UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

AUG 3 1 2009

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Clarification on EPA-FLM Recommended Settings for CALMET

TO: Regional Modeling Contacts

FROM: Tyler J Fox, Group Leader
Air Quality Modeling Group, C439-01

The purpose of this memorandum is to update the draft recommendations for CALMET settings that were provided previously with the draft *Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations* (EPA, 2009).

On May 15, 2009, the EPA Model Clearinghouse issued a memorandum addressing a number of issues related to the operation of the CALMET diagnostic meteorological model in regulatory modeling applications for long-range transport (LRT). Additionally, a draft version of revisions to the existing IWAQM Phase 2 guidance was released on May 27, 2009 to provide technical context for the Clearinghouse memorandum. This draft document outlined a series of recommendations for CALMET settings that were intended to facilitate the direct "pass-through" of prognostic meteorological data to the CALPUFF modeling system using the same horizontal and vertical grid structure of the parent prognostic data set. This purpose is consistent with one of our overarching goals expressed at the 8th Conference on Air Quality Modeling promoting the use of prognostic meteorological model products in regulatory dispersion modeling applications.

Due to the time sensitive nature of the Clearinghouse memorandum, it was not possible to complete extensive testing of the recommended CALMET operational settings prior to release of the memorandum and draft IWAQM reassessment report. Subsequent testing of the CALMET model with the proposed settings against mesoscale tracer databases indicates that CALMET/CALPUFF performance using the draft recommendations deteriorates somewhat in comparison to other MM5/CALMET horizontal grid configurations that were tested. Specifically, testing against the Cross-Appalachian Tracer Experiment (CAPTEX) mesoscale tracer study dataset showed that when MM5 and CALMET were run on the same horizontal grid resolution, performance was poorer than other MM5/CALMET grid configurations tested. While the performance deterioration was not drastic, it was significant. These results have caused us to reconsider our interim guidance because it is inconsistent with our desire to promote the use of both the best meteorological products and prognostic data in general. The use of

CALMET as a vehicle to "pass-through" MM5 or other numerical weather prediction (NWP) model data is no longer considered viable.

The EPA has dedicated considerable time and resources to the evaluation of the use of NWP data in conjunction with the CALMET/CALPUFF modeling system. As discussed in the draft IWAQM reassessment report, there are technical limitations to the applicability of diagnostic wind field models that together with advances in NWP model technology and resolution make the fuller use of NWP model data an attractive alternative. The draft IWAQM reassessment document also discusses EPA's intention to transition to the full use of NWP model data rather than continue reliance upon wind fields from DWMs for LRT applications. Therefore, rather than continue to dedicate time and resources to evaluating configurations for CALMET that would facilitate a direct "pass-through" of NWP data, EPA will focus its efforts toward expediting the testing and review of its MM5/WRF-to-CALPUFF software prototype discussed at the 9th Conference on Air Quality Modeling in anticipation of an early 2010 release.

In the interim, a revised series of recommendations for CALMET settings were agreed upon during a recent meeting with modelers from EPA and the Federal Land Manager (FLM) community. Therefore, as discussed during the EPA modelers' conference call on August 19th, the EPA Model Clearinghouse is providing all of the Regional Modeling Contacts with the attached revised list of recommended switch settings for CALMET. These recommendations are based in large part upon the understanding we have developed from the numerous tracer evaluations we have conducted in addition to the collective experience of the National Park Service, Forest Service, and US Fish and Wildlife from the BART process. In general the recommendations are based upon values from the VISTAS BART modeling protocol with limited modifications based on our internal testing.

