On The Spatial Assessment of Forest Fire Smoke Exposure and Its Health Effects:

Part 2: CALMET Initialization Methodology

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1.0 Introduction

During the fire season of 2003, more than 266 000 hectares of forest in British Columbia were consumed by wildfires. In comparison, only 8 581 ha burned in the province in 2002 and 76 574 ha were consumed in 1998, the latter being the worst fire season of the previous decade. Of the fires occurring in 2003, approximately 75% were in the relatively dry southern interior region of the province.[1] While the damage these widespread fires caused to the property of individuals and the commons was well-documented, less is known about the acute health effects of exposure to the extremely high levels of particulate matter witnessed during this time period.

This report concerns a small component of a larger health study which seeks to assess the health effects of exposure to the wildfire smoke during the summer of 2003 in Southern Interior British Columbia. The study region, consisting of a population of approximately 638 800 people, is shown for reference in Figure 1.

Figure 1: Region of Interest for Health Study. The shaded area in the south-east corner of the province constitutes the study area.

The first stage of the health study will use the CALPUFF dispersion modelling system to arrive upon a spatially-variant estimate of exposure to particulate matter originating from wildfires in the region during the time period of interest. This document outlines the initialization of the CALMET deterministic meteorological model which will be used to provide the meteorological inputs necessary to drive CALPUFF.

[1] BC Ministry of Forests: Forest Fire Statistics, 2004

2.0 Modelling Domain

A 325 000 km^2 domain was chosen to cover the study area, as well as any significant wildfires which may have impacted air quality in the communities of Southern Interior British Columbia during the fire season of 2003. The area modelled, as shown below (Figure 2), covers the majority of Southern BC, including the Kootenay, Thompson-Okanagan, and Cariboo regions of the province.

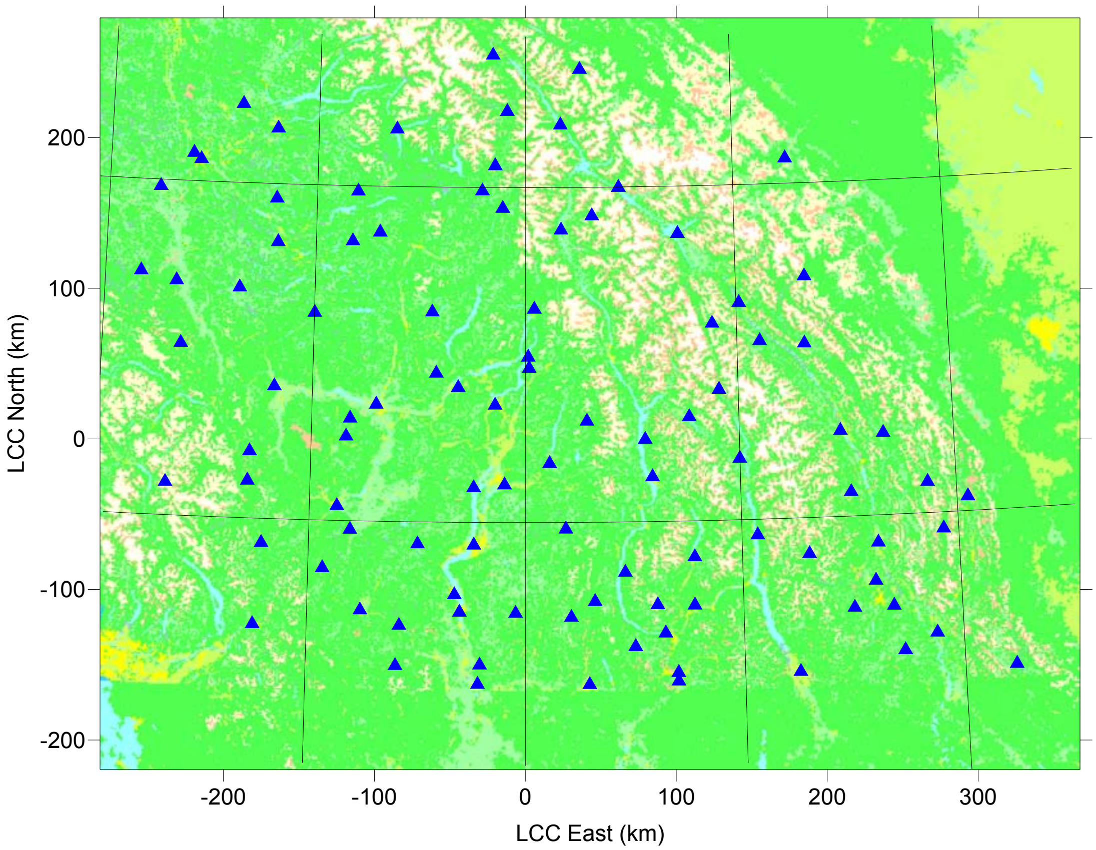

Figure 2: Modelling Domain. CALMET land-use categories and locations of input meteorological stations outline the relative location and extent of the study domain. Primary land-use categories for the region include Forest (Green), Urban (Bright Yellow), Water (Light Blue), Rangelands (Grey-Green), and Alpine (White). The coordinate system is a custom LCC projection as defined in Table 1.

A modelling grid was chosen to represent the landscape at a 1-km resolution (Table 1). Although modelling at 500 m or even 250 m resolution would have been preferable to properly resolve terrain features in an area of such complex terrain, the very large size of the study area would have made this endeavour quite computationally expensive. Furthermore, during preliminary testing, no significant improvements were seen in model winds when such higher resolutions were evoked. Finally, as the input prognostic data was only available at 12-km resolution, it is very unlikely that a finer grid structure would have been of benefit to the modelling done for this study.

Table 1: Map Projections and Horizontal Grid Parameters

Parameter	Value
Map Projection	Lambert Conformal Conic
False Easting, Northing	0 km, 0km
Projection Origin	50.5 N, 119.0 W
Matching Parallels of Latitude	51.5 N, 49.5 N
Datum	WGS-84
Number of Grid Cells (nx,ny)	650, 500
SW Corner (x,y)	- 282 km, -220 km
Grid Spacing	1 km

A locally-centered Lambert Conformal Conic projection was used to represent the region of interest. This particular projection was chosen, as advised by the model's authors,[2] to minimize any potential distortion over the relatively large 650 × 500 km area.

3.0 Data Sources and Treatment

3.1 Geophysical Data

Both land-use and terrain elevation data are necessary to initialize the CALMET model's geophysical file. For this study, terrain elevations were initialized with data from the Shuttle Radar Topography Mission (SRTM). This data, a preliminary product from a joint project between the US National Aeronautics and Space Administration (NASA) and the US National Geospatial-Intelligence Agency (NGA), is available at 3 arc-second (approximately 90 m) resolution for the continent of North America.[3] The SRTM data was then processed by the CALPUFF terrain pre-processor TERREL over the domain of interest.

