UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

MAR 16 2006

OFFICE OF
AIR QUALITY PLANNING
AND STANDARDS

MEMORANDUM

SUBJECT: Dispersion Coefficients for Regulatory Air Quality Modeling in CALPUFF

FROM Dennis Atkinson, Meteorologist Dennis Atkinson
Model Clearinghouse Director, C439-01

TO: Kay T. Prince, Chief
Regulatory Planning Branch, APTMD-12

THRU: Tyler Fox, Leader TF
Air Quality Modeling Group, C439-01

In response to your memo of February 23, 2006, the Model Clearinghouse has reviewed your request for details related to CALPUFF and its use of regulatory and non-regulatory settings. Specific responses to your questions follow.

1. What constitutes a regulatory version of the CALPUFF model?

M/C Response: The CALPUFF modeling system consists of the entire suite of CALPUFF components, including CALMET, CALPUFF, CALPOST, POSTUTIL, etc. The regulatory version of CALPUFF is that version that has been tested, along with its specific default options, and functions satisfactorily against a standard criteria of sources, building configurations, and receptor information. The regulatory version of CALPUFF, along with specific regulatory options, resides on the Earth Tech website, described as the "EPA-Approved Version." Accessing CALPUFF via the Support Center for Regulatory Atmospheric Modeling (SCRAM) website is the best way to ensure the regulatory version of CALPUFF is obtained. Updates to the regulatory version of CALPUFF versions will require a formal protocol which includes sensitivity testing and analysis employing the use of the standard evaluation criteria, as presented at the 8th Conference on Air Quality Modeling (http://www.epa.gov/ttn/scram/8thmodconf/presentations/day2morning/calpuffanalysistoolrevised.ppt).

2. What is the regulatory default setting for the MDISP option for the CALPUFF model?

M/C Response: The regulatory CALPUFF default setting is MDISP=3, which utilizes the Pasquill-Gifford (P-G) dispersion coefficients, as referenced in Appendix W to 40CFR Part 51, A.4(j),(k). These regulatory defaults implement the modeling recommendations as described in the document entitled "Interagency Workgroup on Air Quality Models (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts" (EPA-454/R-98-019, Dec. 1998). A copy of the

CALMET regulatory defaults in Appendix A and the CALPUFF regulatory defaults in Appendix B is attached.

3. Does the distance of a source from a receptor have any impact on the choice of how the MDISP option is set?

M/C Response: Dispersion coefficients are expected to have a greater influence on output concentrations for estimating the design concentration, the closer the receptor is to the emission source. However, the primary justification for allowing the use of CALPUFF within 50km relates to the proper estimate of the design concentration requiring consideration of an existing non-uniform wind field (complex winds). The decision to use CALPUFF in the near field is primarily due to complex meteorological issues which normally could not be resolved by traditional near-field steady-state modeling techniques. Procedures outlined for use of CALPUFF in long-range transport analyses may not be universally appropriate due to the unique considerations in applying CALPUFF in the near-field for complex meteorological situations. Due to these meteorological complexities, the setup and application of the model should be determined in consultation with the appropriate reviewing authority consistent with limitations of paragraph 3.2.2(e) of Appendix W in 40CFR Part 51.

4. Does the promulgation of the AERMOD model mean that AERMOD-based dispersion coefficients must/could/should be used in any model for Gaussian regulatory air modeling applications?

M/C Response: No. The promulgation of the AERMOD model does not mean that AERMOD-based dispersion coefficients must be used in other regulatory models. To that end, the promulgation of a preferred/recommended model does not provide general approval to apply specific portions of that promulgated model to any other model, whether the model is regulatory or non-regulatory. As stated in response to #2, the Model Clearinghouse endorses the use of P-G dispersion coefficients in CALPUFF unless a rationale can be provided to support, on a case-by-case basis, why other dispersion options should be used. Scientific evaluations have been completed and currently others are underway by both EPA and the Federal Land Managers (FLM) to assess the performance results of non-P-G dispersion coefficients. It is possible there could be some scenarios and specific source configurations for which the use of a non-regulatory dispersion option in long-range transport applications is appropriate. This has to be demonstrated subject to Section 3.2.2 of Appendix W of 40CFR Part 51. EPA Regional Offices are willing to review case-by-case demonstrations that support the use of a non-regulatory approach. Subject to Section 3.2.2 of Appendix W, acceptability of a model is a Regional Office responsibility and subject to approval from the Regional Administrator.

