



Support Center for Regulatory Atmospheric Modeling (SCRAM) Preferred/Recommended Models

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These refined dispersion models are listed in [Appendix W](#) and are required to be used for State Implementation Plan (SIP) revisions for existing sources and for New Source Review (NSR) and Prevention of Significant Deterioration (PSD) programs. The models in this section include the following:

AERMOD Modeling System - A steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

CALPUFF Modeling System - A non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation, and removal. CALPUFF can be applied for long-range transport and for complex terrain.

Other Models - Other dispersion models including [BLP](#), [CALINE3](#), [CAL3QHC/CAL3QHCR](#), [CTDMPLUS](#), and [OCD](#).

AERMOD Modeling System

The American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC) was formed to introduce state-of-the-art modeling concepts into the EPA's air quality models. Through AERMIC, a modeling system, AERMOD, was introduced that incorporated air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

There are two input data processors that are regulatory components of the AERMOD modeling system: [AERMET](#), a meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, and [AERMAP](#), a terrain data preprocessor that incorporates complex terrain using USGS Digital Elevation Data. Other non-regulatory components of this system include: [AERSCREEN](#), a screening version of AERMOD; [AERSURFACE](#), a surface characteristics preprocessor, and [BPIPRIME](#), a multi-building dimensions program incorporating the GEP technical procedures for PRIME applications.

At this time, AERMOD does not calculate design values for the lead NAAQS (rolling 3-month averages). A post-processing tool, [LEADPOST](#), is available to calculate design values from monthly AERMOD output. This tool calculates and outputs the rolling cumulative (all sources) 3-month average concentration at each modeled receptor with source group contributions and the maximum cumulative (all sources) rolling 3-month average concentration by receptor.

Below is the model code and documentation for AERMOD Version 15181. The model code and supporting documents are not static but evolve to accommodate the best available science. Please check this website often for updates to model code and associated documents. As of December 9, 2006, AERMOD is fully promulgated as a replacement to ISC3, in accordance with [Appendix W](#).

AERMOD Implementation Guide

[AERMOD Implementation Guide](#) (PDF, 133KB) - Provides information on the recommended use of AERMOD for particular applications and is an evolving document. (Updated August 3, 2015.)

Model Code

[README \(v15181\)](#) (TXT, 1KB)
[Executable \(v15181\)](#) (ZIP, 1.2MB)
[Source Code \(v15181\)](#) (ZIP, 506KB)

Model Documentation

[README \(v15181\)](#) (TXT, 1KB)
[AERMOD Quick Reference Guide](#) (PDF, 61KB)
[User's Guide Addendum](#) (ZIP, 2.3MB)

[Model Change Bulletin #11 - Version Date 15181](#) (PDF, 43KB)
[Model Change Bulletin #10 - Version Date 14134](#) (PDF, 37KB)
[Model Change Bulletin #9 - Version Date 13350](#) (TXT, 9KB)
[Model Change Bulletin #8 - Version Date 12345](#) (TXT, 9KB)
[Model Change Bulletin #7 - Version Date 12060](#) (TXT, 6KB)
[Model Change Bulletin #6 - Version Date 11353](#) (TXT, 3KB)
[Model Change Bulletin #5 - Version Date 11103](#) (TXT, 3KB)
[Model Change Bulletin #4 - Version Date 11059](#) (TXT, 13KB)
[Model Change Bulletin #3 - Version Date 09292](#) (TXT, 33KB)
[Model Change Bulletin #2 - Version Date 07026](#) (TXT, 4KB)
[Model Change Bulletin #1 - Version Date 06341](#) (TXT, 10KB)

[Model Formulation Document](#) (PDF, 441KB)

[Addendum to the AERMOD Model Formulation Document](#) (PDF, 44KB) - PVMRM and LOWWIND options technical description

Test Cases

[Test Cases README](#) (TXT, 5KB)
[AERMET-AERMOD Test Comparisons](#) (XLSX, 516KB)
[Test Case - AERMET_Def 14134_AERMOD_15181](#) (ZIP, 13.2MB)
[Test Case - AERMET_Def 15181_AERMOD_14134](#) (ZIP, 14.3MB)

