use of MERPs as a Tier 1 demonstration tool for use by permit applicants and state or local air agencies. The EPA will work with stakeholder and modeling community as other tools or approaches are applied and can be leveraged or used by others.

Comment:

The commenter (0082) further recommends that the EPA develop an optional numerical approach to be used in place of or in addition to a qualitative assessment. They step through a possible numerical screening method that uses worst-case conversion ratios (7% for SO_2 and 5% for NO_2 (24-hour) & 3% for SO_2 and 2.5% for NO_2 (annual) based on literature review and then fuzzy math) which provide an additional amount of direct to model via AERMOD. Afterwards, NESCAUM asks for additional urban, eastern and western US examples of qualitative assessments.

Response:

The EPA encourages the use of chemical transport models to appropriately capture the complex spatial and temporal heterogeneity of meteorology and chemical transformation in source plumes. Lagrangian models such as SCIPUFF exist as an option for applicants as an alternative to photochemical transport models. These approaches provide the most appropriate and credible estimates of single source secondary impacts.

CALPUFF 6.42

Comment:

Commenter (0082) recommends the consideration of the use of CALPUFF v6.42 as an option for estimating secondary $PM_{2.5}$ in the hybrid and/or qualitative approaches.

Response:

Any modeling system that meets the requirements for alternative models in section 3.2 of the *Guideline* and is consistent with the general requirements outlined in section 5 for estimating single source secondary impacts could be used to support a permit related demonstration for secondary pollutants.

Modeling Procedures

Comment:

One commenter (0082) stated some areas in their region were designated nonattainment for $PM_{2.5}$ when the major source baseline date (October 20, 2010) and the trigger date (October 20, 2011) occurred, but have since been redesignated to attainment for $PM_{2.5}$ after these dates. The Final Guidance should address the timeline for areas that were redesignated to nonattainment for $PM_{2.5}$ after the baseline and trigger dates discussed above.

Another commenter (0092) stated that the revisions to the *Guideline* do not address how increment consumption will be addressed for O_3 and secondary $PM_{2.5}$.

Response:

The specific policy aspects of the PSD increment program, ***e.g.***, timelines for major source baseline and trigger dates and how to address increment consumption, are outside the scope of the *Guideline*. Such information would be more appropriately addressed in NSR / PSD policy guidance or memorandum. Additionally, it is worth nothing that there is not an established PSD increment for ozone.

Clarification of "Box Model"

Comment:

A commenter (0087) recommends that the term "box model" be defined and a further description be included.

Response:

The EPA did not include photochemical box models as part of the discussion of potential tools since they are not designed to provide a 3-D representation of the chemical and physical processes at the source, receptors, and area between the source and receptors through time and space. Since these types of tools are not encouraged for permit related demonstration assessments additional examples and description are not provided.

Use of Ambient Monitoring to Assess Secondary Impacts

Comment:

The commenter (0099) requests the EPA allow the use of ambient monitoring data (local or semi-regional ambient data) to assessing the potential likelihood of adverse secondary impacts from proposed project sources in rural areas. The EPA introduces this general concept in section 9.1(c) of the *Guideline*, but never develops it.

Response:

The concept that was introduced in section 9.1(c) of the *Guideline* and then further discussed in section 9.2.4 pertains to the rare circumstances where the performance of the air quality model may be shown to be less than reasonable acceptable or where no preferred air quality model, screening model or technique, or alternative model are suitable for an air quality demonstration. In such unique instances, there is the possibility of assuring compliance and establishing emissions limits for an existing source solely on the basis of observed air quality data in lieu of an air quality modeling analysis. For the assessment of secondary impacts from proposed project sources, there are clearly acceptable techniques (***i.e.***, Tier 1 demonstration tools and Tier 2 single-source air quality models) as described throughout section 5 of the Guideline. So, sections 9.1(c) and the related 9.2.4 are not applicable in this case.

However, we will point out that there is such flexibility in characterizing the contributions of secondary formation from other sources and/or regional background as a part of a cumulative impact analysis. Please reference sections 8.3.1(a)(ii), 8.3.2(a), and 8.3.3(d).

Comment:

The commenter (0099) requests the EPA state specifically in The *Guideline* that a Tier 2 assessment is not needed for "minor" permit applicants.

Response:

This comment is outside the scope of this rulemaking. Section 1 of the *Guideline* begins with a definitive statement that "the *Guideline* provides air quality modeling techniques that should be applied to State Implementation Plan (SIP) submittals and revisions, to NSR, including new or modifying sources under Prevention of Significant Deterioration (PSD), conformity analyses, and other air quality assessments required under EPA regulation." However, we acknowledge in section 6.1 of the *Guideline* that other federal government agencies and state, local, and tribal agencies have developed specific modeling approaches for their own regulatory or other requirements. In such cases, we note in section 6.1(b), "When using the model recommended or discussed in the *Guideline* in support of programmatic requirements not specifically covered by EPA regulations, the model user should consult the appropriate federal, state, local, or tribal agency to ensure the proper application and use of the models and/or techniques. These agencies have developed specific modeling approaches for their own regulatory or other requirements. Most of the programs have, or will have when fully developed, separate guidance documents that cover the program and a discussion of the tools that are needed."

Comment:

The commenter (0128) states that the EPA should only use a single modeling system to estimate $PM_{2.5}$ impacts and not allow the use of different modeling systems for primary $PM_{2.5}$ impacts and separately for secondary pollutant impacts.

Response:

The preferred model for primary $PM_{2.5}$ permit related demonstrations does not include secondary $PM_{2.5}$ chemistry. A mandate from the EPA to use AERMOD for both primary and secondary pollutant demonstrations would not be technically sound and would likely inadequately represent secondary pollutant impacts. The most appropriate technical approach at this time would be to use the preferred model for primary $PM_{2.5}$ impacts and some other appropriate modeling system to estimate secondary $PM_{2.5}$ impacts.

Ammonia as a Precursor to $PM_{2.5}$

Comment:

A commenter (0115) stated that ammonia is a precursor to $PM_{2.5}$, and the EPA must treat it as such in any guidance or regulations on secondarily formed $PM_{2.5}$. It is well-known that ammonia reacts with sulfates and nitrates to form ammonium nitrates and ammonium sulfates which are major components of $PM_{2.5}$. See, *e.g.*, 70 Fed. Reg. 65,984, 65,993 & tbl.2 (Nov. 1, 2005) (describing dominant species of $PM_{2.5}$ in various regions of country and concluding that ammonium compounds comprise significant percentage of $PM_{2.5}$). Some facilities such as coal-fired power plants emit large quantities of ammonia, which is used in NO_X emission control by selective catalytic converters. Under NRDC v. EPA, 706 F.3d 428, 435 n.7, 437 n.10 (D.C. Cir. 2013), ammonia is presumptively a $PM_{2.5}$ precursor.

Response:

The EPA's PSD and NNSR regulations address the regulation of $PM_{2.5}$ precursors differently. The PSD permitting regulations, as revised by the 2008 $PM_{2.5}$ NSR Rule, do not require states to regulate ammonia as a $PM_{2.5}$ precursor as part of the PSD permitting regulations. *See* 51.166(b)(49)(i)(*b*); 52.21(b)(50)(1)(*b)*. In contrast, the nonattainment NSR permitting regulations do require states to regulate ammonia as a $PM_{2.5}$ precursor except where the EPA approves a demonstration that such sources do not contribute significantly to $PM_{2.5}$ levels that exceed the standard in the area. *See* 51.165(a)(1)(xxxvii)(*2*), (a)(13). The nonattainment NSR permitting regulations previously provided that that ammonia need not be regulated in $PM_{2.5}$ nonattainment areas unless a state determined that it was necessary to control ammonia as a significant contributor to $PM_{2.5}$ concentrations in a particular $PM_{2.5}$ nonattainment area. *See* 73 FR 58108, May 16, 2008. However, in 2013, the D.C. Circuit issued an opinion holding that the EPA erred with this approach in nonattainment areas because CAA section 189(e) presumptively requires that control requirements apply to all $PM_{2.5}$ precursors absent a demonstration that such sources do not contribute significantly to $PM_{2.5}$ levels that exceed the standard in the area. *NRDC v. EPA*, 706 F.3d 428 (D.C. Cir. 2013). Section 189(e) is found in subpart 4 of Part D, Title I of the CAA, which includes plan requirements for particulate matter nonattainment areas. Accordingly, the EPA has revised its nonattainment NSR regulations to require the regulation of ammonia as a $PM_{2.5}$ precursor unless, as allowed by section 189(e), the Administrator determines that ammonia emissions do not contribute significantly to $PM_{2.5}$ levels in a nonattainment area. 81 Fed. Reg. 58010 (Aug. 24, 2016). However, as subpart 4 includes requirements only pertinent to nonattainment areas, the EPA does not consider the portions of the 2008 $PM_{2.5}$ NSR Rule that address requirements for $PM_{2.5}$ attainment and unclassifiable areas to be affected by the court's opinion in *NRDC v. EPA*. Therefore, the EPA has not revised any PSD permitting requirements promulgated in the 2008 $PM_{2.5}$ NSR Rule.

2.6 Status of CALPUFF and Assessing Long-Range Transport for PSD Increments and Regional Haze

Historical Handling of CALPUFF as a Preferred Model

Comment:

Multiple commenters (0031, 0131, and 0105) asserted that the EPA was remiss in its duty to properly maintain the CALPUFF system throughout its life cycle

Response:

Managing the update process to the CALPUFF system has posed a unique challenge to the EPA. The various issues we have contended with have been routinely documented and presented to the modeling community since its promulgation (U. S. EPA, 2008b).[3] [4] [5] We have attempted to convey an

[3] See presentation by Atkinson, Dennis. "CALPUFF Status and Update", 2007 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2007/presentations/Wednesday%20-%20May%2016%202007/CALPUFF_status_update.pdf

[4] See presentation by Brode, Roger. "CALPUFF Regulatory Update", 2008 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2008/presentations/BRODE_CA.pdf

[5] See presentation by Fox. Tyler. J. "CALPUFF Status and Update", 2011 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2011/Presentations/5-Wednesday_PM/5-2_CALPUFF_Status_and_Update_2011.pdf

understanding to the modeling community that the model update process is solely an EPA function, is an involved process, and that many of the recent enhancements to the modeling system are beyond the scope of its 2003 approval as a preferred model. The key points that we have consistently stressed are:

1. It is the responsibility of the EPA to perform an independent assessment when updating to a new version of the model.
2. The EPA requires extensive assessments and understanding of changes made to the model. Approval of changes is solely the responsibility of the EPA.
3. The EPA follows a standardized set of tests to assess model changes. This was handled through the CALPUFF update tool, which was introduced at the 8th Conference on Air Quality Modeling in 2005.
4. Model formulation changes which alter concentrations affect its status as a preferred model as is described in subsection 3.1.2 (c) of the *Guideline*.
5. Model formulation changes such as chemistry are beyond the scope of its 2003 regulatory approval and would require separate, case specific, approval as alternative model per subsection 3.2.2 of the *Guideline*.

A fundamental premise for inclusion in the *Guideline* as a preferred model is adequate and up-to-date documentation as described in subsection 3.1.1(c)(ii) of the *Guideline*. As stated previously, a number of model changes we examined were under-documented enhancements (optional and non-optional) to model formulation and were embedded in the model code along with bug fixes, requiring us to make differentiations between the two, assess impacts to concentrations, and determine next steps. When these enhancements alter design concentration predictions, they alter model status as a preferred model (per subsection 3.1.2 (c)) and use must then be justified in accordance with specifications outlined in subsection 3.2.2 (e) of the *Guideline*.

Enhancements to the modeling system identified in the Version 6 and 7 series primarily deal with chemistry upgrades which are beyond the scope of CALPUFF's 2003 regulatory approval and did not allow us to go through the normal update process. These enhancements would have necessitated a regulatory update to the *Guideline* through notice and comment rulemaking.[6] It is important to note that as part of this revision to the *Guideline*, the EPA has reviewed the state of the science for chemical transport models to address chemically reactive pollutants of ozone and secondary $PM_{2.5}$. As detailed in the final preamble and in Section 5 of the revised *Guideline*, the EPA has not established a preferred model for these pollutants rather has put forth a two-stage screening approach that would utilize chemical transport models as appropriate with justification and approval.

Removal of CALPUFF for LRT

Comment:

Several commenters (0096, 0118, 0119) supported the removal of CALPUFF as a preferred model.

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[6] See presentation by Fox. Tyler. J. "CALPUFF Status and Update", 2011 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2011/Presentations/5-Wednesday_PM/5-2_CALPUFF_Status_and_Update_2011.pdf. "Necessitates a regulatory update to Appendix W through notice and comment rulemaking that includes required public review and comment. EPA informed the model developer of that fact in Feb 2011."

Response:

The EPA appreciates the commenters stated support.

Comment:

A commenter (0119) stated that the EPA could retain CALPUFF as a preferred model but revise the *Guideline* to allow for the use of more recent CALPUFF model updates.

Response:

We disagree with the commenter. As noted in other comment responses, we continue to believe that the circumstances described in the preamble and evidenced by the findings of the LRT TSD (U. S. EPA, 2016d) do not warrant the necessity of maintaining a preferred model for long range transport assessment for NAAQS and/or PSD increment. However, given the flexibility of the use of Lagrangian techniques outlined in subsection 4.2 of the *Guideline*, CALPUFF or other Lagrangian models could be used as a screening model for LRT applications. Additionally, updates to the modeling system identified in the Version 6 and 7 series primarily deal with chemistry upgrades which are beyond the scope of CALPUFF's 2003 regulatory approval, and in most foreseeable cases would continue to be beyond the scope of any case-by-case approval for LRT application for NAAQS and increment demonstrations because subsection 4.2 of the *Guideline* requires their use to be considered conservative, *i.e.*, "When Lagrangian models are used in this manner, they shall not include plume-depleting processes, such that model estimates are considered conservative, as is generally appropriate for screening assessments."

Comment:

A commenter (0147) recommended to retain the continued use of CALPUFF until the air quality modeling sector is more prepared to use CAMx and CMAQ.

Response:

We disagree with the commenter. As noted in multiple responses, we continue to believe that the circumstances described in the preamble and evidenced by the findings of the LRT TSD (U. S. EPA, 2016d) do not warrant the necessity of maintaining a preferred model for long range transport assessment for NAAQS and/or PSD increment. However, given the flexibility of the use of Lagrangian techniques outlined in subsection 4.2 of the *Guideline*, CALPUFF or other Lagrangian models could be used as a screening model for LRT applications. Chemistry applications were never approved under CALPUFF's 2003 approval, and thus retention of its regulatory status should not be contingent upon preparation for use of new models which would continue to be outside the regulatory niche any such LRT model would occupy.

The EPA disagrees with the assertion that stakeholders are not prepared to use chemical transport models. The EPA has attended numerous modeling conferences and workshops that include extensive representation by State and Local air agencies that are focused on the application of chemical transport models. These meetings include the annual CMAS conference (www.cmascenter.org) and meetings held by multi-jurisdictional agencies such as Lake Michigan Air Directors Consortium, Western Regional Air Partnership, Mid-Atlantic Regional Air Management Association, and Central States Air Resource Agencies to name a few.

In the future, as detailed in the final rule preamble, we anticipate that photochemical models may be recommended by the FLM's for AQRV analyses. However, as we describe in Section 6 of the revised

Guideline, the recommended models and methods for those purposes is the responsibility of the FLM's and is beyond the scope of the *Guideline*.

Comment:

Many commenters (0094, 0105, 0131, 0133, 0141, 0150) stated that they not support the removal CALPUFF without a replacement.

Another commenter (0128) stated the primary issue with the removal of CALPUFF as the long-range transport modeling system is the uncertainty for projects that do not predict impacts less than the Class I significance impact levels using the EPA's proposed 50km AERMOD screening method. This uncertainty causes project scoping and planning prior to official contact with regulators to be nearly impossible.

Response:

To address these comments, EPA modified subsection 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique. For the purpose as a screening technique, such a model does not need to be approved by the EPA as an alternative model. Rather, the selection of specific model and model parameters must be done in consultation with the appropriate reviewing authority and EPA Regional Office. We consider the flexibility in selection of the appropriate screening technique provided by this long-range screening approach to be critically important for applicants to apply the most suitable technical basis to inform these complex situations. Furthermore, the specific recognition of the use of Lagrangian models in section 4.2 of the *Guideline* provides sufficient certainty regarding their use to adequately inform project scoping and planning for LRT screening assessments.

In addition, the EPA continues to believe that the circumstances described in the preamble and evidenced by the findings of the LRT TSD (U. S. EPA, 2016d) do not warrant the necessity of maintaining a preferred model for long range transport assessment for NAAQS and/or PSD increment.

Comment:

Several commenters (0031, 0103, and 0136) pointed out that CALPUFF is widely used and accepted internationally.

Response:

The EPA recognizes the use and acceptance internationally of CALPUFF but that fact has no bearing on the actions taken with respect to that modeling system in the final revisions to the EPA's *Guideline*. As noted elsewhere, the CALPUFF modeling system may continue to be used as part of the LRT screening approach described in Section 4.2 of the revised *Guideline* and its status is not changed for consideration as an alternative model in the near-field for permit situations involving complex wind and/or terrain.

Comment:

A commenter (0096) recommends the EPA more thoroughly document the inconsistent nature of CALPUFF performance in the preamble of the proposed rulemaking. The commenter believes that there was insufficient technical information to support the promulgation of CALPUFF in 2003 as a preferred model for regulatory LRT applications and supports transition towards modeling systems that are based upon more up-to-date science and for which the model update process is more transparent.

Response:

The EPA appreciates the concern expressed by the commenter, and as noted in the preamble for the final rule, we have included many of the references regarding our technical/scientific concerns in this document and believe a more extensive discussion and rehashing of these well-documented concerns in the preamble is not necessary. The EPA believes that the continued reliance on Lagrangian models for use in the LRT screening approach will facilitate the transition noted by the commenter.

Comment:

Multiple commenters (0105, 0106, 0124, 0100, 0131, 0143, and 0145) stated that the EPA has not technically/scientifically justified removal of CALPUFF.

Response:

We disagree with commenters that suggest the EPA has not technically or scientifically justified the proposal to remove CALPUFF's regulatory approval. We adequately summarized in the final rule preamble and have sufficiently documented the many historical challenges and technical issues we have encountered since the promulgation of the CALPUFF modeling system in 2003. Additionally, numerous presentations made by State and EPA staff document many of the ongoing issues with the modeling system have been publicly available for all to reference.[7] [8] [9] [10] [11] [12] [13] Finally, we published a number of EPA technical reports documenting technical and performance issues (U. S. EPA, 2008b).[14] [15] Therefore, we believe there is more than sufficient technical information to justify the withdrawal of CALPUFF's regulatory approval as an EPA preferred model in appendix A of the *Guideline*. In addition, we continue to believe that the circumstances described in the preamble and evidenced by the findings of the LRT TSD (U. S. EPA, 2016d) do not warrant the necessity of maintaining a preferred model for long range

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[7] See presentation by Anderson, Bret A. "Use of Prognostic Meteorological Model Output in Air Quality Models: The Good, the Bad, and the Ugly." 2006 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2006/documents/RSL1PRESENTATION.pdf

[8] See presentation by Atkinson, Dennis. "CALPUFF Status and Update", 2007 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2007/presentations/Wednesday%20-%20May%2016%202007/CALPUFF_status_update.pdf

[9] See presentation by Anderson, Bret A. "Illustration of Meteorological Issues – CALMET Diagnostic Meteorological Model", 2007 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2007/presentations/Wednesday%20-%20May%2016%202007/Met_Example.pdf

[10] See presentation by Anderson, Bret A. "Regulatory Issues Concerning Use of Prognostic/Diagnostic Meteorological Products", 2007 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2007/presentations/Wednesday%20-%20May%2016%202007/Regulatory_Discussion.pdf

[11] See presentation by Hawkins, Andy, Y. Tang, and B. Anderson. "Regional Haze & BART: The Kansas Perspective", 2008 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2008/presentations/Andy_The%20Kansas%20BART%20Experience.pdf

[12] See presentation by Brode, Roger. "CALPUFF Regulatory Update", 2008 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2008/presentations/BRODE_CA.pdf

[13] See presentation by Bowman, Clint. "Scale Effects of Topography on Modeled Impacts", 2008 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2008/presentations/Clint_scale_effects_on_calpuff.pdf

[14] See report Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations (EPA-454/R-16-007).

[15] See report *Documentation of the Evaluation of CALPUFF and Other Long Range Transport Models Using Tracer Field Experiment Data* (EPA-454/R-12-003)

transport assessment of NAAQS and/or PSD increment. However, given the flexibility of the use of Lagrangian techniques outlined in subsection 4.2 of the *Guideline*, CALPUFF or other Lagrangian models could be used as a screening model for LRT applications.

In addition, there was no substantive or technical information submitted in the public comments that would lead the EPA to reconsider its documented concerns about the CALPUFF modeling system and its regulatory use.

Comment:

Two commenters (0096 and 0117) recommended that if CALPUFF is retained as appendix A model or screening model, recommends the EPA revise the *Guideline* to specify MMIF be required to process prognostic met data.

Response:

We, in part, concur with commenters. The EPA has documented a number of concerns with developing physically consistent meteorological fields with the CALMET system and recognize the potential utility of MMIF in overcoming those challenges (U. S. EPA, 2009b; U. S. EPA, 2016i). However, since we have restructured Section 4 of the *Guideline* to more generically reflect use of Lagrangian models, including CALPUFF, for screening purposes, we do not believe it appropriate to specify the method for producing meteorology for only one modeling system. We expect that this concern could be addressed in the future through the development of guidance in conjunction with the FLMs through the IWAQM process.

Comment:

A commenter (0100) stated that for moderate and complex terrain, the fine scale and land use effects produced by CALMET are more suitable than MMIF.

Response:

We disagree with the commenter. The degree to which terrain and land use are represented in CALPUFF is contingent both upon the resolution at which the model is exercised (prognostic model in the case of MMIF) and the resolution of the terrain and land use data sets used to construct the geophysical files for CALMET or prognostic models. The commenter has not shown that in an 'apples to apples' comparison, where data from MMIF are at the same resolution as data produced for CALMET, that one or the other produces effects that are more suitable.

Use of Updated CALPUFF Versions

Comment:

Multiple commenters (0031, 0105, 0143, 0124, and 0126) recommended that the EPA review and adopt later versions of the CALPUFF modeling system.

Response:

The EPA adopted CALPUFF as a regulatory model on April 15, 2003. In its approval, we specifically highlighted that CALPUFF was only approved for primary pollutants of PM_{10} and SO_2 for distances beyond 50-km and not approved for chemistry applications.[16] [17] Adoption of CALPUFF as an approved model for secondary fine particulate matter would require a separate notice and comment rulemaking and is inconsistent with the EPA final action of not specifying a preferred model for ozone and fine particulate model applications.[18] We disagree with commenters that suggest newer versions of the CALPUFF system should be examined and adopted for the following reasons: 1) we have worked with the developers to incorporate relevant fixes of known code errors into the regulatory version identified on the EPA's Support Center for Regulatory Air Models website; 2) enhancements to the modeling system identified in the Version 6 and 7 series primarily deal with chemistry enhancements which are beyond the scope of its 2003 regulatory approval highlighted previously; and 3) such enhancements would require the same rigor of evaluation of other models used for ozone and fine particulate matter applications, and would be required to follow criteria delineated in subsection 3.2.2 of the *Guideline* for approval, which heretofore has not been accomplished.[19]

Recommendations for Other Models for Inclusion in the Guideline

Comment:

Commenters (0065 and 0150) recommended the SCIPUFF model for inclusion in the *Guideline* as a preferred model. SCICHEM was recommended by multiple commenters (0105, 0083, 0150 and 0098). Commenter 0098 also recommended CAMx and CMAQ be considered for inclusion in the *Guideline* as preferred models.

Response:

We continue to believe that the circumstances described in the preamble and evidenced by the findings of the LRT TSD (U. S. EPA, 2016d) do not warrant the necessity of maintaining a preferred model for long range transport. However, given the flexibility of the use of Lagrangian techniques outlined in

[16] See 68 FR 18444. "CALPUFF will be adopted as a refined model for use in sulfur dioxide and particulate matter ambient air quality standards and PSD increment impact analyses involving (1) transport greater than 50km from one or several closely spaced sources, and (2) analyses involving a mixture of both long range and short-range source-receptor relationships in a large modeling domain (*e.g.*, several industrialized areas located along a river or valley)."

[17] See presentation by Fox, Tyler J. entitled "CALPUFF Status and Update", 2012 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2012/presentations/2-5_2012RSL_CALPUFFstatus_TFox.pdf. "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 $PM_{2.5}$ or uniform rate of progress assessments for regional haze."

[18] See 76 FR 52432. We must have a full understanding of these changes before 'approving' their use. The information provided indicates the new science includes chemistry for which this model was never approved so these changes would necessitate a notice and comment rulemaking and not a simply update as previously done for this model to address bug-fixes and the like. We believe that with such modifications to the modeling system, CALPUFF (Version 6.4) used in this manner could no longer be considered a screening technique under Section 4 of GAQM. The CALPUFF Version 6.112 would be considered an alternative model and would be subject to the requirements of Section 3.2 of GAQM. As covered in more thorough detail below and in our RTC, these alternate versions of CALPUFF (6.112 and 6.4) are subject to the provisions of GAQM.

[19] See presentation by Fox, Tyler J. entitled "CALPUFF Status and Update", 2012 R/S/L Modeler's Workshop, available at http://www.cleanairinfo.com/regionalstatelocalmodelingworkshop/archive/2012/presentations/2-5_2012RSL_CALPUFFstatus_TFox.pdf. "For San Juan Generating Station FIP, EPA found insufficient technical justification for use of v6.4 as alternative model. 1) Failure to establish scientific basis nor provide statistical analysis supporting use of higher resolution meteorological grid (1km)—did not establish relationships between grid resolution and chemistry nor explain "better" air quality model performance; and 2) Lack of documentation, adequate peer review, technical justification, and validation of the ALM that EPA and FLMs have --previously reviewed and not approved for use."

subsection 4.2 of the *Guideline*, we envision that the SCIPUFF/SCICHEM model could be considered for used as part of this screening approach.

With respect to refined regulatory applications necessitating use of chemistry (*e.g.* CAMx, CMAQ, or SCICHEM), we believe that these models have been successfully subjected to scientific and peer reviews and have underwent numerous performance evaluations throughout the years, establishing sufficient information to justify their use as alternative models. As such, we continue to believe that the alternative models framework established under subsection 3.2.2 remains adequate to address the limited cases where refined model applications for chemistry would be necessary.

Use of CALPUFF for Complex Wind Situations

Comment:

Commenters (0082, 0136) recommended that the EPA should specify use of CALPUFF for special situations (*e.g.*, complex winds and complex terrain).

Response:

When the CALPUFF modeling system was promulgated in 2003, the EPA added subsection 7.2.8 (Complex Winds) to the *Guideline* to address these unique situations. In adding subsection 7.2.8, we made clear that any use of the of CALPUFF modeling system in the near-field for these situations would be case-by-case and subject to the general requirements for alternative models specified in subsection 3.2.2 of the *Guideline*.[20]

In 2008, we issued a Model Clearinghouse memorandum to clarify CALPUFF's status for near-field applications. In the memo, we outlined the specific steps that should be taken when proposing CALPUFF's use in the near field. The three main components identified were:

1. A determination that treatment of complex winds is critical to estimating design concentrations,
2. a determination that the preferred model is not appropriate or less appropriate than CALPUFF, and
3. a demonstration that the five criteria listed in paragraph 3.2.2(e) for use of an alternative model are adequately addressed.

While we have removed subsection 7.2.8 from the *Guideline*, the regulatory architecture for justifying CALPUFF or any model for complex wind situations remains unaltered by this action since any action taken under 7.2.8 was dependent upon a successful demonstration under subsection 3.2.2(e) by design. Thus, we view the removal of subsection 7.2.8 as a simple streamlining of regulatory language without altering the regulatory landscape which governs alternative model use. Therefore, we do not see the necessity of specifying a particular model for this purpose.

[20] See 68 FR 18444. "On a case-by-case basis, the CALPUFF modeling system may be applied for air quality estimates involving complex meteorological conditions, where the assumptions of steady-state straight-line transport both in time and space are inappropriate. In such situations, where the otherwise preferred dispersion model is found to be less appropriate, use of the CALPUFF modeling system will be in accordance with the procedures and requirements outlined in paragraph 3.2.2(e) of the *Guideline.*"

Comment:

A commenter (0104) recommended the EPA clarify that CALPUFF is appropriate for LRT and complex winds even though it will no longer be a preferred model.

Response:

As noted in the preamble to the final rulemaking, the EPA has addressed concerns by commenters related to the approval of CALPUFF or other Lagrangian models by modifying section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that does not need to be approved by the EPA as an alternative model.

With respect to complex winds, we refer the commenter to the previous response on use of CALPUFF for complex wind situations as the consideration of the CALPUFF modeling system for such situations as an alternative model in the near-field has not been changed through these final revisions to the *Guideline*.

Comment:

A commenter (0134) recommended the EPA provide more guidance for modeling complex winds.

Response:

In 2008, we issued a Model Clearinghouse memorandum clarifying CALPUFF's status for near-field applications. This memo summarized the main points that should be followed in making a justification for using a model in a complex wind situation.

We also noted in this Memorandum that the 2003 Preamble further amplified the case-by-case nature of the use of CALPUFF for nearfield. At 68 FR 18441, it stated:

> "We will require approval to be obtained prior to accepting CALPUFF for complex wind situations, as this will ensure that a protocol is agreed to between the parties involved, and that all are willing to accept the results as binding. As experience is gained in using CALPUFF for complex wind situations, acceptance will become clear and those cases that are problematic will be better identified."

Finally, we highlighted that the stated goal of learning from experience and identifying cases that are problematic could only effectively be achieved through utilizing the Model Clearinghouse process involving the EPA's OAQPS. Unfortunately, we did not receive such requests through the Clearinghouse or otherwise identification of such situations over the years that has undermined the goal of learning from experience. Thus, we do not have an experiential reservoir to draw upon to provide more detailed guidance and do not believe that any additional guidance beyond what we provided in 2008 would be instructive at this time.

Comment:

Two commenters (0117 and 0137) stated the case-by-case review would operate most effectively if managed through the Regional Offices.

Response:

The approval of alternative models, such as CALPUFF for use in near-field rather than AERMOD to address complex winds not adequately treated by the EPA preferred model, does work through the

Regional office in conjunction with the Model Clearinghouse and then concurred by the Model Clearinghouse to promote transparency and national consistency.

Federal Land Managers and Air Quality Related Values

Comment:

A commenter (0088) stated that the reorganization and consolidation of the information pertaining to AQRVs within the *Guideline* on Air Quality Models is a positive step.

Response:

We appreciate the stated support for the reorganization of this section of the *Guideline*.

Comment:

A commenter (0124) stated that it does not support in the *Guideline* a requirement to consult the latest FLM guidance on modeling impacts on AQRVs, without including any requirement that the decision to rely on such guidance has been the subject of notice-and-comment rulemaking.

Response:

As noted in Section 6 of the revised *Guideline*, although such regulatory requirements and guidance have come about because of EPA rules or standards, the implementation of regulations and the use of the modeling techniques is under the jurisdiction of the agency issuing the guidance or directive. In the case of AQRV's, the reviewing authority (per subsection 3.0 (b)) is the Federal Land Manager's (or tribal authorities for those with non-mandatory, redesignated Class I areas), thus guidance on models and methods for use in analyzing AQRV's is their responsibility.

It should be noted that each successive version of FLM guidance has underwent a formal public review process. For example, a "notice of availability" of the draft FLAG 2010 report was published in the July 8, 2008, *Federal Register*, and the FLMs provided a 60-day public comment period. The FLMs also offered to conduct a public meeting to discuss the proposed changes to the FLAG report, but there was not sufficient public interest to warrant such a meeting.

Comment:

A commenter (0094) stated that the *Guideline* language in Section 6.0 should be amended to recognize that Tribal Class I areas require management and that tribal air quality agencies have adopted programs to protect air quality in Class I areas under their jurisdiction, including AQRVs where applicable.

Response:

We concur with the comment and the language in Section 6 has been amended to reflect this comment.

Comment:

A commenter (0147) recommended dispersion modeling and increment consumption analyses be completed for Class I areas located more than 50 km from emissions sources so that Federal Land Managers (FLMs) and Tribes with redesignated Class I areas may protect and manage area quality in these areas.

Response:

The proposed and final revisions to the *Guideline* do not change the regulatory requirements for permit applicants to complete increment and air quality related values analyses under the PSD program. The EPA believes that the screening approach provided in Section 4.2 of the revised *Guideline* for LRT assessment of NAAQS and/or PSD increment provides for a credible and thorough account for such situations.

Use of Alternative Models

Comment:

A commenter (0134) stated that use of a Lagrangian model as the next step in a Class I increment should not require an alternative modeling demonstration.

Response:

We agree with the commenter and have modified section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that do not need to be approved by the EPA as an alternative model. If a cumulative impact assessment is necessary, then the use of a Lagrangian model would necessitate an alternative model approval. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed.

Comment:

Multiple commenters (0079, 0108, 0147) expressed concern about the resources required to use photochemical models. A commenter (0137) expressed that states with limited resources need a method other than PGM for conducting cumulative analyses. Running a PGM for every PSD analysis involving LRT for Class I increment is impractical, unless an appropriate model is already set up for routine use.

Response:

The EPA's revisions to section 4.2.1 of the *Guideline* specifically recognizes the use of Lagrangian models as an appropriate screening technique in conducting LRT assessment of NAAQS and/or PSD increment. For this purpose, the EPA is not requiring nor suggesting the use of photochemical models rather we point to the use of Lagrangian models that do not need to be approved by the EPA as an alternative model. If a cumulative impact assessment is necessary, then the use of a Lagrangian model would necessitate an alternative model approval. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed.

Comment:

Multiple commenters (0079, 0088, 0090, 0098, 0117, 0133, 0137) expressed concern about a potentially lengthy and/or burdensome alternative model approval process.

Response:

We have modified section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that do not need to be approved by the EPA as an alternative model. If a cumulative impact assessment is necessary, then the use of a Lagrangian model would necessitate an alternative model approval. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed.

In the case of alternative model approvals for such cumulative impact assessments, the EPA disagrees with the commenters statement about the length and burden of an alternative model approval process. The Model Clearinghouse process has been in practice for almost three decades during which the MCH has served a critical role in providing timely approvals for use of alternative models or techniques across a range of applications. As noted in the preamble of the final rule, the EPA's MCH has formally accepted and concurred with five alternative model requests from the EPA Regional Offices since proposal of this rule with an average MCH response time for those five requests being 28 days.

Comment:

Commenters (0096, 0110, and 0117) recommended the EPA document a process to manage alternative model justification including information for the most likely modeling systems that could be applied by the regulated community so that the permit review timeline is not severely impeded.

Response:

We have modified section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that do not need to be approved by the EPA as an alternative model. If a cumulative impact assessment is necessary, then the use of a Lagrangian model would necessitate an alternative model approval. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed.

In the case of alternative model approvals for such cumulative impact assessments, the EPA will fully document all alternative model approvals by the Model Clearinghouse through the Model Clearinghouse Information Storage and Retrieval System (MCISRS) available to the public from the EPA's SCRAM website. In regard to impediments to the permit review timeline, as noted in the preamble of the final rule, the EPA's MCH has formally accepted and concurred with five alternative model requests from the EPA Regional Offices since proposal of this rule with an average MCH response time for those five requests being 28 days.

Comment:

Commenters (0142 and 0145) stated the proposal to eliminate a preferred model for LRT will lead to increased instances in which alternative models will be used.

Response:

We disagree with the commenters. As noted previously, we have modified section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that do not need to be approved by the EPA as an alternative model. If a cumulative impact assessment is necessary, then the use of a Lagrangian model would necessitate an alternative model approval. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed. Lastly, the EPA understands that the LRT screening approach codifies the current standard practice in conducting such assessments and allows for appropriate and timely use of Lagrangian models as screening tools with only EPA regional office concurrence. Given the flexibility of the use of Lagrangian models outlined in subsection 4.2 of the *Guideline*, the use of CALPUFF consistent with its historical regulatory applications under the previous *Guideline* could be considered as part of this screening process.

Comment:

Commenters (0079 and 0094) recommended automatic pre-approval from the EPA on any CALPUFF use that fits historical application of the model.

Response:

Pre-approval as suggested by the commenter is not possible nor appropriate unless done through a notice and comment rulemaking as necessary for establishing an EPA preferred model that essentially allows for "automatic pre-approval." As noted previously, we have modified section 4.2.1 of the *Guideline* to specifically recognize the use of Lagrangian models as an appropriate screening technique, for this purpose, that do not need to be approved by the EPA as an alternative model. The EPA understands that the LRT screening approach codifies the current standard practice in conducting such assessments and allows for appropriate and timely use of Lagrangian models as screening technique with only EPA regional office concurrence. The EPA notes that use of CALPUFF consistent with its historical regulatory applications under the *Guideline* may be considered as part of this screening process.

Comment:

A commenter (0126) stated that in lieu of a preferred model for LRT applications, the EPA should allow the use of CALPUFF with advanced chemistry as a generally approved alternative model for LRT. Allow use of current regulatory version until advanced chemistry is approved as an alternative model.

Response:

The EPA disagrees with the commenter because we have clearly and specifically defined the use of CALPUFF or other Lagrangian model as an appropriate screening technique as part of the LRT screening approach within Section 4.2 of the revised *Guideline*. For this purpose, their use does not need to be approved by the EPA as an alternative model. We believe that this allows for both appropriate and sufficient flexibility in the use of Lagrangian model and limits the alternative model approval to only those situations where a cumulative impact assessment is needed.

The use of Lagrangian models is well-established, and the EPA expects that the specific use of the current regulatory version of CALPUFF as a screening tool for LRT assessments can be done in a manner consistent with section 4.2 the *Guideline*. However, updates to the modeling system identified in the Version 6 and 7 series primarily deal with chemistry upgrades which are beyond the scope of CALPUFF's 2003 regulatory approval, and in most foreseeable cases would continue to be beyond the scope of any case-by-case approval for LRT application for NAAQS and/or PSD increment demonstrations because subsection 4.2 of the *Guideline* requires their use to be considered conservative, *i.e.*, "When Lagrangian models are used in this manner, they shall not include plume-depleting processes, such that model estimates are considered conservative, as is generally appropriate for screening assessments."

Comment:

A commenter (0119) stated that the EPA should clarify in the final rule that CALPUFF is not superior to other models in the BART context and should clearly provide for the use of alternative models such as "CAMx".

Response:

No response provided because the use of Lagrangian and other chemical transport models for past actions related to the BART is not within the scope of this rulemaking. The EPA clearly stated in the final rule preamble that our final actions here do not reflect upon the use of CALPUFF or any other model in those past and current actions.

Comment:

A commenter (0130) stated that long-range modeling procedures are not defined.

Response:

The EPA disagrees with the commenter because we have clearly and specifically defined the LRT screening approach within Section 4.2 of the revised *Guideline* including the use of CALPUFF or other Lagrangian model as an appropriate screening technique. To the extent that additional guidance is needed by stakeholders, the EPA will consider providing additional technical guidance under the IWAQM process in conjunction with the Federal Land Managers.

Screening Approach

Comment:

Commenters (0089 and 0151) expressed support of the proposed screening approach.

Response:

The EPA is appreciative of the stated support for the proposed screening approach.

Comment:

Multiple commenters (0079, 0094, 0147) stated the proposed *Guideline* allows CALPUFF to be used as a screening tool, but is not identified or discussed as a screening tool in Section 4.2.1.

One of the commenters (0079) recommended that the *Guideline* include a discussion under Section 4.2.1 about using CALPUFF as an appropriate long-range transport screening tool.

Response:

The EPA has modified section 4.2.1 to address this comment as follows:

> "e. As discussed in section 4.2(c)(ii), there are screening techniques needed for long-range transport assessments that will typically involve the use of a Lagrangian model. Based on the long-standing practice and documented capabilities of these models for long-range transport assessments, the use of a Lagrangian model as a screening technique for this purpose does not need to be approved as an alternative model. However, their usage shall occur in consultation with the appropriate reviewing authority (paragraph 3.0(b)) and EPA Regional Office."

Comment:

A commenter (0088) stated there was a potential conflict in developing a long-range transport screening method without the establishment of appropriate Class I SIL.

Response:

No response provided because the establishment of appropriate Class I SIL is not within the scope of this rulemaking.

Comment:

A commenter (0088) stated there were limited discussions and evaluation of a proposed long-range transport screen for Class I increment.

Response:

The EPA disagrees with the commenter because we have clearly defined the LRT screening approach within Section 4.2 of the revised *Guideline* with an emphasis on Class I areas. Section 4.2(c) specifically states (please see bolded text):

> "To determine if a compliance demonstration for NAAQS and/or PSD increments may be necessary beyond 50 km (*i.e.*, long-range transport assessment), the following screening approach shall be used to determine if a significant ambient impact will occur **with particular focus on Class I areas** and/or the applicable receptors that may be threatened at such distances."

To support the EPA's proposed approach for long-range transport, we provided a detailed TSD (U. S. EPA, 2015c) that demonstrated the level of single-source impacts from a variety of facility types. The facility impacts were compared to benchmark ambient values for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in order to determine which facility types and pollutants might have impacts above these levels at 50 km from the source. For all NAAQS analyses, a uniform set of benchmark ambient values were used in the TSD across all class areas. However, the EPA recognizes that, historically, Congress has provided special protections to Class I areas, via more protective PSD increments. Thus, for all PSD increments analyses detailed in the TSD, more conservative benchmark ambient values applicable to Class I areas for PSD increments were used. The EPA has updated the TSD (U. S. EPA, 2016d) to more clearly reflect these conditions and alleviate concerns on behalf of the commenters. These modifications do not affect the results or conclusions from the analysis or the finalization of the EPA's approach for long-range transport screening.

Comment:

Multiple commenters (0088, 0096, 0133) stated they did not support screening approach because the proposed approach relied upon Class II SILs and thereby departs from historical practice and threatens Class I area protections engendered by the PSD increment program. A commenter recommended that the EPA work with FLMs to develop appropriate thresholds and provide relevant information on the modeling systems most likely to be applied so as not to impede the permit review timeline.

Response:

As part of the inter-agency review process conducted by the Office of Management and Budget, the EPA discussed the issues raised by the commenters and, as detailed below, subsequently made edits to the regulatory text and the associated TSD to clarify the LRT screening approach. These revisions fully addressed the concerns raised by the commenters. During this review process, the EPA did agree to work with the FLMs in the development of technical guidance on the LRT screening approach to address comments about the providing more clarity and information on the models and process to avoid any delays in the permit review timeline.

To support the EPA's proposed approach for long-range transport, we provided a detailed TSD (U. S. EPA, 2015c) that demonstrated the level of single-source impacts from a variety of facility types. The facility impacts were compared to SIL values for NO_2, SO_2, PM_{10}, and $PM_{2.5}$, which have been used in practice under the PSD program over the past 20 years, in order to determine which facility types and pollutants might have impacts above these levels at 50 km from the source. The EPA believes that because each NAAQS is uniform throughout the class areas, no class-specific protection is necessary when assessing whether a source causes or contributes to a violation of the NAAQS. Thus, for all NAAQS analyses, a uniform set of benchmark ambient values were used in the TSD across all class areas. However, the EPA recognizes that, historically, Congress has provided special protections to Class I areas, via more protective PSD increments. Thus, for all PSD increments analyses detailed in the TSD, more conservative benchmark ambient values applicable to Class I areas for PSD increments were used. Per the comments and discussion during OMB's interagency review process, the EPA has updated the TSD (U. S. EPA, 2016d) to more clearly reflect these conditions and alleviate the confusion regarding these benchmark ambient levels on behalf of the commenters. These modifications do not affect the results or conclusions from the analysis or the finalization of the EPA's approach for long-range transport screening.

