MMS 2006-006

Development of the Next Generation Air Quality Models for Outer Continental Shelf (OCS) Applications

Final Report: Volume 2 - CALPUFF Users Guide

(CALMET and Preprocessors)

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Contents

A. OVERVIEW

A.1 Background

The purpose of this study is to develop an updated regulatory model for evaluating air quality impacts from emission sources located on federal waters of the Outer Continental Shelf (OCS). The United States Department of the Interior Minerals Management Service (MMS) is in charge of a national program to develop the mineral resources, including oil and gas and alternative energy sources (such as wind power), on the OCS waters of the United States. The areas of development are located at distances ranging from 3 miles to more than 100 miles from shore.

In the early 1980s the MMS developed the Offshore & Coastal Dispersion (OCD) model (Hanna et al., 1985) to evaluate impacts from the so-called "nonreactive" pollutants (NO_2, SO_2, CO, PM) emitted from point, line, or area sources located over water. Since then the science of dispersion modeling has made significant advances, as have the computational and data resources that support this modeling. Therefore the focus of this study was to modify and/or enhance an existing model so that it can be appropriately applied to overwater transport and dispersion simulations using the most current knowledge, and is versatile enough to be used in short-range as well as long-range regulatory applications. The new model for OCS applications is an update to the CALPUFF (Scire et al., 2000a, 2000b) modeling system.

The original design specifications for CALPUFF included: (1) the capability to treat time-varying sources, (2) suitability for modeling domains from tens of meters to hundreds of kilometers from a source, (3) predictions for averaging times ranging from one-hour to one year, (4) applicability to inert pollutants and those subject to linear removal and chemical conversion mechanisms, and, (5) applicability for rough or complex terrain situations. The modeling system developed to meet these objectives consisted of three components:

- CALMET, a meteorological modeling package with both diagnostic and prognostic wind field generators
- CALPUFF, a Gaussian puff dispersion model with chemical removal, wet and dry deposition, complex terrain algorithms, building downwash, plume fumigation, and other effects
- CALPOST and other postprocessing programs for the output fields of meteorological data, concentrations and deposition fluxes.

CALMET, CALPUFF, and CALPOST have been substantially revised and enhanced over time, and the modeling system has achieved regulatory status. The U.S. EPA has designated the CALPUFF modeling system as a *Guideline* ("Appendix A") model for regulatory applications involving long range transport, and on a case-by-case basis for near-field applications where non-steady-state effects (situations where factors such as spatial variability in the meteorological fields, calm winds, fumigation, recirculation or stagnation, and terrain or coastal effects) may be important.

In the early 1990s, the Interagency Workgroup on Air Quality Modeling (IWAQM) reviewed various modeling approaches suitable for estimating pollutant concentrations at Class I areas, including the individual and cumulative impacts of proposed and existing sources on Air Quality Related Values (AQRVs), Prevention of Significant Deterioration (PSD) increments, and National Ambient Air Quality Standards (NAAQS). IWAQM consists of representatives from the U.S. Environmental Protection Agency (EPA), U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. IWAQM released a Phase I report (EPA, 1993) which recommended using the MESOPUFF II dispersion model and MESOPAC II meteorological model on an interim basis for simulating regional air quality and visibility impacts. These recommendations were to apply until more refined (Phase 2) techniques could be identified and evaluated. As part of the development of the Phase 2 recommendations, IWAQM reviewed and intercompared diagnostic wind field models, tested the use of coarse gridded wind fields from the Penn State/NCAR Mesoscale Model with four dimensional data assimilation (MM4) as input into the diagnostic models, and evaluated the MESOPUFF II and CALPUFF modeling systems using tracer data collected during the Cross-Appalachian Tracer Experiment (CAPTEX). The CAPTEX evaluation results (EPA, 1995) indicated that by using the CALMET/ CALPUFF models with MM4 data, performance could be improved over that obtained with the interim Phase I modeling approach. The Phase 2 IWAQM report (EPA, 1998) recommends the use of the CALMET and CALPUFF models for estimating air quality impacts relative to the National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments.

Changes to the system that were designed and implemented for OCS applications include ease-of-use features as well as new and modified subroutines in both the CALMET meteorological model and the CALPUFF dispersion model:

- CALMET Updates
  - An option is provided to use the COARE (Coupled Ocean Atmosphere Response Experiment) overwater flux model, Version 2.6bw, with or without wave data.
  - A convective (rather than mechanical) overwater boundary layer height is computed for $L<0$ (positive surface heat flux). Note that the overwater mixing height is computed only when it is not provided in a SEA.DAT file.
  - A new convective mixing height parameterization option is provided.
  - Surface winds are adjusted from anemometer height to 10m (middle of CALMET layer 1).
  - Consistent similarity profile equations are used throughout system.

- CALPUFF updates
  - A building downwash adjustment is introduced for elevated (platform) structures with an open area between the surface and the bulk of the structure. This platform height is provided for point sources, and applies to the ICS downwash option.
  - An option is provided for computing turbulence profiles using the AERMOD subroutines
  - A <u>diagnostic</u> option is provided to test a Lagrangian time-scale for lateral plume growth functions that is computed from boundary layer scales.
  - An option is provided to accept the AERMET version of SURFACE and PROFILE meteorological data files.

- An option is provided to include an adjustment for turbulence advection from regions of larger turbulence velocity into regions of smaller turbulence velocity. This adjustment is applied to computed (not measured) turbulence.
- The minimum lateral turbulence velocity (σ_v) allowed is partitioned to distinguish values appropriate for over-land cells and over-water cells.

- BUOY processor
  - This new processor creates revised SEA.DAT files for CALMET with wave data for the COARE overwater flux option.
  - Data files readily obtained from NODC and NDBC web sites are read.

- Graphical user interface (GUI) updates
  - The CALPRO system for geophysical and meteorological preprocessors and CALPOST and PRTMET postprocessors was extensively revised and enhanced.
  - A GUI for the BUOY processor was developed and integrated into CALPRO.
  - A GUI option was added to CALPRO for extracting a subset from the surface meteorological data, precipitation data, and ozone data from the Gulf of Mexico dataset for a user's CALMET domain.
  - The CALVIEW display system for meteorological fields and concentration/deposition fields using the SURFER® contouring package was extensively revised and enhanced.

- Standard Gulf of Mexico Meteorology and Ozone Dataset
  - Meteorological, geophysical and ozone data required for CALMET/CALPUFF simulations within the MMS Gulf of Mexico region were prepared for year 2003.
  - USGS terrain elevation files with 90m resolution and USGS land use data files with 200m resolution were assembled for the domain.
  - Buoy stations in the domain were processed into 13 SEA.DAT files (1 station/file).
  - Upper-air stations in the domain were processed into 21 UP.DAT files (1 station/file).
  - 230 NWS hourly surface meteorological stations in the domain were processed into the SURF.DAT file.
  - 271 NWS precipitation stations in the domain were processed into the PRECIP.DAT file.
  - 201 ozone data stations in the domain were processed into the OZONE.DAT file.
  - One full year (2003) of gridded prognostic meteorological output fields from the Rapid Update Cycle (RUC) mesoscale weather model were reformatted into 50 tiles (90 RUC grid-points/tile), for the portion of the 20km RUC grid that covers the MMS Gulf of Mexico domain.
  - The RUCDECODE program was created to assemble RUC grid cell data from one or more tiles into a 3D.DAT file for a user's CALMET domain.

The technical formulation for CALMET is provided in Section 2 of Scire et al., 2000a and the technical formulation CALPUFF is provided in Section 2 of Scire et al., 2000b. Formulations for the updates to CALMET and CALPUFF are provided in Section 3 in Volume I of this report. Volumes II and III of this report contain application details for the following core system components:

(Volume II)

- Geophysical Data Processors
- Meteorological Data Processors
- Prognostic Meteorological Model Processors
- CALMET

(Volume III)

- CALPUFF
- Postprocessors

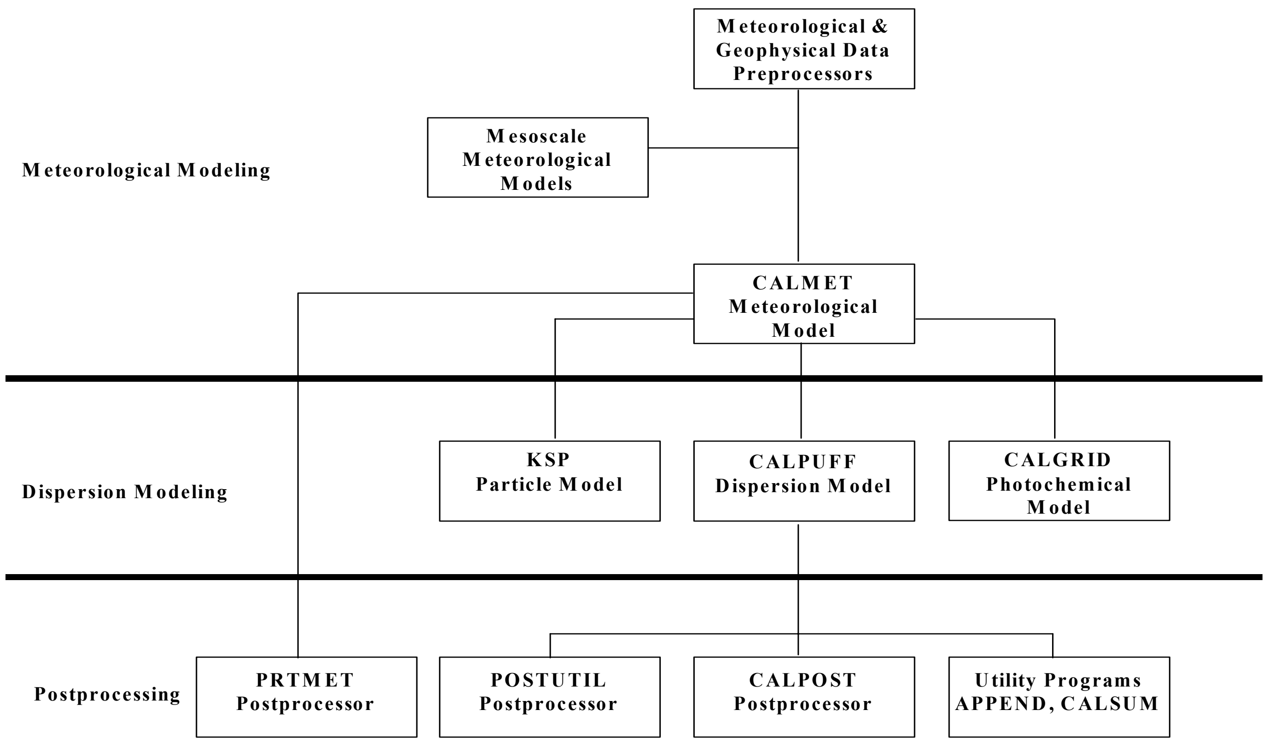
Linkages between programs are identified and the content of input and output files are provided. All of these programs can be used without the aid of the GUIs, but most can be accessed and configured using the GUI system.

A.2 Overview of the Modeling System

The CALPUFF Modeling System includes three main components: CALMET, CALPUFF, and CALPOST and a large set of preprocessing programs designed to interface the model to standard, routinely-available meteorological and geophysical datasets. In the simplest terms, CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded modeling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modeled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by CALMET, or as an option, it may use simpler non-gridded meteorological data much like existing plume models. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentrations or hourly deposition fluxes evaluated at selected receptor locations. CALPOST is used to process these files, producing tabulations that summarize the results of the simulation, identifying the highest and second highest 1-hour and 3-hour average concentrations at each receptor, for example. When performing visibility-related modeling, CALPOST uses concentrations from CALPUFF to compute extinction coefficients and related measures of visibility, reporting these for selected averaging times and locations.

To enhance the functionality of the modeling system, a PC-based GUI is provided for nearly every component. The GUIs can be used to prepare the control file that configures a run, execute the corresponding component model, and conduct file management functions. The GUIs also contain an extensive help system that makes much of the technical information contained in this manual available to the user on-line. The modeling system may also be setup and run without the aid of the GUIs. The control file for each component is simply a text file that is readily edited, and it contains extensive information about model options, default values, and units for each variable.

In addition to CALMET, CALPUFF, CALPOST, the modeling system interfaces to several other models, which is facilitated by several preprocessors and utilities. Figure A-1 displays the overall modeling system configuration. Two of the models plus the mesoscale meteorological models referenced in Figure



A-1 are external models that are not included in the CALPUFF system, but they can be interfaced with CALPUFF modules:

Figure A-1. Overview of the program elements in the CALMET/CALPUFF modeling system. Also shown are the associated CALGRID photochemical model, the KSP particle model, and mesoscale meteorological models that may include MM5/MM4, NAM(Eta), WRF, RUC, RAMS, and CSUMM.

MM5/MM4 (Penn State/NCAR Mesoscale Model) is a prognostic wind field model with four-dimensional data assimilation. The interface program CALMM5 converts the MM5 output data into a form compatible with CALMET.

NAM(formerly Eta) (North American Mesoscale model), and the **WRF** (Weather Research and Forecasting) model are NCEP operational weather models. Eta/NAM/WRF model output files are produced for use by the Advanced Weather Interactive Processing System (AWIPS) in various AWIPS grids. The interface program CALETA converts the NAM and WRF output data into a form compatible with CALMET.

RUC (Rapid Update Cycle) model is an NCEP operational weather model with high-frequency (every hour) short-range weather model forecasts (out to 12+ hours). The interface program CALRUC converts the RUC output data into a form compatible with CALMET.

RAMS (Regional Atmospheric Modeling System, Version 4.3) model is a NOAA Air Resources Laboratory (ARL) numerical weather model that can be run at global, mesoscale, and local scales. The interface program CALRAMS converts the RAMS output data into a form compatible with CALMET.

CSUMM (a version of the Colorado State University Mesoscale Model) is a primitive equation wind field model that simulates mesoscale airflow resulting from differential surface heating and terrain effects. Various options for using CSUMM output with CALMET are provided.

CALGRID is an Eulerian photochemical transport and dispersion model which includes modules for horizontal and vertical advection/diffusion, dry deposition, and a detailed photochemical mechanism (Yamartino et al., 1989, 1992). The output from CALMET may be used in CALGRID.

KSP is a multi-layer, multi-species Lagrangian particle model that simulates transport, dispersion, and deposition using explicit kinematic simulation (KS) of the larger transportive and dispersive eddies in the atmosphere (Yamartino et al., 1996, Strimaitis et al., 1995). The output from CALMET may be used in KSP.

The components in Figure A-1 that are included in the system are:

CALMET is a meteorological model which includes a diagnostic wind field generator containing objective analysis and parameterized treatments of slope flows, kinematic terrain effects, terrain blocking effects, and a divergence minimization procedure, and a micro-meteorological model for overland and overwater boundary layers.

CALPUFF is a non-steady-state Lagrangian Gaussian puff model containing modules for complex terrain effects, overwater transport, coastal interaction effects, building downwash, wet and dry removal, and simple chemical transformation.

CALPOST is a postprocessing program with options for the computation of time-averaged concentrations and deposition fluxes predicted by the CALPUFF and CALGRID models. CALPOST computes visibility impacts in accordance with IWAQM recommendations and the current Federal Land Managers' Air Quality Related Values Workgroup (FLAG) recommendations.

PRTMET is a postprocessing program that displays user-selected portions of the meteorological data file produced by the CALMET meteorological model.

APPEND is a postprocessor which appends two or more sequential CALPUFF concentration, wet flux, dry flux or relative humidity (visibility) files in time.

CALSUM is a postprocessor which sums and scales concentrations or wet/dry fluxes from two or more source groups from different CALPUFF runs.

POSTUTIL is a postprocessor which operates on one or more CALPUFF concentration and wet/dry flux files to create new species as weighted combinations of modeled species; to sum wet and dry deposition fluxes; to merge species from different runs into a single output file; to sum and scale results from different runs; to repartition nitric acid/nitrate based on total available sulfate and ammonia; and to add time/space-varying background.

Preprocessors and utilities provided with the modeling system for use with CALMET include:

READ62 is a meteorological preprocessor that extracts and processes upper air wind and temperature data from the standard NCDC TD-6201 data format or the NCDC CD-ROM FSL rawinsonde data format.

SMERGE is a meteorological preprocessor that processes hourly surface observations from a number of stations in NCDC CD-144 format, NCDC TD3505 format, NCDC TD9956 format, or NCDC CD-ROM format, and reformats the data into a single file with the data sorted by time rather than station. The CD-ROM format contains data in either the Solar and Meteorological Surface Observational Network (SAMSON) format or the Hourly U.S. Weather Observations (HUSWO) format.

PXTRACT is a meteorological preprocessor which extracts precipitation data for stations and a time period of interest from a fixed length, formatted precipitation data file in NCDC TD-3240 format.

PMERGE is a meteorological preprocessor responsible for reformatting the precipitation data files created by the PXTRACT program. PMERGE resolves "accumulation periods" into hourly values and flags suspicious or missing data. The output file can be formatted or binary, which can be directly input into the CALMET model, containing the precipitation data sorted by hour rather than station.

TERREL is a terrain preprocessor which coordinates the allocation of terrain elevation data from several digitized databases to a user-specified modeling grid.

CTGCOMP is a preprocessor used to compress the data file format of a USGS land use CTG data file.

CTGPROC is a land use preprocessor which reads compressed CTG land use data files, USGS Global Dataset format land use data files, USGS NLCD files, or a generic land use format, and computes the fractional land use for each grid cell in the user-specified modeling domain.

MAKEGEO is the final preprocessor which reads the fractional land use data, user inputs which define land use category mapping, and values relating each of the surface parameters to land use, and (optionally) the gridded terrain data file, and produces a GEO.DAT file ready for input to CALMET.

CALMM5 is a processor that extracts and interprets data in the output file from MM5 (Version 3), and creates a file of meteorological data for direct input to CALMET in either the preferred 3D.DAT format or the MM4.DAT format.

CALETA is a processor that extracts and interprets data in selected output files from NAM(Eta) and WRF, and creates a file of meteorological data for direct input to CALMET in its 3D.DAT format.

CALRUC is a processor that extracts and interprets data in selected output files from RUC, and creates a file of meteorological data for direct input to CALMET in its 3D.DAT format.

CALRAMS is a processor that extracts and interprets data in selected output files from RAMS, and creates a file of meteorological data for direct input to CALMET in its 3D.DAT format.

Preprocessors and utilities provided with the modeling system for use with CALPUFF include:

OPTHILL is a processor that uses topographical data (such as terrain maps) to develop hill shape factors that are used in the subgrid scale complex terrain (CTSG) module in CALPUFF.

EPM2BAEM is a conversion utility which creates a time-varying emissions file for buoyant forest fire area sources based on the output from the U.S.D.A Forest Service Emissions Production Model (EPM).

The meteorological modeling with the CALMET model is detailed in Figure A-2. Note that the preprocessors for the raw meteorological data are written to accommodate the U.S. National Climatic Data Center (NCDC) file formats. Figure A-3 is the schematic of the CALPUFF dispersion model indicating the model input and output files. The postprocessing approach for the meteorological and dispersion modeling results are shown in Figure A-4 and Figure A-5.

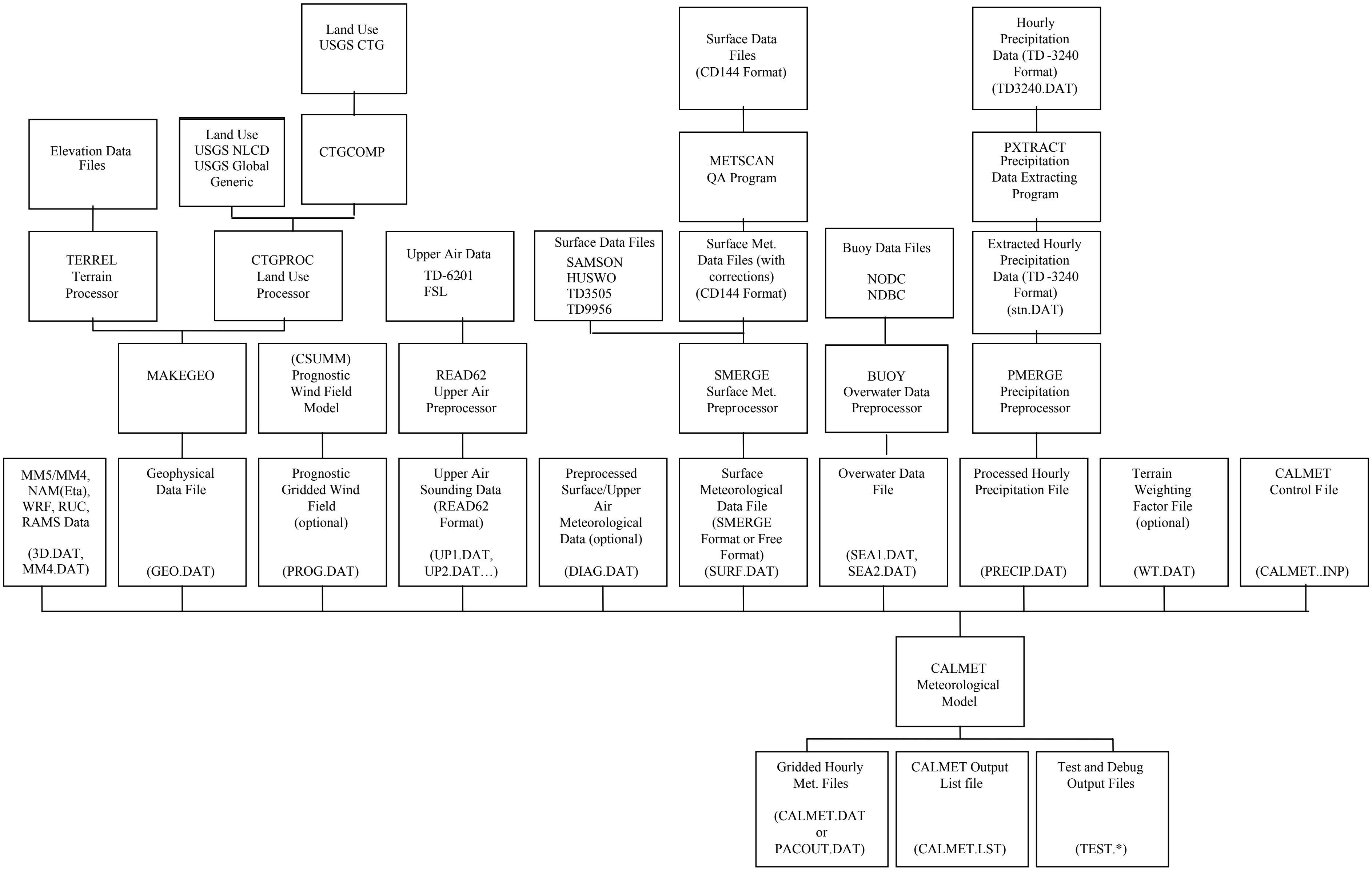


Figure A-2. Meteorological modeling: CALMET modeling flow diagram.

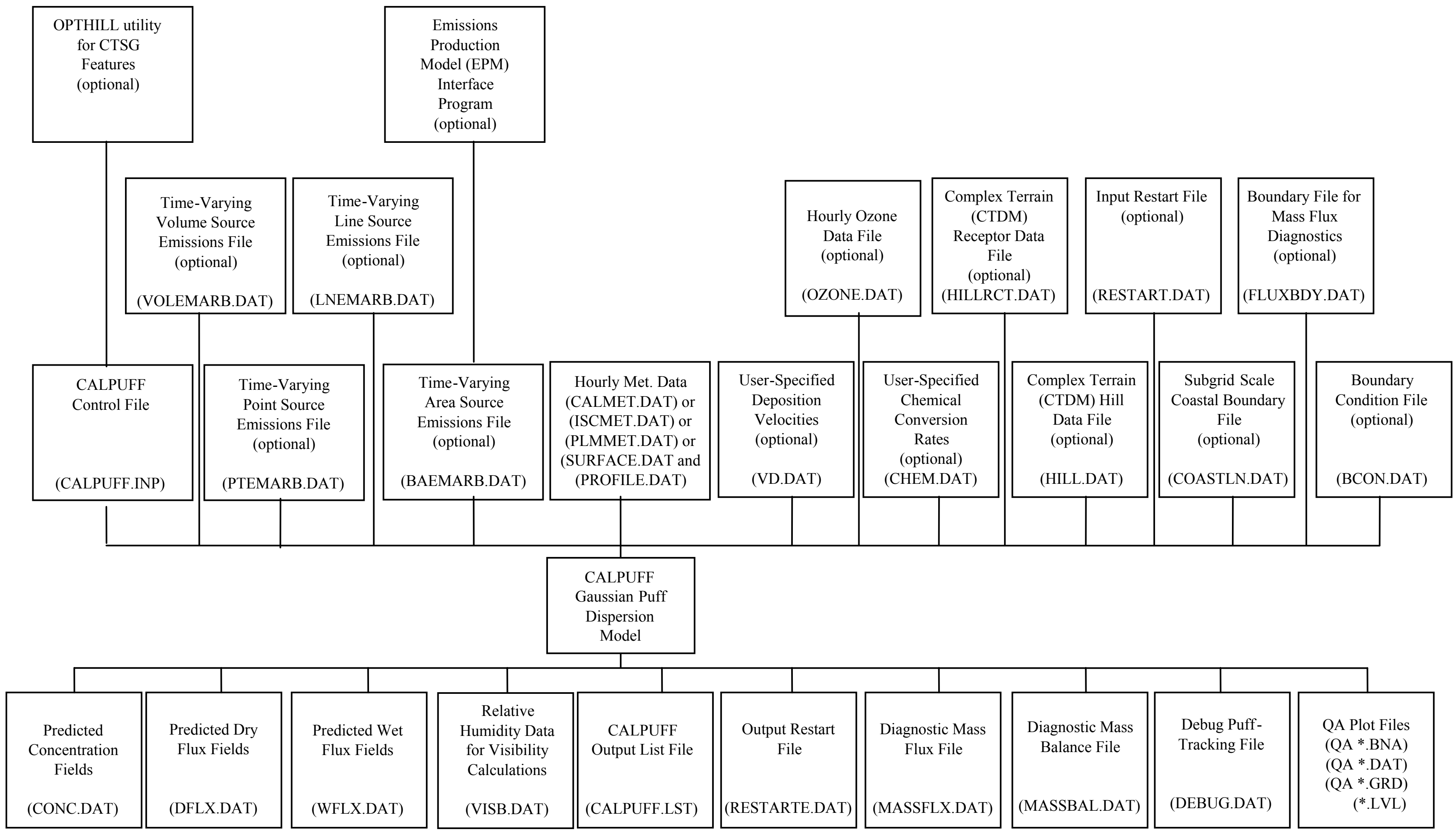


Figure A-3. Dispersion Modeling: CALPUFF modeling flow diagram.

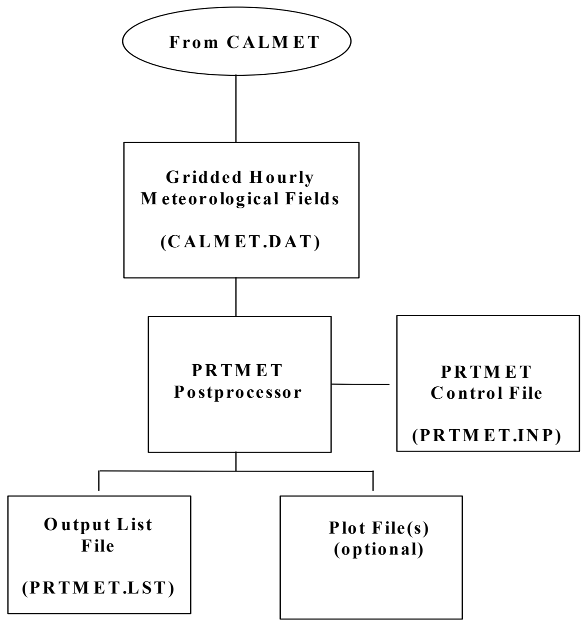


Figure A-4. Postprocessing: PRTMET postprocessing flow diagram.

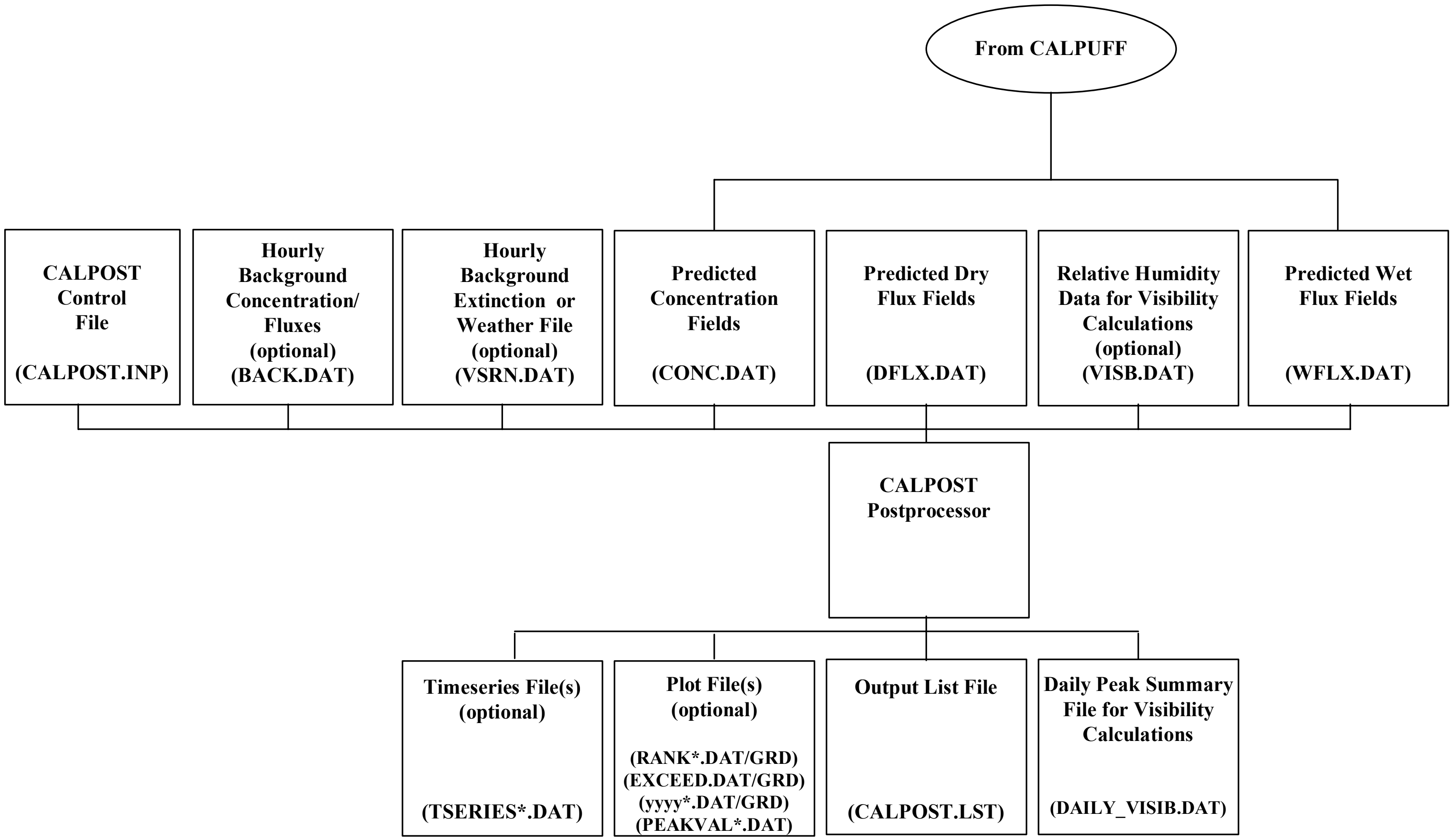


Figure A.5 Postprocessing: CALPOST postprocessing flow diagram.

A.3 Major Model Algorithms and Options

A.3.1 CALMET

The CALMET meteorological model consists of a diagnostic wind field module and micro-meteorological modules for overwater and overland boundary layers. The major features and options of the meteorological model are summarized in Table A-1. When using large domains, the user has the option to adjust input winds to a Lambert Conformal Projection coordinate system to account for the Earth's curvature.

The diagnostic wind field module uses a two-step approach to the computation of the wind fields (Douglas and Kessler, 1988), as illustrated in Figure A-6. In the first step, an initial-guess wind field is adjusted for kinematic effects of terrain, slope flows, and terrain blocking effects to produce a Step 1 wind field. The second step consists of an objective analysis procedure to introduce observational data into the Step 1 wind field to produce a final wind field.

An option is provided to allow gridded prognostic wind fields to be used by CALMET, which may better represent regional flows and certain aspects of sea breeze circulations and slope/valley circulations. Wind fields generated by the CSUMM prognostic wind field model can be input to CALMET as either the initial guess field (pathway A in Figure A-6) or the Step 1 wind field (pathway B in Figure A-6). MM4/MM5, NAM(Eta), WRF, RUC, and RAMS model output fields can be introduced into CALMET in one of three different ways:

- as a replacement for the initial guess wind field (pathway A in Figure A-6);
- as a replacement for the Step 1 field (pathway B); or
- as "observations" in the objective analysis procedure (pathway C).

The techniques used in the CALMET model are briefly described below.

Step 1 Wind Field

Kinematic Effects of Terrain: The approach of Liu and Yocke (1980) is used to evaluate kinematic terrain effects. The domain-scale winds are used to compute a terrain-forced vertical velocity, subject to an exponential, stability-dependent decay function. The kinematic effects of terrain on the horizontal wind components are evaluated by applying a divergence-minimization scheme to the initial guess wind field. The divergence minimization scheme is applied iteratively until the three-dimensional divergence is less than a threshold value.

Table A-1

Major Features of the CALMET Meteorological Model

- **Boundary Layer Modules of CALMET**

    - Overland Boundary Layer - Energy Balance Method
    - Overwater Boundary Layer - Profile Method
    - Produces Gridded Fields of:
        - Surface Friction Velocity
        - Convective Velocity Scale
        - Monin-Obukhov Length
        - Mixing Height
        - PGT Stability Class
        - Air Temperature (3-D)
        - Precipitation Rate

- **Diagnostic Wind Field Module of CALMET**

    - Slope Flows
    - Kinematic Terrain Effects
    - Terrain Blocking Effects
    - Divergence Minimization
    - Produces Gridded Fields of U, V, W Wind Components
    - Inputs Include Domain-Scale Winds, Observations, and (optionally) Prognostic Model Winds
    - Lambert Conformal Projection Capability

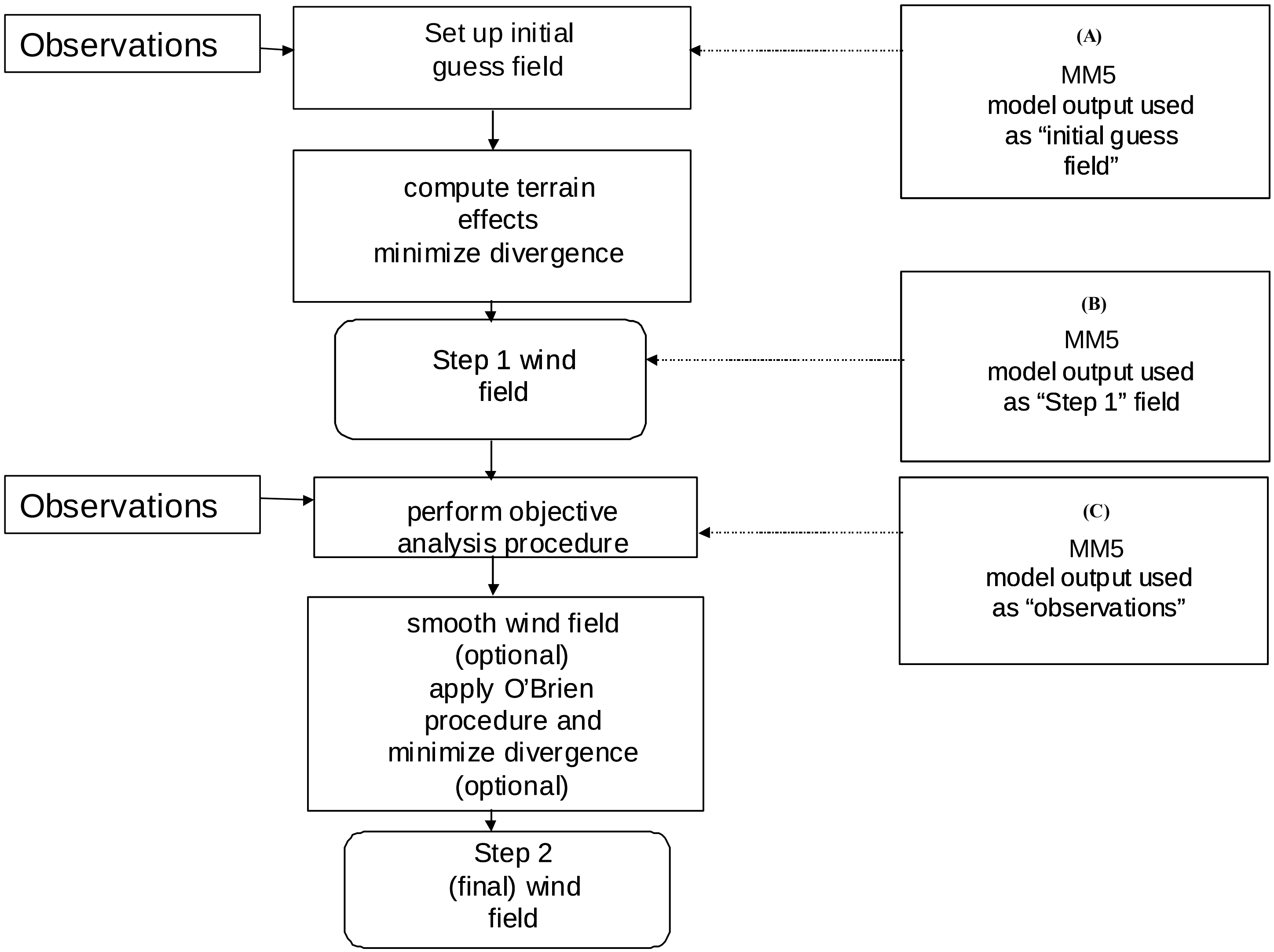


Figure A-6. Flow diagram of the diagnostic wind model in CALMET. Winds derived from mesoscale models MM4/MM5, NAM(Eta), WRF, RUC, RAMS, or CSUMM can be introduced as the initial guess field A, or the Step 1 field B. Mesoscale model wind data (except CSUMM) can also be treated as "observations" C.