As attached, these updated recommendations supersede the recommendations from the draft IWAQM reassessment report. While the draft IWAQM recommendations intended to configure CALMET to facilitate a direct "pass-through" of MM5 data are no longer considered viable, our position regarding grid resolution presented in the May 15, 2009, Model Clearinghouse memorandum have not changed. In particular, we wish to call to your attention that in most circumstances it is considered inappropriate to consider CALMET horizontal grid resolutions of less than four (4) kilometers, consistent with our discussion in the May 15, 2009 Model Clearinghouse memorandum. It is anticipated that the FLMs will likewise require adherence to these recommendations for modeling conducted pursuant to the Class I AQRV requirements of the PSD program. In those cases, it is important to remember that the FLMs have the affirmative responsibility for AQRV related studies, and usually take the lead in negotiating the protocol for model settings (per Section 6.2.3 of the *Guideline on Air Quality Models*, Appendix W to 40 CFR Part 51).

REFERENCES

USEPA, 2009: Reassessment of the Interagency Workgroup on Air Quality Modeling (IWAQM) Phase 2 Summary Report: Revisions to Phase 2 Recommendations (Draft). EPA- EPA-454/B-09-XXX, Research Triangle Park, NC, 56 pp.

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EPA-FLM Recommended CALMET Input File Values

August 28, 2009

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
0 - Input and output file names	a	GEODAT	Input filename of geophysical data	GEO.DAT	User defined
		SRFDAT	Input filename of hourly meteorological data	SURF.DAT	User defined
		CLDDAT	Input filename of gridded cloud data	CLOUD.DAT	
		PRCDAT	Input filename of hourly precipitation data	PRECIP.DAT	User defined
		WTDAT	Input filename of gridded fields of terrain weighting factors	WT.DAT	
		METLST	Output filename of list file	CALMET.LST	User defined
		METDAT	Output filename of generated gridded met fields	CALMET.DAT	User defined
		PACDAT	Output filename of generated gridded met files (MESEOPUFF II)	PACOUT.DAT	
		LCFILES	Convert names to upper or lower case	User defined	T
		NUSTA	Number of upper air stations	User defined	User defined (>0)
		NOWSTA	Number of over water met stations	User defined	User defined
		NM3D	Number of MM4/MM5/3D.DAT files	User defined	User defined (>0)
		NIGF	Number of coarse grid CALMET fields as initial guess fields	User defined	0
	b	UPDAT	Input filenames of upper air data	UPn.DAT (n=1,2,3...)	User defined
	c	SEADAT	Input filename of over water stations	SEAn.DAT (n=1,2,3;..)	User defined
	d	M3DDAT	Input filename of MM4/MM5/3D.DAT	MM50n.DAT	User defined
	e	IGFDAT	Input filename of IGF-CALMET files	IGFn.DAT (n=1,2,3...)	
	f	DIADAT	Input filename of preprocessed sfc/UA data	DIAG.DAT	
		PRGDAT	Input filename of prognostic gridded wind fields	PROG.DAT	
		TSTPRT	Output filename of intermediate winds, and misc...etc	TEST.PRT	

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		TSTOUT	Output filename of final wind fields	TEST.OUT	
		TSTKIN	Output filename of wind fields after kinematic winds	TEST.KIN	
		TSTFRD	Output filename of winds after Froude Number effects	TEST.FRD	
		TSTSLP	Output filename winds after slope effects	TEST.SLP	
		DCSTGD	Output filename of distance land internal variables	DCST.GRD	
1 - General run and control parameters		IBYR	Beginning year	User defined	User defined
		IBMO	Beginning month	User defined	User defined
		IBDY	Beginning day	User defined	User defined
		IBHR	Beginning hour	User defined	User defined
		IBTZ	Base time zone	User defined	User defined
		IRLG	Length of run (hours)	User defined	User defined
		IRTYPE	Output type to create	1	1
		LCALGRD	Require fields for CALGRID	T	T
		ITEST	Flag to stop run after setup phase	2	2
		MREG	Conformity to regulatory values	User defined	1
2 - Map projection and grid control parameters		PMAP	Map projection	UTM	LCC
		FEAST	False Easting at projection origin (km)	0.0	0.0
		FNORTH	False northing at projection origin (km)	0.0	0.0
		IUTMZN	UTM zone	User defined	-999
		UTMHEM	Hemisphere of UTM projection	N	N
		RLAT0	Latitude of projection origin (decimal degrees - N)	User defined	User defined
		RLON0	Longitude of projection origin (decimal degrees - W)	User defined	User defined
		XLAT1	Matching latitude for projection (decimal degrees - N)	User defined	User defined