Baseline Thematic Mapping (BTM) land-use data[4] was provided for this study by the British Columbia Ministry of Environment (BC MoE). The BTM data was provided in a polygonized format at a scale of 1:250 000, with a minimum polygon size of about 10 ha for most land-use categories. This data was re-projected to the LCC projection defined in Table 1, then converted to a raster grid covering the modelling domain. This information was then exported to a text format and converted into the fractional land-use format accepted by the CALMET MAKEGEO pre-processor. This conversion was accomplished by mapping the dominant BTM land-use category for each grid cell into one of the Level

[2] See Earth Tech's FAQs at http://www.src.com/calpuff/FAQ-answers.htm#1.1.5
[3] Data can be obtained at ftp://e0mss21u.ecs.nasa.gov/srtm/North_America_3arcsec/3arcsec/
[4] For more information or to order this product: http://srmwww.gov.bc.ca/dss/initiatives/ias/btm/index.htm

I (and in a few cases, Level II) US Geological Survey (USGS) land-use categories typically used in the CALMET model (Table 2).

Table 2: Mapping from BC to CALMET Land-Use Categories

BC Category	USGS Category	USGS Level	CALMET Code
Agriculture	Agricultural Land	I	20
Residential-Agricultural Mix	Agricultural Land	I	20
Alpine	Tundra	I	80
Sub-alpine Avalanche Shoots	Barren Land	I	70
Recent Burn	Forest Land	I	40
Old Forest	Forest Land	I	40
Young Forest	Forest Land	I	40
Recently Logged	Rangeland	I	30
Selectively Logged	Forest Land	I	40
Rangeland	Rangeland	I	30
Mining	Barren Land	I	70
Recreational Activities	Rangeland	I	30
Barren Land	Barren Land	I	70
Urban	Urban or Built-up Land	I	10
Shrub	Rangeland	I	30
Glacier	Perennial Snow or Ice	I	90
Wetlands	Non-forested Wetland	II	62
Fresh Water	Fresh Water	II	51
Estuaries	Bays and Estuaries	II	54
Salt Water	Salt Water	II	55

As the BC land-use categories are generally more descriptive than most of the default CALMET categories, the approximations made in the mapping defined by Table 1 appear legitimate. Note that CALMET Codes 51, 54, and 55 all have the same default physical properties defined in the MAKEGEO namelist file. Thus, any distinction between these categories is probably not relevant to this study.

Unfortunately the coverage of the high-resolution BTM data received from the BC MoE was limited to the province of British Columbia. Therefore, another source was required to initialize the land-use data over Southern Alberta and the North-Western United States. US Geological Service (USGS) Global Land Cover Characterization Database (GLCC) data,[5] available at 30 arc-second (approximately 1 km) resolution, was used for this purpose. The relatively lower spatial resolution of this data can be seen in Figure 2. Although the USGS land-use data was neither as accurate nor as resolved as the BTM data, as the majority of the modelling for this study concerns sources and receptors inside

[5] Data can be obtained at: http://edcftp.cr.usgs.gov/pub/data/glcc/na/lambert/nausgs2_0l.img.gz

provincial boundaries, the use of the coarser 30 arc-second data outside British Columbia was considered reasonable.

USGS North American land-use data covering the modelled domain was converted to the same fractional land-use form as the BC BTM data. This was accomplished by the CALMET CTGPOG pre-processor. Then, all missing cells in the BTM fractional land-use file were filled with the corresponding cells from the USGS fractional land-use file to produce a ‘merged’ file of the same format. This resultant land-use was then combined with the processed terrain data in the CALMET MAKEGEO pre-processor. This, in turn, provided the geophysical file which was used to initialize the CALMET meteorological model for this study.

3.2 Meteorological Data

Prognostic data at approximately 12 km[6] resolution was provided for use in this study by SENES Consultants Ltd. in a CALMET-ready format. This data was prepared by extracting the necessary meteorological fields from archived output of the US National Weather Service (NWS) / National Centers for Environmental Prediction (NCEP) ‘Eta’ model. This product, which has analysis fields available at 6-hour time intervals, uses a vertical coordinate system which may improve modelling over complex terrain such as that found in the study domain. Table 3 outlines all data fills of missing archived ‘Eta’ records during the time period of interest.

Table 3: Prognostic Data Fills

Date	Missing Hour	Fill
June 3	6 UTC	0 UTC
June 11	0 & 6 UTC	12 UTC
July 9	12 UTC	6 UTC
July 12	6 UTC	0 UTC
July 20	0 UTC	6 UTC
Aug 27	0 UTC	6 UTC

Observed hourly-averaged meteorological data from surface stations during the modelling period was provided by Environment Canada (EC), the British Columbia Ministry of Forests (MoF), and the British Columbia Ministry of the Environment (MoE). The relative location of these stations across the modelled domain has previously been shown in Figure 2. While certain EC weather stations contained all fields necessary to initialize CALMET for the two-week period, the majority of stations used were either missing records for certain hours or did not monitor for some of the required input variables.

[6] GRIB Grid ID #218: http://www.nco.ncep.noaa.gov/pmb/docs/on388/tableb.html#GRID218

Hourly cloud and station pressure information is not recorded at MoE weather stations. Because EC wind instrumentation tends to be of a lower precision than at MoE stations, five MoE stations located sufficiently near to EC stations were initialized with the cloud and station pressure from the latter source. The omission of the EC wind data was done in these cases to avoid the dampening of the more accurate MoE signal in the interpolation of CALMET surface winds. The six remaining MoE stations used provided only wind, temperature, and relative humidity fields.

All EC stations sufficiently far from the higher-quality MoE stations were used as independent station inputs for CALMET. A total of thirteen EC stations from various locations within the modelling domain were used to help initialize both surface variables as well as cloud data. Seventy-five MoF stations were also used to help initialize surface variables in areas with neither EC nor WLAP stations nearby. These MoF stations provided additional wind, temperature, and relative humidity fields for model initialization. As these stations are often located in very remote locations and sometimes utilize less accurate wind instrumentation, wind data from these stations was investigated more carefully before use in model initialization than for MoE or EC stations.

For all ninety-nine surface stations used, short sequential missing entries were filled for select meteorological variables whenever possible.[7] For larger data gaps, fields were marked missing and, subsequently, were not included in the data assimilation during this time period. Hours with calm wind records were labelled as ‘missing’ during the pre-processing.

4.0 Model Parameterization

For each day from June 1st to Sept 30th, a twenty-four hour CALMET simulation commencing at 0:00 PST was initialized and run over the domain of interest. While the majority of parameterizations selected for the production runs were model default values, some required more specific tailoring for this application. Appendix A contains a sample CALMET input file used to initialize one of the daily simulations. Besides the simulation date, all other input files used were identical to this one.

The model was configured to run with CALMET parameter NOOBS = 1. This mode of running CALMET uses prognostic data to create the ‘Initial guess’[8] wind field and provide the upper-air temperatures required for input. Then, input data from local surface stations is used to initialize most surface variables as well as model cloud cover and ceiling height. The advantage of running CALMET in this mode was made clear in the

[7] Automated interpolation of singular missing values was done for wind-speed, relative humidity, temperature, station pressure, and cloud cover; consecutive missing values, as well as wind-direction and ceiling height, were assessed manually on an individual case-by-case basis. Note that manual data fills were only done for EC and MoE stations.