The EPA is not responding here to the commenter's recommendation of working with FLMs on appropriate thresholds as it is out of scope of this rulemaking as it does not involve development of appropriate thresholds, *i.e.*, SILs for Class I PSD increment.

Comment:

Multiple commenters (0110, 0118, and 0119) stated the EPA should include additional guidance regarding the use of AERMOD or other dispersion models to screen for long range impacts.

Response:

The EPA will consider such guidance subsequent to the final rule and work through the IWAQM process in conjunction with FLMs and modeling community to determine need and aspects necessitating such guidance.

Comment:

Commenters (0110 and 0117) stated the EPA should provide a streamlined process for approval of LRT screening models.

Response:

The EPA, in defining "screening tools/techniques" in Section 4 of the revised *Guideline*, has effectively streamlined the process by allowing for Regional office concurrence rather than formal approval as alternative model under the *Guideline*.

Comment:

Multiple commenters (0126, 0128, and 0133) stated the EPA's proposed method of using AERMOD or other dispersion models to screen for long range impacts may not be viable for some applications such as the assessment of $PM_{2.5}$.

Response:

As described in section 4.2, the first step of LRT screening approach describes using AERMOD (or another appropriate screening model) is intended to account for the primary impacts from inert pollutants only. The technical approaches for conducting secondary impact analyses of $PM_{2.5}$ are provided in section 5 of the revised *Guideline* and may be applicable for assessing long-range transport of secondary $PM_{2.5}$. The EPA will consider the need for clarification on this aspect as part of subsequent technical guidance on the LRT screening approach in conjunction with the FLMs under IWAQM process.

Comment:

A commenter (0128) stated the EPA should add additional language to address terrain elevation differences within the 50 km screening technique proposed in the *Guideline*.

Response:

The screening approach described in section 4.2 to determine the impacts at 50 km should apply the appropriate modeling techniques applicable for any other near-field assessment. Thus, as appropriate for an AERMOD-based assessment, the receptor grid should be processed through AERMAP and actual receptor heights accounting for terrain differences should be included in the modeling analysis. Given this regulatory application of AERMOD in the near-field, we did not add the regulatory text as suggested by the commenter.

Comment:

A commenter (0145) stated the proposal to address LRT assessment through screening on a case by case basis frustrates the intention of the *Guideline* and weakens the consistency in the *Guideline* sought after by the Act.

Response:

The EPA disagrees with commenter as the LRT screening approach allows for the appropriate level of flexibility that can provide for best science and timely assessments for these situations that is entirely consistent with the intent of the *Guideline*.

SIL, Significant Impacts, Protection of Class I Areas

Comment:

Multiple commenters (0106, 0079, 0126, 0131, and 0141) stated that the need to address long-range transport for Class I PSD increment compliance for new and modified sources has been underestimated or unsubstantiated by the EPA.

Response:

To support the EPA's proposed approach for long-range transport, we provided a detailed TSD (U. S. EPA, 2015c) that demonstrated the level of single-source impacts from a variety of facility types. The facility impacts were compared to benchmark ambient values for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in order to determine which facility types and pollutants might have impacts above these levels at 50 km from the source. For all NAAQS analyses, a uniform set of benchmark ambient values were used in the TSD across all class areas. However, the EPA recognizes that, historically, Congress has provided special protections to Class I areas, via more protective PSD increments. Thus, for all PSD increments analyses detailed in the TSD, more conservative benchmark ambient values applicable to Class I areas for PSD increments were used. The findings of the EPA's technical analyses confirm that only a small number of source types are expected to exceed these benchmarks for Class I PSD increment and thereby consistent with our historical observations and statements in the proposed preamble regarding the likelihood of cumulative impact analyses.

Comment:

Commenters (0124 and 0138) stated that the EPA does not explain what is meant by "significant ambient impacts".

Response:

To support the EPA's proposed approach for long-range transport, we provided a TSD (U. S. EPA, 2015c) that used significant impact levels (SILs) for illustrative purposes as a demonstration tool to determine the culpability of a new or modifying source to any NAAQS or PSD increment violations. As detailed in the TSD, the facility impacts were compared to SIL values for NO_2, SO_2, PM_{10}, and $PM_{2.5}$, which have been used in practice under the PSD program over the past 20 years, in order to determine which facility types and pollutants might have impacts above these levels at 50 km from the source. In this context, a modeled ambient impact from a proposed new or modified source that is determined to be less than the applicable SIL is generally considered not to "cause or contribute" to any modeled violations of the relevant NAAQS or PSD increment. The EPA believes that because each NAAQS is uniform throughout the class areas, no class-specific protection is necessary when assessing whether a source causes or contributes to a violation of the NAAQS. Thus, for all NAAQS analyses, a uniform set of benchmark ambient values were used in the TSD across all class areas. However, the EPA recognizes that, historically, Congress has provided special protections to Class I areas, via more protective PSD increments. Thus, for all PSD increments analyses detailed in the TSD, more conservative benchmark ambient values applicable to Class I areas for PSD increments were used. The EPA has updated the TSD (U. S. EPA, 2016d) to more clearly reflect these conditions and alleviate the confusion regarding these benchmark ambient levels on behalf of the commenters. These modifications do not affect the results or conclusions from the analysis or the finalization of the EPA's approach for long-range transport screening.

Comment:

A commenter (0138) stated a maximum modeled impact at or near the SIL at 50km does not mean that the source will have an impact greater than the SIL at a Class I area 150-300 km from the source. The commenter adds that the proposed screening approach does not take into account the distance of the source from the Class I area and that requiring a review for a source located 150-200km from the source is burdensome since there is no preferred model for this case.

Response:

The EPA has finalized a LRT screening approach in section 4.2 with the intent to streamline the process and focus time and efforts on situations where impacts are most likely to warrant assessment. The EPA is not requiring a permit applicant to assess every source at a distance over 150 km rather only if appropriate screening at 50 km would necessitate conduct of that next screening step. This next step in the screening process would allow for the use of a Lagrangian model as a screening technique that provides more flexibility and no approval as an alternative model so there is little or no change in burden from the previous situation where CALPUFF, as the preferred model, would have been applied for the LRT assessment and can still be used as part of this next screening step.

In addition, this next screening step is expected to account for the distance of the source from the Class I area because section 4.2(c) of the *Guideline* states that " . . . the following screening approach shall be used to determine if a significant ambient impact will occur **with particular focus on Class I areas and/or the applicable receptors that may be threatened at such distances**."

Comment:

A commenter (0124) stated that the EPA does not discuss how the decision would be made whether modeling of long-range transport would be required for a pollutant such as ozone for which no SIL has been established and for which no single-source model has been identified.

Response:

The EPA has provided a credible approach to assess single source impacts for ozone in this revised *Guideline* and also draft guidance regarding significant impact levels (SILs) for ozone. The EPA has determined that advances in chemical transport modeling science indicate it is now reasonable to provide more specific, generally-applicable guidance that identifies particular models or analytical techniques that may be used under specific circumstances for assessing the impacts of an individual or single source on ozone and secondary $PM_{2.5}$. In order to provide the user community flexibility in estimating single-source secondary pollutant impacts that allows for different approaches to credibly address these different areas, the EPA has finalized a two-tiered demonstration approach as described in section 5 of the *Guideline* for addressing single-source impacts on ozone (and secondary $PM_{2.5}$). In addition, the EPA has issued draft guidance (U. S. EPA, 2016j) for use by permitting authorities and permit applicants to address how permitting authorities may develop and use SILs for ozone and $PM_{2.5}$. The approaches described in section 5 and associated technical guidance are applicable for use in situations where long-range transport assessment of ozone for NAAQS compliance demonstration under PSD would be deemed necessary. There is no PSD increment for ozone so a LRT assessment would not be necessary for that purpose.

Comment:

A commenter (0133) stated that the EPA's TSD applied SILs appropriate for Class II increment or NAAQS to come to a conclusion that a source would not require a long-range transport assessment; however, the use of SILs for Class II areas does not adequately protect Class I areas.

Response:

To support the EPA's proposed approach for long-range transport, we provided a TSD (U. S. EPA, 2015c) that demonstrated the level of single-source impacts from a variety of facility types. The facility impacts were compared to benchmark ambient values for NO_2, SO_2, PM_{10}, and $PM_{2.5}$ in order to determine which facility types and pollutants might have impacts above these levels at 50 km from the source. The comments indicate confusion about which values were applied in the TSD and, in particular, confusion about values used for Class I areas for both NAAQS and PSD increments. The EPA believes that because each NAAQS is uniform throughout the class areas, no class-specific protection is necessary when assessing whether a source causes or contributes to a violation of the NAAQS. Thus, for all NAAQS analyses, a uniform set of benchmark ambient values were used in the TSD across all class areas. However, the EPA recognizes that, historically, Congress has provided special protections to Class I areas, via more protective PSD increments. Thus, for all PSD increments analyses detailed in the TSD, more conservative benchmark ambient values applicable to Class I areas for PSD increments were used. The EPA has updated the TSD (U. S. EPA, 2016d) to more clearly reflect these conditions and alleviate the confusion on behalf of the commenters that SILs for Class II areas were used for Class I areas. These modifications do not affect the results or conclusions from the analysis or the finalization of the EPA's approach for long-range transport screening.

Comment:

Commenters (0079 and 0147) expressed concerned that removal of CALPUFF would be interpreted as eliminating the need for PSD increment assessments beyond 50km, especially for Class 1 areas.

Response:

Section 4.2 explicitly describes a screening approach for long-range transport assessment of PSD increment with Class I areas being identified as a focal point for such analyses. The EPA notes that final action to remove CALPUFF as a preferred model has no effect on the obligation of sources subject to PSD to conduct a source impact analysis and demonstrate that a proposed source or modification will not cause or contribute to a violation of any NAAQS or applicable increment. 40 CFR 5I.166(k); 52.21(k). That is, the inclusion of a process rather than a specific preferred model in the *Guideline* does not relieve the source of the requirement to make this demonstration, which necessarily involves an analysis. Section 4.2 clearly identifies the need and approach for conducting applicable LRT assessments.

Comment:

A commenter (0147) recommended that the EPA clarify that long range (over 50 km) modeling must be done for cumulative assessments of increment consumption in Class I areas.

Response:

The EPA has defined a screening approach for LRT assessment in Section 4.2 of the revised *Guideline* that would necessitate a cumulative impact assessment of PSD increment only if initial stages of the screening approach are not satisfied. Thus, consistent with past and current practice, a cumulative impact assessment would only be done in that situation and not for all situations.

Comment:

A commenter (0109) stated that the lack of a preferred model could lead to inconsistent approaches to Class I assessments within the modeling community.

Response:

Section 4.2 specifies a screening approach for determining the need for long-range transport assessments. This approach identifies Lagrangian models as an appropriate screening technique for assessing long-range transport. This approach allows for flexibility in selecting the specific model, based on the applicant's needs and model availability. However, the requirements in section 4.2 also specify that the selection of such a model shall occur in consultation with the EPA Regional Office. As such, the

EPA expects that the chosen model will be consistent in using the best model science and model inputs, such that there be a national consistency in such assessments.

Regional Haze

Comment:

Commenters (0124 and 0149) stated the EPA does not discuss the use of modeling for reasonable progress demonstrations under the regional haze rule. Furthermore, commenter (0124) stated that the EPA should make clear that states are free to choose to rely on photochemical grid models or Lagrangian models like CALPUFF.

Response:

The EPA does not address the specific modeling for the Regional Haze program in this rulemaking rather technical guidance (U. S. EPA, 2014a; U. S. EPA, 2016k) on the use of modeling for reasonable progress demonstrations is provided for separately.

Comment:

A commenter (0149) stated that the EPA should provide clarification on the modeling framework for the regional haze process.

Response:

The comment is out of scope for this rulemaking so not response provided.

Comment:

Commenters (0106 and 0119) stated the *Guideline* and the Regional Haze Rules should remain consistent in specifying CALPUFF as the preferred long-range transport model for both permitting applications and BART determinations.

Response:

The EPA determined that the CALPUFF modeling system was appropriate for use in BART determinations separately for that program such that its use was not established under the previous *Guideline* and was not deemed a “preferred model” for that purpose. The recently released draft Regional Haze technical guidance (U. S. EPA, 2016k) addresses the use of models as part of the screening process for RFP and does not determine any particular model or modeling system to be used for that purpose and therefore it is not appropriate to specify such uses under the Regional haze program in the revised *Guideline*.

Comment:

A commenter (0137) said the that the following statement should be made more clear: "when Lagrangian models are used in this manner, they shall not include plume-depleting reactions, such that model estimates are considered conservative, as is generally appropriate for screening assessments." The commenter asks, does neglecting plume-depleting reactions mean not deploying chemistry, or does it mean not deploying plume deposition or depletion?

Response:

For purposes of conducting LRT screening approach under section 4.2 of the revised *Guideline*, the quoted statement refers to both plume deposition/depletion and chemical reactions in the broad sense such that the corresponding model estimates are considered conservative. Additionally, if an applicant intends to use Lagrangian models with plume deposition/depletion and/or chemistry, then that application is not consistent with the screening nature of section 4.2 of the *Guideline*.

2.7 Role of EPA's Model Clearinghouse (MCH)

Support of Proposal

Comment:

Some commenters (0084, 0092, and 0138) expressed support for the proposed updated role of the EPA's MCH. It was stated by these commenters that the proposed role for the MCH will ensure consistency in decisions by the Regional Offices concerning unique modeling issues and will be helpful in improving communications between the various regulatory agencies and stakeholders involved in an alternative model justification and approval.

Additionally, one of the commenters (0092) expressed appreciation to the EPA's MCH and Air Quality Modeling Group for the increased outreach to the stakeholder community and willingness to engage with industry on general modeling issues over the last several years.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*.

Potential for Burdensome Delays to the Permit Review Process

Comment:

Numerous commenters (0077, 0080, 0085, 0089, 0090, 0098, 0099, 0101, 0105, 0106, 0107, 0109, 0110, 0119, 0120, 0124, 0126, 0127, 0128, 0130, 0135, 0141, 0142, 0143, 0144, 0145, and 0149) expressed varying levels of concern with the potential for significant delay to the permit review process if all Regional Office alternative model approvals must seek concurrence from the MCH. Many of these commenters acknowledged the need for fairness, consistency, and transparency in decisions across the country and appreciate the attempt to streamline the MCH process, but they suggest that the existing understood process of the Regional Office approving alternative models and only consulting the MCH as needed should be maintained given the concerns of potential significant delays.

Two commenters (0125 and 0131) stated that the existing MCH process is slow, cumbersome, and in many ways, not needed or is outdated. These commenters believe that the EPA Regional Offices should retain the authority to approve alternative models or modeling techniques without seeking concurrence from with the EPA's MCH and were not supportive of the proposed updated role of the EPA's MCH.

Several industry commenters (0107, 0124, 0126, 0135, 0144, and 0149) recommended the establishment of specific timeline requirements for the Regional Office and MCH alternative model approvals in order to ensure that significant delays will not occur with permit reviews involving alternative model or modeling techniques.

Response:

With regard to comments about possible delay to the approval process for an alternative model, it is important to point out that the revisions to the *Guideline* are codifying an existing process between the

Regional Offices and the Model Clearinghouse. Therefore, the administrative processing time for these approvals should not be affected by codifying the existing process. In fact, we anticipate that this action will further streamline the process by clarifying it for the regulatory modeling community. Additionally, the revisions will ensure fairness, consistency, and transparency in modeling decisions across all the EPA Regional Offices. Additional important aspects of these revisions were noted and supported through comment by several state air permitting agencies, an organization representing the state agencies, and a large industrial trade organization, as highlighted above.

It is important to note that the EPA's MCH has formally accepted and concurred with five alternative model requests from the EPA Regional Offices since proposal of this rule. The average MCH response time for those five requests was 28 days. There was some variability in the timing of these formal concurrences with one of the concurrences being completed within less than a day; three of the concurrences taking approximately 22 days; and one of the more complex requests taking slightly longer than 2 months. The range of MCH response times over the past year is indicative of applicants that have either engaged early with their respective Regional Office through vetting of a modeling protocol and the identification and coordination of significant issues prior to submittal of their modeling compliance demonstration, or applicants that have performed a substantial amount of modeling work and justification documentation prior to any engagement with the Regional Office or MCH.

When applicants do not engage with the EPA early in the process, additional time is often needed for the justification of the alternative model or options selected and/or remodeling of their facility based on issues realized through review by the EPA. In a few cases, the approach desired by an applicant had to be completely reworked from the beginning, which created significant delays in the permit review and approval process. Early engagement with the EPA will result in the shortest amount of time needed for any alternative model approval by the Agency. However, complex situations involving facilities with unique issues, and requesting a completely new or novel alternative model approach, will require additional time for the applicant, the appropriate reviewing authority, the EPA Regional Office, and the EPA's MCH to collaboratively work together through an informed and iterative process to achieve an approvable alternative model submittal. For these reasons and the recently observed response time of MCH concurrences on alternative models of less than a month, we believe that it is unwarranted to impose a regulatory time limit on the MCH concurrence process. The revised Model Clearinghouse Operational Plan (U. S. EPA, 2016g) outlines the MCH process by defining the roles and responsibilities of all parties, providing thorough descriptions and flow diagrams, referencing the current databases that store all formal MCH decisions, making available templates for request memoranda and other pertinent information, and providing "best practice" examples of request memoranda that highlight how to best inform the MCH process. We believe these enhancements will increase clarity and understanding of this process and make the imposition of a regulatory time limit unnecessary. This Model Clearinghouse Operational Plan is included in the docket and available on the EPA's SCRAM website.

Suggestion for External/Independent Review Committee

Comment:

Two commenters (0092 and 0144) recommended the establishment of an external/independent review committee for alternative model approvals and/or an external advisory group to recommend additional changes to the MCH process.

Response:

The suggestion by commenters to use an external review committee for alternative model approvals is unnecessary and inappropriate. The CAA requires that air quality models are specified by the EPA Administrator. Any modification or substitution of a regulatory model under the *Guideline* can only be made with written approval of the Administrator. The delegation of this preferred model or alternative model approval process can only occur within the EPA. Also, an external review committee would add another layer of review and coordination to the prerequisite EPA processes and would ultimately result in more time and delays in the overall permit review and approval process. Aside from future regulatory revisions of the *Guideline*, the EPA is required per CAA section 320 to conduct a Conference on Air Quality Modeling at least every 3 years, at which time formal public comment on the MCH process or any other aspect of the *Guideline* can be provided. The EPA believes that the current process demonstrates our continued commitment to provide the regulatory community with scientifically credible models and techniques developed from collaborative efforts, which are provided in updates to the *Guideline*.

Additional MCH Related Comments

Comment:

Multiple commenters (0119, 0124, 0126, 0144, and 0149) expressed a mixture of concerns about needed clarification of aspects of the proposed MCH process, enhanced communication of the MCH decisions, and importance of modeling guidance and other clarification memorandum with respect to alternative model approvals.

Response:

As mentioned previously, the revised Model Clearinghouse Operational Plan (U. S. EPA, 2016g) is included in the docket and available on the EPA's SCRAM website. It outlines the MCH process by defining the roles and responsibilities of all parties, providing thorough descriptions and flow diagrams, referencing the current databases that store all formal MCH decisions, making available templates for request memoranda and other pertinent information, and providing "best practice" examples of request memoranda that highlight how to best inform the MCH process. The proper communication pathways should be more understandable and transparent by both the co-regulating agencies and the industrial stakeholder community. We believe these enhancements will increase clarity and understanding of this process.

Comment:

A commenter (0077) expressed concern that the proposed updates to the MCH process would result in a preferred model with non-preferred options being classified as an alternative model and, also, in long-range transport models for secondary $PM_{2.5}$ and ozone requiring alternative model approval.

Response:

Any alterations to the regulatory version or application of a preferred model, such as use of non-regulatory or non-preferred options, by definition changes the "preferred" status of that model. In such case, an appropriate justification for the use of the non-preferred or alternative model option would be required, along with approval by the EPA Regional Office with concurrence by the MCH per Section 3.2.2 of the *Guideline*. Additionally, if explicit modeling of non-inert pollutant, such as secondary $PM_{2.5}$ or ozone, is required for a permit application or SIP revision using a chemical transport or Lagrangian model, then the requirements of Section 3.2.2(e) must be followed as there is not a preferred EPA model for chemical transformations.

Comment:

One commenter (0128) asserted that alternative models listed on the EPA's SCRAM website should not require formal approval from the Regional Office with concurrence from the EPA MCH.

Response:

The regulatory application of all models other than those listed in appendix A to the *Guideline* are subject to the requirements of Section 3.2.2 of the *Guideline*. The EPA has provided links to various other air quality models on the SCRAM website for many years as a service for the air quality modeling community. The inclusion of an air quality model or modeling technique on the EPA's SCRAM website does not bestow any particular "status" to that model or technique.

Comment:

Two commenters (0107 and 130) recommended that the EPA allow for the review and approval of alternative modeling approaches without requiring them to be tied to a specific permit application.

Response:

Occasionally, special situations may arise where numerous facilities and/or SIP revisions may consider use of a particular alternative model or modeling technique that is broadly applicable and not fundamentally case specific. In such cases, the MCH will engage with the Regional Offices and other permit reviewing authorities to assist in the broad sharing of information that will assist the appropriate stakeholders (permit applicants, states seeking SIP revisions, etc.) with the necessary alternative model justification. Section 3.2.2 of the *Guideline* cannot be circumvented, however. So, even if the MCH issues a broad clarification memorandum that includes many of the necessary elements for an alternative model justification, a complete alternative model justification would need to be included as part of the permit record and/or SIP revision along with approval from the Regional Office with concurrence from the MCH.

2.8 Updates to Modeling Procedures for Cumulative Impact Analysis

Support of Proposal for Updates to Modeling Procedures

Comment:

Several commenters (0098, 0099, 0107, 0113, and 0124) provided supportive statements for the proposed revisions to the *Guideline* that help to avoid the literal and uncritical application of very prescriptive procedures for conducting NAAQS and PSD increments modeling compliance demonstrations based on old draft modeling guidance, which has led to practices that are overly conservative and unnecessarily complicated.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline.*

Modeling Domain

Comment:

There was general support of the addition of the definition of the modeling domain, including the appropriate factors to consider, for NAAQS and PSD increments assessments and for SIP attainment demonstrations in section 8 of the proposed *Guideline*. However, several commenters (0099, 0105, 0137, and 0138) stated that the discussion in the proposed Guideline could result in conservatively large modeling domains regularly extending to 50 km. One commenter (0098) recommends the *Guideline* either remain silent concerning the size of the modeling domain or indicate the size of the domain be based on other factors. Another commenter (0118) stated that the changes, as proposed, should be included in the final version of the *Guideline*.

Response:

A typographical error was identified in that discussion that may have caused this confusion and is corrected in this final rule. With this correction, it is now clear that 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* [emphasis added]. 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.

Source Data

Comment:

We received numerous comments (0089, 0124, 0126, 0130, and 0150) from the stakeholder community supporting the proposed revisions to Tables 8-1 and 8-2 that allow for the modeling of nearby sources using a representation of average actual emissions based on the most recent 2 years of normal source operation. Typographical errors in both of these tables were noted in the public comments (0138 and 0151). The public comments (0101, 0110, 0124, 0126, 0128, and 0130) also include additional recommendations for alternate procedures to develop or calculate actual emissions.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*. We have subsequently corrected the typographical errors in both Table 8-1 and 8-2. With respect to the additional recommendation for alternative procedures to develop or calculate actual emissions, these commenters either did not include substantive technical support for these recommendations or they were inconsistent with the required application of the preferred appendix A model.

Comment:

A few commenters (0093, 0128) requested additional clarification or suggested revisions to particular details related to source data and how it is classified in section 8.2 or Tables 8-1 and 8-2 of the proposed *Guideline*

Response:

Where appropriate, revisions were made to the *Guideline* to address many of these comments. A few of the public comments identified concerns that we have already addressed within other portions of the

Guideline or desired more technical detail than is necessary in regulatory text and are best addressed through updates to existing technical guidance.

Comment:

Section 8, Table 8-1, presents the concept of operating factors to adjust a nearby source inventory to model the annual ambient air quality standards. Commenter (0117) does not agree with this approach. There is no discussion or evidence to suggest that a better (*i.e.*, more explicit) modeling demonstration will result from this practice. Additionally, there is nothing in the record that explains why operating factors are applicable for the annual ambient air standards but not the shorter term standards. Lastly, the EPA did not provide a discussion on how they intend to develop the operating factors. Without a technical discussion that illustrates the EPA's approach to develop operating factors and a commitment to develop additional guidance on this topic, the commenter does not support this approach.

Response:

The EPA did not propose any revisions to the "operating factors" in Table 8-1 from the previous version of the *Guideline*, so this comment is outside the scope of this rulemaking. While the portion of Table 8-1 with respect to nearby sources was explicitly described with the proposed revisions to the *Guideline*, it contains the same information for operating factors of nearby sources as previously footnoted. The only change regarding nearby sources was to the "operating level" portion of the table.

Comment:

Several commenters (0109, 0120, 0126, 0130, and 0141) suggested that the *Guideline* should be further amended to allow modeling approaches that account for emissions variability in NSR permitting for new and modifying sources. Additionally, there was public comment (0130 and 0141) that highly intermittent sources should be categorically excluded from NAAQS assessments for statistically-based short-term standards.

Response:

The emissions variability approaches and exclusion of highly intermittent sources would be a significant departure from long-standing EPA policy in the NSR program and are not addressed in the *Guideline*. If there are future revisions to the NSR program that would allow for such considerations, then appropriate revisions to the *Guideline* would be considered at that time.

Comment:

A commenter (0093) questioned why flexibility is given when characterizing emission from mobile sources with typical daily or weekly cycles and similar flexibility is not offered for stationary sources.

Response:

If specific operating limits or defined operating cycles were established in the permit for a proposed or modifying facility, then the compliance demonstration modeling could appropriately consider such operating limits or defined operating cycles in the characterization of the project sources' emissions. Otherwise, the facility would not be constrained from operating at whatever maximum emission limit is established in the permit on a continual basis, which could potentially cause or contribute to a violation of a NAAQS.

Comment:

One commenter (0124) stated that, similar to nearby sources, the use of actual emissions should apply to characterizing operation and emissions of the point source that is at the center of the modeling and to modeling for PSD permitting purposes.

Response:

The EPA did not propose any change to the provisions in Table 8-1 for a source subject to SIP evaluation or Table 8-2 for a proposed new or modified PSD source. We maintain that a source subject to SIP evaluation or a proposed new or modifying PSD source shall be modeled using maximum allowable emissions, as provided in Tables 8-1 and 8-2. Modeling the project source with actual emissions would not thoroughly assess the potential that the project source could cause or contribute to a violation of a NAAQS or PSD increment, as applicable. The maximum allowable or permit enforceable emissions shall be used to make the appropriate demonstration.

Comment:

(0099) - Commenter expresses some concern with the wording of Section 8.2.2(e) with respect to emissions from mobile sources in the context of PSD project impact and cumulative analyses that would typically not include such emissions sources.

Response:

While it is true that PSD impact analyses typically do not include modeling to represent roadway emissions, if these types of emissions are not captured by the monitoring data, these sources might need to be explicitly modeled for such an analysis. In these cases, the temporal profiles of this emission source could be considered, particularly as it relates to appropriately representing background. However, it should be noted that this paragraph is not specific to PSD, as the commenter suggests. We note that other paragraphs in this section specifically relate the modeling discussed to SIP or PSD programs. Instead, this is a general statement that may be applied to any case that needs to model mobile sources for any program (PSD, SIP, or conformity demonstrations).

Background Concentrations

Comment:

There was overwhelming support by the stakeholder community (0099,0113, 0120, 0124, 0126, 0127, and 0141) for revisions to the *Guideline* that would bring additional clarity and flexibility concerning the process of determining background concentrations used in constructing the design concentration, or total air quality concentration, as a part of a cumulative impact analysis for NAAQS and PSD increments. There were, however, numerous specific public comments (0099, 0113, 0119, 0120, 0128, and 0137) highlighting typographical errors or requesting additional clarifications on particular details of this process.

Response:

Where appropriate, revisions were made to sections 8.3.1, 8.3.2, and 8.3.3 of the *Guideline* to address many of these comments. A few of the public comments identified concerns that we have already addressed within other portions of the *Guideline* or desired more technical detail than is necessary in regulatory text and are best addressed through updates to existing technical guidance.

Comment:

There were several public comments (0087, 0098, 0109, 0117) that provided specific recommendations or requested additional guidance regarding the selection of a representative background monitor(s) and subsequent background concentrations that do not include the ambient impacts of the project source under consideration.

Response:

The EPA offers a comprehensive discussion and set of recommendations in section 8.3.1 and 8.3.2 of the *Guideline* regarding the development of background concentrations from existing ambient monitors for isolated single sources. However, we could not establish a specific set of requirements for the determination of representativeness of a background monitor(s) or development of background concentrations given the uniqueness of each permit situation. We appreciate the recommendations for alternative methods to establish background concentrations and continue to encourage the exercise of professional judgment to be accomplished jointly by the permit applicant and the appropriate reviewing authority. Following this final action, we will continue to work with the stakeholder and modeling community to clarify and improve upon the existing technical guidance, where appropriate.

Comment:

A few commenters (0127 and 0141) provided recommendations on aspects of the pairing of monitoring background and modeled concentrations. In one comment, it was stated that daily pairing of monitoring and modeling concentrations to address 24-hour PM_{10} or $PM_{2.5}$ standards could be appropriate in many cases. In another comment, revisions to section 8.3.2.e were suggested to allow additional flexibility in the pairing of monitoring and modeling concentrations.

Response:

The EPA appreciates the feedback; however, lacking substantive technical support for the recommendations, we continue to maintain our recommendation of not pairing monitoring and modeling concentrations on a direct hourly or daily basis, except in rare cases, as stated in section 8.3.2.e of the *Guideline*. However, the EPA does continue to allow for flexibility in pairing monitoring and modeling concentrations under appropriate situations with justification, *e.g.*, seasonal (quarterly) by hour-of-day and day-of-week or monthly by hour of day.

Comment:

One commenter (0117) stated that they do not support the down-scaling practice that EPA is proposing with respect to adjusting ambient air quality background concentrations.

Response:

In the revisions to the *Guideline*, we were providing additional flexibility and recommendations for establishing inputs, including background concentrations, for conducting regulatory modeling. In section 8.3.2(e), we provide that it may be appropriate to use results from a regional-scale photochemical grid model, or other representative model application, as background concentrations, but only in those cases where adequately representative monitoring data to characterize background concentrations are not available. This is not a recommendation to adjust ambient air quality background concentrations. Rather, the broader scale modeling results could potentially be used as background in consultation with the appropriate reviewing authority.

Comment:

Commenter (0117) agrees that states should have the authority to remove the impact of atypical activities from ambient air quality data used in modeling demonstrations, such as impacts from recent Canadian forest fires. It would be useful for the EPA to provide clarification of "atypical" activities to avoid multiple and competing definitions of this concept

Response:

The EPA appreciate the stated support, but we note that the desired clarification would provide more technical detail than is appropriate in regulatory text and are best addressed through updates to existing technical guidance.

Comment:

A commenter (0128) states that the use of background concentration data from modeling can be appropriate if concentrations are spatially averaged over a wide area. However, the use of the Gaussian dispersion models to predict background concentrations without any model verification should be excluded explicitly from the *Guideline*.

Response:

We state in section 8.3.2(f) of the *Guideline*, "In those cases where adequately representative monitoring data to characterize background concentrations are not available, it may be appropriate to use results from a regional-scale photochemical grid model, or other representative model application, as background concentrations consistent with the considerations discussed above and in consultation with the appropriate reviewing authority (paragraph 3.0(b))." Thus, we are not making any recommendation that a Gaussian dispersion model would be appropriate in such cases and are clearly stating that the selection of a model, or other representative model application, for the purposes of developing background concentrations should be done in consultation with the appropriate reviewing authority. We also note that the use of the EPA's preferred near-field dispersion model, AERMOD, or other approved alternative model is required to account for the contributions to the overall background air quality by nearby sources in a cumulative impact analysis.

Nearby Sources

Comment:

With respect to identifying which sources to explicitly include in the modeling ("nearby" sources), commenter (0089) express their understanding that this can be a difficult process that can be affected by a number of variables, and supports the flexibility to use professional judgment in making these determinations.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*.

Comment:

A few commenters (0110, 0126, and 0137) took issue with the suggestion in the proposed *Guideline* that in most cases, the few nearby sources to be explicitly modeled in an air quality analysis would be located within the first 10 to 20 km from the source(s) under consideration. Either the commenters felt that the statement in section 8.3.3(b)(iii) was an over generalization or conflicted with previous Model Clearinghouse guidance from March 1, 2011.

Response:

The stated range of “10 to 20 km” was not intended to serve as any kind of requirement or limitation regarding the modeling of nearby sources and is only indicative of the typically observed compliance demonstration situations. Certainly, there will be unique situations in which a nearby source further than 20km from the source(s) under consideration should be explicitly included in the modeling analysis. However, most additional sources at distances beyond 10 to 20 km will not produce a significant concentration gradient in the vicinity of the project source or source under consideration for emissions limits. In such cases, these additional sources likely are adequately represented by ambient monitoring and should be considered “other” sources as discussed in section 8.3.1 of the *Guideline.* As stated further in section 8.3.3(b)(iii), the “identification of nearby sources calls for the exercise of professional judgment by the appropriate reviewing authority. This guidance is not intended to alter the exercise of that judgment or to comprehensively prescribe which sources should be included as nearby sources.”

Comment:

Several commenters (0098, 0120, 0124, 0126 and 0151) suggested that actual/raw emissions data, *e.g.*, direct Continuous Emissions Monitoring (CEM) data or National Emissions Inventory (NEI) emissions data, should be allowed for the characterization of emissions from nearby sources in the air quality modeling analysis.

Response:

It should be noted that Tables 8-1 and 8-2 both state that CEM data or other information could be used to establish, for short-term standards, the temporally representative operating level of a facility. However, this should be determined through consultation with the appropriate reviewing authority and be reflective of when the nearby source was actually operating from the most recent 2 years. While the use of CEM, NEI, or other raw emission data would create a more realistic representation of historical air quality, such emissions databases would not account for periods that a nearby facility may have been non-operational (*e.g.*, down for maintenance) or operating on an atypical schedule that may or may not happen again in the future. A nominal operating level for these nearby facilities is necessary for the purposes of appropriately analyzing NAAQS and/or PSD increments compliance in the modeling demonstration.

Comment:

Referring to section 8.3.3(c)(i), commenter (0128) stated that modeling nearby sources that do not have permits will require a great deal of input from the reviewing authority, especially if it is a large source and a competitor. Attempting to procure the information necessary to conduct a modeling demonstration is difficult in these circumstances. Further, the sentence regarding the burden of documentation is not helpful to the process required and this language should be eliminated from the *Guideline* as it should be addressed by the individual reviewing authorities.

Response:

While it is understood that the development of the modeling inventory of nearby sources is not a trivial matter, any “large” nearby source will have some type of air permit, if not PSD, issued by a reviewing authority from which the applicant should be able to acquire the necessary information to conduct a regulatory modeling assessment. As described in section 9.2.1 of the *Guideline* and mentioned in the Air Quality Analysis Checklist, consultation with this reviewing authority through the development of a modeling protocol and subsequently the development of a nearby source inventory and representative background concentrations for use in the compliance demonstration modeling is paramount to streamline the process and avoid unnecessary work. Throughout the process, the onus is on the applicant to appropriately document the information used in the compliance demonstration as a part of the permit record.

Comment:

Commenter (0109) notes that the actual emissions data is obtained from an existing database that only collects data on an annual basis and subsequently requests that the EPA to establish criteria for determining short term emission estimates in order to promote consistency within the modeling community.

Response:

We appreciate the feedback and look forward to future engagements with the various permit reviewing authorities and EPA Regional Offices to help promote common and consistent methodologies for determining temporally representative short-term emissions estimates from nearby sources, but the comment requests more technical detail than is appropriate in regulatory text and are best addressed through updates to existing technical guidance.

Comment:

A few commenters (0120, 0101, and 0126) requested the ability to use ambient monitoring data to characterize nearby sources as a part of the overall background air quality or additional clarification on nearby sources in section 8.3 of the proposed *Guideline*.

Response

The EPA notes that section 8.3.1(i) of the *Guideline* begins with, “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.” So, “nearby” sources in the *Guideline* are those that are not adequately represented by ambient monitoring data and must be explicitly modeled in the cumulative impact analysis. However, consistent with sections 8.3.1(i) and (ii) of the *Guideline*, if there are additional sources not causing a significant concentration gradient in the vicinity of the project source in the modeling domain that are adequately represented by ambient monitoring data, then these “other” sources can be appropriately characterized by that ambient monitoring data and included as part of the background concentrations in the cumulative impact analysis.

Comment:

Commenter (0128) states that the EPA’s characterization of background concentration data for use in cumulative analyses for PSD increments in section 8.3 is not consistent with section 9.2.4. The use of the term background concentrations as part of a cumulative impact analysis outside its traditional use (*i.e.*, un-modeled concentration data) is confusing and should be eliminated. The use of monitoring data to support permit limits or emission limits for attainment demonstrations has merit, but the EPA’s attempt to include it as part of a “background” discussion is not helpful; especially with respect to the last sentence in the excerpt from section 8.3.1 (Background air quality should not include the ambient impacts of the project source under consideration.)

Response:

The EPA has defined distinct uses of ambient monitoring data in the development of background concentrations in section 8.3 for use in a cumulative impact analysis as opposed to the use of ambient monitoring data in lieu of model estimates in section 9.2.4. For the cumulative impact analysis, the "background" concentrations should not include impacts from the new or modifying project source or any nearby sources that are accounted for through modeling. These sources are explicitly modeled and the resulting model concentrations are combined with the background concentrations to assess pollutant impacts and compliance. If ambient impacts of the project source and nearby sources are included in the background concentrations, then there will be a level of double counting of those impacts through the cumulative impact analysis. For the use of ambient monitoring data in lieu of model estimates, it will have been determined that a modifying source cannot be appropriately represented by an air quality model or that air quality models or modeling techniques do not exist for such an assessment, and, therefore, comprehensive air quality monitoring in the area of the modifying source potentially could be used to assist in the determination of adequate emissions limits for demonstration that the modification will not cause or contribute to a violation of any NAAQS or PSD increment. In this case, the monitoring data must account for or adequately reflect the impacts of the project source. It is also worth noting, that the term "background" is not used in any aspect of the discussion in section 9.2.4 regarding the use of ambient monitoring data in lieu of model estimates.

Significant Concentration Gradients

Comment:

One commenter (0084) recommended that the EPA remove the significant concentration gradient from the discussion of which nearby sources should be modeled in section 8.3, Background Concentrations, and maintain the use of SILs for determining inventory sources.

Response:

In the proposed revisions to the *Guideline*, we expanded the concept of significant concentration gradients from the previous version of the *Guideline* as a recommended, not required, process to assist in the determination of nearby sources that should be explicitly modeled along with the project source and background concentrations in a cumulative impact analysis. The use of SILs, in general, is outside the scope of this rulemaking, as discussed elsewhere in this document, and we did not propose to use SILs for this purpose. Therefore, we are not changing our approach to modeling of nearby sources as requested by the commenter.

Comment:

There were numerous requests by commenters (0109, 0124, 0137) to further clarify the analysis of significant concentration gradients from "nearby sources," as used in the selection of which nearby sources should be explicitly modeled in a cumulative impact assessment under PSD.

Response:

In the proposed revisions to the *Guideline*, we expanded the concept of significant concentration gradients from the previous version of the *Guideline*. Given the uniqueness of each modeling situation and the large number of variables involved in identifying nearby sources, we continue to believe that comprehensively defining significant concentration gradients in the *Guideline* is inappropriate and could be unintentionally and excessively restrictive. Rather, the identification of nearby sources to be explicitly modeled is regarded as an exercise of professional judgment to be accomplished jointly by the applicant and the appropriate reviewing authority. Following this final action, we will continue to work with the stakeholder community to clarify and improve upon the existing technical guidance and associated approaches that could be used to develop and analyze significant concentrations gradients from nearby sources.

Modeling Protocol

Comment:

One commenter (0084) expressed concern about the model protocol discussion in section 9 and requested clarification to state that Regional Offices would not need to be involved in reviewing every protocol. Such coordination should only be on an "as needed" basis.

Comment:

Another commenter (0119) stated that deadlines should be set for the required coordination with permitting authorities on draft modeling protocols reviews and for approval, or disapproval, of a developed/final modeling protocol.

Response:

We are aware that the discussion on modeling protocols does not contain any specific requirements for applicants or permit reviewing authorities. Rather, the modeling protocol discussion is provided to recommend best practices to streamline the regulatory modeling process and avoid unnecessary work and additional permit delays. Given the added complexity of the technical issues that arise in the context of demonstrating regulatory compliance through air quality modeling, we strongly encourage the development of comprehensive modeling protocols by the applicants and a thorough vetting of these protocols by the appropriate reviewing authority prior to the start of any work on a project. In circumstances where alternative models or non-*Guideline* procedures are being considered, it is advisable to also include the EPA Regional Office in the initial protocol meeting if it is not the primary permit reviewing authority.

Design Concentrations

Comment:

A few public comments (0105, 0126, and 0128) expressed concern with our recommendation of using the current monitored design value as the background ambient concentration to be included with any explicitly modeled nearby sources and the estimated modeled impact of the source for comparison to the appropriate NAAQS in PSD assessments. The concern expressed in the comments is that this practice is exceedingly conservative and results in very unrealistic characterizations of the design concentration.

Response:

We agree that using certain potential combinations of monitored background data and modeled concentrations can lead to overly conservative assessments. However, we also point out that section 8.3.2(c) of the *Guideline* clearly states that the best starting point for many cases is the use of the current design value, but there are many cases in which the current design value may not be appropriate. We then provide four example cases where the use of the current monitored design value is not appropriate and further state that this list of examples is not exhaustive such that other cases could be considered on a case-by-case basis with approval by the appropriate reviewing authority.

Receptor Sites

Comment:

One commenter (0137) was supportive of the expanded discussion of receptor sites in section 9 of the *Guideline*. This commenter further provided feedback on practices that have worked well with initially defining the appropriate receptor grid without having to perform a second model run with a refined receptor grid based on an initial model run.

Response:

The EPA appreciates the stated support for the proposed changes to the *Guideline*. We further appreciate the feedback and understand that there are situations where the appropriate receptor grid could be defined without the need of a second re-run of the model. However, our recommendation in section 9.2.3(d) applies in all situations and was focused on limiting the existing practice of numerous iterations of modeling runs to continually refine the receptor network.

Comment:

There were several requests (0089, 0098, and 0141) for additional considerations for the potential exclusion of receptors from the modeling domain based on various factors. Along these lines, commenters (0117 and 0141) requested that we add a formal definition of “ambient air” into the *Guideline* and provide specific exceptions to allow for the exclusion of certain receptors.

Response:

The definition of “ambient air” and related provisions are provided in 40 CFR 50.1(e). Principles for justifying exclusion of particular areas from this definition of “ambient air” are discussed in EPA guidance for the PSD program. The EPA has not proposed to revise this definition or how the EPA has interpreted it in guidance. Thus, we do not believe it is necessary to address this topic within the *Guideline*.