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		XLAT2	Matching latitude of projection (decimal degrees - N)	User defined	User defined
		Datum	Datum-region of output coordinates	WGS-84	User defined
		NX	Number of east to west or X grid cells	User defined	User defined
		NY	Number of north to south or Y grid cells	User defined	User defined
		DGRIDKM	Grid spacing in kilometers (km)	User defined	User defined (≥4km)
		XORIGKM	Southwest corner of grid cell (1,1), X-coordinate (km)	User defined	User defined
		YORIGKM	Southwest corner of grid cell (1,1), Y-coordinate (km)	User defined	User defined
		NZ	Number of vertical layers	User defined	10
		ZFACE	Cell face heights in arbitrary vertical grid (ZFACE (NZ+1)) (m)	User defined	0,20,40,80,160,320, 640,1200,2000,3000, 4000
3 - Output options		LSAVE	Save met fields in unformatted file	T	T
		IFORMO	Type of unformatted output file	1	1
		LPRINT	Print met fields	F	F
		IPRINF	Print interval in hours	1	1
		IUVOUT	Layers of U, V wind components to print (IUVOUT (NZ))	NZ*0	10*0
		IWOUT	Levels of W wind component to print (IWOUT (NZ))	NZ*0	10*0
		ITOUT	Levels of 3-D temps to print (ITOUT (NZ))	NZ*0	10*0
		STABILITY	Print PGT Stability	0	0
		USTAR	Print friction velocity	0	0
		MONIN	Print Monin-Obukhov	0	0
		MIXHT	Print mixing height	0	0
		WSTAR	Print convective velocity scale	0	0
		PRECIP	Print precipitation rate	0	0

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		SENSHEAT	Print sensible heat flux	0	0
		CONVZI	Print convective mixing height (Zic)	0	0
		LDB	Print met data and internal variables)	F	F
		NN1	Test and debug print options: first time step	1	1
		NN2	Test and debug print options: last time step	1	1
		LDBCST	Test and debug print options: distance to land internal variables	F	F
		IOUTD	Test and debug print options: control variables for writing winds	0	0
		NZPRN2	Test and debug print options: number of levels starting at sfc	1	0
		IPR0	Test and debug print options: interpolated winds	0	0
		IPR1	Test and debug print options: terrain adjusted surface wind	0	0
		IPR2	Test and debug print options: smoothed wind and diverge fields	0	0
		IPR3	Test and debug print options: final wind speed and direction	0	0
		IPR4	Test and debug print options: final divergence	0	0
		IPR5	Test and debug print options: winds after Kinematic effects	0	0
		IPR6	Test and debug print options: winds after Froude No. adjustment	0	0
		IPR7	Test and debug print options: winds after slope flow	0	0
		IPR8	Test and debug print options: final winds	0	0
4 - Meteorological data options		NOOBS	No observation mode	0	0
		NSSTA	Number of surface stations	User defined	User defined (>0)
		NPSTA	Number of precipitation stations	User defined	User defined (>0)
		ICLOUD	Gridded cloud fields	0	0
		IFORMS	Surface met data file format	2	2
		IFORMP	Precipitation data file format	2	2

