Meteorological Data & CALMET

If the Federal Land Manager (FLM) indicates that a Class I area evaluation is necessary prior to permit issuance, and the facility is located greater than 50-kilometers from a Class I area, a refined air quality impact analysis using the CALPUFF modeling system will be required. Refined air quality analyses utilize real-world meteorological data inputs, comprehensive receptor grids and site-specific source characterizations. This document focuses on the meteorological data inputs that are required for input into the CALPUFF model.

The CALMET meteorological model contained within the CALPUFF modeling system should be used to develop a three-dimensional gridded modeling domain containing hourly wind and temperature fields. The CALMET meteorological processor produces a collection of atmospheric variables for each grid cell and time step specified by the user. These variables include wind direction, wind speed, temperature, atmospheric turbulence parameters and vertical profiles. Because the meteorological variables produced by CALMET are output on a grid cell by grid cell basis, the grid resolution chosen by the user can directly impact the location at which maximum impacts are predicted to occur. As such, the FLM should be consulted to ensure that proper grid spacing is assigned.

During initial processing, CALMET develops an initial guess wind field that is adjusted for the kinematic effects of terrain, terrain blocking, and slope flows to produce a first guess wind field that will be "nudged" by hourly observational data. Additionally, the user should input prognostic wind data obtained from the gridded output of the MM5 meteorological model as the initial guess wind field prior to the application of adjustments for kinematic effects. The introduction of prognostic data should enhance the accuracy of the initial wind field provided the prognostic outputs have undergone a thorough performance evaluation.

During the second phase of processing, CALMET introduces observational data into the system using an objective analysis approach after the development of the first guess wind field. In regions where observational data is available, the wind field will be heavily influenced by the data collected at National Weather Service and local meteorological stations. In areas where no observational data is available, the final wind field relies on the first step wind field described above.

The applicant is required to develop a modeling domain that is designed to accept prognostic wind data from the MM5 meteorological database for a minimum three year period. A five year data period is preferred if the MM5 data is available. The grid resolution utilized in the development of the prognostic model output for each year considered should be incorporated into the Class I analysis. The CALMET domain should utilize a UTM coordinate system with ten vertical layers and an initial horizontal array based upon the extent of the domain that is necessary to encompass the source in question and the Class I area being considered. Two-kilometer grid resolution is preferred but can be altered based upon the size and extent of the meteorological domain. Each year modeled should include surface, upper air, and precipitation sites located throughout the modeling domain based upon the default options that have been assigned by the FLM.

The most recent version of the CALMET meteorological model should be used unless prior approval for the use of an alternate version or alternate model has been obtained from the FLM. The Environmental Protection Agency maintains a website, the Support Center for Regulatory Atmospheric Modeling (SCRAM) Dispersion Modeling | TTN - Support Center for Regulatory Atmospheric Modeling | US EPA, that provides links to the preferred/recommended models that are currently in use.

CALMET Keyword Reference

Table 1 contains a listing of all required CALMET inputs for far field Class I area impact assessments. The keyword reference provides guidance on those items that are default values and those that are user defined values. If a CALMET keyword is not present in Table 1, it is likely that the keyword is not required or is not acceptable for use in a Class I analysis. For example, the FLMs require applicants to input three to five years of mesoscale meteorological data into the CALPUFF system. Because other meteorological inputs are not suggested for use, they are not contained within Table 1.