Slope Flows: Slope flows are computed based on the shooting flow parameterization of Mahrt (1982). Shooting flows are buoyancy-driven flows, balanced by advective of weaker momentum, surface drag, and entrainment at the top of the slope flow layer. The slope flow is parameterized in terms of the terrain slope, distance to the crest and local sensible heat flux. The thickness of the slope flow layer varies with the elevation drop from the crest.

Blocking Effects: The thermodynamic blocking effects of terrain on the wind flow are parameterized in terms of the local Froude number (Allwine and Whiteman, 1985). If the Froude number at a particular grid point is less than a critical value and the wind has an uphill component, the wind direction is adjusted to be tangent to the terrain.

Step 2 Wind Field

The wind field resulting from the adjustments described above of the initial-guess wind is the Step 1 wind field. The second step of the procedure involves the introduction of observational data into the Step 1 wind field through an objective analysis procedure. An inverse-distance squared interpolation scheme is used which weighs observational data heavily in the vicinity of the observational station, while the Step 1 wind field dominates the interpolated wind field in regions with no observational data.

The resulting wind field is subject to smoothing, an optional adjustment of vertical velocities based on the O'Brien (1970) method, and divergence minimization to produce a final Step 2 wind field.

Introduction of Prognostic Wind Field Results

The CALMET model contains an option to allow the introduction of gridded wind fields generated by MM4/MM5, NAM(Eta), WRF, RUC and RAMS (or the CSUMM model) as input fields. The procedure permits the prognostic model to be run with a significantly larger horizontal grid spacing and different vertical grid resolution than that used in the diagnostic model. This option allows certain features of the flow field such as the sea breeze circulation with return flow aloft, which may not be captured in the surface observational data, to be introduced into the diagnostic wind field results. An evaluation with CAPTEX tracer data indicated that the better spatial and temporal resolution offered by the hourly MM4 fields can improve the performance of the dispersion modeling on regional scales (EPA, 1995).

If the prognostic wind data are used as the initial guess field, the coarse grid scale data are interpolated to the CALMET fine-scale grid. The diagnostic module in CALMET will then adjust the initial guess field for kinematic effects of terrain, slope flows and terrain blocking effects using fine-scale CALMET terrain data to produce a Step 1 wind field. A second approach is to use prognostic wind data directly as the Step 1 wind field. This field is then adjusted using observational data, but additional terrain adjustments are not made. A third available option in CALMET is to treat the gridded prognostic data as "observations" in the objective analysis procedure.

CALMET Boundary Layer Models

The CALMET model contains two boundary layer models for application to overland and overwater grid cells.

> Overland Boundary Layer Model: Over land surfaces, the energy balance method of Holtslag and van Ulden (1983) is used to compute hourly gridded fields of the sensible heat flux, surface friction velocity, Monin-Obukhov length, and convective velocity scale. Mixing heights are determined from the computed hourly surface heat fluxes and observed temperature soundings using either a modified Carson (1973) method based on Maul (1980), or the method of Batchvarova and Gryning (1991, 1994) which has a newer formulation for computing the temperature jump across the entrainment zone at the top of the layer and an explicit term for the "spin-up" growth early in the development of the mixed layer. Gridded fields of PGT stability class and optional hourly precipitation rates are also determined by the model.

> Overwater Boundary Layer Model: The aerodynamic and thermal properties of water surfaces require a different method for calculating the boundary layer parameters in the marine environment. A profile technique, using air-sea temperature differences, is used to compute the micro-meteorological parameters in the marine boundary layer. Two options are provided: one is similar to that developed for OCD (Hanna et al., 1985), and the other is the Coupled Ocean Atmosphere Response Experiment (COARE) bulk flux model (Bradley et al., 2000; Fairall et al., 2002). Once the surface fluxes are computed, the same mixing height options used over land are applied over water.

An upwind-looking spatial averaging scheme is optionally applied to the mixing heights and 3-dimensional temperature fields in order to account for important advective effects.

A.3.2 CALPUFF

CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model which can simulate the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF can use the three dimensional meteorological fields developed by the CALMET model, or simple, single station winds in a format consistent with the meteorological files used to drive the ISCST3 (EPA, 1995), AUSPLUME (Lorimer, 1976), CTDMPLUS (Perry et al., 1989), or AERMOD (Cimorelli, et al., 2002) steady-state Gaussian models. However, such single-station winds should be used with caution, because they do not allow CALPUFF to take advantage of its capabilities to treat spatially-variable meteorological fields.

CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, subgrid scale terrain interactions as well as longer range effects such as pollutant removal (wet scavenging and dry deposition), chemical transformation, vertical wind shear, overwater transport and coastal interaction effects. It can accommodate arbitrarily-varying point source and gridded area source emissions. Most of the algorithms contain options to treat the physical processes at different levels of detail depending on the model application.

The major features and options of the CALPUFF model are summarized in Table A-2. Some of the technical algorithms are briefly described below.

Dry Deposition: A full resistance model is provided in CALPUFF for the computation of dry deposition rates of gases and particulate matter as a function of geophysical parameters, meteorological conditions, and pollutant species. Options are provided to allow user-specified, diurnally varying deposition velocities to be used for one or more pollutants instead of the resistance model (e.g., for sensitivity testing) or to by-pass the dry deposition model completely.

Wet Deposition: An empirical scavenging coefficient approach is used in CALPUFF to compute the depletion and wet deposition fluxes due to precipitation scavenging. The scavenging coefficients are specified as a function of the pollutant and precipitation type (i.e., frozen vs. liquid precipitation).

Chemical Transformation: CALPUFF includes options for parameterizing chemical transformation effects using either the five species scheme (SO_2, $SO_4^{=}$, NO_x, HNO_3, and NO_3^{-}) employed in the MESOPUFF II model, the six species RIVAD scheme (SO_2, $SO_4^{=}$, NO, NO_2, HNO_3, and NO_3^{-}) employed in the ARM3 model, or a set of user-specified, diurnally-varying transformation rates.

Subgrid Scale Complex Terrain: The complex terrain module in CALPUFF is based on the approach used in the Complex Terrain Dispersion Model (CTDMPLUS) (Perry et al., 1989). Plume impingement on subgrid scale hills is evaluated using a dividing streamline (H_d) to determine which pollutant material is deflected around the sides of a hill (below H_d) and which material is advected over the hill (above H_d). Individual puffs are split into up to three sections for these calculations.

Puff Sampling Functions: A set of accurate and computationally efficient puff sampling routines are included in CALPUFF which solve many of the computational difficulties with applying a puff model to near-field releases. For near-field applications during rapidly-varying meteorological conditions, an elongated puff (slug) sampling function is used. An integrated puff approached is used during less demanding conditions. Both techniques reproduce continuous plume results exactly under the appropriate steady state conditions.

Wind Shear Effects: CALPUFF contains an optional puff splitting algorithm that allows vertical and horizontal wind shear effects across individual puffs to be simulated. Differential rates of dispersion and transport occur on the puffs generated from the original puff, which under some conditions can substantially increase the effective rate of horizontal growth of the plume.

Building Downwash: The Huber-Snyder and Schulman-Scire downwash models are both incorporated into CALPUFF. An option is provided to use either model for all stacks, or make the choice on a stack-by-stack and wind sector-by-wind sector basis. Both algorithms have been implemented in such a way as to allow the use of wind direction specific building dimensions. The more advanced treatment of the PRIME downwash model is also incorporated as an option. This includes treating representative streamline patterns and diffusion rates in both the near and far wakes and recirculation effects in the cavity zone.

Overwater and Coastal Interaction Effects: Because the CALMET meteorological model contains both overwater and overland boundary layer algorithms, the effects of water bodies on plume transport, dispersion, and deposition can be simulated with CALPUFF. The puff formulation of CALPUFF is designed to handle spatial changes in meteorological and dispersion conditions, including the abrupt changes that occur at the coastline of a major body of water. A subgrid TIBL option is also provided to better resolve the relationship between the coastline and source locations during periods conducive to onshore fumigation events.

Dispersion Coefficients: Several options are provided in CALPUFF for the computation of dispersion coefficients, including the use of turbulence measurements (σ_v and σ_w), the use of similarity theory to estimate σ_v and σ_w from modeled surface heat and momentum fluxes, or the use of Pasquill-Gifford (PG) or McElroy-Pooler (MP) dispersion coefficients, or dispersion equations based on the Complex Terrain Dispersion Model (CDTM). Options are provided to apply an averaging time correction or surface roughness length adjustments to the PG coefficients. When similarity theory is used to compute turbulence-based dispersion coefficients, an option is also provided for a PDF treatment of dispersion in the convective boundary layer.

Table A-2

Major Features of the CALPUFF Model

- **Source types**
  - Point sources (constant or variable emissions)
  - Line sources (constant or variable emissions)
  - Volume sources (constant or variable emissions)
  - Area sources (constant or variable emissions)

- **Non-steady-state emissions and meteorological conditions**
  - Gridded 3-D fields of meteorological variables (winds, temperature)
  - Spatially-variable fields of mixing height, friction velocity, convective velocity scale, Monin-Obukhov length, precipitation rate
  - Vertically and horizontally-varying turbulence and dispersion rates
  - Time-dependent source and emissions data

- **Efficient sampling functions**
  - Integrated puff formulation
  - Elongated puff (slug) formulation

- **Dispersion coefficient (σ_y, σ_z) options**
  - Direct measurements of σ_v and σ_w
  - Estimated values of σ_v and σ_w based on similarity theory
  - PDF treatment of dispersion in convective boundary layers
  - Pasquill-Gifford (PG) dispersion coefficients (rural areas)
  - McElroy-Pooler (MP) dispersion coefficients (urban areas)
  - CTDM dispersion coefficients (neutral/stable)

- **Vertical and horizontal wind shear**
  - Puff splitting
  - Differential advection and dispersion

- **Plume rise**
  - Partial penetration
  - Buoyant and momentum rise
  - Stack tip effects
  - Vertical wind shear
  - Building downwash effects

- **Building downwash**
  - Huber-Snyder method
  - Schulman-Scire method
  - PRIME method

(Continued)

Table A-2 (Concluded)
Major Features of the CALPUFF Model

- **Subgrid scale complex terrain**
  - Dividing streamline, H_d:
    - Above H_d, puff flows over the hill and experiences altered diffusion rates
    - Below H_d, puff deflects around the hill, splits, and wraps around the hill

- **Interface to the Emissions Production Model (EPM)**
  - Time-varying heat flux and emissions from controlled burns and wildfires

- **Dry Deposition**
  - Gases and particulate matter
  - Three options:
    - Full treatment of space and time variations of deposition with a resistance model
    - User-specified diurnal cycles for each pollutant
    - No dry deposition

- **Overwater and coastal interaction effects**
  - Overwater boundary layer parameters
  - Abrupt change in meteorological conditions, plume dispersion at coastal boundary Plume fumigation
  - Option to introduce subgrid scale Thermal Internal Boundary Layers (TIBLs) into coastal grid cells

- **Chemical transformation options**
  - Pseudo-first-order chemical mechanism for SO_2, $SO_4^{=}$, NO_x, HNO_3, and NO_3^{-} (MESOPUFF II method)
  - Pseudo-first-order chemical mechanism for SO_2, $SO_4^{=}$, NO, NO_2, HNO_3, and NO_3^{-} (RIVAD method)
  - User-specified diurnal cycles of transformation rates
  - No chemical conversion

- **Wet Removal**
  - Scavenging coefficient approach
  - Removal rate a function of precipitation intensity and precipitation type

- **Graphical User Interface**
  - Point-and-click model setup and data input
  - Enhanced error checking of model inputs
  - On-line Help files

A.4 Summary of Data and Computer Requirements

CALMET Data Requirements

The input data requirements of the CALMET model are summarized in Table A-3. The modeling system flow diagrams (Figures A-1 through A-4) provides an overview of the various input data sets required by the model as well as the preprocessing steps used to produce them. CALMET is designed to require only routinely-available surface and upper air meteorological observations, although special data inputs can be accommodated. For example, twice-daily sounding data (e.g., at the standard sounding times of 00 and 12 GMT) are needed as a minimum, but if soundings at more frequent (even arbitrarily spaced) intervals are available, they will be used by the model.

CALMET reads hourly surface observations of wind speed, wind direction, temperature, cloud cover, ceiling height, surface pressure, relative humidity, and precipitation type codes (optional, used only if wet removal is to be modeled). These parameters are available from National Weather Service surface stations. The preprocessors are designed to use data in the National Climatic Data Center's (NCDC) standard data formats. However, the data can also be input into the model by way of free-formatted, user-prepared files. This option is provided to eliminate the need for running the preprocessors to prepare the data files for short CALMET runs for which the input data can easily be input manually.

Missing values of temperature, cloud cover, ceiling height, surface pressure, and relative humidity at surface stations are allowed by the program. The missing values are internally replaced by values at the closest station with non-missing data. However, one valid value of each parameter must be available from at least one station for each hour of the run. Missing values of the precipitation code are passed through to the output file, since CALPUFF contains logic to handle missing values and CALGRID does not use this parameter.

The upper air data required by CALMET include vertical profiles of wind speed, wind direction, temperature, pressure, and elevation. As noted above, routinely-available NWS upper air data (e.g., in TD-5600 and TD-6201 format) or non-standard sounding data can be used. The use of non-standard data formats would require a user-prepared reformatting program to convert the data into the appropriate CALMET format.

Table A-3

Summary of Input Data Required by CALMET

Surface Meteorological Data

Hourly observations of:
- wind speed
- wind direction
- temperature
- cloud cover
- ceiling height
- surface pressure
- relative humidity

Hourly precipitation data:
- precipitation rates
- precipitation type code (part of surface data file)

Upper Air Data

Twice-daily observed vertical profiles of:
- wind speed
- wind direction
- temperature
- pressure
- elevation

Hourly gridded wind fields (optional)
- MM4/MM5 output
- NAM(Eta) output
- WRF output
- RUC output
- RAMS output
- CSUMM output

Overwater Observations (optional)

- air-sea temperature difference
- air temperature
- relative humidity
- overwater mixing height
- wind speed
- wind direction
- overwater temperature gradients above and below mixing height

Geophysical Data

Gridded fields of:
- terrain elevations
- land use categories
- surface roughness length (optional)
- albedo (optional)
- Bowen ratio (optional)
- soil heat flux constant (optional)
- anthropogenic heat flux (optional)
- vegetative leaf area index (optional)

If the upper air wind speed, wind direction, or temperature is missing, CALMET will interpolate to replace the missing data. Actually, the interpolation of wind data is performed with the u and v components, so both the wind speed and direction must be present for either to be used. Because the program does not extrapolate upper air data, the top valid level must be at or above the model domain and the lowest (surface) level of the sounding must be valid.

For modeling applications involving overwater transport and dispersion, the CALMET boundary layer model requires observations of the air-sea temperature difference, air temperature, relative humidity and overwater mixing height (optional) at one or more observational sites. The model can accommodate overwater data with arbitrary time resolution (e.g., hourly, daily, or seasonal values). The location of the overwater stations is allowed to vary in order to allow the use of observations made from ships. CALMET optionally can use only land stations to calculate temperatures over land and only overwater stations to calculate temperatures over water. If this option is used, vertical temperature lapse rate information may be included at the overwater observational sites.

If the wet removal algorithm of the CALPUFF model is to be applied, CALMET can be made to produce gridded fields of precipitation rates from hourly precipitation observations. The routinely available NCDC precipitation data in TD-3240 format or a free-formatted, user-prepared file of precipitation rates can be used as input to CALMET.

CALMET also requires geophysical data including gridded fields of terrain elevations and land use categories. Gridded fields of other geophysical parameters, if available, may be input to the model. The optional inputs include surface roughness length, albedo, Bowen ratio, a soil heat flux parameter, anthropogenic heat flux, and vegetation leaf area index. These parameters can be input as gridded fields or specified as a function of land use. Default values relating the optional geophysical parameters to land use categories are provided within CALMET.

As described in the previous section, CALMET contains an option to read as input gridded wind fields produced by the prognostic wind field models. The CSUMM prognostic wind field model generates a file called PROG.DAT which can be directly input into CALMET, or if using the MM4/MM5, NAM(Eta), WRF, RUC, or RAMS derived data, a file called 3D.DAT (MM4.DAT is also accepted, but not recommended) is required.

One of the options in CALMET is to by-pass the boundary layer model and compute only gridded wind fields (i.e., produce U, V wind components only without the micro-meteorological variables such as friction velocity, Monin-Obukhov length, etc.). Although the CALPUFF and CALGRID models cannot be executed with such a file, there may be some applications in which only the wind components are of interest. For example, a postprocessor (CAL2UAM) can be used to convert the CALMET winds into a format suitable for input into the UAM model. If CALMET is to be run in this mode, an option is provided to allow preprocessed surface and upper air observations to be input. The preprocessed input file, DIAG.DAT, is compatible with the stand-alone version of the diagnostic wind field model developed by Douglas and Kessler (1988).

CALMET reads the user's inputs from a "control file" with a default name of CALMET.INP. This file contains the user's selections of the various model options, input variables, output options, etc.

CALPUFF Data Requirements

The input data sets used by CALPUFF are summarized in Table A-4 (also see the modeling system flow diagram, Figure A-1). CALPUFF reads user inputs from a "control file" with a default name of CALPUFF.INP. This file contains the user's selections for the various model options, technical input variables, output options, and other user-controllable options.

A meteorological data file (CALMET.DAT) contains hourly gridded fields of micro-meteorological parameters and three-dimensional wind and temperature fields. The meteorological data file also contains geophysical data such as terrain heights and land use that are required by both the meteorological model (e.g., for terrain adjustment of the wind fields) and by the CALPUFF model. The contents of the CALMET.DAT input file and the other input data bases are summarized in Table A-5. Options also exist for using single-station meteorological data in ISCST3, CTDMPLUS, AERMOD, or AUSPLUME data format.

Five files are provided for the input of emissions data. The control file, CALPUFF.INP includes point, line, volume and area source data for sources with constant emission parameters or those that can be described by a cycle based on time of day (24 factors), month (12 factors), hour and season (24 x 4 factors), wind speed and stability class (6 x 6 factors), or temperature (12 factors). Separate scaling factors can be specified for each source-species combination. Arbitrarily-varying source data may be provided in files for point sources (default name PTEMARB.DAT), area sources (default name AREMARB.DAT), line sources (default name LNEMARB.DAT), and volume sources (default name VOLEMARB.DAT).

Hourly observations of ozone data are used in the calculation of SO_2 and NO_x transformation rates if the MESOPUFF II or RIVAD chemical transformation scheme is selected. The hourly ozone data for one or more ozone stations are read from a data file called OZONE.DAT.

Table A-4
Summary of CALPUFF Input Files

Default File Name	Contents	Unit* Number	Type
RESTARTB.DAT	Input restart file containing a dump of all puff parameters sufficient to allow a model run to continue (optional)	IO3	Unformatted
CALPUFF.INP	Control file inputs	IO5	Formatted
CALMET.DAT	Geophysical and hourly meteorological data, created by the CALMET meteorological model	IO7	Unformatted
or ISCMET.DAT	Single-station ASCII meteorological data in ISCST3-format	IO7	Formatted
or PLMMET.DAT	Single-station ASCII meteorological data in AUSPLUME format	IO7	Formatted
BCON.DAT	Boundary condition concentration file (optional)	IO15	Formatted
PTEMARB.DAT	Source and emissions data for point sources with arbitrarily-varying emission parameters (optional)	IO16	Formatted or unformatted
BAEMARB.DAT	Emissions data for area sources with arbitrarily-varying emission parameters. Can be derived from EPM model files (optional)	IO17	Formatted
VOLEMARB.DAT	Emissions data for volume sources with arbitrarily- varying emission parameters (optional)	IO18	Formatted or unformatted
LNEMARB.DAT	Emission data for line sources with arbitrarily-varying line source emissions (optional)	I019	Formatted
VD.DAT	User-specified deposition velocities (optional)	IO20	Formatted
OZONE.DAT	Hourly ozone measurements at one or more ozone stations (optional)	IO22	Formatted
H202.DAT	Hourly H202 monitoring data (optional)	IO23	formatted
CHEM.DAT	User-specified chemical transformation rates (optional)	IO24	Formatted
COASTLN.DAT	Subgrid scale coastal boundary file (optional)	IO25	Formatted
HILL.DAT	Hill specifications from CTDMPLUS terrain processor (optional)	IO28	Formatted
HILLRCT.DAT	CTSG Receptors from CTDMPLUS processor (optional)	IO29	Formatted
PROFILE.DAT	Single-station ASCII meteorological tower data as prepared for CTDMPLUS (optional)	IO31	Formatted
SURFACE.DAT	CTDMPLUS surface layer parameters (optional)	IO32	Formatted
FLUXBDY.DAT	Boundary Data for Mass flux (optional)	IO35	Formatted

* Variable shown is the parameter controlling the FORTRAN unit number associated with the file. Usually, the value assigned to the parameter is consistent with the name (i.e., IO7 = 7). However, the value can be easily changed in the parameter file to accommodate reserved unit numbers on a particular system.

Table A-5

Summary of Input Data Used by CALPUFF

Geophysical Data (CALMET.DAT)

Gridded fields of:

- surface roughness lengths (z_o)
- land use categories
- terrain elevations
- leaf area indices

Meteorological Data (CALMET.DAT)

Gridded fields of:

- u, v, w wind components (3-D)
- air temperature (3-D)
- surface friction velocity (u_*)
- convective velocity scale (w_*)
- mixing height (z_i)
- Monin-Obukhov length (L)
- PGT stability class
- Precipitation rate

Hourly values of the following parameters at surface met. stations:

- air density (ρ_a)
- air temperature
- short-wave solar radiation
- relative humidity
- precipitation type

Meteorological Data (ISCST ISCMET.DAT)

Hourly values (standard records)

- wind speed, flow direction
- temperature, stability class
- mixing height (z_i) for rural/urban

Hourly values (extended records)

- surface friction velocity (u_*), Monin-Obukhov length (L)
- surface roughness (z_o)
- precipitation code and rate
- potential temperature gradient
- wind speed profile power-law exponent
- short-wave solar radiation
- relative humidity

(Continued)

Table A-5 (Continued)
Summary of Input Data Used by CALPUFF

Meteorological Date (AUSPLUME PLMMET.DAT)

Hourly values (standard records)

- wind speed, wind direction
- temperature, stability class
- mixing height (z_i)
- turbulence (σ_2)
- wind speed profile power-law exponent
- potential temperature gradient

Hourly values (extended records)

- precipitation code and rate
- short-wave solar radiation
- relative humidity

Meteorological Data (CTDMPLUS or AERMOD SURFACE.DAT, PROFILE.DAT)

Hourly values (SURFACE.DAT - standard records)

- mixing height (z_i)
- surface friction velocity (u_*), Monin-Obukhov length (L)
- surface roughness (z_o)

Hourly values (SURFACE.DAT - extended records)

- precipitation code and rate
- short-wave solar radiation
- relative humidity

Hourly values at multiple levels (PROFILE.DAT)

- height
- wind speed (scalar, vector)
- wind direction
- temperature
- turbulence (σ_v/σ_2, σ_w)

Restart Data (RESTARTB.DAT)

Model puff data generated from a previous run (allows continuation of a previous model run)

(Continued)

Table A-5 (Continued)
Summary of Input Data Used by CALPUFF

Emissions Data (CALPUFF.INP, PTEMARB.DAT, BAEMARB.DAT, VOLEMARB.DAT, LNEMARB.DAT)

Point source emissions:

- Source and emissions data for point sources with constant or cyclical emission parameters (CALPUFF.INP)
- Source and emissions data for point sources with arbitrarily-varying emission parameters (PTEMARB.DAT)

Area source emissions

- Emissions and initial size, height, and location for area sources with constant or cyclical emission parameters (CALPUFF.INP)
- Gridded emissions data for buoyant area sources with arbitrarily-varying emission parameters (BAEMARB.DAT)

Volume source emissions

- Emissions, height, size, and location of volume sources with constant or cyclical emission parameters (CALPUFF.INP)
- Emissions data for volume sources with arbitrarily-varying emission parameters (VOLEMARB.DAT)

Line source emissions

- Source and emissions data, height, length, location, spacing, and orientation of buoyant line sources with constant or cyclical emission parameters (CALPUFF.INP)
- Emissions data for buoyant line sources with arbitrarily-varying emission parameters (LNEMARB.DAT)

Boundary Condition Data (BCON.DAT)

- Concentration of each species specified by air-mass
- Air-mass types mapped to segments along boundary of computational grid

Deposition Velocity Data (VD.DAT)

- Deposition velocity for each user-specified species for each hour of a diurnal cycle

Ozone Monitoring Data (OZONE.DAT)

- Hourly ozone measurements at one or more monitoring stations

H_2O_2 Concentration Data (H2O2.DAT)

- Hourly H_2O_2 concentrations at one or more locations

Chemical Transformation Data (CHEM.DAT)

- Species-dependent chemical transformation rates for each hour of a diurnal cycle

Table A-5 (Concluded)
Summary of Input Data Used by CALPUFF

Hill Data (HILL.DAT)

- Hill shape and height parameters in CTDMPLUS format for use in the subgrid-scale complex terrain module (CTSG)

CTSG Receptors (HILLRCT.DAT)

- Receptor locations and associated hill ID in CTDMPLUS format

Subgrid Scale Coastal Boundary Data (COASTLN.DAT)

- File containing X,Y coordinates of subgrid scale coastlines to be treated by CALPUFF

Boundary Data for Diagnostic Mass Flux Option (FLUXBDY.DAT)

- File containing X,Y coordinates of boundaries used to evaluate hourly mass transport

Because of the similarity between CTDMPLUS and the CTSG option within CALPUFF, an input option is provided for hill data and the associated receptor data in files produced for CTDMPLUS. These files, HILL.DAT and HILLRCT.DAT can be read by CALPUFF without modification, to specify all CTSG input requirements.

Two additional input files, VD.DAT and CHEM.DAT, contain diurnal cycles of user-specified deposition velocities and chemical transformation rates, respectively. These files are necessary only if the user wishes to substitute the values normally computed internally by the deposition and chemical models with sets of time-varying but spatially-uniform externally specified values.

The optional input file, PROFILE.DAT in the CTDMPLUS or AERMOD format can also be used to provide vertical profiles of hourly observations of σ_v and σ_w. These parameters can be used to compute the plume dispersion coefficients σ_y and σ_z.

CALPUFF can continue a previous simulation using an optional restart file (RESTARTB.DAT). The restart file contains all of the puff variables at the end of the previous run needed to allow the model to continue the simulation. The restart file used as input of a continuation run must be generated as the output restart file in the previous CALPUFF simulation. The restart file is an optional file.

CALPUFF contains a subgrid scale coastal effects module that allows a parameterization of the Thermal Internal Boundary Layer (TIBL) at scales smaller than the grid spacing. The user inputs the X,Y coordinates of one or more coastlines in an optional file called COASTLN.DAT.

The CALPUFF output files are summarized in Table A-6. The list file contains a copy of the inputs used in the run, optional output fields of gridded and discrete receptor concentrations, wet deposition fluxes, and dry deposition fluxes and other run data. The CONC.DAT, WFLX.DAT, and DFLX.DAT files contain the output concentrations, wet and dry fluxes, respectively, in an unformatted form suitable for further processing by the postprocessing program, CALPOST. The VISB.DAT file contains relative humidity information which is required by CALPOST in order to perform certain visibility-related computations. The model can generate an optional output restart file (RESTARTE.DAT) containing all the puff parameters needed to continue the CALPUFF simulation. The output restart file can be generated at regular intervals of the simulation to protect against loss of the simulation resulting from power failures or other interruptions. The output restart file of a run serves as the input restart file of the next (continuation) run.

Three additional files may be produced for diagnostic purposes. When CALPUFF is run with the debug switch set to true, much information about specific puffs is written to the list file for specific sampling steps. Summary information for these puffs is also written to the file DEBUG.DAT. Because of the volume of information written to list file, the debug option is generally used for very short periods. Options to characterize hourly changes in pollutant mass report results to the files MASSFLX.DAT and

Table A-6
Summary of CALPUFF Output Files

Default File Name	Contents	Unit* Number	Type
RESTARTE.DAT	Output restart file containing a dump of all puff parameters sufficient to allow a model run to continue (optional)	IO4	Unformatted
CALPUFF.LST	List file produced by CALPUFF	IO6	Formatted
CONC.DAT	One-hour averaged concentrations (g/m^3) at the gridded and discrete receptors for species selected by the user in the control file (optional)	IO8	Unformatted
DFLX.DAT	One-hour averaged dry deposition fluxes ($g/m^2/s$) at the gridded and discrete receptors for species selected by the user in the control file (optional)	IO9	Unformatted
WFLX.DAT	One-hour averaged wet deposition fluxes ($g/m^2/s$) at the gridded and discrete receptors for species selected by the user in the control file (optional)	IO10	Unformatted
VISB.DAT	Relative humidity data required for visibility-related postprocessing (optional)	IO11	Unformatted
TK2D.DAT	2D temperature output file	IO13	Unformatted
RHO2D.DAT	2D density output file	IO14	Unformatted
FOG.DAT	Water saturation information at receptors for use with fog analysis postprocessors (optional)	IO12	Unformatted
DEBUG.DAT	Tables of detailed puff/slug data useful for debugging (optional)	IO30	Formatted
MASSFLX.DAT	Hourly report of mass flux into and out of regions defined by the boundaries in the FLUXBDY.DAT file	IO36	Formatted
MASSBAL.DAT	Hourly report of changes in mass of all species modeled	IO37	Formatted
QATERR.GRD	gridded terrain elevations (mMSL) in SURFER GRD format, created when CALMET.DAT is used with variable topography	IOQA	Formatted
QALUSE.GRD	gridded land use in SURFER GRD format, created when CALMET.DAT is used	IOQA	Formatted
QAGRID.BNA	borders (km) for the METEOROLOGICAL, COMPUTATIONAL, and SAMPLING (when LSAMP=T) grid domains, in Atlas Boundary File format	IOQA	Formatted
QARECD.DAT	x,y coordinates (km), elevation (m), and height above ground (m) of discrete receptors, created only when discrete receptors are used (NREC>0)	IOQA	Formatted

Table A-6 (Concluded)
Summary of CALPUFF Output Files

Default File Name	Contents	Unit* Number	Type
QARECG.DAT	x,y coordinates (km), and elevation (m) of gridded receptors, created only when gridded receptors are used (LSAMP=T)	IOQA	Formatted
QARECT.DAT	x,y coordinates (km), and elevation (m) of CTSG receptors, created only when CTSG receptors are used (NCTREC>0)	IOQA	Formatted
QAPNTS.DAT	x,y coordinates (km), elevation (m), and source index of point sources, created only when point sources are used	IOQA	Formatted
QAVOLS.DAT	x,y coordinates (km), elevation (m), and source index of volume sources, created only when volume sources are used	IOQA	Formatted
QAAREA.BNA	outlines (km) for area sources, in Atlas Boundary File format, created only when area sources are used	IOQA	Formatted
QALINE.BNA	segments (km) for buoyant line sources, in Atlas Boundary File format, created only when line sources are used	IOQA	Formatted
LUSE.CLR	Default land-use color map file for SURFER, always created	IOQA	Formatted

* Variable shown is the parameter controlling the FORTRAN unit number associated with the file. Usually, the value assigned to the parameter is consistent with the name (i.e., IO8 = 8). However, the value can be easily changed in the parameter file to accommodate reserved unit numbers on a particular system.

MASSBAL.DAT. MASSFLX.DAT reports the mass of selected species that cross into and out of regions defined by the user in the file FLUXBDY.DAT. MASSBAL.DAT reports changes in the mass of all modeled species throughout the modeling domain.

A sequence of 'QA' files is produced during the setup phase of a run. These are designed to allow a user to make one or more maps displaying geographical aspects of the run, including the modeling domain, terrain elevations, gridded land use, source locations, and receptor locations. Maps of this type convey the key spatial relationships of the model application.

Computer Requirements

The memory management scheme used in CALMET and CALPUFF is designed to allow the maximum array dimensions in the model to be easily adjusted to match the requirements of a particular application. An external parameter file contains the maximum array size for all of the major arrays. A re-sizing of the program can be accomplished by modifying the appropriate variable or variables in the parameter file and re-compiling the program. All appropriate arrays in the model will be automatically re-sized by the updated parameter values. For example, the maximum number of horizontal grid cells allowed in the model, MXNX and MXNY, are two of the variables which can be adjusted within the parameter file. However, no change to the parameter file is necessary if a particular application requires a smaller array size than the maximum values specified in the parameter file.

The memory management scheme used in CALMET and CALPUFF is designed to allow the maximum array dimensions in the model to be easily adjusted to match the requirements of a particular application. An external parameter file contains the maximum array size for all of the major arrays. A re-sizing of the program can be accomplished by modifying the appropriate variable or variables in the parameter file and re-compiling the program. All appropriate arrays in the model will be automatically re-sized by the updated parameter values. For example, the maximum number of horizontal grid cells allowed in the model, MXNX and MXNY, are two of the variables which can be adjusted within the parameter file. However, no change to the parameter file is necessary if a particular application requires a smaller array size than the maximum values specified in the parameter file.

The memory required by CALPUFF will be a strong function of the specified maximum array dimensions in the parameter file. However, as an example, CALPUFF required approximately 300 K bytes of memory for a test run with a 10 x 10 horizontal grid, with 5 vertical layers, and a maximum number of puffs of 100. This type of configuration may be suitable for ISC-mode simulations of a small number of point sources. For more typical studies, memory requirements will typically be at least 32 megabytes, with more required for simulations involving large numbers of sources.

The run time of CALPUFF will vary considerably depending on the model application. Variations of factors of 10-100 are likely depending of the size of the domain, the number of sources, selection of technical options, and meteorological variables such as the mean wind speed. Because each puff is treated independently, any factor which influences the number and residence time of puffs on the computational grid, and the model sampling time step will affect the run time of the model. As an example of the range of runtimes, an annual simulation of CALPUFF in ISC-mode for 2 sources and 64 receptors required less than one minute on a 500 MHz PC. A visibility application involving 218 sources and 425 receptors for an annual period required approximately 9 hours of runtime for CALMET and 95 hours for CALPUFF.

Program Execution

CALPUFF can be executed with the following DOS command line:

CALPUFF filename

where it is assumed that the executable file is called CALPUFF.EXE and the "filename" is the name of the file (up to 70 characters in length) containing all of the input information for the run. The default input file name is CALPUFF.INP. The first input group in CALPUFF.INP contains all of the other input and output (I/O) filenames used in the run. Within this group the user can change the name of any of the input and output files from their default names, and change the directory from which the files will be accessed by specifying the file's full pathname.

Similarly, CALMET can be executed with the following DOS command line:

CALMET filename

where the default input filename is CALMET.INP, and the executable file is assumed to be called CALMET.EXE.

B. GEOPHYSICAL DATA PROCESSORS

The GEO.DAT data file contains the geophysical data inputs required by the CALMET model. These inputs include land use type, elevation, surface parameters (surface roughness length, albedo, Bowen ratio, soil heat flux parameter, and vegetation leaf area index) and anthropogenic heat flux. The land use and elevation data are entered as gridded fields. The surface parameters and anthropogenic heat flux can be entered either as gridded fields or computed from the land use data at each grid point. A series of programs have been developed to process the terrain and land use data and produce a GEO.DAT file containing gridded fields of terrain, land use, and land use weighted fields of surface parameters and heat flux. Creating the GEO.DAT is a three step process. The first two steps involve processing the relevant terrain and land use data and then, in the third step, the processed files are combined into a final file (GEO.DAT) that can be read by CALMET. The following preprocessors are used to generate a GEO.DAT file:

TERREL is a terrain preprocessor which coordinates the allocation of terrain elevation data from several digitized data bases to a user-specified modeling grid.

CTGCOMP is a preprocessor used to compress the data file format of a USGS land use data file in Composite Theme Grid (CTG) format.

CTGPROC is a land use preprocessor which reads the compressed CTG land use data (or the USGS Global Dataset format) and computes the fractional land use for each grid cell in the user-specified modeling domain.