[8] The ‘Initial guess’ wind field refers to the initial interpolation of winds onto the three-dimensional model grid.

initial testing: while the 12-km prognostic data allows for a higher-resolution representation of upper-level winds than do sparsely-located radiosonde stations, the addition of the surface data provides valuable localized wind information as well as actual cloud amounts for model input. See '*Part 1: Initialization of the CALMET Meteorological Model'*, for more detailed information concerning the use of the different CALMET initialization 'modes'.

Twelve vertical levels were used to model the atmosphere up to a maximum cell face height of 5000 m (Table 4). Although emissions from forest fires may exceed this height, it was thought to be unlikely that the well-mixed particulate above the chosen maximum height would return to the ground in any significant concentration.

Table 4: CALMET Vertical Levels

Level	Height at Top (m)
1	20
2	40
3	80
4	160
5	320
6	600
7	1000
8	1500
9	2200
10	3000
11	4000
12	5000

For all simulations, the CALMET diagnostic wind module was used. This module treats the 'Initial guess' wind field with processes such as divergence minimization, blocking effects of terrain, and slope-flow algorithms to form the so-called 'Step 1' wind field. One important model parameter which affects the action of this wind module is TERRAD, which specifies the radius of influence for terrain features. This variable was set to a value of 8 km to ensure that terrain effects would be seen up to the ridgeline for wider valleys, but would not be apparent across mountain ranges. For all other diagnostic wind module parameters, model default options were used as no clear advantage was observed during the testing of alternative configurations.

When CALMET is run with both prognostic as well as observed station data, an additional treatment of the wind field is performed following the diagnostic wind module. In brief, this involves the introduction of the observed station data into the 'Step 1' wind field output from the diagnostic wind module. This is accomplished by a simple inverse-distance method. Weighting factors (R1/2) as well as maximum radii of influence parameters (RMAX1/2/3) control this interpolation process (see Table 5). The result is a limited, localized effect of surface stations in the final CALMET wind field. For this study, the parameter values shown in Table 5 were chosen to allow for station influence to dominate within the larger valley systems, and for a gradual blending of these signals into the 'Initial Guess' field.

Table 5: Radius of Influence Parameters

Parameter	Definition	Value (km)
R1	Distance from Surface Station at which Observation and Initial Guess Field are Equally Weighted for Surface Layer	8
R2	Same as R1, but for all Non-Surface Levels	8
RMAX1	Maximum Radius of Influence Over Land in the Surface Layer	25
RMAX2	Maximum Radius of Influence Over Land Aloft	25
RMAX3	Maximum Radius of Influence Over Water	25

The extrapolation of surface winds within CALMET allows input surface station winds to have influence in the levels aloft. When CALMET is run in the NOOBS=1 mode, this extrapolation is limited to the extent defined by model parameters R2 and RMAX2. It is important to note the model's BIAS parameter cannot be used to control the relative weighting of the extrapolated surface and upper-air values in the final interpolation. This is an important deficiency which occurs when running CALMET in this mode; it is recommended that newer versions of CALMET allow for the use of the BIAS parameter when running the model in NOOBS=1 mode.

A 'Power Law' method (IEXTRP=2) was used to extrapolate surface winds into the levels aloft. Note that this is not the default parameterization for running CALMET with surface extrapolation. This alternate configuration was chosen as the default 'Similarity Theory' method was seen to overestimate wind speeds up to the height of the mixed layer during preliminary testing. One disadvantage seen in using the 'Power Law' approach is that the extrapolation effect extends all the way up to the model top. Preliminary testing showed that this behaviour, at times, could cause unrealistic upper-level wind speeds and directions aloft above surface station locations. This is another aspect of the CALMET code that could probably be improved.

Although prognostic data was used to initialize the temperature field in the levels aloft, it was decided that model level 1 temperatures should be initialized from surface station values only (ITPROG = 1). This method, while beneficial in allowing for more realistic surface temperature values, is severely limited as it does not allow the influence of this data to extend into non-surface levels. However, as the prognostic surface temperatures were often much lower than expected across the domain, this configuration was seen as the best possible option.

Precipitation data was not formatted for entry into CALMET. This information, although not required to run CALMET, is necessary if wet deposition is to be considered in the CALPUFF dispersion model. As the majority of days of interest for this study saw little precipitation, the amount of particulate removed through wet deposition would probably not have been very significant.

5.0 Discussion

As extensive investigation of CALMET output had already been conducted during the configuration and preliminary testing stages of this study, a detailed analysis of the modelling results was not conducted. However, for select days, output meteorological fields were investigated to get a sense of the overall run quality.

Besides the erroneous prognostic temperatures, as discussed in '*Part 1: Initialization of the CALMET Meteorological Model'*, the only potential problem worth mentioning concerns the extrapolation of surface winds. While the 'Power Law' method was seen as favourable to the 'Similarity Theory' approach in preliminary testing, the extension of surface wind influence to the model top in the former method may have an important effect on the directionality of dispersion in CALPUFF. As the prognostic data probably more accurately depicts upper-level flow than do extrapolated winds (often from valley bottoms), and as wildfire smoke plumes will have a very high associated buoyancy, it may, in certain instances, actually be more desirable to not use surface wind extrapolation. Note, however, that this would mean surface station winds would effectively play no role in plume advection; this would clearly not be advantageous in many situations either.

Validation and comparison of CALPUFF output with data from PM_{10} monitors within the study domain as well as satellite imagery will provide valuable information concerning the relative accuracy of the CALMET fields produced for this study. At this point, if it is seen as necessary, CALMET could easily be re-parameterized to try to deal any deficiencies in output. However, without additional input data, it is highly unlikely that any clear improvements will be seen in the modelling results.