Table 1
CALMET Keyword Reference & Default Input Values

Keyword	Description	Default Value	Required?
GEO.DAT	Geophysical Data File	User Defined	Yes
SURF.DAT	National Weather Service Surface Met Data	User Defined	Yes
CLOUD.DAT	National Weather Service Cloud Data	User Defined	No
PRECIP.DAT	National Weather Service Precipitation Data	User Defined	Yes
CALMET.LST	Meteorological Data Output File	User Defined	Yes
CALMET.DAT	CALMET Output File for Input into CALPUFF	User Defined	Yes
NUSTA	Number of Upper Air Stations	User Defined	Yes
NOWSTA	Number of Overwater Met Sites	User Defined	Yes
UPDAT	Upper Air File	User Defined	Yes, Repeatable, One Station Per Line
IBYR	Starting Year	User Defined	Yes
IBMO	Starting Month	User Defined	Yes
IBDY	Starting Day	User Defined	Yes
IBHR	Starting hour	User Defined	Yes
IBTZ	Time Zone	6	Yes
IRLG	Length of Run in Hours	User Defined	Yes
IRTYPE	Run Type	1 = Wind Fields and Micro-Met Variables	Yes
LCALGRD	Compute Spatial Data Fields for CALGRID	T	Yes
UTM	Map Projection	UTM	Yes
FEAST	False Easting for Map Projection Origin	0.00	Yes
FNORTH	False Northing for Map Projection Origin	0.00	Yes
IUTMZN	UTM Zone	15	Yes
UTMHEM	Hemisphere for UTM Projection	N = Northern	Yes
RLAT0	Latitude for Projection Origin	35.367N	Yes
RLON0	Longitude for Projection Origin	94.01W	Yes
XLAT1	Matching Parallels of Latitude	36N	Yes

Keyword	Description	Default Value	Required?
XLAT2	Matching Parallels of Latitude	40N	Yes
DATUM	Datum	WGS-84	Yes
NX	Number of Grid Cells in X-Direction	User Defined	Yes
NY	Number of Grid Cells in Y-Direction	User Defined	Yes
DGRIDKM	Grid Spacing	User Defined	Yes
XORIGKM	Reference Coordinate of SW Corner	User Defined	Yes
YORIGKM	Reference Coordinate of SW Corner	User Defined	Yes
NZ	Number of Vertical Layers	10	Yes
ZFACE	Cell Face Heights	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000	Yes
LSAVE	Save Met Files in Unformatted Output?	T = Yes	Yes
IFORMO	Unformatted Output Type	1 = CALPUFF	Yes
LPRINT	Print Met Files?	F = No	Yes
IPRINF	Print Interval in Hours	1	Yes
IUVOUT	Specify Layers of U, V Wind Component to Print	NZ * 0	Yes
IWOUT	Specify Levels of W Wind Component to Print	NZ * 0	Yes
ITOUT	Specify Levels of 3D Temperature Field to Print	NZ * 0	Yes
LDB	Print Input Met and Internal Variables?	F = No	Yes
NN1	First Time Step for Debug Data	1	Yes
NN2	Last Time Step for Debug Data	2	Yes
IOUTD	Control Variable for Writing the Test/Debug Wind Fields to Disk Files	0 = Do Not Write	Yes
NZPRN2	Number of Levels Starting at Surface to Print	1	Yes
IPR0	Print Interpolated Wind Components?	0 = No	Yes
IPR1	Print Terrain Adjusted Surface Wind Components?	0 = No	Yes
IPR2	Print Smoothed Wind Components and Initial Divergence Fields?	0 = No	Yes
IPR3	Print Final Wind Speed and Direction?	0 = No	Yes
IPR4	Print Final Divergence Fields?	0 = No	Yes
IPR5	Print the Wind After Kinematic Effects?	0 = No	Yes
IPR6	Print the Wind After Froude Number?	0 = No	Yes
IPR7	Print the Wind After Slope Flows?	0 = No	Yes
IPR8	Print Final Wind Components?	0 = No	Yes
NOOBS	No Observation Mode	0 = Use Surface, Overwater and Upper Air Stations	Yes
NSSTA	Number of Surface Stations	User Defined	Yes
NPSTA	Number of Precipitation Stations	User Defined	Yes
ICLOUD	Gridded Cloud Fields	0 = Gridded Clouds Not Used	Yes
IFORMS	Surface Met Data File Format	2 = Formatted	Yes
IFORMP	Precipitation Data File Format	2 = Formatted	Yes
IFORMC	Cloud Data File Format	2 = Formatted	Yes
IWFCOD	Model Selection Variable	1 = Yes	Yes
IFRADJ	Compute Froude Number Adjustment?	1 = Yes	Yes
IKINE	Compute Kinematic Effects?	0 = No	Yes