MAKEGEO is the final preprocessor which reads the fractional land use data, user inputs which define land use category mapping, and values relating each of the surface parameters to land use and optionally, the gridded terrain file, and produces a GEO.DAT file ready for input to CALMET. Note: if the gridded terrain data file is not incorporated into MAKEGEO, it must be hand-edited into the GEO.DAT file before running CALMET.

The complete process is illustrated in Figure B-1 and further described in the following sections.

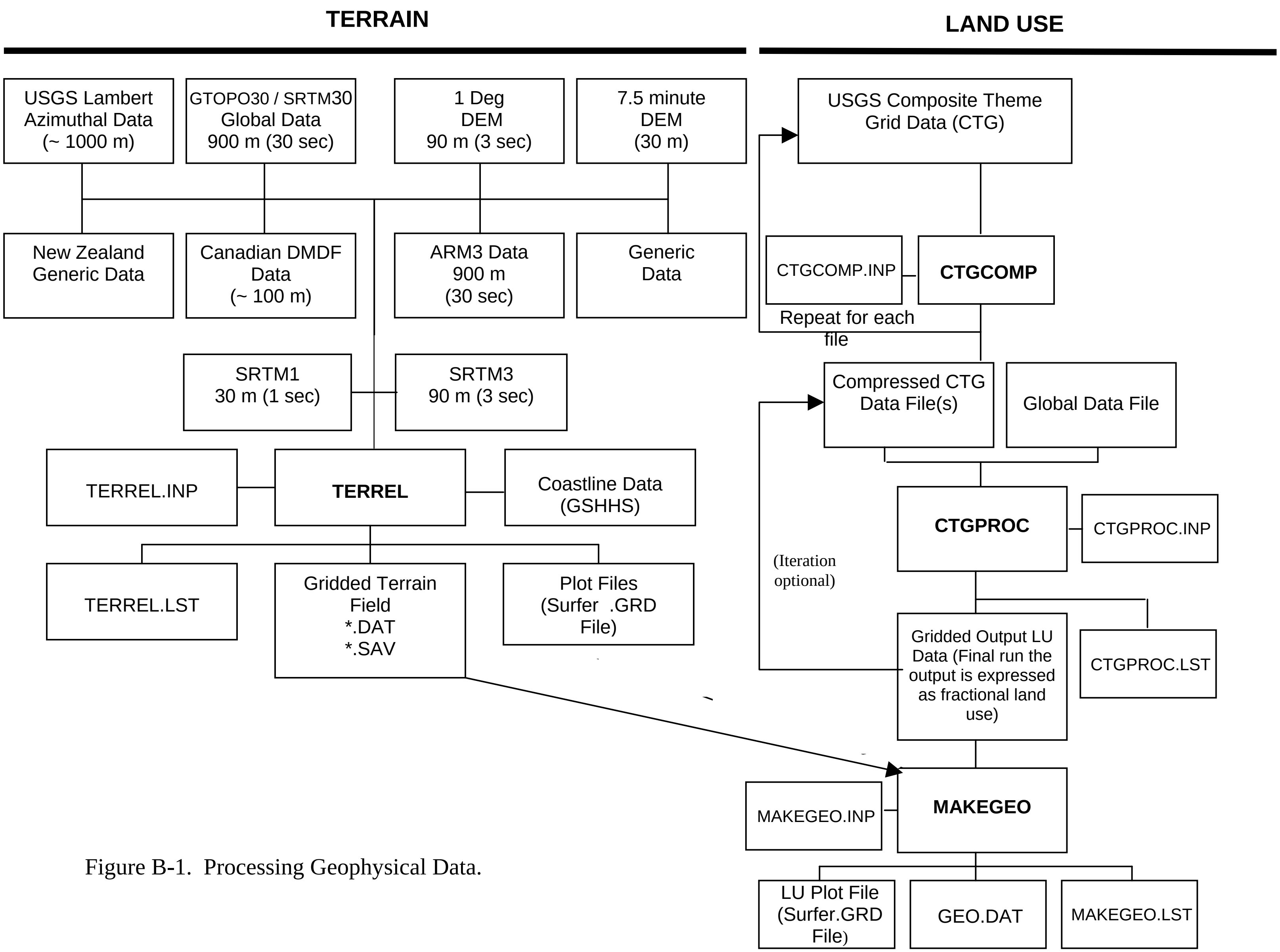


Figure B-1. Processing Geophysical Data.

B.1 TERREL Terrain Preprocessor

TERREL is a preprocessing program that extracts and reformats Digital Elevation Model (DEM) terrain data according to the options selected by the user (domain, resolution, etc.). Eleven DEM formats are currently supported. TERREL has the ability to produce Cartesian gridded fields of terrain elevations or a polar grid of terrain elevations. For the Cartesian gridded field option, TERREL averages all of the terrain data points which fall within the grid cell to obtain the elevation assigned to the center of the user-specified grid cell. When using the polar grid option, TERREL uses the maximum terrain elevation in the area either from the current ring out to the next ring (user input switch - SCREEN) or halfway between adjacent rings (user input switch - NORMAL) and halfway between the adjacent radials. TERREL can produce terrain data files in the formats compatible with the following models: CALMET, MESOPAC, NUATMOS, and ISC3. TERREL requires at least one input file and produces four output files. TERREL can first be run without any data files and the program will indicate for the user the latitude and longitude of the four corners of the area required to cover the user-specified domain. A message indicates how many terrain data files of each type are required based on the domain parameters supplied by the user. This is helpful, for example, when only UTM coordinates are known, but not the latitude and longitude of the corners of the modeling domain. Once the appropriate data files are obtained, the TERREL input file must be modified to reflect the names and types of the data files and TERREL must be run again to process the terrain data. This could be done in one run or as an iterative process, where intermediate results are stored in a binary file (e.g., TERREL.SAV) and incorporated into the next TERREL run using the next set of digital terrain input data. The .SAV file option is helpful if the user doesn't have the available disk space to store all of the raw terrain files at once.

TERREL has an input (ITHRES) which is used for quality assurance purposes. ITHRES is a whole number (%) identifying the acceptable threshold of variance from the average number of data points ('hits') per cell. If a particular grid cell had less than ITHRES percent of the average number of data 'hits' per cell, a warning message is written to alert the user to check the results. If using a mix of 1-degree DEM data and 30 meter DEM data, the grid cells using the 30 meter data will have many more 'hits' than the 1-degree DEM grid cells. The user might want to adjust the value of ITHRES to reduce the number of warning messages written.

TERREL has the option (variable PMAP) to define the gridded output fields for a number of map projections. Note that CALMET currently supports either a Universal Transverse Mercator (UTM) grid or a Lambert Conformal Projection (LCC). The latter should be used when the modeling domain is large, because a Lambert Conformal grid accounts for the earth's curvature. If the LCC option is specified, TERREL uses the user-specified standard parallels (latitudes) and reference longitude to calculate a "cone constant" and the east-west distance from the reference longitude. The reference longitude is the longitude at which true north and map north are defined to be the same. It also defines where x=0 in the Lambert Conformal grid. The reference latitude defines where y=0 in the Lambert Conformal grid.

TERREL INPUT:

1. Terrain database: Table B-1 defines the types of terrain databases that can be processed by TERREL. Eleven types of terrain data can be read, corresponding to different resolutions and formats: 30 arc-seconds (-900 m spacing, GTOPO30, USGSLA, or ARM3 format), 3 arc-seconds (-90 m spacing, USGS DEM, SRTM3, or Rocky Mtn. Communications (3CD) format), 1 arc-second (-30 m spacing, SRTM1 format), 30 meters (7.5 minute USGS DEM format), and Canadian Digital Map Data Format (DMDF) data (~100 m resolution). Two are generic formats, one based on a system used in New Zealand (NZGEN), and one designed to enable a user to reformat existing gridded terrain files into a simple format for TERREL (GEN). The terrain data ordered from the USGS can be obtained through file transfer protocol (FTP) access, on CD-ROM, or on magnetic tape.

2. Obtaining the Data: 3 arc-second terrain data are available from the USGS with file names corresponding to the 1:250,000-scale map names followed by -e or -w for the eastern and western portions respectively. In some regions, 30-m data are also available with the names corresponding to the 1:100,000-scale map names. The user must first identify the names of the quadrants encompassed by the domain. These names are listed in a USGS map index as well as on the WWW home page of the USGS. Select "FTP via Graphics" in the DEM section to view a map of the US and the names of the quadrants.

3-sec terrain data are available by anonymous FTP from: edcftp.cr.usgs.gov, or can be downloaded from the WWW site: http://edcftp.cr.usgs.gov/pub/data/DEM/250. 30-m terrain data must be ordered from the USGS. Note that the files do not contain record delimiters. These must be added as described in the documentation.

The Shuttle RADAR Topography Mission (SRTM) data are available from the USGS in 1, 3, and 30 arc-second resolutions. The 30 arc-second data are combined with the GTOPO30 data and processed by TERREL in the same way as the GTOPO30 data, so these data files should be presented as GTOPO30. The 1 and 3 arc-second data files must be processed as type SRTM1 and SRTM3, respectively. The SRTM data are available at the FTP site: ftp://edcsgs9.cr.usgs.gov/pub/data/srtm/ and also (along with documentation) at the WWWsite: http://edcwww.cr.usgs.gov/pub/data/srtm/ .

30 arc-second terrain data for the globe are available from the USGS WWW site: (http://edcwww.cr.usgs.gov/landdaac/gtopo30/gtopo30.html). The GTOPO30 data set is divided into files (or tiles), where each file covers 40 degrees of longitude and 50 degrees of latitude, except for in the

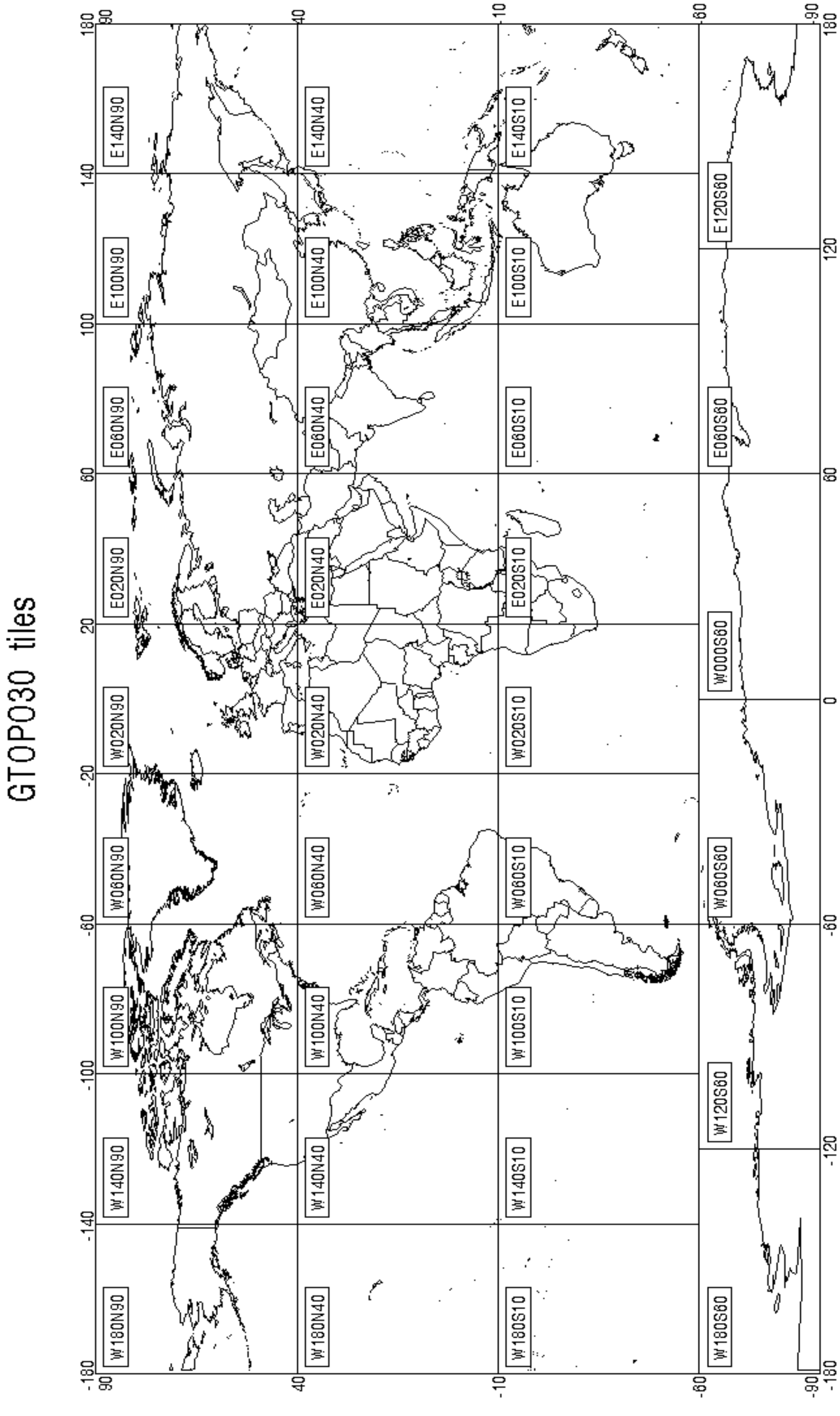


Figure 2-2. Spatial coverage of each GTOPO30 tiles (files).

Antarctica region where each file covers 60 degrees of longitude and 30 degrees of latitude. Figure B-2 shows the spatial coverage of the data files. Each file is either 57,600,000 (non-Antarctica) or 51,840,000 bytes (Antarctica) in size. These DEM data are provided in 16-bit signed integers in a simple binary raster, with no imbedded header or trailer bytes and no internal indexing. The data are stored in Motorola byte order, which stores the most significant byte first, i.e., *big endian*. The Motorola, SUN, HP, and SGI platforms use *big endian*; where as the Intel (PC) and DEC platforms use *little endian*. Therefore, the user must be careful regarding the intended platform for TERREL. The code uses a logical flag, LBIGENDIAN (set in subroutine SETGLOB), to define whether the intended platform is *big endian* or *little endian*. LBIGENDIAN=.FALSE. is for *little endian*, and LBIGENDIAN=.TRUE. is for *big endian*. The flag enables the porting of TERREL across different machine platforms.

3. User control file (TERREL.INP): this input file specifies the filenames and type of databases being processed and the modeling domain related parameters. The format of the TERREL control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). A sample file is shown in Table B-2 and a description of each input variable is provided in Table B-3. Detailed information on the input variables is included in the default input file itself. TERREL.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO).

4. Save file: this input data file contains the binary results from an intermediate run of TERREL. It is read as input to the current run.

TERREL OUTPUT:

1**. list file**: echoes the selected options, reports errors and provides a listing of the gridded terrain elevations and the number of raw data points ('hits') used to compute the terrain elevation for each grid cell (e.g., TERREL.LST).

2**. plot file**: can be read directly by a contouring software package such as SURFER (e.g., TERREL.GRD).

3. **save file**: contains the intermediate binary output (e.g., TERREL.SAV).

4. **terrain elevation output file**: an ASCII file in the format specified by the user. For example, choosing the model option 'CALMET' produces a gridded terrain file which can be directly read by MAKEGEO (e.g., TERREL.DAT).

Table B-1
Terrain Databases

Database Type	**Description**	**Source**	**File Format**	**Reference System**	**Spatial Resolution (m)**
USGS90	1-deg DEM 3 arc-second data	USGS	ASCII	Geographic (lat/lon)	-90
USGS30	7.5 min USGS quadrangle	USGS	ASCII	UTM	30
3CD	1-deg DEM 3 arc-second data	Rocky Mtn Communications CD-ROM	Binary	Geographic (lat/lon)	-90
SRTM1	1-deg HGT format 1 arc-second data covering USA	USGS	Binary	Geographic (lat/lon)	~30
SRTM3	3-deg HGT format 3 arc-second data covering world	USGS	Binary	Geographic (lat/lon)	~90
GTOPO30 (SRTM30)	30 second DEM 40E lon. by 50Elat. covering world	USGS	Binary	Geographic (lat/lon)	~900
ARM3	30 second data 4 N-S sheets covering U.S.	CALPUFF CD-ROM (available from NTIS)	ASCII	Geographic (lat/lon)	-900
DMDF	7.5 min Alberta DEM	Alberta Environ. Protection	ASCII	UTM	~100
USGSLA	30 sec DEM	USGS	Binary	Lambert Azimuthal	~1000
NZGEN	Generic New Zealand file format	Misc.	ASCII	Geographic (lat/lon)	Arbitrary
GEN	Generic File format	Misc.	ASCII	UTM or Lambert Conformal	Arbitrary

Table B-2
Sample TERREL Control File Inputs
(TERREL.INP)

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

                 TERREL PROCESSOR CONTROL FILE
                 -----------------------------

  TERREL accepts terrain surface elevation data from a number of
  digital data bases and forms grid-cell averages or point-values for
  use in particular dispersion modeling systems.  For the CALPUFF
  system, TERREL produces a gridded terrain file for the MAKEGEO
  processor, and it produces a file of point-values for discrete
  receptors for CALPUFF.  Use TERREL one or more times to build the
  requested file.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

-------------
Subgroup (0a)
-------------

     Number of Terrain Data Files provided in Subgroup 0b

     By default, no data files are expected, and running TERREL
     without input data files will allow it to complete its set-up
     procedures, and report the number of data files needed to cover
     the specified modeling domain.  This information can be helpful
     when assembling the data files for an application.

     (NTDF)                     Default: 0      ! NTDF = 4 !


     Other Input and Output files:
     -----------------------------

     Default Name    Type        File Name
     ------------    ----        ---------
    TERREL.DAT       output    ! OUTFIL = terr1km.dat      !
    TERREL.LST       output    ! LSTFIL = terr1km.lst      !
    TERREL.GRD       output    ! PLTFIL = qaterr.grd      !
    ----------------------------------------------------------
    (Save-files)
    PREV.SAV         input     * PREVFIL =                 *
    TERREL.SAV       output    ! SAVEFIL = terr1km.sav     !
    ----------------------------------------------------------
    (Discrete (X,Y) Point Files)
    XYINP.DAT        input     * XYINP =                  *
    XYOUT.DAT        output    * XYOUT =                  *
    ----------------------------------------------------------
    (Coastline Data)
       USGS Global Self-consistent Hierarchical High-resolution
       Shoreline Database (GSHHS)
    GSHHS_F.B        input     ! GSHHSIN  = GSHHS_F.B   !
       Processed coastline polygons for
       TERREL grid (BLN)
    COAST.BLN        input or  ! COASTBLN = coast.bln   !
                     output

     --------------------------------------------------------------------------
     All file names will be converted to lower case if LCFILES = T
     Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
     (LCFILES)                  Default: T      ! LCFILES = F !
        T = lower case
        F = UPPER CASE

     NOTE: file/path names can be up to 70 characters in length

!END!


-------------
Subgroup (0b)
-------------

     The following NTDF Terrain Data Files are processed.
     Enter NTDF lines identifying the file name for each,
     followed by a group terminator.  The type of data base
     for each file is designated by the assignment name:

    (USGS90)   designates USGS 1-deg DEM files (~90m)
    (USGS30)   designates USGS 7.5-min DEM files (typically 30m)
    (ARM3)     designates ARM3 terrain data files(~900m)
    (3CD)      designates 3CD (binary) 1-deg DEM files (~90m)
    (DMDF)     designates Canadian DMDF files (~100m)
    (SRTM1)    designates 1-sec Shuttle RADAR Topo Mission files (~30m)
    (SRTM3)    designates 3-sec Shuttle RADAR Topo Mission files (~90m)
```

Table B-2 (continued)
Sample TERREL Control File Inputs
(TERREL.INP)

```
    (GTOPO30)  designates GTOPO30 30-sec data (~900m)
    (USGSLA)   designates USGS Lambert Azimuthal data (~1000m)
    (NZGEN)    designates New Zealand Generic data files
    (GEN)      designates Generic data files

     1 !USGS90 = portland.e!     !END!
     2 !USGS90 = portland.w!     !END!
     3 !USGS90 = lewiston.w!     !END!
     4 !USGS90 = lewiston.e!     !END!


-------------
Subgroup (0c)
-------------

     Datum-Region
     ------------

     The Datum-Region for coordinates in each of the input Terrain Data Files
     may be identified in the header records of the file.  Check the file
     documentation and change these defaults if needed.  The list of Datum-Regions
     with official transformation parameters provided by the National Imagery and
     Mapping Agency (NIMA).

     Datum-region for input Terrain Data File coordinates
    (DUSGS90)       Default: WGS-72  ! DUSGS90  = WGS-72    !
    (DUSGS30)       Default: NAS-C   ! DUSGS30  = NAS-C     !
    (DARM3)         Default: NAS-C   ! DARM3    = NAS-C     !
    (D3CD)          Default: WGS-72  ! D3CD     = WGS-72    !
    (DDMDF)         Default: NAS-C   ! DDMDF    = NAS-C     !
    (DSRTM1)        Default: WGS-96  ! DSRTM1   = WGS-96    !
    (DSRTM3)        Default: WGS-96  ! DSRTM3   = WGS-96    !
    (DGTOPO30)      Default: WGS-84  ! DGTOPO30 = WGS-84    !
    (DUSGSLA)       Default: ESR-S   ! DUSGSLA  = ESR-S     !
    (DNZGEN)        Default: WGS-84  ! DNZGEN   = WGS-84    !
    (DGEN)          Default: WGS-84  ! DGEN     = WGS-84    !

     Datum-region for input GSHHS Coastal Data File coordinates
    (DWVS)          Default: WGS-84  ! DWVS     = WGS-84 !

!END!

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

INPUT GROUP: 1 -- Processing Options
--------------

   Intermediate data for the terrain grid are saved in a binary
   file for subsequent applications of TERREL.  When TERREL is
   applied more than once (with different terrain data files), the
   save file must be used to pass previous results along.

     Previous SAVE file used to start this run?
     (LPREV)                   Default: F      ! LPREV = F !
        T = PREV.SAV file is used
        F = PREV.SAV file is NOT used


   TERREL constructs gridded terrain elevations (m MSL), and may also
   estimate the terrain elevation at discrete points by selecting the
   peak elevation within a prescribed distance (km) from each point.
   When processing discrete points, the XYINP.DAT provides the grid
   coordinates (km) of each point, and may also include a height above
   ground (m) for each point (e.g. for elevated receptors).  The
   structure of the XYINP.DAT file is a free-format text file with
   either 2 columns (X,Y) or 4 columns (X,Y,Elevation,Height).  When
   the 4-column form is used, data in the 3rd column are replaced
   with the elevations obtained from the terrain data base files.


   Report elevations for discrete (X,Y) points?
     (LXY)                     Default: F      ! LXY = F !
     T = Yes (XYINP.DAT and XYOUT.DAT files are used)
     F = No  (XYINP.DAT and XYOUT.DAT files are NOT used)

   Interpolate elevations for discrete points?
     (Used only if LXY=T)
     (LINTXY)                  Default: F      ! LINTXY = T !
     T = Yes (elevations will be interpolated)
     F = No  (elevations will be terrain peaks)

   Number of data columns in XYINP.DAT file
     (Used only if LXY=T)
     (NXYCOL)                  Default: 4      ! NXYCOL = 2 !

   Search radius (km) about each (X,Y) for locating terrain peak
     or for carrying out interpolation
```

Table B-2 (continued)
Sample TERREL Control File Inputs
(TERREL.INP)

```
  (Used only if LXY=T)
  (XYRADKM)                  No Default      ! XYRADKM = 0.15 !


Some terrain data sets contain void areas where the data are
missing.  Others may contain areas where data are inaccurate (noisy).
Both situations occur mostly over oceans or large lakes, but for SRTM
data it can also occur over land due to the data set still evolving.
These void (missing) or noisy input data can be replaced in several
ways.

Noisy Data ---
Noise affects SRTM data for oceans and lakes and the adjacent shores,
due to the scattering effects of water on radar measurements.
The most obvious occurence of noise is negative elevations for water
and adjacent land points.  This can be filtered with the specification
of a minimum acceptable elevation by water/land type.  Extracted
elevations that are greater than this minimum are retained, while those
lower than this minimum value can be re-defined as missing for
subsequent treatment by the missing values processing, or can be
replaced with either the minimum value or with another default value
defined for treatment of void (missing) data.  The minimum values must
be chosen judiciously for the region being treated since some regions
have valid elevations below MSL.

Missing data ---
Cells with missing elevations can be interpolated from surrounding
cells with valid values, and a maximum search radius is defined.
Also, if coastline processing has been used, default elevations for
each water/land type can be defined and used in place of voids.
This replacement can be carried out as the final step before output
on a cell-by-cell and receptor-by-receptor basis, or can be carried
out for values extracted from the terrain files as missing.  This
latter option is best used only for oceans and lakes.  For oceans
and lakes it is also possible to not use extracted elevations but
only use the default.

Coastline data are used to define coarse water/land type by
point or cell, for several of the options available for treating
missing or noisy data.  Coarse water/land type definitions currently
available in TERREL are:
    1 = ocean
    2 = mainland and marine islands

Coastline data are accepted in the form of either the USGS Global
Self-consistent Hierarchical High-resolution Shoreline (GSHHS) Database
file, or a BLN file produced in a previous application for the modeling
domain (it must have correct grid limits and polygon headers).  The
processed coastline (BLN) file for the domain is automatically created
when the GSHHS database is input.  No BLN is created when an existing
BLN file is input.

  Process coastline data?
  (LCOAST)                   Default: F      ! LCOAST = F !
    T = Process coastline data
    F = Do not process coastline data

  Read pre-processed coastline data (existing BLN file)?
  (LBLNREAD)                 Default: F      ! LBLNREAD = F !
    T = Use pre-processed coastline data
    F = Process raw coastline data

Noisy Data Replacement Options
------------------------------

--Filtering with minimum elevations by water/land type (2 values)
  (INOISEREP)                Default: 0,0
     0 = Do not check for noise
     1 = Set values lower than minimum to missing
     2 = Replace values lower than minimum with minimum value
     3 = Replace values lower than minimum with default value
         (set in TERDEF below)

  Minimum terrain elevations (m) for noise detection (2 values)
  (ZNOISE)                   Default: 0.,1.

                    |      |mainland |
                    |      |& marine |
                    |ocean |islands  |
                    ------ --------- -
      ! INOISEREP =   0,      0     !
      !    ZNOISE =   0.,     1.    !

Missing Data Replacement Options
--------------------------------

--Application of default elevations by water/land type (2 values)
```

```
     (ITERREP)                  Default: 3,0
        0 = Do not replace voids
        1 = Replace voids on output only
        2 = Replace void point values on extraction and voids on output
        3 = Always replace all values for this water type with default
            (only valid for oceans and lakes)

     Default terrain elevations (m) (2 values)
     (TERDEF)                   Default: 0.,0.

                       |      |mainland |
                       |      |& marine |
                       |ocean |islands  |
                       ------ --------- -
            ! ITERREP =   3,      0     !
            !  TERDEF =   0.,     0.    !


   --Carry out interpolation to fill void cells?
     (LVOIDFILL)                Default: F      ! LVOIDFIL = F !
       T = Try interpolation to fill void cells
       F = Do not try interpolation to fill void cells

   --Search radius (km) around grid cells for interpolation to fill
     voids   (Should be several times larger than DGRIDKM)
     (Used only if LVOIDFIL=T)
     (CELLRADKM)                No Default       ! CELLRADKM = 5. !


   Terrain data may be prepared for one of several models, and the
   structure of the output data file varies accordingly.

     Structure of output TERREL.DAT file
     (IMODEL)                   Default: 1      ! IMODEL = 1 !
        1 = CALMET        (grid-cell-average elevations)
        2 = MESOPAC       (grid-cell-average elevations)
        3 = ISC POLAR     (grid-cell-peak elevations)
        4 = ISC CARTESIAN (grid-cell-peak elevations)
        5 = NUATMOS       (grid-cell-average elevations)
        6 = Generic       (grid-cell-average elevations)

   Warnings are posted to the list file if grid cells contain fewer
   data points than ITHRES(%) of the mean for all cells.  Such a
   warning may indicate that insufficient data coverage is provided by
   the terrain data files that are processed.

     Threshold (%) of the average number of data points in a cell
     (ITHRES)                   Default: 75     ! ITHRES = 75 !

!END!

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

INPUT GROUP: 2 -- Map Projection and Grid Information for Output
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (PMAP)                     Default: UTM    ! PMAP = UTM !

         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  = 0.0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN = 19 !

     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 =   *
```

Table B-2 (continued)
Sample TERREL Control File Inputs
(TERREL.INP)

```
(RLON0)                    No Default      * RLON0 =   *

    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)
(RLAT1)                    No Default      * RLAT1 =  *
(RLAT2)                    No Default      * RLAT2 =  *

    LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
    PS  :  Projection plane slices through Earth at RLAT1
           (RLAT2 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 output 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 TERREL 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).

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


Grid
----

Grid type
(IGRID)                    Default: 1      ! IGRID = 1 !
   1 = Cartesian, with reference point at Lower Left CORNER
       of cell (1,1)    --- CALMET Convention ---
   2 = Cartesian, with reference point at CENTER of cell (1,1)
   3 = Polar, with reference point at center of rings
----------
Note: cell (1,1) is at the SW corner of the grid

Reference point coordinates X,Y (km) for grid
where X is Easting, Y is Northing
(XREFKM)                   No Default      ! XREFKM = 310.0  !
(YREFKM)                   No Default      ! YREFKM = 4820.0 !

Cartesian grid definition
(Used only if IGRID=1,2)
No. X grid cells (NX)      No default      ! NX =   99  !
No. Y grid cells (NY)      No default      ! NY =   99  !
Grid Spacing (km)(DGRIDKM) No default      ! DGRIDKM = 1. !

Polar grid definition -- enter ring distances and ray angles
                         in Input Group 3
(Used only if IGRID=3)
No. of rings (NRING)       No default      ! NRING =   0  !
No. of radials (NRAYS)     No default      ! NRAYS =   0  !

Elevation processing method for polar grid
(Used only if IGRID=3)
(IPROC)                    Default: 2      ! IPROC = 2 !
   1 = NORMAL: terrain data for point at the intersection of ring
               and ray is extracted from the region bounded by
               rings and radials halfway to the adjacent rings and
               radials
   2 = SCREEN: terrain data for point at the intersection of ring
               and ray is extracted from the region bounded by the
               current ring and the next larger ring, and radials
               halfway to the adjacent radials

!END!
```

Table B-2 (concluded)
Sample TERREL Control File Inputs
(TERREL.INP)

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

INPUT GROUP: 3 -- Polar Grid Ring Distances (km) and Ray Angles (deg)
--------------

     Enter NRING lines identifying the radius (DISKM) of each ring in
     the polar grid, using a group terminator on each line.
     (Enter only if IGRID=3)
     * DISKM =  1.5  *   *END*
     * DISKM =  3.0  *   *END*


     Enter NRAYS lines identifying the angle (ANGDEG) from North of
     each radial in the polar grid, using a group terminator on each line.
     (Enter only if IGRID=3)
     * ANGDEG =   0.  *   *END*
     * ANGDEG =  45.  *   *END*
     * ANGDEG =  90.  *   *END*

-------------------------------------------------------------------------------
NIMA Datum-Regions  (Documentation Section)
-------------------------------------------------------------------------------
     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
```

Table B-3
TERREL Control File Inputs

Input Group	Variable	Type	Description
(0a)	NTDF	integer	Number of data files to process
	OUTFIL	character*70	Output file name of terrain elevations (ASCII) for input to MAKEGEO
	LSTFIL	character*70	List file name.
	PLTFIL	character*70	Plot file (.GRD format) name.
	PREVFIL	character*70	Previous run binary output file (.SAV). Used only if it is a continuation run.
	SAVEFIL	character*70	Output binary save file name.
	LCFILES	logical	Conversion to upper (F) or lower (T) case
	XYINP	character*70	Input file containing discrete location coordinates (x,y) in km, (and if NXYFIELD=4, ground elevation placeholder and flagpole height (m))
	XYOUT	character*70	Output file containing (x,y, elevation, flagpole height, with elevation filled in by TERREL).
	GSHHSIN	character*70	Input USGS Global Self-consistent Hierarchical High-resolution Shoreline Database (GSHHS)
	COASTBLN	character*70	Processed coastline polygons for the current TERREL grid (BLN format): output when a GSHHS file is used, or may be input in place of a GSHHS file if available.
(0b)	USGS90 USGS30 ARM3 3CD DMDF SRTM1 SRTM3 GTOPO30 USGSLA NZGEN GEN	character*70	Assignment of input data file names of type USGS90, ARM3,… (as many lines as the number of files of each type – the total number must be NTDF)

Table B-3 (continued)
TERREL Control File Inputs

Input Group	Variable	Type	Description
(0c)	DUSGS90 DUSGS30 DARM3 D3CD DDMDF DSRTM1 DSRTM3 DGTOPO30 DUSGSLA DNZGEN DGEN DWVS	character*8	Assignment of DATUM Code for each type of input data file listed in sub-group 0b. Note that the USGS GSHHS database file contains information from two distinct databases, each with its own datum. These are the World Vector Shoreline (WVS) for "salt water" coasts, and the World Data Base II (WDBII) for fresh water coasts.
(1)	LPREV	logical	Continuation run flag (F=no, T=yes).
	LXY	logical	Process discrete (x,y) locations (F=no, T=yes)
	NXYCOL	integer	No. columns in receptor file
	LINTXY	logical	Interpolate elevation at discrete (x,y) locations (F= no – take nearest maximum terrain elevation, T= yes)
	XYRADKM	real	Search radius (km) around (x,y) for determining maximum terrain elevation, or for selecting elevations for interpolation
	LCOAST	logical	Process coastline data? (T=yes, F=no)
	LBLNREAD	logical	Read pre-processed coastline data (existing BLN file)? (T=yes, F=no)
	INOISEREP	integer	Filtering with minimum elevations by water/land type (5 values) 0 = Do not check for noise 1 = Set values lower than minimum to missing 2 = Replace values lower than minimum with minimum value 3 = Replace values lower than minimum with default value (set in TERDEF)
	ZNOISE	real	Minimum terrain elevations (m) for noise detection (5 values)

Table B-3 (continued)
TERREL Control File Inputs

Input Group	Variable	Type	Description
	ITERREP	integer	Application of default elevations by water/land type (5 values) 0 = Do not replace voids 1 = Replace voids on output only 2 = Replace void point values on extraction and voids on output 3 = Always replace all values for this water type with default (only valid for oceans and lakes)
	TERDEF	integer	Default elevation (m) for cells or discrete points that cannot be assigned valid data (5 values)
	LVOIDFIL	logical	Carry out interpolation to fill void cells? (T=yes, F=no)
	CELLRADKM	real	Search radius (km) around grid cells for interpolation to fill voids (Should be several times larger than DGRIDKM) (Used only if LVOIDFIL=T)
	IMODEL	integer (1,..,6)	Meteorological or dispersion model using terrain data; options are: (1) CALMET, (2) MESOPAC, (3) ISC3 polar grid receptor terrain format, (4) ISC3 discrete receptor format; (5) NUATMOS, or (6) GENERIC.
	ITHRES	integer	Threshold flag in % of the average number of data 'hits' per cell used for QA reporting.
(2)	PMAP *	character*8	Map projection for grid: UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA: Lambert Azimuthal Equal Area
	FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA
	FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA
	IUTMZN	integer	UTM zone for PMAP = UTM

Table B-3 (concluded)
TERREL Control File Inputs

Input Group	Variable	Type	Description
	UTMHEM	character*1	Use (N) northern or (S) southern hemisphere for UTM projection
	RLAT0, RLON0	character*16	Reference latitude and longitude (degrees) for PMAP = TTM, LCC, PS, EM, or LAZA. Enter numeric degrees and either N or S for latitude, or E or W for longitude.
	RLAT1, RLAT2	character*16	Two standard parallels of latitude for PMAP= LCC or PS. Enter numeric degrees and either N or S.
	DATUM	character*8	Datum Code for output grid
	IGRID	Integer	Grid definitions are: (1) Cartesian-corner, (2) Cartesian-Center, (3) Polar. For CALMET, IGRID should be set to (1).
	XREFKM, YREFKM	Real	Reference X and Y coordinates origin (km) of the output grid.
	NX, NY	integer	Number of grid cells in X and Y directions (if IGRID=1 or 2).
	DGRIDKM	real	Horizontal grid spacing (km).
	NRING, NRAYS	integer	Number of rings and radials (if IGRID=3).
	IPROC	integer	Terrain extraction approach for polar grid only:
			(1) NORMAL=Terrain data extracted from the region extending halfway to previous ring and halfway to next ring. (2) SCREEN=Terrain data extracted from the region extending from the current ring out to the next ring distance.
(3)	DISKM	Real (nring lines)	Distance of concentric rings for polar grid (km). Read only if IGRID=3.
	ANGDEG	real (nray lines)	Polar grid radials (degrees). Read only if IGRID=3.

* PMAP = PS, EM and LAZA is NOT AVAILABLE in CALMET

B.2 Land Use Data Preprocessors (CTGCOMP and CTGPROC)

This section explains how to obtain and process Composite Theme Grid (CTG) Land Use and Land Cover (LULC) data. CTG files are sequential ASCII files which consist of five header records and then one grid cell per logical record. The land use code is defined at the center point of each cell which are usually spaced 200 meters apart in both east-west and north-south directions. The points are oriented to the UTM projection. These files can be quite large (- 38 MB for one quadrant), therefore, the first step in processing these land use data is to compress the data file (CTGCOMP) and then to work (CTGPROC) with the much smaller compressed file (- 0.5 MB).