2.9 NAAQS and PSD Increments Compliance Demonstrations for New or Modifying Sources

Comment:

One commenter (0087) stated that rounding should be allowed when comparing model results to the NAAQS and PSD increments.

Response:

The rounding of modeling results has not been an acceptable approach in the regulatory air quality modeling community for more than three decades and also has been an issue that the EPA's Model Clearinghouse has advised against numerous times in both SIP attainment modeling and PSD compliance demonstrations. We believe there is no reason to change these precedents and past agency recommendations.

Comment:

One commenter (0128) stated that the EPA should remove "Case-by-case determinations must be made as to the appropriate form of the limits; *i.e.*, whether the emissions limits restrict the emission factor (*e.g.*, limiting lb/MMBTU), the emission rate (*e.g.*, lb/hr), or both" and replace it with the following: "Emission limits derived from air quality modeling should focus solely on the amount of emissions and not on the emission factors or operating level used to calculate those emissions" in section 9.2.3.1.

Response:

The appropriate reviewing authority and appropriate EPA guidance should be consulted, in light of the relevant applicable requirement, to determine the appropriate form of emissions limits on a case-by-case basis. This is indicated in the sentence immediately following the *Guideline* text quoted by the commenter. We believe that limits in an air permit are typically not developed in this manner and have no reason to change the language in the *Guideline*.

Comment:

Commenter (0128) provides that the concept regarding the use of Measured Data is valuable as it continues to provide on-the-ground evidence of the concentration data that models are designed to predict. One specific example of its use is for increment consumption/expansion in areas with "older" baselines. As air quality concentrations throughout the United States have consistently been reduced since the Clean Air Act was adopted, the differences in these concentrations suggest that more increment is available for many areas than what is traditionally seen in air quality modeling demonstrations. One of the solutions to this problem is the use of air quality data from the baseline time period in conjunction with current air quality data to determine the "real" expansion of increment over the years. The characterization of the single source tools discussed in Section 9.2.4 does not reflect the use of historical air quality data to expand increment.

Response:

The EPA is uncertain about the meaning of the comment because it is not clear that the commenter is referencing the appropriate section of the *Guideline*. Section 9.2.4 is associated with the use of ambient monitoring data in lieu of model estimates. In this section, the discussion is focused on situations where a modifying source cannot be appropriately represented by an air quality model or that air quality models or modeling techniques do not exist for such an assessment, and, therefore, comprehensive air quality monitoring in the area of the modifying source potentially could be used to assist in the determine the adequate emissions limits for demonstration that the modification will not cause or contribute to a violation of any NAAQS or PSD increment. The focus of this section is not to discuss PSD increment consumption or expansion. If the commenter was meaning to reference Section 9.2.3 instead, where PSD increment compliance demonstrations are discussed, then it is worth noting that a detailed discussion of the characterization of increment consumption and increment expansion would provide more detail than is necessary in regulatory text and are best addressed through updates to existing technical guidance.

Comment:

Commenter (0101) states that there are two substantial issues in applying the language as proposed in section 9.1(c) (and subsequently section 9.2.4). First, given the increasing stringency of the ambient air quality standards, such circumstances are becoming less rare and the burden of “showing” the inadequacy of models in their representation of a facility is a significant one. Second, “Comprehensive air quality monitoring in the vicinity of the existing source with proposed modifications will be necessary in these cases” is vague and could be interpreted to make impractical the use of air quality monitoring in a permitting exercise. Many may believe, for example, that “comprehensive” means multiple ambient monitoring stations located around a facility when, for some facilities, a single and well-sited station could suffice.

Response:

While it is understood that the increasing stringency of the ambient air quality standards is pushing the limits of traditional methodologies in regulatory air quality modeling to demonstrate compliance, one of the primary purposes of the revisions to the *Guideline* is to help avoid the literal and uncritical application of very prescriptive procedures for conducting NAAQS and PSD increments modeling compliance demonstrations based on old draft modeling guidance, which has led to practices that are overly conservative and unnecessarily complicated. The EPA preferred air quality models have consistently demonstrated their ability to maintain good model performance and support the compliance demonstration needs when appropriately informed with input data that doesn’t include double counting of emissions sources or other overly conservative and not recommended characterizations of emissions or background data.

To the second aspect of the comment about “comprehensive” air quality monitoring potentially meaning multiple ambient monitors, in many situations multiple ambient monitors would be necessary, but it is possible that a single and well-sited monitor could appropriately characterize the modifying source and surrounding background air quality. As stated in section 9.2.4(d), “The appropriate number of air quality and meteorological monitors from a scientific and technical standpoint is a function of the situation being considered. The source configuration, terrain configuration, and meteorological variations all have an impact on number and optimal placement of monitors. Decisions on the monitoring network appropriate for this type of analysis can only be made on a case-by-case basis.”

Comment:

Commenter (0128) states that one critical issue not raised is the translation of modeling results into emission limitations or construction/operational limits on processes. The *Guideline* provides a great deal of information about the way that modeling is to be conducted including specifying models approved for use. However, there is very limited discussion to inform permit engineers as to how modeling inputs and results should be utilized in crafting new source review permits.

Response:

This comment is outside the scope of this rulemaking, which is focused on the EPA’s preferred air quality models, processes for approval of alternative models, and the information necessary to appropriately inform these models for regulatory application. Additional aspects of how to use model results in the development of NSR permits can be found in other NSR regulations and guidance.

Comment:

A commenter (0117) stated that air quality dispersion modeling is applied by state permitting authorities to a variety of situations outside the PSD and SIP programs. It would be beneficial for the EPA to explicitly address the use of the *Guideline* for developing an air quality modeling demonstration for non-PSD permit.

Response:

This comment is outside the scope of this rulemaking. Section 1 of the *Guideline* begins with a definitive statement that "the *Guideline* provides air quality modeling techniques that should be applied to State Implementation Plan (SIP) submittals and revisions, to NSR, including new or modifying sources under Prevention of Significant Deterioration (PSD), conformity analyses, and other air quality assessments required under EPA regulation." However, we acknowledge in section 6.1 of the *Guideline* that other federal government agencies and state, local, and tribal agencies have developed specific modeling approaches for their own regulatory or other requirements. In such cases, we note in section 6.1(b), "When using the model recommended or discussed in the *Guideline* in support of programmatic requirements not specifically covered by EPA regulations, the model user should consult the appropriate federal, state, local, or tribal agency to ensure the proper application and use of the models and/or techniques. These agencies have developed specific modeling approaches for their own regulatory or other requirements. Most of the programs have, or will have when fully developed, separate guidance documents that cover the program and a discussion of the tools that are needed."

Multi-stage Compliance Demonstration and Use of SILs

Comment:

A commenter (0115) stated that the EPA's proposed changes to the framework for NAAQS and increment compliance demonstrations would weaken protections and further open the door to NAAQS and increment violations, threatening public health and the environment. They stated that the EPA must revise its approach to ensure that major source permitting complies with section 165(a)(3) of the Act. They further criticized the "'significant impact levels' and other unnamed measures of 'significant impact' (collectively, 'SILs') that EPA endorses" as being "unlawful and arbitrary". They also stated that The EPA must not weaken aspects of its current guidance that require major sources to analyze the ambient air quality to which they will be adding pollution as part of demonstrating they will not cause or contribute to NAAQS or increment violations, and thus receive a construction permit.

The commenter argued that SILs "unlawfully allow a proposed source to receive a permit without actually showing that its impacts will not cause or contribute to a violation of the NAAQS or increments," citing section 165(a)(3) of the Act. They argued that SILs cannot be lawfully or rationally used as a screening tool, a cumulative impact analysis must always be conducted, and there was no other rational way to show that a new or modifying source will not cause or contribute to a violation of the NAAQS or PSD increments. They stated that demonstrating compliance with SILs is not the same thing as demonstrating compliance with increments or NAAQS; the mere fact that a source's impacts do not exceed SILs does not suffice to show that it will not cause or contribute to exceedances.

They further argued that SILs cannot be lawfully used in a culpability analysis because section 165(a) of the Act lacks any 'significance' qualifier, that omission must be given effect, and the EPA cannot rewrite the statute to include "significantly" here. They commented that culpability analysis is further unlawful and arbitrary because section 165(a)(3) of the Act does not allow a source to receive a permit unless it shows that its emissions will not cause or contribute to a violation, and if it cannot make that demonstration, there is no further question of "culpability" to investigate – it is statutorily barred from obtaining a PSD permit, and the EPA lacks authority to overturn Congress' plainly expressed policy judgments. Further, the use of SILs to authorize additional pollution in areas already exceeding the NAAQS is inconsistent with the Act's approach in section 173 which requires a new major source locating in a nonattainment area to obtain offsetting emission cuts. They say it is wholly inconsistent with that scheme to allow the same source to locate just outside the nonattainment area boundary can cause pollution increases inside the nonattainment area that do not have to be offset so long as they are below the SILs. They further stated that models tend to underestimate $PM_{2.5}$, so relying on models to claim a project's impacts will be below the SIL is arbitrary. The commenter noted that the EPA had never promulgated such SILs, the $PM_{2.5}$ SILs for PSD purposes were vacated in the Sierra Club court decision, and no SILs exist under any PSD permitting regulations to evade cumulative impact analysis.

The commenter states that if the EPA persists in endorsing SILs, the EPA should not depart from its existing position that "where information exists demonstrating that a proposed source's impact would cause a NAAQS or increments violation, which violation would not exist <u>but for</u> the source's impact at any particular location, then EPA agrees it <u>would not</u> be appropriate to use the SILs." They state that the EPA provides no reason for weakening its existing position (nor any apparent awareness that it is changing positions, rendering a change arbitrary). Nor is there any reason for doing so: as EPA agrees, the Act "unambiguously requires all permit applicants to demonstrate that proposed construction will not cause or contribute to a violation of air quality standards." They say that the EPA's existing position is contrary to the bar on contributing to violations; the EPA must not now extend its position to also be contrary to the bar on causing violations.

The commenter asks the EPA to reverse its position that it can import a significance requirement into the word "contribute" in §165(a)(3) and thereby allow so-called culpability analysis, citing Bluewater Network v. EPA, 370 F.3d 1, 13 (D.C. Cir. 2004), for the position that "the term ['contribute'] has no inherent connotation as to the magnitude or importance of the relevant 'share' in the effect; certainly it does not incorporate any 'significance' requirement." They argue that by using the phrase "cause, or contribute to," in §165(a)(3), Congress comprehensively covered any triggering or worsening of a violation.

The commenter concluded that even if there were some ambiguity about whether the Act authorizes SILs, it is arbitrary to use compliance with SILs as a proxy for compliance with increments and NAAQS and that the EPA has acknowledged that there are cases in which a source's compliance with SILs does not mean it complies with the NAAQS or increments.

Response:

The EPA disagrees with the commenter in several respects. First, the revisions to the *Guideline* will not weaken protections, open the door to violations, or threaten public health and the environment, and are fully consistent with section 165(a)(3) of the Act. In fact, the updated recommendations in the *Guideline* more clearly and accurately reflect the long-standing practice of first evaluating the impact of the new or modifying source (a single-source impact analysis) as part of the NAAQS and PSD increments compliance demonstration and, as necessary, conducting a more comprehensive cumulative impact analysis as the second stage. This historical practice in the PSD program is consistent with a fundamental principle that has been reflected in the *Guideline* for many years -- that it is desirable to begin an air quality analysis by using simplified and conservative methods followed, as appropriate, by more complex and refined methods. This principle is reflected in section 2.2 of the *Guideline*, which carries forward concepts discussed in sections 2.2 and other parts of the prior version of the *Guideline*. As discussed in section 2.2, "the purpose of this approach is to streamline the process and sufficiently address regulatory requirements by eliminating the need of more detailed modeling when it is not necessary in a specific regulatory application." Like the earlier version of section 2.2, the revised section 2.2 says the following: "in the context of a PSD permit application, a simplified or conservative analysis may be sufficient where it shows the proposed construction clearly will not cause or contribute to ambient concentrations in excess of either the NAAQS or the PSD increments." The recommendation to begin with relatively simple estimating techniques and then progress toward more refined and precise techniques as needed is partly based on the recognition that more complex air quality modeling analysis requires more resources. Appendix W, § 2.1.f.; 75 Fed. Reg. at 64,891 ("a screening tool greatly improves PSD program implementation by streamlining the permit process and reducing the labor hours necessary to submit and review a complete permit application").

In addition, the proposed *Guideline* described this two-stage approach as a recommendation, not a requirement. The EPA has further clarified the wording of section 9.2.3 of the *Guideline* to make this even more clear. To the extent this recommendation is followed and a permitting authority proposes to rely on a single-source impact analysis to support a PSD permitting action, interested parties retain the opportunity during the permit proceeding to comment on the adequacy of the analysis and to call for a cumulative impact analysis to be conducted to satisfy the air quality impact demonstration requirement. The revised *Guideline* does not pre-determine whether a single-source impact analysis will always be adequate in particular circumstances to show that proposed construction does not cause or contribute to a violation.

Further, the EPA did not propose and is not establishing SILs in this rulemaking and did not intend to codify the use of these values in the *Guideline*. In the preamble to the proposed rule, we clearly expressed our intent to pursue a separate rulemaking concerning SILs. 80 Fed. Reg. at 45347. Our use of the term "significant impact" in the proposed revisions was intended to carry forward principles previously reflected in sections 10.2.1(b), 10.2.1(c) and 10.2.3.2(a) of the 2005 version of the *Guideline*. To remove any doubt that this rule is not codifying the use of SILs, we have removed the term "significant impact" from many parts of section 9.2.3. In a separately issued draft guidance, the EPA is addressing the use of "significant impact levels" to help satisfy PSD permitting requirements under section 165(a)(3) of the Act (U. S. EPA, 2016j). A technical and legal rationale that a permitting authority may adopt to support the use of SILs is described in the guidance and supporting material, which are expressly not part of this rulemaking. The draft SILs guidance and supporting rationales differ in material respects from how SILs have been developed and described in past EPA documents, some of which the commenter criticized in their comments. Because this action neither establishes SILs nor provides guidelines for their use in PSD permitting, the comments concerning the use of SILs are outside the scope of this rulemaking. Thus, we are not responding to the specifics of the commenters' criticism of the application of SILs in the PSD program.

Clarification on Increment Violations

Comment:

A commenter (0115) stated that the EPA wrongly suggests that sources can somehow disregard modeling results that show increment violations. The EPA says that “the highest, second-highest increase in estimated concentrations for the short-term averages as determined by a model should be less than or equal to the permitted increment. The modeled annual averages should not exceed the increment.” *Id.* 45,377/3 (emphasis added). It is not clear why the EPA uses the word “should” instead of “must.”

Response:

The EPA agrees with the commenter on the use of the word “should” in the context of increment violations. The EPA has revised section 9.2.2(c) of the proposed *Guideline* to replace the words “should” with “must.”

Use of Measured Data in Lieu of Model Estimates

Comment:

A commenter (0115) asserted that the EPA appears to continue to fight against the statutory requirement that monitoring data be incorporated into PSD permitting analyses. The EPA refers to the “rare” “regulatory application” of “air quality monitoring data.” 80 Fed. Reg. 45,353/3. The precise import of its statement is not entirely clear, but to the extent it is suggesting that air quality monitoring data serves no regulatory role in PSD permitting, it is incorrect. The Act requires monitoring data to go into PSD permitting analysis. 42 U.S.C. §7475(e)(3); see Sierra Club, 705 F.3d at 467-69 (rejecting EPA effort to allow sources to provide monitoring data as part of PSD application); Alabama Power Co. v. Costle, 636 F.2d 323, 372 (D.C. Cir. 1979) (same).

Response:

The commenter misinterprets the EPA’s statement. In the passage at 80 Fed. Reg. 45, 353/3 to which the commenter is commenting concerning the use of the word “rare” with respect to “air quality monitoring data,” the EPA is not implying that the collection or use of air quality monitoring data would be rare in a PSD permitting analysis. Rather, the statement coincides with the discussion in section 9.2.4 of the *Guideline* on the use of solely air quality monitoring data in a PSD compliance demonstration in lieu of air quality modeling estimates. This type of situation would only occur if a situation were so unique that there is no preferred or alternative model or technique that could appropriately assess the impact of emissions from a modifying facility and sufficient air quality monitoring data in the vicinity of the facility and areas of anticipated maximum emissions impact has been collected.

2.10 Updates on Use of Meteorological Input Data for Regulatory Dispersion Modeling

2.10.1 Prognostic meteorological data

Support for the use of prognostic meteorological data

Comment:

Multiple commenters (0080, 0089, 0090, 0091, 0092, 0106, 0107, 0109, 0117, 0119, 0128, 0130, 0141, 0145, 0150, and 0151) supported the use of prognostic meteorological data. One of the commenters

(0092) urged the EPA to approve the MMIF program for wider use as soon as possible, not waiting until the 12th Modeling Conference.

Response:

The EPA appreciates the commenters' support of MMIF and has finalized the regulatory use of prognostic data in the *Guideline*.

Need for more guidance on prognostic meteorological data use

Comment:

Several commenters (0080, 0097, 0106, 0109, 0119, 0128, 0130, 0150, 0051) requested more guidance was needed for running and evaluating the prognostic data as well as more guidance on processing the data for AERMET/AERMOD. One of the commenters (0097) also stated that the EPA clarify who (applicant or reviewing authority) should be responsible for the evaluation of the prognostic model outputs. A commenter (0080) also stated that the EPA supplement the finalization of the *Guideline* with a comprehensive technical document on the use of meteorological mesoscale prognostic models for the purpose described in Section 8.4.5. Another commenter (0119) requested more guidance on when the Agency would consider it to be "prohibitive or infeasible to adequately collect representative site-specific data." A commenter (0130) stated that the EPA develop a procedure and process for the use and application of the prognostic data including domain, grid cell resolution, length of record, requirement for evaluating data, etc.

Response:

The EPA recognizes the need for more guidance and has updated the MMIF guidance document (U. S. EPA, 2016l). The document will undergo periodic review and updates as prognostic data is used more routinely in dispersion modeling applications. The EPA has also clarified in Section 8.4.5.2(a) that the permit applicant is responsible for evaluating the prognostic meteorological data. The EPA has clarified in the MMIF guidance document on when it is prohibitive or infeasible to adequately collect representative site-specific data.

Need for a better definition of adequately representative meteorological data

Comment:

A commenter (0084) stated that the new MMIF guidance suggests using prognostic meteorological data when no other "adequately representative site-specific data" is available and that "adequately representative" needs to be better defined in order to justify using prognostic meteorological data as opposed to actual measured data in any application. An anonymous commenter (0122) stated that "adequately representative" is used to describe NWS data but not site-specific nor prognostic meteorological data. The commenter goes on to state that for consistency within the sentence and with Section 8.4.1, and to eliminate misinterpretations, "adequately representative" should be used to describe all data sources that are used in dispersion modeling for regulatory applications.

Response:

The EPA believes that the idea of "adequately representative" is defined clearly in the *Guideline*. While the *Guideline* offers guidance on determining the representativeness of a meteorological station for a particular application, determining representativeness is ultimately a case-specific exercise and requires best professional judgment of the permit applicant, appropriate reviewing authority, and Regional office. With regards to the comment from Anonymous (122) regarding "adequately representative" in Section 8.4.2(e), the EPA believes that the term "adequately representative" refers to all meteorological data sources as written. Section 8.4.1(c) already recommends that NWS, site-specific, and prognostic meteorological data be representative, so there would be no reason for Section 8.4.2(e) to state otherwise.

Use of prognostic meteorological data and role of reviewing authority and MCH

Comment:

A commenter (0092) supports the use of MMIF but commented that applicants can only use the tool if there is concurrence between the local and regional modeling authorities and the Model Clearinghouse. The option to work with the appropriate reviewing authority to use prognostic meteorological data in situations where in situ measurements are not representative and/or cost prohibitive is welcomed.

Response:

In the final revisions to the *Guideline*, the EPA is allowing for the use of prognostic meteorological data. The EPA anticipates that the applicant and reviewing authority relationship/concurrence on use of prognostic data to be no different than determining what representative National Weather Service data to use in a permit application. The Model Clearinghouse would not be involved in the decisions unless formally requested from the Regional office.

Concerns over use of prognostic meteorological data when no adequately observed data available

Comment:

An anonymous commenter (0122) wrote that in the absence of representative NWS or site-specific meteorological data, nearly every permit applicant argues to use existing non-representative meteorological data to avoid the time and resources needed to set up a site-specific meteorological tower to obtain representative meteorological data. If this sentence is in the final rule, sources will refer to it on regular occurrence and claim that collecting site-specific meteorological data is cost-prohibitive and/or not feasible because of insufficient time and/or it costs money/not in the budget. It should be noted that the lack of a representative NWS or site-specific data is the norm in some states with complex terrain, one of the biggest challenges for meteorological models is complex terrain, a meteorological model is as or more complicated than an air quality model, so more consideration needs to be given to these issues when introducing this concept. This language would encourage the pursuit to use prognostic meteorological data more frequently than not by permit applicants in some parts of the country regardless of whether it is or is not appropriate. Is the EPA's intent that prognostic meteorological data replaces site-specific data or just that it serves as a last resort when collecting on-site data is truly not feasible or prohibitive? The phrase "it may be necessary to use prognostic meteorological data in a regulatory modeling application" presumes that prognostic meteorological data is by default adequately representative. As with air dispersion models, a meteorological model may not be applicable for all situations. It would be more appropriate for this section to state the following: "For these cases, it may be necessary to consider the use of prognostic meteorological data in a regulatory modeling application. However, if prognostic meteorological data is not representative of transport and dispersion conditions in the area of concern, the collection of site-specific data is necessary."

Another commenter (0130) said they do not support any required analysis to demonstrate that collecting site-specific data are either cost prohibitive or infeasible.

Response:

The EPA believes that in the absence of representative NWS or comparable data, every attempt should be made to collect site-specific data which is considered the most representative of the source location. The EPA has recognized that site-specific data collection may be infeasible or cost-prohibitive in some cases, thus, the proposed use of prognostic meteorological data in such cases. The EPA has clarified in Section 8.4.5.1(a) that if the prognostic data are not representative of transport and dispersion conditions in the area of concern, the collection of site-specific data is necessary.

The EPA appreciates the commenter's (0130) concerns that applicants will use the "cost-prohibitive or infeasible" argument in a majority of cases in order to use prognostic meteorological data. The EPA has stated in Section 8.4.5.2(a) that the use of prognostic meteorological data is contingent upon concurrence with the appropriate reviewing authority that the data are of acceptable quality. The EPA has not directed any formal required analysis to determine how prohibitive or infeasible the collection of site-specific data, and the EPA believes that issues regarding the infeasibility or cost concerns of site-specific data collection should be addressed during the modeling protocol development process with the applicant and appropriate reviewing authority.

Evaluations of prognostic meteorological data

Comment:

A commenter (0113) performed evaluations of MMIF output at several WRF resolutions and found it to perform well in comparison to airport data for high resolution cases (1.33, 0.8, and 0.444 km) with some diminished performance at the highest resolution (0.444 km). Another commenter (0113) concurred with the draft MMIF guidance that comparisons should be made to know multi-level data. The commenter (0113) found that WRF/MMIF can adequately simulate most surface and multi-level meteorological parameters in southwestern PA. The commenter (0113) reported a bias in wind speed apparently due to terrain smoothing retention of plateau-based airport characteristics. WRF is not forcing profiles far enough into river valleys, where lower wind speeds are evident based on measured multi-level data. This may cause excess wind shear at increasing heights/levels that may affect concentrations, specifically for sources with building downwash. Without modifying MMIF onsite input or AERMET output data, a possible solution to bias in multi-level data is to skip specific levels in AERMET stage 1 processing. This allows for standard AERMOD hourly profile extrapolation for omitted levels. Another solution could involve future development of MMIF, possibly the addition of weighting factors for known terrain/valley effects (similar to CALMET weighting with BIAS, TERRAD, etc.).

Response:

The EPA appreciates the commenter's evaluations and concurrence on guidance.

Comment:

An anonymous commenter (0122) said that Section 8.4.5.2(a) should be modified to state that prognostic meteorological data should be also be compared to nearby site-specific meteorological towers if available to assess the model data.

Response:

The EPA agrees with the commenter and has modified Section 8.4.5.2(a) to include that other data should be used in evaluations in addition to NWS data.

Comment:

An anonymous commenter (0122) said that the model evaluation process should be provided in detail in the final *Guideline* for national consistency and to ensure adequate review meets such expectations and requirements. Because of the complexity of the meteorological model, it should be careful and thoroughly considered/assessed prior to the use of its results. The commenter also questioned whether MMIF was fully ready for widespread use.

Response:

The EPA has provided more guidance in the MMIF guidance document (U.S. EPA, 2016l) on running and evaluating the meteorological models. The EPA is prepared to update the guidance as prognostic data use becomes more widespread. The EPA does feel that MMIF is ready for widespread use.

MMIF evaluation report

Comment:

An anonymous commenter (0122) stated that the MMIF evaluation technical support document (U.S. EPA, 2016m) reports findings from a study that is limited in scope and such conclusions may not be applicable for other situations. The commenter stated it would be more accurate to state “MMIF output has been found to compare favorably against observed data (site-specific or NWS) where the local terrain features are larger than the grid cell size of the meteorological model.”

Response:

The EPA’s MMIF evaluation TSD (U.S. EPA, 2016m) presented results for three case studies involving flat terrain and complex terrain and multiple grid resolutions. While the evaluation is not comprehensive to evaluate all possible scenarios, the EPA feels the report provides evidence that prognostic meteorological data is a feasible tool for dispersion modeling applications and provides justification for proposing the use of prognostic meteorological data in dispersion modeling applications. The EPA acknowledges that there may be situations where prognostic meteorological data is not adequate and those are situations where the applicant and reviewing authority will work together to develop the proper meteorological data, observed or modeled, for the specific application.

Comment:

A commenter (0113) noted several typographical errors in the MMIF evaluation technical support document.

Response:

The EPA has corrected the typographical errors in the updated TSD (U. S. EPA, 2016m).

Data clearinghouse/availability

Comment:

A commenter (0092) suggested the EPA establish a portal on the SCRAM website to encourage submission of datasets for use in evaluating and improving the models, especially AERMOD. Another commenter (0130) encouraged the EPA to develop and provide a clearinghouse of prognostic meteorological data, as it becomes available, for the general use and application in dispersion modeling. A commenter (0150) said that the EPA needs to better define how prognostic meteorology will be provided to the modeling community. Another commenter (0090) stated that it would be helpful if the EPA could compile a list of any existing datasets that may be suitable for review and indicate where these datasets may be obtained.

Response:

The EPA welcomes data that can be used to evaluate and improve the models. Per the comments on databases, the EPA has developed a database of 12 km WRF output for 2013-2015 and is making available for each year, AERMET ready files for each grid cell over the contiguous U.S. For areas outside the contiguous U.S., it may be necessary for applicants or other stakeholders to run the prognostic meteorological models following the EPA MMIF guidance (U.S. EPA, 2016l) to suit their respective needs.

Development of MMIF

Comment:

A commenter (0131) pointed out that MMIF was not developed by the EPA; rather, by a contractor under contract by the EPA.

Response:

No response as this comment as it is immaterial to the final revisions to the *Guideline*.

CALMET performance versus MMIF performance

Comment:

A commenter (0129) questioned the replacement of CALMET with MMIF, and another commenter (0131) refuted the claims made by the EPA that MMIF was developed because of concerns that CALMET could be configured in too many ways, has been shown to degrade meteorological model performance, and the EPA was not able to achieve pass through of MM5 winds. The commenter (0131) calls these claims myths and then provides the following bullets:

- CALMET in its properly configured “pass-through” mode does not change the MM5 winds at the MM5 wind points (*i.e.*, dot points).
- MMIF always does spatial interpolation of the MM5 winds even though this interpolation is not necessary.
- Interpolation is done because MMIF places the CALMET grid points on the MM5 cross points, whereas the proper pass-through configuration for CALMET is to place the CALMET grid points at the MM5 dot points.
- CALMET pass-through matches MM5 on MM5 grid points.

- MMIF pass through does not.
- Some vertical interpolation may be done due to differences in the sigma layer structure in MM5 vs. the constant thickness layers in CALMET which will introduce differences.

Response:

Commenters restated elements of a conversation between the CALPUFF developer and the MMIF developer at the 10th Conference on Air Quality Modeling in relation to design differences between MMIF and CALMET. Commenters further restate points made by CALPUFF developer on how to configure CALMET for a "pass through" configuration.

According the CALMET User's Guide (Scire et al., 2000) CALMET can incorporate prognostic winds in three methods. These are 1) as the first guess wind field; 2) as the Step 1 wind field; and 3) as "observations". The EPA recommendations for use of CALMET in Section 8.3(d) of the *Guideline* focus exclusively upon the first option, incorporation of prognostic data as the first guess wind field. Historically, this practice has involved use of coarser scale prognostic meteorological data (80-km MM4 or 36-km/12-km from models such as MM5 or WRF) with a much finer resolution CALMET configuration (typically 4-km). In this procedure, intermediate preprocessors such as CALMM5 output prognostic wind variables at the latitude and longitude of the dot-points in an ASCII sequential file. CALMET then uses a $1/R^2$ interpolation technique to fit prognostic wind variables to the CALMET grid. Section 2.1 of the User's Guide describes the CALMET grid structure as follows:

> *"The "grid point" refers to the center of the grid cell in both the horizontal and vertical dimensions. The "cell face" refers to either the horizontal or vertical boundary between two adjacent cells. In CALMET, the horizontal wind components (u and v) are defined at each grid point. The position of the meteorological grid in real space is determined by the reference coordinates (XORIGKM, YORIGKM) of the southwest corner of grid cell (1,1). Thus, grid point (1,1), the cell center, is located at XORIGKM + DGRIDKM/2., YORIGKM + DGRIDKM/2.), where DGRIDKM is the length of one side of the grid square."*

Since CALMET describes wind variables at the cell center, essentially two types of interpolation take place. First, a coarser scale prognostic data set is interpolated to the typically finer CALMET grid resolution by means of the aforementioned $1/R^2$ interpolation technique; and secondly, CALMET must displace prognostic wind variables from their Arakawa-B ("dot-point") configuration (MM5) or Arakawa-C (WRF) to the cell center where winds are defined on the CALMET grid. The commenters incorrectly characterize that CALMET always directly matches MM5 on its "dot-points" as this would require the DGRIDKM of CALMET to be specified at the exact same resolution as the prognostic data and orient the CALMET cell centers (through input group 5 of the CALMET input file) such that they align with the MM5 dot-points. This point is nuanced, but is non sequitur when preparing meteorological fields for input into air quality models. When the user is specifically trying to match the CALMET grid to the parent prognostic field, the above procedures are necessary. However, the most common approach in all meteorological preprocessors for grid models is to adapt the prognostic field to the grid structure of the air quality model, not the reverse. Meteorological preprocessors for almost all models follow the latter approach, and thus meteorological variable translation is a fundamental prerequisite of preprocessor design. For example, when using the Meteorology-Chemistry Interface Processor (MCIP) (Byun, et al., 1999) with MM5, MCIP shifts the scalar wind components (u and v at dot-points) by half of the grid cell distance (east and north) to flux points (defined at the center of cell interfaces) to match the prognostic data to the chemical transport model grid structure. With CAMx (Ramboll Environ, 2016), it is recommended that meteorology be supplied in Arakawa-C configuration (as with WRF), but it is acknowledged that it is not always possible to do so due to the source of the prognostic meteorology. In those cases, users can supply all meteorological variables, including scalar velocity components of the wind, at cell centers, and then CAMx internally interpolates velocity components to the cell interfaces.

To achieve the equivalency of a pass through using CALMET requires the user to adhere to certain basic principles and disable many of the features of the CALMET system. As discussed in the draft revisions to the IWAQM Phase 2 guidance (U. S. EPA, 2009a), we strongly emphasized that the candidate prognostic data used should appropriately characterize the key meteorological features that govern source-receptor relations for the specific application. This places a higher emphasis on ensuring that the prognostic dataset is at the appropriate horizontal grid resolution and that the dataset captures the key meteorological features for the specific application and not attempting to use features of a diagnostic model such as CALMET to induce features into the meteorological fields that are not captured by a coarser resolution prognostic dataset. In 2009, when we first drafted the revisions to the IWAQM Phase 2 recommendations, the most common practice in applying CALMET was to use prognostic datasets that were produced by the Regional Planning Organizations (RPO's). These datasets were most commonly only available at a 36-km resolution, which in most cases is inadequate to properly characterize the key meteorological features important to source-receptor relations in complex meteorological environments where most Federal Class I areas exist, which is the most common regulatory application of the CALPUFF system. This reality was a practical barrier to achieving any form of a direct pass through approach with the modeling technology at that time. Thus, under this paradigm, the end user would have been required to output meteorological variables at a much higher resolution than 36-km, and the many of the diagnostic features of the CALMET system would have to be employed in order to try to induce meteorological features that would not be present in the prognostic dataset at the coarse resolution. This reality violated many of the key assumptions necessary to achieve a true pass through with CALMET given the modeling technology of the time as we would not recommend a direct pass through of coarse resolution prognostic data.

Additionally, the commenters neglected to examine the extensive discussion of the impact of a pass through configuration on additional diagnosed meteorological variables that are important to air quality simulations with the CALPUFF system. As noted from the literature review in the draft IWAQM 2 revisions, McEwan and Murphy (2004), Evangelista (2005), and U. S. EPA (2008a) all found significant differences between diagnosed cloud cover from prognostic hydrometeors and observed cloud cover. Cloud cover is an essential element of the Holtslag and van Ulden (1982) energy budget model contained within CALMET. Incoming shortwave radiation influences many meteorological variables CALMET calculates, such as Monin-Obukhov length, convective velocity scale, and the convective boundary layer heights. Opaque cloud cover is a parameter required by CALMET, normally introduced through surface observational data. When using CALMET in its 'no-observations' mode (NOOBS=2), CALMET calculates a diagnostic cloud from the 850 mb prognostic relative humidity value derived from the MM5 hydrometeoric mixing ratio data based upon algorithms from Teixeira (2001). However, the CALMET implementation of this algorithm incorrectly assumed that the equation from Teixeira (2001) should only consider prognostic relative humidity from the 850 mb level, and that this value in turn represents total cloud cover. As noted in Teixeira and Hogan (2002), the algorithm actually only represents the diagnostic cloud fraction for cumuliform clouds implemented in the Naval Research Laboratory's NOGAPS model (Hogan and Rosmond,1991), and that stratiform clouds may be significantly underestimated (Duynkerke and Teixeira, 2001). Cumuliform clouds are typically a small, subgrid-scale feature and often play less of a role in large scale radiation balance represented in most climate models. More important to the global radiation balance are large scale stratiform cloud cover which is neglected in the CALMET implementation of its cloud diagnostic algorithm. Large scale stratiform clouds are a prominent feature of climate systems because of their high albedo and large areal coverage. The NOGAPS cloud scheme is a combination of the diagnostic cloud fraction for cumuliform (Teixeira, 2001) and stratiform clouds (Teixeira and Hogan, 2002). Normally, prognostic cloud cover is derived at all model levels and then a total cloud cover is calculated (Xu and Randall, 1996a, 1996b). The current implementation of diagnostic cloud cover in CALMET Version 5.8 potentially misses cumuliform cloud cover that exists both below and above the 850 mb level as well as neglecting the larger scale stratiform clouds (Anderson, 2007a). In subsequent versions of CALMET, an additional cloud diagnostic scheme adapted from the MM5GrADS program was introduced to overcome this implementation error in the existing algorithm.

Comparisons with ASOS observed clouds for the Philadelphia area (Touma et al, 2007) showed that the diagnosed cloud cover was on average 30% lower than the ASOS cloud cover (Evangelista, 2005). The net result is that, under periods of higher daytime cloudiness as indicated by ASOS observations, insolation and sensible heat flux estimates from the CALMET diagnosed cloud cover would be significantly higher because CALMET is only diagnosing cumuliform cloud cover at one model level. This would result in greater atmospheric "instability" or enhanced mixing when compared to boundary layer parameter estimates when using ASOS observed clouds. Theoretically, this could translate into lower ground level concentrations as compared to ASOS derived estimates, depending on source characteristics and transport distance. The opposite effect would occur at night, with more stable conditions expected based on CALMET diagnosed cloud cover. CALMET utilizes a modified Turner approach based upon ceiling height, cloud cover, and 10-m wind speed for calculating hour PG stability classes. When using CALMET in NOOBS=2 mode, it must rely upon diagnosed cloud cover and ceiling heights from the prognostic hydrometeors, thus PG stability estimates are directly impacted by the issue discussed above.

In order to test the impacts from these differences, the EPA created the equivalent of a single column model by extracting radiation and boundary layer modules from CALMET and supplied both ASOS and diagnosed cloud estimates from the 2001 Philadelphia Study (Evangelista, 2005; Touma et al., 2007) to the off-line single column model. The resulting boundary layer parameters responded as conjectured, with the enhanced insolation and sensible heat flux estimates resulting from lower cloud cover estimates. As a result, the atmosphere was often times "less stable" during the daytime as compared to the ASOS cloud case, meaning that puff growth will often be enhanced using the NOOBS approach, as compared to the ASOS cloud case. Hourly Pasquill-Gifford (PG) stability classes were estimated from the Monin-Obukhov lengths based upon the work of Golder (1972). When the EPA examined the downstream impact of this, it was shown that PG stability classes for the full "NOOBS" case were often times lower (less stable) during the daytime as compared to the ASOS cloud case, and hourly stability class estimates differed on average by 1 class, but differed by as much as 4 PG classes in the same hour between the two approaches (Anderson, 2006, 2007b). Thus, the commenter neglects a fundamental point regarding CALMET configurations and developing a viable pass through that we discussed at length in 2009 - a pass through approach must also consider the impact on how other diagnosed meteorological variables are derived and their impact on the dispersion model based upon the inherent strengths and/or weaknesses of the technical formulation of software platform used to create the pass through, and not solely focus upon horizontal wind components. Stated directly, an approach that results in degradation or misdiagnosis of other key meteorological variables due to inherent design limitations or formulation errors of the meteorological platform does not constitute a viable pass through configuration.

Due to the technical issues previously described, the EPA believed that a true pass through using a NOOBS=2 approach could not be achieved without significant impact upon other diagnosed meteorological variables (variables other than just scalar velocity components of the horizontal wind) that are important in CALPUFF simulations, and recommended an alternative approach in the draft 2009 IWAQM 2 revisions. These recommendations took into consideration the impacts imposed on radiation budget and stability estimates by errors in diagnosed cloud cover estimates by recommending incorporation of surface observations (which include station cloud cover) and minimizing potential physical discontinuities in the Step 2 wind field created by speed and directional differences in wind values between surface observations and prognostic data from the Step 1 wind field (by use of small interpolation weights or “R” values). The physical discontinuity issue is discussed below. Subsequent statistical performance evaluations of this recommended approach resulted in statistically poorer performance when compared to CALMET fields with larger interpolation weights. As a result, the EPA and FLM’s believed it necessary to recommend a standardized set of CALMET model control options based upon a CALMET configuration in the classical “hybrid” mode with interpolation weights that yielded the best statistical performance. These recommendations were documented in the August 31, 2009 EPA Model Clearinghouse Memorandum.

Several commenters discussed the issue of CALMET’s interpolation scheme and methods to overcome artifacts observed in the development of “hybrid” wind fields. Commenters summarized several options for minimizing the physical discontinuities and suggested that these artifacts resulted from poor modeling practice.

The issue of wind field discontinuities was highlighted in presentations made by State and EPA staff (Anderson, 2007a, 2007b; Hawkins, et al., 2008) and discussed at length in the 2009 IWAQM report. All of these presented a graphical analysis of actual wind fields developed by contractors for modeling demonstrations supporting Best Available Retrofit Technology (BART) analyses in the central United States, thus were not produced by the EPA. These were presented as an example of resultant wind fields from model configuration options routinely used in regulatory applications of the modeling system, and to highlight the need for better quality assurance of CALMET wind fields from the regulatory agencies and user community. These examples were in the central United States, an area noted for very modest terrain relief. Qualitatively speaking, one would nominally expect there to be greater consistency between observations and prognostic meteorological fields in areas not heavily influenced by complex meteorological environments such as coastal zones or areas of complex orography. However, the graphical evaluation that both the EPA and the State of Kansas conducted on BART cases both found a significant number of periods where physical discontinuities were noticed in surface and aloft wind fields.

As we noted in the 2009 draft IWAQM report and discussed again at the 10th Conference, an undesirable paradigm had developed in the United States with regard to the development of meteorological fields almost from the inception of use of CALMET. Users would obtain readily available prognostic and observational datasets and run CALMET without any statistical or graphical performance evaluations to determine the suitability or adequacy of the CALMET wind fields. This was the primary motivation in our development of software utilities for graphical and statistical analysis (CALMET-to-netCDF and MMIFStat) of CALMET presented at the 10th Conference, to promote performance evaluations of the meteorological fields as is required under Section 8.3(d) of the *Guideline*, a practice heretofore and subsequently not adhered to by the user community.

These examples illustrated a known artifact in CALMET fields when using objective analysis (OA) procedures. Whenever there is a wind direction/speed mismatch between observations and the background first guess field, physical discontinuities or "bullseye" effects manifest themselves in the final wind field. When using the similarity theory profiling option, these discontinuities will be extended through a portion of the boundary layer. To minimize or avoid this would require the user to employ vertical layer weight options to scale or shut down surface influence on layers aloft, an available option in CALMET, but one that we have never encountered in regulatory applications. Finally, since the selected interpolation weight is applied uniformly to all observations, it is not possible to vary the interpolation of an individual or limited group of observation sites where the likelihood of differences exists (such as in complex meteorological environments where the coarse scale prognostic field would not resolve finer scale features). This effect is largely unavoidable in CALMET if differences between the first guess field and observations exist, with the horizontal and vertical extent of physical discontinuity determined by the interpolation weighting and similarity theory profiling described previously.

OA preprocessing procedures in prognostic systems such MM5 or WRF contain error or "buddy check" routines which compare observations to the first guess field. If the difference between observations and first guess field exceed a predetermined threshold, the observation is discarded, thus limiting the potential for physical discontinuities in the wind field. No such procedures exist in CALMET, thus the final wind field will have physical discontinuities if these differences exist. We have not contended there was an issue with the model code implementing OA procedures in CALMET; however, because CALMET lacks any error checking routines to discard observations if large differences between the observation and first guess field exist, it is an artifact that will manifest itself most times when differences exist while using the convention of the "hybrid" approach with CALMET. Thus, we disagree with commenters that suggest this is only the result of poor modeling practice. We maintain that without such error or buddy checks in an OA procedure, these artifacts will manifest themselves when differences exist. Modifying interpolation weights to minimize influence is entirely counterintuitive to the diagnostic modeling paradigm, especially when the first guess is derived from a coarse scale prognostic dataset and when focusing upon complex meteorological environments. In those situations, observations are critical to properly characterizing the three dimensional structure of local wind and temperature fields. Finally, as we have routinely highlighted, because the user community does not routinely screen the CALMET meteorological fields as part of regulatory applications of the model, these discontinuities go largely undetected.

These commenters also summarized alternative methods to minimize discontinuities suggested by the model developer (Scire, 2008). These options are: 1) run CALMET in pure observation mode, 2) run CALMET in full NOOBS mode using prognostic fields only, and 3) configure CALMET in such a way as to pass through as much of the prognostic data unaltered by optimizing selection of radii of influence and minimizing changes caused by CALMET diagnostic features.