5. Is the Frequently Asked Questions (FAQ) document that is maintained on the CALPUFF website (http://www.src.com/calpuff/FAQ-questions.htm) the source of EPA regulatory modeling guidance for the CALPUFF model?

M/C Response: No. CALPUFF regulatory modeling guidance is provided by the EPA on the Support Center for Regulatory Atmospheric Modeling (SCRAM) website, through the Modeling Support and Guidance area and within Appendix W of 40CFR Part 51 (http://www.epa.gov/scram001/guidanceindex.htm). Supporting documentation for CALPUFF is provided on SCRAM in the CALPUFF model area, along with the link to the "EPA-Approved Version" (http://www.epa.gov/scram001/dispersion prefrec.htm#calpuff).

If you have any further questions or comments, please contact Dennis Atkinson at (919) 541-0518 or Tyler Fox at (919) 541-5562.

2 Attachments
Original Request
CALPUFF Regulatory Defaults

cc: Desmond Bailey, C439-01
Tom Curran, C304-02
Mark Evangelista, C439-03
Tyler Fox, C439-01
Bill Harnett, C304-03
Todd Hawes, C504-01
Joe Paisie, C504-02
Racqueline Shelton, C339-03
Regional Modeling Contacts

4APT-ATMB

MEMORANDUM

SUBJECT: Dispersion Coefficients for Regulatory Air Quality Modeling

FROM: Kay T. Prince, Chief
Regulatory Planning Branch

TO: Tyler Fox, Leader
Air Quality Modeling Group

The Air Planning Branch of the Environmental Protection Agency (EPA) Region 4 requests that the EPA Model Clearinghouse formally address the following questions with supporting details as appropriate.

1. What constitutes a regulatory version of the CALPUFF model?
2. What is the regulatory default setting for the MDSIP option for the CAPUFF model?
3. Does the distance of a source from a receptor have any impact on the choice of how the MDSIP option is set?
4. Does the promulgation of the AERMOD model mean that AERMOD-based dispersion coefficients must/could/should be used in any model for Gaussian regulatory air modeling applications?
5. Is the Frequently Asked Questions (FAQ) document that is maintained on the CALPUFF website (http://www.src.com/calpuff/FAQ-questions.htm) the source of EPA regulatory modeling guidance for the CALPUFF model?

Region 4 has a need for a very prompt and formal response from the EPA Model Clearinghouse. The above issues impacts work that the many of Visibility Improvement – State and Tribal Association of the Southeast (VISTAS) states need to have resolved immediately for their Best Available Retrofit Technology (BART) assessments. We would like for you to note that these issues have been raised informally to the Office of Air Quality Planning and Standards (OAQPS) and discussed in several Model Clearinghouse sponsored calls in recent months. For instance, they have been specifically discussed in reviews of the VISTAS BART protocol by many of the EPA Regional Offices and the Federal Land Managers (FLMs) in Model Clearinghouse sponsored calls. They were also discussed in much detail in a CALPUFF training meeting that, while not sponsored by EPA OAQPS, was attended by your staff. Therefore, your group should be aware of the issues and the opinions of the Regional Offices and FLMs.

Thank you for your prompt response. If questions arise, please do not hesitate to contact Brenda Johnson at 404-562-9037.

APPENDIX A

CALMET RECOMMENDATIONS

In the following, a listing is provided of the defaults currently assumed in CALMET for long-range transport analyses in involving assessments of not on concentration impacts, but also deposition flux impacts and visibility impacts. Some of the variables have the 'Value' is listed in bold. This is meant to indicate that these likely will need to be tailored for a given application.