B.2.1 Obtaining the Data

Land Use and Land Cover Data are available from the USGS at the 1:250,000-scale with file names corresponding to the 1:250,000-scale map names. In some regions, land use data are also available at the 1:100,000-scale. Land use and land cover types are divided into 37 categories.

CTG LULC data are available by anonymous ftp from: edcftp.cr.usgs.gov, or can be downloaded from the WWW site: http://edcftp.cr.usgs.gov/pub/data/LULC. Note that the CTG files (named 'grid_cell') do not contain record delimiters. These must be added as described in the documentation for the GIRAS files. The user must first identify the names of the quadrants encompassed by the domain. These names are listed in a USGS map index as well as on the WWW home page of the USGS. Select the "250K FTP via Graphics" in the LULC section to view a map of the US and the names of the quadrants.

B.2.2 CTGCOMP - the CTG land use data compression program

CTG LULC data files retrieved from the ftp/web sites are ASCII files which are quite large, and it is useful to compress the data. CTGCOMP reads an uncompressed CTG file and produces a compressed CTG file. Both files are in ASCII.

CTGCOMP requires an input file called "CTGCOMP.INP" in which the user specifies the uncompressed CTG land use data file name and the compressed output file name. A list file (CTGCOMP.LST) is created which echoes the header records of the land use data file and provides summary information about the run. CTGCOMP must be run for each CTG data file. CTGCOMP.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO).

B.2.3. CTGPROC - the land use preprocessor

CTGPROC reads a compressed USGS Land Use and Land Cover data in Composite Theme Grid (CTG) format, or the USGS Global Dataset format. The CTG data is available for the United States, with a horizontal resolution of approximately 200 m. The global dataset covers the world with a resolution of approximately 900 m.

Each run of CTGPROC processes one file (i.e., one quadrant of data processed per run) and determines the fractional land use for each grid cell in the user-specified gridded domain. If the domain encompasses several CTG files (quadrants), CTGPROC must be run iteratively and the continuation flag must be turned on in the control file. The output from a previous run of CTGPROC can be used as an input.

CALMET grid cells are often large enough to include more than one land use data point: CTGPROC keeps track of the number of process 'hits' of each land use category for each grid cell and in the final run of an iteration compiles final fractional land use categories for each grid cell. A hit is a landuse datapoint from the CTG or global dataset that falls within a grid cell defined by CTGPROC. If the number of hits for a given grid cell is less than a user-specified threshold of the domain average number of hits, the program flags possibly missing data in a list file (or possibly incorrectly specified domain parameters).

Input: a user input control file CTGPROC.INP (grid definition parameters must be compatible with those used in TERREL), and a compressed CTG data file or a global data file. The format of the CTGPROC control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). CTGCOMP.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO). An example of the input file and a description of the input variables are shown in Tables B-5 and B-6, respectively.

Output: a list file (CTGPROC.LST), and a gridded land use data file. A sample list file is shown in Table B-7.

Table B-4
Sample CTGCOMP Control File Inputs
(CTGCOMP.INP)

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

                 CTGCOMP PROCESSOR CONTROL FILE
                 ------------------------------

     USGS Composite Theme Grid (CTG) format Land Use and Land Cover
     (LULC) data files must be compressed prior to use in the CTGPROC
     utility processor.  Use CTGCOMP to compress the data file.

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

INPUT GROUP: 0 -- Input and Output File Names
--------------

Default Name  Type          File Name
------------  ----          ---------
CTG.DAT        input   ! CTGFIL  =ctgin.dat  !
CTGCOMP.DAT   output   ! COMPFIL =ctgout.dat  !
CTGCOMP.LST   output   ! COMPLST =ctgcomp.lst  !

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

NOTE: file/path names can be up to 70 characters in length

!END!
```

Input Group	Variable	Type	Description
(0)	CTGFIL	character*70	Name of uncompressed CTG land use data file (input)
	COMPFIL	character*70	Name of compressed CTG land use data file (output)
	COMPLST	character*70	Name of list file (output)

Table B-5
Sample CTGPROC Control File Inputs
(CTGPROC.INP)

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

                 CTGPROC PROCESSOR CONTROL FILE
                 ------------------------------

  CTGPROC reads a Land Use and Land Cover (LULC) data file and determines
  fractional land use for each grid cell in a user-specified gridded
  domain.  If the domain requires multiple files, CTGPROC is applied
  iteratively (continuation option) to build the land use grid
  incrementally.  The LULC file must be either a compressed USGS
  Composite Theme Grid (CTG) format (available for the U.S.), a
  USGS Global format, or the New Zealand Generic format.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

-------------
Subgroup (0a)
-------------

     Number of Land Use Data Files provided in Subgroup 0b

     (NDBF)                     Default: 0      ! NDBF = 6 !


     Other Input and Output files:
     -----------------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     PREV.DAT      input    ! PREVDAT =lu1.dat      !
     LU.DAT        output   ! LUDAT   =lu2.dat      !
     CTGPROC.LST   output   ! RUNLST  =lu2.lst      !
    ---------------------------------------------------------
    (Coastline Data)
       USGS Global Self-consistent Hierarchical High-resolution
       Shoreline Database (GSHHS)
    GSHHS_F.B      input    ! GSHHSIN  = GSHHS_F.B   !
       Processed coastline polygons for
       CTGPROC grid (BLN)
    COAST.BLN      input or ! COASTBLN = stlcoast.bln   !
                   output
    ---------------------------------------------------------

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

     NOTE: File/path names can be up to 70 characters in length;
           PREV.DAT is used only if LPREV=T (Input Group 1)

!END!


-------------
Subgroup (0b)
-------------

     The following NDBF Land Use Data Files are processed.
     Enter NDBF lines identifying the file name for each,
     followed by a group terminator.  The type of data base
     for each file is designated by the assignment name:
```

Table B-5 (continued)
Sample CTGPROC Control File Inputs
(CTGPROC.INP)

```
     (CTG)     designates USGS CTG (compressed)
     (NZGEN)   designates New Zealand Generic
     (GLAZNA)  designates USGS Global (Lambert Azimuthal) for North America
     (GLAZSA)  designates USGS Global (Lambert Azimuthal) for South America
     (GLAZEU)  designates USGS Global (Lambert Azimuthal) for Eurasia - Europe
     (GLAZAS)  designates USGS Global (Lambert Azimuthal) for Eurasia - Asia
     (GLAZAF)  designates USGS Global (Lambert Azimuthal) for Africa
     (GLAZAP)  designates USGS Global (Lambert Azimuthal) for Australia-Pacific

    ! GLAZNA  =  noameric.lu   !  !END!
    ! GLAZSA  =  soameric.lu   !  !END!
    ! GLAZEU  =  europe.lu     !  !END!
    ! GLAZAS  =  asia.lu       !  !END!
    ! GLAZAF  =  africa.lu     !  !END!
    ! GLAZAP  =  auspacif.lu   !  !END!

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

INPUT GROUP: 1 -- Run control parameters
--------------

     When multiple applications of CTGPROC are needed, the gridded land
     use data file (LU.DAT) must be written in a continuation format rather
     than in the fractional land use format expected by MAKEGEO.  This
     applies to all applications except the FINAL application, which must
     be in the fractional land use format.  Futhermore, if the application
     is not the first one in a series, then a PREVIOUS LU.DAT file must
     be identified.

     Is this the final run?
     (LFINAL)                  Default: T      ! LFINAL = T !
        T = LU.DAT file written in fractional land use format
        F = LU.DAT file written in continuation format

     Is a previous LU.DAT output file used to start this run?
     (LPREV)                   Default: F      ! LPREV = F !
        T = PREV.DAT file is used
        F = PREV.DAT file is NOT used

     Control for distributing input land use within its cell to improve
     the sampling density.  A mesh density greater than one is used to
     split each input cell into a finer grid of cells.  A density of 2
     creates 2 cells per side; 3 creates 3 cells per side.  The input
     land use is assigned to the center of each of the new cells.
     Specify a mesh density for CTG and USGS GLAZ file types:
     (MESHCTG)                 Default=1       ! MESHCTG  = 1 !
     (MESHGLAZ)                Default=1       ! MESHGLAZ = 1 !


     Marine Coastline Processing
     ---------------------------
     Land use data may be augmented with coastline information.  Coastline
     data are used to determine whether a particular point lies offshore,
     so that it may be given a marine (ocean) land use code.

     Process coastline data?
     (LCOAST)                  Default: F      ! LCOAST = T !
       T = Process coastline data
       F = Do not process coastline data

     Coastline processing method for points offshore may SWAP a land use
     type as it is read from an input data file with the type for ocean,
     and it may FILL empty marine cells at the end of a run with the
     type for ocean.
```

Table B-5 (continued)
Sample CTGPROC Control File Inputs
(CTGPROC.INP)

```
     (LMARSWAP)                 Default: F      ! LMARSWAP = F !
     (Used only if LCOAST=T)
       T = Replace land use type read from data file with type IOCEAN
       F = Use land use type read from data file

     (LMARFILL)                 Default: T      ! LMARFILL = T !
     (Used only if LCOAST=T and LFINAL=T)
       T = Fill empty marine grid cells with land use type IOCEAN
       F = Maintain empty grid cells

     Marine land use type:
     (Used only if LCOAST=T)
     (IOCEAN)                   Default: 55     ! IOCEAN = 55 !

     Read pre-processed coastline data (existing BLN file)?
     (Used only if LCOAST=T)
     (LBLNREAD)                 Default: F      ! LBLNREAD = F !
       T = Use pre-processed BLN coastline data
       F = Process GSHHS coastline data and create BLN


     Input Datum-Region
     ------------------
     The Datum-Region for coordinates in the input LULC Data File may be
     identified in the header records of the file.  Check the file documentation
     and change these defaults as needed.  The list of Datum-Regions with
     official transformation parameters is provided by the National Imagery and
     and Mapping Agency (NIMA).

     Datum-region for input LULC Data File coordinates

     (DCTG)                     Default: NAS-C     ! DCTG     = NAS-C  !
     for LULC = 1: USGS CTG (compressed)

     (DUSGSLA)                  Default: ESR-S     ! DUSGSLA  = ESR-S  !
     for LULC = 2: USGS Global (Lambert Azimuthal)

     (DNZGEN)                   Default: WGS-84    ! DNZGEN   = WGS-84 !
     for LULC = 3: New Zealand Generic


     QA threshold (% of average number of data points/grid cell)
     for reporting cells with poor data coverage
     (ITHRESH)                  Default: 75     ! ITHRESH = 75 !

!END!

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

INPUT GROUP: 2 -- Map Projection and Grid Information for Output
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (PMAP)                     Default: UTM    ! PMAP = UTM !

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

Table B-5 (continued)
Sample CTGPROC Control File Inputs
(CTGPROC.INP)

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

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN)                   No Default      ! IUTMZN = 19 !

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 = 40.0N !
(RLON0)                    No Default      ! RLON0 = 70.0W !

    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)
(RLAT1)                    No Default      ! RLAT1 = 30.0N !
(RLAT2)                    No Default      ! RLAT2 = 60.0N !

    LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
    PS  :  Projection plane slices through Earth at RLAT1
           (RLAT2 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


Output Datum-Region
-------------------

The Datum-Region for the output 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 TERREL 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).

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

Table B-5 (continued)
Sample CTGPROC Control File Inputs
(CTGPROC.INP)

```
     Grid
     ----

     Reference coordinates X,Y (km) assigned to the southwest corner
     of grid cell (1,1)  (lower left corner of grid)
     (XREFKM)                  No Default      ! XREFKM = 310.0  !
     (YREFKM)                  No Default      ! YREFKM = 4820.0 !

     Cartesian grid definition
     No. X grid cells (NX)      No default      ! NX =   99  !
     No. Y grid cells (NY)      No default      ! NY =   99  !
     Grid Spacing (DGRIDKM)     No default      ! DGRIDKM = 1. !
     in kilometers


!END!


--------------------------------------------------------------------------------
NIMA Datum-Regions  (Documentation Section)
--------------------------------------------------------------------------------
     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
```

Table B-6
Control File Inputs (CTGPROC.INP)

Input Group	**Variable**	**Type**	**Description**
(0a)	NDBF	integer	Number of data files to process
	PREVDAT	character*70	Previous CTGPROC output data file used as input if the run is a continuation run, (used only if it is a continuation run)
	LUDAT	character*70	Name of the gridded LU output file
	RUNLST	character*70	Name of the output list file
	GSHHSIN	character*70	Input USGS Global Self-consistent Hierarchical High-resolution Shoreline Database (GSHHS)
	COASTBLN	character*70	Processed coastline polygons for the current TERREL grid (BLN format): output when a GSHHS file is used, or may be input in place of a GSHHS file if available.
	LCFILES	logical	Filename converted to lower case (T) or upper case (F)
(0b)	CTG NZGEN GLAZNA GLAZSA GLAZEU GLAZAS GLAZAF GLAZAP	character*70	Assignment of input data file names of type CTG, NZGEN, … (as many lines as the number of files of each type – the total number must be NDBF)

Table B-6 (continued)
Control File Inputs (CTGPROC.INP)

Input Group	Variable	Type	Description
(1)	LFINAL	logical	Final run flag (F=not a final run, T=yes, a final run)
	LPREV	logical	Use a previous LUDAT file? (F=no, T=yes)
	LCOAST	logical	Process coastline data? (T=yes, F=no)
	LBLNREAD	logical	Read pre-processed coastline data (existing BLN file)? (T=yes, F=no)
	MESHCTG	Integer	Control for distributing land use (CTG) within a cell to improve sampling density
	MESHGLAZ	Integer	Control for distributing land use (USGS GLAZ) within a cell to improve sampling density
	LMARSWAP	Logical	Replace land use type read from data file with type IOCEAN
	LMARFILL	Logical	Fill empty marine cells with Land Use type IOCEAN
	IOCEAN	Integer	Marine land use type
	DCTG	character*8	DATUM Code for USGS CTG
	DUSGSLA	character*8	DATUM Code for USGS Global Lambert Azimuthal files (GLAZNA, GLAZSA, GLAZEU, GLAZAS, GLAZAF, GLAZAP)
	DNZGEN	character*8	DATUM Code for New Zealand Generic
	ITHRESH	Integer	Threshold flag in % of the average number of data 'hits' per cells

Table B-6 (concluded)
Control File Inputs (CTGPROC.INP)

Input Group	**Variable**	**Type**	**Description**
(2)	PMAP *	character*8	Map projection for grid: UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA: Lambert Azimuthal Equal Area
	FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA
	FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA
	IUTMZN	integer	UTM zone for PMAP = UTM
	UTMHEM	character*1	Use (N) northern or (S) southern hemisphere for UTM projection
	RLAT0, RLON0	character*16	Reference latitude and longitude (degrees) for PMAP = TTM, LCC, PS, EM, or LAZA. Enter numeric degrees and either N or S for latitude, or E or W for longitude.
	RLAT1, RLAT2	character*16	Two standard parallels of latitude for PMAP= LCC or PS. Enter numeric degrees and either N or S.
	DATUM	character*8	Datum Code for output grid
	XREFKM, YREFKM	real	Reference X and Y coordinates origin (km) of the output grid.
	NX, NY	integer	Number of grid cells in X and Y directions (if IGRID=1 or 2)
	DGRIDKM	real	Horizontal grid spacing (km)

* PMAP = PS, EM, and LAZA is NOT AVAILABLE in CALMET

Table B-7
Sample CTGPROC Output List File
(CTGPROC.LST) - Partial Listing

```
                         CTGPROC OUTPUT SUMMARY
                  VERSION:  2.63         LEVEL:  050128



 Internal Coordinate Transformations by  ---  COORDLIB   Version: 1.95   Level: 050126




 --------------------------
     SETUP Information
 --------------------------


 Control File Used -----
 ctgproc.inp

 Processing Options -----
 Continues Previous Run? :   F
 Final Run in Series?    :   T

 Coastline processing?   =   F

 Mesh Density for CTG files  =   1
 Mesh Density for GLAZ files =   1

 QA Threshold (%)        =   75

 Input Land Use File(s) -----

 luindat: LEWISTON.CMP
 (USGS CTG - compressed)

 luindat: PORTLAND.CMP
 (USGS CTG - compressed)

 Default Datum-Region for each File Type --------
 CTG    : NAS-C
 USGSLA : ESR-S
 NZGEN  : WGS-84
 GSHHS  : WGS-84

 Output File Names -------------
runlst  : CTGPROC.LST
ludat   : LULC1KM.DAT
 (LUDAT written in fractional land use format)

 Grid data (for output) --------------------
 datum  : NAS-C
 pmap   : UTM
 Hemisphere : N
 UTM zone   :  19
 xorigin:  310.000000
 yorigin:  4820.00000
 izone  :  19
 dgrid  :  1.00000000
 nx     :  99
 ny     :  99



 --------------------------
     PROCESS Information
 --------------------------

 Land use data file: LEWISTON.CMP

   Header of Compressed CTG data file:
```

Table B-7 (concluded)
Sample CTGPROC Output List File
(CTGPROC.LST) - Partial Listing

```
      575    884064       808    0  200    4   17   19    1   7874016      1973
   1    1  808  575    0  556   21    0  415   13  809   20  802  575  401  373
   440000    720000    450000    720000    450000    710000    450000    700000
   440000    700000    440000    710000    259500   4987100     84180
LEWISTON, ME VT NH 1:250,000 QUAD LU PB CN HU


 Number of records read:  73693
 Number of data points read:  442039
 Number of data points used to update grid:  113089
 Number of data points with missing LU:  225


 Land use data file: PORTLAND.CMP

   Header of Compressed CTG data file:
      570    757734       822    0  200    4   17   19    1   7874016      1973
   1    1  822  570    0  556   20    1  421   13  822   20  815  576  408  380
   430000    720000    440000    720000    440000    710000    440000    700000
   430000    700000    430000    710000    255500   4876100     84180
PORTLAND, ME NH 1:250,000 QUAD LU PB CN HU


 Number of records read:  89863
 Number of data points read:  379005
 Number of data points used to update grid:  129519
 Number of data points with missing LU:  321


 Number of CTG land use cell hits

 Multiply all values by 10 **   0

  99 I 25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
  98 I 25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
  97 I 25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +
  96 I 25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25  25
     I  +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +   +



 Number of land use hits low in       104 Cells
 with fewer than    18 hits per cell.
 INVESTIGATE cells that are partially filled.



 POTENTIAL ERROR: Number of Grid Cells with no defined land use =         88
 This should NOT be your LAST run unless these cells are PROPERLY filled in
 with the missing value (IMISS) used in the next processing step (MAKEGEO).
 Consult the gridded table printed above to identify the cells.

 Land Use Processing Complete.


  End of run -- Clock time: 16:53:34
                      Date: 02-21-2005

        Elapsed Clock Time:        5.0 (seconds)

                  CPU Time:        5.0 (seconds)
```

B.3 MAKEGEO

MAKEGEO generates a GEO.DAT file that provides the geophysical data inputs required by the CALMET model[1]. These inputs include land use types, elevation, surface parameters (surface roughness length, albedo, Bowen ratio, soil heat flux parameter, vegetation leaf area index), and anthropogenic heat flux. An extensive description of GEO.DAT is provided in Section 8.

MAKEGEO requires 3 **input files**: a gridded elevation file (e.g. produced by TERREL)[2], a gridded land use file (e.g. generated by CTGPROC), and a user input control file (MAKEGEO.INP).

MAKEGEO reads gridded fractional land use, calculates dominant land use categories, as well as weighted surface parameters and remaps to new LULC categories, if desired. In MAKEGEO.INP, the user can define new LU categories by remapping the USGS LU categories. For example, the USGS land use category system has 7 types of urban or built-up land and these would all be mapped to one land use category for urban or built-up land in CALMET if using the 14 category system (see Table 8-6).

A value of each surface parameter is provided by the user for each land use category in the MAKEGEO control input file. MAKEGEO computes area weighted values for each grid cell based on the amount of area each land use category covers in the grid cell. For example, a grid cell which is half water and half forest would have surface parameters that would reflect 50% of the value assigned to water and 50% of the value assigned to forest categories. An arithmetic weighting is computed for albedo, Bowen ratio, soil heat flux, vegetation leaf area index and anthropogenic heat flux. For the surface roughness, a logarithmic weighting is used.

The format of the MAKEGEO control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). MAKEGEO.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO). A sample MAKEGEO.INP file is provided in Table B-8 and the input variables are described in Table B-9.

---

[1] MAKEGEO also produces a binary “terrain” file suitable for input into UAM.

[2] MAKEGEO will run if a gridded elevation file is not supplied, but gridded terrain elevations must then be manually inserted into GEO.DAT before using as input for CALMET.

Table B-8
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
Demo Application
-------------------- Run title (1 line) ------------------------------------

                 MAKEGEO PROCESSOR CONTROL FILE
                 ------------------------------

  MAKEGEO creates the geophysical data file (GEO.DAT) for CALMET.  Using
  the fractional land use data from CTGPROC (LU.DAT), it calculates the
  dominant land use for each cell and computes weighted surface parameters.
  It may also remap land use categories if desired.  Terrain data can
  be obtained from TERREL, or provided in a file of similar format
  (TERR.DAT).

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

INPUT GROUP: 0 -- Input and Output Files
--------------

     Default Name  Type          File Name
     ------------  ----          ---------
     LU.DAT        input    ! LUDAT   =lulc1km.dat   !
     LU2.DAT       input    ! LU2DAT  =luglobe.dat !
     TERR.DAT      input    ! TERRDAT =terr1km.dat !
     GEO.DAT       output   ! GEODAT  =geo1km.dat  !
     MAKEGEO.LST   output   ! RUNLST  =makegeo.lst  !
     QALUSE.GRD    output   * LUGRD   =qaluse.grd  *
     QATERR.GRD    output   * TEGRD   =qaterr.grd  *

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

     NOTE: File/path names can be up to 70 characters in length

!END!

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

INPUT GROUP: 1 -- Run control parameters
--------------

   Terrain Processing Control

     Read in a gridded terrain file?
     (LTERR)                    Default: T      ! LTERR = T !
        T = terrain elevations in GEO.DAT read from TERR.DAT
        F = terrain elevations in GEO.DAT are zero


   Land Use Processing Control

   A second file of fractional land use (LU2.DAT) may be provided for
   use when a cell in the primary land use file (LU.DAT) has no indicated
   land use.  This option allows a lower resolution dataset to supplement
   a higher resolution dataset where the higher resolution data are
   unavailable.

     Read in a second fractional land use file?
     (LLU2)                     Default: F      ! LLU2 = F !
        T = supplemental fractional land use read from LU2.DAT
        F = no supplemental fractional land use data are available
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
   QA information for 1 cell in the grid can be written to the list
   file.  Identify the cell by its grid location (IX,IY).
   No QA output is generated if either index is outside your grid.  For
   example, using 0 for either turns the QA output off.

     Location of grid cell for QA output
     (IXQA)                    Default: 0      ! IXQA = 20 !
     (IYQA)                    Default: 0      ! IYQA = 15 !

!END!

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

INPUT GROUP: 2 -- Map Projection and Grid Information for Output
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (PMAP)                    Default: UTM    ! PMAP = UTM !

         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  = 0.0 !
     (FNORTH)                  Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                  No Default      ! IUTMZN = 19 !

     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 = 40.0N !
     (RLON0)                   No Default      ! RLON0 = 70.0W !

         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)
     (RLAT1)                   No Default      ! RLAT1 = 30.0N !
     (RLAT2)                   No Default      ! RLAT2 = 60.0N !
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
         LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
         PS  :  Projection plane slices through Earth at RLAT1
                (RLAT2 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


     Output Datum-Region
     -------------------

     The Datum-Region for the output 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 TERREL 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
     and Mapping Agency (NIMA).

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



     Grid
     ----

     Reference coordinates X,Y (km) assigned to the southwest corner
     of grid cell (1,1)  (lower left corner of grid)
     (XREFKM)                   No Default      ! XREFKM = 310.0  !
     (YREFKM)                   No Default      ! YREFKM = 4820.0 !

     Cartesian grid definition
     No. X grid cells (NX)      No default      ! NX =   99  !
     No. Y grid cells (NY)      No default      ! NY =   99  !
     Grid Spacing (DGRIDKM)     No default      ! DGRIDKM = 1. !
     in kilometers


!END!

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

INPUT GROUP: 3 -- Output Land Use
--------------

-------------
Subgroup (3a)
-------------

     Number of output land use categories
     (NOUTCAT)                  Default: 14     ! NOUTCAT = 14 !

     Output land use categories assigned to water
     range from IWAT1 to IWAT2 (inclusive)
     (IWAT1)                    Default: 50     ! IWAT1 = 50 !
     (IWAT2)                    Default: 55     ! IWAT2 = 55 !

!END!
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
-------------
Subgroup (3b)
-------------
                                                         a
           OUTPUT LAND USE CATEGORIES (NOUTCAT entries)
           --------------------------------------------

! OUTCAT =   10, 20, -20, 30, 40, 51, 54, 55    !  !END!
! OUTCAT =   60, 61,  62, 70, 80, 90            !  !END!

-------------
    a
     List categories in ascending order (absolute value), with up to 10
     per line.  Each line is treated as a separate input subgroup and
     therefore must end with an input group terminator.



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

INPUT GROUP: 4 -- Input Land Use (Defaults are set for USGS categories)
--------------

-------------
Subgroup (4a)
-------------

     Number of input land use categories
     (NINCAT)                   Default: 38     ! NINCAT = 38 !

     Number of input water categories
     (NUMWAT)                   Default: 5      ! NUMWAT = 5  !

     Number of input categories that are split
     by apportioning area among the other land
     use categories
     (NSPLIT)                   Default: 0      ! NSPLIT = 0  !

     Minimum fraction of cell covered by water required
     to define the dominant land use as water
     (CFRACT)                   Default: 0.5    ! CFRACT = 0.5  !

     Land use category assigned to cell when
     no land use data are found
     (IMISS)                    Default: 55     ! IMISS = 55  !

     Minimum total fractional land use expected
     in a cell when land use data are available
     (FLUMIN)                   Default: 0.96   ! FLUMIN = 0.96 !

!END!


-------------
Subgroup (4b)
-------------
                                                                a
           LAND USE PROPERTIES AND OUTPUT MAP (NINCAT entries)
           ---------------------------------------------------

     Input                                    Soil   Anthropogenic Leaf   Output
    Category    z0     Albedo    Bowen   Heat Flux  Heat Flux   Area  Category
       ID       (m)   (0 to 1)   Ratio   Parameter  (W/m**2)   Index     ID
     ------   ------   ------    ------  ---------  --------   ------  ------
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
! X =   11,     0.5,    0.18,    1.0,    0.20,     0.0,     1.0,    10  !  !END!
! X =   12,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   13,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   14,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   15,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   16,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   17,     1.0,    0.18,    1.5,    0.25,     0.0,     0.2,    10  !  !END!
! X =   21,    0.25,    0.15,    1.0,    0.15,     0.0,     3.0,    20  !  !END!
! X =   22,    0.25,    0.15,    1.0,    0.15,     0.0,     3.0,    20  !  !END!
! X =   23,    0.25,    0.15,    1.0,    0.15,     0.0,     3.0,    20  !  !END!
! X =   24,    0.25,    0.15,    1.0,    0.15,     0.0,     3.0,    20  !  !END!
! X =   31,    0.05,    0.25,    1.0,    0.15,     0.0,     0.5,    30  !  !END!
! X =   32,    0.05,    0.25,    1.0,    0.15,     0.0,     0.5,    30  !  !END!
! X =   33,    0.05,    0.25,    1.0,    0.15,     0.0,     0.5,    30  !  !END!
! X =   41,     1.0,     0.1,    1.0,    0.15,     0.0,     7.0,    40  !  !END!
! X =   42,     1.0,     0.1,    1.0,    0.15,     0.0,     7.0,    40  !  !END!
! X =   43,     1.0,     0.1,    1.0,    0.15,     0.0,     7.0,    40  !  !END!
! X =   51,   0.001,     0.1,    0.0,     1.0,     0.0,     0.0,    51  !  !END!
! X =   52,   0.001,     0.1,    0.0,     1.0,     0.0,     0.0,    51  !  !END!
! X =   53,   0.001,     0.1,    0.0,     1.0,     0.0,     0.0,    51  !  !END!
! X =   54,   0.001,     0.1,    0.0,     1.0,     0.0,     0.0,    54  !  !END!
! X =   55,   0.001,     0.1,    0.0,     1.0,     0.0,     0.0,    55  !  !END!
! X =   61,     1.0,     0.1,    0.5,    0.25,     0.0,     2.0,    61  !  !END!
! X =   62,     0.2,     0.1,    0.1,    0.25,     0.0,     1.0,    62  !  !END!
! X =   71,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   72,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   73,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   74,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   75,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   76,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   77,    0.05,     0.3,    1.0,    0.15,     0.0,    0.05,    70  !  !END!
! X =   81,     0.2,     0.3,    0.5,    0.15,     0.0,     0.0,    80  !  !END!
! X =   82,     0.2,     0.3,    0.5,    0.15,     0.0,     0.0,    80  !  !END!
! X =   83,     0.2,     0.3,    0.5,    0.15,     0.0,     0.0,    80  !  !END!
! X =   84,     0.2,     0.3,    0.5,    0.15,     0.0,     0.0,    80  !  !END!
! X =   85,     0.2,     0.3,    0.5,    0.15,     0.0,     0.0,    80  !  !END!
! X =   91,    0.05,     0.7,    0.5,    0.15,     0.0,     0.0,    90  !  !END!
! X =   92,    0.05,     0.7,    0.5,    0.15,     0.0,     0.0,    90  !  !END!

-------------
    a
     Data for each land use category are treated as a separate input
     subgroup and therefore must end with an input group terminator.


-------------
Subgroup (4c)
-------------
                                                                    a
           INPUT CATEGORIES DEFINED AS WATER (NUMWAT entries)
           --------------------------------------------------

           ! IWAT =   51  !  !END!
           ! IWAT =   52  !  !END!
           ! IWAT =   53  !  !END!
           ! IWAT =   54  !  !END!
           ! IWAT =   55  !  !END!

-------------
    a
     Each water category ID is read as a separate input
     subgroup and therefore must end with an input group terminator.
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
-------------
Subgroup (4d)
-------------
                                                        a
           CATEGORY SPLIT INFORMATION (NSPLIT Categories)
           ----------------------------------------------

            Split         To       Amount
           Category   Category   of Split
              ID         ID        (%)
           --------   --------   --------

* XSPLIT =    14,        76,       15.8  *  *END*
* XSPLIT =    14,        77,       84.2  *  *END*

-------------
    a
     Each assignment is read as a separate input subgroup and therefore
     must end with an input group terminator.  A total of NSPLIT input
     land use categories must be listed, and the % split from each one
     of these to all receiving land use categories must sum to 100.0%


--------------------------------------------------------------------------------
NIMA Datum-Regions  (Documentation Section)
--------------------------------------------------------------------------------
     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
```

Table B-8 (continued)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
-------------
Subgroup (4b)
-------------
                                                               a
           LAND USE PROPERTIES AND OUTPUT MAP (NINCAT entries)
           ---------------------------------------------------

     Input                                 Soil   Anthropogenic Leaf   Output
    Category    z0     Albedo    Bowen   Heat Flux  Heat Flux   Area  Category
       ID       (m)   (0 to 1)   Ratio   Parameter  (W/m**2)   Index     ID
     ------   ------   ------    ------  ---------  --------   ------  ------

! X =   11,     0.5,    0.18,     1.0,     0.20,      0.0,      1.0,     10  !  !END!
! X =   12,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   13,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   14,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   15,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   16,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   17,     1.0,    0.18,     1.5,     0.25,      0.0,      0.2,     10  !  !END!
! X =   21,    0.25,    0.15,     1.0,     0.15,      0.0,      3.0,     20  !  !END!
! X =   22,    0.25,    0.15,     1.0,     0.15,      0.0,      3.0,     20  !  !END!
! X =   23,    0.25,    0.15,     1.0,     0.15,      0.0,      3.0,     20  !  !END!
! X =   24,    0.25,    0.15,     1.0,     0.15,      0.0,      3.0,     20  !  !END!
! X =   31,    0.05,    0.25,     1.0,     0.15,      0.0,      0.5,     30  !  !END!
! X =   32,    0.05,    0.25,     1.0,     0.15,      0.0,      0.5,     30  !  !END!
! X =   33,    0.05,    0.25,     1.0,     0.15,      0.0,      0.5,     30  !  !END!
! X =   41,     1.0,     0.1,     1.0,     0.15,      0.0,      7.0,     40  !  !END!
! X =   42,     1.0,     0.1,     1.0,     0.15,      0.0,      7.0,     40  !  !END!
! X =   43,     1.0,     0.1,     1.0,     0.15,      0.0,      7.0,     40  !  !END!
! X =   51,   0.001,     0.1,     0.0,      1.0,      0.0,      0.0,     51  !  !END!
! X =   52,   0.001,     0.1,     0.0,      1.0,      0.0,      0.0,     51  !  !END!
! X =   53,   0.001,     0.1,     0.0,      1.0,      0.0,      0.0,     51  !  !END!
! X =   54,   0.001,     0.1,     0.0,      1.0,      0.0,      0.0,     54  !  !END!
! X =   55,   0.001,     0.1,     0.0,      1.0,      0.0,      0.0,     55  !  !END!
! X =   61,     1.0,     0.1,     0.5,     0.25,      0.0,      2.0,     61  !  !END!
! X =   62,     0.2,     0.1,     0.1,     0.25,      0.0,      1.0,     62  !  !END!
! X =   71,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   72,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   73,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   74,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   75,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   76,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   77,    0.05,     0.3,     1.0,     0.15,      0.0,     0.05,     70  !  !END!
! X =   81,     0.2,     0.3,     0.5,     0.15,      0.0,      0.0,     80  !  !END!
! X =   82,     0.2,     0.3,     0.5,     0.15,      0.0,      0.0,     80  !  !END!
! X =   83,     0.2,     0.3,     0.5,     0.15,      0.0,      0.0,     80  !  !END!
! X =   84,     0.2,     0.3,     0.5,     0.15,      0.0,      0.0,     80  !  !END!
! X =   85,     0.2,     0.3,     0.5,     0.15,      0.0,      0.0,     80  !  !END!
! X =   91,    0.05,     0.7,     0.5,     0.15,      0.0,      0.0,     90  !  !END!
! X =   92,    0.05,     0.7,     0.5,     0.15,      0.0,      0.0,     90  !  !END!

-------------
    a
     Data for each land use category are treated as a separate input
     subgroup and therefore must end with an input group terminator.


-------------
Subgroup (4c)
-------------
                                                              a
           INPUT CATEGORIES DEFINED AS WATER (NUMWAT entries)
           --------------------------------------------------

           ! IWAT =   51  !  !END!
           ! IWAT =   52  !  !END!
           ! IWAT =   53  !  !END!
           ! IWAT =   54  !  !END!
           ! IWAT =   55  !  !END!

-------------
    a
     Each water category ID is read as a separate input
     subgroup and therefore must end with an input group terminator.