The EPA disagrees with commenters that these methods represent a viable solution to this issue. The first option, running CALMET in pure observation mode, is an alternative that was allowed under Section 8.3.1.2(d) of the *Guideline*. A minimum of five (5) years of meteorological data is required if this option is exercised. However, studies such as Irwin et al. (1996) have shown that this approach was the least desirable from a LRT model performance perspective when conducting mesoscale modeling. This approach moves the user community further away from a long standing goal of greater utilization of prognostic data. The second option, full NOOBS mode, could not be endorsed by the EPA due to the findings of McEwen and Murphy (2004), Evangelista (2005), and Anderson (2006, 2007b) that was discussed previously. The third option, minimization of interpolation weights, was originally suggested by the EPA in the draft 2009 report, but was replaced by the August 31, 2009 memorandum recommendations, based upon statistical performance evaluation results documented by EPA (U. S. EPA, 2011) highlighted previously. Based upon the information learned through issues, and in order to facilitate a better pass through approach for prognostic data, we sponsored the development of the Mesoscale Model Interface Program (MMIF) (Anderson, 2008; Ramboll Environ, 2015).

These commenters also suggested a flaw in the conceptual design of MMIF exists whereby MMIF always conducts spatial interpolation when such is not necessary. We disagree with these points for two basic reasons. First, to maintain consistency in horizontal resolution and perform the necessary translation from either an Arakawa-B or Arakawa-C grid (MM5/WRF), it is necessary to translate horizontal scalar components of the wind to the cell center grid structure of CALMET (Section 2.1, Scire et al., 2000). We do not disagree that this could be achieved as commenters described by aligning CALMET cell centers to locations of prognostic wind variables, but the commenters overlook several key points. As stated previously, a fundamental purpose of a meteorological preprocessor is to adapt the prognostic fields to the grid structure of the air quality model, not the reverse. Second is the fundamental reality of the knowledge base of the CALPUFF user community. As we stated in 2009 in the draft IWAQM 2 revisions, most individuals that employ the CALPUFF system are not well versed in prognostic meteorological model theory and are not familiar with Arakawa-B or Arakawa-C grid concepts. The conceptual design of MMIF took this reality into account and produces a grid structure that is directly compatible with CALPUFF without burdening the user to know what grid structure is necessary to properly align a CALPUFF grid to match the locations of where scalar components of the wind are defined in a particular prognostic model. It has been the collective experience of the EPA and the FLM's that the end user is most familiar with simply specifying a grid based upon their knowledge of the CALPUFF system and the relevant EPA/FLM guidance. To facilitate this, MMIF was designed to output a grid directly compatible with CALPUFF, which does require horizontal and vertical translation of meteorological variables to be compatible with the CALPUFF grid structure. It is incorrect to characterize this approach as unnecessary or to insinuate that the EPA deliberately mischaracterized the nature of MMIF and how it translates meteorological variables for CALPUFF grid compatibility. We clearly stated at the 10th Conference that MMIF was specifically designed without features to interpolate prognostic data from a coarser to a finer resolution, but the design does require meteorological variable translation to facilitate compatibility with the CALPUFF grid structure, as is the case in all meteorological preprocessors for grid based models.

Second, with MMIF, additional meteorological variables such as temperature, insolation, and mixing heights are passed through without alteration (unless rediagnosis is directly invoked in MMIF) and thus greater overall consistency of all prognostic variables is achieved compared to CALMET. This approach eliminates many of the technical concerns we described above with respect to additional diagnosed meteorological variables that significantly limited the development of a true pass through option with respect to CALMET, a fundamental point consistently neglected by the commenters.

Finally, we note that the commenters offered no concrete evidence other than vague theoretical arguments to substantiate their arguments. The EPA's observations and recommendations with respect to CALMET and MMIF are based upon extensive literature review, have been analyzed statistically using state-of-the-practice statistical methods and metrics, visualized, and documented, and the EPA has developed and made available statistical and visualization analysis tools on the SCRAM website for the user community to explore these issues and form their own conclusions.

2.10.2 Site specific data

Clarifications

Comment:

A commenter (0119) recommended the following clarifications in regards to site-specific data in AERMOD: 1) Section 8.4.4.2 should be expanded to include measurements of u* and heat flux. Currently heat flux is read in by AERMET but not used. 2) Section 8.4.4.2(d) should be updated to clarify that, if solar radiation measurements are collected, AERMET still requires cloud cover data. To remove the need for cloud cover data, site-specific net radiation measurements must be collected and 3) guidance on site-specific meteorological data collection should be updated to reflect AERMOD's expanded meteorological dataset.

Response:

Section 8.4.4.2, specifically Sections 8.4.4.2(a) and 8.4.4.2(b), are meant to discuss the more common variables measured or calculated from site-specific data. While variables such as surface friction velocity, u* are not specifically discussed, applicants are not precluded from calculating or measuring such variables with site-specific measurements. The EPA does not agree with the commenter's assertion that if solar radiation measurements are collected, AERMET still requires cloud cover data. AERMET calculates equivalent cloud cover estimates from the insolation, if provided, and the calculated cloud cover replaces the observed cloud cover for subsequent calculations. Cloud cover is used in the calculation of insolation and net radiation, if those variables are missing in the input data to AERMET. One example is MMIF inputs into AERMET do not have cloud cover and inputs insolation to AERMET. AERMET proceeds normally and issues no warnings or errors.

Per the comment on updating the site-specific meteorological data guidance, the EPA is investigating updating the guidance to reflect AERMOD's meteorological data needs versus those models that were preferred at the time of the issuance of the guidance.

Review of site-specific data

Comment:

An anonymous commenter (0122) commented that Section 8.4.4.1(a) states "Site-specific data should always be reviewed for representativeness and adequacy by an experienced meteorologist, atmospheric scientist, or other qualified scientist." The commenter (122) said this analysis should be completed by or under the direction of the appropriate reviewing authority by qualified personnel as described above. The final rule should include a modification of the sentence to "Site-specific data should always be reviewed for representativeness and adequacy by an experienced meteorologist, atmospheric scientist, or other qualified scientist of the appropriate reviewing authority." At the very least, any such analysis should be reviewed and approved by the appropriate reviewing authority.

Response:

The EPA has modified Section 8.4.4.1(a) to state that the review of the site-specific data should be reviewed by an experienced meteorologist, atmospheric scientist, or other qualified scientist in consultation with the appropriate reviewing authority.

Calculation of site-specific turbulence

Comment:

A commenter (0126) said that the use of a true hourly-averaged σ_θ is more appropriate than the approach recommend by the EPA, the average of 4 15-minute values as discussed in Section 8.4.4.2(h). The commenter (0126) referenced Section 5.2 of the AERMET user's guide as justification of a true hourly average, versus the average of four 15-minute values.

Response:

The EPA has removed the reference to the use of four 15-minute values from the *Guideline* in Section 8.4.4.2 for turbulence calculations and refers users to the appropriate meteorological processor user's guide. That being said, it should be noted that while the AERMET user's guide implies the use of a true hourly average, AERMET only allows up to 12 observations per hour (5-minute averages), so some averaging of data may need to occur before input into AERMET, if the number of observations exceeds 12 per hour.

Site-specific wind speed threshold

Comment:

A commenter (0126) stated that a 0.5 m/s threshold should be specified for on-site wind data, no matter what the starting threshold. The comment stated that the AERMET user's guide addendum specifies that for Automated Surface Observing System (ASOS) winds, a minimum threshold speed of 0.5 m/s should be specified. This same approach should be used for on-site wind data – a 0.5 m/s threshold wind speed should be specified, no matter what the starting threshold is. This will avoid extension of AERMOD to extremely low wind speeds that are not consistent with the limitations of a steady-state model.

Response:

The EPA disagrees with the commenter that a 0.5 m/s threshold should be applied to site-specific wind data, no matter the starting threshold of the instrument. As stated in a previous response regarding thresholds, the threshold of the site-specific wind data is the greater of the threshold for the instruments of the wind speed and wind direction as discussed in the meteorological monitoring guidance for dispersion model inputs. The 0.5 m/s threshold recommended for ASOS data is not a required threshold and is a recommended default threshold when specifying a threshold for ASOS wind data.

Specifics of guidance on site-specific variables

Comment:

A commenter (0128) stated that the usefulness and readability of Section 8.4.4 suffers from arbitrary specificity related to individual component measurements combined with references to other guidance. The particulars of establishing an appropriate on-site meteorological data collection program are quite involved, and the individual subsections of 8.4.4.2.b. – j. are incomplete and confusing especially as some terms are not defined (*e.g.* σ_E, σ_A). To be more consistent with other sections of appendix W, specifics associated with setting up a site-specific meteorological monitoring program should be contained in the references as part of a revised Section 8.4.4.2 with the specific discussion of each component omitted from appendix W. As necessary, updates to the references should be made to align with the intentions of the appendix W guidance. The commenter recommended that Subsections 8.4.4.2 b. through j. be removed with appropriate references to the overall site-specific meteorological monitoring program guidance provided as part of revised Section 8.4.4.2 (previously 8.4.4.2.a). In addition, the commenter stated the EPA should update Reference 111, as follows: Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements Version 2.0 (Final). EPA-454/B-08-002. March 2008.

Response:

The EPA disagrees with the commenter's statement that Section 8.4.4 suffers from arbitrary specificity. The EPA feels it is useful to discuss guidance for key measurements in more detail in the *Guideline*, instead of only referring to guidance.

Miscellaneous

Comment:

A commenter (0131) stated ASOS data compromise sky cover input to AERMET due to limitations by the equipment to "see" beyond 12,000 feet. The AQMG did not engage appropriately with the NWS to push back on their meteorological monitoring network design in the mid-2000's such that more resolved sky cover information would have been collected above 12,000'.

Response:

No response to this comment as it is outside the scope of the *Guideline*.

AERCOARE

Comment:

A commenter (0099) requested that AERCOARE be promulgated as the meteorological preprocess for overwater applications as part of this rule as the current preferred model for overwater applications, OCD, is extremely dated and will not process hourly estimates in a manner consistent with the 1-hour NO_2 and SO_2 NAAQS and 24-hour $PM_{2.5}$ NAAQS. Promulgating AERCOARE would allow AERMOD to provide estimates in overwater applications.

Response:

The EPA did not pursue replacement of OCD as part of this rulemaking and recognizes the need to engage with the modeling community regarding advances in the modeling science and appropriate met inputs for such overwater applications. The EPA has committed to establishing an overwater team under IWAQM to coordinate and collaborate with BOEM to conduct the necessary evaluations to improve modeling capabilities. The EPA hopes that this effort in conjunction with efforts by the modeling community will be a topic of discussion at the 12th Modeling Conference and inform the EPA's considerations for future revisions to the *Guideline*. That said, the EPA has allowed for the use of AERCOARE through the May, 6, 2011 Model Clearinghouse concurrence memorandum on the use of AERCOARE in the Arctic so there is a viable path currently available for its use in permitting applications.

2.10.3 General Meteorological data

AERMINUTE

Comment:

A commenter (0099) said that in Section 8.4.3.2(d), the EPA should clarify that the randomly generated wind directions used with standard hourly observations in AERMET are not applied to the hourly averaged winds from AERMINUTE.

Response:

The EPA clarified that the randomly generated numbers are used with the standard hourly observation winds in Section 8.4.3.2(c) and is also discussed in the March 8, 2013 Tyler Fox memo "Use of ASOS Meteorological data in AERMOD dispersion modeling."

Comment:

A commenter (0119) expressed support for the EPA's recommendation to use hourly averaged winds from AERMINUTE for input into AERMET whenever NWS 1-minute ASOS site data are available.

AERMINUTE is an effective pre-processor to AERMET that reduces the number of calms and variable winds recorded in the standard hourly ASOS data file.

Response:

The EPA appreciates the commenter's support and agrees that AERMINUTE is an effective pre-processor to AERMET that reduces calms and variable winds input into AERMOD.

Light and variable winds

Comment:

A commenter (0137) offered comments on the use of Lagrangian models under light wind, near calm conditions. The commenter stated that in Section 8.4.6.1, the EPA states "a steady-state Gaussian plume model does not apply during calm conditions, and that our knowledge of wind patterns and plume behavior during these conditions does not, at present, permit the development of a better technique." The commenter stated that this is true for steady-state models, but available non-steady-state Lagrangian models such as CALPUFF can simulate dispersion during near-calm and calm conditions. The commenter goes on to say a Lagrangian model such as CALPUFF could be used to address such near-calm and calm conditions if they were found to be worst-case conditions for a source, but instead the EPA is delisting CALPUFF as a preferred model and not listing another Lagrangian model as a preferred alternative, even though it would better handle such wind conditions. The commenter continues, "Even though such Lagrangian models could be used as alternative models, having to get approval to use a

Lagrangian model as an alternative model would probably inhibit much use of the Lagrangian model in such cases. Even though steady-state models cannot address near calm and calm conditions, it is possible that research using Lagrangian models could result in a technique to better address near-calm and calm conditions that could be used with AERMOD. Thus, when the EPA states here that we don't have the knowledge of plume behavior to develop a 'better technique,' they are not telling the whole story. The EPA would prefer to limit modeling of such near-calm and calm conditions to only the steady-state model AERMOD. More could be done."

Response:

Consistent with the 2005 version of the *Guideline*, CALPUFF can be used as an alternative model under the guidance of Section 3.2.2 if the user feels that AERMOD is not adequate for the near-field modeling application.

Comment:

A commenter (0137) offered comments on the use of light and variable winds in AERMOD. The commenter questioned the use of light and variable winds in dispersion modeling applications where quantitative calculates based on those winds have great consequences. The commenter states that while it is good to make better use of lighter wind speeds that were previously ignored to reduce the number of missing hours, but questions the accuracy of model calculations based on light winds, when standard deviation could exceed the absolute value. The commenter goes on to state that even if an hourly averaged wind speed results in a reasonably accurate concentration calculation directly downwind of a source for an hour, the commenter questions the use of a potentially highly variable hourly averaged wind direction in the dispersion calculations for the hour. For wind speeds as low as 2, kt, and especially 1 kt, corresponding wind directions could be extremely variable over an hour, resulting in a large value of standard deviation of wind direction over the hour, *e.g.*, +/-30, 60, even greater than 90 degrees in an hour (upwind of the source). Some of the reported poor AERMOD performance using the 1-minute ASOS winds in recent years has occurred when the actual plume didn't even blow toward the monitor (very low or zero monitored concentration), *i.e.*, when the wind direction was greatly in error (*e.g.*, large standard deviation of wind direction). The commenter suggests examining the standard deviation of wind direction over the hour and if the standard deviation is fairly small, then the hourly averaged wind direction is probably reasonably representative and could be used in a concentration calculation. If, on the other hand, the standard deviation is too large, above a certain threshold, the wind direction is too variable over the hour, resulting in a highly uncertain hourly averaged wind direction (*i.e.*, no direction is representative, it is essentially random), which could result in large errors in plume location and resultant concentration calculations, and the hour should be treated as calm and concentrations not calculated. In such a case when the standard deviation of wind direction is so large, it may be as likely that a representative wind "direction" for plume transport for the hour could be 180 degrees (southerly) as 90 degrees (easterly) for example, resulting in a completely erroneous concentration calculation. The commenter would submit that such highly variable wind directions (such large values of standard deviation of wind direction) will not produce a reasonably accurate concentration calculation in AERMOD, and we would recommend ignoring those hours as calms.

Response:

Before the promulgation of AERMINUTE in 2011, when using NWS standard hourly observations in AERMOD, the data were subjected to the METAR codes for calms and variable winds. Winds below 3 knots were considered calm and winds up to 6 knots with a wind variation of more than 60 degrees during the 2-minute averaging period were considered variable. Those variable winds were listed with a missing wind direction, thus concentrations were not calculated for those hours in AERMOD, in addition to no calculations for hours that were considered calm. The purpose of AERMINUTE was to retrieve those hours from the raw 1-minute data and calculate hourly average winds based on the 1-minute values without the restrictions of the METAR codes. The use of AERMINUTE has introduced wind speeds that are lower in magnitude than that would be ordinarily used by AERMOD when using standard hourly observations. The EPA agrees with the commenter that at low wind speeds, the standard deviation of the wind direction could be quite large. However, one should also consider what has been done in the past before the promulgation of AERMINUTE, especially when using NWS data. Before AERMINUTE, a single 2-minute wind speed and direction observation that was taken approximately 10 minutes before the hour was reported as the hourly observation for the NWS station, *i.e.* standard hourly observation. This observation was used to represent the whole hour in AERMOD. With AERMINUTE, true hourly average wind speed and direction are calculated from among the non-overlapping 2-minute values. While it may be true that the hour may experience a large variation in wind direction, especially for low wind conditions, the EPA feels that this hourly average is influenced by all of the wind directions over the hour and is a better input to the model than a single 2-minute observation, which by random chance, could be as likely to be 180 degrees (southerly) or 90 degrees (easterly). At this time, the EPA is not recommending to use wind direction variability as a criterion for excluding an hour for concentration calculations.

Comment:

A commenter (0113) said when using multi-level met data, including MMIF, any non-missing hour up to 100 m can be used for reference level wind. AERMOD extrapolates downward from the reference level to generate hourly vertical profiles. As a result, light wind at a reference wind level of 100 m may lead to very small wind speeds closer to the surface. This is essentially substituting calm winds below the wind speed threshold into the vertical profile for levels that were classified as calm/missing during AERMET processing. It is uncertain if this is appropriate as a calms handling procedure. A maximum reference level of 50 m may be more representative of surface wind.

Response:

The EPA agrees that a light wind at 100 m could lead to a light wind at the surface. However, if the surface wind was already below a user-supplied threshold in AERMET, then the wind speed substituted for the surface wind speed would be greater than the observed wind speed at the surface, since AERMET searched for higher levels for a reference wind.

Transport distance

Comment:

A commenter (0137) commented on the use of low wind speeds and transport distance for a given hour. The commenter specifically questioned the validity of estimating concentrations that exceed the distance plume material could physically be transported in an hour given the wind speed. The commenter uses the example of 1-2 knot winds with transport distances of 1850-3700 m. The commenter states that for such winds, much a receptor grid is too far from the source during the simulated hour, before the next hour begins and another wind speed and direction should be used. The commenter recommended, if the EPA persists in using such low wind speeds in AERMOD, then the EPA should modify concentration calculations at receptors well below the steady-state limit in a given receptor grid for an hour to fairly represent a realistic wind observation (not necessarily the current hour's), especially the wind direction, to make a more accurate and fair concentration calculate under such low-wind conditions.

Response:

The idea of a transport distance based on wind speed has become very popular among the regulatory community since the promulgation of the 2010 NO_2 and SO_2 1-hour NAAQS. The idea is that if the wind speed is *x* m/s, then the plume should only be calculated for receptors that fall within the distance that a parcel would travel in one hour for the given wind speed and the fact that AERMOD calculates concentrations for receptors outside that distance is incorrect, inaccurate, or unreliable. The EPA points out that this concept has been around before the promulgation of the 2010 NO_2 and SO_2 NAAQS. For example, the standard practice for years has been to model receptors out to 50 km from a source, the nominal distance of near-field Gaussian models. Using the transport distance concept outlined by the commenter, it would take a wind speed of 13.9 m/s for a parcel to travel 50 km from a source in 1 hour. That wind speed corresponds to 27 kts or 31 mph. Such sustained wind speeds are not normally encountered in most areas, so a parcel would not reach 50 km from a source in 1 hour in most areas. Yet, before the promulgation of the 2010 NO_2 and SO_2 NAAQS, the modeling community was willing to accept such a condition for years and only recently has brought up the idea of the transport distance. The EPA feels that the commenter has more of an issue with the stringency of the new NAAQs than with the theory of the Gaussian dispersion models. The higher levels of the older NAAQS allowed for more conservative practices through the years as usually there were little to no issue with meeting the NAAQS. At this time, the EPA does not feel it is necessary to adjust model calculations to account for transport distance and receptor distance to the source. The EPA also would like to state that if any applicant feels that AERMOD is not appropriate for an application, then an alternative model can be selected based on the guidance of Section 3.2.2 of the *Guideline*.

Comment:

A commenter (0085) stated a need for clarification in Section 8.4.6.2(c) about the adjustment of site-specific winds to 1 m/s when the winds are less than 1 m/s but higher than the response threshold of the instrument. The commenter points out this adjustment is not done for input into AERMOD. The commenter also commented on the fact that a minimum wind speed threshold of 0.5 m/s is established for ASOS and prognostic meteorological data processed through MMIF. The commenter also said that it is not clear why no adjustment should be made to site-specific wind data when previously in the same paragraph the EPA suggests two adjustments should be made. Also, the EPA offers no justification for the distinction in minimum wind speeds for ASOS/MMIF data and site-specific data. If the performance of AERMOD is compromised with the introduction of very low wind speeds, thus necessitating a minimum wind speed threshold of 0.5 m/s for ASOS and MMIF data, the EPA should establish the same threshold of 0.5 m/s for site-specific data.

Response:

The EPA has clarified Section 8.4.6.2(c) that for site-specific winds less than 1 m/s but higher than the response threshold of the instrument, should be reset to 1 m/s for models other than AERMOD as AERMOD has algorithms to account for very low wind speeds. The 0.5 m/s threshold for ASOS data is based on the minimum wind speed threshold for site-specific data discussed in the met monitoring guidance and the 2013 ASOS memo and is referenced in Section 8.4.6.2(c). This is a recommended default value but is not required when processing ASOS data. The same 0.5 m/s threshold was implemented in MMIF and again is a default value but not required.

Comment:

A commenter (0099) requested the following changes and clarifications. In Section 8.4.2(d), "MPRM" should be included for use with OCD in addition to PCRAMMET. In Section 8.4.6.1(b), the EPA should clarify which value should be used as the threshold wind speed when the wind speed sensor and wind direction sensor have different starting thresholds. It is ADEC's understanding from personal communication with the EPA that the larger of the two values should be used.

Response:

The EPA has added MPRM with use with OCD in Section 8.4.2(d), and has clarified that the wind speed threshold is the larger of the speed or direction instrument in Section 8.4.6.1(b).

Comment:

A commenter (0138) stated that Section 8.4.2(e) should include similar wording as in Section 8.4.1(c) which references comparable stations, even though Section 8.4.2.2(c) indicates that "other" data may be used.

Response:

The EPA has modified Section 8.4.2(e) to state: "The use of 5 years of adequately representative NWS or **comparable** meteorological data, at least 1 year of site-specific or at least 3 years of prognostic meteorological data, are required.

Comment:

An anonymous commenter (0122) stated that the 2005 version of appendix W specifies that consecutive years from the most recent, readily available 5-year period are preferred. The proposed revision removes this preference that served to prevent the selective removal of years that yielded higher modeled concentrations. The final rule should include a preference that the data period should consist of consecutive years unless there are extenuating circumstances (representativeness or incompleteness issues) that warrant the use of non-consecutive years.

Response:

The EPA has re-inserted text into Section 8.4.2(e) regarding consecutive years. The section now states that "Depending on the completeness of the data record, consecutive years of NWS, site-specific, or prognostic data are preferred. With regards to the most recent data being used, the EPA has from past experience that the most recent years are routinely processed by states and other reviewing authorities and applicants for dispersion modeling applications. Given this routine processing of the most recent data, the EPA felt it was not necessary to include that recommendation.

Comment:

An anonymous commenter (0122) stated that the text of Section 7.2.1(c) in the 2005 version of the *Guideline* discussing incomplete meteorological data periods and design value calculations should be reinserted back into the final version of the *Guideline*. The commenter's specific comment is "The scenario described in this section could exist in the future even with the changes to the meteorological data section to include prognostic meteorological data. The final rule should include the language from 2005 appendix W, Section 7.2.1.1(c) to address all possible situations that could occur with limited representative meteorological data." Section 7.2.1.1(c) states:

"When sufficient and representative data exist for less than a 5-year period from a nearby NWS site, or when site specific data have been collected for less than a full continuous year, or when it has been determined that the site specific data may not be temporally representative (subsection 8.3.3), then the highest concentration estimate should be considered the design value. This is because the length of the data record may be too short to assure that the conditions producing worst-case estimates have been adequately sampled. The highest value is then a surrogate for the concentration that is not to be exceeded more than once per year (the wording of the deterministic standards). Also, the highest concentration should be used whenever selected worst-case conditions are input to a screening technique, as described in EPA guidance."

Response:

The EPA feels that guidance on design value calculations are best handled in the pollutant specific modeling guidance documents (memorandum, technical assistance documents) given the individual nature of each pollutant's design values.

Comment:

A commenter (0131) stated that the sentence in Section 8.4.6.1(b) "The reference wind speed is selected by the model as the lowest level of non-missing wind speed and direction data where the speed is greater than the wind speed threshold, and the height of the measurement is between seven times the local surface roughness length and 100 meters" is incorrect and that it should be "and the height of the measurement is between seven and 100 times the local surface roughness height."

Response:

The EPA disagrees with the commenter and the sentence is correct as written. The same language is found on page 3-25 of the AERMET User's Guide.

AERMOD post-processor

Comment:

A commenter (0113) stated the need for an AERMOD post-processor to allow for the post-processing of runs using multiple meteorological data within the same domain, which may be more representative for areas with complex meteorology. Post-processing is also necessary with the current AERMOD version to more than one BLP line source. The commenter also stated that post-processor should be able to sum hourly impacts (preferably using unformatted AERMOD post files) and post-process averages across multiple years, similar to the CALSUM and CALPOST tools for CALPUFF. LEADPOST used for lead AERMOD modeling could be incorporated into the tool.

Response:

The EPA has considered the idea of an AERMOD post-processor since the promulgation of the 2010 NO_2 and SO_2 NAAQS to calculate model design values. Some stakeholders thought this would create very large output files from AERMOD (*i.e.*, hourly POSTFILES). The EPA is open to the idea of such post-processors and will engage with the modeling community as part of future development efforts.

3.0 Editorial Changes

General Editorial Comments

Comment:

Numerous commenters (0079, 0085, 0087, 0088, 0089, 0093, 0094, 0097, 0099, 0112, 0122, 0126, 0128, 0131, 0137, 0138, 0147, and 0148) identified errors in the proposed revisions, such as misspelled words, typographical errors, etc.

Response:

The EPA appreciates the commenters identifying these needed corrections. The text has been revised accordingly.

Redline/Strikeout Versions

Comment:

Two commenters (0056 and 0110) provided red line strike-out versions (RLSOs) of the proposed rule. One commenter () provided a commented version of the proposed rule.

Response:

We reviewed the RLSO versions and considered the suggestions. In addition to incorporating several typographical errors, we made modifications to the regulatory text in section 3.1.2.c.

4.0 Statutory and Executive Orders

Tribal Consultation

Comment:

A few commenters (0079, 0094, and 0147) noted that the preamble to the Proposed *Guideline* states that it does "not have tribal implications, as specified in Executive Order 13175." The rationale for the EPA's finding is that the Proposed *Guideline* "imposes no requirements on tribal governments." One of the commenters (0079) stated that the EPA does not understand fully the intent behind EO 13175 as it is not limited to federal actions imposing requirements on tribal governments. The commenter also stated that Proposed *Guideline* has implications to Indian Tribes beyond those identified by the EPA. EO 13175 requires the EPA to develop an accountability process to ensure "meaningful and timely input by development of regulatory policies that have tribal implications."

Response:

We appreciate these comments and recognize the importance of appropriate outreach and consultation with tribes in developing the revisions to the *Guideline*, consistent with the federal government's trust responsibility to all federally recognized tribes. Although we did not find that this action met the EO 13175 criteria as discussed in the preamble to the final rule, we actively encouraged tribes to participate in this rulemaking as we recognized that it may influence the way tribes run their air quality modeling program. We conducted outreach and information sharing on the content of this rulemaking with tribal environmental professionals through the monthly National Tribal Air Association (NTAA) call held on September 10, 2015. We also held an informational webinar for tribes on October 21, 2015. During these events, we offered to hold additional informational meetings, webinars, and consultation on the proposal to ensure that tribes had the opportunity to participate in the process. We did not receive any such requests.

Compliance with Executive Orders

Comment:

One commenters (0086) stated that they believe the EPA has not fulfilled the requirements of Executive Order (EO) 12866 and 13563.

Response:

The EPA satisfied the applicable provisions of EO 12866 and EO 13563, including those pertaining to public participation and consideration of impacts. In addition to the normal notice and comment rulemaking process, in which we received and are responding to comments from AASHTO and two state DOTs, the EPA obtained considerable stakeholder input and feedback during the Tenth and Eleventh Modeling Conferences, as discussed in the preamble to the final rule. The final action was determined to be a "significant regulatory action" by the Office of Management and Budget (OMB) and was thoroughly vetted through the interagency review process. Any changes made in response to OMB recommendations have been documented in the docket.

5.0 General and Non-specific

SO_2

Comments:

A commenter (134) requested that the EPA confirm that this statement does not expand the role of the *Guideline* or of AERMOD in determining SO_2 levels for purposes of designating nonattainment areas. Rather, the choice to use a dispersion model or ambient monitoring data to determine SO_2 levels for purposes of area designations is a function of the recent SO_2 data requirements rule.

Response:

The EPA notes that modeling of SO_2 impacts in order to inform area designations decisions may occur for areas and sources that are not subject to the data requirements rule. Moreover, even where air agencies choose to use ambient monitoring under the data requirements rule to characterize air quality, there may be instances where dispersion modeling is also conducted in the context of designating that area. However, the EPA confirms that the revision of the *Guideline* does not "expand the role" of the *Guideline* in the implementation of the SO_2 data requirements rule. The choice of modeling or monitoring to characterize air quality in areas subject to that rule is still a function of the data requirements rule and the use of actual emissions and stack heights, and receptor placement for the designations modeling for SO_2 is still guided in principle by the SO_2 Modeling TAD. Other modeling considerations described in the SO_2 Modeling TAD that refer to the *Guideline* are still subject to the *Guideline*, as revised. This could include situations where air agencies conduct modeling of allowable emissions, rather than actual emissions, and account for good engineering practice restrictions on creditable dispersion due to stack heights. The SO_2 Modeling TAD will be updated to reflect the latest recommendations from the *Guideline*, specifically the adjusted u* option in AERMOD, the capped and horizontal stacks, and use of prognostic meteorological data.

Call for Ombudsman

Comment:

A commenter (0114) expressed concern that industry and consultants may have developed a distorting relation with OAQPS in the areas of model development. The commenter said this was evident in the collaboration between industry and OAQPS that has been touted at recent conferences on air quality modeling and at the Regional/State/Local modeler's workshops. The commenter further stated that the collaboration between industry and OAQPS misses an obvious group that is virtually absent from technical model development activities, that is the US citizens that are exposed to the air pollutants emitted by industry. When budget allows, the commenter said the citizens are represented by environmental groups, but funding is never anywhere close to the amount spent by industry in model review, development, and revision efforts. In conclusion, the commenter suggested that the EPA appoint an Ombudsman to oversee the exchanges between OAQPS and industry, and to help make these exchanges transparent to the general public.

Response:

We disagree that an Ombudsman is needed. There are many stakeholders who put much time and resources toward conducting field studies, model evaluations, and model improvements which we may consider, as appropriate. The collaborators in many cases are industry supported consultants and experts in the field, as well as academic and other researchers. There are numerous ways the EPA provides transparency, ranging from making the materials from the triennial modeling conferences and annual Regional/State/Local modeler's workshops available on the SCRAM website. The modeling conferences are open to the public and are considered public hearings with formal transcripts. The Regional/State/Local workshops include a specific day that is open to stakeholders with the other days reserved for the EPA and state and local air agencies to engage with agenda and presentations that are made available to the public. Rulemaking such as this revision to the *Guideline* requires a public notice and comment period, and a response to comments, such as this document. As an example, comments and technical work provided by this commenter regarding the proposed ADJ_U* and LOWWIND3 options were carefully reviewed and responded to under this final action. Our review of their work led to further assessment and evaluation of these proposed options, which resulted in substantial changes from our proposed actions related to these options.

Support for Revisions Related to AQRV

Comment:

A commenter (0088) strongly supports the revisions to the *Guideline* related to air quality related values (AQRVs) as presented in Chapter 6.

Response:

The EPA appreciates the commenter's support for the revisions to the *Guideline* related to air quality related values.

Guidance on Criteria Pollutant Modeling

Comment:

A commenter (1028) states that the *Guideline* is intended to address criteria pollutant modeling and Section 6 does not contain relevant information or guidance on the use of air quality models for this purpose and should be removed from the *Guideline*.

Response:

Some commenters (0088, 0079, 0094) advocate for the content of Chapter 6 related to single source modeling for other governmental programs while another (0128) did not deem the material suitable for inclusion in the *Guideline* and suggested that material would be a better fit on an EPA website. Given the interest in modeling single source impacts for other governmental programs and to ensure clarity with respect to the reviewing authority, the content for Chapter 6 will remain in the *Guideline* to direct project sources to appropriate reviewing authorities to help ensure the appropriate guidelines are followed for different governmental programs.

Levels of Sophistication of Air Quality Analyses and Models

Comment:

A commenter (0115) indicated that the EPA's endorsement of starting air quality analyses with "simplified or conservative methods" is misplaced, 80 Fed. Reg. 45,358/1 (emphasis added); accord id. 45,358/2. The use of "or" suggests that the first cut doesn't need to be conservative, which would allow sources to use simplified analyses that are not conservative and that thus allow them to turn a blind eye to exceedances that a realistic—or conservative—analysis would catch. The EPA must instead make clear that a conservative analysis is required.

Response:

In the passage quoted, the EPA did not mean to imply that an initial air quality analyses need be only simplified and not conservative. The use of the word "or" was intended to make the two adjoining words mutually exclusive. To clarify, section 2.2(a) has been amended to remove the word "or" and replace it with a comma, which should avoid future misinterpretation.

Refinements to Source Characterization

Comment:

A commenter (0126) stated that a case-specific refinement that better characterizes a source but does not change the AERMOD formulation should be considered a *Guideline* modeling approach. Such source characterizations should be allowed on a case-by-case basis without the need for Model Clearinghouse review. The commenter supports these additional source characterization approaches: 1) urban effects due to large industrialized areas; 2) source heat release effects on building downwash; 3) buoyancy effects from multiple stacks in a line; and 4) buoyant rise effects due to moisture in plumes.

Response:

In general, the source-characterizations options that are not associated with dispersion are already incorporated into the model system. The effects associated with urban heat islands and interplay between plume rise and building downwash are clearly related to dispersion of a plume in the atmosphere and would not be considered a source characterization approach. There may be cases where buoyancy, as estimated by the current modeling system, is not entirely reflective of the anticipated initial plume parameters (*e.g.*, the BLP model has been incorporated into AERMOD to capture buoyancy from multiple line sources). In such cases, modifications to the model input or changes to the model code may be appropriate, but would still need to be considered on a case-by-case basis in consultation with the appropriate reviewing authority and may need alternative model approval for regulatory usage.

Modeling of Fugitive Dust Emissions

One commenter (0141) noted that appendix W, Section 4.2.3.6 "Models for PM_{10}" provides a discussion on modeling fugitive dust emissions, but only as it pertains to PM_{10}. The EPA should therefore clarify in Section 4.2.3.5 "Models for $PM_{2.5}$" that fugitive dust sources are exempt from $PM_{2.5}$ modeling.

Response:

As defined in federal PSD regulation CFR 52.21, fugitive emissions are those which could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening. Fugitive dust emission factors have been determined for several industrial operations and may be divided into three general types. These types include unpaved roads, paved roads and storage piles. Factors are compiled from tests at numerous operations to include (gravel operations, coal handling operations, iron ore handling, coke breeze handling, limestone handling, etc.).

With these factors established, it is reasonably applicable to any source where small particulate (PM_{10} or $PM_{2.5}$) is potentially emitted as a fugitive dust source. These fugitive emissions should be characterized and included in modeling analyses where relevant relative to the emissions sources. The EPA recognizes that the existing guidance and other technical information may not currently reflect all possible circumstances, but in many cases, the existing information is sufficiently similar to be appropriate. The EPA welcomes new information on emission factors and other useful data, provided that they are submitted through the appropriate process.

Appropriateness of Emissions Factors

One commenter (0141) noted in Section 4.2.3.6 "Models for PM_{10}," the EPA should acknowledge the overestimation tendencies of emission factors and modeling procedures and the ongoing development of methods to more accurately characterize effective emissions, accounting for physical phenomena, such as traffic intermittency, agglomeration and vegetative scavenging.

Response:

Emission factors and emission rates may be determined through a number of pathways, including existing emission factors and emissions rates provided by the EPA though other regulation and guidance (*e.g.*, the AP-42 and MOVES). The *Guideline* does not address the accuracy or appropriateness of those emissions factors, but instead gives direction on how those emission factors should be applied to modeling demonstrations. Thus, this comment is outside the scope of this rulemaking.

Adequately Representative Data

Commenter (0128) states that while the EPA suggests correctly that refined emission inventory and meteorological data are necessary to effectively utilize any air quality model, there are two issues with these statements. First, the determination of "adequate data" is not defined with respect to the use of an air quality model. Second, the selection of meteorological conditions and "permit enforceable emissions" to evaluate source impacts and to distinguish control strategy effects is much too limited.

Response:

The EPA believes that the idea of "adequately representative" or "adequate data" is defined clearly throughout serval portions of in the *Guideline*. While the *Guideline* offers requirements and recommendations on determining the representativeness of meteorological or emission inventory data for a particular application, determining representativeness is ultimately a case-specific exercise and requires best professional judgment of the permit applicant, appropriate reviewing authority, and Regional office. The second aspect of the comment is not supported by the commenter with any substantive technical basis.

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Appendix A. EPA Reassessment of Low Wind Options

Summary

On July 29, 2015, the U.S. EPA (EPA) proposed revisions to the Guideline on Air Quality Models (*Guideline)* in the Federal Register (80 FR 45340). The proposed revisions to the *Guideline* and preferred models are based upon stakeholder input received during the Tenth Conference on Air Quality Modeling. These proposed revisions were presented at the Eleventh Conference on Air Quality Modeling that included the public hearing for the proposed action.

In our proposed action, we invited comments on two proposed scientific updates to the regulatory version of the AERMOD modeling system that address the overprediction of pollutant concentrations for some source types during stable, low wind conditions, including:

1. A proposed “ADJ_U*” option incorporated in AERMET that adjusts the surface friction velocity (u*) and
2. A proposed “LOWWIND3” option in AERMOD that increases the minimum value of the lateral turbulence intensity (sigma-v), as well as adjusts the dispersion coefficient and eliminates upwind dispersion, incongruous with a straight-line, steady-state plume dispersion model, such as AERMOD.

For example, design values associated with low-level fugitive emissions and tall stacks located near complex terrain are often associated with light winds during stable conditions.

While the majority of the comments received during the public comment period are in support of these proposed options, a few commenters expressed concern that these options would result in underprediction, and also concern regarding the appropriateness of the field study databases used in the EPA model evaluations.

In addition to the set of 17 field studies used to support the development and evaluation of the original version of AERMOD, EPA also utilized data from two field studies conducted by National Oceanic and Atmospheric Administration (NOAA) that are relevant to evaluating the proposed ADJ_U* and LOWWIND3 options., i.e., the 1974 Idaho Falls, Idaho study (NOAA, 1974) and the 1974 Oak Ridge, Tennessee study (NOAA, 1976).

One commenter (0114) criticized the use of the NOAA studies to evaluate these proposed options, claiming that they were “severely flawed and outdated datasets” and “wholly inappropriate for evaluating AERMOD performance”. The commenter also stated that the data necessary to model these field study evaluations were not publicly available. EPA acknowledges that these databases have not been posted on the SCRAM website yet, but the field study data are available in the NOAA technical memoranda cited above. However, we disagree with the statement that these studies are “severely flawed” and we do not consider the date of the study as being relevant to the appropriateness of the data. The commenter also claimed that “several of the Idaho Falls sample release periods occurred during daylight hours” which is incorrect. The 1974 Idaho Falls study was a landmark field study to investigate dispersion of low-level/non-buoyant emissions during stable/light-wind conditions.

The Idaho Falls study was located in a broad, relatively flat plain at the Idaho National Engineering Laboratory (INEL) in Southeastern Idaho with a dry climate and semi-desert conditions. The study included 3 rings of ambient monitors located at 6-degree intervals along concentric arcs located at 100m, 200m, and 400m from the release point. Use of concentric rings of monitors minimizes the influence of wind direction variability on model-to-monitor comparisons, which is often a key factor contributing to uncertainty regarding model-to-monitor comparisons. The Idaho Falls study also included a robust set of meteorological data, including vertical profiles of wind speed, wind direction, ambient temperature, and sigma-theta at heights of 2m, 4m, 8m, 16m, 32m, and 64m above ground, which facilitated a number of diagnostic evaluations to assess the sensitivity of model performance across a range of inputs and options.

The 1974 Oak Ridge NOAA study was also focused on characterizing dispersion of low-level releases during low-wind conditions. However, the release site was "*near the center of one of the heavily forested small valleys of 'hollers' that cross the peninsula*" near the Clinch River. The top of the ridge nearest to the source location is about 26m above the ground-level release point. Furthermore, since wind speeds at the site were often below the threshold of standard anemometers, wind speed measurements were determined by laser anemometry using two lasers and two receivers positioned approximately orthogonal to each other located on the nearby ridges. The intersection of the bilinear lasers was approximately 30m above the release site. However, since the laser wind estimates reflect a volume "sample" rather than a point measurement, EPA's evaluations for Oak Ridge used a nominal "measurement height" of 10m and also used the VECTORWS option in AERMOD to treat the wind speeds as vector, rather than scalar, averages.

Given the extremely light winds during the Oak Ridge study, with wind speeds less than 0.5 m/s for 10 of the 11 tests and a minimum wind speed of 0.15 m/s, nighttime drainage flows may have influenced plume dispersion which could limit lateral plume spread and contribute to higher concentrations. However, plume dispersion could also be enhanced due to eddies that may form due to the nearby ridges. Given these factors, we do consider the Oak Ridge evaluation results to be less robust for evaluating model performance than the evaluation results for the Idaho Falls study. However, despite these potential issues and concerns regarding results for the Oak Ridge field study, we are encouraged by the significant improvement in model-to-monitor comparisons for Oak Ridge based on use of the ADJ_U* option in AERMET. For example, the geometric mean ratio of Pred/Obs concentrations without ADJ_U* was 3.93 at the 100m arc, 4.28 at the 200m arc, and 6.56 at the 400m arcas compared to Pred/Obs ratios of 0.93, 0.91, and 1.48 with the ADJ_U* option.

The data associated with these NOAA evaluation studies are available from the respective NOAA memoranda referenced above, and results for both evaluations were included in the Addendum to the AERMOD User's Guide for version 15181 (EPA, 2015). Brief summaries of the results of each of these evaluations are included later in this document for the evaluation of the ADJ_U* option. The data for these evaluations are available upon request. It should also be noted that the influence of the ADJ_U* and LOWWIND3 options on AERMOD model performance has also been assessed based on the full suite of field study data sets used to support the initial promulgation of the AERMOD model in 2005. Results of these evaluations are provided below.