Variable	Description	Value
GEO.DAT	Name of Geophysical data file	GEO.DAT
SURF.DAT	Name of Surface data file	SURF.DAT
PRECIP.DAT	Name of Precipitation data file	PRECIP.DAT
NUSTA	Number of upper air data sites	User Defined
UPn.DAT	Names of NUSTA upper air data files	UPn.DAT
IBYR	Beginning year	User Defines
IBMO	Beginning month	User Defines
IBDY	Beginning day	User Defines
IBHR	Beginning hour	User Defines
IBTZ	Base time zone	User Defines
IRLG	Number of hours to simulate	User Defines
IRTYPE	Output file type to create (must be 1 for CALPUFF)	1
LCALGRD	Are w-components and temperature needed?	T
NX	Number of east-west grid cells	**User Defines**
NY	Number of north-south grid cells	**User Defines**
DGRIDKM	Grid spacing	**User Defines**
XORIGKM	Southwest grid cell X coordinate	User Defines
YORIGKM	Southwest grid cell Y coordinate	User Defines
XLAT0	Southwest grid cell latitude	User Defines
YLON0	Southwest grid cell longitude	User Defines

IUTMZN	UTM Zone	User Defines
LLCONF	When using Lambert Conformal map coordinates, rotate winds from true north to map north?	F
XLAT1	Latitude of 1st standard parallel	**30**
XLAT2	Latitude of 2nd standard parallel	**60**
Variable	Description	Value
RLON0	Longitude used if LLCONF = T	**90**
RLAT0	Latitude used if LLCONF = T	**40**
NZ	Number of vertical layers	**User Defines**
ZFACE	Vertical cell face heights (NZ+1 values)	**User Defines**
LSAVE	Save met. data fields in an unformatted file?	T
IFORMO	Format of unformatted file (1 for CALPUFF)	1
NSSTA	Number of stations in SURF.DAT file	User Defines
NPSTA	Number of stations in PRECIP.DAT	User Defines
ICLOUD	Is cloud data to be input as gridded fields? (0 = No)	0
IFORMS	Format of surface data (2 = formatted)	2
IFORMP	Format of precipitation data (2 = formatted)	2
IFORMC	Format of cloud data (2 = formatted)	2
IWFCOD	Generate winds by diagnostic wind module? (1 = Yes)	1
IFRADJ	Adjust winds using Froude number effects? (1 = Yes)	1
IKINE	Adjust winds using kinematic effects? (1 = Yes)	0
IOBR	Use O'Brien procedure for vertical winds? (0 = No)	0
ISLOPE	Compute slope flows? (1 = Yes)	1
IEXTRP	Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data)	-4

ICALM	Extrapolate surface calms to upper layers? (0 = No)	0
BIAS	Surface/upper-air weighting factors (NZ values)	NZ*0
Variable	Description	Value
IPROG	Using prognostic or MM-FDDA data? (0 = No)	0
LVARY	Use varying radius to develop surface winds?	**F**
RMAX1	Max surface over-land extrapolation radius (km)	**User Defines**
RMAX2	Max aloft over-land extrapolation radius (km)	**User Defines**
RMAX3	Maximum over-water extrapolation radius (km)	**User Defines**
RMIN	Minimum extrapolation radius (km)	0.1
RMIN2	Distance (km) around an upper air site where vertical extrapolation is excluded (Set to -1 if IEXTRP = ±4)	4
TERRAD	Radius of influence of terrain features (km)	**User Defined**
R1	Relative weight at surface of Step 1 field and obs	**User Defines**
R2	Relative weight aloft of Step 1 field and obs	**User Defines**
DIVLIM	Maximum acceptable divergence	5.E-6
NITER	Max number of passes in divergence minimization	50
NSMTH	Number of passes in smoothing (NZ values)	2, 4*(NZ-1)
NINTR2	Max number of stations for interpolations (NA values)	**99**
CRITFN	Critical Froude number	1
ALPHA	Empirical factor triggering kinematic effects	0.1
IDIOPT1	Compute temperatures from observations (0 = True)	0
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	**User Defines**
IDIOPT2	Compute domain-average lapse rates? (0 = True)	0
IUPT	Station for lapse rates (between 1 and NUSTA)	**User Defines**