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		IFORMC	Cloud data format	2	2
5 - Wind field options and parameters		IWFCOD	Wind model options	1	1
		IFRADJ	Compute Froude number adjustment effects	1	1
		IKINE	Compute Kinematic effects	0	0
		IOBR	Use O'Brien procedures for adjust vertical velocity	0	0
		ISLOPE	Compute slope effects	1	1
		IEXTRP	Extrapolate sfc wind obs to upper levels	-4	-4
		ICALM	Extrapolate sfc winds even if calm	0	0
		BIAS	Surface/upper weighting factors (BIAS (NZ))	NZ*0	10*0
		RMIN2	Minimum distance for extrapolation of winds	4	-1
		IPROG	Use prognostic model winds as input to diagnostic wind model	0	14
		ISTEPPG	Timestep (hours) of prognostic model data	1	1
		IGFMET	Use coarse CALMET fields as initial guess	0	0
		LVARY	Use varying radius of influence	F	F
		RMAX1	Maximum radius of influence in surface layer (km)	User defined	100
		RAMX2	Maximum radius of influence over land aloft (km)	User defined	200
		RMAX3	Maximum radius of influence over water (km)	User defined	200
		RMIN	Minimum radius of influence in wind field interpolation (km)	0.1	0.1
		TERRAD	Radius of influence of terrain features (km)	User defined	15
		R1	Relative weight at surface of 1st guess fields and obs (km)	User defined	50
		R2	Relative weight aloft of 1st guess fields and obs (km)	User defined	100
		RPROG	Weighting factors of prognostic wind field data (km)	User defined	0
		DIVLIM	Maximum acceptable divergence	5.0E-06	5.0E-06

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		NITER	Maximum number of iterations in divergence minimum	50	50
		NSMTH	Number of passes in smoothing (NSMITH (NZ))	2, (nxnz-1)*4	2, 9*4
		NINTR2	Maximum number of stations for interpolation (NINTR2(NZ))	99	10*99
		CRITFN	Critical Froude Number	1	1
		ALPHA	Empirical factor controlling influence of kinematic effects	0.1	0.1
		FEXTR2	Multiplicative scaling factor for extrap of sfc obs to upper layers (FEXTRS(NX))	NZ*0.0	10*0
		NBAR	Number of barriers to interpolation of wind fields	0	0
		KBAR	Level (1 to NZ) up to which barriers apply	NZ	10
		XBBAR (NBAR>0)	X coordinate of beginning of each barrier (km)	User defined	0
		YBBAR (NBAR>0)	Y coordinate of beginning of each barrier (km)	User defined	0
		XEBAR (NBAR>0)	X coordinate of ending of each barrier (km)	User defined	0
		YEBAR (NBAR>0)	Y coordinate of ending of each barrier (km)	User defined	0
		IDIOPT1	Compute surface temperature	0	0
		ISURFT [b]	Sfc met station to use for sfc temp	User defined	User defined
		IDIOPT2	Domain-averaged temp lapse rate	0	0
		IUPT (IDIOPT2=0) [b]	UA station to use for the domain-scale lapse rate	User defined	User defined
		ZUPT (IDIOPT2=0)	Depth through which domain-scale lapse rate is computed (m)	200	200
		IDIOPT3	Domain-averaged wind component	0	0
		IUPWIND (IDIOPT3=0)	UA station to use for domain-scale winds	-1	-1
		ZUPWIND (IDIOPT3=0)	Bottom and top of layer thru which domain winds computed (m)	1., 1000	1., 1000
		IDIOPT4	Read observed surface wind components	0	0
		IDIOPT5	Read observed upper wind components	0	0