--------------------------------------------------------------------------------
NIMA Datum-Regions  (Documentation Section)
--------------------------------------------------------------------------------
     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
```

Table B-8 (concluded)
Sample MAKEGEO Control File
(MAKEGEO.INP)

```
-------------
Subgroup (4d)
-------------
                                                         a
           CATEGORY SPLIT INFORMATION (NSPLIT Categories)
           ----------------------------------------------

            Split      To       Amount
           Category   Category   of Split
              ID         ID        (%)
           --------   --------   --------

* XSPLIT =    14,        76,       15.8  *  *END*
* XSPLIT =    14,        77,       84.2  *  *END*

-------------
    a
     Each assignment is read as a separate input subgroup and therefore
     must end with an input group terminator.  A total of NSPLIT input
     land use categories must be listed, and the % split from each one
     of these to all receiving land use categories must sum to 100.0%
```

Table B-9
MAKEGEO Control File Inputs

Input Group	**Variable**	**Type**	**Description**
(0)	CTITLE	character*80	Title for GEO.DAT file (first line)
	LUDAT	character*70	Input gridded fractional land use file
	LU2DAT	character*70	Second input gridded land use
	TERRDAT	character*70	Input gridded terrain data file (used only if CTER=y)
	GEODAT	character*70	Output GEO.DAT file
	RUNLST	character*70	Output list file
	LUGRD	character*70	Output land use plot (GRD) file
	TEGRD	character*70	Output terrain plot (GRD) file
	LCFILES	logical	Convert filename to lower case (T) or upper case (F)
(1)	LTERR	logical	Flag to read input gridded terrain file (T=yes, F=no)
	LLU2	Logical	Read in a second fractional land use file
	IXQA.IYQA	integers	I,J, indices of cell to write out for QA check (used only if >0)
(2)	PMAP *	character*8	Map projection for grid: UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA: Lambert Azimuthal Equal Area
	FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA
	FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA
	IUTMZN	integer	UTM zone for PMAP = UTM
	UTMHEM	character*1	Use (N) northern or (S) southern hemisphere for UTM projection
	RLAT0, RLON0	character*16	Reference latitude and longitude (degrees) for PMAP = TTM, LCC, PS, EM, or LAZA. Enter numeric degrees and either N or S for latitude, or E or W for longitude.
	RLAT1, RLAT2	character*16	Two standard parallels of latitude for PMAP= LCC or PS. Enter numeric degrees and either N or S.
	DATUM	character*8	Datum Code for output grid

Table B-9 (concluded)
MAKEGEO Control File Inputs

Input Group	Variable	Type	Description
	XREFKM, YREFKM	real	Reference X and Y coordinates origin (km) of the output grid.
	NX, NY	integer	Number of grid cells in X and Y directions (if IGRID=1 or 2)
	DGRIDKM	real	Horizontal grid spacing (km)
(3a)	NOUTCAT	integer	Number of output categories (14 for default CALMET run)
	IWAT1, IWAT2	integer	Range of output categories assigned to water
(3b)	OUTCAT	integer array	List of output LU categories (14 default CALMET; see sample MAKEGEO.INP) (up to 10 categories per line)
(4a)	NINCAT	integer	Number of input land use categories (if USGS LULC categories: NINCAT=38)
	NUMWAT	integer	Number of water categories (4 for USGS LU categories)
	NSPLIT	integer	Number of input categories that are split among other LU categories
	CFRACT	real	Fraction of the cell area covered by water required to define the dominant land use category as water
	IMISS	integer	Land use category assigned for missing land use data (whenever LU data is missing for a grid cell in the domain, IMISS will be attributed to that cell)
(4b)	X (nincat entries)	Real arrays (8 components)	Arrays containing, the input land use properties (roughness length, albedo, Bowen ratio, soil heat flux parameter, anthropogenic heat flux, leaf area index) and the output category ID
(4c)	IWAT (numwat entries)	integer	Input LU categories defined as water (e.g., 51, 52, 53, 54 for USGS LU categories)
(4d)	XSPLIT	Array (int,int,real)	Category split information: category ID to be split, output category , amount of split (%). A total of NSPLIT land use categories must be listed, and the % split from each one must sum to 100%

* PMAP = EM, PS, and LAZA is NOT AVAILABLE in CALMET

B.4 NIMA Datum Reference Information

Continent	Spheroid	Region	CODE
GLOBAL	WGS-84 WGS-84	Global coverage	WGS-84
GLOBAL	WGS-84 EMG 96	Global coverage	WGS-96
GLOBAL	WGS-84 GRS 80	Global coverage	WGS-G
GLOBAL	WGS-72 WGS-72	Global coverage	WGS-72
GLOBAL	NWS 6370 KM Sphere	Global Sphere	NWS-84
GLOBAL	ESRI REFERENCE 6371 KM Sphere	Global Sphere	ESR-S
AFRICA	ADINDAN Clarke 1880	MEAN FOR Ethiopia, Sudan	ADI-M
AFRICA	ADINDAN Clarke 1880	Burkina Faso	ADI-E
AFRICA	ADINDAN Clarke 1880	Cameroon	ADI-F
AFRICA	ADINDAN Clarke 1880	Ethiopia	ADI-A
AFRICA	ADINDAN Clarke 1880	Mali	ADI-C
AFRICA	ADINDAN Clarke 1880	Senegal	ADI-D
AFRICA	ADINDAN Clarke 1880	Sudan	ADI-B
AFRICA	AFGOOYE Krassovsky 1940	Somalia	AFG
AFRICA	ARC 1950 Clarke 1880	MEAN FOR Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe	ARF-M
AFRICA	ARC 1950 Clarke 1880	Botswana	ARF-A
AFRICA	ARC 1950 Clarke 1880	Burundi	ARF-H
AFRICA	ARC 1950 Clarke 1880	Lesotho	ARF-B
AFRICA	ARC 1950 Clarke 1880	Malawi	ARF-C
AFRICA	ARC 1950 Clarke 1880	Swaziland	ARF-D
AFRICA	ARC 1950 Clarke 1880	Zaire	ARF-E
AFRICA	ARC 1950 Clarke 1880	Zambia	ARF-F
AFRICA	ARC 1950 Clarke 1880	Zimbabwe	ARF-G
AFRICA	ARC 1960 Clarke 1880	MEAN FOR Kenya, Tanzania	ARS-M
AFRICA	ARC 1960 Clarke 1880	Kenya	ARS-A
AFRICA	ARC 1960 Clarke 1880	Tanzania	ARS-B
AFRICA	AYABELLE LIGHTHOUSE Clarke 1880	Djibouti	PHA
AFRICA	BISSAU International 1924	Guinea-Bissau	BID
AFRICA	CAPE Clarke 1880	South Africa	CAP
AFRICA	CARTHAGE Clarke 1880	Tunisia	CGE
AFRICA	DABOLA Clarke 1880	Guinea	DAL
AFRICA	EUROPEAN 1950 International 1924	Egypt	EUR-F
AFRICA	EUROPEAN 1950 International 1924	Tunisia	EUR-T
AFRICA	LEIGON Clarke 1880	Ghana	LEH
AFRICA	LIBERIA 1964 Clarke 1880	Liberia	LIB
AFRICA	MASSAWA Bessel 1841	Eritrea	MAS
AFRICA	MERCHICH Clarke 1880	Morocco	MER
AFRICA	MINNA Clarke 1880	Cameroon	MIN-A
AFRICA	MINNA Clarke 1880	Nigeria	MIN-B
AFRICA	M-PORALOKO Clarke 1880	Gabon	MPO
AFRICA	NORTH SAHARA 1959 Clarke 1880	Algeria	NSD
AFRICA	OLD EGYPTIAN 1907 Helmert 1906	Egypt	OEG
AFRICA	POINT 58 Clarke 1880	Burkina Faso, Niger	PTB
AFRICA	POINTE NOIRE 1948 Clarke 1880	Congo	PTN

Continent	Spheroid	Region	CODE
AFRICA	SCHWARZECK Bessel 1841	Namibia	SCK
AFRICA	SIERRA LEONE 1960 Clarke 1880	Sierra Leone	SRL
AFRICA	TANANARIVE OBSERVATORY 1925 International 1924	Madagascar	TAN
AFRICA	VOIROL 1874 Clarke 1880	Tunisia, Algeria	VOI
AFRICA	VOIROL 1960 Clarke 1880	Algeria	VOR
ASIA	AIN EL ABD 1970 International 1924	Bahrain Island	AIN-A
ASIA	AIN EL ABD 1970 International 1924	Saudi Arabia	AIN-B
ASIA	BUKIT RIMPAH Bessel 1841	Bangka and Belitung Islands (Indonesia)	BUR
ASIA	DJAKARTA (BATAVIA) Bessel 1841	Sumatra (Indonesia)	BAT
ASIA	EUROPEAN 1950 International 1924	Iran	EUR-H
ASIA	EUROPEAN 1950 International 1924	Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, Syria	EUR-S
ASIA	GUNUNG SEGARA Bessel 1841	Kalimantan (Indonesia)	GSE
ASIA	HERAT NORTH International 1924	Afghanistan	HEN
ASIA	HONG KONG 1963 International 1924	Hong Kong	HKD
ASIA	HU-TZU-SHAN International 1924	Taiwan	HTN
ASIA	INDIAN Everest (1830)	Bangladesh	IND-B
ASIA	INDIAN Everest (1956)	India, Nepal	IND-I
ASIA	INDIAN Everest	Pakistan	IND-P
ASIA	INDIAN 1954 Everest (1830)	Thailand	INF-A
ASIA	INDIAN 1960 Everest (1830)	Vietnam (near 16°N)	ING-A
ASIA	INDIAN 1960 Everest (1830)	Con Son Island (Vietnam)	ING-B
ASIA	INDIAN 1975 Everest (1830)	Thailand	INH-A
ASIA	INDIAN 1975 Everest (1830)	Thailand	INH-A1
ASIA	INDONESIAN 1974 Indonesian 1974	Indonesia	IDN
ASIA	KANDAWALA Everest (1830)	Sri Lanka	KAN
ASIA	KERTAU 1948 Everest (1948)	West Malaysia, Singapore	KEA
ASIA	KOREAN GEODETIC SYSTEM 1995 WGS 84	South Korea	KGS
ASIA	NAHRWAN Clarke 1880	Masirah Island (Oman)	NAH-A
ASIA	NAHRWAN Clarke 1880	United Arab Emirates	NAH-B
ASIA	NAHRWAN Clarke 1880	Saudi Arabia	NAH-C
ASIA	OMAN Clarke 1880	Oman	FAH
ASIA	PULKOVO 1942 Krassovsky 1940	Russia	PUK
ASIA	QATAR NATIONAL International 1924	Qatar	QAT
ASIA	SOUTH ASIA Modified Fischer 1960	Singapore	SOA
ASIA	TIMBALAI 1948 Everest	Brunei, East Malaysia (Sarawak and Sabah)	TIL
ASIA	TOKYO Bessel 1841	MEAN FOR Japan, Okinawa, South Korea	TOY-M
ASIA	TOKYO Bessel 1841	Japan	TOY-A
ASIA	TOKYO Bessel 1841	Okinawa	TOY-C
ASIA	TOKYO Bessel 1841	South Korea	TOY-B
ASIA	TOKYO Bessel 1841	South Korea	TOY-B1
AUSTRALIA	AUSTRALIAN GEODETIC 1966 Australian National	Australia, Tasmania	AUA
AUSTRALIA	AUSTRALIAN GEODETIC 1984 Australian National	Australia, Tasmania	AUG

Continent	Spheroid	Region	CODE
EUROPE	COORD SYSTEM 1937 OF ESTONIA Bessel 1841	Estonia	EST
EUROPE	EUROPEAN 1950 International 1924	MEAN FOR Austria, Belgium, Denmark, Finland, France, FederalRepublic of Germany (Prior to 1 January 1993), Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spa	EUR-M
EUROPE	EUROPEAN 1950 International 1924	MEAN FOR Austria, Denmark, France, Federal Republic of Germany (Prior to 1 January 1993), Netherlands, Switzerland	EUR-A
EUROPE	EUROPEAN 1950 International 1924	Cyprus	EUR-E
EUROPE	EUROPEAN 1950 International 1924	England, Channel Islands, Scotland, Shetland Islands	EUR-G
EUROPE	EUROPEAN 1950 International 1924	England, Ireland, Scotland, Shetland Islands	EUR-K
EUROPE	EUROPEAN 1950 International 1924	Greece	EUR-B
EUROPE	EUROPEAN 1950 International 1924	Sardinia (Italy)	EUR-I
EUROPE	EUROPEAN 1950 International 1924	Sicily (Italy)	EUR-J
EUROPE	EUROPEAN 1950 International 1924	Malta	EUR-L
EUROPE	EUROPEAN 1950 International 1924	Norway, Finland	EUR-C
EUROPE	EUROPEAN 1950 International 1924	Portugal, Spain	EUR-D
EUROPE	EUROPEAN 1979 International 1924	MEAN FOR Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland	EUS
EUROPE	HERMANNSKOGEL Bessel 1841	Yugoslavia (Prior to 1990), Slovenia, Croatia, Bosnia and Herzegovina, Serbia	HER
EUROPE	IRELAND 1965 Modified Airy	Ireland	IRL
EUROPE	ORD SURV OF GREAT BRITAIN 36 Airy	MEAN FOR England, Isle of Man, Scotland, Shetland Islands, Wales	OGB-M
EUROPE	ORD SURV OF GREAT BRITAIN 36 Airy	England	OGB-A
EUROPE	ORD SURV OF GREAT BRITAIN 36 Airy	England, Isle of Man, Wales	OGB-B
EUROPE	ORD SURV OF GREAT BRITAIN 36 Airy	Scotland, Shetland Islands	OGB-C
EUROPE	ORD SURV OF GREAT BRITAIN 36 Airy	Wales	OGB-D
EUROPE	ROME 1940 International 1924	Sardinia	MOD
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Hungary	SPK-A
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Poland	SPK-B
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Czechoslovakia (Prior to 1 January 1993)	SPK-C
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Latvia	SPK-D
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Kazakhstan	SPK-E
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Albania	SPK-F
EUROPE	S-42 (PULKOVO 1942) Krassovsky 1940	Romania	SPK-G

Continent	Spheroid	Region	CODE
EUROPE	S-JTSK Bessel 1841	Czechoslovakia (Prior to 1 January 1993)	CCD
NORTH AMERICA	CAPE CANAVERAL Clarke 1866	Florida, Bahamas	CAC
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR (CONUS)	NAS-C
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Arizona, Arkansas, California, Colorado, Idaho, Iowa, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington,	NAS-B
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Alabama, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana,Maine, Maryland, Massachusetts, Michigan, Minnesota, Missis	NAS-A
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Alaska (Excluding Aleutian Islands)	NAS-D
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Aleutian Islands (East of 180°W)	NAS-V
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Aleutian Islands (West of 180°W)	NAS-W
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Bahamas (Excluding San Salvador Island)	NAS-Q
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	San Salvador Island	NAS-R
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Canada (Including Newfoundland)	NAS-E
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Alberta, British Columbia	NAS-F
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Newfoundland, New Brunswick, Nova Scotia, Quebec	NAS-G
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Manitoba, Ontario	NAS-H
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Northwest Territories, Saskatchewan	NAS-I
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Yukon	NAS-J
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Canal Zone	NAS-O
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Antigua Island, Barbados, Barbuda, Caicos Islands,Cuba, Dominican Republic, Grand Cayman, Jamaica, Turks Islands	NAS-P
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	MEAN FOR Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua	NAS-N
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Cuba	NAS-T
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Greenland (Hayes Peninsula)	NAS-U

Continent	Spheroid	Region	CODE
NORTH AMERICA	NORTH AMERICAN 1927 Clarke 1866	Mexico	NAS-L
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	Alaska (Excluding Aleutian Islands)	NAR-A
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	Aleutian Islands	NAR-E
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	Canada	NAR-B
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	CONUS	NAR-C
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	Hawaii	NAR-H
NORTH AMERICA	NORTH AMERICAN 1983 GRS 80	Mexico, Central America	NAR-D
SOUTH AMERICA	BOGOTA OBSERVATORY International 1924	Colombia	BOO
SOUTH AMERICA	CAMPO INCHAUSPE 1969 International 1924	Argentina	CAI
SOUTH AMERICA	CHUA ASTRO International 1924	Paraguay	CHU
SOUTH AMERICA	CORREGO ALEGRE International 1924	Brazil	COA
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	MEAN FOR Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela	PRP-M
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Bolivia	PRP-A
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Northern Chile (near 19°S)	PRP-B
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Southern Chile (near 43°S)	PRP-C
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Colombia	PRP-D
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Ecuador	PRP-E
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Guyana	PRP-F
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Peru	PRP-G
SOUTH AMERICA	PROVISIONAL S. AMERICAN 1956 International 1924	Venezuela	PRP-H
SOUTH AMERICA	PROVISIONAL S. CHILEAN 1963 International 1924	Southern Chile (near 53°S)	HIT
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	MEAN FOR Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Trinidad and Tobago, Venezuela	SAN-M
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Argentina	SAN-A
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Bolivia	SAN-B
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Brazil	SAN-C

Continent	Spheroid	Region	CODE
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Chile	SAN-D
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Colombia	SAN-E
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Ecuador (Excluding Galapagos Islands)	SAN-F
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Baltra, Galapagos Islands	SAN-J
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Guyana	SAN-G
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Paraguay	SAN-H
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Peru	SAN-I
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Trinidad and Tobago	SAN-K
SOUTH AMERICA	SOUTH AMERICAN 1969 South American 1969	Venezuela	SAN-L
SOUTH AMERICA	SIRGAS GRS 80	South America	SIR
SOUTH AMERICA	YACARE International 1924	Uruguay	YAC
SOUTH AMERICA	ZANDERIJ International 1924	Suriname	ZAN
ATLANTIC OCEAN	ANTIGUA ISLAND ASTRO 1943 Clarke 1880	Antigua, Leeward Islands	AIA
ATLANTIC OCEAN	ASCENSION ISLAND 1958 International 1924	Ascension Island	ASC
ATLANTIC OCEAN	ASTRO DOS 71/4 International 1924	St. Helena Island	SHB
ATLANTIC OCEAN	BERMUDA 1957 Clarke 1866	Bermuda Islands	BER
ATLANTIC OCEAN	CAPE CANAVERAL Clarke 1866	Bahamas, Florida	CAC
ATLANTIC OCEAN	DECEPTION ISLAND Clarke 1880	Deception Island (Antarctica)	DID
ATLANTIC OCEAN	FORT THOMAS 1955 Clarke 1880	Nevis, St. Kitts, Leeward Islands	FOT
ATLANTIC OCEAN	GRACIOSA BASE SW 1948 International 1924	Faial, Graciosa, Pico, Sao Jorge, Terceira Islands (Azores)	GRA
ATLANTIC OCEAN	HJORSEY 1955 International 1924	Iceland	HJO
ATLANTIC OCEAN	ISTS 061 ASTRO 1968 International 1924	South Georgia Island	ISG
ATLANTIC OCEAN	L. C. 5 ASTRO 1961 Clarke 1866	Cayman Brac Island	LCF
ATLANTIC OCEAN	MONTSERRAT ISLAND ASTRO 1958 Clarke 1880	Montserrat, Leeward Islands	ASM
ATLANTIC OCEAN	NAPARIMA, BWI International 1924	Trinidad and Tobago	NAP
ATLANTIC OCEAN	OBSERVAT. METEOROLOGICO 1939 International 1924	Corvo and Flores Islands (Azores)	FLO

Continent	Spheroid	Region	CODE
ATLANTIC OCEAN	PICO DE LAS NIEVES International 1924	Canary Islands	PLN
ATLANTIC OCEAN	PORTO SANTO 1936 International 1924	Porto Santo, Madeira Islands	POS
ATLANTIC OCEAN	PUERTO RICO Clarke 1866	Puerto Rico, Virgin Islands	PUR
ATLANTIC OCEAN	QORNOQ International 1924	South Greenland	QUO
ATLANTIC OCEAN	SAO BRAZ International 1924	Sao Miguel, Santa Maria Islands (Azores)	SAO
ATLANTIC OCEAN	SAPPER HILL 1943 International 1924	East Falkland Island	SAP
ATLANTIC OCEAN	SELVAGEM GRANDE 1938 International 1924	Salvage Islands	SGM
ATLANTIC OCEAN	TRISTAN ASTRO 1968 International 1924	Tristan da Cunha	TDC
INDIAN OCEAN	ANNA 1 ASTRO 1965 Australian National	Cocos Islands	ANO
INDIAN OCEAN	GAN 1970 International 1924	Republic of Maldives	GAA
INDIAN OCEAN	ISTS 073 ASTRO 1969 International 1924	Diego Garcia	IST
INDIAN OCEAN	KERGUELEN ISLAND 1949 International 1924	Kerguelen Island	KEG
INDIAN OCEAN	MAHE 1971 Clarke 1880	Mahe Island	MIK
INDIAN OCEAN	REUNION International 1924	Mascarene Islands	REU
PACIFIC OCEAN	AMERICAN SAMOA 1962 Clarke 1866	American Samoa Islands	AMA
PACIFIC OCEAN	ASTRO BEACON E 1945 International 1924	Iwo Jima	ATF
PACIFIC OCEAN	ASTRO TERN ISLAND (FRIG) 61 International 1924	Tern Island	TRN
PACIFIC OCEAN	ASTRONOMICAL STATION 1952 International 1924	Marcus Island	ASQ
PACIFIC OCEAN	BELLEVUE (IGN) International 1924	Efate and Erromango Islands	IBE
PACIFIC OCEAN	CAMP AREA ASTRO International 1924	Camp McMurdo Area (Antarctica)	CAZ
PACIFIC OCEAN	CANTON ASTRO 1966 International 1924	Phoenix Islands	CAO
PACIFIC OCEAN	CHATHAM ISLAND ASTRO 1971 International 1924	Chatham Island (New Zealand)	CHI
PACIFIC OCEAN	DOS 1968 International 1924	Gizo Island (New Georgia Islands)	GIZ
PACIFIC OCEAN	EASTER ISLAND 1967 International 1924	Easter Island	EAS
PACIFIC OCEAN	GEODETIC DATUM 1949 International 1924	New Zealand	GEO
PACIFIC OCEAN	GUAM 1963 Clarke 1866	Guam	GUA

Continent	Spheroid	Region	CODE
PACIFIC OCEAN	GUX l ASTRO International 1924	Guadalcanal Island	DOB
PACIFIC OCEAN	INDONESIAN 1974 Indonesian 1974	Indonesia	IDN
PACIFIC OCEAN	JOHNSTON ISLAND 1961 International 1924	Johnston Island	JOH
PACIFIC OCEAN	KUSAIE ASTRO 1951 International 1924	Caroline Islands, Federal States of Micronesia	KUS
PACIFIC OCEAN	LUZON Clarke 1866	Philippines (Excluding Mindanao Island)	LUZ-A
PACIFIC OCEAN	LUZON Clarke 1866	Mindanao Island	LUZ-B
PACIFIC OCEAN	MIDWAY ASTRO 1961 International 1924	Midway Islands	MID
PACIFIC OCEAN	OLD HAWAIIAN Clarke 1866	MEAN FOR Hawaiian Islands	OHA-M
PACIFIC OCEAN	OLD HAWAIIAN Clarke 1866	Hawaii	OHA-A
PACIFIC OCEAN	OLD HAWAIIAN Clarke 1866	Kauai	OHA-B
PACIFIC OCEAN	OLD HAWAIIAN Clarke 1866	Maui	OHA-C
PACIFIC OCEAN	OLD HAWAIIAN Clarke 1866	Oahu	OHA-D
PACIFIC OCEAN	PITCAIRN ASTRO 1967 International 1924	Pitcairn Island	PIT
PACIFIC OCEAN	SANTO (DOS) 1965 International 1924	Espirito Santo Island	SAE
PACIFIC OCEAN	VITI LEVU 1916 Clarke 1880	Viti Levu Island (Fiji Islands)	MVS
PACIFIC OCEAN	WAKE-ENIWETOK 1960 Hough	Marshall Islands	ENW
PACIFIC OCEAN	WAKE ISLAND ASTRO 1952 International 1924	Wake Atoll	WAK

C. METEOROLOGICAL DATA PROCESSORS

C.1 READ62 Upper Air Preprocessor

READ62 is a preprocessing program that extract and process upper air wind and temperature data from standard NCDC data formats into a form required by the CALMET meteorological model. READ62 processes data in TD-6201 format or the NCDC FSL rawinsonde data format. Note that the user must specifically request the TD-6201 format when ordering upper air data from NCDC, if this format is desired.

User options are specified in a control file. In the control file, the user selects the starting and ending dates of the data to be extracted, the top pressure level, the type of input data, and the format of the output file. Also selected are processing options determining how missing data are treated. The programs will either flag or eliminate sounding levels with missing data.

If the user selects the option to flag (rather than eliminate) levels with missing data, the data field of the missing variables are flagged with a series of nines. If the option to eliminate levels with missing data is chosen, only sounding levels with all values valid will be included in the output data file. It is generally recommended that the levels with missing data be retained in order to avoid eliminating levels that might have some valid data.

Although CALMET allows missing values of wind speed, wind direction, and temperature at intermediate levels (i.e., levels other than the surface and model top), the user is cautioned against using soundings with significant gaps due to missing data. For example, adequate vertical resolution of the morning temperature structure near the surface is especially important to the model for predicting daytime mixing heights. It should be kept in mind that the model will fill in missing data by assuming that a straight-line interpolation between valid levels is appropriate. If this assumption is questionable, the sounding should not be used with the model.

Two input files are required by the preprocessor: a user input control file and the NCDC upper air data file. Two output files are produced. A list file summarizes the options selected, provides a summary of the soundings processed, and contains informational messages indicating problems in the data set. The second output file contains the processed upper air data in a CALMET-ready format. Table C-1 contains a listing of the input and output files for READ62.

The format of the READ62 control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). READ62.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO). A description of each input variable is shown in Table C-2. A sample input file is shown in Table C-3. The output list file is shown in Table C-4.

The output data file (UP.DAT) produced by READ62 is a formatted file containing the pressure, elevation, temperature, wind speed, and wind direction at each sounding level. The first level of each sounding is assumed to represent surface-level observations. If the surface level is missing from the sounding, it must be filled in before running CALMET.

READ62 allows the user to select either a slash (/) delimiter format (the original format), or a comma delimiter format for the UP.DAT file. The comma-delimited form of the UP.DAT file facilitates the use by CALMET of non-NCDC data sources, such as SODAR data. In CALMET, a slash-delimited file is read using Fortran format statements, while the comma-delimited file is read using Fortran free read statements. READ62 can be by-passed, and a comma-delimited UP.DAT file can be easily prepared from non-NCDC data by following the format discussed in Section E.3. Sample UP.DAT files in both formats are shown in Table C-5.

Table C-1
READ62 Input and Output Files

Unit	File Name	Type	Format	Description
IO5	READ62.INP	input	formatted	Control file containing user inputs
IO6	READ62.LST	output	formatted	List file (line printer output file)
IO8	TD6201.DAT or	input	formatted	Upper air data in NCDC TD-6201 format
	NCDC_U.DAT	input	formatted	Upper air data in NCDC FSL format
IO9	UP.DAT	output	formatted	Output file containing processed upper air data in format required by CALMET
IO18	SUBSOUND.DAT	Input	formatted	Input sounding (substitutions)

Table C-2
READ62 Control File Inputs

Input Group	Variable	Type	Description
(0)	INDAT	character*70	Input sounding data file name
	SUBDAT	character*70	Name of the substitute input data file (optional)
	UPDAT	character*70	Name of the output upper air file (UP.DAT)
	RUNLST	character*70	Name of the output list file
	LCFILES	logical	Convert to lower case (T) or upper case (F)
(1)	IBYR	integer	Starting year of data to print (four digit)
	IBMO	integer	Starting month
	IBDAY	integer	Starting day
	IBHR	integer	Starting hour (00-23 UTC)
	IEYR	integer	Ending year of data to print (four digit)
	IEMO	integer	Ending month
	IEDAY	integer	Ending day
	IEHR	integer	Ending hour (00-23 UTC)
	JDAT	integer	Type of sounding data file - 1: TD-6204 format -2: NCDC FSL format
	ISUB	integer	Type of substitute up.dat input sounding data file – 0: no substitute sounding file is use; 1: slash delimited format (wind speed and direction are integers)- 2: comma delimited (all data are real)
	IFMT	Integer	Format used in UP.DAT output data record; 1: slash delimited format (wind speed and direction are integers)- 2: comma delimited (all data are real)
	PSTOP	Real	Top pressure level (mb) for which data are extracted (e.g., 850, 700, 500). The output file will contain data from the surface to the PSTOP pressure level.

Table C-2 (continued)
READ62 Control File Inputs

Input group	Variable	Type	Description
(1)	LHT	Logical	Height field control variable. If LHT = T, a sounding level is eliminated if the height field is missing. IF LHT = F, the sounding level is included in the output file but the height field is flagged with a "9999", if missing.
	LTEMP	Logical	Temperature field control variable. If LTEMP = T, a sounding level is eliminated if the temperature field is missing. If LTEMP = F, the sounding level is included in the output file but the temperature field is flagged with a "999.9", if missing.
	LWD	logical	Wind direction field control variable. If LWD = T, a sounding level is eliminated if the wind direction field is missing. If LWD = F, the sounding level is included in the output file but the wind direction field is flagged with a "999", if missing.
	LWS	logical	Wind speed field control variable. If LWS = T, a sounding level is eliminated if the wind speed is missing. If LWS = F, the sounding level is included in the output file but the wind speed field is flagged with a "999", if missing.
	LXTOP	Logical	Extrapolate missing data to from PVTOP to PSTOP (constant wind and temperature). T: Yes- F: No
	PVTOP	real	Minimum pressure above which sounding is extrapolated (if missing)
	LXSFC	logical	Extrapolate missing data down to surface (lowest wind speed extrapolate down with neutral power law. - Temperature is not extrapolated). T: Yes- F: No
	ZVSFC	real	Maximum elevation (m) of the first valid data for extrapolation to the surface

Table C-3

Sample READ62 Control File (READ62.INP)

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

                 READ62 PROCESSOR CONTROL FILE
                 -----------------------------

  CALMET accepts upper air data (wind and temperature soundings) from
  UP.DAT files, where each UP.DAT file contains data for one station.
  READ62 processes soundings from standard NCDC data formats, reports
  problems with data entries, and produces an output file in the UP.DAT
  format.  NCDC formats supported include TD-6201 and FSL.

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

INPUT GROUP: 0 -- Input and Output Files
--------------


     Input and Output files:
     -----------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     SOUNDING.DAT  input    ! INDAT   =90010100.alb !
     SUBSOUND.DAT  input    ! SUBDAT  =90010100.sub !
     UP.DAT        output   ! UPDAT   =upalb.dat    !
     READ62.LST    output   ! RUNLST  =upalb.lst    !

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

     NOTE: file/path names can be up to 70 characters in length

!END!

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

INPUT GROUP: 1 -- Run control parameters
--------------

 --- Processing Period ---

     Starting date:   Year (IBYR) -- No default       ! IBYR = 1990  !
                     Month (IBMO) -- No default       ! IBMO =  1  !
                       Day (IBDY) -- No default       ! IBDY =  8  !
          [00-23 UTC] Hour (IBHR) -- No default       ! IBHR =  1  !

     Ending date:     Year (IEYR) -- No default       ! IEYR = 1990  !
                     Month (IEMO) -- No default       ! IEMO =  1  !
                       Day (IEDY) -- No default       ! IEDY = 15  !
          [00-23 UTC] Hour (IEHR) -- No default       ! IEHR =  0  !
```

Table C-3 (continued)

Sample READ62 Control File (READ62.INP)

```
    ---------------
    NOTE:  The hour is defined by the time at the end of the hour
           in Universal Time (UTC), also known as Greenwich Mean
           Time (GMT).


--- File Options ---

    Type of NCDC input sounding data file
    (JDAT)                    No Default      ! JDAT = 1 !
       1 = TD-6201 format
       2 = NCDC FSL format

    Type of SUBSTITUTE UP.DAT input sounding data file
    (ISUB)                    Default: 0      ! ISUB = 0 !
       0 = NO substitute sounding file is used
       1 = Delimiter between data in a sounding level is a slash (/)
           and wind speed and direction are written as integers
       2 = Delimiter between data in a sounding level is a comma (,)
           and all data are written as reals (more significant digits)

    Format used in UP.DAT output data records
    (IFMT)                    Default: 2      ! IFMT = 2 !
       1 = Delimiter between data in a sounding level is a slash (/)
           and wind speed and direction are written as integers
       2 = Delimiter between data in a sounding level is a comma (,)
           and all data are written as reals (more significant digits)

--- Processing Options ---

    Top pressure (mb) level for which data are extracted (e.g., 850 mb,
    700 mb, 500 mb, etc.).  Pressure level must correspond to a height
    that equals or exceeds the top of the CALMET modeling domain, or
    else CALMET will stop with an error message.
    (PSTOP)                   Default: 700.   ! PSTOP = 700. !

    Missing data control options to determine when a sounding level
    is rejected, and when an incomplete sounding level is written to
    the UP.DAT file with missing value indicators.  The missing value
    indicators are:
            Height         = 9999.
            Temperature    = 999.9
            Wind Direction = 999
            Wind Speed     = 999   (999.9)
    Eliminate level if at least one of the following is missing?
    (LHT)   Height            Default: F      ! LHT   = F !
    (LTEMP) Temperature       Default: F      ! LTEMP = F !
    (LWD)   Wind Direction    Default: F      ! LWD   = F !
    (LWS)   Wind Speed        Default: F      ! LWS   = F !

    Sounding repair options to automatically fix-up certain deficiencies
    identified in the sounding data.  Any deficiencies not addressed will
    be identified in the UP.DAT output file and must be addressed by the
```

Table C-3 (continued)

Sample READ62 Control File (READ62.INP)

```
     user before that file can be used in CALMET.  Note that the repair
     options selected will be applied before any sounding replacement is
     done (soundings are replaced using the SUBSOUND.DAT file only if the
     ISUB variable is not zero).

     (1) Extrapolation to extend missing profile data to PSTOP pressure level?
         - Wind speed and direction are constant with height
         - Temperature gradient is constant with height
         - Valid data must exist at heights as great as PVTOP (mb) pressure level
         (LXTOP)                Default: F      ! LXTOP   = F !
         (PVTOP)                Default: 850.   ! PVTOP   = 850. !

     (2) Extrapolation to extend missing profile data to surface?
         - Wind  direction is constant with height
         - Wind  speed is set with first valid speed, extrapolated to 10m
           using the neutral power law
         - Valid data must exist within first ZVSFC (m) of the surface
         - Temperature is NOT extrapolated
         (LXSFC)                Default: F      ! LXSFC   = F !
         (ZVSFC)                Default: 200.   ! ZVSFC   = 200. !

!END!
```

Table C-4

Sample READ62 Output List file

```
                    READ62 OUTPUT SUMMARY
             VERSION:  5.53         LEVEL:  040109



STARTING DATE:                ENDING DATE:

              YEAR = 1990                  YEAR = 1990
        JULIAN DAY =    1            JULIAN DAY =   15
              HOUR =    0 (GMT)            HOUR =   12 (GMT)


PRESSURE LEVELS EXTRACTED:

                    SURFACE TO   500. MB


INPUT FILE FORMAT (1=TD6201,2=NCDC CD-ROM):   2
OUTPUT FILE FORMAT (1=/ DELIMITED,2=COMMA DELIMITED):   1


ALT. SOUNDING FILE FOR SUBSTITUTIONS IS NOT USED


DATA LEVEL ELIMINATED IF HEIGHT MISSING ?         F

DATA LEVEL ELIMINATED IF TEMPERATURE MISSING ?    F

DATA LEVEL ELIMINATED IF WIND DIRECTION MISSING ? F

DATA LEVEL ELIMINATED IF WIND SPEED MISSING ?     F


MISSING PROFILE DATA EXTRAPOLATED TO TOP ?         F

Last valid data must be above pressure (mb):      850.0

MISSING PROFILE DATA EXTRAPOLATED TO SURFACE ?     F

First valid data must be below height (m AGL):      200.0


FILENAMES:
    Control file:          r62chh.inp
    Input upper air file:  90010100.chh
    Output upper air file: upchh.dat
    Output list file:      r62chh.lst

-------------------------------------------------
NOTICE: Starting year in control file sets the
        expected century for the simulation.  All
        YY years are converted to YYYY years in
        the range:  1940 2039
-------------------------------------------------


FSL Station ID used:         14684
            WBAN ID:       14684
             WMO ID:       74494


Temperature values used in range checks:
    TMIN = 175.0
```

Table C-4 (continued)

Sample READ62 Output List file

```
    TMAX = 322.0

Pressure values used in range checks:
    PMIN =    0.0
    PMAX = 1040.0


THE FOLLOWING SOUNDINGS HAVE BEEN PROCESSED:
```

YEAR	MONTH	DAY	JULIAN DAY	HOUR (GMT)	NO. LEVELS EXTRACTED
1990	1	1	1	0	28
1990	1	1	1	12	19
1990	1	2	2	0	30
1990	1	2	2	12	32
1990	1	3	3	0	24
1990	1	3	3	12	34
1990	1	4	4	0	25
1990	1	4	4	12	34
1990	1	5	5	0	22
1990	1	5	5	12	29
1990	1	6	6	0	17
1990	1	6	6	12	34
1990	1	7	7	0	19
1990	1	7	7	12	33
1990	1	8	8	0	23
1990	1	8	8	12	37
1990	1	9	9	0	38
1990	1	9	9	12	39
1990	1	10	10	0	26
1990	1	10	10	12	21
1990	1	11	11	0	29
1990	1	11	11	12	30
1990	1	12	12	0	38
1990	1	12	12	12	19
1990	1	13	13	0	27
1990	1	13	13	12	33
1990	1	14	14	0	18
1990	1	14	14	12	29
1990	1	15	15	0	23
1990	1	15	15	12	34

```
 End of run -- Clock time: 10:51:11
                      Date: 09-08-2004

      Elapsed Clock Time:        0.0 (seconds)

                CPU Time:        0.0 (seconds)
```