Appendix A: Sample CALMET Input File

----------- FILE STARTS ON NEXT LINE ---

```
production


---------------- Run title (3 lines) ------------------------------------------

                    CALMET MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names


Subgroup (a)
------------
Default Name  Type          File Name
------------  ----          ---------
GEO.DAT       input    ! GEODAT=C:\BENJAMIN\CALMET\PROD\INPUT\GEO.DAT       !
SURF.DAT      input    ! SRFDAT=C:\BENJAMIN\CALMET\PROD\INPUT\SURF.DAT      !
CLOUD.DAT     input    * CLDDAT=             *
PRECIP.DAT    input    * PRCDAT=             *
MM4.DAT       input    ! MM4DAT=C:\BENJAMIN\CALMET\PROD\INPUT\M3D.DAT     !
WT.DAT        input    * WTDAT=              *

CALMET.LST    output   ! METLST=CALMET.LST     !
CALMET.DAT    output   ! METDAT=CALMET.DAT    !
PACOUT.DAT    output   * PACDAT=             *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
         T = lower case      ! LCFILES = F !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

    Number of upper air stations (NUSTA)  No default     ! NUSTA =  0  !
    Number of overwater met stations
                                 (NOWSTA) No default     ! NOWSTA =  0  !

                       !END!
--------------------------------------------------------------------------------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name  Type       File Name
------------  ----       ---------
--------------------------------------------------------------------------------
Subgroup (c)
-----------------------------------------
Overwater station files (one per station)
-----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
--------------------------------------------------------------------------------
Subgroup (d)
----------------
Other file names
----------------

Default Name  Type       File Name
```

```
------------  ----       ---------
DIAG.DAT      input      * DIADAT=                  *
PROG.DAT      input      * PRGDAT=                  *

TEST.PRT      output     * TSTPRT=                  *
TEST.OUT      output     * TSTOUT=                  *
TEST.KIN      output     * TSTKIN=                  *
TEST.FRD      output     * TSTFRD=                  *
TEST.SLP      output     * TSTSLP=                  *

--------------------------------------------------------------------------------
NOTES: (1) File/path names can be up to 70 characters in length
       (2) Subgroups (a) and (d) must have ONE 'END' (surround by
           delimiters) at the end of the group
       (3) Subgroups (b) and (c) must have an 'END' (surround by
           delimiters) at the end of EACH LINE

                         !END!


-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

     Starting date:   Year (IBYR) -- No default       ! IBYR=  2003  !
                     Month (IBMO) -- No default       ! IBMO=  9  !
                       Day (IBDY) -- No default       ! IBDY=  1  !
                      Hour (IBHR) -- No default       ! IBHR=  0  !

     Base time zone        (IBTZ) -- No default       ! IBTZ=  8  !
        PST = 08, MST = 07
        CST = 06, EST = 05

     Length of run (hours) (IRLG) -- No default       ! IRLG=  24  !

     Run type            (IRTYPE) -- Default: 1       ! IRTYPE=  1  !

        0 = Computes wind fields only
        1 = Computes wind fields and micrometeorological variables
            (u*, w*, L, zi, etc.)
        (IRTYPE must be 1 to run CALPUFF or CALGRID)

     Compute special data fields required
     by CALGRID (i.e., 3-D fields of W wind
     components and temperature)
     in additional to regular            Default: T    ! LCALGRD = T !
     fields ? (LCALGRD)
     (LCALGRD must be T to run CALGRID)

      Flag to stop run after
      SETUP phase (ITEST)             Default: 2       ! ITEST=  2   !
      (Used to allow checking
      of the model inputs, files, etc.)
      ITEST = 1 - STOPS program after SETUP phase
      ITEST = 2 - Continues with execution of
                  COMPUTATIONAL phase after SETUP

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------
```

```
Map projection
(PMAP)                   Default: UTM    ! PMAP = LCC  !

    UTM :  Universal Transverse Mercator
    TTM :  Tangential Transverse Mercator
    LCC :  Lambert Conformal Conic
     PS :  Polar Stereographic
     EM :  Equatorial Mercator
   LAZA :  Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin
(Used only if PMAP= TTM, LCC, or LAZA)
(FEAST)                  Default=0.0     ! FEAST  = 0.000  !
(FNORTH)                 Default=0.0     ! FNORTH = 0.000  !

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN)                 No Default      ! IUTMZN = -999   !

Hemisphere for UTM projection?
(Used only if PMAP=UTM)
(UTMHEM)                 Default: N      ! UTMHEM = N  !
    N   :  Northern hemisphere projection
    S   :  Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0)                  No Default      ! RLAT0 =  50.5N  !
(RLON0)                  No Default      ! RLON0 =  119W  !

    TTM :  RLON0 identifies central (true N/S) meridian of projection
           RLAT0 selected for convenience
    LCC :  RLON0 identifies central (true N/S) meridian of projection
           RLAT0 selected for convenience
    PS  :  RLON0 identifies central (grid N/S) meridian of projection
           RLAT0 selected for convenience
    EM  :  RLON0 identifies central meridian of projection
           RLAT0 is REPLACED by 0.0N (Equator)
    LAZA:  RLON0 identifies longitude of tangent-point of mapping plane
           RLAT0 identifies latitude of tangent-point of mapping plane

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1)                  No Default      ! XLAT1 =  51.5N  !
(XLAT2)                  No Default      ! XLAT2 =  49.5N  !

    LCC :  Projection cone slices through Earth's surface at XLAT1 and XLAT2
    PS  :  Projection plane slices through Earth at XLAT1
           (XLAT2 is not used)

----------
Note:  Latitudes and longitudes should be positive, and include a
       letter N,S,E, or W indicating north or south latitude, and
       east or west longitude.  For example,
       35.9  N Latitude  =  35.9N
       118.7 E Longitude = 118.7E


Datum-region
------------

The Datum-Region for the coordinates is identified by a character
string.  Many mapping products currently available use the model of the
Earth known as the World Geodetic System 1984 (WGS-84).  Other local
models may be in use, and their selection in CALMET will make its output
consistent with local mapping products.  The list of Datum-Regions with
official transformation parameters is provided by the National Imagery and
Mapping Agency (NIMA).
```

```
     NIMA Datum - Regions(Examples)
     ------------------------------------------------------------------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                    Default: WGS-84    ! DATUM = WGS-84  !


     Horizontal grid definition:
     ---------------------------

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =   650  !
            No. Y grid cells (NY)      No default     ! NY =   500  !

     Grid spacing (DGRIDKM)            No default     ! DGRIDKM = 1. !
                                       Units: km

     Reference grid coordinate of
     SOUTHWEST corner of grid cell (1,1)

        X coordinate (XORIGKM)         No default     ! XORIGKM = -282.000 !
        Y coordinate (YORIGKM)         No default     ! YORIGKM = -220.000 !