[Test Case - AERMET_Def_15181_AERMOD_15181](#) (ZIP, 13.2MB)
[Test Case - AERMET_UStar_14134_AERMOD_15181](#) (ZIP, 13.3MB)
[Test Case - AERMET_UStar_15181_AERMOD_14134](#) (ZIP, 13.1MB)
[Test Case - AERMET_UStar_15181_AERMOD_15181](#) (ZIP, 13.1MB)
[Test Case - AERMET_Def_15181_AERMOD_15181_LOWWIND3](#) (ZIP, 13.1MB)
[Test Case - AERMET_UStar_15181_AERMOD_15181_LOWWIND3](#) (ZIP, 13.1MB)
[Test Case - MAXDCONT](#) (ZIP, 4.3MB)

Installation Guide (Sample Run)

[Read Me](#) (TXT, 1KB) - please read this file first
[Sample Run Instructions](#) (PDF, 250KB) - detailed installation and execution instructions
[Sample Run](#) (ZIP, 1.3MB) - sample test case

Model Supporting Documents

[Model Evaluation Paper](#) (PDF, 1.3MB)
[Bulk Richardson Number Evaluation Report](#) (PDF, 329KB)
[Comparison of Regulatory Design Concentrations: AERMOD vs ISCST3, CTDMPPLUS, ISC-PRIME](#) (PDF, 311KB)
[Development and Evaluation of the PRIME Plume Rise and Building Downwash Model](#) (PDF, 31KB)
[Project PRIME: Evaluation of Building Downwash Models Using Field and Wind Tunnel Data](#) (PDF, 18KB)
[Development and Evaluation of the PRIME Plume Rise and Building Downwash Model](#) (PDF, 588KB)
[Evaluation of Bias in AERMOD-PVMRM](#) (PDF, 236KB)
[PVMRM and OLM Sensitivity Analysis](#) (PDF, 522KB)
[Ambient Ratio Method Version 2 \(ARM2\) Development and Evaluation Report](#) (PDF, 2.2MB)
[AERMOD Deposition Science Document](#) (PDF, 196KB)
[AERMOD Deposition Parameterizations Document](#) (ZIP, 338KB)
[Draft Peer Review Document](#) (ZIP, 797KB) - For the AERMOD Deposition Parameterizations Document (above)

Model Evaluation Databases

[README](#) (TXT, 1KB) - Document that explains the databases below that contain input and output data for the model evaluation
[AGA](#) (ZIP, 2.1MB) - Input/output data for AGA: Flat, Rural, Downwash, Independent
[Alaska](#) (ZIP, 0.7MB) - Input/output data for Alaska: Flat, Rural Downwash, Developmental
[Baldwin](#) (ZIP, 4.6MB) - Input/output data for Baldwin: Flat, Rural, Non-downwash, Independent
[Bowline](#) (ZIP, 1.8MB) - Input/output data for Bowline: Flat, Rural, Downwash, Developmental/Independent
[Clifty Creek](#) (ZIP, 3.5MB) - Input/output data for Clifty Creek: Flat, Rural, Non-downwash, Independent
[DAEC](#) (ZIP, 1.1MB) - Input/output data for DAEC: Flat, Rural, Downwash, Developmental
[EOCR](#) (ZIP, 4.3MB) - Input/output data for EOCR: Flat, Rural, Downwash, Independent
[Indianapolis](#) (ZIP, 1.3MB) - Input/output data for Indianapolis: Flat, Urban, Non-downwash, Developmental
[Kincaid SF6](#) (ZIP, 3.1MB) - Input/output data for Kincaid SF6: Flat, Rural, Non-downwash, Developmental
[Kincaid SO2](#) (ZIP, 5.6MB) - Input/output data for Kincaid SO2: Flat, Rural, Non-downwash, Developmental
[Lee Wind Tunnel](#) (ZIP, 13.4MB) - Input/output data for Lee Wind Tunnel: Flat, Rural, Downwash, Independent
[Lovett](#) (ZIP, 9.0MB) - Input/output data for Lovett: Terrain, Rural, Non-downwash, Developmental
[Martin's Creek](#) (ZIP, 11.5MB) - Input/output data for Martin's Creek: Terrain, Rural, Non-downwash, Independent
[Millstone](#) (ZIP, 0.6MB) - Input/output data for Millstone: Flat, Rural, Downwash, Developmental
[Prairie Grass](#) (ZIP, 0.4MB) - Input/output data for Prairie Grass: Flat, Rural, Non-downwash, Developmental
[Tracy](#) (ZIP, 2.4MB) - Input/output data for Tracy: Terrain, Rural, Non-downwash, Independent
[Westvaco](#) (ZIP, 10.1MB) - Input/output data for Westvaco: Terrain, Rural, Non-downwash, Independent