At the 11th Modeling Conference on Air Quality Modeling, the EPA presented an additional evaluation based on the 1993 Cordero Rojo Mine PM_{10} field study in Wyoming (EPA, 1995) to further support adoption of the ADJ_U* and LOWWIND3 options. The commenter expressed concerns with the use of the Cordero surface coal mine study since about 75% of the PM_{10} emissions were fugitive emissions from roadways, and it was not clear whether the roads were paved or unpaved or how emission rates were determined. The roads were unpaved, and the intent of the study was to evaluate methods for estimating fugitive emissions from surface coal mine operations, and to evaluate the performance of dispersion models in predicating ambient impacts from these activities. The EPA acknowledges that there are some limitations and challenges associated with use of the Cordero study to evaluate dispersion model performance since the evaluation was limited to 24-hour average impacts of fugitive PM10 emissions over a period of two months. However, the Cordero mine model evaluation study was part of a multi-phase effort that included a detailed study of emission factors associated with various coal mine operations, including particle size distributions to account for settling and removal of particulate emissions downwind of the source. The Cordero evaluation study was most recently performed with version 14134 of AERMET and AERMOD. While Cordero has not been considered a landmark evaluation leading to the proposed adoption of these options in the regulatory versions of AERMET and AERMOD given that ambient impacts associated with the various mining operations are likely to be highest during stable/low wind conditions, we believe that results from this study add to the weight of evidence supporting our final action. Furthermore, unlike the more limited study period associated with the Idaho Falls and Oak Ridge tracer studies, the EPA "Protocol for Determining the Best Performing Model" (EPA, 1992) (Cox-Tikvart method) was applied to the Cordero evaluation which showed that the use of the proposed ADJ_U* option in AERMET resulted in a statistically significant improvement in model performance relative to the default option in AERMET. A brief summary of the evaluation of the ADJ_U* option for the Cordero study is included later in this document.

To support their position that these proposed options (ADJ_U* and LOWWIND3) reduce model accuracy and significantly reduce modeled impacts in some cases, the same commenter (0114) provided a detailed modeling assessment of these options across a number of field studies, including: Baldwin, Kincaid, Tracy, Lovett, and Prairie Grass (EPA, 2003). The EPA has reviewed the results of the commenter's assessment and performed additional analyses to further assess the potential for underprediction during stable, low wind conditions.

Based on a review of the commenters analyses and a reassessment of the results for the ADJ_U* and LOWWIND3 options, the EPA has concluded that the ADJ_U* option shows a bias toward underprediction when applied with site-specific meteorological data that includes turbulence parameters, i.e., sigma-theta (the standard deviation of horizontal wind direction fluctuations) and/or sigma-w (the standard deviation of the vertical wind speed fluctuations). Thus, the EPA has determined that the use of ADJ_U* as a regulatory option should not be considered when processing site-specific meteorological data that includes turbulence measurements. The EPA is adopting the proposed ADJ_U* option in AERMET as a regulatory option for use in AERMOD for modeling applications using standard NWS airport meteorological data, site-specific meteorological data without turbulence parameters, or prognostic meteorological inputs derived from prognostic meteorological models. With regard to LOWWIND3, the EPA concluded that the public cannot be assured that the proposed LOWWIND3 option does not have a tendency to bias model predictions towards underestimation, especially in combination with the ADJ_U* option. In response to these results, we are deferring final action on the LOWWIND3 option pending further analysis and evaluation. Each of the three LOWWIND options in AERMOD v.15181 will remain as beta options in v.16216.

The results of our reassessment of the ADJ_U* and LOWWIND3 options are presented in the sections that follow.

Reassessment of Adjust U-star Beta Option

The EPA's review of the modeling results provided by the commenter (0114) indicated almost no influence of the ADJ_U* option on those field studies associated with tall stacks in flat terrain, including the Baldwin and Kincaid field studies. We agree with the commenter that the ADJ_U* option has very little effect on the Baldwin and Kincaid field studies. These results are expected since the "worst-case" meteorological conditions for tall stacks in flat terrain generally occur during daytime convective conditions that are not affected by the ADJ_U* option. In addition, the commenter's modeling results presented for the Lovett field study, a tall stack with nearby complex terrain, appear to show improved performance (with less underprediction) with the ADJ_U* option as compared to the default option in AERMET, thereby supporting the use of the ADJ_U* option in appropriate situations.

The commenter also stated that the issue of underprediction with the ADJ_U* option is "particularly so in the case of the Tracy validation study." The Tracy field study involved a tall stack located with nearby terrain similar to the Lovett field study. However, the Tracy field study differs from the Lovett and other complex terrain field studies in that Tracy had the most extensive set of site-specific meteorological data, including several levels of wind speed, wind direction, ambient temperature, and turbulence parameters (i.e., sigma-theta and/or sigma-w), extending from 10m above ground up to 400m above ground for some parameters. The Tracy field study also included the largest number of ambient monitors of any complex terrain study used in evaluating AERMOD performance, including 106 monitors extending across a domain of about 75 square kilometers, and used sulfur hexafluoride (SF6) as a tracer which reduces uncertainty in evaluating model performance by minimizing the influence of background concentrations on the model-to-monitor comparisons. The EPA's review of the commenter's results for the Tracy database confirms their finding of a bias toward underprediction by almost a factor of two with the ADJ_U* option in AERMET, compared to relatively unbiased results with the default option in AERMET based on the full set of meteorological inputs. However, there was no diagnostic performance evaluation included with the commenter's analysis that could provide the necessary clarity regarding the potential connection between the ADJ U* option and cause for the bias to underpredict concentrations.

After proposal, the EPA received several requests through its Model Clearinghouse (MCH) for alternative model approval of the ADJ U* option under section 3.2.2 of the *Guideline*. In two of the cases, the request memoranda from the EPA Region to the MCH noted the potential for underprediction by AERMOD with the ADJ U* option in situations where turbulence data from site-specific meteorological data inputs were also used. Through the MCH concurrence for each case, the EPA acknowledged the potential for this underprediction.

To evaluate the public comments in light of these MCH concurrences, the EPA conducted additional analyses for the Baldwin, Kincaid, Tracy, and Lovett databases used in the commenter's assessment. The full meteorological dataset available for the Tracy field study provides a robust case study for this assessment because it includes several levels of turbulence data, i.e., sigma-theta (the standard deviation of horizontal wind direction fluctuations) and/or sigma-w (the standard deviation of the vertical wind speed fluctuations), in addition to several levels of wind speed, direction and temperature. As with the Tracy field study, the Lovett database also includes wind speed, wind direction, ambient temperature, and turbulence data at multiple levels. Included in our reassessment of the ADJ_U* option, we performed a meteorological degradation analysis with the Tracy and Lovett databases. Though the Lovett evaluation provided in the 15181 version of AERMOD User's Guide addendum included a meteorological degradation analysis, we extended the analysis to include additional modeling scenarios for comparison. It should also be noted that the surface characteristics for the Lovett database were evaluated and were updated from the original values in the database as previously provided on the EPA's Support Center for Regulatory Atmospheric Modeling (SCRAM) website. [1] In addition, we re-visited the Idaho Falls evaluation included in Appendix F of the Addendum to the AERMOD User's Guide. The Idaho Falls field study also includes a robust set of meteorological data to assess this potential issue for ground-level sources.

The results of this EPA study confirm good performance for the Tracy field study using the full set of meteorological inputs with the default options (i.e., without the ADJ_U* option in AERMET and without any LOWWIND option in AERMOD). Including the ADJ_U* option in AERMET with full meteorological data results in an underprediction of about 40 percent in a comparison of the peak observed and predicted concentrations. On the other hand, AERMOD results without the ADJ_U* option in AERMET and without the observed profiles of temperature and turbulence (i.e., mimicking standard airport meteorological inputs) results in significant overprediction by about a factor of 4 in a comparison of the peak observed and predicted concentrations. However, using the ADJ_U* option with the degraded meteorological data shows very good agreement with observations, comparable to or slightly better than the results with full meteorological inputs.

Similarly, the best performing case with the Lovett database is the scenario using the full set of meteorology, including turbulence, without the ADJ_U* option applied. This is consistent with our position that using site-specific meteorology that includes turbulence measurements is preferable. Applying the ADJ_U* option to the full set of site-specific meteorology that includes turbulence measurements has a bias toward underprediction.

The 1974 Idaho Falls study also provides evidence of this potential bias toward underprediction when the ADJ_U* option is applied for applications that also include site-specific meteorological data with turbulence parameters. As with the Tracy field study, the Idaho Falls field study results with site-specific turbulence data do not show a bias toward underprediction without the ADJ_U* option, but do show a bias toward underprediction using turbulence data with the ADJ_U* option.

Based on these detailed findings, the public cannot be assured that the proposed ADJ_U* option, when used with site-specific meteorological inputs including turbulence data (i.e., sigma-theta and/or sigma-w), would not bias model predictions towards underestimation. Therefore, the EPA has determined that the ADJ_U* option should not be used in AERMET in combination with use of measured turbulence data because of the observed tendency for model underpredictions resulting from the combined influences of the ADJ_U* and the turbulence parameters within the current model formulation.

[1] https://www.epa.gov/scram

The results of the EPA's reassessment of the ADJ_U* option include the Baldwin, Kincaid, Tracy, and Lovett field studies which are presented in the sections that follow. They are preceded by a brief summary of the prior Cordero and Oak Ridge studies presented at the 11th Modeling Conference. Also included is a summary of further reassessment of the 1974 Idaho Falls evaluation.

Cordero Rojo Mine, Wyoming (1993)

The 1993 Cordero Rojo Mine field study (EPA, 1995) is a two month study conducted in 1993 at the Cordero Rojo Mine in eastern Wyoming to evaluate emission factor and dispersion model options. The majority of the emissions, approximately 75%, were from roadways for which 24-hour averages of PM-10 and total suspended particulates (TSP) were evaluated. The Cox-Tikvart protocol for determining the best performing model was applied to AERMOD results to produce confident intervals on model performance. Figure A-1 and Figure A-2 compare the Composite Performance Measure (CPM) and Model Comparison Measure (MCM), respectively for various combinations of the ADJ_U* and LOWWIND1 and LOWWIND2 options. Though the evaluation was performed using AERMOD v.14134, which did not include LOWWIND3, the results show improved performance when the ADJ_U* option was applied. The LOWWIND 1 and LOWWIND2 options had little effect on model performance.

EPA acknowledges there are challenges with the Cordero field study such as determining appropriate source characteristics for the various mining activities that were accounted for in the evaluation, including wind erosion, and determining appropriate emission rates for the various sources included in the study. However, as stated previously, the proposed actions related to the ADJ_U* and LOWWIND3 options were not solely dependent on the results of the Cordero evaluation. The Cordero evaluation was presented at the 11th Conference on Air Quality Modeling to supplement the Idaho Falls and Oak Ridge results as futher evidence to support the proposed actions. The results of the Cordero evaluation are consistent with the results of the Idaho Falls and Oak Ridge evaluations and the proposed action to promote ADJ_U* to a regulatory option.

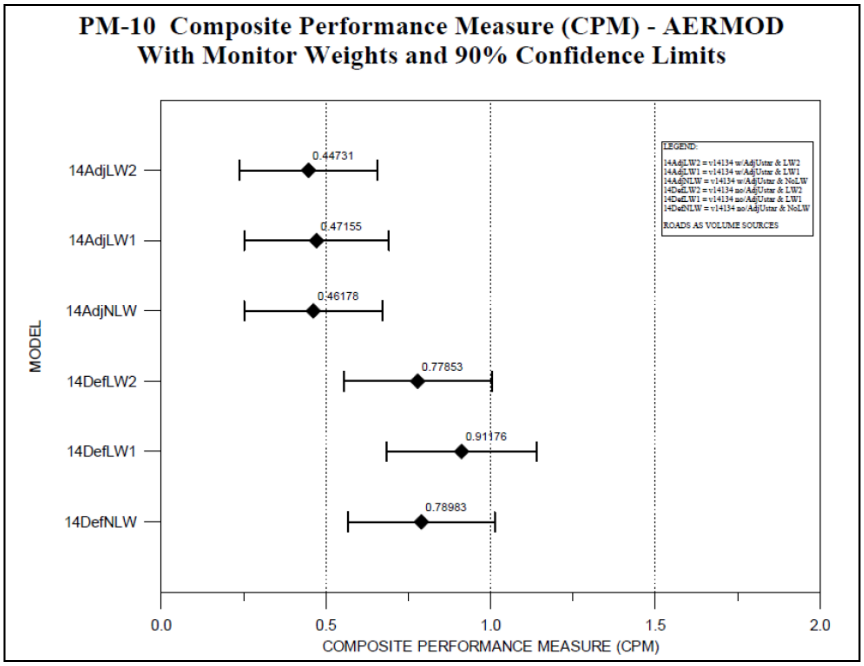

Figure A-1. Cordero Composite Performance Measure Comparison (AERMOD v.14134)

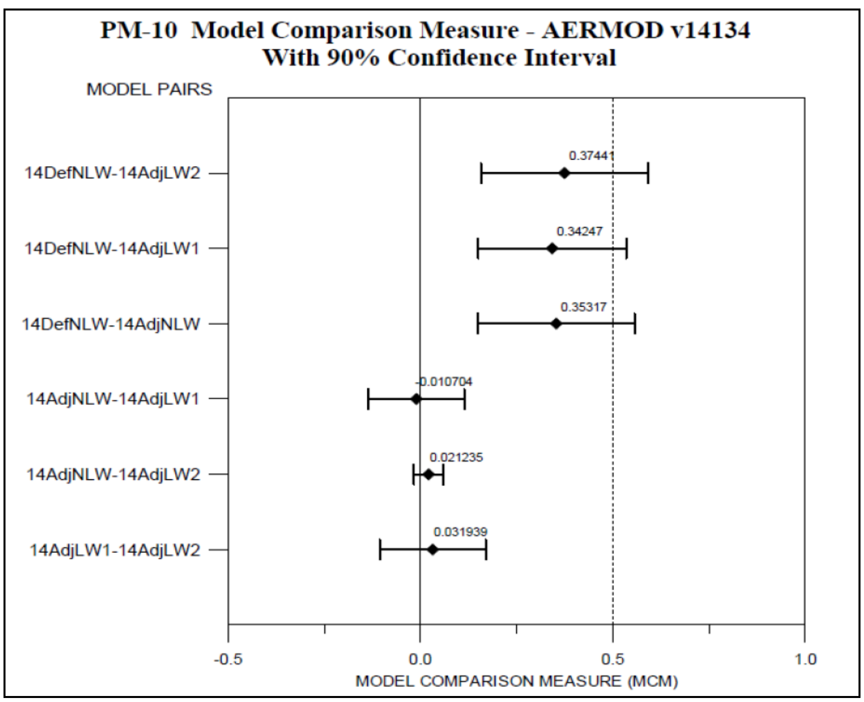

Figure A-2. Cordero Model Comparison Measure Comparison (AERMOD v.14134)

Oak Ridge, Tennessee (1974)

The 1974 Oak Ridge, Tennessee (NOAA, 1976) study consisted of eleven 1-hour tracer releases during July and August of 1974, all of which occurred during neutral to stable, low wind conditions with wind speeds less than 1 m/s. Since wind speeds at the site were often below the threshold of standard anemometers, wind speed measurements were determined by laser anemometry using two lasers and two receivers positioned approximately orthogonal to each other located on the nearby ridges. The evaluation results are based on an "effective" measurement height of 10 meters, and no turbulence data were included. Three arcs of samplers were located at 100m, 200m, and 400m from the release point. The release site for the Oak Ridge study was "*near the center of one of the heavily forested small valleys of 'hollers' that cross the peninsula*" near the Clinch River. The EPA evaluations for Oak Ridge are presented below.

Figure A-3 and Figure A-4 are a paired plot (paired in space and time) of predicted vs. concentrations and a residual plot of the ratio of predicted to observed concentrations vs. distance, with the ADJ _U* option. Figure A-5 and Figure A-6 are a paired and residual plot without ADJ_U*. Each of the plots display results by receptor arc distance. These four figures illustrate the substantial effect the ADJ_U* option can have on the predicted concentrations during low wind conditions, and they demonstrate considerable improvement for the Oak Ridge evaluation.

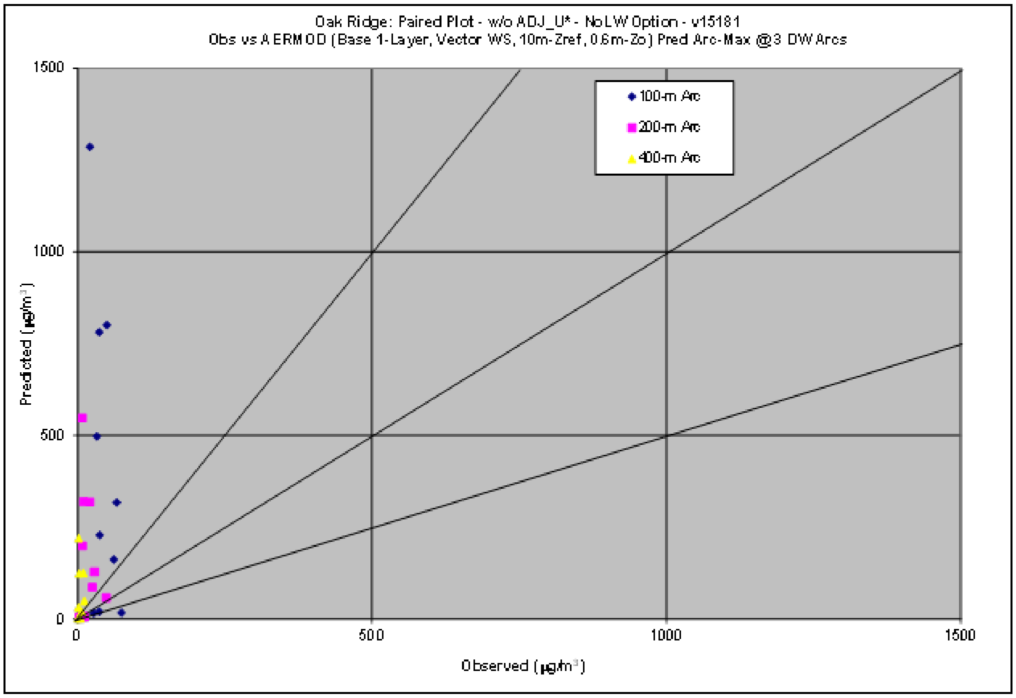

Figure A-3. Oak Ridge Paired Plot, Observed-to-Predicted Concentrations, without ADJ_U*

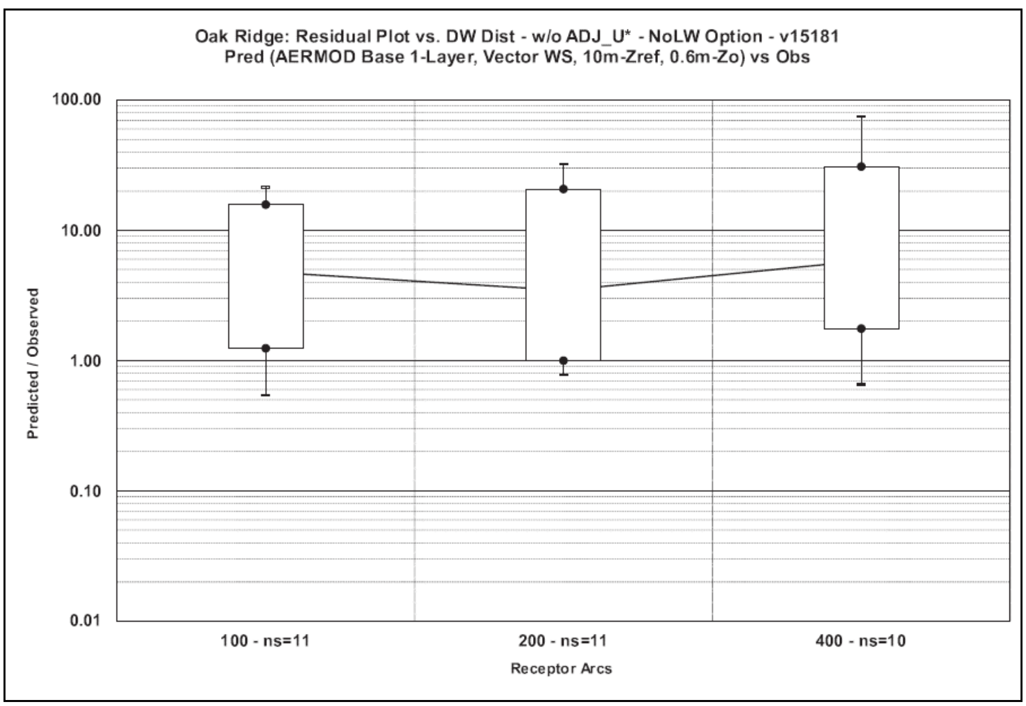

Figure A-4. Oak Ridge, Ratio of Predicted-to-Observed Concentrations, without ADJ_U*

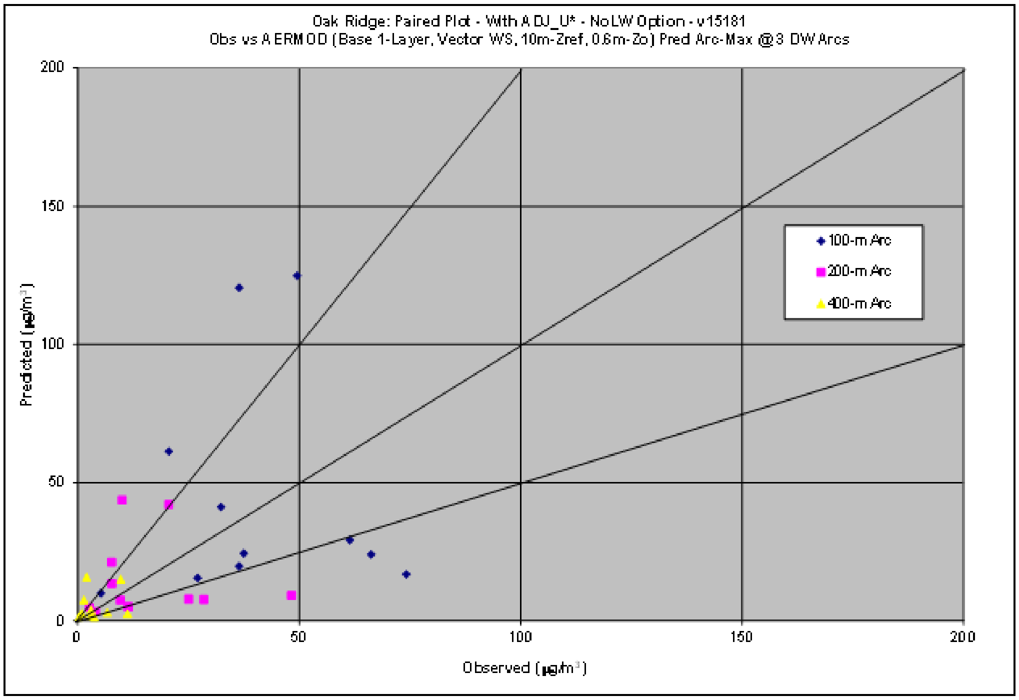

Figure A-5. Oak Ridge Paired Plot, Observed-to-Predicted Concentrations, with ADJ_U*

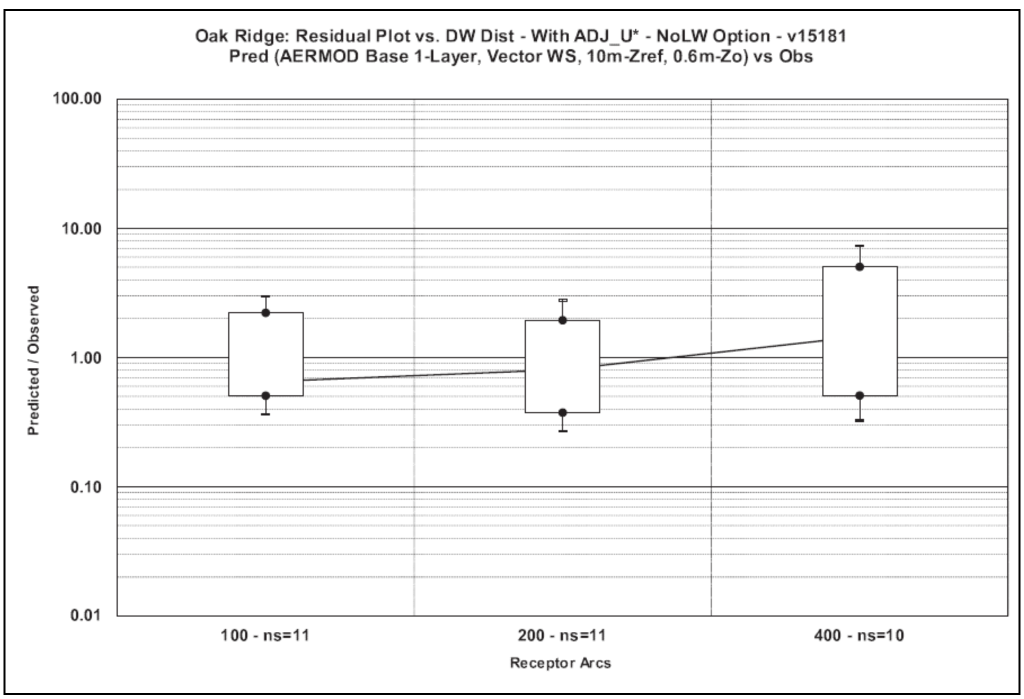

Figure A-6. Oak Ridge, Ratio of Predicted-to-Observed Concentrations, with ADJ_U*

Baldwin Power Plant, Illinois (1982-1983)

Located in rural, flat terrain of southwestern Illinois, the Baldwin Power Plant, Illinois study (Hanna and Chang, 1993) occurred from April 1, 1982 through March 31, 1983. The plant consisted of three identical stacks with a release height of 184 meters, about 100 meters apart along a line oriented north and south. Ground level SO_2 concentrations were collected at 10 monitor locations at distances between two and ten kilometers from the plant. Site-specific hourly averaged wind speed, wind direction, and temperature were collected at a 10-meter height and wind speed and wind direction were collected at 100 meters.

Quantile-Quantile (Q-Q) plots, a comparison of robust highest concentrations (RHCs), and results of the Cox-Tikvart method show that the ADJ_U* option made almost no difference in modeled concentrations with and without the ADJ_U* option applied. Figure A-7 through Figure A-9 are Q-Q plots for 1-, 3-, and 24-hour averaged concentrations, respectively. The Baldwin dataset does not include turbulence measurements, and the two plotted curves that compare concentrations that were modeled with and without ADJ_U* match so closely that only one curve is visible. This is consistent with a comparison RHCs in Table A-1 and the results of the Cox-Tikvart method shown in Table A-2 which include the model comparison measure (MCM). The MCM results show that concentration differences with and without ADJ_U* were statistically insignificant at the 95% confidence interval (i.e., intervals cross zero).

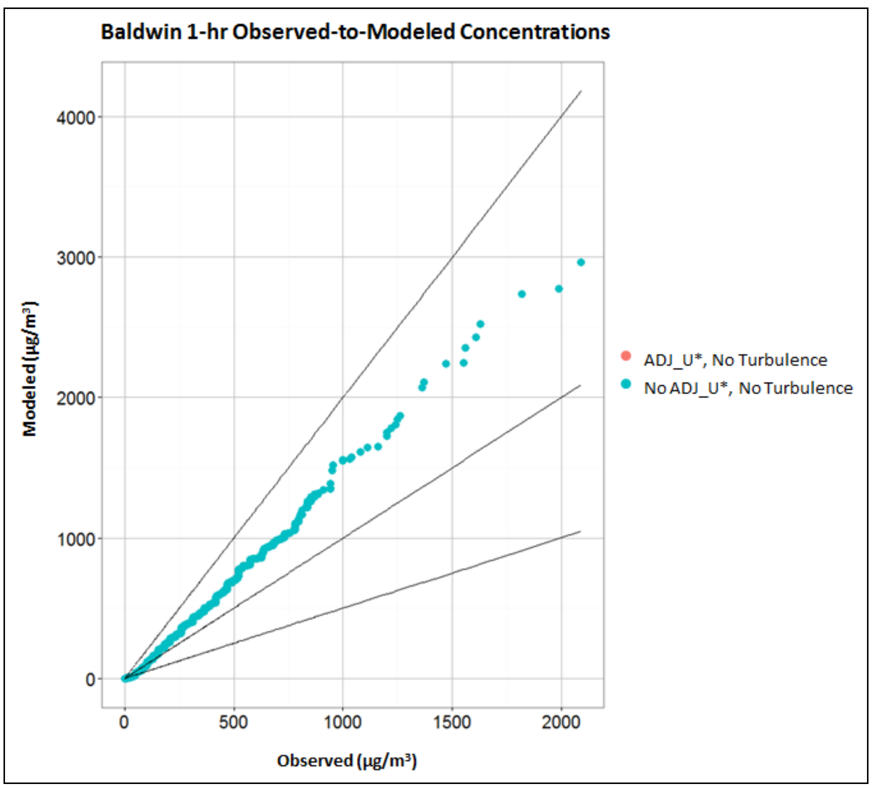

Figure A-7. Baldwin 1-hour Q-Q Plots, With and Without ADJ_U*

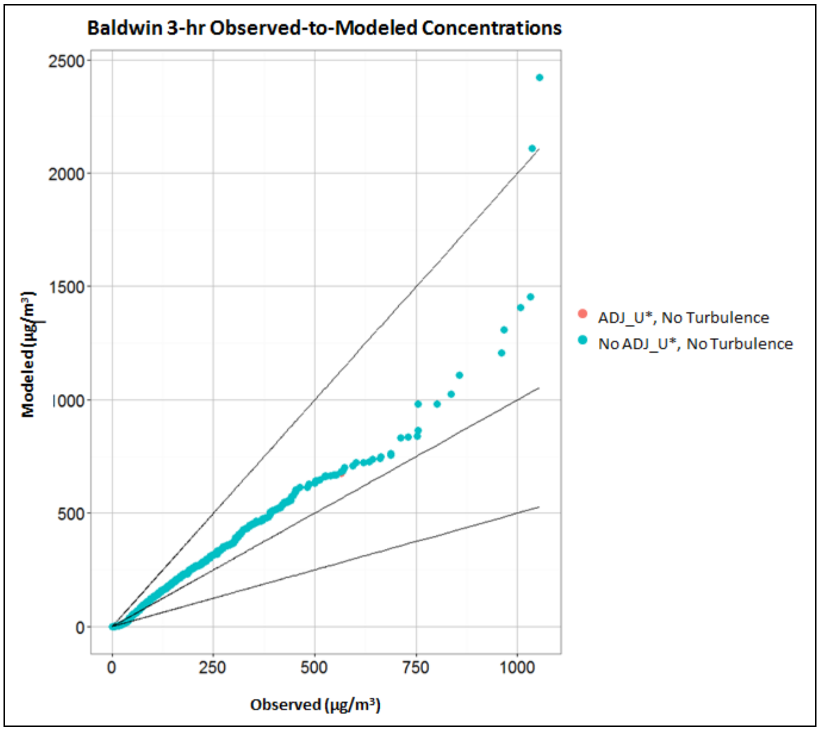

Figure A-8. Baldwin 3-hour Q-Q Plots, With and Without ADJ_U*

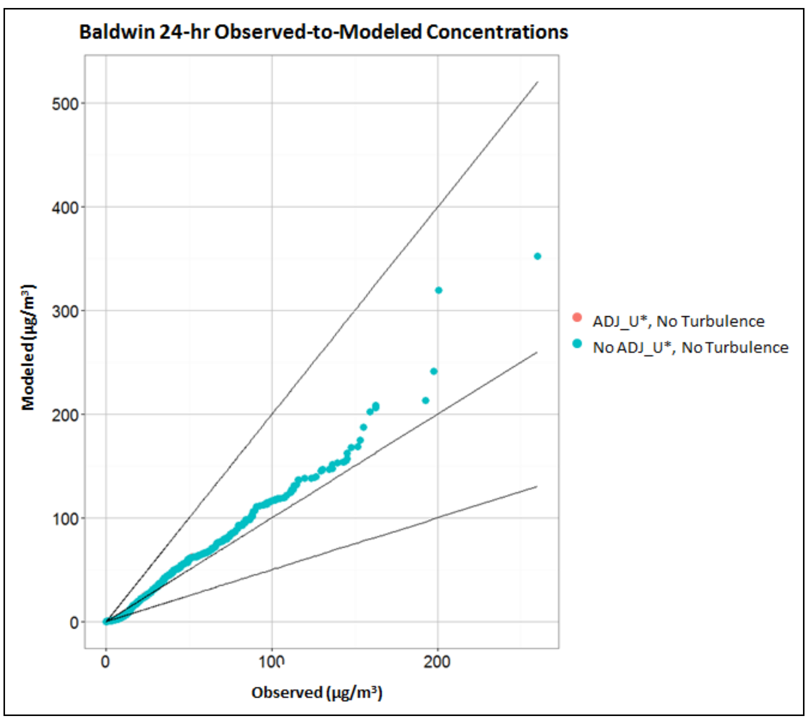

Figure A-9. Baldwin 24-hour Q-Q Plots, With and Without ADJ_U*

Table A-1. Comparison of Baldwin Observed and Modeled Robust High Concentrations

Location	Avg. Time (hr)	Robust Highest Concentration (μg/m^3)		
		Observed	No ADJ_U* No Turbulence	ADJ_U* No Turbulence
Baldwin	1	2348	3531	3531
	3	920	1184	1182
	24	209	230	230

Table A-2. Baldwin Model Comparison Measure

No ADJ_U* - ADJ_U* MCM	90% CI	95% CI
0.002	±0.134	±0.194

Kincaid SO_2, Illinois (1980-1981)

The Kincaid SO_2 field study (Liu and Moore, 1984; Bowne et al., 1983) occurred in rural, flat terrain in Illinois at which a continuous, buoyant release of SO_2 from a 187-meter stack. SO2 was monitored at 30 monitors ranging from 2 kilometers to 20 kilometers downwind of the stack. About six months of data were collected between April 1980 and June 1981. Meteorological data included wind speed and direction, sigma-theta on a 94-meter tower; and wind speed, temperature difference between 2-meter and 10-meter heights.

Similar to Baldwin, Q-Q plots, analysis of RHCs, and the Cox-Tikvart method for determining the best performing model indicate that the use of ADJ_U* had little effect, i.e. statistically insignificant, on concentrations, regardless of the use of turbulence data. In Figure A-10 through Figure A-12 are Q-Q plots for 1-, 3-, and 24-hour averaged concentrations, respectively. Only two of the four plots are visible because, like Baldwin, comparable scenarios, with and without the ADJ_U* applied, are nearly identical. This is also observed in a comparison of the RHCs and MCMs in Table A-3 and Table A-4. A comparison of the Q-Q plots, RHCs, and MCMs for the two cases that include turbulence, with and without the use of the ADJ_U* option, are nearly identical as are the two cases in which the turbulence data are omitted.

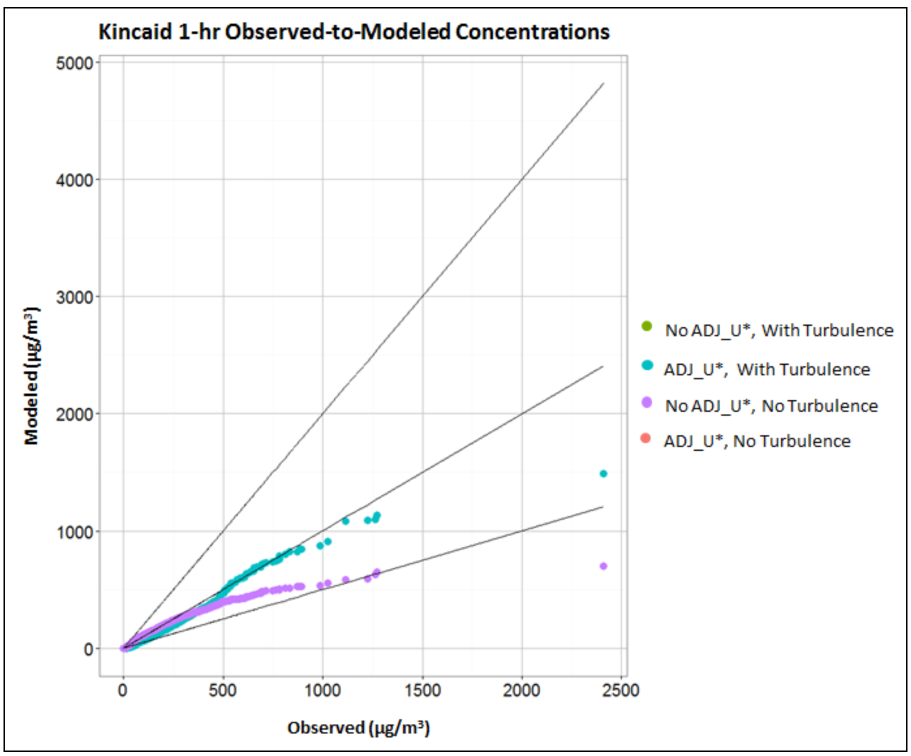

Figure A-10. Kincaid 1-hour Q-Q Plots, w/ and w/o Turbulence, w/ and w/o ADJ_U*

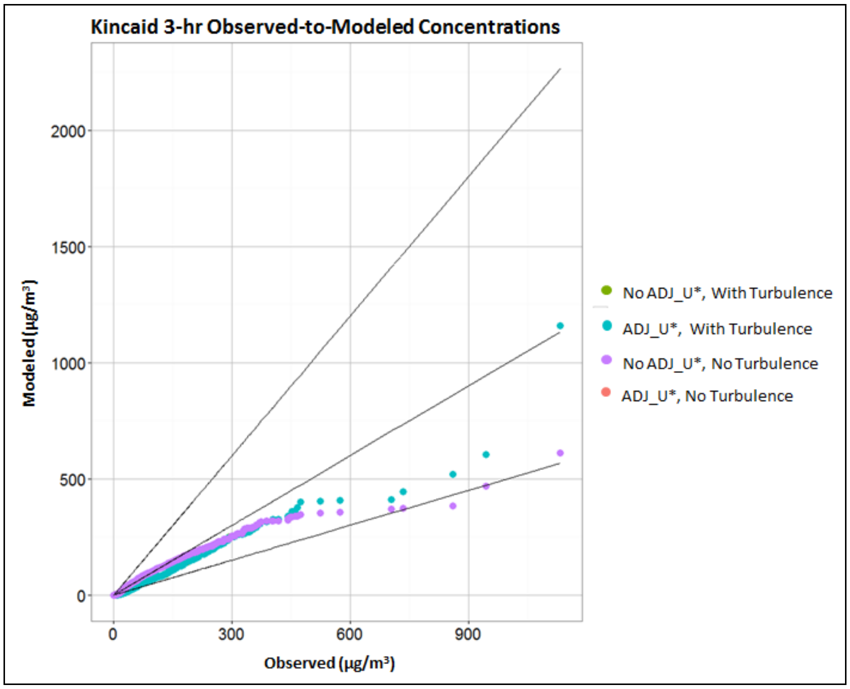

Figure A-11. Kincaid 3-hour Q-Q Plots, w/ and w/o Turbulence, w/ and w/o ADJ_U*

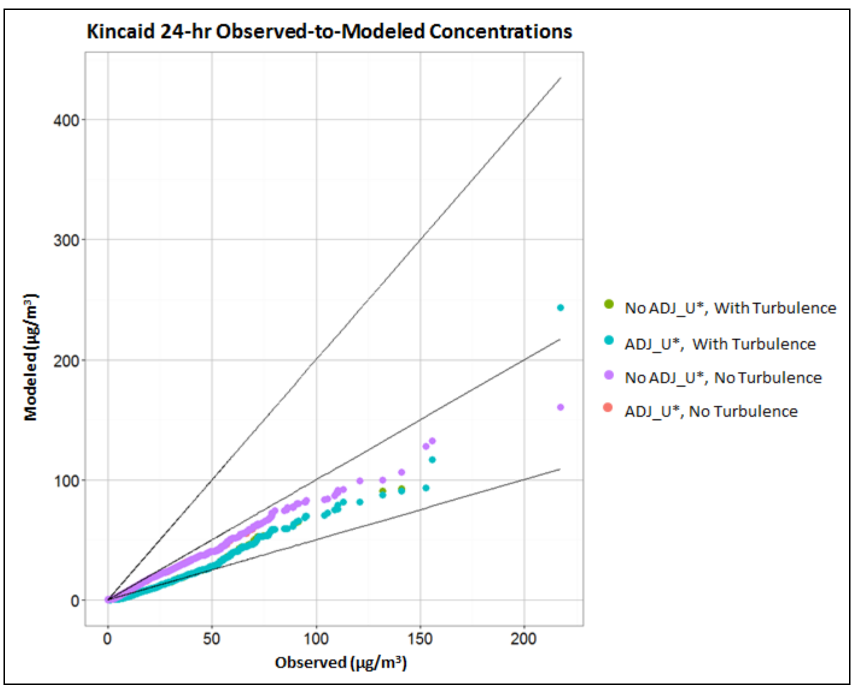

Figure A-12. Kincaid 24-hour Q-Q Plots, w/ and w/o Turbulence, w/ and w/o ADJ_U*

Table A-3. Comparison of Kincaid Observed and Modeled Robust High Concentrations

Location	Avg. time (hr)	Robust Highest Concentration (μg/m^3)				
			No ADJ_U*		ADJ_U*	
		Observed	No Turbulence	With Turbulence	No Turbulence	With Turbulence
Kincaid	1	1611	718	1313	717	1313
	3	618	470	615	470	599
	24	113	167	101	167	101

Table A-4. Kincaid Model Comparison Measures

Scenarios	MCM	90% CI	95% CI
ADJ_U*/No Turbulence - No ADJ_U*/No Turbulence	0.0005	±0.1406	±0.1648
No ADJ_U*/With Turbulence - ADJ_U*/With Turbulence	-0.0084	±0.3907	±0.4580
No ADJ_U*/ With Turbulence - No ADJ_U*/No Turbulence	-0.1890	±0.3128	±0.3667
ADJ_U*/ No Turbulence - No ADJ_U*/With Turbulence	0.1894	±0.3098	±0.3632
No ADJ_U*/ No Turbulence - ADJ_U*/With Turbulence	0.1805	±0.3217	±0.3772
ADJ_U*/ No Turbulence - ADJ_U*/With Turbulence	0.1810	±0.3191	±0.3741

Tracy Power Plant, Reno, Nevada (1984)

The Tracy Power Plant (DiCristofaro et al., 1985), located 27 kilometers east of Reno, Nevada in the rural Truckee River valley is completely surrounded by mountainous terrain. A buoyant plume of SF_6 was released from a 91-meter stack in August of 1984 during predominantly stable atmospheric conditions. Site-specific meteorological data (wind, temperature, and turbulence) were collected from an instrumented 150-m tower. The wind measurements from the tower were extended above 150 meters using a Doppler acoustic sounder and temperature measurements were extended with a tethersonde.

Given the robust set of meteorological data available from the Tracy study, a met degradation analysis was performed to compare AERMOD results with and without applying ADJ_U* with various degradations of the meteorological data that ranged from full temperature and wind profiles, with turbulence data included, to a minimal set of data similar to that collected by the National Weather Service (NWS) at an airport site that has temperature at a single height, without turbulence data included. Q-Q plots from this analysis are presented in Figure A-13 through Figure A-18. Note that the figures also include results for the LOWWIND2 and LOWWIND3 options. This discussion of the results is focused on ADJ_U* without the inclusion of LOWWIND2 and LOWWIND3 options (blue symbols).

In Figure A-13, Tracy results show very good performance with full meteorology, including turbulence, without ADJ_U* applied. When ADJ_U* is applied to the full meteorology with turbulence measurements, AERMOD underpredicts as shown in Figure A-14. When turbulence data are omitted from the full meteorological dataset, AERMOD substantially overpredicts as Figure A-15 demonstrates, but AERMOD's performance improves when ADJ_U* is applied, shown in Figure A-16. Figure A-17 and Figure A-18 represent meteorology similar to that collected at NWS airport sites in which there is only a single level of wind and temperature measurements, without turbulence data. In this scenario, the results show substantial overprediction when ADJ_U* is not applied. However, there is good agreement with observed concentrations when ADJ_U* is included.