                                       Units: km


     Vertical grid definition:
     -------------------------

        No. of vertical layers (NZ)    No default     ! NZ =  12  !

        Cell face heights in arbitrary
        vertical grid (ZFACE(NZ+1))    No defaults
                                       Units: m
        ! ZFACE = 0.,20.,40.,80.,160.,320.,600.,1000.,1500.,2200.,3000.,4000.,5000. !

!END!


--------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output Options
--------------


    DISK OUTPUT OPTION

       Save met. fields in an unformatted
       output file ?             (LSAVE)  Default: T     ! LSAVE = T !
       (F = Do not save, T = Save)

       Type of unformatted output file:
       (IFORMO)                           Default: 1    ! IFORMO =  1  !

            1 = CALPUFF/CALGRID type file (CALMET.DAT)
            2 = MESOPUFF-II type file     (PACOUT.DAT)


    LINE PRINTER OUTPUT OPTIONS:

       Print met. fields ?  (LPRINT)       Default: F     ! LPRINT = F !
```

```
(F = Do not print, T = Print)
(NOTE: parameters below control which
       met. variables are printed)

Print interval
(IPRINF) in hours                  Default: 1     ! IPRINF =  1  !
(Meteorological fields are printed
 every  1  hours)


Specify which layers of U, V wind component
to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T)        Defaults: NZ*0
! IUVOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !
-----------------------


Specify which levels of the W wind component to print
(NOTE: W defined at TOP cell face --  12  values)
(IWOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! IWOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !


Specify which levels of the 3-D temperature field to print
(ITOUT(NZ)) -- NOTE: NZ values must be entered
(0=Do not print, 1=Print)
(used only if LPRINT=T & LCALGRD=T)
-----------------------------------
                                     Defaults: NZ*0
 ! ITOUT =  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0 ,  0  !

Specify which meteorological fields
to print
(used only if LPRINT=T)            Defaults: 0 (all variables)
-----------------------


  Variable            Print ?
                  (0 = do not print,
                   1 = print)
  --------        ------------------

!  STABILITY  =           0           ! - PGT stability class
!  USTAR      =           0           ! - Friction velocity
!  MONIN      =           0           ! - Monin-Obukhov length
!  MIXHT      =           0           ! - Mixing height
!  WSTAR      =           0           ! - Convective velocity scale
!  PRECIP     =           0           ! - Precipitation rate
!  SENSHEAT   =           0           ! - Sensible heat flux
!  CONVZI     =           0           ! - Convective mixing ht.


Testing and debug print options for micrometeorological module

   Print input meteorological data and
   internal variables (LDB)         Default: F       ! LDB = F !
   (F = Do not print, T = print)
   (NOTE: this option produces large amounts of output)

   First time step for which debug data
   are printed (NN1)                Default: 1       ! NN1 =  1  !

   Last time step for which debug data
```

```
          are printed (NN2)                Default: 1       ! NN2 =  2  !

       Testing and debug print options for wind field module
       (all of the following print options control output to
        wind field module's output files: TEST.PRT, TEST.OUT,
        TEST.KIN, TEST.FRD, and TEST.SLP)

          Control variable for writing the test/debug
          wind fields to disk files (IOUTD)
          (0=Do not write, 1=write)        Default: 0       ! IOUTD =  0  !

          Number of levels, starting at the surface,
          to print (NZPRN2)                Default: 1       ! NZPRN2 =  1  !

          Print the INTERPOLATED wind components ?
          (IPR0) (0=no, 1=yes)             Default: 0       !  IPR0 =  0  !

          Print the TERRAIN ADJUSTED surface wind
          components ?
          (IPR1) (0=no, 1=yes)             Default: 0       !  IPR1 =  0  !

          Print the SMOOTHED wind components and
          the INITIAL DIVERGENCE fields ?
          (IPR2) (0=no, 1=yes)             Default: 0       !  IPR2 =  0  !

          Print the FINAL wind speed and direction
          fields ?
          (IPR3) (0=no, 1=yes)             Default: 0       !  IPR3 =  0  !

          Print the FINAL DIVERGENCE fields ?
          (IPR4) (0=no, 1=yes)             Default: 0       !  IPR4 =  0  !

          Print the winds after KINEMATIC effects
          are added ?
          (IPR5) (0=no, 1=yes)             Default: 0       !  IPR5 =  0  !

          Print the winds after the FROUDE NUMBER
          adjustment is made ?
          (IPR6) (0=no, 1=yes)             Default: 0       !  IPR6 =  0  !

          Print the winds after SLOPE FLOWS
          are added ?
          (IPR7) (0=no, 1=yes)             Default: 0       !  IPR7 =  0  !

          Print the FINAL wind field components ?
          (IPR8) (0=no, 1=yes)             Default: 0       !  IPR8 =  0  !

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 4 -- Meteorological data options
--------------

    NO OBSERVATION MODE             (NOOBS)  Default: 0     ! NOOBS =  1   !
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air observations)
              Use MM5 for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM5 for surface, overwater, and upper air data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA =  99  !

       Number of precipitation stations
```

```
      (NPSTA=-1: flag for use of MM5 precip data)
                             (NPSTA)  No default     ! NPSTA =  0  !

    CLOUD DATA OPTIONS
       Gridded cloud fields:
                            (ICLOUD)  Default: 0     ! ICLOUD =  0  !
       ICLOUD = 0 - Gridded clouds not used
       ICLOUD = 1 - Gridded CLOUD.DAT generated as OUTPUT
       ICLOUD = 2 - Gridded CLOUD.DAT read as INPUT
       ICLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity

    FILE FORMATS

       Surface meteorological data file format
                            (IFORMS)  Default: 2     ! IFORMS =  2  !
       (1 = unformatted (e.g., SMERGE output))
       (2 = formatted   (free-formatted user input))

       Precipitation data file format
                            (IFORMP)  Default: 2     ! IFORMP =  2  !
       (1 = unformatted (e.g., PMERGE output))
       (2 = formatted   (free-formatted user input))

       Cloud data file format
                            (IFORMC)  Default: 2     ! IFORMC =  2  !
       (1 = unformatted - CALMET unformatted output)
       (2 = formatted   - free-formatted CALMET output or user input)

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------


    WIND FIELD MODEL OPTIONS
       Model selection variable (IWFCOD)     Default: 1      ! IWFCOD =  1  !
          0 = Objective analysis only
          1 = Diagnostic wind module

       Compute Froude number adjustment
       effects ? (IFRADJ)                    Default: 1      ! IFRADJ =  1  !
       (0 = NO, 1 = YES)

       Compute kinematic effects ? (IKINE)   Default: 0      ! IKINE  =  0  !
       (0 = NO, 1 = YES)

       Use O'Brien procedure for adjustment
       of the vertical velocity ? (IOBR)     Default: 0      ! IOBR =  0  !
       (0 = NO, 1 = YES)

       Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE  =  1  !
       (0 = NO, 1 = YES)

       Extrapolate surface wind observations