CALPUFF Modeling System

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. CALPUFF can be applied on scales of tens to hundreds of kilometers. It includes algorithms for subgrid scale effects (such as terrain impingement), as well as, longer range effects (such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, and visibility effects of particulate matter concentrations).

--Please read the following before accessing the CALPUFF modeling system--

The files associated with this system, e.g., executables/source code, preprocessors, associated utilities, test cases, selected meteorological data sets and documentation can be found on Exponent's website. Support documents related to CALPUFF can be found on this website and are listed below. Exponent will provide updates and changes as necessary for the CALPUFF modeling system on their website. Users entering the Exponent website will have the opportunity to register their e-mail addresses in order to receive notices of any updates to the system. This registration is voluntary and not necessary to access the system files.

Upon entering the Exponent website, you will see the CALPUFF Model listing on the left-hand panel. To access the system code, click on "DOWNLOAD", then click on Skip Registration if you do not want to register. Go to [Exponent](#) [\[EXIT Disclaimer\]](#)

CALPUFF Regulatory Updates and Consequence Analysis

The current regulatory version of the CALPUFF Modeling System includes:

- CALPUFF version 5.8.5, level 151214
- CALMET version 5.8.5, level 151214
- CALPOST version 6.221, level 080724

For every update of the "EPA-Approved" version of the CALPUFF Modeling System, a consequence analysis is performed by USEPA using an update protocol that identifies what model changes have been made and their implications based on the analysis results. This analysis compares the base CALPUFF Modeling System (i.e., current regulatory version) with the beta (i.e., proposed updated version).

Summary of Update Process**07-26-16 UPDATE**

The USEPA has approved an update of CALMET and CALPUFF from V5.8.4 (dated July 31, 2013) to V5.8.5 (dated December 14, 2015). This update includes code changes described in Model Change Bulletin H ([MCB-H](#)). These changes include fixes to bugs in the implementation of PRIME downwash, along with updates to eliminate specific compilation and list file errors.

12-04-13 UPDATE

The USEPA has approved an update of CALMET and CALPUFF from V5.8 (dated June 23, 2007) to V5.8.4 (dated July 31, 2013). This update includes portions of code changes described in Model Change Bulletin E ([MCB-E](#)), [MCB-F](#) and [MCB-G](#). The USEPA has approved only those portions of the Model Change Bulletins that are recognized as bug fixes. All other code changes (enhancements and new features) are not included at this time. A [Modification of CALPUFF and CALMET Memorandum](#) is available and describes bug fixes versus enhancements in this update of CALPUFF and CALMET. Note that the EPA-Approved version of CALPOST remains V6.221 (level 080724).

08-27-12 UPDATE

The EPA-Approved version of CALPOST has been updated from version 5.6394 (level 070622) to version 6.221 (level 080724). Version 6.221 includes "Method 8" (MVISBK = 8, M8_MODE = 5, MVISCHECK = 1), which utilizes the revised IMPROVE equation per the Federal Land Managers' Air Quality Related Values Work Group (FLAG) revised October 2010 [Phase 1 Report](#). This update only effects CALPOST and no other program in the CALPUFF System of programs. The EPA-approved version of CALPUFF remains version 5.8 (level 070623), and the EPA-Approved version of CALMET is still version 5.8 (level 070623).