These results support the position that ADJ_U* should not be applied with site-specific turbulence data for applications where design concentrations are likely to be associated with low-wind/stable conditions, such as tall stacks in complex terrain settings or low-level releases.

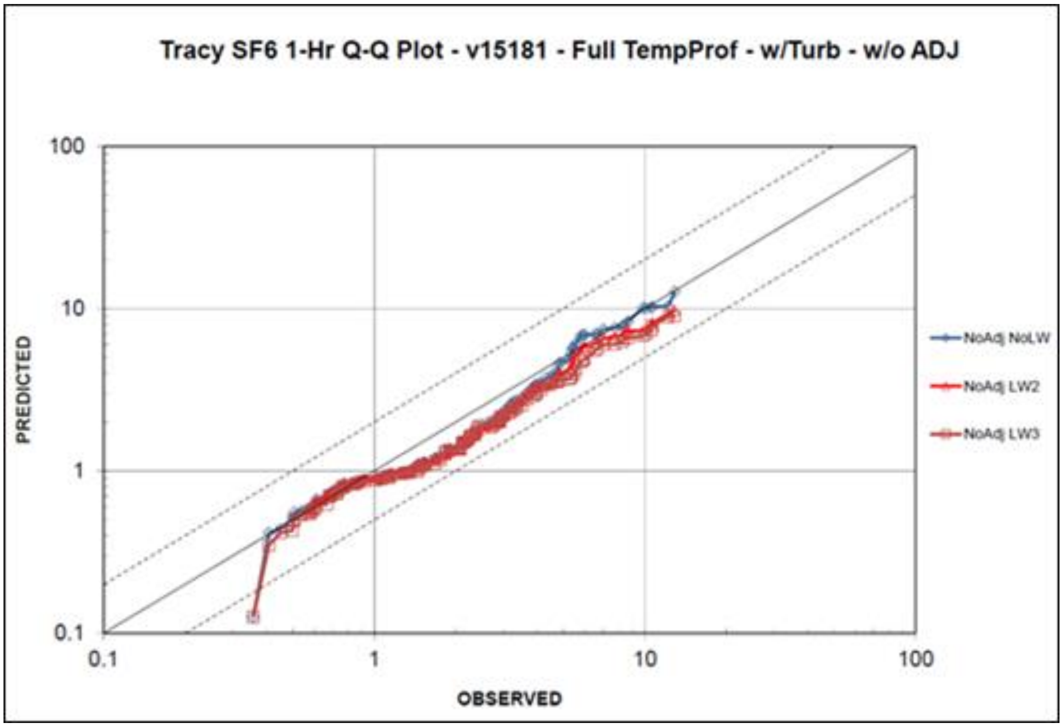

Figure A-13. Tracy 1-hr Q-Q Plot (Full Temperature Profile, with Turbulence, No ADJ_U*)

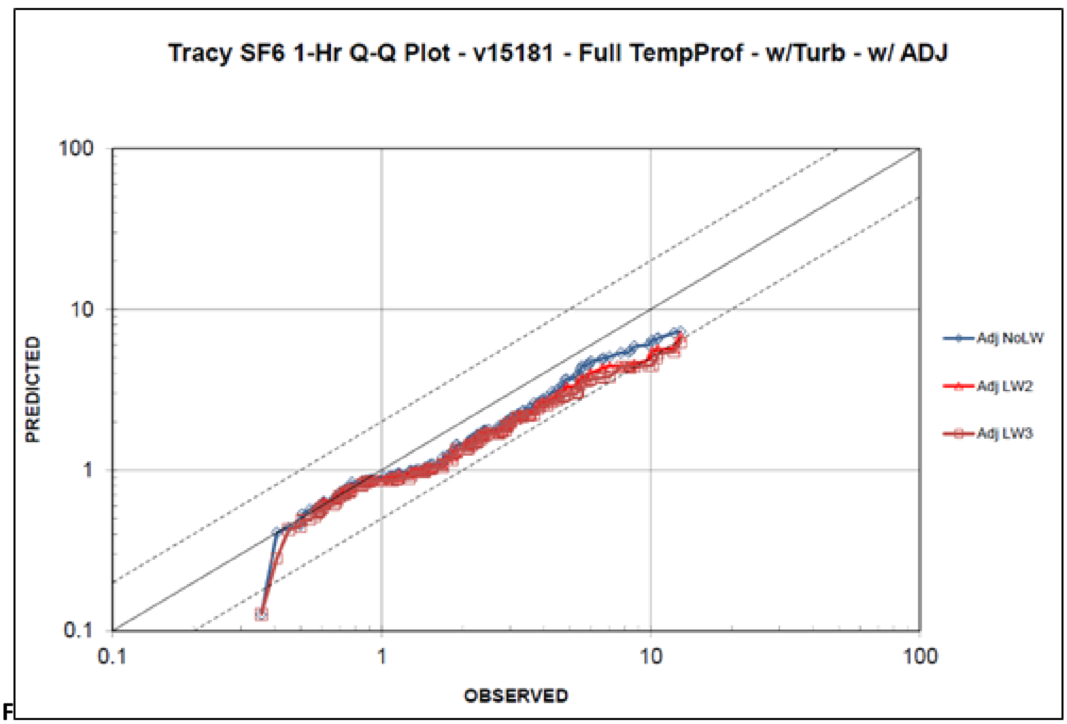

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Figure A-14. Tracy 1-hr Q-Q Plot (Full Temperature Profile, with Turbulence, with ADJ_U*)

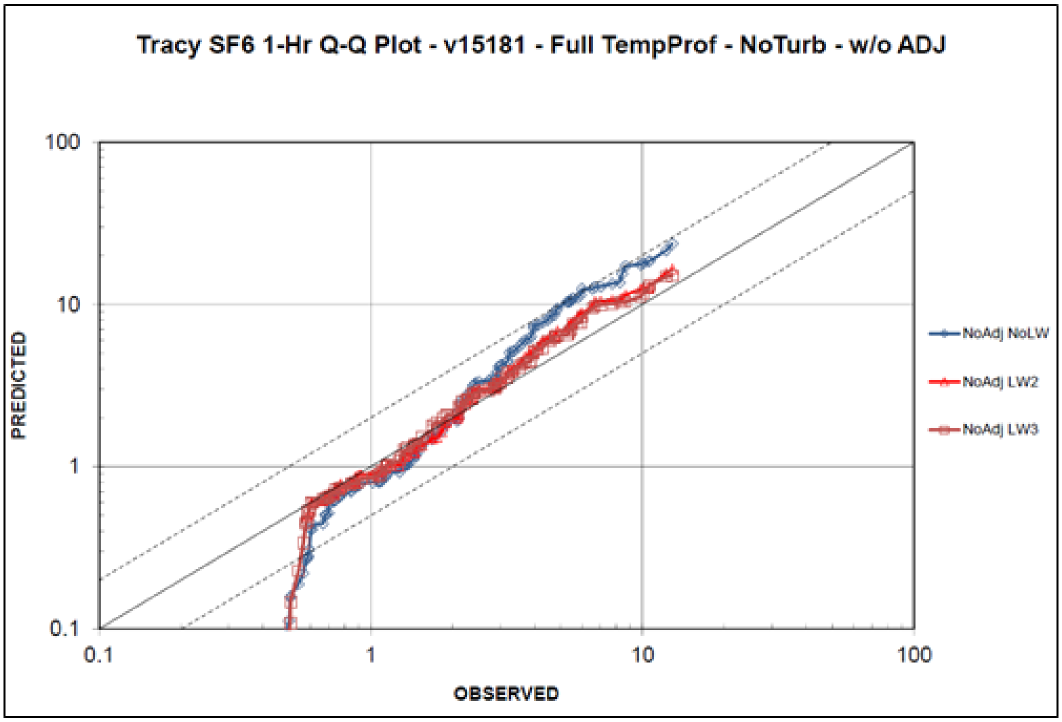

Figure A-15. Tracy 1-hr Q-Q Plot (Full Temperature Profile, No Turbulence, No ADJ_U*)

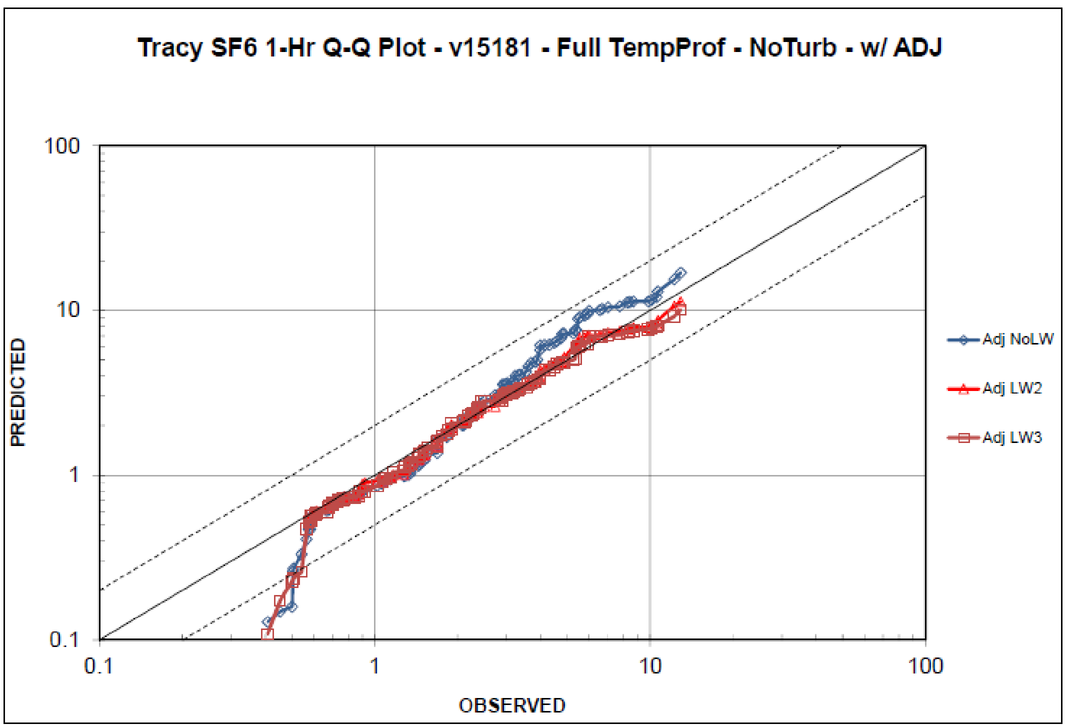

Figure A-16. Tracy 1-hr Q-Q Plot (Full Temperature Profile, No Turbulence, with ADJ_U*)

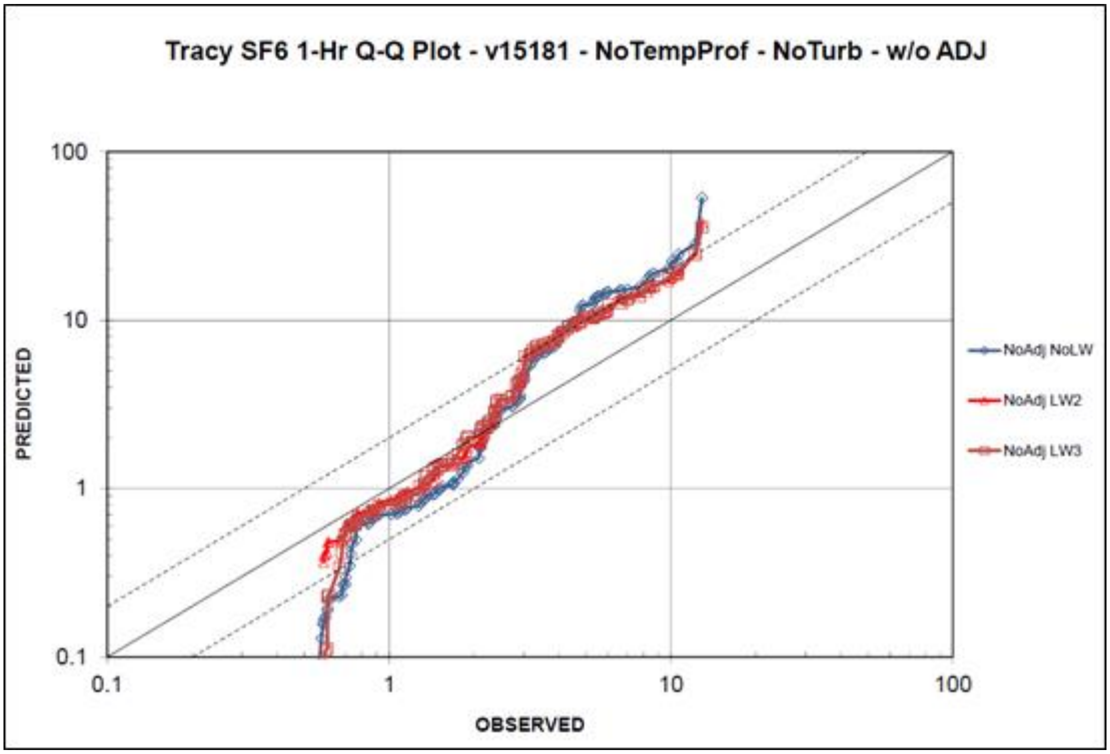

Figure A-17. Tracy 1-hr Q-Q Plot (No Temperature Profile, No Turbulence, No ADJ_U*)

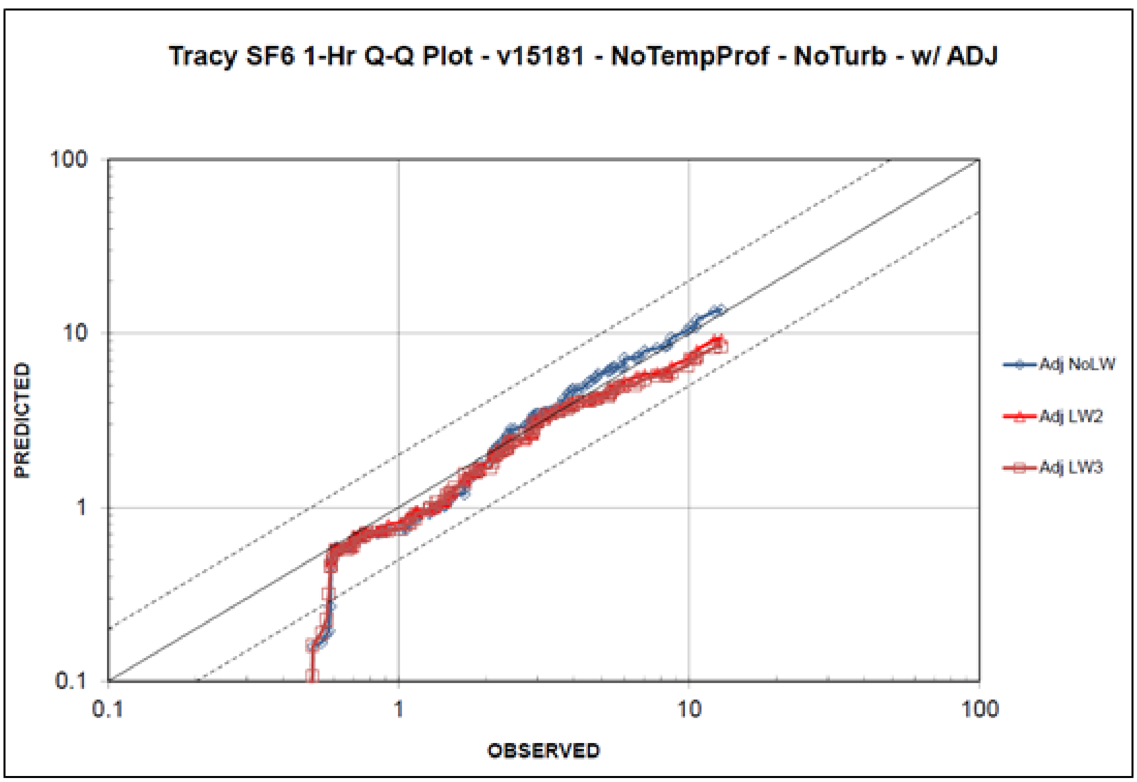

Figure A-18. Tracy 1-hr Q-Q Plot (No Temperature Profile, No Turbulence, with ADJ_U*)

Lovett Power Plant, New York (1987-1988)

The Lovett Power Plant field study (Paumier et al., 1992) consisted of a buoyant, continuous release of SO_2 from a 145-m tall stack located in a rural area in New York State with complex terrain for a year from December 1987 through December 1988. The terrain rises approximately 250m to 330m above the stack, 2km to 3km from the stack. Ground level concentrations of SO_2 were collected from 12 monitoring sites (ten on elevated terrain and two near stack-base elevation) at a distance of 2 to 3 km from the plant. The monitors provided hourly-averaged concentrations.

The site-specific meteorological data includes a 100 m meteorological tower with wind speed, wind direction, sigma-theta and temperature collected at the 10 m, 50 m, and 100 m levels. In addition, sigma-w was also collected at the 10 m and 100 m levels.

A meteorological degradation analysis was performed for the Lovett evaluation database to compare concentrations modeled with and without the ADJ_U* option, to observed concentrations using site-specific meteorological data that represent varying degrees of degradation, including:

- Wind and temperature profile with turbulence
- Wind and temperature profile without turbulence;
- Temperature profile without wind profile and without turbulence;
- 10-m temperature, wind profile and turbulence;
- 10-m temperature, wind profile, without turbulence;
- 10-m temperature without wind profile and without turbulence.

The Cox-Tikvart method for determining the best performing model was applied. Table A-5 shows the 1-hour, 3-hour, and 24-hour RHCs and the composite performance measure (CPM) for each modeled meteorological scenario. For reference, the 1-hour, 3-hour, and 24-hour RHC for the observed concentrations are 426, 187, and 52 $\mu g/m^3$, respectively. The best performing scenario was the full meteorological data without ADJ_U* (shaded green in Table A-5), which fits EPA's recommendation that when turbulence data are present, ADJ_U* should not be used. When turbulence data are not included, the use of the ADJ_U* option improves model performance when compared to non-ADJ_U* results. The yellow shaded rows in Table A-5 represent the meteorological scenario similar NWS data.

Table A-5. Robust High Concentrations and Composite Performance Measures for Lovett Meteorological Degradation Analysis

Scenario	Robust Highest Concentration (μg/m³)			CPM
	1-hour	3-hour	24-hour	
Adjusted u*; with temperature profile; with wind profile; with turbulence (Full data)	344	165	44	0.43
Non-adjusted u*; with temperature profile; with wind profile; with turbulence (Full data, best performance)	374	169	48	0.39
Adjusted u*; with 10 m temperature only; with wind profile; with turbulence	535	251	75	0.57
Non-adjusted u*; with 10 m temperature only; with wind profile; with turbulence	656	293	90	0.68
Adjusted u*; with 10 m temperature only; with wind profile; no turbulence	658	343	87	0.75
Non-adjusted u*; with 10 m temperature only; with wind profile; no turbulence	1055	598	120	1.01
Adjusted u*; with 10 m temperature only; no wind profile; no turbulence (similar to NWS)	884	353	69	0.64
Non-adjusted u*; with 10 m temperature only; no wind profile; no turbulence (similar to NWS)	1145	525	109	0.91
Adjusted u*; with temperature profile; with wind profile; no turbulence	267	228	61	0.49
Non-adjusted u*; with temperature profile; with wind profile; no turbulence	622	254	68	0.58
Adjusted u*; with temperature profile; no wind profile; no turbulence	500	160	34	0.50
Non-adjusted u*; with temperature profile; no wind profile; no turbulence	549	165	36	0.47

Figure A-19 through Figure A-21 are Q-Q plots of observed-to-modeled 1-, 3-, and 24-hour concentrations for the meteorological scenarios that include the full data and a degraded dataset that is most similar to NWS data. These results are consistent with the comparison of the RHCs and CPMs in Table A-5. The figures illustrate the best performing scenario was the full meteorological dataset without the ADJ_U* option applied (green curve). When ADJ_U* is applied to the full dataset, which includes turbulence, there is a greater bias toward underprediction (orange). For the meteorological scenario most similar to NWS data, there was improved performance when the ADJ_U* option was applied (blue), compared to the AERMET default (purple).

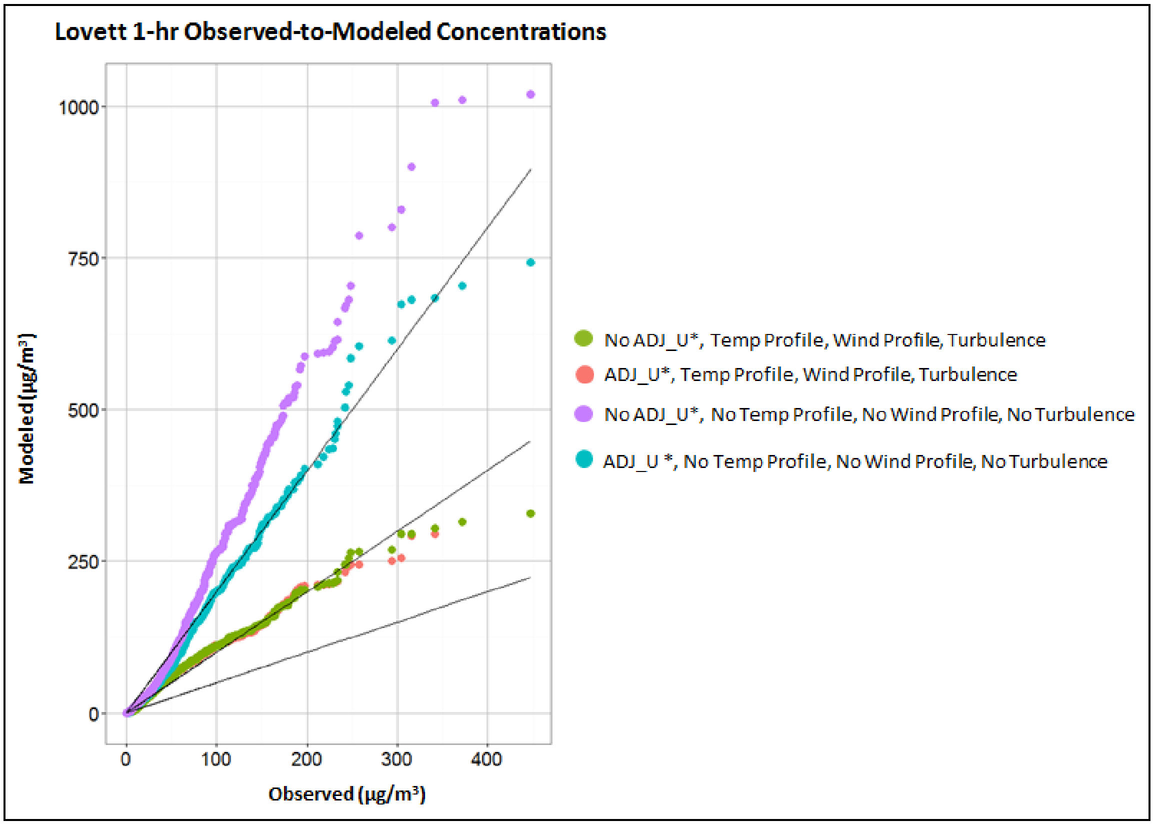

Figure A-19. Lovett 1-hr Q-Q Plot for Meteorological Degradation Analysis

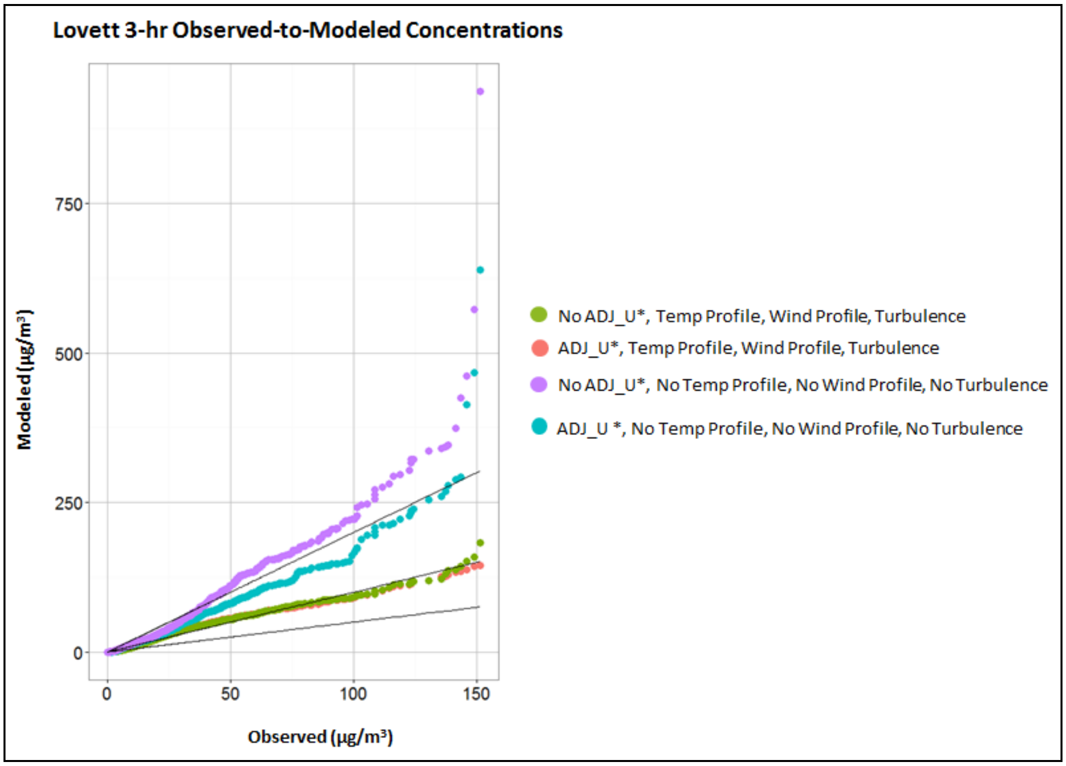

Figure A-20. Lovett 3-hr Q-Q Plot for Meteorological Degradation Analysis

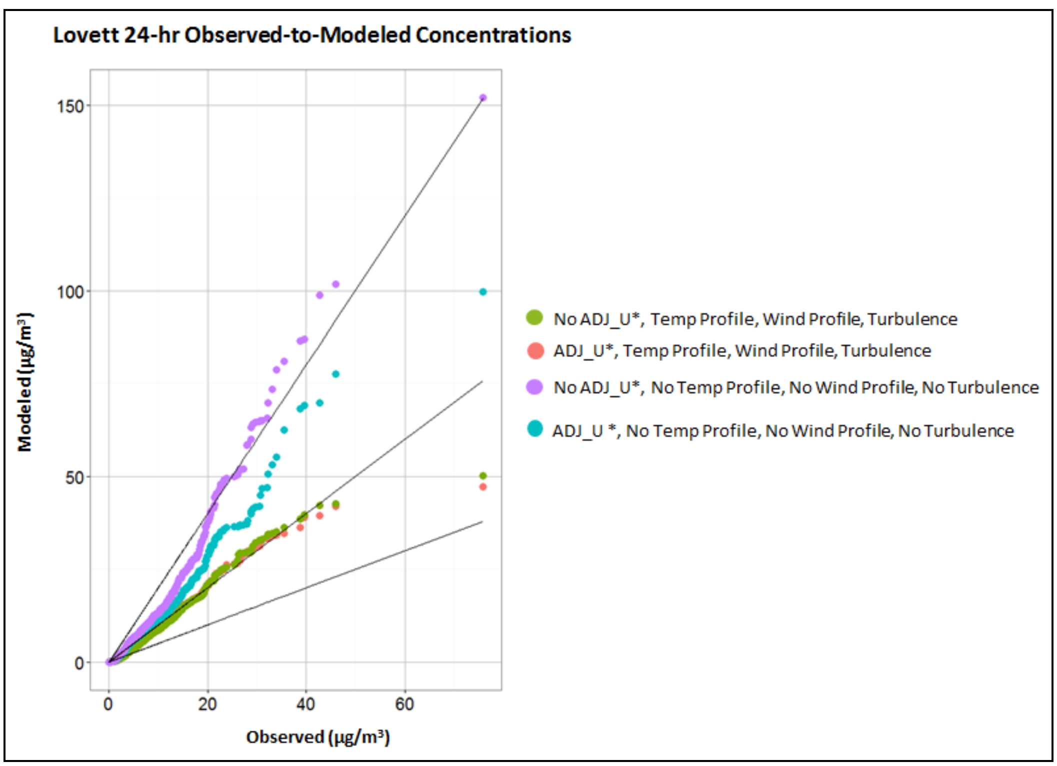

Figure A-21. Lovett 24-hr Q-Q Plot for Meteorological Degradation Analysis

Idaho Falls, Idaho (1974)

The Idaho Falls study (NOAA, 1974) was conducted at the Idaho National Engineering Laboratory (INEL) in southeastern Idaho. The study was performed with tracer releases in flat terrain with three arcs of samplers spaced six degrees apart at distances of 100m, 200m, and 400m from the release point. The meteorological dataset includes multiple levels of wind speed and direction, temperature, and sigma-theta (turbulence).

The evaluation results for Idaho Falls were based in part on information provided by AECOM from a 2009 low wind evaluation study (AECOM, 2010). However, some adjustments to inputs were made based on an independent assessment of surface roughness, and an adjustment was made to the effective tracer release height at Idaho Falls from 1.5 to 3m based on information provided in the NOAA technical memorandum (NOAA, 1974).

The ADJ_U* option was evaluated using: 1) the full set of meteorology, which includes multiple levels of wind, temperature, and sigma-theta, and 2) degraded meteorology, which includes the multiple levels of wind and temperature but does not include sigma-theta.

Figure A-22 through Figure A-25 are plots of paired predicted vs. concentrations and residual plots of the ratio of predicted to observed concentrations vs. distance with and without the ADJ _U* option, using full meteorology without the BULKRN option. Figure A-26 through Figure A-29 are paired and residual plots using degraded meteorology (without turbulence and without BULKRN), with and without ADJ_U*. Each of the plots display results by receptor arc distance. Using the full set of site-specific meteorology, including turbulence, without the ADJ_U* option (Figure A-22 and Figure A-23) shows generally good agreement with observed concentration. Applying ADJ_U* to the full set of meteorology shows a tendency to underpredict for most hours when turbulence data are present (Figure A-24 and Figure A-25). The underprediction is more substantial at the farthest distance.

When turbulence measurements were omitted from the meteorological processing and ADJ_U* was not applied, there is substantial overprediction as shown in Figure A-26 and Figure A-27. Applying ADJ_U* in this case, as illustrated in Figure A-28 and Figure A-29, shows a slight improvement in model performance, but there is still substantial overprediction. The best performing scenario is the use of full site-specific meteorology, with turbulence measurements, and without the ADJ_U* option applied (Figure A-22 and Figure A-23). This is consistent with EPA's position that modeling with a full meteorological dataset that includes turbulence measurements is preferred and results in the best performance. This evaluation also demonstrates a tendency to underpredict when ADJ_U* is applied when turbulence data are present.