       to upper layers ? (IEXTRP)            Default: -4     ! IEXTRP =  2  !
       (1 = no extrapolation is done,
        2 = power law extrapolation used,
        3 = user input multiplicative factors
            for layers 2 - NZ used (see FEXTRP array)
        4 = similarity theory used
        -1, -2, -3, -4 = same as above except layer 1 data
            at upper air stations are ignored

       Extrapolate surface winds even
       if calm? (ICALM)                      Default: 0      ! ICALM  =  0  !
```

```
       (0 = NO, 1 = YES)

       Layer-dependent biases modifying the weights of
       surface and upper air stations (BIAS(NZ))
         -1<=BIAS<=1
       Negative BIAS reduces the weight of upper air stations
         (e.g. BIAS=-0.1 reduces the weight of upper air stations
       by 10%; BIAS= -1, reduces their weight by 100 %)
       Positive BIAS reduces the weight of surface stations
         (e.g. BIAS= 0.2 reduces the weight of surface stations
       by 20%; BIAS=1 reduces their weight by 100%)
       Zero BIAS leaves weights unchanged (1/R**2 interpolation)
       Default: NZ*0
                               ! BIAS = -1 , -1 , -1 , -1 , -.5 ,  0 ,  .5 ,  1 ,  1 ,  1
,  1 ,  1  !

       Minimum distance from nearest upper air station
       to surface station for which extrapolation
       of surface winds at surface station will be allowed
       (RMIN2: Set to -1 for IEXTRP = 4 or other situations
        where all surface stations should be extrapolated)
                                       Default: 4.    ! RMIN2 = -1.0 !

       Use gridded prognostic wind field model
       output fields as input to the diagnostic
       wind field model (IPROG)              Default: 0      ! IPROG =  14  !
       (0 = No, [IWFCOD = 0 or 1]
        1 = Yes, use CSUMM prog. winds as Step 1 field, [IWFCOD = 0]
        2 = Yes, use CSUMM prog. winds as initial guess field [IWFCOD = 1]
        3 = Yes, use winds from MM4.DAT file as Step 1 field [IWFCOD = 0]
        4 = Yes, use winds from MM4.DAT file as initial guess field [IWFCOD = 1]
        5 = Yes, use winds from MM4.DAT file as observations [IWFCOD = 1]
        13 = Yes, use winds from MM5.DAT file as Step 1 field [IWFCOD = 0]
        14 = Yes, use winds from MM5.DAT file as initial guess field [IWFCOD = 1]
        15 = Yes, use winds from MM5.DAT file as observations [IWFCOD = 1]

       Timestep (hours) of the prognostic
       model input data   (ISTEPPG)          Default: 1      ! ISTEPPG =  6   !

    RADIUS OF INFLUENCE PARAMETERS

       Use varying radius of influence       Default: F      ! LVARY =  F!
       (if no stations are found within RMAX1,RMAX2,
        or RMAX3, then the closest station will be used)

       Maximum radius of influence over land
       in the surface layer (RMAX1)          No default      ! RMAX1 = 25. !
                                             Units: km
       Maximum radius of influence over land
       aloft (RMAX2)                         No default      ! RMAX2 = 25. !
                                             Units: km
       Maximum radius of influence over water
       (RMAX3)                               No default      ! RMAX3 = 25. !
                                             Units: km


    OTHER WIND FIELD INPUT PARAMETERS

       Minimum radius of influence used in
       the wind field interpolation (RMIN)   Default: 0.1    ! RMIN = 0.1 !
                                             Units: km
       Radius of influence of terrain
       features (TERRAD)                     No default      ! TERRAD = 8. !

                                             Units: km
       Relative weighting of the first
       guess field and observations in the
       SURFACE layer (R1)                    No default      ! R1 = 8. !
```

```
       (R1 is the distance from an           Units: km
       observational station at which the
       observation and first guess field are
       equally weighted)

       Relative weighting of the first
       guess field and observations in the
       layers ALOFT (R2)                     No default      ! R2 = 8. !
       (R2 is applied in the upper layers    Units: km
       in the same manner as R1 is used in
       the surface layer).

       Relative weighting parameter of the
       prognostic wind field data (RPROG)    No default      ! RPROG = 0. !
       (Used only if IPROG = 1)              Units: km
       ------------------------

       Maximum acceptable divergence in the
       divergence minimization procedure
       (DIVLIM)                              Default: 5.E-6  ! DIVLIM= 5.0E-06 !

       Maximum number of iterations in the
       divergence min. procedure (NITER)     Default: 50     ! NITER =  50  !

       Number of passes in the smoothing
       procedure (NSMTH(NZ))
       NOTE: NZ values must be entered
            Default: 2,(mxnz-1)*4 ! NSMTH =
 2 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4 ,  4  !

       Maximum number of stations used in
       each layer for the interpolation of
       data to a grid point (NINTR2(NZ))
       NOTE: NZ values must be entered       Default: 99.    ! NINTR2 =
 99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99 ,  99  !

       Critical Froude number (CRITFN)       Default: 1.0    ! CRITFN = 1. !

       Empirical factor controlling the
       influence of kinematic effects
       (ALPHA)                               Default: 0.1    ! ALPHA = 0.1 !

       Multiplicative scaling factor for
       extrapolation of surface observations
       to upper layers (FEXTR2(NZ))          Default: NZ*0.0
       ! FEXTR2 = 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0. !
       (Used only if IEXTRP = 3 or -3)


    BARRIER INFORMATION

       Number of barriers to interpolation
       of the wind fields (NBAR)             Default: 0      ! NBAR =  0  !

       THE FOLLOWING 4 VARIABLES ARE INCLUDED
       ONLY IF NBAR > 0
       NOTE: NBAR values must be entered     No defaults
             for each variable               Units: km

          X coordinate of BEGINNING
          of each barrier (XBBAR(NBAR))      ! XBBAR = 0. !
          Y coordinate of BEGINNING
          of each barrier (YBBAR(NBAR))      ! YBBAR = 0. !

          X coordinate of ENDING
          of each barrier (XEBAR(NBAR))      ! XEBAR = 0. !
          Y coordinate of ENDING
          of each barrier (YEBAR(NBAR))      ! YEBAR = 0. !
```

```
DIAGNOSTIC MODULE DATA INPUT OPTIONS

   Surface temperature (IDIOPT1)         Default: 0      ! IDIOPT1 =  0  !
      0 = Compute internally from
          hourly surface observations
      1 = Read preprocessed values from
          a data file (DIAG.DAT)

      Surface met. station to use for
      the surface temperature (ISURFT)   No default     ! ISURFT =  1  !
      (Must be a value from 1 to NSSTA)
      (Used only if IDIOPT1 = 0)
      --------------------------

   Domain-averaged temperature lapse
   rate (IDIOPT2)                        Default: 0     ! IDIOPT2 =  0  !
      0 = Compute internally from
          twice-daily upper air observations
      1 = Read hourly preprocessed values
          from a data file (DIAG.DAT)

      Upper air station to use for
      the domain-scale lapse rate (IUPT) No default     ! IUPT   =  0  !
      (Must be a value from 1 to NUSTA)
      (Used only if IDIOPT2 = 0)
      --------------------------

      Depth through which the domain-scale