Keyword	Description	Default Value	Required?
IOBR	Use O'Brien Procedure for Adjustment?	0 = No	Yes
ISLOPE	Compute Slope Flow Effects?	1 = Yes	Yes
IEXTRP	Extrapolate Surface Wind Observations?	-4 = Similarity Theory, Layer 1 Upper Air Stations Ignored	Yes
ICALM	Extrapolate Surface Winds Even If Calm?	0 = No	Yes
BIAS	Layer-dependent Biases Modifying Weight of Surface and Upper Air Stations	-1 , -0.8 , -0.6 , -0.6 , -0.4 , -0.4 , -0.2 , 0 , 0 , 0 , 0 , 0	Yes
RMIN2	Minimum Distance from Nearest Upper Air Station	4	Yes
IPROG	Use Gridded prognostic Wind Field Model Outputs as Input into Diagnostic Wind Field Model?	0 = No	Yes
ISTEPPG	Time Step for Prognostic Model Input Data	1	Yes
LVARY	Use Varying Radius of Influence?	F = No	Yes
RMAX1	Maximum Radius of Influence over Land in Surface Layer	50	Yes
RMAX2	Maximum Radius of Influence over Land Aloft	500	Yes
RMAX3	Maximum Radius of Influence over Water	50	Yes
RMIN	Minimum Radius of Influence Used in the Wind Field Interpolation	0.1	Yes
TERRAD	Radius of Influence of Terrain Features	20	Yes
R1	Relative Weighting of the First Guess Field and Observations in the SURFACE Layer	20	Yes
R2	Relative Weighting of the First Guess Field and Observations in the Layers ALOFT	50	Yes
RPROG	Relative Weighting Parameter of the Prognostic Wind Field Data	0	Yes
DIVLIM	Maximum Acceptable Divergence in the Divergence Minimization Procedure	5.0E-06	Yes
NITER	Maximum Number of Iterations in the Divergence Min. Procedure	50	Yes
NSMTH	Number of Passes in the Smoothing Procedure	2 , 4 , 4 , 4 , 4 , 4 , 4, 4 , 4 , 4 , 4 , 4	Yes
NINTR2	Maximum Number of Stations Used in Each Layer for the Interpolation of Data to a Grid Point	99 , 99 , 99 , 99 , 99 , 99 , 99 , 99 , 99 , 99 , 99 , 99	Yes
CRITFN	Critical Froude Number	1	Yes
ALPHA	Empirical Factor Controlling the Influence of Kinematic Effects	0.1	Yes
FEXTR2	Multiplicative Scaling Factor for Extrapolation of Surface Observations to Upper Layers	0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.	Yes
NBAR	Number of Barriers to Interpolation of the Wind Fields	0	Yes
XBBAR	X Coordinate of BEGINNING of Each Barrier	0	Yes
YBBAR	Y Coordinate of BEGINNING of Each Barrier	0	Yes
XEBAR	X Coordinate of ENDING of Each Barrier	0	Yes