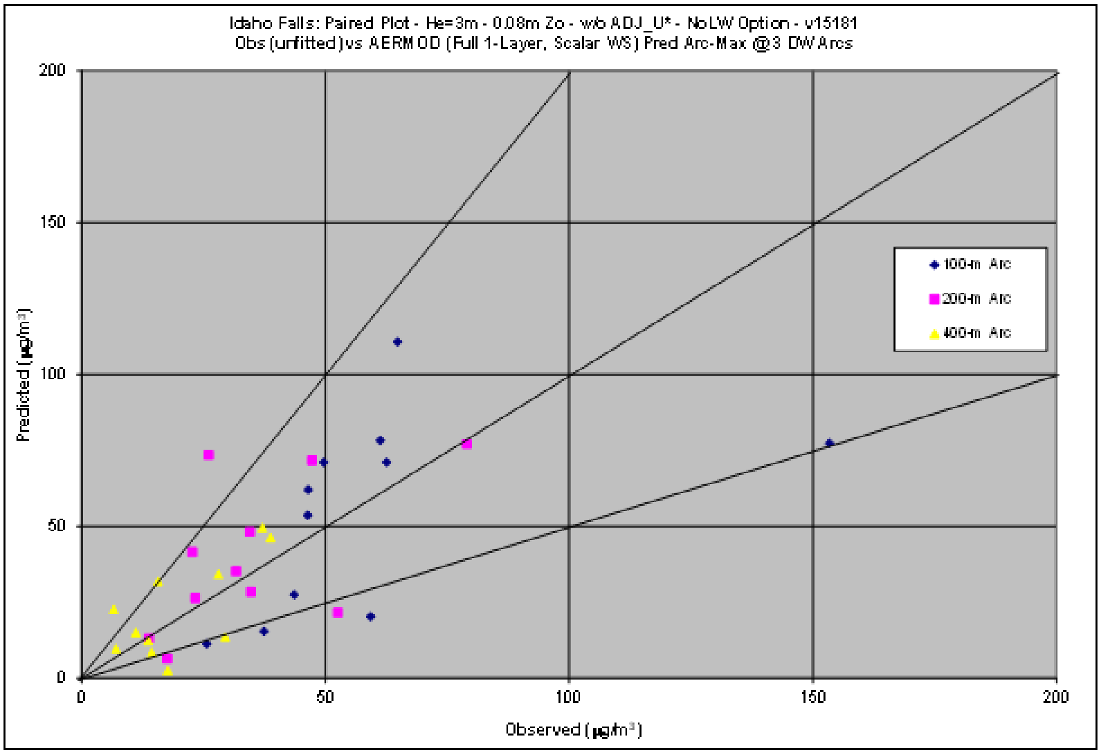

Figure A-22. Idaho Falls 1-hr Paired Plot, Full Met, No ADJ_U*, No BULKRN

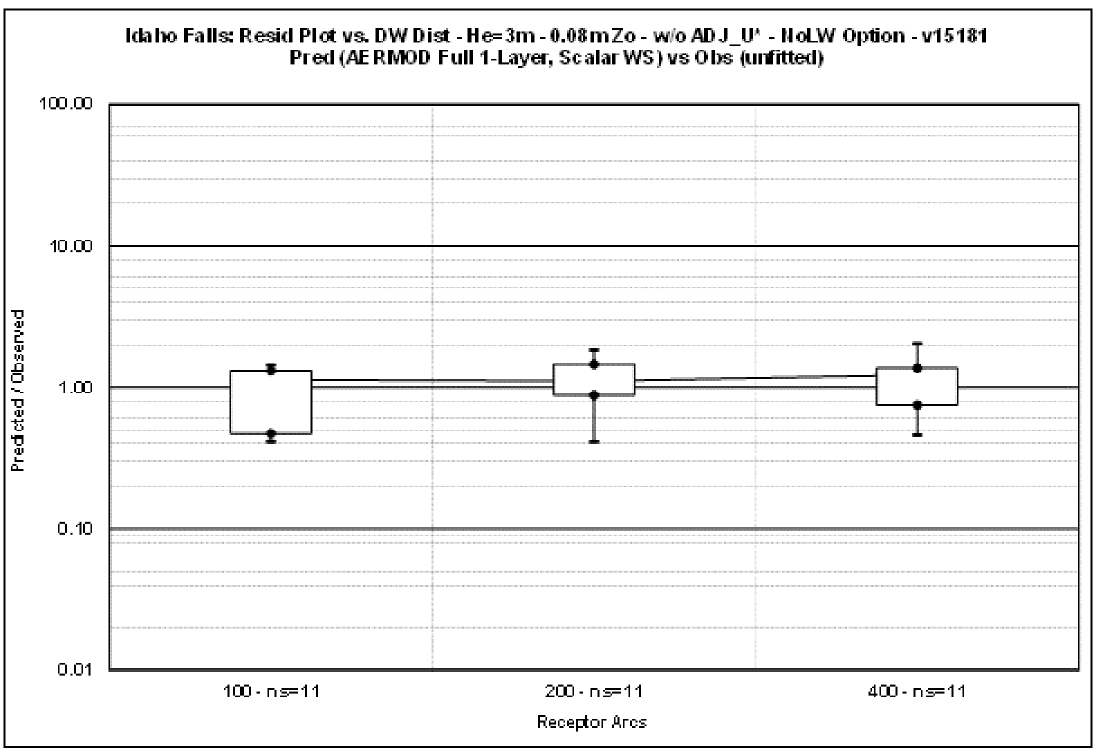

Figure A-23. Idaho Falls 1-hr Ratios, Full Met, No ADJ_U*, No BULKRN

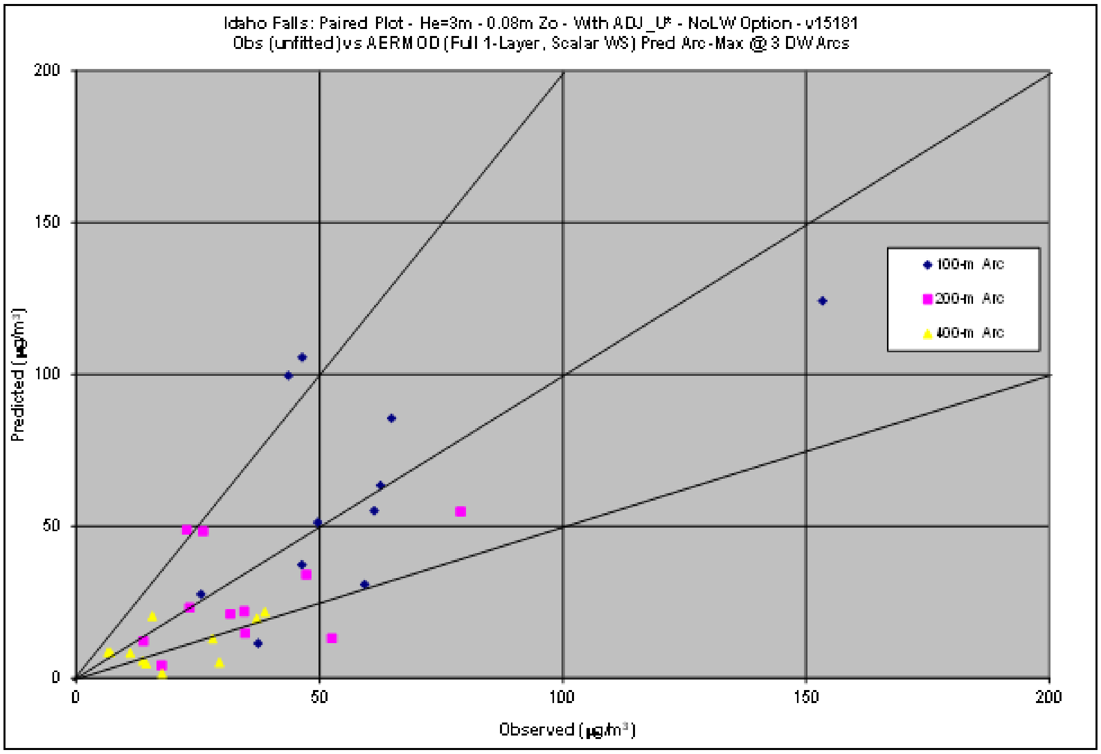

Figure A-24. Idaho Falls 1-hr Paired Plot, Full Met, ADJ_U*, No BULKRN

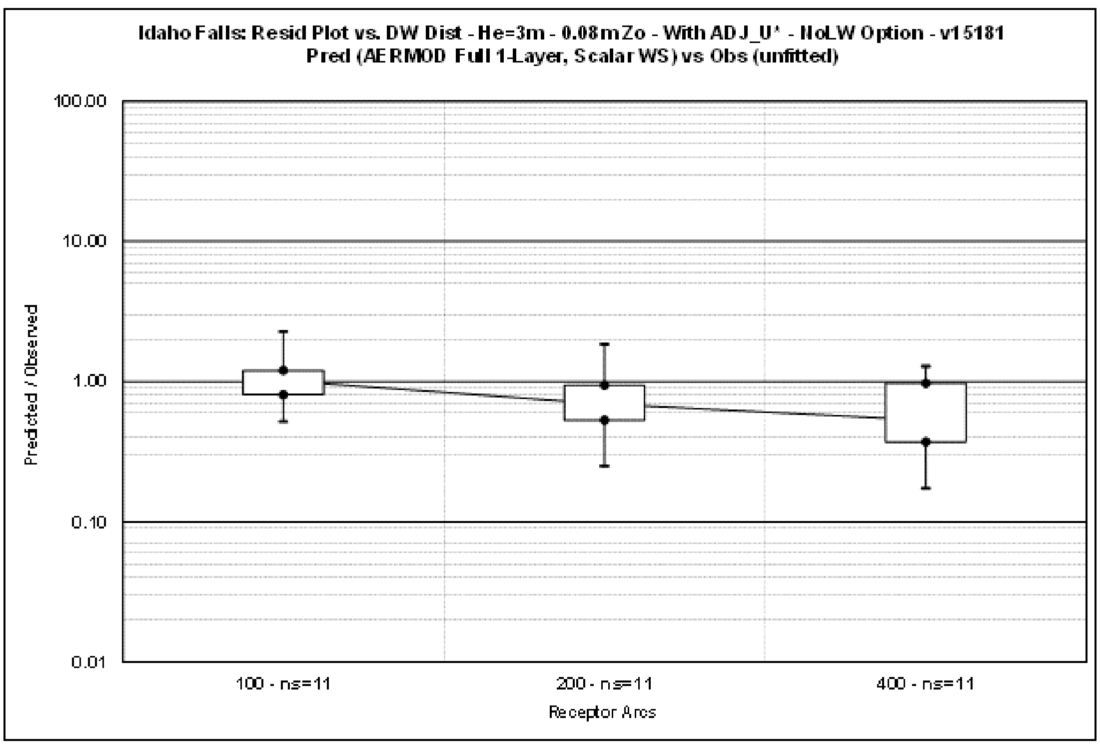

Figure A-25. Idaho Falls 1-hr Ratios, Full Met, ADJ_U*, No BULKRN

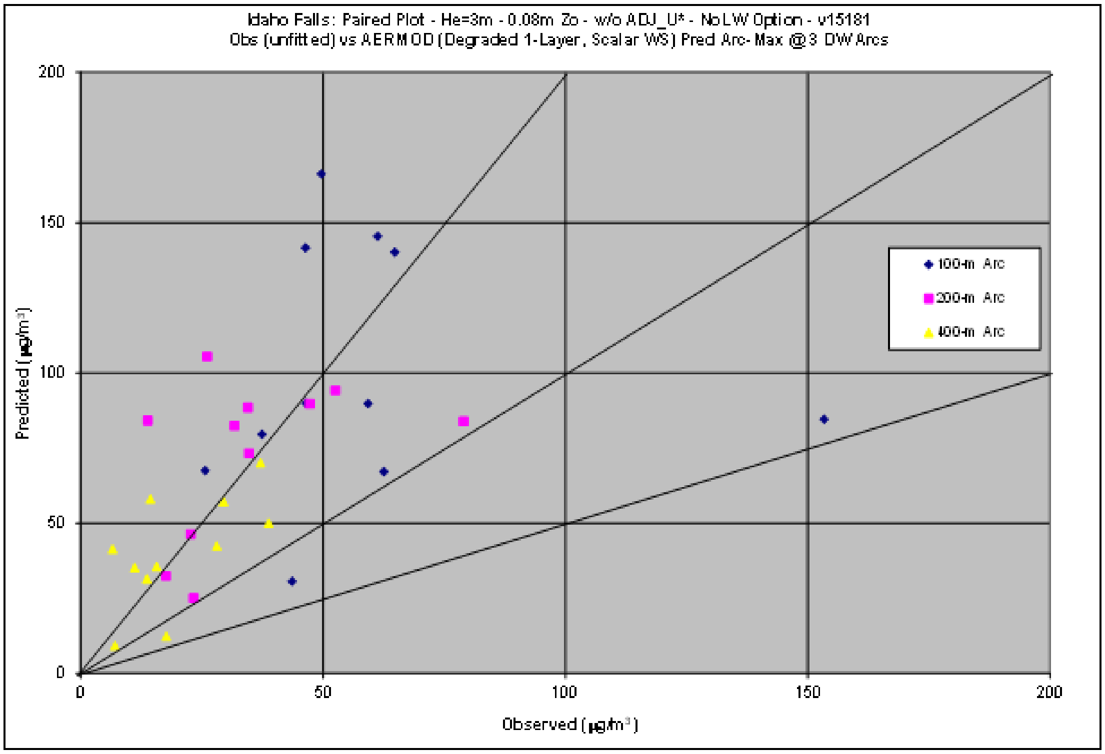

Figure A-26. Idaho Falls 1-hr Q-Q Plot, No Turbulence, No ADJ_U*, No BULKRN

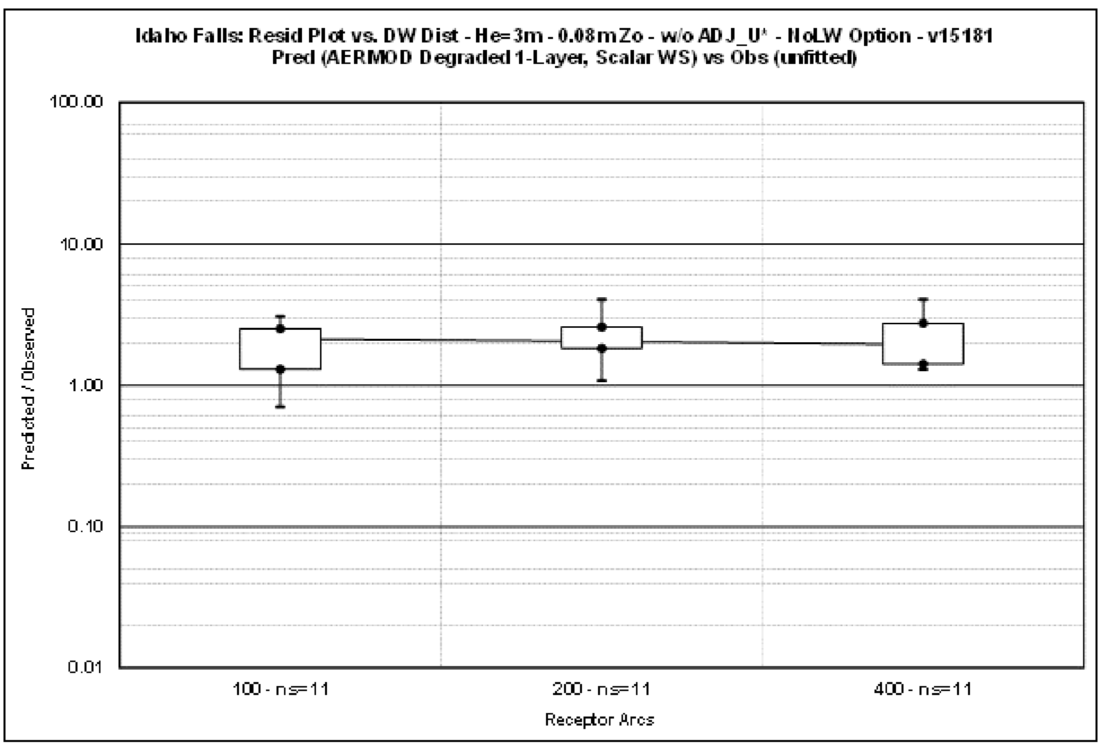

Figure A-27. Idaho Falls 1-hr Ratios, No Turbulence, No ADJ_U*, No BULKRN

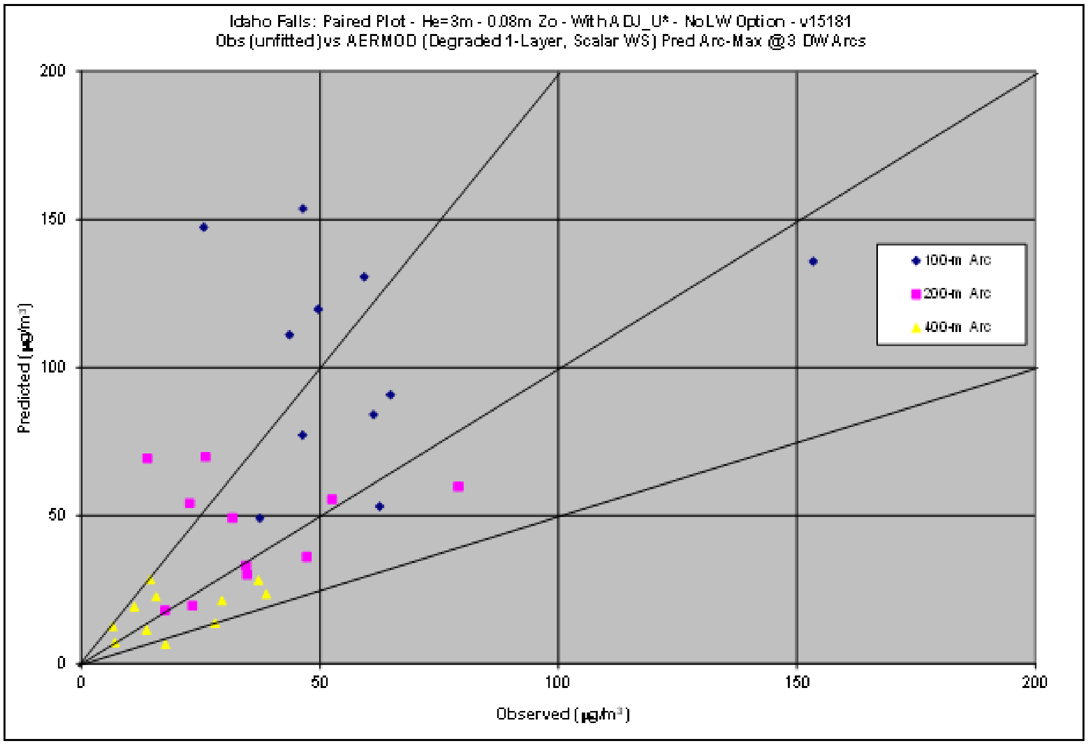

Figure A-28. Idaho Falls 1-hrPaired Plot, No Turbulence, ADJ_U*, No BULKRN

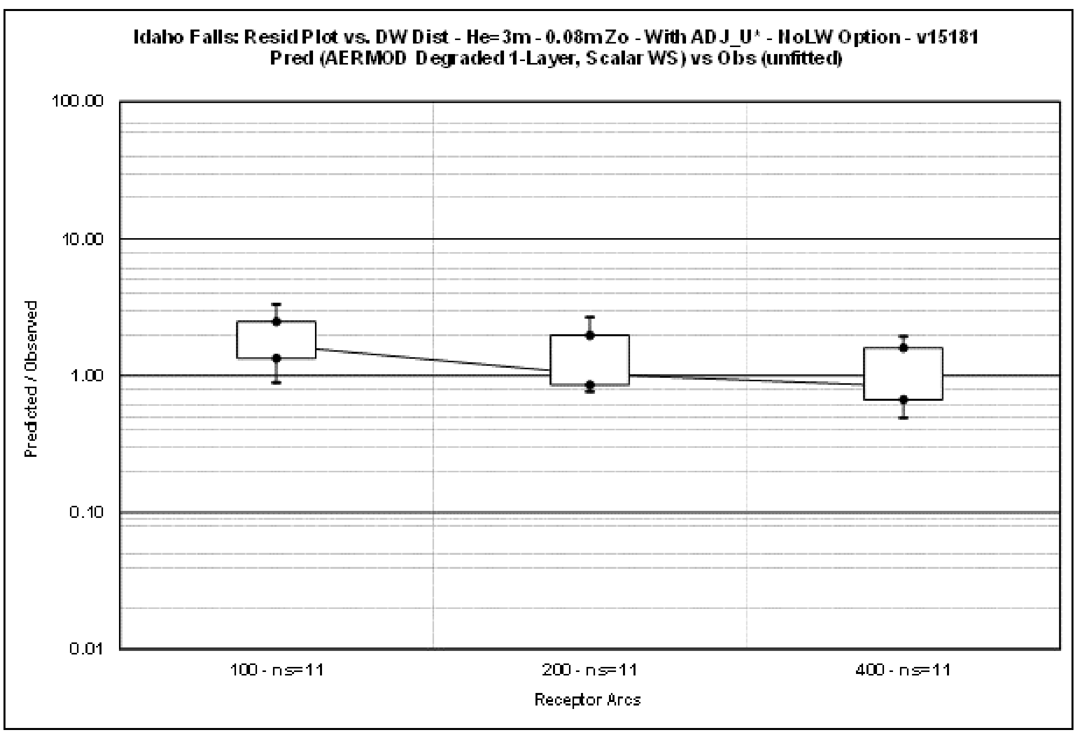

Figure A-29. Idaho Falls 1-hr Ratios, No Turbulence, ADJ_U*, No BULKRN

Reassessment of the LOWWIND3 Beta Option

LOWWIND3 is a variation on the LOWWIND1 and LOWWIND2 “beta” options that have been available in AERMOD beginning with version 12345.

The LOWWIND options modify the minimum value of sigma-v, the lateral turbulence intensity, which is used to determine the lateral plume dispersion coefficient, sigma-y. The LOWWIND3 option also addresses the horizontal meander component in AERMOD that contributes to lateral plume spread, especially during low wind, stable conditions. Furthermore, since the horizontal meander component in AERMOD is a function of the “effective” sigma-v value, lateral plume dispersion may be further enhanced under the LOWWIND3 option by increased meander, beyond the influence of the minimum sigma-v value alone. The default option in AERMOD uses a minimum sigma-v of 0.2 m/s, while the LOWWIND3 option increases the minimum sigma-v to 0.3 m/s and eliminates upwind dispersion. Setting a higher minimum value of sigma-v would tend to increase lateral dispersion during low wind conditions and, therefore, could reduce predicted ambient concentrations. Unlike the proposed ADJ_U* option in AERMET that adjusts u* under stable conditions, the LOWWIND options in AERMOD are applied for both stable and unstable/convective conditions. However, since atmospheric turbulence will generally be higher during unstable/convective conditions than for stable conditions, the potential influence of the minimum sigma-v value on plume dispersion is likely to be much less important during unstable/convective conditions.

As with ADJ_U*, concerns were expressed by a commenter (0114) that the use of the LOWWIND3 option can lead to underprediction prompted the EPA to reassess LOWWIND3 as a regulatory option.

The influence of the LOWWIND3 option on model performance is mixed, and has shown a tendency toward underprediction with increasing distance in some cases, especially when LOWWIND3 is applied in conjunction with the ADJ_U* option in AERMET. The EPA’s reassessment of model performance confirmed this finding of underprediction with increasing distance, in particular for the 1974 Idaho Falls field study database (discussed previously) and the Prairie Grass, Kansas field study, which involved a near-surface tracer release in flat terrain. As noted above, there is an interaction between the ADJ_U* option and LOWWIND options because the values of sigma-v derived in AERMOD are based on the surface friction velocity (u*) parameter generated in AERMET. As a result, the ADJ_U* option in conjunction with the LOWWIND3 option influences the AERMOD derived sigma-v parameter and, in some cases, may exacerbate the tendency for AERMOD with LOWWIND3 to underpredict at higher concentrations, as shown in the commenter’s assessment and the EPA’s reassessment.

Another aspect of the AERMOD model formulation that may contribute to an increasing bias toward underprediction with distance is the treatment of the “inhomogeneous boundary layer” (IBL) that accounts for changes in key parameters such as wind speed and temperature with height above ground. The IBL approach determines “effective” values of wind speed, temperature, and turbulence that are averaged across a layer of the plume between the plume centerline height and the height of the receptor. The extent of this layer depends on the vertical dispersion coefficient (i.e., sigma-z). Therefore, as the plume grows downwind of the source, the extent of the layer used to calculate the effective parameters will increase (up to specified limits). The potential influence of this aspect of AERMOD formulation on modeled concentrations will depend on several factors, including source characteristic, meteorological condition, and the topographic characteristics of the modeling domain.

Lacking sufficient evidence to support adoption of LOWWIND3 (or other LOWWIND options) as a regulatory option in AERMOD, the EPA has not promulgated our proposed action to incorporate LOWWIND3 a regulatory option in AERMOD, and we are deferring action on the LOWWIND options in general pending further analysis and evaluation in conjunction with the modeling community.

The results of the EPA's reassessment of the LOWWIND3 option based on the 1974 Idaho Falls, 1974 Oak Ridge, 1956 Prairie Grass, and a collection of field studies used in the original evaluation of AERMOD (EPA, 2003) are discussed in the sections that follow.

Idaho Falls, Idaho (1974)

The evaluation of ADJ_U* with the 1974 Idaho Falls field study, discussed above, was repeated adding the LOWWIND3 option in AERMOD. Each scenario modeled with and without ADJ_U* was subsequently modeled with the LOWWIND3 option to evaluate the potential for underprediction when LOWWIND3 is applied.

Recall Figure A-22 and Figure A-23 above which represents the full meteorological dataset and includes multiple levels of wind speed and direction, temperature, and sigma-theta, without the ADJ_U* option applied. That scenario demonstrated the best performance of those evaluated, although there was a slight bias toward overprediction for the majority of the hours modeled. When the LOWWIND3 option was applied, the results in the paired plot in Figure A-30 and Figure A-31 show a bias towards underprediction for nearly all hours at each receptor distance. The bias toward underprediction is increased when the LOWWIND3 option is used in conjunction with the ADJ_U* option, illustrated in Figure A-32 and Figure A-33. Furthermore, Figure A-32 and Figure A-33 show the potential for the overprediction to increase with distance.

Results are mixed when comparing the application of LOWWIND3 with and without ADJ_U* when the turbulence data was omitted. Figure A-26 and Figure A-27, above, show a substantial overpredicion without ADJ_U* applied. Results look more favorable in Figure A-34 and Figure A-35 when LOWWIND3 is applied without the use of ADJ_U*. However, Figure A-36 and Figure A-37 show substantial underprediction across the two arcs of receptors farthest from the release point when both ADJ_U* and LOWWIND3 were applied.

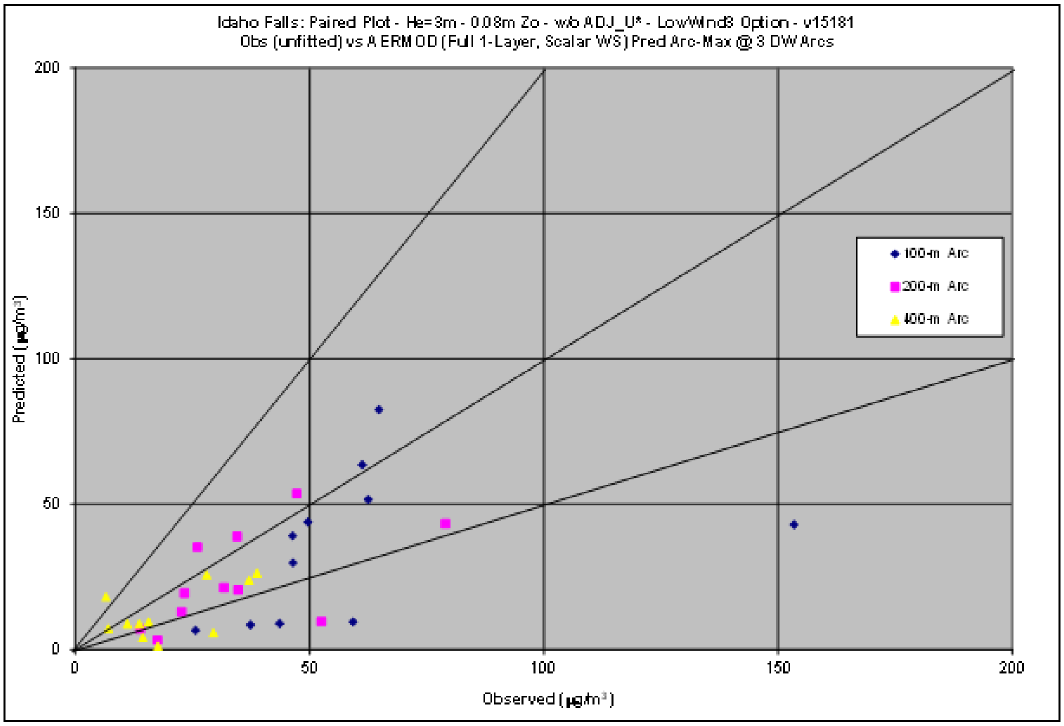

Figure A-30. Idaho Falls 1-hr Paired Plot, Full Met, No ADJ_U*, No BULKRN, with LW3

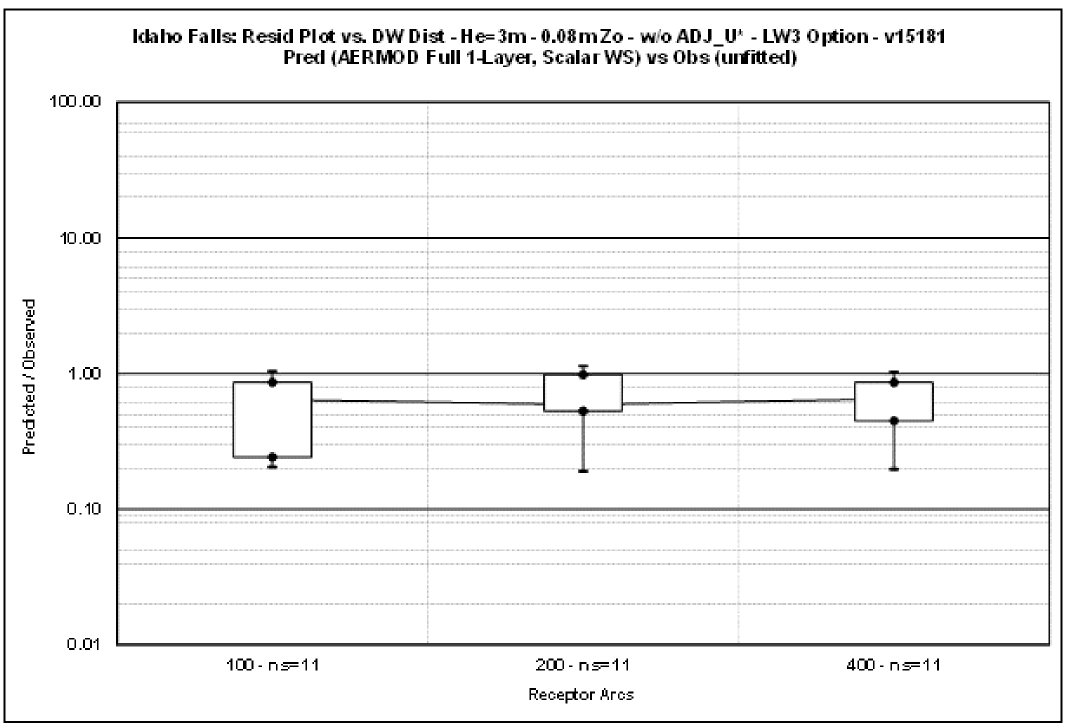

Figure A-31. Idaho Falls 1-hr Ratios, Full Met, No ADJ_U*, No BULKRN, with LW3

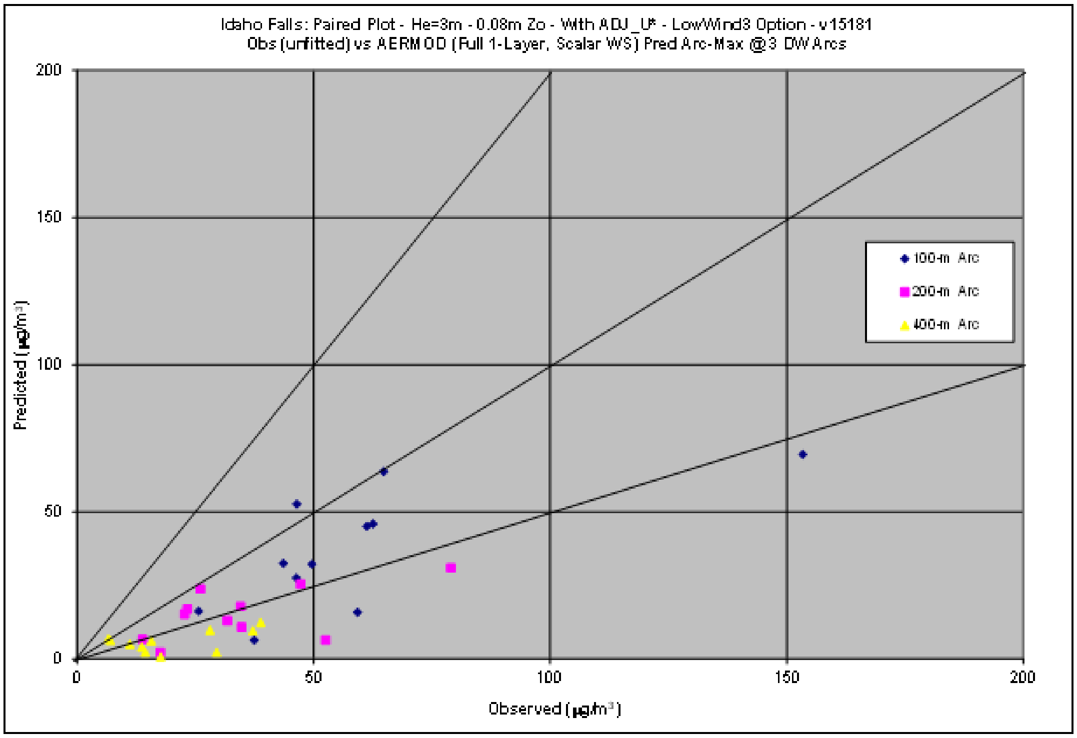

Figure A-32. Idaho Falls 1-hr Paired Plot, Full Met, ADJ_U*, No BULKRN, with LW3

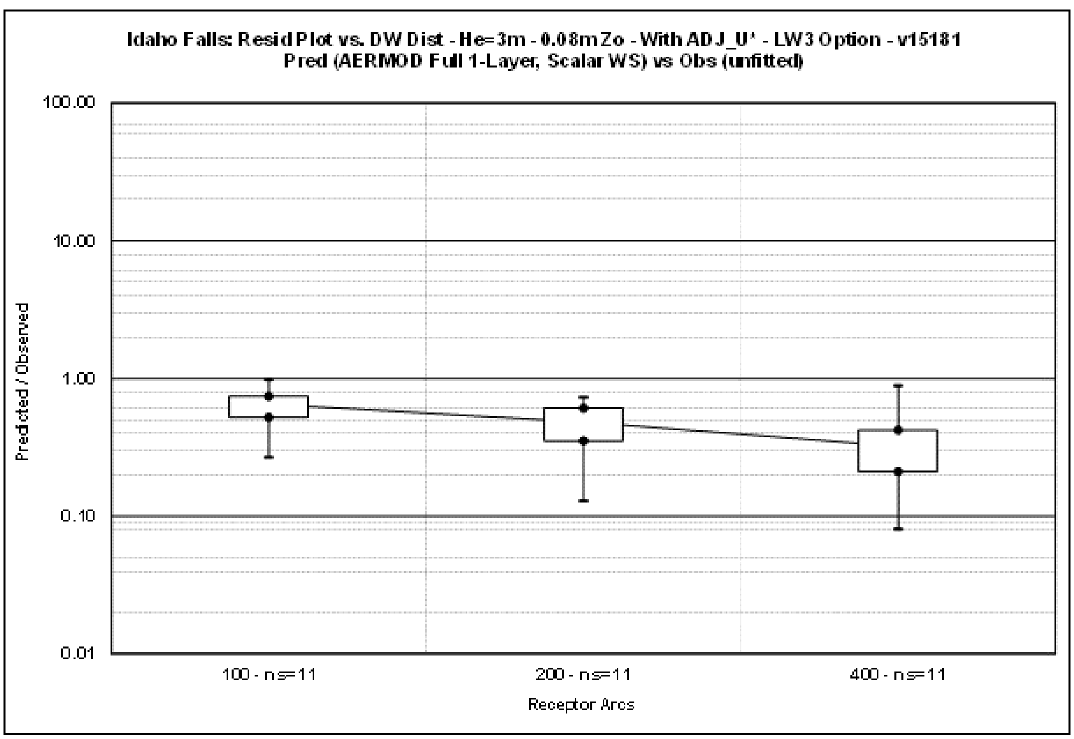

Figure A-33. Idaho Falls 1-hr Ratios, Full Met, ADJ_U*, No BULKRN, with LW3

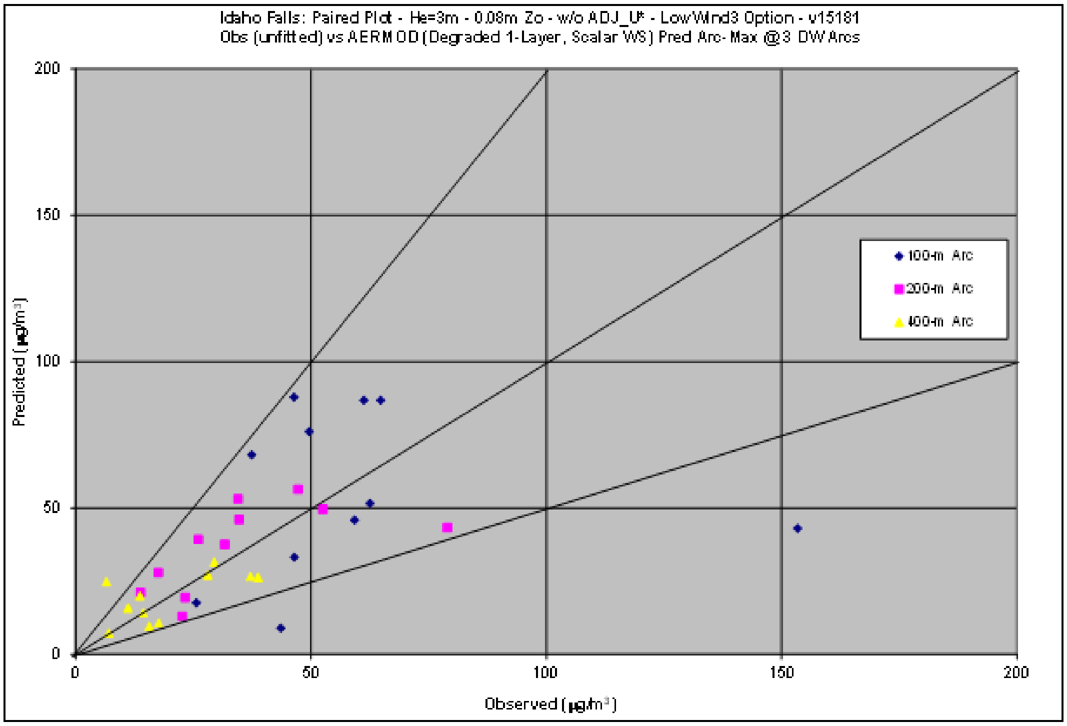

Figure A-34. Idaho Falls 1-hr Paired Plot, No Turbulence, No ADJ_U*, No BULKRN, with LW3

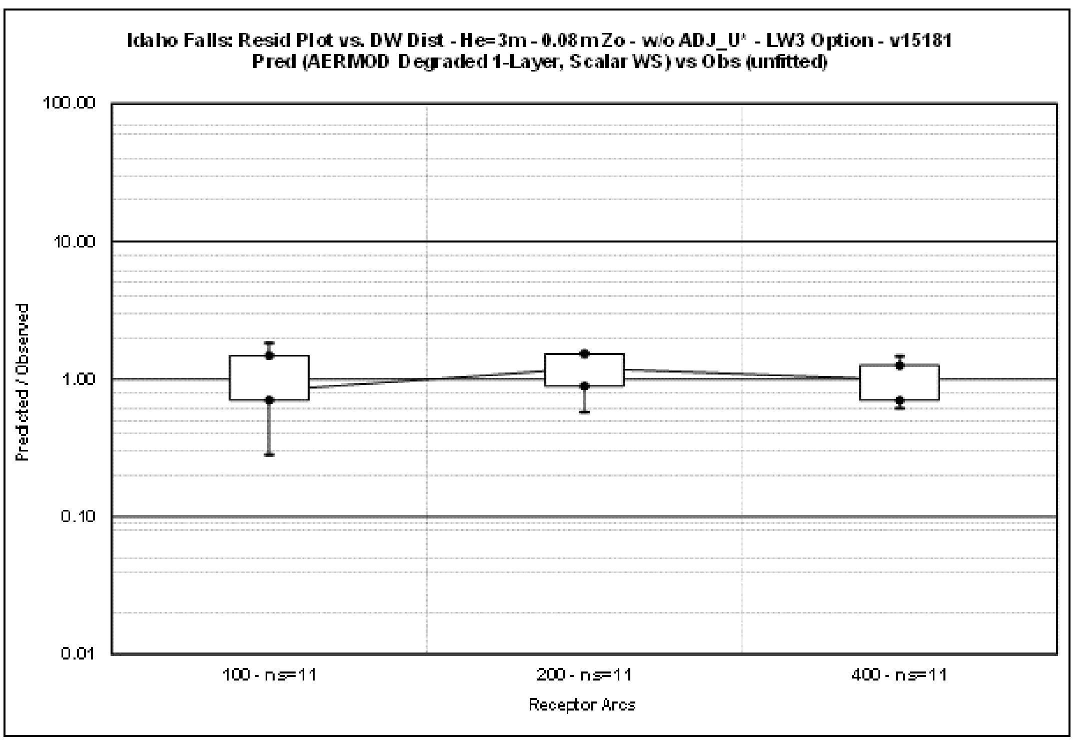

Figure A-35. Idaho Falls 1-hr Ratios, No Turbulence, No ADJ_U*, No BULKRN, with LW3

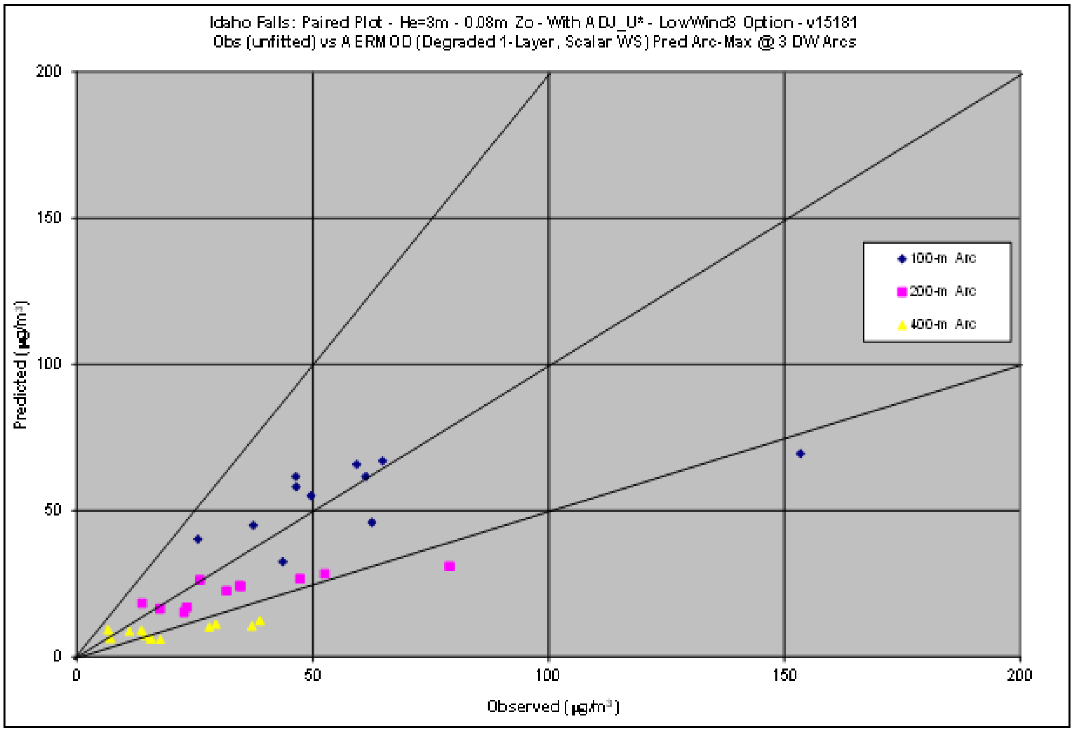

Figure A-36. Idaho Falls 1-hr Paired Plot, No Turbulence, ADJ_U*, LW3 No BULKRN

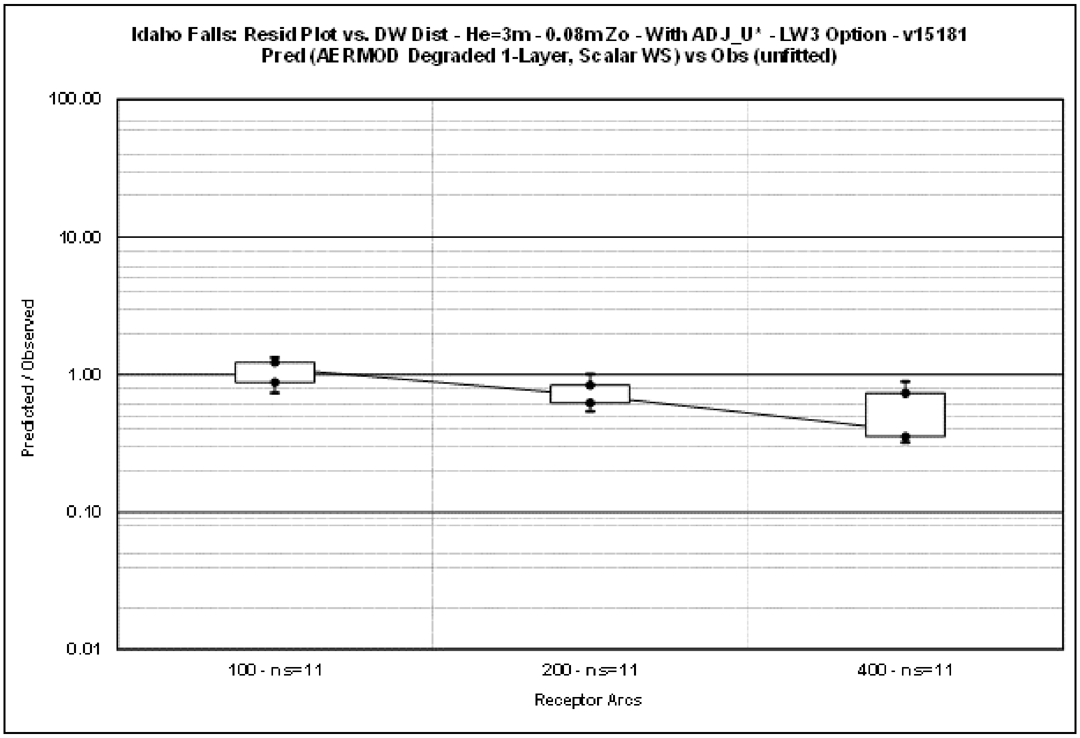

Figure A-37. Idaho Falls 1-hr Ratios, No Turbulence, ADJ_U*, LW3 No BULKRN

Project Prairie Grass, Nebraska (1956)

Project Prairie Grass (Barad22; Haugen23) used a near-surface (0.46m), non-buoyant tracer release of SO_2 in a flat rural area in Nebraska during July and August of 1956. Surface sampling arrays (arcs) were positioned from 50 m to 800 m downwind. Meteorological data included the 2-m level wind direction and speed, the root-mean-square wind direction fluctuation, and the temperature difference between 2 m and 16 m. Other surface parameters, including friction velocity, Monin-Obukhov length, and lateral plume spread, were estimated. Wind, turbulence, and temperature were obtained from a multi-leveled instrumented 16-m meteorological tower.

Figure A-38 is a Q-Q plot that compares results using full meteorology (includes turbulence measurements) without ADJ_U* or LOWWIND3 applied (base case) to full meteorology with ADJ_U*, with and without the LOWWIND3 option. Similarly, Figure A-39 is a Q-Q plot comparing the base case to degraded meteorology (without turbulence) with ADJ_U*, with and without LOWWIND3. In both figures, the best performing case is full meteorology without either the ADJ_U* or LOWWIND3 option applied. Figure A-38 demonstrates a decrease in concentrations (similarly a decrease in performance) compared to the base case when ADJ_U* is applied and a further decrease when both ADJ_U* and LOWWIND3 are applied. Figure A-39 demonstrates a similar decrease compared to the base case when ADJ_U* is applied when the turbulence data are omitted. Concentrations further decrease compared to the base case when both ADJ_U* and LOWWIND3 are applied and the turbulence data are not included. These plots illustrate potential for a decrease in concentrations resulting in underprediction when using the LOWWIND3 option in combination with the ADJ_U* option.

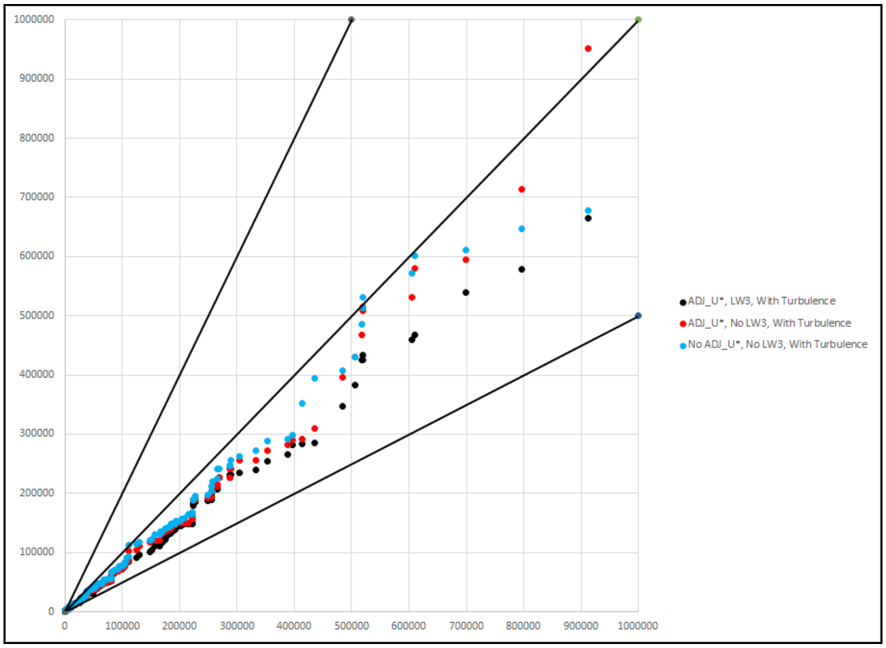

Figure A-38. Prairie Grass 1-hr Q-Q Plots, Comparing Base Case to ADJ_U*, with Turbulence, with and w/o LW3

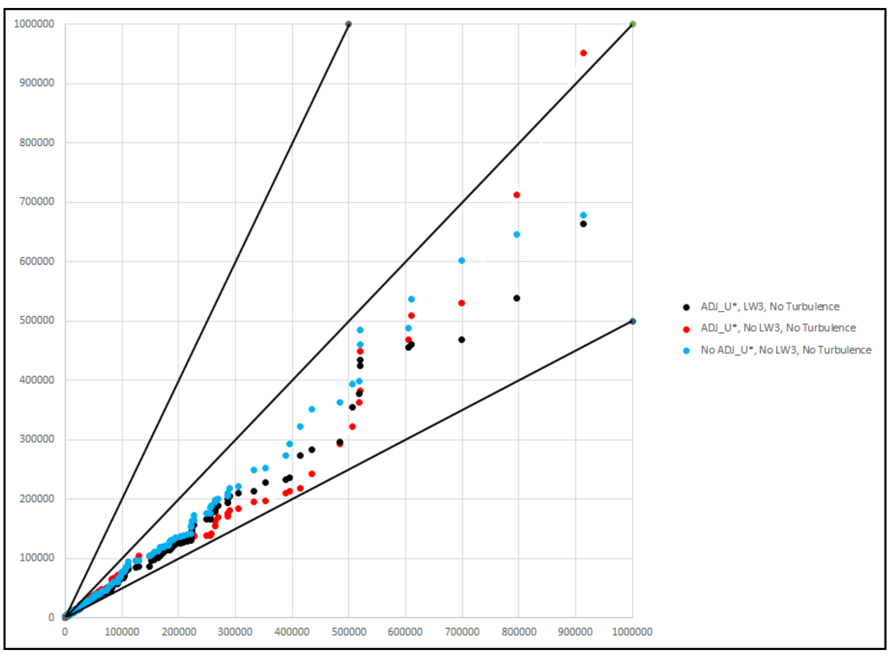

Figure A-39. Prairie Grass 1-hr Q-Q Plots Comparing Base Case to ADJ_U*, w/o Turbulence, with and w/o LW3

Other Studies

Many of the standard evaluation databases used in the original evaluation of AERMOD (EPA, 2003) were modeled with and without the LOWWIND3 option and in combination with ADJ_U* and turbulence (where available). Twelve of the standard databases were modeled including: AGA, Alaska, Baldwin, Bowline, Clifty Creek, DAEC, Kincaid, Lovett, Martins Creek, Millston, Tracy, and Westvaco (EPA, 2003). Q-Q plots of 1-hr observed-to-modeled concentrations for each of the sites listed are provided in Figure A-40 through Figure A-42.

An analysis of 1-hour Q-Q plots showed that the use of LOWWIND3 made little to no difference for some cases (i.e., AGA, Alaska, Baldwin, Bowline, DAEC with 1 and 24 m release heights, EOCR, Lovett, and Martins Creek) on concentrations, regardless of the use of adjusted u* or non-adjusted u*. In some cases, the use of LOWWIND3 decreased concentrations (i.e., Baldwin, Clifty Creek, DAEC with 46 m release height, Indiana, Kincaid, Lovett, Millston, Tracy and Westvaco). Of those cases, LOWWIND3 decreased concentrations regardless of the use of adjusted u* or non-adjusted u* (i.e., Baldwin, Clifty Creek, Kincaid, Lovett, Tracy, and Westvaco). Millston showed more decrease with LOWWIND3 without ADJ_U* than with ADJ_U* applied. For no case did LOWWIND3 increase concentrations. Results were mixed for cases not involving turbulence (i.e., Baldwin, Bowline, Clifty Creek, and Millston). Results were also mixed for cases involving turbulence (i.e., AGA, Alaska, DAEC, EOCR, Indiana, Lovett, Martins Creek, Tracy, and Westvaco).