      lapse rate is computed (ZUPT)      Default: 200.  ! ZUPT = 200. !
      (Used only if IDIOPT2 = 0)         Units: meters
      --------------------------

   Domain-averaged wind components
   (IDIOPT3)                             Default: 0     ! IDIOPT3 =  0  !
      0 = Compute internally from
          twice-daily upper air observations
      1 = Read hourly preprocessed values
          a data file (DIAG.DAT)

      Upper air station to use for
      the domain-scale winds (IUPWND)    Default: -1    ! IUPWND = -1  !
      (Must be a value from -1 to NUSTA)
      (Used only if IDIOPT3 = 0)
      --------------------------

      Bottom and top of layer through
      which the domain-scale winds
      are computed
      (ZUPWND(1), ZUPWND(2))        Defaults: 1., 1000. ! ZUPWND= 1., 1000. !
      (Used only if IDIOPT3 = 0)    Units: meters
      --------------------------

   Observed surface wind components
   for wind field module (IDIOPT4)  Default: 0     ! IDIOPT4 =  0  !
      0 = Read WS, WD from a surface
          data file (SURF.DAT)
      1 = Read hourly preprocessed U, V from
          a data file (DIAG.DAT)

   Observed upper air wind components
   for wind field module (IDIOPT5)  Default: 0     ! IDIOPT5 =  0  !
      0 = Read WS, WD from an upper
          air data file (UP1.DAT, UP2.DAT, etc.)
      1 = Read hourly preprocessed U, V from
          a data file (DIAG.DAT)
```

```
LAKE BREEZE INFORMATION

   Use Lake Breeze Module  (LLBREZE)
                                  Default: F      ! LLBREZE = F !

    Number of lake breeze regions (NBOX)          ! NBOX =  0  !

 X Grid line 1 defining the region of interest
                                               ! XG1 = 0. !
 X Grid line 2 defining the region of interest
                                               ! XG2 = 0. !
 Y Grid line 1 defining the region of interest
                                               ! YG1 = 0. !
 Y Grid line 2 defining the region of interest
                                               ! YG2 = 0. !

  X Point defining the coastline (Straight line)
            (XBCST)  (KM)   Default: none    ! XBCST = 0. !

  Y Point defining the coastline (Straight line)
            (YBCST)  (KM)   Default: none    ! YBCST = 0. !

  X Point defining the coastline (Straight line)
            (XECST)  (KM)   Default: none    ! XECST = 0. !

  Y Point defining the coastline (Straight line)
            (YECST)  (KM)   Default: none    ! YECST = 0. !


Number of stations in the region     Default: none ! NLB =  0 !
(Surface stations + upper air stations)

Station ID's  in the region   (METBXID(NLB))
(Surface stations first, then upper air stations)
  ! METBXID =  0 !

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters
--------------

    EMPIRICAL MIXING HEIGHT CONSTANTS

       Neutral, mechanical equation
       (CONSTB)                        Default: 1.41   ! CONSTB = 1.41 !
       Convective mixing ht. equation
       (CONSTE)                        Default: 0.15   ! CONSTE = 0.15 !
       Stable mixing ht. equation
       (CONSTN)                        Default: 2400.  ! CONSTN = 2400.!
       Overwater mixing ht. equation
       (CONSTW)                        Default: 0.16   ! CONSTW = 0.16 !
       Absolute value of Coriolis
       parameter (FCORIOL)             Default: 1.E-4  ! FCORIOL = 1.0E-04!
                                       Units: (1/s)

    SPATIAL AVERAGING OF MIXING HEIGHTS

       Conduct spatial averaging
       (IAVEZI)  (0=no, 1=yes)         Default: 1      ! IAVEZI =  1  !

       Max. search radius in averaging
       process (MNMDAV)                Default: 1      ! MNMDAV =  1  !
                                       Units: Grid
                                              cells
       Half-angle of upwind looking cone
```

```
   for averaging (HAFANG)               Default: 30.    ! HAFANG = 30. !
                                        Units: deg.
   Layer of winds used in upwind
   averaging (ILEVZI)                   Default: 1      ! ILEVZI =  1  !
   (must be between 1 and NZ)

OTHER MIXING HEIGHT VARIABLES

   Minimum potential temperature lapse
   rate in the stable layer above the
   current convective mixing ht.        Default: 0.001  ! DPTMIN = 0.001 !
   (DPTMIN)                             Units: deg. K/m
   Depth of layer above current conv.
   mixing height through which lapse    Default: 200.   ! DZZI = 200. !
   rate is computed (DZZI)              Units: meters

   Minimum overland mixing height       Default:  50.   ! ZIMIN = 50. !
   (ZIMIN)                              Units: meters
   Maximum overland mixing height       Default: 3000.  ! ZIMAX = 3000. !
   (ZIMAX)                              Units: meters
   Minimum overwater mixing height      Default:   50.  ! ZIMINW = 50. !
   (ZIMINW) -- (Not used if observed    Units: meters
   overwater mixing hts. are used)
   Maximum overwater mixing height      Default: 3000.  ! ZIMAXW = 3000. !
   (ZIMAXW) -- (Not used if observed    Units: meters
   overwater mixing hts. are used)


TEMPERATURE PARAMETERS

   3D temperature from observations or
   from prognostic data? (ITPROG)       Default:0         !ITPROG =  1   !

      0 = Use Surface and upper air stations
          (only if NOOBS = 0)
      1 = Use Surface stations (no upper air observations)
          Use MM5 for upper air data
          (only if NOOBS = 0,1)
      2 = No surface or upper air observations
          Use MM5 for surface and upper air data
          (only if NOOBS = 0,1,2)

   Interpolation type
   (1 = 1/R ; 2 = 1/R**2)               Default:1         ! IRAD =  1  !

   Radius of influence for temperature
   interpolation (TRADKM)               Default: 500.     ! TRADKM = 500. !
                                        Units: km

   Maximum Number of stations to include
   in temperature interpolation (NUMTS)  Default: 5        ! NUMTS = 10  !

   Conduct spatial averaging of temp-
   eratures (IAVET)  (0=no, 1=yes)        Default: 1     ! IAVET =  1  !
   (will use mixing ht MNMDAV,HAFANG
    so make sure they are correct)

   Default temperature gradient        Default: -.0098 ! TGDEFB = -0.0098 !
   below the mixing height over
   water (K/m) (TGDEFB)

   Default temperature gradient        Default: -.0045 ! TGDEFA = -0.0045 !
   above the mixing height over
   water (K/m) (TGDEFA)

   Beginning (JWAT1) and ending (JWAT2)
   land use categories for temperature                   ! JWAT1 =  999  !
   interpolation over water -- Make                      ! JWAT2 =  999  !
```

```
       bigger than largest land use to disable

   PRECIP INTERPOLATION PARAMETERS

       Method of interpolation (NFLAGP)      Default = 2    ! NFLAGP =  2  !
        (1=1/R,2=1/R**2,3=EXP/R**2)
       Radius of Influence (km) (SIGMAP)     Default = 100.0  ! SIGMAP = 100. !
        (0.0 => use half dist. btwn
         nearest stns w & w/out
         precip when NFLAGP = 3)
       Minimum Precip. Rate Cutoff (mm/hr)   Default = 0.01  ! CUTP = 0.01 !
        (values < CUTP = 0.0 mm/hr)
!END!


--------------------------------------------------------------------------------

INPUT GROUP: 7 -- Surface meteorological station parameters
--------------

     SURFACE STATION VARIABLES
     (One record per station --  99  records in all)


              1     2
         Name   ID            X coord.   Y coord.   Time   Anem.
                                (km)       (km)     zone   Ht.(m)
       ----------------------------------------------------------