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		LLBREZE	Use lake breeze module	F	F
		NBOX	Number of lake breeze regions	User defined	0
		XG1	X grid line 1 defining the region of interest	User defined	0
		XG2	X grid line 2 defining the region of interest	User defined	0
		YG1	Y grid line 1 defining the region of interest	User defined	0
		YG2	Y grid line 2 defining the region of interest	User defined	0
		XBCST	X point defining the coastline (km)	User defined	0
		YBCST	Y point defining the coastline (km)	User defined	0
		XECST	X point defining the coastline (km)	User defined	0
		YECST	Y point defining the coastline (km)	User defined	0
		NLB	Number of stations in the region (sfc + upper air)	User defined	0
		METBXID	Station ID's in the region (METBXID (NLB))	User defined	0
6 - Mixing height, temperature and precipitation parameters		CONSTB	Mix ht constant: neutral, mechanical equation	1.41	1.41
		CONSTE	Mix ht constant: convective equation	0.15	0.15
		CONSTN	Mix ht constant: stable equation	2400	2400
		CONSTW	Mix ht equation: over water	0.16	0.16
		FCORIOL	Absolute value of Coriolis parameter	1.0E-04	1.0E-04
		IAVEZI	Spatial averaging of Mix ht: conduct spatial averaging	1	1
		MNMDAV	Spatial averaging of Mix ht: Max search radius (# of grid cells)	1	1
		HAFANG	Spatial avg'n of Mix ht: 0.5-angle of upwind cone for avg (deg)	30	30
		ILEVZI	Spatial averaging of Mix ht: Layer of winds used in upwind	1	1
		IMIXH	Zic Mix Ht Options: Method to compute Mix ht	1	-1

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		THRESHL	Zic Mix Ht Options: Threshold buoyancy flux reqrd to sustain over land (W/m3)	0.05	0.0
		THRESHW	Zic Mix Ht Options: Threshold buoyancy flux reqrd sustain over water (W/m3)	0.05	0.05
		ITWPROG	Zic Mix Ht Options: Overwater lapse rates used in Zic growth	0	0
		ILUOC3D	Zic Mix Ht Options: Land use category in 3D.DAT	16	16
		DPTMIN	Min potential Temp lapse rate in stable layer above Zic (deg-K/m)	0.001	0.001
		DZZI	Depth of computing capping lapse rate (m)	200	200
		ZIMIN	Minimum over land mixing height (m)	50	50
		ZIMAX	Maximum over land mixing height (m)	3000	3000
		ZIMINW	Minimum over water mixing height (m)	50	50
		ZIMAXW	Maximum over water mixing height (m)	3000	3000
		ICOARE	Over water surface fluxes methods and parameters	10	0
		DSELF	Coastal/shallow water length scale (km)	0	0
		IWARM	COARE warm layer computation	0	0
		ICOOL	COARE cool skin layer computation	0	0
		ITPROG	3D temp from obs or from prognostic data	0	0
		IRAD	Temp interpolation type	1	1
		TRADKM	Radius of influence of temp interpolation (km)	500	500
		NUMTS	Max number of stations to include in interpolation	5	5
		IAVET	Conduct spatial averaging of temp	1	1
		TGDEFB	Default temp gradient below mix ht over water (deg-K/m)	-0.0098	-0.0098
		TGDEFA	Default temp gradient above mix ht over water (deg-K/m)	-0.0045	-0.0045

Input Group	Subgroup	Variable	Description	Default	EPA-FLM
		JWAT1	Beginning land use categories for temp interpolation over water	User defined - 999	55
		JWAT2	Ending land use categories for temp interpolation over water	User defined - 999	55
		NFLAGP	Method of precipitation interpolation	2	2
		SIGMAP	Radius of influence for precipitation (km)	100	100
		CUTP	Minimum precipitation rate cutoff (mm/hr)	0.01	.01
7 -Surface meteorolo-gical station parameters		CSNAM	Station name	User defined	User defined
		IDSSTA	Station identification number	User defined	User defined
		XSSTA	X-coordinate (km)	User defined	User defined
		YSSTA	Y-coordinate (km)	User defined	User defined
		XSTZ	Time zone	User defined	User defined
		ZANEM	Anemometer height (m)	User defined	User defined
8- Upper air meteorolo-gcal station parameters		CUNAM	Station name	User defined	
		IDUSTA	Station identification number	User defined	
		XUSTA	X-coordinate (km)	User defined	
		YUSTA	Y-coordinate (km)	User defined	
		UUTZ	Time zone	User defined	
9 - Precipitation station parameters		CPNAM	Station name	User defined	User defined
		IDPSTA	Station identification number	User defined	User defined
		XPSTA	X-coordinate (km)	User defined	User defined
		YPSTA	Y-coordinate (km)	User defined	User defined