Table C-5

Sample UP.DAT files

(a) UP.DAT - Slash-delimited format

```
UP.DAT          2.0             Header structure with coordinate parameters
   1
Produced by READ62 Version: 5.53  Level: 040109
NONE
  1990    1    0 1990   15   12 500.    2    1
     F    F    F    F
   6201     14684   1990 1 1 0     54                             28
   1007.0/  16./279.3/160/ 10   1000.0/  77./281.0/174/ 13    983.0/ 221./284.6/186/ 19    973.0/ 304./999.9/190/ 21
    959.0/ 427./285.2/199/ 23    950.0/ 507./284.9/203/ 24    938.0/ 609./999.9/210/ 26    905.0/ 914./999.9/220/ 29
    900.0/ 959./283.1/222/ 30    872.0/1219./999.9/225/ 31    850.0/1433./281.2/222/ 31    822.0/1710./278.5/223/ 30
    810.0/1827./999.9/225/ 30    800.0/1931./277.6/226/ 29    780.0/2132./999.9/225/ 29    752.0/2437./999.9/225/ 28
    750.0/2456./275.3/226/ 28    724.0/2742./999.9/230/ 27    708.0/2920./273.2/230/ 26    700.0/3011./272.9/231/ 26
    697.0/3047./999.9/230/ 26    650.0/3601./269.6/236/ 27    645.0/3657./999.9/235/ 27    600.0/4230./266.1/240/ 31
    597.0/4267./999.9/240/ 32    552.0/4875./999.9/240/ 36    550.0/4905./262.2/241/ 36    500.0/5630./257.9/240/ 38
   6201     14684   1990 1 112     38                             19
    994.0/  16./276.5/240/  7    979.0/ 140./279.7/250/ 11    968.0/ 233./280.3/254/ 14    950.0/ 388./280.0/254/ 18
    933.0/ 536./279.6/250/ 19    900.0/ 832./280.4/243/ 22    898.0/ 852./280.5/242/ 22    850.0/1303./277.8/244/ 24
    800.0/1795./275.8/251/ 29    750.0/2316./273.5/256/ 35    742.0/2402./273.1/256/ 36    728.0/2554./272.3/254/ 38
    707.0/2787./273.0/249/ 39    700.0/2868./272.5/248/ 39    650.0/3457./268.6/241/ 35    603.0/4042./264.5/230/ 30
    600.0/4081./264.4/230/ 30    550.0/4754./262.3/222/ 38    500.0/5482./259.9/219/ 53

          (... records removed for clarity)

   6201     14684   1990 11512     66                             34
   1029.0/  16./273.1/150/  4   1025.0/  46./273.1/154/  4   1000.0/ 243./271.4/170/  6    992.0/ 304./999.9/175/  7
    956.0/ 601./269.3/200/  8    955.0/ 609./999.9/200/  8    950.0/ 651./269.0/202/  8    919.0/ 914./999.9/225/  8
    900.0/1075./266.1/243/  9    890.0/1162./267.5/251/ 10    884.0/1219./999.9/255/ 10    883.0/1224./268.4/254/ 10
    850.0/1523./267.4/254/ 13    824.0/1766./267.0/246/ 14    818.0/1827./999.9/245/ 14    804.0/1959./268.3/239/ 14
    800.0/1997./268.0/238/ 15    786.0/2132./999.9/235/ 15    776.0/2236./265.8/232/ 16    756.0/2437./999.9/230/ 18
    750.0/2502./264.0/230/ 18    727.0/2742./999.9/230/ 18    700.0/3031./260.2/233/ 18    691.0/3130./261.1/236/ 19
    685.0/3197./263.6/237/ 19    674.0/3323./263.9/240/ 20    650.0/3603./262.0/247/ 20    645.0/3657./999.9/250/ 20
    600.0/4213./257.8/256/ 19    596.0/4267./999.9/255/ 19    550.0/4864./253.2/255/ 20    549.0/4875./999.9/255/ 21
    527.0/5180./999.9/255/ 22    500.0/5564./248.1/258/ 23
```

(b) UP.DAT - Comma-delimited format

```
UP.DAT          2.0             Header structure with coordinate parameters
   1
Produced by READ62 Version: 5.53  Level: 040109
NONE
  1990    1    0 1990   15   12 500.    2    2
     F    F    F    F
   6201     14684   1990 1 1 0     54                             28
   1007.0,  16.,279.3,160, 10.0,   1000.0,  77.,281.0,174, 13.0,    983.0, 221.,284.6,186, 19.0,    973.0, 304.,999.9,190, 21.1,
    959.0, 427.,285.2,199, 23.0,    950.0, 507.,284.9,203, 24.0,    938.0, 609.,999.9,210, 26.2,    905.0, 914.,999.9,220, 29.8,
    900.0, 959.,283.1,222, 30.0,    872.0,1219.,999.9,225, 31.3,    850.0,1433.,281.2,222, 31.0,    822.0,1710.,278.5,223, 30.0,
    810.0,1827.,999.9,225, 30.3,    800.0,1931.,277.6,226, 29.0,    780.0,2132.,999.9,225, 29.8,    752.0,2437.,999.9,225, 28.8,
    750.0,2456.,275.3,226, 28.0,    724.0,2742.,999.9,230, 27.2,    708.0,2920.,273.2,230, 26.0,    700.0,3011.,272.9,231, 26.0,
    697.0,3047.,999.9,230, 26.7,    650.0,3601.,269.6,236, 27.0,    645.0,3657.,999.9,235, 27.7,    600.0,4230.,266.1,240, 31.0,
    597.0,4267.,999.9,240, 32.4,    552.0,4875.,999.9,240, 36.0,    550.0,4905.,262.2,241, 36.0,    500.0,5630.,257.9,240, 38.0
   6201     14684   1990 1 112     38                             19
    994.0,  16.,276.5,240,  7.0,    979.0, 140.,279.7,250, 11.0,    968.0, 233.,280.3,254, 14.0,    950.0, 388.,280.0,254, 18.0,
    933.0, 536.,279.6,250, 19.0,    900.0, 832.,280.4,243, 22.0,    898.0, 852.,280.5,242, 22.0,    850.0,1303.,277.8,244, 24.0,
    800.0,1795.,275.8,251, 29.0,    750.0,2316.,273.5,256, 35.0,    742.0,2402.,273.1,256, 36.0,    728.0,2554.,272.3,254, 38.0,
    707.0,2787.,273.0,249, 39.0,    700.0,2868.,272.5,248, 39.0,    650.0,3457.,268.6,241, 35.0,    603.0,4042.,264.5,230, 30.0,
    600.0,4081.,264.4,230, 30.0,    550.0,4754.,262.3,222, 38.0,    500.0,5482.,259.9,219, 53.0

          (... records removed for clarity)

   6201     14684   1990 11512     66                             34
   1029.0,  16.,273.1,150,  4.0,   1025.0,  46.,273.1,154,  4.0,   1000.0, 243.,271.4,170,  6.0,    992.0, 304.,999.9,175,  7.2,
    956.0, 601.,269.3,200,  8.0,    955.0, 609.,999.9,200,  8.2,    950.0, 651.,269.0,202,  8.0,    919.0, 914.,999.9,225,  8.7,
    900.0,1075.,266.1,243,  9.0,    890.0,1162.,267.5,251, 10.0,    884.0,1219.,999.9,255, 10.2,    883.0,1224.,268.4,254, 10.0,
    850.0,1523.,267.4,254, 13.0,    824.0,1766.,267.0,246, 14.0,    818.0,1827.,999.9,245, 14.4,    804.0,1959.,268.3,239, 14.0,
    800.0,1997.,268.0,238, 15.0,    786.0,2132.,999.9,235, 15.9,    776.0,2236.,265.8,232, 16.0,    756.0,2437.,999.9,230, 18.0,
    750.0,2502.,264.0,230, 18.0,    727.0,2742.,999.9,230, 18.0,    700.0,3031.,260.2,233, 18.0,    691.0,3130.,261.1,236, 19.0,
    685.0,3197.,263.6,237, 19.0,    674.0,3323.,263.9,240, 20.0,    650.0,3603.,262.0,247, 20.0,    645.0,3657.,999.9,250, 20.5,
    600.0,4213.,257.8,256, 19.0,    596.0,4267.,999.9,255, 19.0,    550.0,4864.,253.2,255, 20.0,    549.0,4875.,999.9,255, 21.1,
    527.0,5180.,999.9,255, 22.6,    500.0,5564.,248.1,258, 23.0
```

C.2 PXTRACT Precipitation Data Extraction Program

PXTRACT is a preprocessor program which extracts precipitation data for stations and time periods of interest from a formatted precipitation data file in NCDC TD-3240 format. The TD-3240 data used by PXTRACT can be in either the fixed record length format or the variable record length format. The fixed record length format reports each hourly precipitation event in a separate record, whereas the variable record length format reports all hourly precipitation events that occur on a single day in a single record, and also includes the daily total. The hourly precipitation data usually come in large blocks of data sorted by station. For example, a typical TD-3240 file for California may contain data from over 100 stations statewide in blocks of time of 30 years or more. Modeling applications require the data sorted by time rather than station, and involve specific spatial domains and time periods from less than one year up to five years. PXTRACT allows data for a particular model run to be extracted from the larger data file and creates a set of station files that are used as input files by the second-stage precipitation preprocessor, PMERGE (see Section C.3).

NOTE: If wet removal is not to be considered by the CALPUFF or MESOPUFF II dispersion models, no precipitation processing needs to be done. PXTRACT (and PMERGE) are required only if wet removal is an important removal mechanism for the modeling application of interest. In addition, if wet removal is a factor, the user has the option of creating a free-formatted precipitation data file that can be read by CALMET. This option eliminates the need to run the precipitation preprocessing programs for short CALMET runs (e.g., screening runs) for which the data can easily be input manually.

The input files used by PXTRACT include a control file (PXTRACT.INP) containing user inputs, and a data file (TD3240.DAT) containing the NCDC data in TD-3240 format. The precipitation data for stations selected by the user are extracted from the TD3240.DAT file and stored in separate output files (one file per station) called xxxxxx.DAT, where xxxxxx is the station identification code. PXTRACT also creates an output list file (PXTRACT.LST) which contains the user options and summarizes the station data extracted. Table C-6 contains a summary of PXTRACT's input and output files.

The PXTRACT control file contains the user-specified variables which determine the method used to extract precipitation data from the input data file (i.e., by state, by station, or all stations), the appropriate state or station codes, and the time period to be extracted. A sample PXTRACT control file is shown in Table C-7. The format and contents of the file are described in Table C-8.

The PXTRACT output list file (PXTRACT.LST) contains a listing of the control file inputs and options. It also summarizes the station data extracted from the input TD-3240 data file, including the starting and ending date of the data for each station and the number of data records found. Since the TD-3240 data are not hourly, PXTRACT will extract the records that cover the period requested by the user. Therefore, the dates of the data extracted from different stations may be different although the same time period was requested by the user. If the starting (or ending) record has a data flag, the previous (or next) record will also be extracted to complete the information necessary for PMERGE to interpret the data correctly. A sample output list file is shown in Table C-9. The PXTRACT output data files consist of precipitation data in TD-3240 format for the time period selected by the user. Each output data file contains the data for one station. A sample output file is shown in Table C-10.

Table C-6

PXTRACT Input and Output Files

Unit	File Name	Type	Format	Description
IO5	PXTRACT.INP	input	formatted	Control file containing user inputs
IO2	TD3240.DAT	input	formatted	Precipitation data in NCDC TD-3240 format
IO6	PXTRACT.LST	output	formatted	List file (line printer output file)
Unit 7	id1.DAT (id1 is the 6-digit station code for station #1, e.g., 040001)	output	formatted	Precipitation data (in TD-3240) format for station #1 for the time period selected by the user
Unit 7 Plus 1	id2.DAT (id2 is the 6-digit station code for station #2, e.g., 040002)	output	formatted	Precipitation data (in TD-3240) format for station #2 for the time period selected by the user

.
.
.
(Up to 200 new precipitation data files are allowed by PXTRACT).

Table C-7

Sample PXTRACT Control File (PXTRACT.INP)

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

                 PXTRACT PROCESSOR CONTROL FILE
                 ------------------------------

  CALMET accepts data for a number of precipitation stations in a
  single PRECIP.DAT file.  These data are obtained in the NCDC TD-3240
  format, with either fixed (hourly event records) or variable record
  length (daily records of hourly precipitation events).  This NCDC format
  typically places data for many stations and long periods in a single
  file.  PXTRACT extracts a subset of stations, for a specific period,
  into files for subsequent processing by PMERGE.  Each output file
  contains the data for a single station.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

     Input and Output files:
     -----------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     TD3240.DAT    input    ! PRECDAT =file0001.dat !
     PXTRACT.LST   output   ! RUNLST  =pxtract1.lst  !

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

     NOTES: 1)  File/path names can be up to 70 characters in length;
            2)  Output files are named automatically using the state/station
                ID (e.g., 412797.DAT for station 412707)

!END!

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

INPUT GROUP: 1 -- Run control parameters
--------------

 --- Processing Period ---

     Starting date:   Year (IBYR) -- No default       ! IBYR = 1990  !
                     Month (IBMO) -- No default       ! IBMO =  1  !
                       Day (IBDY) -- No default       ! IBDY =  8  !

     Ending date:     Year (IEYR) -- No default       ! IEYR = 1990  !
                     Month (IEMO) -- No default       ! IEMO =  1  !
                       Day (IEDY) -- No default       ! IEDY = 15  !

-------------
     Specify a processing period that includes a couple of days
     before and after your modeling period.


 --- Station Extraction Method ---

     Method for selecting stations to extract
     (ICODE)                    No Default      ! ICODE = 1 !
        1 = Extract all stations within specified states
            (2-digit state codes are entered in Input Group 2)
        2 = Extract specified stations
```

Table C-7 (continued)

Sample PXTRACT Control File (PXTRACT.INP)

```
           (6-digit station codes are entered in Input Group 3)
        3 = Extract all stations in the TD3240 file

     Number of states OR stations to extract
     (Used only if ICODE= 1 OR 2)
     (NSTA)                    Default: 0      ! NSTA = 2 !


!END!

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

INPUT GROUP: 2 -- State codes (used only if ICODE=1)
--------------

     Data for all precipitation stations in one or more states can be
     extracted.  Specify the 2-digit code for each state selected by
     entering NSTA lines.
     (IDSTATE)                  No Default

    ! IDSTATE = 34 !  !END!
    ! IDSTATE = 41 !  !END!

-------------
     Each line is treated as a separate input subgroup and therefore
     must end with an input group terminator.

State/Territory Code Table:
---------------------------
  01 Alabama       16 Louisiana      31 North Carolina   46 West Virginia
  02 Arizona       17 Maine          32 North Dakota     47 Wisconsin
  03 Arkansas      18 Maryland       33 Ohio             48 Wyoming
  04 California    19 Massachusetts  34 Oklahoma         49 (not used)
  05 Colorado      20 Michigan       35 Oregon           50 Alaska
  06 Connecticut   21 Minnesota      36 Pennsylvania     51 Hawaii
  07 Delaware      22 Mississippi    37 Rhode Island
  08 Florida       23 Missouri       38 South Carolina   66 Puerto Rico
  09 Georgia       24 Montana        39 South Dakota     67 Virgin Islands
  10 Idaho         25 Nebraska       40 Tennessee
  11 Illinois      26 Nevada         41 Texas            91 Pacific Islands
  12 Indiana       27 New Hampshire  42 Utah
  13 Iowa          28 New Jersey     43 Vermont
  14 Kansas        29 New Mexico     44 Virginia
  15 Kentucky      30 New York       45 Washington

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

INPUT GROUP: 3 -- Station codes (used only if ICODE=2)
--------------

     Data for specific precipitation stations can be extracted.
     Specify the 6-digit code for each station selected by
     entering NSTA lines.
     (IDSTN)                    No Default

    * IDSTN = 341003 *  *END*
    * IDSTN = 342615 *  *END*

-------------
     Each line is treated as a separate input subgroup and therefore
     must end with an input group terminator.
```

Table C-8
PXTRACT Control File Inputs (PXTRACT.INP)

Input Group	Variable	Type	Description
(0)	PRECDAT	Character*70	Input data file (TD3240.DAT)
	RUNLST	Character*70	List output file
	LCFILES	logical	Convert to upper case (F) or lower case(T)
(1)	IBYR	integer	Beginning year of data to process (YYYY)
	IBMO	integer	Beginning month
	IBDY	integer	Beginning day
	IEYR	integer	Ending year of data to process (YYYY)
	IEMO	integer	Ending month
	IEDY	integer	Ending day
	ICODE	integer	Method for selecting stations to extract.
			1: extract all stations within specified states
			2: extract specified stations
			3: extract all station in the TD3240 file
	NSTA	integer	Number of stations to extract if ICODE =1 or 2
(2)	IDSTATE	2-digit integer	2-digit code for each state selected (NSTA lines; used only if ICODE=1)
(3)	IDSTN	6-digit integer	6-digit ID for each station selected (NSTA lines ; used only if ICODE=2)

Table C-9

Sample PXTRACT Output List File (PXTRACT.LST)

```
                  PXTRACT OUTPUT SUMMARY
                  VERSION:  4.22         LEVEL:  030709



 ------------------------------------------------
 NOTICE: Starting year in control file sets the
         expected century for the simulation.  All
         YY years are converted to YYYY years in
         the range:  1940 2039
 ------------------------------------------------


 FILENAMES:
     Control file:          pxtract.inp
     Input TD3240 file:     TD3240.DAT
     Output list file:      PXTRACT.LST


  Data Requested by Station ID

  Period to Extract:    1/ 1/1990  to   1/15/1990


  Requested Precipitation Station ID Numbers -- :

    No.    ID           No.    ID           No.    ID           No.    ID

     1   170273          5   270741          9   274732          13   276234
     2   176905          6   270998         10   274808          14   276818
     3   177325          7   272842         11   275639          15   278885
     4   178641          8   273182         12   275780          16   437054


  Station      Starting     Ending       No. of
    Code         Date        Date        Records

  170273        1/ 1/1990   1/17/1990      6
  176905        1/ 1/1990   1/16/1990     13
  177325        1/ 1/1990   1/16/1990      6
  178641        1/ 1/1990   1/21/1990      6
  270741        1/ 1/1990   1/16/1990      5
  270998        1/ 1/1990   1/18/1990      6
  272842        1/ 1/1990   1/17/1990      8
  273182        1/ 1/1990   1/21/1990      6
  274732        1/ 1/1990   1/16/1990      9
  274808        1/ 1/1990   1/17/1990      6
  275639        1/ 1/1990   1/16/1990     83
  275780        1/ 1/1990   1/18/1990      5
  276234        1/ 1/1990   1/17/1990      9
  276818        1/ 1/1990   1/17/1990     13
  278885        1/ 1/1990   1/18/1990      7
  437054        1/ 1/1990   1/16/1990      5


  End of run -- Clock time: 18:10:35
                      Date: 07-11-2003

        Elapsed Clock Time:        0.0 (seconds)

CPU Time:        0.0 (seconds)
```

C.3 PMERGE Precipitation Data Preprocessor

PMERGE reads, processes and reformats the precipitation data files created by the PXTRACT program, and creates either a formatted or an unformatted data file for input into the CALMET meteorological model. The output file (e.g., PRECIP.DAT) contains the precipitation data sorted by hour, as required by CALMET, rather than by station. The program can also read an existing unformatted output file and add stations to it, creating a new output file. PMERGE also resolves "accumulation periods" and flags missing or suspicious data.

Accumulation periods are intervals during which only the total amount of precipitation is known. The time history of precipitation within the accumulation period is not available. For example, it may be known that within a six-hour accumulation period, a total of a half inch of precipitation fell, but information on the hourly precipitation rates within the period is unavailable. PMERGE resolves accumulation periods such as this by assuming a constant precipitation rate during the accumulation period. For modeling purposes, this assumption is suitable as long as the accumulation time period is short (e.g., a few hours). However, for longer accumulation periods, the use of precipitation data with poor temporal resolution is not recommended. PMERGE will eliminate and flag as missing any accumulation periods longer than a user-defined maximum length.

PMERGE provides an option to "pack" the precipitation data in the unformatted output in order to reduce the size of the file. A "zero packing" method is used to pack the precipitation data. Because many of the precipitation values are zero, strings of zeros are replaced with a coded integer identifying the number of consecutive zeros that are being represented. For example, the following record with data from 20 stations requires 20 unpacked “words”:

0.0, 0.0, 0.0, 0.0, 0.0, 1.2, 3.5, 0.0, 0.0, 0.0,
0.0, 0.0, 0.0, 0.7, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,

These data in packed form would be represented in six words:

-5., 1.2, 3.5, -6., 0.7, -6.

where five zero values are replaced by -5., six zero values are replaced by -6., etc. With many stations and a high frequency of zeros, very high packing ratios can be obtained with this simple method. All of the packing and unpacking operations are performed internally by PMERGE and CALMET, and are transparent to the user. The header records of the data file contain information flagging the file to CALMET as a packed or unpacked file. If the user selects the unpacked format, each precipitation value is assigned one full word.

The input files used by PMERGE include a control file (PMERGE.INP), an optional unformatted data file created in a previous run of PMERGE, and up to 150 TD-3240 precipitation station files (e.g., as created by PXTRACT). The output file consists of a list file and a new unformatted or formatted data file in CALMET format with the data for all stations sorted by hour. Table C-11 lists the name, type, format, and contents of PMERGE's input and output data files.

The PMERGE control file (PMERGE.INP) contains the user-specified input variables indicating the number of stations to be processed, a flag indicating if data are to be added to an existing, unformatted data file, the maximum length of an accumulation period, packing options, station data, and time zone data. PMERGE allows data from different time zones to be merged by time-shifting the data to a user-specified base time zone.

The format of the PMERGE control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). PMERGE.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO). A sample PMERGE control file is shown in Table C-12, and the input variables are described in Table C-13.

The PMERGE output list file (PMERGE.LST) contains a listing of the control file inputs and options. It also summarizes the number of valid and invalid hours for each station including information on the number of hours with zero or non-zero precipitation rates and the number of accumulation period hours. Additional statistics provide information by station on the frequency and type of missing data in the file (i.e., data flagged as missing in the original data file, data which are part of an excessively long accumulation period, or data missing from the input files before (after) the first (last) valid record. A sample output file is shown in Table C-14.

Table C-11
PMERGE Input and Output Files

Unit	File Name	Type	Format	Description
I05	PMERGE.INP	input	formatted	Control file containing user inputs
I06	PMERGE.LST	output	formatted	List file (line printer output file)
Ioprev	user input file name	input	unformatted	Previous PMERGE data file to which stations are to be added (Used only if CFLAG=Y)
ioprec	user input file name	output	unformatted or formatted	Output data file created by PMERGE (this file is an input file to CALMET)
Unit 7	user input file name	input	formatted	Precipitation data (in TD-3240) format for station #1. (Output file of PXTRACT)
Unit 7 Plus 1	user input file name	input	formatted	Precipitation data (in TD-3240) format for station #2. (Output file of PXTRACT)

.
.
.

(Up to 150 new precipitation data files are allowed by PMERGE although this may be limited by the number of files an operating system will allow open at one time. Multiple runs of PMERGE may be necessary.)

Table C-12

Sample PMERGE Control File (PMERGE.INP)

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

                 PMERGE PROCESSOR CONTROL FILE
                 -----------------------------

  CALMET accepts data for a number of precipitation stations in a
  single PRECIP.DAT file.  PMERGE creates this file from several
  single-station files with precipitation event data.  Use PMERGE
  one or more times to build the PRECIP.DAT file.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

-------------
Subgroup (0a)
-------------

     Number of precipitation station files provided in Subgroup 0b.
     Up to MXPF are allowed in 1 application, although this may be
     limited by your operating system.  MXPF is set in the code,
     which needs to be  recompiled if another value is needed.
     (NPF)                      No Default      ! NPF = 2 !


     Other Input and Output files:
     -----------------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     PREV.DAT      input    ! PREVDAT =firstrun.dat !
     PRECIP.DAT    output   ! PRECDAT =precip.dat     !
     PMERGE.LST    output   ! RUNLST  =pmerge2.lst  !

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

     NOTE: File/path names can be up to 70 characters in length

!END!


-------------
Subgroup (0b)
-------------

     The following NPF formatted Precipitation Station files are processed.
     Enter NPF 3-line groups identifying the file name (STNFIL), the
     station number (IFSTN), and the station time zone (XSTZ) for each,
     followed by a group terminator.

     1    ! STNFIL = 14745.dat    !
     1    ! IFSTN  = 14745        !
     1    ! XSTZ   = 5.           !   !END!

     2    ! STNFIL = 14606.dat    !
     2    ! IFSTN  = 14606        !
     2    ! XSTZ   = 5.           !   !END!


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

Table C-12 (continued)

Sample PMERGE Control File (PMERGE.INP)

```
INPUT GROUP: 1 -- Run control parameters
--------------

 --- Processing Period ---

     Starting date:   Year (IBYR) -- No default       ! IBYR = 1990  !
                     Month (IBMO) -- No default       ! IBMO =  1  !
                       Day (IBDY) -- No default       ! IBDY =  8  !
              [00-23] Hour (IBHR) -- No default       ! IBHR =  1  !

     Ending date:     Year (IEYR) -- No default       ! IEYR = 1990  !
                     Month (IEMO) -- No default       ! IEMO =  1  !
                       Day (IEDY) -- No default       ! IEDY = 15  !
              [00-23] Hour (IEHR) -- No default       ! IEHR =  0  !

     Base time zone        (XBTZ) -- No default       ! XBTZ   = 5. !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     ---------------
     NOTE:  The hour is defined by the time at the end of the hour
            in time zone XBTZ.


 --- Processing Options ---

     Maximum accumulation period accepted (hrs)
     (MAXAP)                   Default: 6      ! MAXAP = 0 !


 --- File Options ---

     Previous PRECIP.DAT file is used in this run?
     (LPREV)                   No Default      ! LPREV = T !
        T = Unformatted PREV.DAT file is used
        F = PREV.DAT file is NOT used

     Number of stations to use from previous PRECIP.DAT file
     (NBSTN)                   Default: 0      ! NBSTN = 0 !
        0 = Use ALL stations
       >0 = Use only those NBSTN stations listed in Input Group 2


 --- File Formats ---

     Format of output PRECIP.DAT file
     (IOFORM)                  Default: 2      ! IOFORM = 2 !
        1 = Unformatted
        2 = Formatted
     (IOPACK)                  Default: 0      ! IOPACK = 0 !
        0 = NOT packed
        1 = Packed (used only if IOFORM=1)

     Format of previous PRECIP.DAT file
     (IPFORM)                  Default: 2      ! IPFORM = 1 !
        1 = Unformatted
        2 = Formatted


!END!

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

INPUT GROUP: 2 -- Stations used from previous PRECIP.DAT file
--------------
```

Table C-12 (concluded)

Sample PMERGE Control File (PMERGE.INP)

```
Data for the following NBSTN stations in the previous PRECIP.DAT
file identified as PREV.DAT are transferred to the new PRECIP.DAT
file created in this run.  Enter NBSTN lines identifying the
station number (IBSTN) for each, followed by a group terminator.
This Input Group is used only if LPREV=T and NBSTN>0.  All stations
from a previous PRECIP.DAT file are transferred to the new
PRECIP.DAT file if NBSTN=0.

1    * IBSTN  = 14764         *   *END*
```

Table C-13

PMERGE Control File Inputs (PMERGE.INP)

Line	Variable	Type	Description
0a	NPF	integer	Number of formatted TD3240 data files to process
	PREVDAT	character*70	Previous PMERGE output data file (used only if it is a continuation run)
	PRECDAT	character*70	Output data filename
	RUNLST	character*70	List-file name
	LCFILES	logical	Convert names to lower case? (T=yes; F=no)
0b	STNFIL	character*70	Input file pathname for formatted data files
	IFSTN	integer	Six digit station id number (SSIIII), where SS=two digit state code, IIII is the station id
	XSTZ	real	Time zone of station (5=EST, 6=CST, 7=MST, 8=PST)
1	IBYR	integer	Beginning year of data to process (YYYY)
	IBMO	integer	Beginning month
	IBDAY	integer	Beginning day
	IBHR	integer	Beginning hour (01-24 LST)
	IEYR	integer	Ending year of data to process (YYYY)
	IEMO	integer	Ending month
	IEDAY	integer	Ending day
	IEHR	integer	Ending hour (01-24 LST)
	XBTZ	real	Time zone of output data (5=EST, 6=CST, 7=MST, 8=PST)
	MAXAP	integer	Maximum allowed length of an accumulation period (hours). It is recommended that MAXAP be set to 24 hours or less.
	LPREV	logical	Use previous PMERGE output data file? (Y=yes, N=no)
	NBSTN	integer	Number of stations requested from previous PMERGE binary output file (0 = use all stations in binary file).
	IOFORM	integer	Format of output data file (1=unformatted, 2=formatted)

Table C-13 (continued)
PMERGE Control File Inputs (PMERGE.INP)

Line	Variable	Type	Description
	IOPACK	integer	Flag indicating if output data are to be packed (0=no, 1=yes)
	IPFORM	integer	Format of previous PRECIP.DAT file (1=unformatted, 2=formatted)
2	IBSTN	integer	6-digit station ids requested from binary input file (1 station id per record), NBSTN records in all.

Table C-14

Sample PMERGE Output List File (PMERGE.LST)

```
                         PMERGE OUTPUT SUMMARY
                  VERSION:  5.31     LEVEL:  030528



 -------------------------------------------------
 NOTICE: Starting year in control file sets the
         expected century for the simulation.  All
         YY years are converted to YYYY years in
         the range:  1940 2039
 -------------------------------------------------


Control file name     : pmerge.inp
Output list file name : PMERGE.LST
Output file name      : PRECIP.DAT
 Continuation Run?     :  F


 Time Zone      Station ID     Formatted TD3240 Precipitation
                                       Input Files

     5           170273       170273.DAT
     5           176905       176905.DAT
     5           177325       177325.DAT
     5           178641       178641.DAT
     5           270741       270741.DAT
     5           270998       270998.DAT
     5           272842       272842.DAT
     5           273182       273182.DAT
     5           274732       274732.DAT
     5           274808       274808.DAT
     5           275639       275639.DAT
     5           275780       275780.DAT
     5           276234       276234.DAT
     5           276818       276818.DAT
     5           278885       278885.DAT
     5           437054       437054.DAT

 Period to Extract (in time zone  5):    1/ 1/1990   1:00  to   1/15/1990   0:00


 Maximum Accumulation Period (hours):     12


 PMERGE Stations in Output File:
    No.    ID           No.    ID           No.    ID           No.    ID

     1   170273          5   270741          9   274732          13   276234
     2   176905          6   270998         10   274808          14   276818
     3   177325          7   272842         11   275639          15   278885
     4   178641          8   273182         12   275780          16   437054


 Summary of Data from Formatted TD3240 Precipitation Files:


                  Valid Hours:
```

Table C-14 (continued)

Sample PMERGE Output List File (PMERGE.LST)

Station IDs	Zero	Nonzero	Accum Period	Total Valid Hours	% Valid Hours
170273	333	3	0	336	100.0
176905	327	9	0	336	100.0
177325	333	3	0	336	100.0
178641	333	3	0	336	100.0
270741	334	2	0	336	100.0
270998	334	2	0	336	100.0
272842	326	3	0	329	97.9
273182	334	2	0	336	100.0
274732	331	5	0	336	100.0
274808	334	2	0	336	100.0
275639	267	69	0	336	100.0
275780	334	2	0	336	100.0
276234	331	5	0	336	100.0
276818	326	10	0	336	100.0
278885	333	3	0	336	100.0
437054	334	2	0	336	100.0

Invalid Hours:

Station IDs	Flagged Missing	Excessive Accum Period	Missing Data Before First Valid Record	Missing Data After Last Valid Record	Total Invalid Hours	% Invalid Hours
170273	0	0	0	0	0	0.0
176905	0	0	0	0	0	0.0
177325	0	0	0	0	0	0.0
178641	0	0	0	0	0	0.0
270741	0	0	0	0	0	0.0
270998	0	0	0	0	0	0.0
272842	7	0	0	0	7	2.1
273182	0	0	0	0	0	0.0
274732	0	0	0	0	0	0.0
274808	0	0	0	0	0	0.0
275639	0	0	0	0	0	0.0
275780	0	0	0	0	0	0.0
276234	0	0	0	0	0	0.0
276818	0	0	0	0	0	0.0
278885	0	0	0	0	0	0.0
437054	0	0	0	0	0	0.0

```
 LAST DAY/HOUR PROCESSED:
    Year: 1990  Month:  1   Day: 15   Julian day:  15   Hour:  0


 End of run -- Clock time: 18:11:03
                     Date: 07-11-2003

       Elapsed clock time:        0.0 (seconds)

                 CPU time:        0.0 (seconds)
```

C.4 SMERGE Surface Meteorological Data Preprocessor

SMERGE processes and reformats hourly surface observations, and creates either a formatted or an unformatted file which is used as input by the CALMET model. It is assumed that the observations have been validated by METSCAN (for CD144 formatted data) or similar utility. SMERGE reads "N" data files containing surface data in either NCDC 80-column format (CD144 format), NCDC Solar and Meteorological Surface Observational Network (SAMSON) CD-ROM format, NCDC Hourly U.S. Weather Observations (HUSWO) CD-ROM format, or NCDC Integrated Surface hourly Data (TD3505) format. Note that all parameters need to be extracted from the CD-ROM datasets, and if the HUSWO CD-ROM data are used, they must be extracted using the “English” units options.

The output file (e.g., SURF.DAT) contains the processed hourly data for all the stations. SMERGE can also add stations to an existing formatted or unformatted output file. A free-formatted SURF.DAT file can be created by the user and read by CALMET. This option relieves the user of the need to run the preprocessor for short CALMET runs for which the surface data can easily be input manually, or when non-standard data sources (e.g., site-specific meteorological observations) are used.

SMERGE extracts the following variables from the NCDC surface data files: wind speed, wind direction, air temperature, ceiling height, cloud cover, surface pressure, relative humidity, and precipitation type code.

An option is provided to allow the surface data stored in the unformatted output file to be "packed." Packing reduces the size of the data file by storing more than one variable in each word. If the packing option is used, the eight hourly meteorological variables for each station are stored in three words:

Word 1:	TTTTPCRRR --	TTTT	= temp. (XXX.X deg. K)
		PC	= precipitation code (XX)
		RRR	= relative humidity (XXX. %)
Word 2:	pPPPPCCWWW --	pPPPP	= station pressure (pXXX.X mb, with p = 0 or 1 only)
		CC	= opaque sky cover (XX tenths)
		WWW	= wind direction (XXX. deg.)
Word 3:	HHHHSSSS --	HHHH	= ceiling height (XXXX. hundreds of feet)
		SSSS	= wind speed (XX.XX m/s)

For example, the following variables,

Temperature = 273.5 deg. K

Precipitation code	= 12
Relative humidity	= 88 percent
Station pressure	= 1012.4 mb
Opaque sky cover	= 8 tenths
Wind direction	= 160 degrees
Ceiling height	= 120 hundreds of ft
Wind speed	= 5.65 m/s

are stored as the following three integer words:

273512088, 1012408160, 01200565

All of the packing and unpacking operations are performed internally by SMERGE and CALMET, and are transparent to the user. The header records of the data file contain information flagging the file to CALMET as a packed or unpacked file. If the user selects the unpacked format, eight full 4-byte words are used to store the data for each station.

The input files used by SMERGE consist of a control file (SMERGE.INP) containing user inputs, up to 150 surface data files (one per surface station), and an optional SMERGE data file (formatted or unformatted) created in a previous run of SMERGE. The data from the formatted surface station files are combined with the data in the existing SMERGE data file. A new SMERGE output file (formatted or unformatted) containing all the data is created by the program. In addition, SMERGE creates an output list file (SMERGE.LST) which summarizes the user options and run time statistics. Table C-15 contains a listing of the input and output files used by SMERGE.

The SMERGE control file specifies the number and type of input data files, time zone of output data, packing flag, station data (two lines per station), and the starting and ending dates of the period to extract. The format of the SMERGE control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). SMERGE.INP may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for the geophysical preprocessors (CALPRO). A sample SMERGE control file is shown in Table C-16. The format and contents of the SMERGE control file are explained in Table C-17.

The SMERGE output list file (SMERGE.LST) contains a summary of the control file inputs, characteristics of the output data file, and routine statistics. A sample output list file is shown in Table C-18, and a sample SURF.DAT output data file is shown in Table C-19.

Table C-15
SMERGE Input and Output Files

Unit	File Name	Type	Format	Description
ioprev	user input file name	input	unformatted or formatted	Previous SMERGE data file to which stations are to be added (Used only if CFLAG=y)
iosurf	user input file name	output	unformatted or formatted	Output data file created by SMERGE containing the processed hourly surface data (this file is the SURF.DAT input file to CALMET)
io5	SMERGE. INP	input	formatted	Control file containing user inputs
io6	SMERGE.LST	output	formatted	List file (line printer output file)
Unit 7	user input file name	input	formatted	Surface data in one of three NCDC formats for station #1
Unit 7 plus 1	user input file name	input	formatted	Surface data in one of three NCDC formats for station #2

(Up to 150 new surface data files are allowed by SMERGE, although this may be limited by the number of files an operating system will allow open at one time. Multiple runs of SMERGE may be necessary.)

Table C-16

Sample SMERGE Control File Inputs

(SMERGE.INP)

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

                 SMERGE PROCESSOR CONTROL FILE
                 -----------------------------

  CALMET accepts data for a number of 'surface meteorology stations'
  in a single SURF.DAT file.  SMERGE creates this file from several
  single-station files of hourly data.  Use SMERGE one or more times
  to build the SURF.DAT file.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

-------------
Subgroup (0a)
-------------

     Number of formatted Surface Station files provided
     in Subgroup 0b.  Up to MXFF are allowed in 1 application,
     although this may be limited by your operating system.
     MXFF is set in PARAMS.SMG, which is compiled into SMERGE.EXE.
     (NFF)                      No Default      ! NFF = 1 !


     Other Input and Output files:
     -----------------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     PREV.DAT      input    ! PREVDAT =firstrun.dat !
     SURF.DAT      output   ! SURFDAT =surf2.dat     !
     SMERGE.LST    output   ! RUNLST  =smerge2.lst  !

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

     NOTE: file/path names can be up to 70 characters in length

!END!


-------------
Subgroup (0b)
-------------

     The following NFF formatted Surface Station files are processed.
     Enter NFF 4-line groups identifying the file name (SFCMET), the
     station number (IFSTN), the station elevation (optional) in meters
     (XELEV), and the time zone of the data (XSTZ) for each file,
     followed by a group terminator.

     NOTE:  XSTZ identifies the time zone used in the dataset.  The
            TD3505 and TD9956 data are prepared in UTC time rather than
            local time, so XSTZ=0. is expected for these.

     The optional station elevation is a default value used to calculate
     a station pressure from altimeter or sea-level pressure if the
     station presure is missing and the station elevation is missing in
```

```
     the file.  If XELEV is not assigned a value (i.e., XELEV does not
     appear in this control file), no default elevation is available and
     station pressure remains missing.

     1    ! SFCMET = e:\metar\03017.144 !
     1    ! IFSTN  = 03017   !
     1    ! XELEV  = 91.         !
     1    ! XSTZ   = 5.            !   !END!


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

INPUT GROUP: 1 -- Run control parameters
--------------

 --- Processing Period ---

     Starting date:   Year (IBYR) -- No default       ! IBYR = 1997  !
                     Month (IBMO) -- No default       ! IBMO =  1  !
                       Day (IBDY) -- No default       ! IBDY =  1  !
              [00-23] Hour (IBHR) -- No default       ! IBHR =  0  !

     Ending date:     Year (IEYR) -- No default       ! IEYR = 1997  !
                     Month (IEMO) -- No default       ! IEMO =  12 !
                       Day (IEDY) -- No default       ! IEDY = 31  !
              [00-23] Hour (IEHR) -- No default       ! IEHR =  23  !

     Base time zone        (XBTZ) -- No default       ! XBTZ   = 5. !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     ---------------
     NOTE:  The hour is defined by the time at the end of the hour
            in time zone XBTZ.


 --- File Options ---

     Previous SURF.DAT file is used in this run?
     (LPREV)                    No Default      ! LPREV = F !
        T = PREV.DAT file is used
        F = PREV.DAT file is NOT used

     Number of stations to use from previous SURF.DAT file
     (NBSTN)                    Default: 0      ! NBSTN = 0 !
        0 = Use ALL stations
       >0 = Use only those NBSTN stations listed in Input Group 2

 --- File Formats ---

     Format of previous SURF.DAT file
     (Used only if LPREV=T)
     (INFORM)                   Default: 2      ! INFORM = 2 !
        1 = Unformatted
        2 = Formatted

     Format of output SURF.DAT file
     (IOFORM)                   Default: 2      ! IOFORM = 2 !
        1 = Unformatted
        2 = Formatted
     (IOPACK)                   Default: 0      ! IOPACK = 0 !
        0 = NOT packed
        1 = Packed (used only if IOFORM=1)
```