! SS1  ='KELP'       1       -34.148     -70.625    8    10  !
! SS2  ='KAMP'       2       -98.752      22.952    8    10  !
! SS3  ='CSTP'       3        93.107    -128.989    8    10  !
! SS4  ='GOLP'       5       141.428      90.473    8    10  !
! SS5  ='REVP'       6         1.966      54.168    8    10  !
! SS6  ='SKOW'       7       233.991     -68.609    8    10  !
! SS7  ='TRAW'       8       101.741    -155.198    8    10  !
! SS8  ='TCGW'       9       101.848    -160.869    8    10  !
! SS9  ='OHMW'      10      -163.657     130.867    8    10  !
! SS10 ='WLGW'      11      -219.148     190.187    8    10  !
! SS11 ='WLKW'      12      -214.394     185.974    8    10  !
! SS12 ='OSYE'      13       -31.668    -163.067    8    10  !
! SS13 ='PENE'      14       -43.640    -115.156    8    10  !
! SS14 ='SUME'      15       -47.018    -103.560    8    10  !
! SS15 ='CRNE'      16       232.426     -93.948    8    10  !
! SS16 ='CRSE'      17       182.619    -154.523    8    10  !
! SS17 ='NAKE'      18        84.330     -25.242    8    10  !
! SS18 ='PRNE'      19      -109.589    -113.661    8    10  !
! SS19 ='SMAE'      21       -19.991      22.283    8    10  !
! SS20 ='VRNE'      22       -13.771     -30.679    8    10  !
! SS21 ='LYTE'      23      -184.194     -27.494    8    10  !
! SS22 ='YOHE'      24       184.621     108.198    8    10  !
! SS23 ='BLRE'      25       -19.864     181.269    8    10  !
! SS24 ='CLNE'      27       171.818     186.472    8    10  !
! SS25 ='HGCF'      67      -180.967    -122.751    8    10  !
! SS26 ='VALF'     200       -21.252     254.650    8    10  !
! SS27 ='TONF'     202        35.841     245.223    8    10  !
! SS28 ='RCKF'     210      -241.227     168.125    8    10  !
! SS29 ='GSPF'     222      -254.432     112.138    8    10  !
! SS30 ='GVNF'     227      -186.357     222.628    8    10  !
! SS31 ='HFHF'     230      -163.418     206.240    8    10  !
! SS32 ='CSLF'     232       -96.048     137.170    8    10  !
! SS33 ='TIMF'     234      -164.386     159.836    8    10  !
! SS34 ='YGLF'     235      -139.482      83.943    8    10  !
! SS35 ='MDLF'     236      -189.116     100.790    8    10  !
! SS36 ='EBRF'     243       -61.550      84.157    8    10  !
! SS37 ='WMTF'     244      -114.147     131.420    8    10  !
! SS38 ='DCPF'     251      -110.526     164.398    8    10  !
! SS39 ='CTLF'     253       -58.979      43.522    8    10  !
! SS40 ='WGYF'     266       -84.763     205.615    8    10  !
```

```
! SS41 ='BRYF'     267       -28.403      164.537    8    10  !
! SS42 ='GOSF'     270       -11.902      217.342    8    10  !
! SS43 ='GDHF'     272       -14.926      152.984    8    10  !
! SS44 ='TYNF'     279      -134.602      -85.614    8    10  !
! SS45 ='BTNF'     281      -182.661       -7.961    8    10  !
! SS46 ='BMNF'     283       -71.401      -69.779    8    10  !
! SS47 ='TRTF'     286       -44.405       33.923    8    10  !
! SS48 ='MRTF'     294      -124.905      -44.409    8    10  !
! SS49 ='FINF'     298       -34.261      -32.510    8    10  !
! SS50 ='APGF'     302      -116.251      -60.124    8    10  !
! SS51 ='FRBF'     306      -228.248       63.955    8    10  !
! SS52 ='MCLF'     311      -166.236       35.085    8    10  !
! SS53 ='GSNF'     321      -116.056       13.705    8    10  !
! SS54 ='BBRF'     324      -175.057      -68.865    8    10  !
! SS55 ='SWRF'     325       -83.745     -123.914    8    10  !
! SS56 ='PKLF'     326      -118.731        1.783    8    10  !
! SS57 ='ASNF'     331       -86.349     -150.570    8    10  !
! SS58 ='MDYF'     334       -30.280     -150.250    8    10  !
! SS59 ='HWDF'     343        23.206      208.342    8    10  !
! SS60 ='SMAF'     344         5.931       86.020    8    10  !
! SS61 ='BMTF'     345        44.043      148.011    8    10  !
! SS62 ='TFLF'     350         2.580       46.716    8    10  !
! SS63 ='CWCF'     352        40.821       11.648    8    10  !
! SS64 ='GSRF'     355        23.637      138.585    8    10  !
! SS65 ='TRCF'     361        61.653      166.934    8    10  !
! SS66 ='MBLF'     362        16.132      -16.469    8    10  !
! SS67 ='WSKF'     366       155.230       65.193    8    10  !
! SS68 ='MARF'     367       184.828       63.590    8    10  !
! SS69 ='SCCF'     374       100.786      136.282    8    10  !
! SS70 ='PDCF'     380       154.042      -63.783    8    10  !
! SS71 ='FLCF'     383        79.471       -0.435    8    10  !
! SS72 ='HWSF'     384       142.140      -12.957    8    10  !
! SS73 ='DUNF'     385       128.295       32.804    8    10  !
! SS74 ='TRLF'     387       108.640       14.615    8    10  !
! SS75 ='KETF'     388        26.905      -59.990    8    10  !
! SS76 ='BVDF'     390        -6.402     -115.996    8    10  !
! SS77 ='EMLF'     391        30.589     -118.605    8    10  !
! SS78 ='GFKF'     392        42.742     -163.247    8    10  !
! SS79 ='NCLF'     393        46.312     -108.049    8    10  !
! SS80 ='OPKF'     396        66.294      -88.675    8    10  !
! SS81 ='SMWF'     404       112.457     -110.409    8    10  !
! SS82 ='SLOF'     406       112.328      -78.374    8    10  !
! SS83 ='NYGF'     407        73.224     -138.027    8    10  !
! SS84 ='NRNF'     408        87.857     -110.222    8    10  !
! SS85 ='PLSF'     411       237.047        4.223    8    10  !
! SS86 ='ELKF'     412       273.225     -128.406    8    10  !
! SS87 ='TBYF'     417       208.782        5.564    8    10  !
! SS88 ='FHDF'     418       325.943     -149.157    8    10  !
! SS89 ='DWCF'     421       188.412      -76.256    8    10  !
! SS90 ='BLLF'     422       277.239      -59.243    8    10  !
! SS91 ='BKHF'     423       244.516     -110.533    8    10  !
! SS92 ='EMCF'     425       215.981      -35.075    8    10  !
! SS93 ='JFCF'     725      -238.729      -28.366    8    10  !
! SS94 ='RPRF'     788       293.259      -37.867    8    10  !
! SS95 ='NGCF'     789       218.385     -111.914    8    10  !
! SS96 ='WRVF'     790       266.534      -28.331    8    10  !
! SS97 ='CRLF'     791       252.011     -140.050    8    10  !
! SS98 ='CBCF'     793       123.734       76.745    8    10  !
! SS99 ='CRCF'     832      -230.963      105.577    8    10  !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!
```

```
-------------------------------------------------------------------------------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

     UPPER AIR STATION VARIABLES
     (One record per station --  0  records in all)

             1     2
         Name    ID      X coord.   Y coord.  Time zone
                           (km)       (km)
        -----------------------------------------------
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!


-------------------------------------------------------------------------------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

     PRECIPITATION STATION VARIABLES
     (One record per station --  0  records in all)
     (NOT INCLUDED IF NPSTA = 0)

            1          2
         Name   Station    X coord.  Y coord.
                 Code       (km)      (km)
         ------------------------------------


-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Six digit station code composed of state
        code (first 2 digits) and station ID (last
        4 digits)

!END!
```

----------------- LAST LINE OF FILE PRECEEDS THIS ONE ---------------------------