ZUPT	Depth of domain-average lapse rate (m)	200
Variable	Description	Value
IDIOPT3	Compute internally inital guess winds? (0 = True)	0
IUPWND	Upper air station for domain winds (-1 = 1/r**2 interpolation of all stations)	-1
ZUPWND	Bottom and top of layer for 1st guess winds (m)	1, 1000
IDIOPT4	Read surface winds from SURF.DAT? (0 = True)	0
IDIOPT5	Read aloft winds from UPn.DAT? (0 = True)	0
CONSTB	Neutral mixing height B constant	1.41
CONSTE	Convective mixing height E constant	0.15
CONSTN	Stable mixing height N constant	2400
CONSTW	Over-water mixing height W constant	0.16
FCORIOL	Absolute value of Coriolis parameter	1.E-4
IAVEXZI	Spatial averaging of mixing heights? (1 = True)	1
MNMDAV	Max averaging radius (number of grid cells)	1
HAFANG	Half-angle for looking upwind (degrees)	30
ILEVZI	Layer to use in upwind averaging (between 1 and NZ)	1
DPTMIN	Minimum capping potential temperature lapse rate	0.001
DZZI	Depth for computing capping lapse rate (m)	200
ZIMIN	Minimum over-land mixing height (m)	50
ZIMAX	Maximum over-land mixing height (m)	3000
ZIMINW	Minimum over-water mixing height (m)	50
ZIMAXW	Maximum over-water mixing heigh (m)	3000
IRAD	Form of temperature interpolation (1 = 1/r)	1
TRADKM	Radius of temperature interpolation (km)	500
Variable	Description	Value

NUMTS	Max number of stations in temperature interpolations	5
IAVET	Conduct spatial averaging of temperature? (1 = True)	1
TGDEFB	Default over-water mixed layer lapse rate (K/m)	-0.0098
TGDEFA	Default over-water capping lapse rate (K/m)	-0.0045
JWAT1	Beginning landuse type defining water	999
JWAT2	Ending landuse type defining water	999
NFLAGP	Method for precipitation interpolation (2 = 1/r**2)	2
SIGMAP	Precip radius for interpolations (km)	100
CUTP	Minimum cut off precip rate (mm/hr)	0.01
SSn	NSSTA input records for surface stations	User Defines
USn	NUSTA input records for upper-air stations	User Defines
PSn	NPSTA input records for precipitation stations	User Defines

APPENDIX B

CALPUFF RECOMMENDATIONS

In the following, a listing is provided of the defaults currently assumed in CALPUFF for long-range transport analyses in involving assessments of not on concentration impacts, but also deposition flux impacts and visibility impacts. Some of the variables have the 'Value' is listed in bold. This is meant to indicate that these likely will need to be tailored for a given application.

Variable	Description	Value
METDAT	CALMET input data filename	CALMET.DAT
PUFLST	Filename for general output from CALPUFF	CALPUFF.LST
CONDAT	Filename for output concentration data	CONC.DAT
DFDAT	Filename for output dry deposition fluxes	DFLX.DAT
WFDAT	Filename for output wet deposition fluxes	WFLX.DAT
VISDAT	Filename for output relative humidities (for visibility)	VISB.DAT
METRUN	Do we run all periods (1) or a subset (0)?	0
IBYR	Beginning year	User Defined
IBMO	Beginning month	User Defined
IBDY	Beginning day	User Defined
IBHR	Beginning hour	User Defined
IRLG	Length of run (hours)	User Defined
NSPEC	Number of species modeled (for MESOPUFF II chemistry)	5
NSE	Number of species emitted	3
MRESTART	Restart options (0 = no restart), allows splitting runs into smaller segments	**0**
METFM	Format of input meteorology (1 = CALMET)	1
AVET	Averaging time lateral dispersion parameters (minutes)	60
MGAUSS	Near-field vertical distribution (1 = Gaussian)	1