Table C-16 (continued)

Sample SMERGE Control File Inputs

(SMERGE.INP)

```
     Type of ALL Surface Station files in this run
     (JDAT)                    No Default      ! JDAT = 1 !
        1 = CD144
        2 = NCDC SAMSON
        3 = NCDC HUSWO
        4 = CD144 (extended record format with precip rate)
        5 = TD3505(CD) - NCDC Integrated Surface Hourly CD-ROM Set
        6 = TD3505     - NCDC Integrated Surface Hourly Database
        7 = TD9956     - NCDC DATSAV3 Database (not abbreviated)

     Format of input HUSWO file
     (Used only if JDAT=3)
     (IHUSWO)                  Default: 1      ! IHUSWO = 1 !
        1 = All data are in English units
        2 = All data are in Metric units

     Calculate missing station pressure from altimeter or sea level
     pressure?
     (applies to JDAT = 1-4; always T for JDAT = 5-7)
     (LPCALP)                 Default: F      ! LPCALC = T !


!END!

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

INPUT GROUP: 2 -- Stations used from previous SURF.DAT file
--------------

     Data for the following NBSTN stations in the previous SURF.DAT
     file identified as PREV.DAT are transferred to the new SURF.DAT
     file created in this run.  Enter NBSTN lines identifying the
     station number (IBSTN) for each, followed by a group terminator.
     This Input Group is used only if LPREV=T and NBSTN>0.  All stations
     from a previous SURF.DAT file are transferred to the new SURF.DAT
     file if NBSTA=0.

     1    * IBSTN  = 14764         *   *END*

-------------
     Each line is treated as a separate input subgroup and therefore
                        must end with an input group terminator.
```

Table C-17
SMERGE Control File Inputs (SMERGE.INP)

Input Group	Variable	Type	Description
(0a)	NFF	integer	Number of formatted input data files to be processed
	PREVDAT	character*70	Previous SMERGE output data file (used only if it is a continuation run)
	SURFDAT	character*70	SMERGE output data file
	RUNLST	character*70	Output list file
	LCFILES	logical	Convert filename to upper case (T) or lower case (F)
(0b)	SFCMET	Character*70	Input meteorological data file name
	IFSTN	Integer	Station number
	XELEV	Real	Default station elevation in MSL (Optional). Used only if station pressure is calculated and station elevation is not available in the data file
	XSTZ	Real	Time zone used in the input data set
(1)	IBYR	Integer	Starting year of data to print (four digit)
	IBMO	Integer	Starting month
	IBDAY	integer	Starting day
	IBHR	integer	Starting hour (00-23 LST)
	IEYR	Integer	Ending year of data to print (four digit)
	IEMO	Integer	Ending month
	IEDAY	integer	Ending day
	IEHR	integer	Ending hour (00-23 LST)
	XBTZ	integer	Time zone of output data (5=EST, 6=CST, 7=MST, 8=PST)
	LPREV	logical	Previous SURF.DAT file is used in this run (T: yes – F: No)
	NBSTN	integer	Number of station requested from previous SMERGE output data file (0=use all stations in file)
	INFORM	integer	Format of previous data file (PREVDAT) (1=unformatted, 2=formatte)

Table C-17 (concluded)
SMERGE Control File Inputs (SMERGE.INP)

Input Group	Variable	Type	Description
(1)	IOFORM	integer	Output file format flag (1=unformatted, 2=formatted)
	IOPACK	integer	Flag indicating if output data are to be packed (0=no, 1=yes). Used only if IOFORM=1
	JDAT	integer	Formatted input data file format 1 = CD144 2 = NCDC SAMSON 3 = NCDC HUSWO 4 = CD144 (extended record format with precipitation rate) 5 = TD3505(CD) NCDC Integrated Surface Hourly CD-ROM Set 6 = TD3505 NCDC Integrated Surface Hourly Database 7 = TD9956 (full DATSAV3)
	IHUSWO	integer	1 = All data are in English units 2 = All data are in Metric units
	LPCALC	logical	Calculation of missing station pressure from altimeter or sea level pressure?
(2)	IBSTN	Integer	IDs of stations used from the previous SURF.DAT file (if any). NBSTN records must be provided.

Table C-18
Sample SMERGE Output List File
(SMERGE.LST)

```
                    SMERGE OUTPUT SUMMARY
             VERSION:  5.55     LEVEL:  050311


-------------------------------------------------
NOTICE: Starting year in control file sets the
        expected century for the simulation.  All
        YY years are converted to YYYY years in
        the range:  1940 2039
-------------------------------------------------


Control file name: smerge1.inp
Output list file name: smerge1.lst
Output file name: firstrun.dat
Continuation Run?  F



Station ID  Time Zone      Formatted CD144 Surface Data
                                  Input Files

     14606       5        bangor.144
     14611       5        brunswk.144
     14745       5        concord.144
     14742       5        burling.144


Period to Extract (in time zone  5):    1/ 8/1990   1:00  to   1/15/1990   0:00

Multiple ( 2) weather codes (10100) at:1990  11 18, Station:      14742
Multiple ( 2) weather codes (10100) at:1990  12  1, Station:      14606
No. Missing Values for    WS    WD ICEIL   ICC TEMPK   IRH  PRES
                           0     0     0     0     0     0     0

                         ********************



Characteristics of SMERGE Output (SURF.DAT) File:

  Time Zone:     5
  File Format (1=unformatted, 2=formatted):  2

Surface Stations in Output File:
   No.       ID         No.       ID         No.       ID         No.       ID

    1       14606        2       14611        3       14745        4       14742




 LAST DAY/HOUR PROCESSED:
    Year: 1990  Month:  1   Day: 15   Julian day:  15   Hour:  0


 End of run -- Clock time: 18:35:15
                     Date: 03-11-2005

       Elapsed clock time:        0.0 (seconds)

       CPU time:        0.0 (seconds)
```

Table C-19

Sample SURF.DAT Output Data File

(SURF.DAT)

```
SURF.DAT        2.0             Header structure with coordinate parameters
   1
Produced by SMERGE Version: 5.55  Level: 050311
NONE
  1990   8   1  1990  15   0    5    5
   14606
   14611
   14745
   14742
   14764
1990   8   1
    0.000    0.000   50   10  270.928   85 1001.358    0
    5.144  220.000  999 9999  273.150   61 1005.083    0
    2.572  190.000  999    0  268.706   85  997.295    0
    5.144  190.000   37   10  275.372   62  996.956    0
    4.100  220.000  129    8  272.550   69 1007.000    0
1990   8   2
    2.572  190.000   50    9  270.928   85 1001.020    0
    3.087  250.000  999 9999  272.594   67 1005.422    0
    3.601  180.000  999    0  269.261   85  997.295    0
    0.000    0.000   37   10  274.817   67  997.295    0
    4.100  230.000  129    9  272.550   69 1007.000    0
1990   8   3
    0.000    0.000   50   10  271.483   85 1001.358    0
    0.000    0.000  999 9999  272.039   66 1005.761    0
    0.000    0.000  999    0  264.817   96  997.972    0
    3.087  240.000   37   10  275.372   64  998.311    0
    4.100  220.000  999    3  272.550   69 1008.000    0
1990   8   4
    0.000    0.000   50   10  271.483   85 1001.697    0
    0.000    0.000  999 9999  272.039   66 1006.099    0
    0.000    0.000  999    0  265.372   96  998.311    0
    5.144  250.000   43   10  275.372   64  998.649    0
    2.600  230.000  999    0  272.050   75 1008.000    0
1990   8   5
    0.000    0.000   50    9  271.483   85 1001.697    0
    0.000    0.000  999 9999  272.039   66 1006.777    0
    0.000    0.000  999    0  264.261   92  998.988    0
    4.630  210.000   50   10  275.928   62  998.988    0
    2.600  320.000  999    0  270.950   82 1009.000    0
```

C.5 BUOY Over-water Meteorological Data Preprocessor

BUOY reads "N" data files containing sequential over-water data for a single station, and creates the corresponding SEA.DAT file for input to CALMET. Input data files are available from either the National Oceanographic Data Center (NODC) web site (http://www.nodc.noaa.gov/BUOY/buoy.html) or the National Data Buoy Center (NDBC) web site (www.ndbc.noaa.gov). Data from the NODC site are preferred at this time in part because the NODC file structure includes the station location and anemometer height data. Neither file format includes the height of the air and water temperature sensors, however. These must be obtained from descriptive information posted on the NDBC web site. CAUTION: buoy configurations can change in time and the NDBC descriptions are for the current deployment. When you are using historical data, you must verify that the current description is applicable.

The output file (SEA.DAT) contains the processed hourly data for the desired over-water station. It has a free-format file structure that can also be created by the user. This file structure relieves the user of the need to run the preprocessor for short CALMET runs for which the data can easily be input manually, or when non-standard data sources (e.g., site-specific meteorological observations) are used.

BUOY extracts the following meteorological variables from the NDBC and NODC buoy data files:

- wind speed
- wind direction
- air temperature
- air-sea temperature difference
- relative humidity
- precipitation
- pressure
- solar radiation from 0 – 3.6 μm
- solar radiation from 4.0 – 50 μm
- dominant wave period
- significant wave height

Additional data can be extracted when NODC data files are processed:

- average wave period
- mean wave direction
- maximum wave height
- maximum wave steepness
- depth profile of temperature and salinity

An option is provided to write the data to a SEA.DAT file in one of several formats. This allows BUOY to prepare data files that are compatible with a range of CALMET versions. Any version of CALMET recognizes the “contemporary” version and older versions of the SEA.DAT file, but is not able to predict the content of newer SEA.DAT file formats. Significant differences among SEA.DAT formats are:

Dataset Version 2.0	No wave data
Dataset Version 2.1	Includes dominant wave period & significant wave height (CALMET version 5.6 and later)
Dataset Version 2.11	Includes dominant wave period & significant wave height, and time zone (CALMET version 5.613 and later)
Dataset Version 2.2	Includes dominant wave period & significant wave height, time zone, and allows sub-hourly time periods (CALMET version 6.1 and later)
Dataset Version 3.0	Includes extended wave parameters, water column data, time zone, and supports multiple stations in a single file (CALMET version to be determined)

Inclusion of wave data allows such data to be used by the COARE overwater boundary layer flux module as an option, introduced in CALMET version 5.6. The inclusion of the time zone for the data in the file represents an important QA feature. Users must prepare SEA.DAT files in the same base time zone as that used in their CALMET application. Placing the time zone in the file allows CALMET to stop and report incompatible times, when found. Dataset version 2.11 or later is preferred.

Table C-20 contains a listing of the input and output files used by BUOY. The input files consist of a control file (BUOY.INP) containing user inputs, and up to 150 chronological over-water data files for a single buoy station. The output files are the SEA.DAT and an output list file (BUOY.LST) that summarizes the user options and run-time statistics. Note that data version 3.0 allows multiple stations to be placed in a single SEA.DAT file. For this format an optional SEA.DAT data file created in a previous run of BUOY can be combined with the new input data. The previous SEA.DAT file must be in the same projection and cover the same time period as the desired final output.

The BUOY control file specifies the number and type of input data files, base time zone for the output data, the starting and ending dates of the period to extract, and other physical parameters. The format of the BUOY control input file follows the same rules as those used in the CALMET.INP file (refer to the CALMET section for details). Only data within the delimiter characters (!) are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5!). A sample BUOY control file is shown in Table C-21. The format and content of the BUOY control file are explained in Table C-22.

The BUOY output list file (BUOY.LST) contains a summary of the control file inputs, characteristics of the output data file, and routine statistics. A sample output list file is shown in Table C-23, and a sample SEA.DAT output data file (version 2.11) is shown in Table C-24.

Table C-20
BUOY Input and Output Files

Unit	File Name	Type	Format	Description
3	user input file name	input	formatted	Previous SEA.DAT file to which stations are to be added (Used only if LPREV=T and Dataset=3.0)
4	SEA.DAT	output	formatted	Output data file for input to CALMET
5	BUOY. INP	input	formatted	Control file containing user inputs
6	BUOY.LST	output	formatted	List file (line printer output file)
7	user input file name	input	formatted	Over-water data in NODC or NDBC format

(Up to 150 sequential over-water data files are allowed by BUOY, although this may be limited by the number of files an operating system will allow open at one time.)

Table C-21
Sample BUOY Control File Inputs
(BUOY.INP)

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

                     BUOY PROCESSOR CONTROL FILE
                    -----------------------------

  The Buoy processor reads data from either the National Oceanographic
  Data Center (NODC) web site or the National Data Buoy Center (NDBC)
  web site and produces a SEA.DAT file for use with CALMET.

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

INPUT GROUP: 0 -- Input and Output Files
--------------

-------------
Subgroup (0a)
-------------

     Number of Buoy Data Files provided in Subgroup 0b

     (NBDF)                    Default: 0      ! NBDF = 3 !

     Output version of the SEA.DAT file

     (DATAVER)                 Default: 2.11   ! DATAVER = 2.11 !

     ---------------------------------------------------------------------------
     Output dataset versions  2.0:  Data format prior to 10/2005
                                    with no wave data
                              2.1:  Data format with 2 wave parameters
                                    (not recommended)
                              2.11: Data format with 2 wave parameters
                                    and base time zone record
                              2.2:  Data format with sub-hourly
                                    time steps.
                              3.0:  Data format with sub-hourly
                                    time steps, additional
                                    wave records and temperature-
                                    salinity profiles (for future use)


     Other Input and Output files:
     -----------------------------

     Default Name  Type          File Name
     ------------  ----          ---------
     PREV.DAT      input    * PREVDAT =prev.dat  *
     SEA.DAT       output   ! OUTFIL  =42039-2003.dat  !
     BUOY.LST      output   ! LSTFIL  =42039-2003.lst  !

     ---------------------------------------------------------------------------
     All file names will be converted to lower case if LCFILES = T
     Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
     (LCFILES)                 Default: T      ! LCFILES = F !
        T = lower case
        F = UPPER CASE

     NOTE: file/path names can be up to 70 characters in length

!END!
```

Table C-21 (continued)

Sample BUOY Control File Inputs

(BUOY.INP)

```
------------
Subgroup (0b)
------------

     The following Data Files are processed in order.
     Enter NBDF lines identifying the file name for each,
     followed by a group terminator.  Each file should
     represent a different time period for the same buoy
     station.  The type of data base for each file is
     designated by the assignment name:

    (NODC)     designates National Oceanagraphic Data Center (www.nodc.noaa.gov)
               Contains all wave parameters
    (NDBC)     designates National Data Buoy Center Data (www.ndbc.noaa.gov)
               Contains Wave Period and Wave Height for Version 2.1, 2.2 output
               but not extended wave variables for Version 3.0 output

   ! NODC  =   42039_200301.txt  !  !END!
   ! NODC  =   42039_200302.txt  !  !END!
   ! NODC  =   42039_200303.txt  !  !END!


------------
Subgroup (0c)
------------

     Datum-Region
     ------------

     The Datum-Region for coordinates in the input Data Files needs to be identified.
     Check the file documentation and change the default if needed.  The list of
     Datum-Regions with official transformation parameters is provided by the National
     Imagery and Mapping Agency (NIMA).

     Datum-region for input Buoy Data File coordinates
     (DNDBC)                 Default: WGS-84    ! DNDBC  = WGS-84 !
     (DNODC)                 Default: WGS-84    ! DNODC  = WGS-84 !


  !END!


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

INPUT GROUP: 1 -- Processing Options
-------------

 --- Processing Period ---

     Starting date:   Year (IBYR) -- No default       ! IBYR = 2003  !
                     Month (IBMO) -- No default       ! IBMO =  1  !
                       Day (IBDY) -- No default       ! IBDY =  1  !
              [00-23] Hour (IBHR) -- No default       ! IBHR =  1  !

     Ending date:     Year (IEYR) -- No default       ! IEYR = 2003  !
                     Month (IEMO) -- No default       ! IEMO =  3  !
                       Day (IEDY) -- No default       ! IEDY =  1  !
              [00-23] Hour (IEHR) -- No default       ! IEHR =  1  !

      UTC time zone        (ABTZ) -- No default       ! ABTZ = UTC-0500 !
      (character*8)
         PST = UTC-0800, MST = UTC-0700 , GMT = UTC-0000
         CST = UTC-0600, EST = UTC-0500

     ---------------
     NOTE:  The hour is defined by the time at the end of the hour
            in time zone ABTZ.
```

Table C-21 (continued)

Sample BUOY Control File Inputs

(BUOY.INP)

```
 --- File Options ---

     Previous BUOY.DAT file is used in this run?
     (LPREV)                    No Default      ! LPREV = F !
        T = PREV.DAT file is used
        F = PREV.DAT file is NOT used


! END !

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

INPUT GROUP: 2 -- Map Projection Information for Output
--------------

     Projection
     ----------

     Map projection for all X,Y (km)
     (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  = 0.0 !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN = 17 !

     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 = 28.0N !
     (RLON0)                    No Default      ! RLON0 = 90.0W !

         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)
     (RLAT1)                    No Default      ! RLAT1 = 23.0N !
     (RLAT2)                    No Default      ! RLAT2 = 33.0N !

         LCC :  Projection cone slices through Earth's surface at RLAT1 and RLAT2
         PS  :  Projection plane slices through Earth at RLAT1
                (RLAT2 is not used)
```

Table C-21 (concluded)

Sample BUOY Control File Inputs

(BUOY.INP)

```
     ----------
     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 output 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 BUOY 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).

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

! END !

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

INPUT GROUP: 3 -- Station Identification Information
--------------

     (BNAM) Name for Buoy      Default: None    ! BNAM = PENSACOLA 115 NM ESE of Pensacola FL!

          For output dataset version 2.0 or 2.1 this
          character string must be 4 characters or less.
          For output dataset versions 2.11 or later it can be
          a description of up to 132 characters.

     (RASN) Air Temperature Sensor Height
                               Default: None    ! RASN = 4.0 !

     (RWSN) Water Temperature Sensor Depth
                               Default: None    ! RWSN = 0.6 !


     Additional Station Identification Information for NDBC files.
     (These are read directly from the NODC F291 format data file)


     ID number for Buoy
     (IDNUM)                   Default: None    * IDNUM =00000 *

     Stationary Buoy Location

     (BLAT)  Station Latitude   Default: None    * BLAT =00.00N  *
     (BLON)  Station Longitude  Default: None    * BLON =00.00W  *
     (BANM)  Anemometer Height  Default: None    * BANM =0.0  *

! END !

--------------------------------------------------------------------------------
NIMA Datum-Regions  (Documentation Section)
--------------------------------------------------------------------------------
     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
```

Table C-22
BUOY Control File Inputs (BUOY.INP)

Input Group	Variable	Type	Description
(0a)	NBDF	integer	Number of formatted input data files to be processed
	DATAVER	Real	Dataset version of the SEA.DAT file to output: 2.0, 2.11, 2.2, or 3.0
	PREVDAT	character*70	Previous SEA.DAT output data file (used only with dataset version 3.0)
	OUTFIL	character*70	Output SEA.DAT data file
	LSTFIL	character*70	Output list file
	LCFILES	logical	Convert filename to upper case (T) or lower case (F)
(0b)	NDBC	Character*70	Filename for each NBDF NDBC data file
	NODC	Character*70	Filename for each NBDF NODC data file
	DNDBC	Character*8	Input datum for NDBC data files
	DNODC	Character*8	Input datum for NODC data files
(1)	IBYR	Integer	Starting year of data to process (four digit)
	IBMO	Integer	Starting month
	IBDAY	integer	Starting day
	IEHR	integer	Starting hour (00-23 LST)
	IEYR	Integer	Ending year of data to process (four digit)
	IEMO	Integer	Ending month
	IEDAY	integer	Ending day
	IEHR	integer	Ending hour (00-23 LST)
	ABTZ	character*8	Base time zone of output data (UTC-0500=EST, UTC-0600=CST, UTC-0700=MST, UTC-0800=PST)
	LPREV	logical	Previous SEA.DAT file is used in this run (T: yes – F: No) (used only with dataset version 3.0)

Table C-22 (concluded)
BUOY Control File Inputs (BUOY.INP)

Input Group	Variable	Type	Description
(2)	PMAP *	character*8	Map projection for output coordinates: UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA: Lambert Azimuthal Equal Area
	FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA
	FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA
	IUTMZN	integer	UTM zone for PMAP = UTM
	UTMHEM	character*1	Use (N) northern or (S) southern hemisphere for UTM projection
	RLAT0, RLON0	character*16	Reference latitude and longitude (degrees) for PMAP = TTM, LCC, PS, EM, or LAZA. Enter numeric degrees and either N or S for latitude, or E or W for longitude.
	RLAT1, RLAT2	character*16	Two standard parallels of latitude for PMAP= LCC or PS. Enter numeric degrees and either N or S.
	DATUM	character*8	Datum Code for output buoy location
(3)	BNAM	character*132	Name of buoy station for NDBC files.
	BNUM		Number of buoy station for NDBC files. (Not used for NODC files)
	BLAT, BLON	character*16	Location latitude and longitude (degrees) for NDBC station. (Not used for NODC files) Enter numeric degrees and either N or S for latitude, and E or W for longitude.
	BANM	real	Station anemometer height for NDBC files. (Not used of NODC files)

Table C-23
Sample BUOY Output List File
(BUOY.LST)

```
                         BUOY OUTPUT SUMMARY
                  VERSION:  1.23     LEVEL:  060119



--------------------------
    SETUP Information
--------------------------


Control File Used -----
BUOY.INP = buoy.inp

Buoy Data Input File Names -------------
data files:
File Type: NODC
dbfile :    42039_200301.TXT
dbfile :    42039_200302.TXT
dbfile :    42039_200303.TXT

Input Datum-Region used --------
Datum : WGS-84

Output File Names -------------
lstfil   : 42039-2003.LST
outfil   : 42039-2003.DAT

Location Info (for output) ---------------------
datum   : WGS-84
pmap    : LCC
fEast  :  0.00000000E+00
fNorth :  0.00000000E+00
rlat(N):  28.0000000
rlon(E):  -90.0000000
xlat1  :  23.0000000
xlat2  :  33.0000000

Time Period -------
Period to Extract:    1 / 1 / 2003 1 :00  to   3 / 1 / 2003 1 :00

Buoy Specifications ---------
Buoy Name   : 'PENSACOLA 115 NM ESE OF PENSACOLA FL'
Buoy Number :  42039
Lat(N)      :  28.796N
Lon(E)      :  86.056W


Record of missing or replaced data
------------------------------------------
 missing data record  2003 3 9
 missing data record  2003 11 7
```

Table C-24

Sample BUOY Output Data File

(SEA.DAT)