Keyword	Description	Default Value	Required?
YEBAR	Y Coordinate of ENDING of Each Barrier	0	Yes
IDIOPT1	Surface Temperature	0	Yes
ISURFT	Surface Met. Station to Use for the Surface Temperature	User Defined	Yes
IDIOPT2	Domain-Averaged Temperature Lapse rate	0 = Compute Internally from Twice-Daily Upper Air Observations	Yes
IUPT	Upper Air Station to Use for the Domain-Scale Lapse Rate	User Defined	Yes
ZUPT	Depth Through Which the Domain-Scale Lapse Rate is Computed	200	Yes
IDIOPT3	Domain-Averaged Wind Components	0 = Compute Internally from Twice-Daily Upper Air Observations	Yes
IUPWND	Upper Air Station to Use for the Domain-Scale Winds	-1	Yes
ZUPWND	Bottom and Top of Layer Through Which the Domain-Scale Winds are Computed	1, 1000	Yes
IDIOPT4	Observed Surface Wind Components for Wind Field Module	0 = Read WS and WD from Surface File	Yes
IDIOPT5	Observed Upper Air Wind Components for Wind Field Module	0 = Read WS and WD from Upper Air File	Yes
LLBREZE	Use Lake Breeze Module	F	Yes
NBOX	Number of Lake Breeze Regions	0	Yes
XG1	X Grid line 1 Defining the Region of Interest	0	Yes
XG2	X Grid line 2 Defining the Region of Interest	0	Yes
YG1	Y Grid line 1 Defining the Region of Interest	0	Yes
YG2	Y Grid line 2 Defining the Region of Interest	0	Yes
XBCST	X Point Defining the Coastline	0	Yes
YBCST	Y Point Defining the Coastline	0	Yes
XECST	X Point Defining the Coastline	0	Yes
YECST	Y Point Defining the Coastline	0	Yes
NLB	Number of Stations in the Region	0	Yes
CONSTB	Neutral, Mechanical Equation	1.41	Yes
CONSTE	Convective Mixing Ht. Equation	0.15	Yes
CONSTN	Stable Mixing Ht. Equation	2400	Yes
CONSTW	Overwater Mixing Ht. Equation	0.16	Yes
FCORIOL	Absolute Value of Coriolis Parameter	1.0E-04	Yes
IAVEZI	Conduct Spatial Averaging?	1 = Yes	Yes
MNMDAV	Max. Search Radius in Averaging Process	1	Yes
HAFANG	Half-angle of Upwind Looking Cone for Averaging	30	Yes
ILEVZI	Layer of Winds Used in Upwind Averaging	1	Yes
DPTMIN	Minimum Potential Temperature Lapse Rate in the Stable Layer Above the Current Convective Mixing Ht.	0.001	Yes
DZZI	Depth of Layer Above Current Conv. Mixing Height	200	Yes

Keyword	Description	Default Value	Required?
ZIMIN	Minimum Overland Mixing Height	50	Yes
ZIMAX	Maximum Overland Mixing Height	3000	Yes
ZIMINW	Minimum Overwater Mixing Height	50	Yes
ZIMAXW	Maximum Overwater Mixing Height	3000	Yes
ITPROG	3D temperature from Observations or from Prognostic Data?	0 = Use Surface and Upper Air Stations	Yes
IRAD	Interpolation Type	1 = 1/R	Yes
TRADKM	Radius of Influence for Temperature Interpolation	500	Yes
NUMTS	Maximum Number of Stations to Include in Temperature Interpolation	5	Yes
IAVET	Conduct Spatial Averaging of Temperatures	1 = Yes	Yes
TGDEFB	Default Temperature Gradient Below the Mixing Height Over Water	-0.0098	Yes
TGDEFA	Default Temperature Gradient Above the Mixing Height Over Water	-0.0045	Yes
JWAT1	Beginning Land Use Categories for Temperature Interpolation Over Water	999	Yes
JWAT2	Ending Land Use Categories for Temperature Interpolation Over Water	999	Yes
NFLAGP	Method of Precipitation Interpolation	2	Yes
SIGMAP	Radius of Influence	70	Yes
CUTP	Minimum Precipitation Rate Cutoff	0.01	Yes
Surface Stations	Surface Meteorological Station Parameters	User Defined	Yes, Repeatable, One Station Per Line
Upper Air Stations	Upper Air Meteorological Station Parameters	User Defined	Yes, Repeatable, One Station Per Line
Precipitation Stations	Precipitation Meteorological Station Parameters	User Defined	Yes, Repeatable, One Station Per Line

Again, this document merely provides a summary of the data elements that are required to be incorporated into a refined air quality impact analysis. Detailed information on specific modeling procedures should be reviewed and approved by the FLM.