MCTADJ	Terrain adjustments to plume path (3 = Plume path)	**3**
MCTSG	Do we have subgrid hills? (0 = No), allows CTDM-like treatment for subgrid scale hills	**0**
MSLUG	Near-field puff treatment (0 = No slugs)	0
Variable	Description	Value
MTRANS	Model transitional plume rise? (1 = Yes)	1
MTIP	Treat stack tip downwash? (1 = Yes)	1
MSHEAR	Treat vertical wind shear? (0 = No)	0
MSPLIT	Allow puffs to split? (0 = No)	**0**
MCHEM	MESOPUFF-II Chemistry? (1 = Yes)	1
MWET	Model wet deposition? (1 = Yes)	1
MDRY	Model dry deposition? (1 = Yes)	1
MDISP	Method for dispersion coefficients (3 = PG & MP)	3
MTURBVW	Turbulence characterization? (Only if MDISP = 1 or 5)	3
MDISP2	Backup coefficients (Only if MDISP = 1 or 5)	3
MROUGH	Adjust PG for surface roughness? (0 = No)	0
MPARTL	Model partial plume penetration? (0 = No)	1
MTINV	Elevated inversion strength (0 = compute from data)	0
MPDF	Use PDF for convective dispersion? (0 = No)	0
MSGTIBL	Use TIBL module? (0 = No) allows treatment of subgrid scale coastal areas	0
MREG	Regulatory default checks? (1 = Yes)	1
CSPECn	Names of species modeled (for MESOPUFF II, must be SO2, SO4, NOX, HNO3, NO3)	**User Defined**
Specie Names	Manner species will be modeled	**User Defined**
Specie Groups	Grouping of species, if any.	**User Defined**

NX	Number of east-west grids of input meteorology	User Defined
NY	Number of north-south grids of input meteorology	User Defined
NZ	Number of vertical layers of input meteorology	User Defined
Variable	Description	Value
DGRIDKM	Meteorology grid spacing (km)	User Defined
ZFACE	Vertical cell face heights of input meteorology	User Defined
XORIGKM	Southwest corner (east-west) of input meteorology	User Defined
YORIGIM	Southwest corner (north-south) of input meteorology	User Defined
IUTMZN	UTM zone	User Defined
XLAT	Latitude of center of meteorology domain	User Defined
XLONG	Longitude of center of meteorology domain	User Defined
XTZ	Base time zone of input meteorology	User Defined
IBCOMP	Southwest Xindex of computational domain	**User Defined**
JBCOMP	Southwest Y-index of computational domain	**User Defined**
IECOMP	Northeast Xindex of computational domain	**User Defined**
JECOMP	Northeast Y-index of computational domain	**User Defined**
LSAMP	Use gridded receptors? (T = Yes)	F
IBSAMP	Southwest Xindex of receptor grid	User Defined
JBSAMP	Southwest Y-index of receptor grid	User Defined
IESAMP	Northeast Xindex of receptor grid	User Defined
JESAMP	Northeast Y-index of receptor grid	User Defined
MESHDN	Gridded recpetor spacing = DGRIDKM/MESHDN	1
ICON	Output concentrations? (1 = Yes)	1
IDRY	Output dry deposition flux? (1 = Yes)	1
IWET	Output west deposition flux? (1 = Yes)	1
IVIS	Output RH for visibility calculations (1 = Yes)	1
LCOMPRS	Use compression option in output? (T = Yes)	T

Variable	Description	Value
ICPRT	Print concentrations? (0 = No)	0
IDPRT	Print dry deposition fluxes (0 = No)	0
IWPRT	Print wet deposition fluxes (0 = No)	0
ICFRQ	Concentration print interval (1 = hourly)	**1**
IDFRQ	Dry deposition flux print interval (1 = hourly)	1
IWFRQ	West deposition flux print interval (1 = hourly)	1
IPRTU	Print output units (1 = g/m**3; g/m**2/s)	1
IMESG	Status messages to screen? (1 = Yes)	1
Output Species	Where to output various species	**User Defined**
LDEBUG	Turn on debug tracking? (F = No)	F
Dry Gas Dep	Chemical parameters of gaseous deposition species	**User Defined**
Dry Part. Dep	Chemical parameters of particulate deposition species	**User Defined**
RCUTR	Reference cuticle resistance (s/cm)	30.
RGR	Reference ground resistance (s/cm)	10.
REACTR	Reference reactivity	8
NINT	Number of particle-size intervals	9
IVEG	Vegetative state (1 = active and unstressed)	1
Wet Dep	Wet deposition parameters	**User Defined**
MOZ	Ozone background? (1 = read from ozone.dat)	1
BCKO3	Ozone default (ppb) (Use only for missing data)	**80**
BCKNH3	Ammonia background (ppb)	**10**
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2
Variable	Description	Value