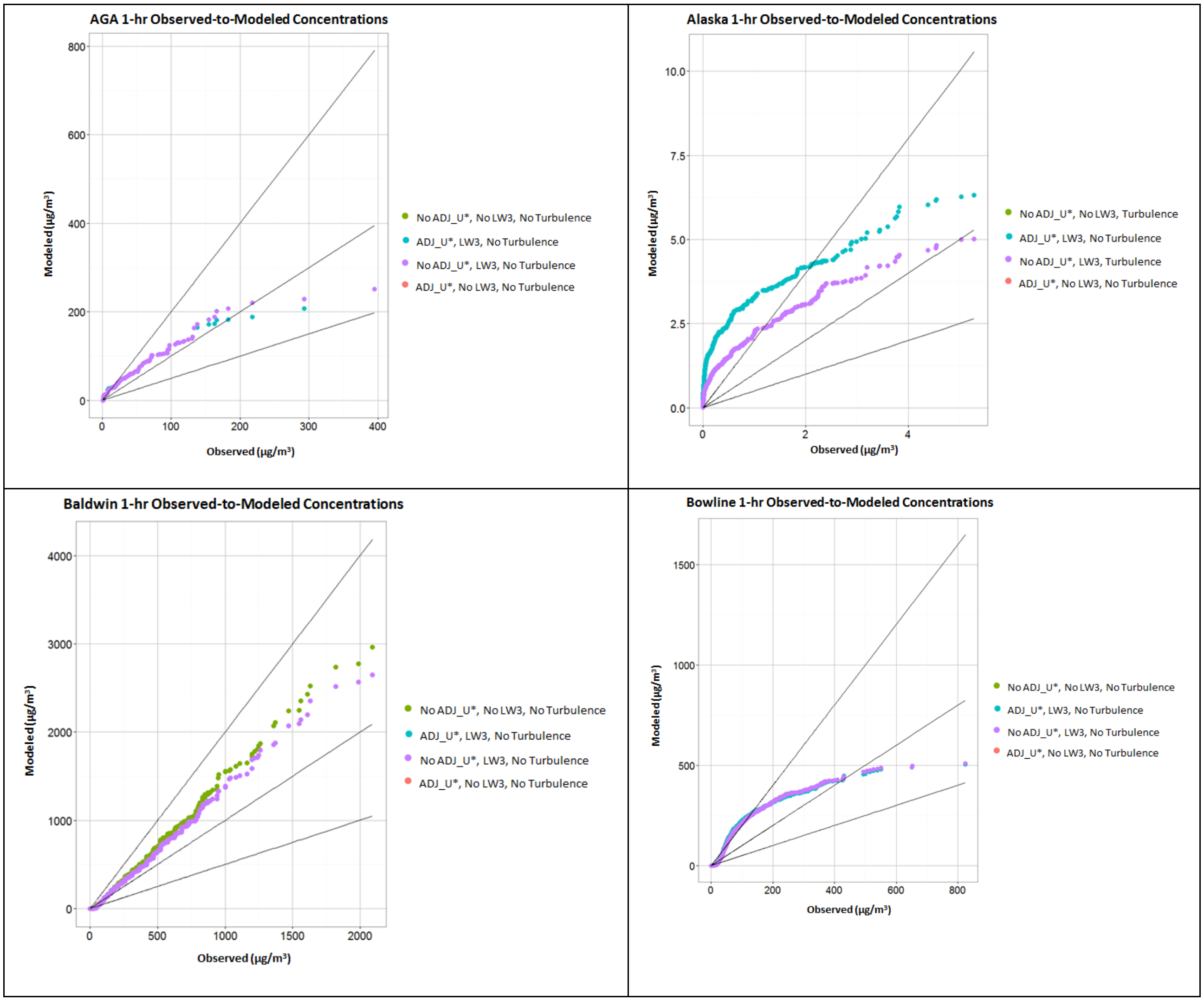

Figure A-40. Q-Q Plots for 1-hr Observed-to-Modeled Concentrations for AGA, Alaska, Baldwin, Bowline

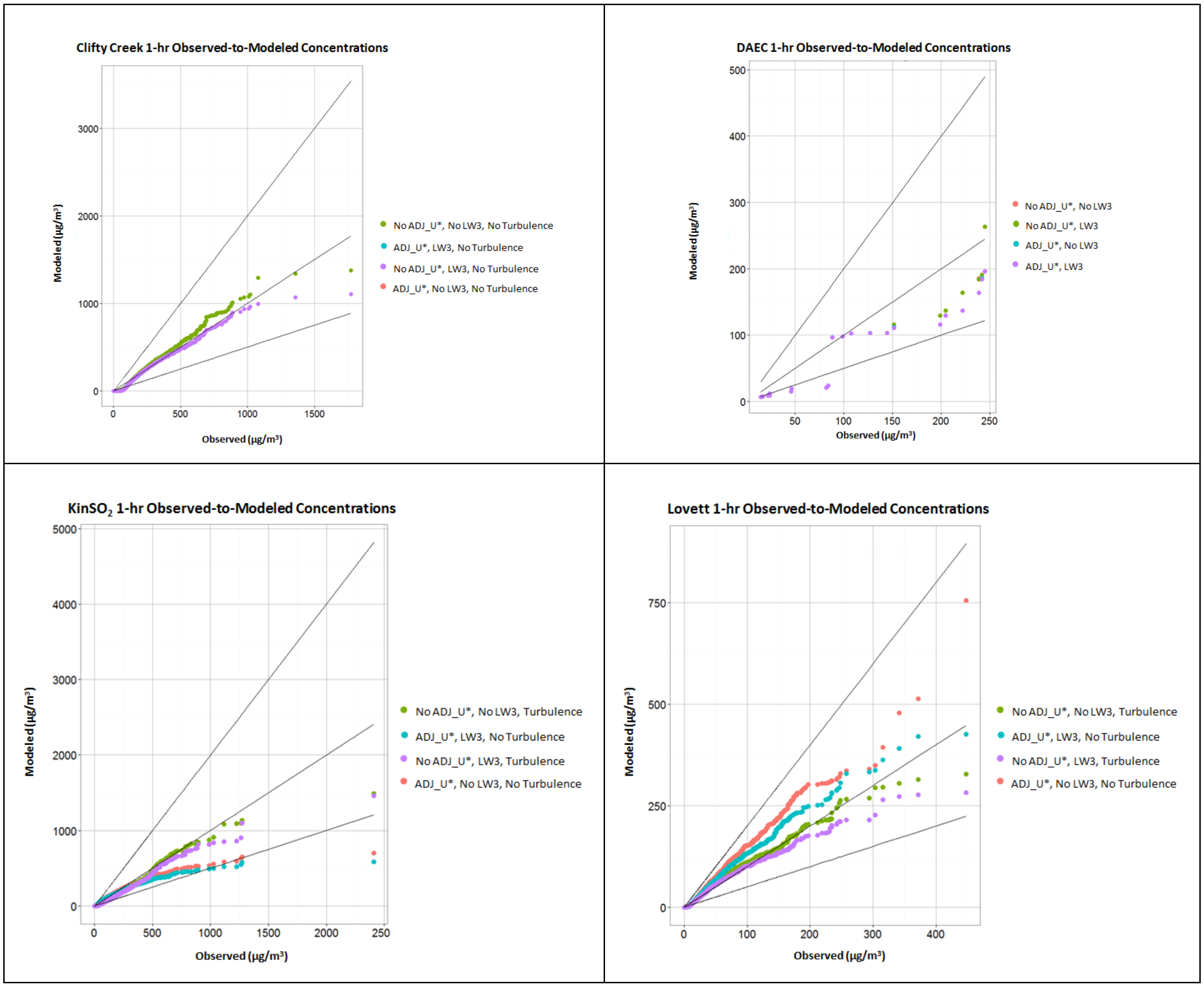

Figure A-41. Q-Q Plots for 1-hr Observed-to-Modeled Concentrations for Clifty Creek, DAEC, Kincaid, and Lovett

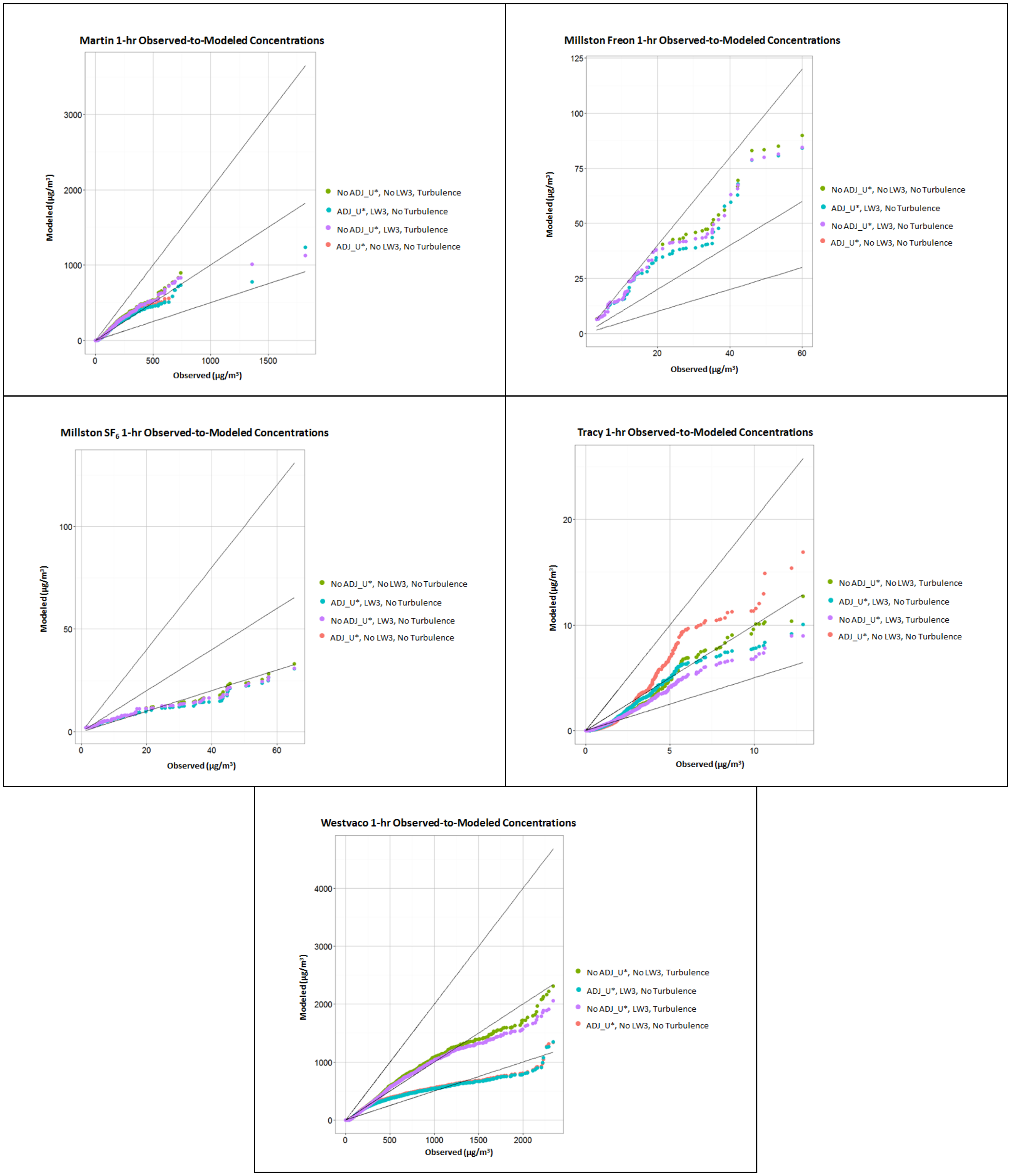

Figure A-42. Q-Q Plots for 1-hr Observed-to-Modeled Concentrations for Martins Creek, Millston, Tracy, and Westvaco

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Appendix B. Summary of CAL3QHC and AERMOD Run Times

Model simulations were performed to compare CAL3QHC run times with those of AERMOD. Roadway links were defined in AERMOD as both LINE and VOLUME sources in separate model runs. In addition, LINE and VOLUME sources were modeled with and without the non-default FASTAREA and FASTALL options enabled, respectively, for a total of four AERMOD runs. The equivalent of 36 hours of meteorology were modeled with each hour having identical meteorological conditions except for wind direction, which was varied by 10 degrees each hour from 10 to 360 degrees. Two CAL3QCH runs were performed with the meteorological inputs specified a different way in each run. In one run, the meteorology was input as a single record and the variation in the wind direction was automated by the model during runtime. In a second run, 36 meteorological records were input, each with a distinct wind direction.

An adaptation of Example 1 in the CAL3QHC user's guide[1] was used to conduct the run time comparisons. The example is a two-way intersection with six free-flow links and three queue links. Approach, departure, and queue links run both north and south and a one-way street runs from west to east, which also includes a queue link. A total of eight receptors are located around the intersection. Figure B-1 taken from the CAL3QHC user's guide, illustrates the configuration of the intersection and the placement of the receptors.

[1] User's Guide to CAL3QHC Version 2.0: A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections (Revised). U. S. Environmental Protection Agency, Office of Air Quality and Planning Standards, EPA-454/R-92-006R, September 1995.

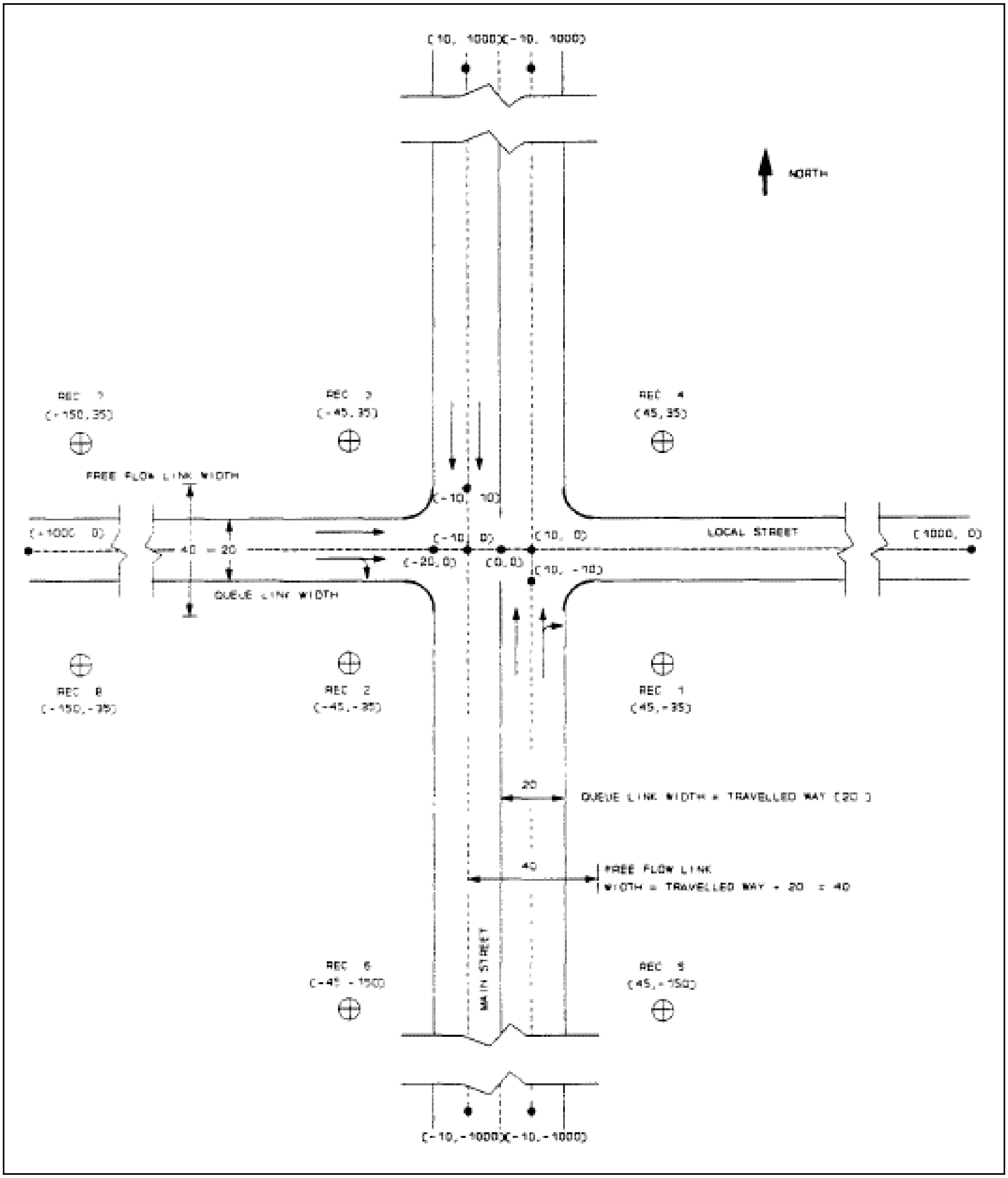

Figure B-1. Intersection Configuration and Receptor Placement

(Example 1 from the CAL3QHC User's Guide[1])

Due to hardcoded array limits in CAL3QHC, no more than 120 roadway links and 60 receptors can be modeled in a single model run. To provide a more robust comparison, the example discussed above was duplicated multiple times to generate 120 roadway links and 60 receptors. The duplicated sources and receptors are collocated with the respective original sources and receptors. The 120 links were converted to AERMOD LINE and VOLUME source equivalents. Each of the 120 links was represented as a single LINE source. As VOLUME sources, each link was divided into adjacent volume sources with a length and width of 40 feet (12.2 meters) for the free-flow links and 20 feet (6.1 meters) for the queue links, as defined in the user's guide. This resulted in a total of 2,412 individual volume sources. Associated with each volume source is an exclusion zone, a circular area surrounding the source with the origin at the center of the source. The radius of the exclusion zone is equal to:

$$r = 2.15 * \sigma_{y0} + 0.99$$

AERMOD will not compute a concentration from an individual source for a receptor located within the boundary of the source or within the source's exclusion zone. Because of their close proximity to the roadway, all eight of the original receptor locations are within the exclusion zone for one or more of the volume sources. To avoid computations from being skipped or omitted, which could bias the AERMOD VOLUME source run times, the receptors were moved for the VOLUME source model runs so that all receptor locations were outside of the exclusion zones for all sources. Figure B-2 through Figure B-5 illustrate the example intersection represented as LINE and VOLUME sources, respectively, and the placement of the receptors for each case. Figure B-2 and Figure B-4 show the entire intersection, while Figure B-3 and Figure B-5 are close-ups of a portion of the intersection. Shaded regions are examples of a free-flow link, queue link, and individual VOLUME sources within the two types of links. Note that duplicate sources and receptors are not illustrated in the figures since they are collocated with the originals.

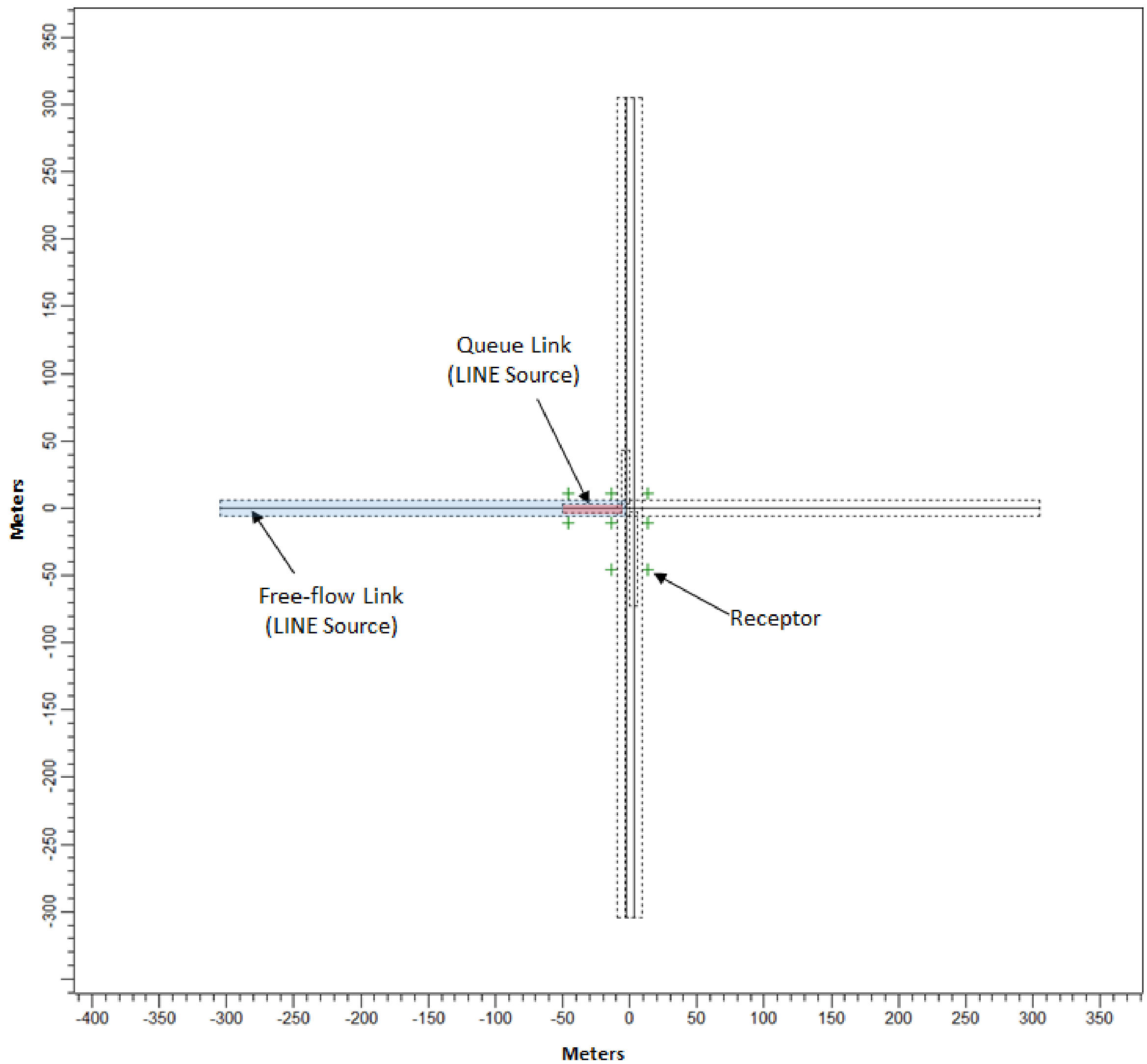

Figure B-2. Roadway Links Defined as LINE Sources in AERMOD

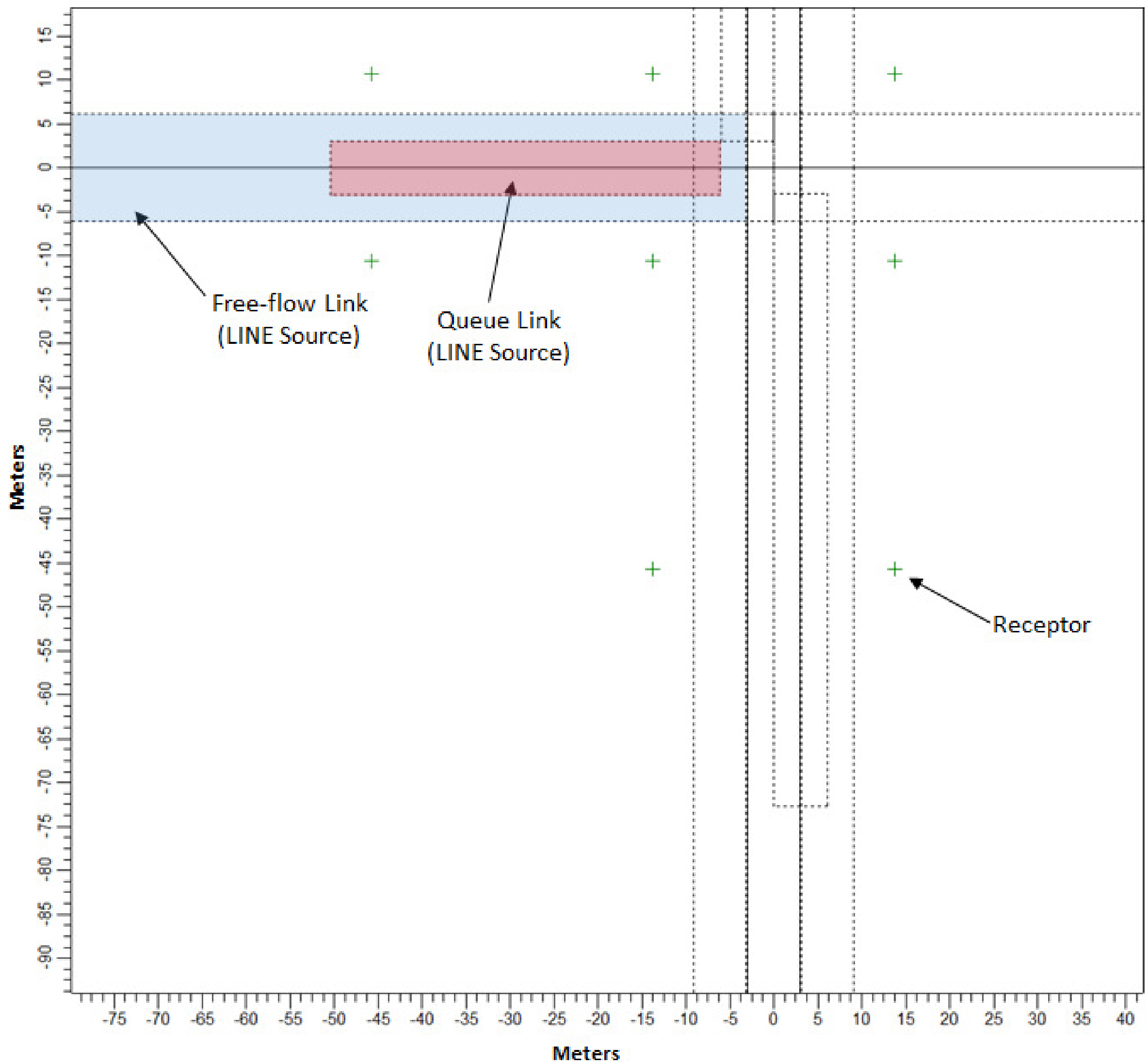

Figure B-3. Roadway Links Defined as LINE Sources in AERMOD (Enlarged)

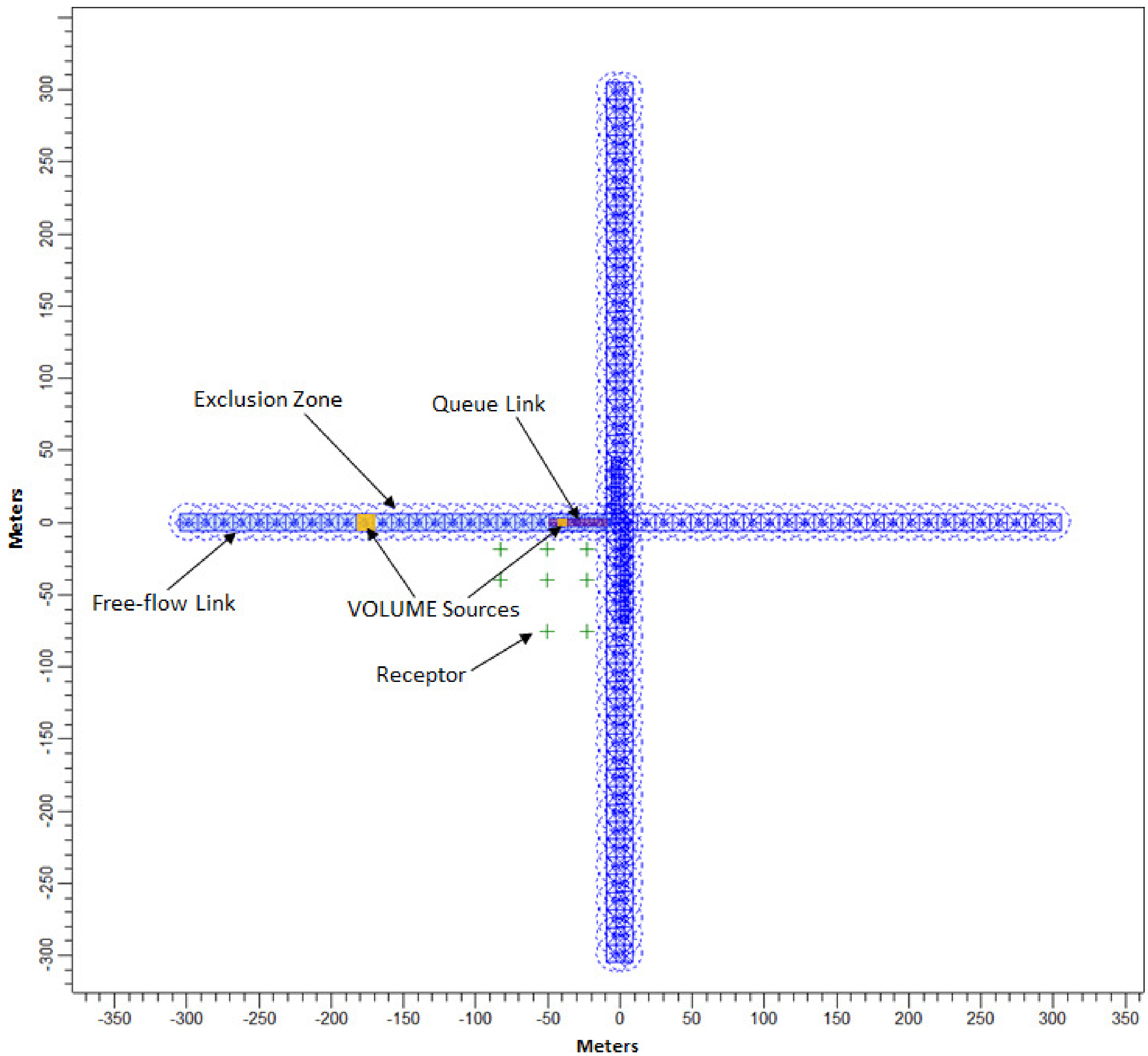

Figure B-4. Roadway Links Defined as VOLUME Sources in AERMOD

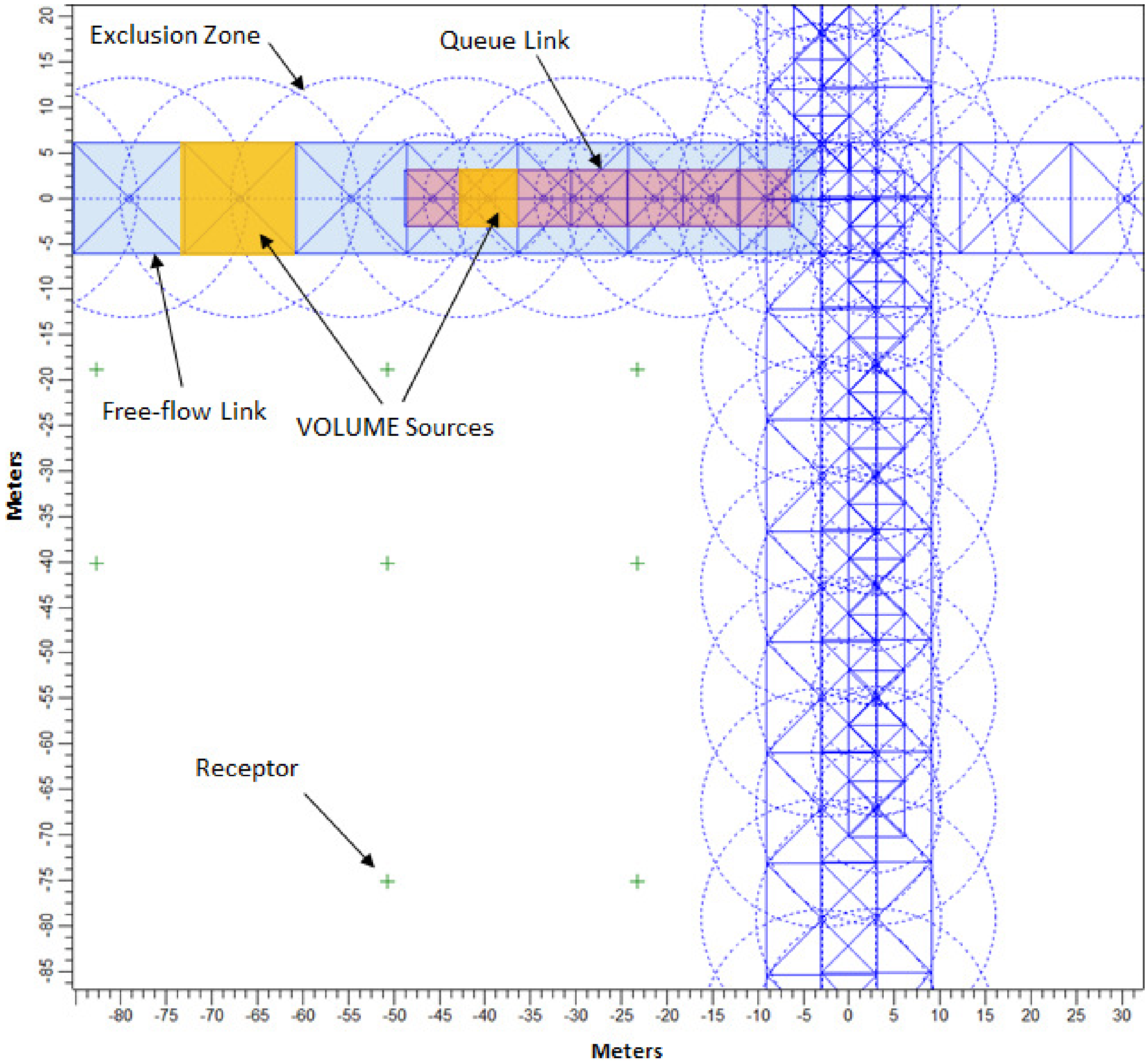

Figure B-5. Roadway Links Defined as VOLUME Sources in AERMOD (Enlarged)

The set of six model cases (two CAL3QHC and four AERMOD) were run on three different computers running Microsoft Windows, including two office computers and a home desktop computer. The set of simulations were performed multiple times on the home desktop computer to observe variation between the runs on the same machine. The average run time was computed for each case. The CAL3QHC run in which a single meteorological record was specified in the control file was used as the base case for comparison. The ratio of the average run time of each case to that of the base case was computed. The model run times for each simulation are compared in Table B-1. As shown in the table, there can be substantial variation in the run times of a given case across different machines due to different processing speeds and other factors. There is also variation between simulations run on the same machine.

Table B-1. Comparison of Computer Runtimes

Model	CAL3	CAL3	AERMOD	AERMOD	AERMOD	AERMOD
Source type			LINE	LINE	VOLUME	VOLUME
Case	1	36	Default	FASTAREA	Default	FASTALL
Computer platform	Model run times (seconds)					
Laptop 1	2.2	2.9	24.1	11.6	14.2	9.1
Desktop 1	3.3	3.1	18.8	11.7	13.9	9.1
Desktop 1	3.4	3.1	21.4	11.5	14.7	10.5
Desktop 1	3.2	3.4	22.2	11.0	13.8	11.0
Desktop 2	2.8	2.3	25.4	11.2	14.3	9.0
Desktop 2	2.4	2.2	24.4	11.0	14.9	9.2
Desktop 2	2.3	2.1	23.1	10.4	13.5	8.4
Desktop 2	2.7	2.1	23.3	10.4	13.6	8.4
Avg	2.8	2.6	22.9	11.1	14.1	9.3
std dev (seconds)	0.5	0.5	2.1	0.5	0.5	0.9
std dev (%)	17%	20%	9%	4%	4%	10%
Ratio of case to base case		0.96	8.27	4.01	5.10	3.38

With respect to real world implications, run times were projected for a CO categorical hot-spot analysis for intersections,[2] originally modeled with CAL3QHC. Using the average run times in Table B-1, model run times to perform the hot-spot analysis for each case were predicted, assuming run times are a linear function of the number of sources, receptors, and meteorological conditions (i.e., hours of meteorology) that are modeled.[3]

[2] Carbon Monoxide Categorical Hot-Spot Finding Technical Document. U.S. Department of Transportation, Federal Highway Administration. Prepared by Volpe National Transportation Systems Center, October 25, 2013.

[3] Strict linearity is not necessarily correct, but reasonable for the rough estimate here. The LINE source scenario was repeated with 360 receptors (a factor of 4 increase) several times. The average run time increased by a factor of 4.5. However, these increased runtimes from slightly non-linear increases in model run times are negligible when considering total model run times on the order of a few minutes.

The hot-spot analysis was based on a large intersection operating at capacity. As represented in the CAL3QHC model control files that accompany the "Carbon Monoxide Categorical Hot-Spot Finding Technical Document,"[2] 20 roadway links and 1,936 receptor locations were modeled for identical meteorological conditions with 36 different wind directions, equivalent to 36 hours of meteorology. To accommodate CAL3QHC's limit of 60 receptors per model run, for the actual analysis, CAL3QHC was run 44 separate times, each for a different set of 44 receptor locations. Predicted run times for CALQHC3 were calculated as if the model run was performed in a single continuous model run.

Run times for each case were predicted using the following equation:

$$T = [(L_r \times R_r \times M_r)/(L_h \times R_h \times M_h)] \times Avg_r$$

where:

T =	*Predicted case run time for hot-spot analysis (seconds)*
L_r=	*Number of CAL3QHC links in run time test case*
R_r =	*Number of receptors in run time test case*
M_r =	*Number of hours of Meteorology in run time test case*
L_h=	*Number of CAL3QHC links in hot-spot analysis*
R_h =	*Number of receptors in hot-spot analysis*
M_h =	*Number of hours of meteorology in hot-spot analysis*
Avg_r =	*Average case run time from run time test (seconds)*

The predicted hot-spot analysis run times for each of the six cases are displayed in Table B-2.

Table B-2. Predicted Case Run Times for Categorical Hot-Spot Analysis

Model	Source Type	Case	Hot-Spot Analysis Predicted Run Time (minutes:seconds)
CAL3QHC		1 Met Record	00:14.9
CAL3QHC		36 Met Records	00:14.2
AERMOD	LINE	Default	02:03.0
AERMOD	LINE	FASTAREA	00:59.7
AERMOD	VOLUME	Default	01:15.8
AERMOD	VOLUME	FASTALL	00:50.2

Appendix C. Response to Comments on CALINE3

Summary

This document provides the results of a literature search attempting to identify additional studies that could be used to assess the model performance of AERMOD versus the CALINE3 model. The literature search used “CALINE3”, “CAL3QHC”, “CAL3QHCR”, and “CALINE4” as keyword searches. AERMOD was not used as a search term in order to limit returning articles that did not include one of the CALINE models. In the technical support document (TSD) for the replacement of CALINE3 with AERMOD, the EPA focused on one study that used “gold standard” modeling data, i.e., modeling data that is based on studies with know, rather than estimated or modeled, emissions. As discussed in the TSD and above in the response to comments, studies that are based on estimated or modeled emissions introduce significant levels of uncertainty and are thus not as reliable when attempting to benchmark model performance. The literature review thus categorized the results into three categories:

- Articles that did not report on model to monitor comparisons. These clearly are not useful for determining the best model, as no real-world benchmark (monitoring data) is provided.
- Articles that do report a model to monitor comparison, but in which the emissions were estimated or based on an emissions model.
- Articles that do report a model to monitor comparison and the emissions are not estimated, but based on a known or measured emission rate.

Considerations were also made for the type of article, i.e., articles that were published in peer-reviewed journals were considered to be appropriate, while articles that were published as conference proceedings or otherwise did not go through a scientific peer review, were not considered appropriate for evaluating the best performing model.

The review returned a total of 68 citations, 27 of those included some sort of model to monitor comparison, 39 did not include such a comparison, 3 were in a foreign language and could not be further evaluated, and 2 were responses to one of the other 39 papers without a comparison. No articles were returned that used know emissions rates other than the one study the EPA has already evaluated and based their recommendation for replacing CALINE3 with AERMOD.

The majority of the returned citations were in some sort of peer-reviewed journal (57 in total), while 5 were conference proceedings or extended abstracts, with 3 being book chapters, and one was not clear.

The majority of the citations were based on analyses conducted with CALINE4 (45 in all), with the minority being based on analyses conducted with one of the CALINE3 models (CALINE3, CAL3QHC, CAL3QHCR, 19 in all), while only 6 of the studies also included AERMOD in the analysis.

Literature Search Results

Summary

June 7, 2016

Subject: Dispersion Models – Roadways
Date Range: 2005 - Present
Databases searched: Web of Science, ProQuest Environmental Science Collection

Number of citations: 68

Search terms:

(Road OR roads OR roadway* OR "near-road" OR nearroad OR vehicle* OR vehicular OR traffic OR intersection*)

AND

(CALINE3 OR CAL3QHC OR CAL3QHCR OR CALINE4)

‡ - citations denoted with this symbol appeared to be from conference proceedings, books, or other sources that did not be appear to be consistent with scientific peer review processes.

Articles that included a model to monitor comparison, but with estimated or modeled emissions

1. Albassam, E., et al. (2009). "Management of air quality in the vicinity of congested area in Kuwait." Environmental Monitoring and Assessment **157**(1-4): 539-555. http://dx.doi.org/http://dx.doi.org/10.1007/s10661-008-0554-5

2. Al-Naimi, N., et al. (2015). "Measurement and modelling of nitrogen dioxide (NO sub(2)) emissions: a marker for traffic-related air pollution in Doha, Qatar." Annals of GIS **21**(3): 249-259. http://dx.doi.org/http://dx.doi.org/10.1080/19475683.2015.1057225

3. Anjaneyulu, M. V. L. R., et al. (2006). Modeling Ambient Carbon Monoxide Pollutant Due to Road Traffic. Proceedings of World Academy of Science, Engineering and Technology, Vol 17. C. Ardil. **17:** 103-106.

4. Batterman, S. A., et al. (2010). "Prediction and analysis of near-road concentrations using a reduced-form emission/dispersion model." Environmental Health **9**: 29. http://dx.doi.org/http://dx.doi.org/10.1186/1476-069X-9-29

5. Broderick, B. M., et al. (2005). "Validation of CALINE4 modelling for carbon monoxide concentrations under free-flowing and congested traffic conditions in Ireland." International Journal of Environment and Pollution **24**(1-4): 104-113. http://dx.doi.org/10.1504/ijep.2005.007388

6. Broderick, B. M. and R. T. O'Donoghue (2007). "Spatial variation of roadside C-2-C-6 hydrocarbon concentrations during low wind speeds: Validation of CALINE4 and COPERT III modelling." Transportation Research Part D-Transport and Environment **12**(8): 537-547. http://dx.doi.org/10.1016/j.trd.2007.07.010

7. Cohan, A., et al. (2011). "High-resolution pollutant transport in the San Pedro Bay of California." Atmospheric Pollution Research **2**(3): 237-246. http://dx.doi.org/10.5094/apr.2011.030

8. Fung, D. C., et al. (2013). "Particle Concentration on Freeways: Affecting Factors and a Simple Model Development." Aerosol and Air Quality Research **13**(6): 1693-1701. http://dx.doi.org/10.4209/aaqr.2013.04.0110

9. Ganguly, R. and B. M. Broderick (2008). "Performance evaluation and sensitivity analysis of the general finite line source model for CO concentrations adjacent to motorways: A note." Transportation Research Part D-Transport and Environment **13**(3): 198-205. http://dx.doi.org/10.1016/j.trd.2008.01.006

10. Ganguly, R., et al. (2009). "Assessment of a General Finite Line Source Model and CALINE4 for Vehicular Pollution Prediction in Ireland." Environmental Modeling & Assessment **14**(1): 113-125. http://dx.doi.org/10.1007/s10666-008-9152-8

11. Gokhale, S. and N. Raokhande (2008). "Performance evaluation of air quality models for predicting PM10 and PM2.5 concentrations at urban traffic intersection during winter period." Science of the total environment **394**(1): 9-24. http://dx.doi.org/10.1016/j.scitotenv.2008.01.020

12. ‡ Jacomino, V., et al. (2009). Study of the dispersion process of vehicular emissions at a specific site in Belo Horizonte using numerical simulation. Environmental Health Risk V. C. A. Brebbia. **14:** 23-34.

13. Khare, M., et al. (2012). Performance evaluation of air quality dispersion models at urban intersection of an Indian city: a case study of Delhi city. Air Pollution XX. J. W. S. Longhurst and C. A. Brebbia. **157:** 249-259.

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