02-15-12 UPDATE

The USEPA is releasing the [Documentation of the Evaluation of CALPUFF and Other Long Range Transport Models using Tracer Field Experiment Data](#) (EPA Contract No: EP-D-07-102, Work Assignment No: 4-06). This EPA report documents the evaluation of various Long Range Transport (LRT) dispersion models using several inert tracer study field experiment data. The tracer studies used include:

- 1) 1980 Great Plains Field Experiment (GP80),
- 2) 1975 Savannah River Laboratory Field Experiment (SRL75),
- 3) Cross Appalachian Tracer Experiment (CAPTEX), and
- 4) European Tracer Experiment (ETEX).

The LRT dispersion modeling was performed primarily by the U.S. Environmental Protection Agency (EPA) during 2008 to 2010 and builds off several previous LRT dispersion modeling studies that evaluated models using tracer study field experiments. The work was performed primarily by Mr. Bret Anderson while he was with EPA Region VII, EPA/OAQPS and the United States Forest Service (USFS).

Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

05-27-09 UPDATE

The USEPA is releasing the DRAFT document [Reassessment of the Interagency Workgroup on Air Quality Modeling \(IWAQM\) Phase 2 Summary Report: Revisions to Phase 2 Recommendations](#) at this time to provide additional technical information in support of the [May 15, 2009 Model Clearinghouse recommendations](#) to U.S. EPA Region 8 regarding the Otter Tail BART modeling protocol. The purpose of this document is to inform the modeling community of our concerns regarding the CALPUFF modeling system for long range transport (LRT) applications, and to notify the community of our plans for addressing these concerns. The draft revisions to the IWAQM Phase 2 recommendations provided in this document are still undergoing internal testing to assess their viability for meeting the technical objectives of this reassessment. Some sections are still under development and will be incorporated in future updates to the DRAFT document.

06-29-07 UPDATE

The USEPA has approved an update in CALPUFF from V5.711a (dated July 16, 2004) to V5.8 (dated June 23, 2007). This update includes code changes described in Model Change Bulletin B ([MCB-B](#)), [MCB-C](#) and [MCB-D](#). CALMET has been updated from V5.53a (dated July 16, 2004) to V5.8 (dated June 23, 2007). The new codes are based on the VISTAS-series codes (CALPUFF V5.756 and CALMET V5.726) with the main changes being the addition of a regulatory switch in CALMET and switch settings recommended by the USEPA to configure the models to be consistent with the prior regulatory versions. A [Model Update Report](#) is available and describes the CALPUFF and CALMET updates in greater detail.

06-15-06 UPDATE

The USEPA has approved an update to CALPUFF from v5.7 (dated April 2, 2003) to v5.711a (dated July 16, 2004) as described in Model Change Bulletin A ([MCB-A](#)).

Support Documents

[A Comparison of CALPUFF Modeling Results To Two Tracer Field Experiments.](#) (1998) 48 pages

[An Analysis of the Calmet/Calpuff Modeling System In A Screening Mode.](#) (1998) 56 pages.

[A Comparison of CALPUFF with ISC3.](#) (1998) 50 pages

[Application of CALMET/CALPUFF and MESOPUFF II to Compare Regulatory Design Concentrations for a Typical Long-Range Transport Analysis.](#) (2002) 88 pp.

[Peer Review of Calmet/Calpuff Modeling System.](#) (1998) 40 pp. Note: Part of Appendix F and all of Appendix G are unavailable in electronic form.

[Response to Peer Review Comments of Calmet/Calpuff Modeling System.](#) (1998) 5 pages.

[Technical Issues Related to CALPUFF Near-field Applications.](#) (2008) 16 pages

Support Literature

Bennett, M.J, M.E. Yansura, I.G. Hornyik, J.M. Nall, D.G. Caniparoli and C.G. Ashmore, 2002. Evaluation of the CALPUFF Long-range Transport Screening Technique by Comparison to Refined CALPUFF Results for Several Power Plants in Both the Eastern and Western United States. Proceedings of the Air & Waste Management Association's 95th Annual Conference, June 23-27, 2002; Baltimore, MD. Paper #43454.