SYTDEP	Horizontal size (m) to switch to time dependence	550.
MHFTSE	Use Heffter for vertical dispersion? (0 = No)	0
JSUP	PG Stability class above mixed layer	5
CONK1	Stable dispersion constant (Eq 2.7-3)	0.01
CONK2	Neutral dispersion constant (Eq 2.7-4)	0.1
TBD	Transition for downwash algorithms (0.5 = ISC)	0.5
IURB1	Beginning urban landuse type	10
IURB2	Ending urban landuse type	19
Use Following Only For Single-Point Meteorological Input (CALPUFF Screen)		
ILANDUIN	Land use type (20 = Unirrigated agricultural land)	20
ZOIN	Roughness length (m)	0.25
XLAIIN	Leaf area index	3
ELEVIN	Met. Station elevation (m above MSL)	0
XLATIN	Met. Station North latitude (degrees)	**User Defined**
XLONIN	Met. Station West longitude (degrees)	**User Defined**
ANEMHT	Anemometer height of ISC meteorological data (m)	10.0
ISIGMAV	Lateral turbulence (Not used with ISC meteorology)	1
IMIXCTDM	Mixing heights (Not used with ISC meteorology)	0
End of Single Point Meteorology Input Variables		
XMXLEN	Maximum slug length in units of DGRIDKM	1
XSAMLEN	Maximum puff travel distance per sampling step (units of DGRIDKM)	1
Variable	Description	Value
MXNEW	Maximum number of puffs per hour	99
MXSAM	Maximum sampling steps per hour	99
SL2PF	Maximum Sy/puff length	10
PLX0	Wind speed power-law exponents	0.07,0.07,0.10,0.15,0.35,0.55

WSCAT	Upper bounds 1st 5 wind speed classes (m/s)	1.54,3.09,5.14,8.23.10.8
PGGO	Potential temperature gradients PG E and F (deg/km)	0.020, 0.035
SYMIN	Minimum lateral dispersion of new puff (m)	1.0
SZMIN	Minimum vertical dispersion of new puff (m)	1.0
SVMIN	Array of minimum lateral turbulence (m/s)	6*0.50
SWMIN	Array of minimum vertical turbulence (m/s)	0.20, 0.12, 0.08, 0.06, 0.03, 0.016
CDIV	Divergence criterion for dw/dz (1/s)	0.01
WSCALM	Minimum non-calm wind speed (m/s)	0.5
XMAXZI	Maximum mixing height (m)	3000
XMINZI	Minimum mixing height (m)	50
PPC	Plume path coefficients (only if MCTADJ = 3)	0.5,0.5,0.5,0.5,0.35,0.35
NSPLIT	Number of puffs when puffs split	3
IRESPLIT	Hours when puff are eligible to split	**User Defined**
ZISPLIT	Previous hour's mixing height (minimum), (m)	100
ROLDMAX	Previous Max mixing height/current mixing height ratio, must be less then this value to allow puff split	0.25
Variable	Description	Value
EPSSLUG	Convergence criterion for slug sampling integration	1.0E-04
PESAREA	Convergence criterion for area source integration	1.0E-06
NPT1	Number of point sources	User Defined
IPTU	Units of emission rates (1 = g/s)	1
NSPT1	Number of point source-species combinations	0
NPT2	Number of point sources with fully variable emission rates	0
Point	Point sources characteristics	User Defined

Sources		
Area Sources	Area sources characteristics	User Defined
Line Sources	Buoyant lines source characteristics	User Defined
Volume Sources	Volume sources characteristics	User Defined
NREC	Number of user defined receptors	User Defined
Receptor Data	Location and elevation (MSL) of receptors	User Defined