Levy, JI; Spengler, JD; Hlinka, D; Sullivan, D; Moon, D (2002): Using CALPUFF to evaluate the impacts of power plant emissions in Illinois: mode sensitivity and implications. Atmos. Environ. Vol 36(6):1063-1075.

Zhou, Y; Levy, JI; Hammitt, JK; Evans, JS (2003): Estimating population exposure to power plant emissions using CALPUFF: a case study in Beijing, China. Atmos. Environ. Vol. 37(6):815-826

Other Preferred/Recommended Dispersion Models

BLP

BLP is a Gaussian plume dispersion model designed to handle unique modeling problems associated with aluminum reduction plants, and other industrial sources where plume rise and downwash effects from stationary line sources are important.

Model Code

[Code/Executable/Test Cases/Post-processors](#) (ZIP, 213KB)

Model Documentation

[User's Guide](#) (PDF, 5.8MB)

[User's Guide Addendum](#) (PDF, 505KB)

[Model Change Bulletin](#) (TXT, 1KB)

CALINE3

CALINE3 is a steady-state Gaussian dispersion model designed to determine air pollution concentrations at receptor locations downwind of highways located in relatively uncomplicated terrain. CALINE3 is incorporated into the more refined [CAL3QHC](#) and [CAL3QHCR](#) models.

Model Code

[Code/Executable/Test Case](#) (ZIP, 442KB)

Model Documentation

[User's Guide - Unabridged](#) (PDF, 7.6MB)

[User's Guide - Abridged](#) (PDF, 108KB)

Latest [Model Change Bulletin](#) (TXT, 6KB)

CAL3QHC/CAL3QHCR

CAL3QHC is a CALINE3 based CO model with queuing and hot spot calculations and with a traffic model to calculate delays and queues that occur at signalized intersections; CAL3QHCR is a more refined version based on CAL3QHC that requires local meteorological data. Both models are available below.

Model Code

CAL3QHC [Executable](#) (ZIP, 235KB)

CAL3QHCR [Executable](#) (ZIP, 917KB)

Model Documentation

CAL3QHC [User's Guide](#) (PDF, 2.4MB)

Latest CAL3QHC [Model Change Bulletin](#) (TXT, 5KB)

CAL3QHCR [User's Guide](#) (PDF, 209KB)

Latest CAL3QHCR [Model Change Bulletin](#) (TXT, 3KB)

CTDMPLUS

Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS) is a refined point source gaussian air quality model for use in all stability conditions for complex terrain. The model contains, in its entirety, the technology of CTDM for stable and neutral conditions. [CTSCREEN](#) is the screening version of CTDMPLUS.

Model Code

[Code/Executable/Test Case](#) (ZIP, 842KB)

Model Documentation

[User's Guide Supplement](#) (PDF, 60KB)

[User's Guide, Volume 1](#) (PDF, 7MB)

[User's Guide, Volume 2](#) (PDF, 2MB)

[User's Guide for Terrain Preprocessor](#) (PDF, 6MB)

[User's Guide for Meteorological Preprocessor](#) (PDF, 5MB)

[Final Report](#) (PDF, 16MB)

Latest [Model Change Bulletin](#) (TXT, 5KB)

OCD

Offshore and Coastal Dispersion Model Version 5 (OCD) is a straight line Gaussian model developed to determine the impact of offshore emissions from point, area or line sources on the air quality of coastal regions. OCD incorporates overwater plume transport and dispersion as well as changes that occur as the plume crosses the shoreline. Hourly meteorological data are needed from both offshore and onshore locations.

Model Code

[Code/Executable](#) (ZIP, 8.6MB)

Model Documentation

[User's Guide](#) (ZIP, 369MB)

[User's Guide Supplement](#) (PDF, 3.0MB)

[Latest Model Change Bulletin](#) (TXT, 6KB)

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