```
SEA.DAT         2.11            Header structure with coordinate parameters
   2
Produced by BUOY Version:   1.23  Level: 060119
 Data values taken from NODC  Data Format 291
LCC
28.0N           90.0W           23.0N           33.0N
 0.00000000E+00 0.00000000E+00
WGS-84  02-21-2003
KM
UTC-0500
  2003     1     1  2003    60     1
    42039 'PENSACOLA 115 NM ESE OF PENSACOLA FL'
  383.560   94.092     5.0     4.0     0.6 2003   1  1 2003   1  1    -0.90   292.6   67.0 9999.0 9999.0 9999.0    9.9  212.0     9.1     3.7
  383.560   94.092     5.0     4.0     0.6 2003   1  2 2003   1  2    -0.80   292.8   67.4 9999.0 9999.0 9999.0   12.1  243.0     9.1     3.9
  383.560   94.092     5.0     4.0     0.6 2003   1  3 2003   1  3    -0.80   292.8   64.8 9999.0 9999.0 9999.0   12.0  239.0     9.1     4.0
  383.560   94.092     5.0     4.0     0.6 2003   1  4 2003   1  4    -0.90   292.6   68.3 9999.0 9999.0 9999.0   12.2  234.0     9.1     4.4
  383.560   94.092     5.0     4.0     0.6 2003   1  5 2003   1  5    -1.00   292.4   72.8 9999.0 9999.0 9999.0   11.6  243.0     9.1     3.8
  383.560   94.092     5.0     4.0     0.6 2003   1  6 2003   1  6    -1.30   292.2   69.5 9999.0 9999.0 9999.0   12.4  250.0     9.1     4.1
  383.560   94.092     5.0     4.0     0.6 2003   1  7 2003   1  7    -1.60   291.9   71.3 9999.0 9999.0 9999.0   13.1  251.0     9.1     4.0
  383.560   94.092     5.0     4.0     0.6 2003   1  8 2003   1  8    -2.30   291.1   72.1 9999.0 9999.0 9999.0   12.9  260.0     9.1     4.3
  383.560   94.092     5.0     4.0     0.6 2003   1  9 2003   1  9    -2.80   290.6   71.5 9999.0 9999.0 9999.0   12.0  253.0     9.1     4.3
  383.560   94.092     5.0     4.0     0.6 2003   1 10 2003   1 10    -3.00   290.4   72.0 9999.0 9999.0 9999.0   12.6  254.0     9.1     4.2
  383.560   94.092     5.0     4.0     0.6 2003   1 11 2003   1 11    -3.10   290.4   69.6 9999.0 9999.0 9999.0   12.1  256.0     9.1     4.4
  383.560   94.092     5.0     4.0     0.6 2003   1 12 2003   1 12    -3.00   290.4   72.5 9999.0 9999.0 9999.0   10.0  257.0    10.0     4.1
  383.560   94.092     5.0     4.0     0.6 2003   1 13 2003   1 13    -3.00   290.4   71.5 9999.0 9999.0 9999.0   10.2  260.0    10.0     3.7
  383.560   94.092     5.0     4.0     0.6 2003   1 14 2003   1 14    -2.80   290.6   73.0 9999.0 9999.0 9999.0    9.3  260.0     9.1     3.8
  383.560   94.092     5.0     4.0     0.6 2003   1 15 2003   1 15    -2.30   291.1   72.1 9999.0 9999.0 9999.0    8.2  258.0    10.0     3.3
  383.560   94.092     5.0     4.0     0.6 2003   1 16 2003   1 16    -2.30   291.1   78.0 9999.0 9999.0 9999.0    8.2  273.0    10.0     3.3
  383.560   94.092     5.0     4.0     0.6 2003   1 17 2003   1 17    -2.10   291.4   73.1 9999.0 9999.0 9999.0    7.6  260.0     9.1     3.0
  383.560   94.092     5.0     4.0     0.6 2003   1 18 2003   1 18    -2.00   291.4   74.1 9999.0 9999.0 9999.0    7.2  239.0     9.1     2.8
  383.560   94.092     5.0     4.0     0.6 2003   1 19 2003   1 19    -2.00   291.4   72.6 9999.0 9999.0 9999.0    6.9  251.0    10.0     2.7
  383.560   94.092     5.0     4.0     0.6 2003   1 20 2003   1 20    -2.00   291.4   72.6 9999.0 9999.0 9999.0    7.0  254.0     9.1     2.5
  383.560   94.092     5.0     4.0     0.6 2003   1 21 2003   1 21    -2.00   291.4   74.6 9999.0 9999.0 9999.0    6.4  265.0    10.0     2.4
  383.560   94.092     5.0     4.0     0.6 2003   1 22 2003   1 22    -2.20   291.2   74.0 9999.0 9999.0 9999.0    6.7  263.0     8.3     2.3
  383.560   94.092     5.0     4.0     0.6 2003   1 23 2003   1 23    -2.40   291.1   71.6 9999.0 9999.0 9999.0    6.7  270.0     9.1     2.2
  383.560   94.092     5.0     4.0     0.6 2003   2  0 2003   2  0    -2.90   290.6   69.7 9999.0 9999.0 9999.0    4.5  279.0     9.1     2.0
  383.560   94.092     5.0     4.0     0.6 2003   2  1 2003   2  1    -3.00   290.5   69.7 9999.0 9999.0 9999.0    4.2  277.0     7.7     1.9
```

ATTACHMENT A

NATIONAL DATA BUOY CENTER (NDBC)
DATA FORMATS
(http://www.ndbc.noaa.gov/measdes.shtml)

Measurement Descriptions and Units

STATION ID Five-digit WMO Station Identifier used since 1976. ID's can be reassigned to future deployments within the same 1 degree square.

DATE In UTC (formerly called Greenwich Mean Time - GMT)

TIME In UTC for data files/display. Station pages show current observations in station local time by default, but can be changed by the viewer to UTC. See the Acquisition Time help topic for a more detailed description of observation times.

Data are classified according to the following groups. Any data field that contains "9 filled" represents missing data for that observation hour. (Example: 999.0 99.0)

Standard Meteorological Data

ATMP Air temperature (Celsius). For sensor heights on buoys, see Hull Descriptions. For sensor heights at C-MAN stations, see C-MAN Sensor Locations

WTMP Sea surface temperature (Celsius). For sensor depth, see Hull Description.

DEWP Dewpoint temperature taken at the same height as the air temperature measurement.

PRES Sea level pressure (hPa). For C-MAN sites and Great Lakes buoys, the recorded pressure is reduced to sea level using the method described in *NWS Technical Procedures Bulletin 291* (11/14/80).

WSPD Wind speed (m/s) averaged over an eight-minute period for buoys and a two-minute period for land stations. Reported Hourly. See Wind Averaging Methods.

WDIR Wind direction (the direction the wind is coming from in degrees clockwise from true N) during the same period used for WSPD. See Wind Averaging Methods

GST Peak 5 or 8 second gust speed (m/s) measured during the eight-minute or two-minute period. The 5 or 8 second period can be determined by payload, See the Sensor Reporting, Sampling, and Accuracy section.

WVHT Significant wave height (meters) is calculated as the average of the highest one-third of all of the wave heights during the 20-minute sampling period. See the Wave Measurements section.

APD Average wave period (seconds) of all waves during the 20-minute period. See the Wave Measurements section.

DPD Dominant wave period (seconds) is the period with the maximum wave energy. See the Wave Measurements section.

MWD Mean wave direction corresponding to energy of the dominant period (DOMPD). The units are degrees from true North just like wind direction. See the Wave Measurements section.

VIS Station visibility (statute miles). Note that buoy stations are limited to reports from 0 to 1.9 miles.

PTDY Pressure Tendency is the direction (plus or minus) and the amount of pressure change (hPa)for a three hour period ending at the time of observation.

TIDE The water level in feet above or below Mean Lower Low Water (MLLW).

Sample Raw NDBC Data

YYYY	MM	DD	hh	WD	WSPD	GST	WVHT	DPD	APD	MWD	BARO	ATMP	WTMP	DEWP	VIS	TIDE
2003	11	01	00	191	5.4	6.0	0.26	2.94	2.89	201	1018.5	16.0	11.4	999.0	99.0	99.00
2003	11	01	01	185	4.4	5.0	0.25	2.86	2.85	197	1018.5	15.2	11.4	999.0	99.0	99.00
2003	11	01	02	248	5.5	6.5	0.21	2.50	2.87	204	1018.8	16.6	11.4	999.0	99.0	99.00
2003	11	01	03	211	4.6	5.0	0.17	2.56	2.71	199	1019.4	14.3	11.4	999.0	99.0	99.00
2003	11	01	04	199	4.7	5.1	0.00	0.00	0.00	0	1019.3	14.3	11.4	999.0	99.0	99.00
2003	11	01	05	222	3.8	4.9	0.18	2.56	2.71	206	1019.5	13.9	11.4	999.0	99.0	99.00
2003	11	01	06	212	3.7	4.2	0.00	0.00	0.00	0	1020.1	13.7	11.4	999.0	99.0	99.00
2003	11	01	07	215	4.7	5.0	0.00	0.00	0.00	0	1020.3	14.1	11.4	999.0	99.0	99.00
2003	11	01	08	278	6.0	7.0	0.00	0.00	0.00	0	1020.9	13.4	11.4	999.0	99.0	99.00
2003	11	01	09	318	3.0	4.3	0.00	0.00	0.00	0	1021.8	12.6	11.4	999.0	99.0	99.00
2003	11	01	10	294	3.5	4.3	0.00	0.00	0.00	0	1022.5	12.5	11.4	999.0	99.0	99.00
2003	11	01	11	282	3.3	4.0	0.00	0.00	0.00	0	1022.7	12.4	11.4	999.0	99.0	99.00
2003	11	01	12	284	3.2	3.6	0.00	0.00	0.00	0	1023.4	12.1	11.4	999.0	99.0	99.00
2003	11	01	13	303	2.8	3.5	0.00	0.00	0.00	0	1024.2	11.8	11.4	999.0	99.0	99.00
2003	11	01	14	312	4.2	5.1	0.00	0.00	0.00	0	1025.0	11.7	11.4	999.0	99.0	99.00
2003	11	01	15	324	3.7	4.3	0.00	0.00	0.00	0	1025.7	11.4	11.5	999.0	99.0	99.00
2003	11	01	16	316	4.2	4.6	0.00	0.00	0.00	0	1025.7	11.3	11.7	999.0	99.0	99.00
2003	11	01	17	325	2.3	2.6	0.00	0.00	0.00	0	1025.8	11.4	11.7	999.0	99.0	99.00
2003	11	01	18	323	1.1	1.4	0.00	0.00	0.00	0	1024.9	11.4	11.7	999.0	99.0	99.00
2003	11	01	19	296	1.0	1.2	0.00	0.00	0.00	0	1024.9	11.7	11.7	999.0	99.0	99.00
2003	11	01	20	268	0.1	0.5	0.00	0.00	0.00	0	1024.9	11.8	11.8	999.0	99.0	99.00
2003	11	01	21	307	0.1	0.5	0.00	0.00	0.00	0	1025.2	12.3	11.8	999.0	99.0	99.00
2003	11	01	22	204	1.1	1.3	0.00	0.00	0.00	0	1025.2	11.4	11.8	999.0	99.0	99.00
2003	11	01	23	242	0.9	1.2	0.00	0.00	0.00	0	1025.7	11.4	11.8	999.0	99.0	99.00
2003	11	02	00	146	0.4	0.6	0.00	0.00	0.00	0	1025.7	11.4	11.8	999.0	99.0	99.00
2003	11	02	01	108	0.5	0.7	0.00	0.00	0.00	0	1025.2	11.4	11.7	999.0	99.0	99.00
2003	11	02	02	95	1.2	1.5	0.00	0.00	0.00	0	1025.2	11.4	11.7	999.0	99.0	99.00
2003	11	02	03	134	2.7	3.7	0.00	0.00	0.00	0	1024.9	11.9	11.7	999.0	99.0	99.00
2003	11	02	04	100	2.8	3.5	0.00	0.00	0.00	0	1024.2	12.1	11.7	999.0	99.0	99.00

ATTACHMENT B

NATIONAL OCEANOGRAPHIC DATA CENTER (NODC)
DATA FORMATS
(www.nodc.noaa.gov/General/NODC-Archive/f291.html)

FILE TYPE 291 - METEOROLOGY OCEANOGRAPHY AND WAVE SPECTRA

THIS FORMAT IS USED TO REPORT METEOROLOGICAL, OCEANOGRAPHIC, AND WAVE SPECTRA DATA FROM NDBC MOORED BUOYS AND FIXED LAND STATIONS. THE FORMAT CONTAINS TEN DATA RECORD TYPES TO:

- IDENTIFY THE BUOY POSITION AND OTHER DESCRIPTIVE INFORMATION;
- REPORT THE METEOROLOGICAL MEASUREMENTS;
- REPORT WAVE ENERGY SPECTRA AND WAVE DIRECTION;
- REPORT SUBSURFACE PHYSICAL, BIOLOGICAL AND CHEMICAL OCEANOGRAPHIC MEASUREMENTS; AND
- REPORT DETAILED INFORMATION ON CONTINUOUSLY MEASURED WIND SPEED AND DIRECTION.

****NOTE****

THIS FORMAT REPLACES FILE TYPE 191 WHICH IN TURN REPLACED 091.

03/30/81 - ADDED WIND SPEED AND DIRECTION TO RECORD TYPE '2'

12/28/81 - ADDED RECORD TYPES '6' AND '7'

11/04/85 - ADDED RECORD TYPE '8'

01/01/88 - ADDED RECORD TYPE '9'

01/30/91 - DESIGNED F291 TO:

- RELABEL RECORD TYPES - RECORD TYPES 1 THROUGH 5 BECOMING A THROUGH E; ADD NEW RECORD TYPE F; AND RELABEL 6 THROUGH 9 AS G THROUGH J;
- ADD A PRESENCE OF A RECORD INDICATOR IN RECORD TYPE 'A';
- REDEFINE RECORD TYPE B BY DELETING "HIGHEST CREST" AND "DEEPEST TROUGH" AND INSERTING "WATER LEVEL";
- IDENTIFY RECORD TYPE C AS "NON-DIRECTIONAL WAVE SPECTRA DATA RECORD";
- DELETE DEFINITION OF COLUMNS 27 THROUGH 33 IN RECORD C AND REPLACE WITH 7 BLANKS;
- ADD A DURATION OF SAMPLING FIELD AT THE END OF RECORD D;
- DEFINE RECORD TYPE E TO PROVIDE ONLY SUBSURFACE CURRENT INFORMATION; AND
- DEFINE NEW RECORD TYPE F TO PROVIDE SUBSURFACE PHOTOSYNTHETIC ACTIVE RADIATION.

05/01/92 - REFINED DEFINITION OF OBSERVED TIME IN RECORDS A THROUGH J TO BE "END OF MET. DATA ACQUISITION, ROUNDED TO THE BEGINNING OF THE NEAREST WHOLE MINUTE." TIME TAG OF DATA ARCHIVED PRIOR TO THIS DATE REFLECTS NEAREST WHOLE HOUR OF MET. DATA ACQUISITION. ALSO, FOR RECORD C, BLANK SPACES 27-30 ARE DEFINED AS "END

OF WAVE DATA ACQUISITION, ROUNDED TO THE BEGINNING OF THE NEAREST WHOLE MINUTE."

01/01/95 - ADDED TWO NEW RECORDS TO 291 TO HANDLE WPM DATA:

- DEFINED RECORD TYPE K TO PROVIDE EXPANDED RESOLUTION FOR NONDIRECTIONAL CENTER FREQUENCY AND WAVE SPECTRA DATA; AND
- DEFINED RECORD TYPE L TO PROVIDE EXPANDED RESOLUTION FOR CENTER FREQUENCY OF THE CO AND QUAD SPECTRA. THE "SENSOR OUTPUT" FIELD WAS ALSO ADDED TO INDICATE THE TYPE OF SENSOR.

03/17/2000 - FOUR DIGIT YEAR

- TO ACCOMMODATE FOUR DIGIT YEARS, THE FORMER FILE DATE FIELD COL 4-9 (THAT WAS USED FOR YEARS FOR THE NODC REFERENCE NUMBER) IS NOW USED TO HOLD THE YYYYMM OF OBSERVATION AND IS CALLED OBS YEAR/MONTH.

04/21/2000 - ADDED NEW COMMENT RECORD M

- ADDED NEW M RECORD FOR COMMENTS. IT CAN OCCUR AT ANY PLACE IN THE FILE.

RECORD FORMAT DESCRIPTION
RECORD NAME: Meteorology Oceanography & Wave Spectra (File Type "291")

DESCRIPTIVE HEADER RECORD (RECORD A)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	"291" (constant)
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'A'
STATION	11	6	Six-character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
LATITUDE	27	7	DDMMSS plus hemisphere 'N' or 'S'
LONGITUDE	34	8	DDDMMSS plus hemisphere 'E' or 'W'
BOTTOM DEPTH	42	5	XXXXX - Meters to tenths
MAGNETIC VARIATION	47	4	XXXX - Whole degrees from true North (signed value)
BUOY HEADING	51	3	XXX - Whole degrees from true North
SAMPLING RATE (WAVES)	54	4	XXXX - Original measurements per minute to tenths
SAMPLING DURATION (WAVES)*	58	4	XXXX - Minutes to hundredths If equal to 40 minutes, the actual duration for all wave calculations varies by frequency range: .02 to .925 Hz - 40 min .1 to .35 Hz - last 20 min .365 to .485 Hz- last 10 min
TOTAL INTERVALS (WAVES)	62	3	XXX - Number of frequency intervals
CHIEF SCIENTIST	65	20	20-Character field for scientist name
INSTITUTION	85	20	20-Character field for data source
WIND SAMPLING DURATION	105	3	XXX - Minutes to tenths
PRESENCE OF 'B'	108	1	X - Y=YES; N=NO
PRESENCE OF 'C'	109	1	X - Y=YES; N=NO
PRESENCE OF 'D'	110	1	X - Y=YES; N=NO
PRESENCE OF 'E'	111	1	X - Y=YES; N=NO
PRESENCE OF 'F'	112	1	X - Y=YES; N=NO
PRESENCE OF 'G'	113	1	X - Y=YES; N=NO
PRESENCE OF 'H'	114	1	X - Y=YES; N=NO
PRESENCE OF 'I'	115	1	X - Y=YES; N=NO
PRESENCE OF 'J'	116	1	X - Y=YES; N=NO
PRESENCE OF 'K'	117	1	X - Y=YES; N=NO
PRESENCE OF 'L'	118	1	X - Y=YES; N=NO
BLANKS	119	2	

ENVIRONMENTAL DATA RECORD (RECORD B)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	"291" (constant)
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'B'
STATION	11	6	Six-character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
ANEMOMETER HEIGHT	27	3	XXX - Height above water level or ground (meters to tenths)
AIR TEMPERATURE	30	4	XXXX - Negative temperatures are preceded by a minus sign adjacent to tempera- ture value Deg C to tenths
DEW POINT	34	4	XXXX - Degrees C to tenths
BAROMETER	38	5	XXXXX - Reduced to sea level (MB to tenths)
WIND SPEED (AVG)	43	4	XXXX - m/sec to hundredths
WIND DIRECTION (AVG)	47	4	XXXX - Degrees from true North to tenths
WEATHER	51	1	One-character weather code
VISIBILITY	52	3	XXX - Nautical miles to tenths
PRECIPITATION	55	4	XXXX - Accumulation in millimeters
SOLAR RADIATION (ATMOSPHERIC	59	3	xxx - Langleys/min to hundredths, wave length less than 3.6 microns
SOLAR RADIATION (ATMOSPHERIC)	62	3	XXX - Langleys/min to hundredths, wave length from 4.0 to 50 microns
SIGNIFICANT WAVE HEIGHT*	65	3	XXX - Corrected for low frequency noise, etc. (meters to tenths)
AVERAGE WAVE PERIOD*	68	3	XXX - Seconds to tenths
MEAN WAVE DIRECTION	71	3	XXX - Mean direction at the dominant wave period (spectral peak period) in whole degrees clockwise from true North to the direction from which the waves are coming. level; minus sign indicates below MLLW (meters to tenths)
BLANKS	78	2	
TEMPERATURE (SEA SURFACE)	80	4	XXXX - Sea surface - Negative temperatures are preceded by a minus sign adjacent to temperature value-Deg C to hundredths
PRACTICAL SALINITY (SEA SURFACE)	84	5	XXXXX - To thousandths
CONDUCTIVITY (SEA SURFACE)	89	5	XXXXX - Millisiemens/cm to thousandths
DOMINANT WAVE PERIOD*	94	3	XXX - Spectral peak period- Seconds to tenths
MAXIMUM WAVE HEIGHT	97	3	XXX - Meters to tenths
MAXIMUM WAVE STEEPNESS	100	3	XXX

WIND GUST	103	4	XXXX - Meters/sec to hundredths
WIND GUST AVERAGING PERIOD	107	2	XX - Seconds
WIND GUST	109	4	XXXX - Meters/sec to hundredths
WIND GUST AVERAGING PERIOD	113	2	XX - Seconds
WIND SPEED (58 MIN AVG)	115	3	XXX - Meters/sec to tenths
WIND DIRECTION (58 MIN AVG)	118	3	XXX - Whole degrees

* Significant wave height, average wave period, and dominant wave period are set to zero when significant wave height is less than 0.15 meters.

NONDIRECTIONAL WAVE SPECTRA DATA RECORD (RECORD C)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	"291" (constant)
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'C'
STATION	11	6	Six-character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
END OF WAVE DATA ACQUISITION	27	4	HHMM (UTC) - Rounded to beginning of nearest whole minute
BLANKS	31	3	
COUNT DATA	34	1	X - Number of frequencies on this record Up to 5 frequency, resolu- tion, and density fields. Null fields are zero or blank
FREQUENCY	35	4	XXXX - Center frequency of interval in Hertz to thousandths
RESOLUTION	39	4	XXXX - Interval width in Hertz to ten-thousandths
DENSITY	43	6	XXXXXX - Spectral Density, C11, in m2/Hz to thousandths
FREQUENCY	49	4	XXXX - See above
RESOLUTION	53	4	XXXX - See above
DENSITY	57	6	XXXXXX - See above
FREQUENCY	63	4	XXXX - See above
RESOLUTION	67	4	XXXX - See above
DENSITY	71	6	XXXXXX - See above
FREQUENCY	77	4	XXXX - See above
RESOLUTION	81	4	XXXX - See above
DENSITY	85	6	XXXXXX - See above
FREQUENCY	91	4	XXXX - See above
RESOLUTION	95	4	XXXX - See above
DENSITY	99	6	XXXXXX - See above
BLANKS	105	16	

SUBSURFACE TEMPERATURE/SALINITY DATA RECORD (RECORD D)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	"291" (constant)
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'D'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
DEPTH	27	5	XXXXX - Meters from the surface to tenths
TEMPERATURE	32	4	XXXX - Negative temperatures are preceded by a minus sign adjacent to temper- ature value-Deg C to hundredths
PRACTICAL SALINITY	36	5	XXXXX - Parts per thousands reported to thousands
CONDUCTIVITY	41	4	XXXX - Millisiemens/cm to hundredths
DEPTH	45, 63, 81,99	5	Repeated in descending order
TEMPERATURE	50, 68, 86, 104	4	Repeated in descending order
PRACTICAL SALINITY	54, 72, 90, 108	5	Repeated in descending order
CONDUCTIVITY	59, 77, 95, 113	4	Repeated in descending order
BLANK	117	1	
DURATION OF SAMPLING PERIOD	118	3	XXX - Minutes to tenths

SUBSURFACE CURRENT DATA RECORD (RECORD E)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'E'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
DEPTH	27	4	XXXX - From the surface in meters
PRESSURE	31	5	XXXXX - Hydrostatic pressure (kg/cm2) to hundredths
U COMPONENT	36	5	XXXXX - East component from true North (cm/sec) to tenths. Minus sign indi- cates westward component
V COMPONENT	41	5	XXXXX - True North component in cm/sec to tenths. Minus sign indicates southward component
W COMPONENT	46	3	XXX - Vertical component in cm/sec to tenths. Minus sign indicates downward component
DEPTH	49, 71, 93	4	Repeated in descending order
PRESSURE	53, 75, 97	5	Repeated in descending order
U COMPONENT	58, 80, 102	5	Repeated in descending order
V COMPONENT	63, 85, 107	5	Repeated in descending order
W COMPONENT	68, 90, 112	3	Repeated in descending order
BIN WIDTH	115	2	XX - Width of each depth bin whole meters
SAMPLING INTERVAL	117	3	XXX - Minutes to tenths
BLANK	120	1	

SUBSURFACE DATA PROFILE (RECORD F)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'F'
STATION	11	6	Six-character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
DEPTH	27	4	XXXX - From the surface in meters. Negative value indicates height in meters above water surface
PHOTOSYNTHETIC ACTIVE RADIATION (PAR)	31	4	XXXX - Micromol/sec/m2
BLANKS	35	15	15 Blanks reserved for future parameters
DEPTH	50, 73, 96	4	Repeated in descending order
PAR	54, 77, 100	4	Repeated in descending order
BLANKS	58, 81, 104	15	Reserved for future parameters
BLANKS	119	2	

CO AND QUAD SPECTRA FOR DIRECTIONAL WAVES DATA RECORD (RECORD G)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'G'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
FREQUENCY	27	4	XXXX - Center frequency of interval in Hz to thousandths
RESOLUTION	31	5	XXXXX - Spectral resolution of this frequency band to Hz to ten-thousandths
CO-SPECTRA (C11)	36	6	XXXXXX - Signed uncorrected spectral density of CO spectra in m2/Hz. Decimal assumed to be left of first digit. Subscripts are: 1=Heave, 2=E-W slope, 3=N-S slope
EXPONENT*	42	2	XX - First space is the sign
CO-SPECTRA (C22)	44	6	XXXXXX - See above
EXPONENT*	50	2	XX - See above
CO-SPECTRA (C33)	52	6	XXXXXX - See above
EXPONENT*	58	2	XX - See above
CO-SPECTRA (C12)	60	6	XXXXXX - See above
EXPONENT*	66	2	XX - See above
QUAD-SPECTRA (Q12)	68	6	XXXXXX - See above
EXPONENT*	74	2	XX - See above
CO-SPECTRA (C13)	76	6	XXXXXX - See above
EXPONENT*	82	2	XX - See above
QUAD-SPECTRA (Q13)	84	6	XXXXXX - See above
EXPONENT*	90	2	XX - See above
CO-SPECTRA C23)	92	6	XXXXXX - See Above
EXPONENT*	98	2	XX - See above
QUAD-SPECTRA (Q23)	100	6	XXXXXX - See above
EXPONENT*	106	2	XX - See above
SPECTRA (C22-C33)	108	6	XXXXXX - See Above
EXPONENT*	114	2	XX - See above
BLANKS	116	5	-

* If this exponent is less than -9, the exponent and its associated spectra will be zero.

DIRECTIONAL WAVE FOURIER COEFFICIENT DATA RECORD (RECORD H)

PARAMETER	**STARTING POSITION**	**FIELD LENGTH**	**DESCRIPTION**
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'H'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
FREQUENCY	27	4	XXXX - Hz to thousandths
RESOLUTION	31	5	XXXXX - Hz to ten- thousandths
ANGULAR FOURIER COEFF (a0)	36	6	XXXXXX - m2/Hz
EXPONENT	42	2	XX
ANGULAR FOURIER COEFF (a1)	44	6	XXXXXX - m2/Hz
EXPONENT	50	2	XX
ANGULAR FOURIER COEFF (b1)	52	6	XXXXXX - m2/Hz
EXPONENT	58	2	XX
ANGULAR FOURIER COEFF (a2)	60	6	XXXXXX - m2/Hz
EXPONENT	66	2	XX
ANGULAR FOURIER COEFF (b2)	68	6	XXXXXX - m2/Hz
EXPONENT	74	2	XX
ANGULAR FOURIER COEFF (a3)	76	6	XXXXXX - m2/Hz
EXPONENT	82	2	XX
ANGULAR FOURIER COEFF (b3)	84	6	XXXXXX - m2/Hz
EXPONENT	90	2	XX
ANGULAR FOURIER COEFF (a4)	92	6	XXXXXX - m2/Hz
EXPONENT	98	2	XX
ANGULAR FOURIER COEFF (b4)	100	6	XXXXXX - m2/Hz
EXPONENT	106	2	XX
MEAN WAVE DIRECTION	108	3	XXX - ARCTAN b1/a1 in whole degrees from true North
BLANKS	111	10	

DIRECTIONAL WAVE PARAMETER DATA RECORD (RECORD I)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'I'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
COUNT	27	1	X - Number of frequencies on this record (1 to 3)
FREQUENCY	28	4	XXXX - Center of frequency interval in Hz to the ten-thousandth
RESOLUTION	32	4	XXXX - Resolution of interval in Hz to the ten-thousandth
R1	36	4	XXXX - Nondimensional. Given to nearest hundredth
R2	40	4	XXXX - Nondimensional. Given to nearest hundredth
WAVE DIRECTION ALPHA1	44	4	XXXX - Direction in degrees to the tenth
WAVE DIRECTION ALPHA2	48	4	XXXX - Direction in degrees to the tenth
WAVE ESTIMATE C11	52	6	XXXXXX - Spectral value in m2/Hz to the thousandth
FREQUENCY	58	4	XXXX - Center of frequency interval in Hz to the ten-thousandth
RESOLUTION	62	4	XXXX - Resolution of interval in Hz to the ten-thousandth
R1	66	4	XXXX - Nondimensional. Given to nearest hundredth
R2	70	4	XXXX - Nondimensional. Given to nearest hundredth
WAVE DIRECTION ALHPA1	74	4	XXXX - Direction in degrees to the tenth
WAVE DIRECTION	78	4	XXXX - Direction in degrees to the tenth
WAVE C11 ESTIMATE	82	6	XXXXXX - Spectral value in m2/Hz to the thousandth
FREQUENCY	88	4	XXXX - Center of frequency interval in Hz to the ten-thousandth
RESOLUTION	92	4	XXXX - Resolution of interval in Hz to the ten-thousandth
R1	96	4	XXXX - Nondimemsional. Given to nearest hundredth
R2	100	4	XXXX - Nondimensional. Given to nearest hundredth
WAVE DIRECTION ALPHA1	104	4	XXXX - Direction in degrees to the tenth
WAVE DIRECTION ALPHA2	108	4	XXXX - Direction in degrees to the tenth
WAVE C11 ESTIMATE	112	6	XXXXXX - Spectral value in m2/Hz to the thousandth
BLANKS	118	3	

NOTE: DIRECTIONAL WAVE SPECTRUM = C11(f)*D(f,A), f=frequency (Hz), A=Azimuth angle measured clockwise from North to the direction wave is from. D(f,A)=(1/PI)*(0.5+R1*COS(A-ALPHA1)+R2*COS(2*(A-ALPHA2))), in which R1 and R2 are dimensionless and ALPHA1 and ALPHA2 are respectively mean and principal wave directions. In terms of Longuet-Higgins Fourier Coefficients R1=(SQRT(a1*a1+b1*b1))/a0, R2=SQRT(a2*a2+b2*b2))/a0, ALPHA1=270.0-ARCTAN(b1,a1), ALPHA2=270.0-(0.5*ARCTAN(b2,a2)+{0. or 180.}), C11(f) is the nondirectional wave spectra data from RECORD C or RECORD K.

CONTINUOUS WIND MEASUREMENT DATA RECORD (RECORD J)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'J'
STATION	11	6	Six character unique name of observation point
REPORT DATE	17	6	YYMMDD (UTC)
REPORT TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
SPEED AVERAGING METHOD	27	1	X - 1=VECTOR, 2=SCALER
STANDARD DEVIATION OF HOURLY SPEED	28	3	XXX - m/sec to tenths
STANDARD DEVIATION OF HOURLY DIRECTION	31	4	XXXX - Whole degrees
HOURLY PEAK WIND	35	3	XXX - m/sec to tenths (high- est 5 sec wind)
DIRECTION OF HOURLY PEAK	38	3	XXX - Whole degrees
MINUTE OF HOURLY PEAK	41	2	XX - Minutes
END OF ACQUISITION TIME	43	4	XXXX - HHMM (UTC)
FIRST AVERAGE DIRECTION	47	3	XXX - Whole degrees
FIRST AVERAGE SPEED	50	3	XXX - m/sec to tenths
SECOND AVERAGE DIRECTION	53	3	XXX - Whole degrees
SECOND AVERAGE SPEED	56	3	XXX - m/sec to tenths
THIRD AVERAGE DIRECTION	59	3	XXX - Whole degrees
THIRD AVERAGE SPEED	62	3	XXX - m/sec to tenths
FOURTH AVERAGE DIRECTION	65	3	XXX - Whole degrees
FOURTH AVERAGE SPEED	68	3	XXX - m/sec to tenths
FIFTH AVERAGE DIRECTION	71	3	XXX - Whole degrees
FIFTH AVERAGE SPEED	74	3	XXX - m/sec to tenths
SIXTH AVERAGE DIRECTION	77	3	XXX - Whole degrees
SIXTH AVERAGE SPEED	80	3	XXX - m/sec to tenths
BLANKS	83	38	

Ten minute average winds are measured for minutes 0-9, 10-19, 20-29, 30-39, 40-49, and 50-59. The first set is for the ten minute time period ending immediately before the end of acquisition time. The remaining sets go back in time. For example, if the end of acquisition time is 1025, then the first average is 1010 to 1019, the second, 1000 to 1009, etc. If the end of acquisition time is 1030, then the first period will be 1020 to 1029.

EXPANDED RESOLUTION NONDIRECTIONAL WAVE SPECTRA DATA RECORD (RECORD K)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	"291" (constant)
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'K'
STATION	11	6	Six-character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
END OF WAVE DATA ACQUISITION	27	4	HHMM (UTC) - Rounded to beginning of nearest whole minute
BLANKS	31	3	
COUNT	34	1	X - Number of frequencies on this record
DATA			Up to 5 frequency, resolu- tion, and density fields. Null fields are zero or blank
FREQUENCY	35	4	XXXX- Center frequency of interval in Hertz to ten-thousandths
RESOLUTION	39	4	XXXX - Interval width in Hertz to ten-thousandths
DENSITY	43	9	XXXXXXXXX - Spectral Density, C11, in m2/Hz to hundred thousandths
FREQUENCY	52	4	XXXX - See above
RESOLUTION	56	4	XXXX - See above
DENSITY	60	9	XXXXXXXXX - See above
FREQUENCY	69	4	XXXX - See above
RESOLUTION	73	4	XXXX - See above
DENSITY	77	9	XXXXXXXXX - See above
FREQUENCY	86	4	XXXX - See above
RESOLUTION	90	4	XXXX - See above
DENSITY	94	9	XXXXXXXXX - See above
FREQUENCY	103	4	XXXX - See above
RESOLUTION	107	4	XXXX - See above
DENSITY	111	9	XXXXXXXXX - See above
BLANKS	120	1	

EXPANDED RESOLUTION CO AND QUAD SPECTRA FOR DIRECTIONAL WAVES DATA RECORD (RECORD L)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always 'L'
STATION	11	6	Six character unique name of observation point
OBSERVED DATE	17	6	YYMMDD (UTC)
OBSERVED TIME	23	4	HHMM (UTC) - End of met. data acquisition, rounded to beginning of nearest whole minute
FREQUENCY	27	4	XXXX - Center frequency of interval in Hz to ten- thousandths
RESOLUTION	31	5	XXXXX - Interval width in Hertz to ten-thousandths
CO-SPECTRA C11)**	36	6	XXXXXX - Signed uncorrected spectral density. Decimal assumed to be left of first digit. Subscripts are: 1=Heave, 2=E-W slope, 3=N-S slope
EXPONENT*	42	2	XX - First space is the sign
CO-SPECTRA (C22)**	44	6	XXXXXX - See above
EXPONENT*	50	2	XX - See above
CO-SPECTRA (C33)**	52	6	XXXXXX - See above
EXPONENT*	58	2	XX - See above
CO-SPECTRA (C12)**	60	6	XXXXXX - See above
EXPONENT*	66	2	XX - See above
QUAD-SPECTRA (Q12)**	68	6	XXXXXX - See above
EXPONENT*	74	2	XX - See above
CO-SPECTRA (C13)**	76	6	XXXXXX - See above
EXPONENT*	82	2	XX - See above
QUAD-SPECTRA (Q13)**	84	6	XXXXXX - See above
EXPONENT*	90	2	XX - See above
CO-SPECTRA C23)**	92	6	XXXXXX - See Above
EXPONENT*	98	2	XX - See above
QUAD-SPECTRA (Q23)**	100	6	XXXXXX - See above
EXPONENT*	106	2	XX - See above
SPECTRA (C22-C33)**	108	6	XXXXXX - See Above
EXPONENT*	114	2	XX - See above
SENSOR OUTPUT	116	1	X - 1=Displacement; 2=Acceleration
BLANKS	117	4	

* If this exponent is less than -9, the exponent and its associated spectra will be zero. ** For displacement: C11 in m2/Hz, C22 in 1/Hz, C33 in 1/Hz, C12 in m/Hz, C13 in m/Hz, Q12 in m/Hz, Q13 in m/Hz, C23 in 1/Hz, Q23 in 1/Hz. For acceleration: C11, C12, C13, Q12, Q13 in [m/s2]2/Hz, C22, C33, Q23,

COMMENT (RECORD M)

PARAMETER	STARTING POSITION	FIELD LENGTH	DESCRIPTION
FILE TYPE	1	3	Always "291"
OBS YEAR/MONTH	4	6	YYYYMM of Observation
RECORD TYPE	10	1	Always "M"
STATION	11	6	Six character unique name of observation point
BLANK	17	1	Always blank
COMMENT	18	103	Free form comments

Sample Raw NODC Data

```
291200401A42002 0401010050251000N0942500W320040004  10244000046                    NDBC                080YNNNNNNYYYY
291200401B42002 0401010050100+238+2081022007501020              011047067      2390          067      083005
291200401I42002 0401010050303250050                    03750050                      04250050
291200401I42002 0401010050304750050                    05250050                      05750050
291200401I42002 0401010050306250050                    06750050                      07250050
291200401I42002 0401010050307750050                    08250050                      08750050
291200401I42002 0401010050309250050                    10000100                      110001000083004609700960
291200401I42002 04010100503120001000087006209100930      130001000084005307100710      140001000087006208400840
291200401I42002 04010100503150001000091006906700650      160001000086005907200710      170001000086005505400540
291200401I42002 04010100503180001000086005506200590      190001000081005106300590      200001000086006706200590
291200401J42002 04010100502006    084107550050101073098067101069105068102070107072
291200401K42002 04010100500039   50325005000000000000375005000000000000425005000000000000475005000000000000525005000000000000
291200401K42002 04010100500039   50575005000000000000625005000000000000675005000000000000725005000000000000775005000000000000
291200401K42002 04010100500039   50825005000000000000875005000000000000925005000000000001000010000000145011000100000013703
291200401K42002 04010100500039   51200010000004485013000100000060398140001000000694241500010000009762916000100000033940
291200401K42002 04010100500039   51700010000002663218000100000049387190001000000390052000010000004485621000100000022119
291200401K42002 04010100500039   52200010000003927023000100000028289240001000000246062500010000002438626000100000022910
291200401K42002 04010100500039   52700010000002337628000100000032790290001000000099393000010000001194231000100000016817
291200401K42002 04010100500039   53200010000000623433000100000006424340001000000064813500010000000592536500200000006232
291200401K42002 04010100500039   53850020000000264740500200000001451425002000000022824450020000000145946500200000001214
291200401K42002 04010100500039   148500200000000971
291200401L42002 0401010050020000200+00000+0+00000+0+00000+0+00000+0+00000+0+00000+0+00000+0+00000+0                2
291200401L42002 0401010050032500050+00000+0                                                                        2
291200401L42002 0401010050037500050+00000+0                                                                        2
291200401L42002 0401010050042500050+00000+0                                                                        2
291200401L42002 0401010050047500050+00000+0                                                                        2
291200401L42002 0401010050052500050+00000+0                                                                        2
291200401L42002 0401010050057500050+00000+0                                                                        2
291200401L42002 0401010050062500050+00000+0                                                                        2
291200401L42002 0401010050067500050+00000+0                                                                        2
291200401L42002 0401010050072500050+00000+0                                                                        2
291200401L42002 0401010050077500050+00000+0                                                                        2
291200401L42002 0401010050082500050+00000+0                                                                        2
291200401L42002 0401010050087500050+21274-3                                                                        2
291200401L42002 0401010050092500050+29484-3                                                                        2
291200401L42002 0401010050100000100+26929-2                                                                        2
```

D. PROGNOSTIC METEOROLOGICAL DATA PROCESSORS

Optionally, CALMET can accept prognostic data extracted from models such as MM5, Eta, RUC, and RAMS and incorporate them in the computation of its own gridded meteorological fields. Prognostic data for CALMET are typically prepared as a 3D.DAT file. Earlier formats for these data are also supported: MM4.DAT and MM5.DAT, referring to the most likely origin of these earlier data sets, i.e. the PSU/NCAR Mesoscale Modeling System 4 (MM4) or the PSU/NCAR Mesoscale Modeling System 5 (MM5). However, not all modeling options in CALMET may be available if an earlier file format is used. Interface programs that create the 3D.DAT files for CALMET from MM5, Eta, RUC, and RAMS output products (CALMM5, CALETA, CALRUC, and CALRAMS) are described in the following sections, followed by a description of the 3D.DAT file format in Section D.5.

D.1 CALMM5 Preprocessor

CALMM5 operates on the output from the PSU/NCAR Mesoscale Modeling System 5 (MM5), Version 3. It contains options to output the following MM5 variables: horizontal and vertical velocity components, pressure, temperature, relative humidity, and water vapor, cloud, rain, snow, ice and graupel mixing ratios (if available in MM5). Table D-1 lists user-controlled options in CALMM5.INP.

The recommended format of the output file from CALMM5 for CALMET applications is the 3D.DAT file format. Other output formats are available, including the old MM4.DAT format, but these are intended for specialty uses. A 2D.DAT file may also be requested for surface variables (those without a vertical profile). Table D-2 lists the variables in 3D.DAT and MM4.DAT. Table D-3 lists the variables in 2D.DAT files. Note that in 3D.DAT files, the five mixing ratios of cloud, rain, ice, snow, and graupel in Table D-2 can be zeros in most of profiles. To reduce file size in these cases, the zeros are compressed using a negative value. For example, -5 indicates all five mixing ratios are zero.

CALMM5 reads and interprets all information contained in the MM5 header (physical options, dates, grid size and location, etc.). Note that the MM5 header is read only once, for the first MM5 record in the MM5 file. MM5 grid specifications (latitude, longitude) are therefore saved at that time and assumed valid for all subsequent times. This assumption fails if MM5 grid has moved during the MM5 simulation. The output files from CALMM5 preserves some of the information of original MM5 configuration. In the latest 3D.DAT/2D.DAT files (Data set Version 2.0), the header records have been modified to include comment lines. These lines can be used to preserve detailed MM5 configurations in the further development of CALMM5.

Data processing in CALMM5 is mainly due to the differences of coordinate systems between MM5 and CALMET. In MM5, an Arakawa B-grid is used (Figure D-1). There are two sets of horizontal grid locations: dot points and cross points. The dimension of cross points is one less than that of corresponding dot points, that is, if NX in the dimension of dot points, then dimension of cross points is

Table D-1
User-Controlled Options in CALMM5.INP

Output Option	3D.DAT	2D.DAT	MM4.DAT
Domain selection using I/J or Lat/Lon	Y	Y	Y
Beg/End X/Y (I/J or Lat/Lon)	Y	Y	Y
Beg/End Z (K)	Y	N	Y
Beg/End Date	Y	Y	Y
Output File format	Y	N	Y
Vertical velocity (w) profile	Y	N	N
Specific and relative humidity profile	Y	N	N
Cloud and rain content profile	Y	N	N
Ice and snow content profile	Y	N	N
Graupel content profile	Y	N	N
Output surface 2D variables	Y	Y	N

Table D-2
Variables Available in CALMM5 Three-dimensional Output Files

Variables	3D.DAT	MM4.DAT
Vertical profile		
Pressure	Y	Y
Height above M.S.L	Y	Y
Temperature	Y	Y
Wind direction	Y	Y
Wind speed	Y	Y
Vertical velocity	Y	Y
Relative humidity	Y	Y (dew point depression)
Vapor mixing ratio	Y	N
Cloud mixing ratio	Y*	N
Rain mixing ratio	Y*	N
Ice mixing ratio	Y*	N
Snow mixing ratio	Y*	N
Graupel mixing ratio	Y*	N
Surface variables in header		
Sea level pressure	Y	Y
Rain fall	Y	Y
Snow cover	Y	Y
Short wave radiation at surface	Y	N
Long wave radiation at surface	Y	N
Air temperature at 2 meters above ground	Y**	N
Specific humidity at 2 meters above ground	Y**	N
U-wind at 10 meters above ground	Y**	N
V-wind at 10 meters above ground	Y**	N
Sea surface temperature	Y	N

* Exists only when available in MM5 output.

** Set to zero or blank if not available.

Table D-3
Possible Variables in 2D.DAT files

Variables	2D.DAT
Ground temperature	Y
PBL height	Y
Sensible heat flux	Y
Latent heat flux	Y
Frictional velocity	Y
Short wave radiation at surface	Y
Long wave radiation at surface	Y
Air temperature at 2 m above ground	Y*
Specific humidity at 2 m above the ground	Y*
U-wind at 10 m above the ground	Y*
V-wind at 10 m above the ground	Y*
Sea surface temperature	Y

* Exists only when available in MM5 output

NX-1. MM5 defines U and V wind components on dot points, and all other variables on cross points. In the vertical direction, MM5 uses sigma coordinate (Figure D-2), where sigma is calculated using Equation D-1

$$\sigma = (P - P_{Top})/P^* \qquad \text{(D-1)}$$

where P is pressure, and P_{top} is the pressure at model top. P^* is the pressure difference between the surface and the model top. All variables are defined at half sigma levels, except vertical velocity (W), which is defined on full sigma levels. Table D-4 lists defined horizontal and vertical locations for MM5 variables used by CALMM5.

CALMET uses a non-staggered horizontal coordinate system (see Figure D-3) and a terrain-following vertical coordinate system. In horizontal, all variables are defined at the center of each grid cell. Therefore the staggered MM5 variables have to be interpolated to one of its two set grid locations, either dot points or cross points. Horizontal wind is the most important in air pollution modeling, which is defined at MM5 dot points. To keep it unaffected, all MM5 variables defined at MM5 cross points are interpolated to dot points using Equation D-2 for internal grids

$$x_d(i, j) = [x_c(i-1, j-1) + x_c(i, j-1) + x_c(i-1, j) + x_c(i, j)]/4.0 \qquad \text{(D-2)}$$

where x_d is the value at a dot points, and x_c is the value at four surrounding cross points. For a dot point along the model boundary, only the two cross points next to it are used. The interpolation in Equation D-2 is based on actual horizontal spatial distance in meters, not on latitude and longitude degrees. The X and Y, or I and J, in MM5 horizontal coordinate system are confusing. MM5 uses X (or I) as its south-north coordinate, and Y (or J) as its west-east coordinate, which is opposite to the conventional use of X and Y. To eliminate this confusion, the output from CALMM5 uses conventional X and Y definition, that is, X (or I) represents the west-east direction, and Y (or J) the south-north direction.

In the vertical direction, MM5 vertical velocities (present in MM5 Version 3 and only in non-hydrostatic runs in MM5 Version 2) are computed at full sigma levels while all other variables are defined at half sigma levels (see Figure D-2). CAMM5 interpolates the vertical velocities at full sigma levels to half sigma levels first using Equation D-3

$$w(k) = [w(k) + w(k+1)]/2.0 \qquad \text{(D-3)}$$

where k is vertical level index starting from the model top. Since the vertical velocity in MM5 is defined at cross point, the vertical velocities from Equation D-3 are further interpolated to dot points using Equation D-2.

Table D-4.
Defined Horizontal and Vertical Locations for MM5 Variables Used in CALMM5

Variables	Native MM5 Horizontal	Native MM5 Vertical	Output from CALMM5 Horizontal	Output from CALMM5 Vertical
Pressure	Cross point	Half sigma	Dot point	Half sigma
Temperature	Cross point	Half sigma	Dot point	Half sigma
Wind direction	Dot point	Half sigma	Dot point	Half sigma
Wind speed	Dot point	Half sigma	Dot point	Half sigma
Vertical velocity	Cross point	Full sigma	Dot point	Half sigma
Relative humidity	Cross point	Half sigma	Dot point	Half sigma
Vapor mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Cloud mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Rain mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Ice mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Snow mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Graupel mixing ratio	Cross point	Half sigma	Dot point	Half sigma
Sea level pressure	Cross point		Dot point	
Rain fall	Cross point		Dot point	
Snow cover	Cross point		Dot point	
Short wave radiation at surface	Cross point		Dot point	
Long wave radiation at surface	Cross point		Dot point	
Air temperature at 2 meters above ground	Cross point		Dot point	
Specific humidity at 2 meters above ground	Cross point		Dot point	
U-wind at 10 meters above ground	Cross point		Dot point	
V-wind at 10 meters above ground	Cross point		Dot point	
Sea surface temperature	Cross point		Dot point	
Ground temperature	Cross point		Dot point	
PBL height	Cross point		Dot point	
Sensible heat flux	Cross point		Dot point	
Latent heat flux	Cross point		Dot point	
Frictional velocity	Cross point		Dot point	

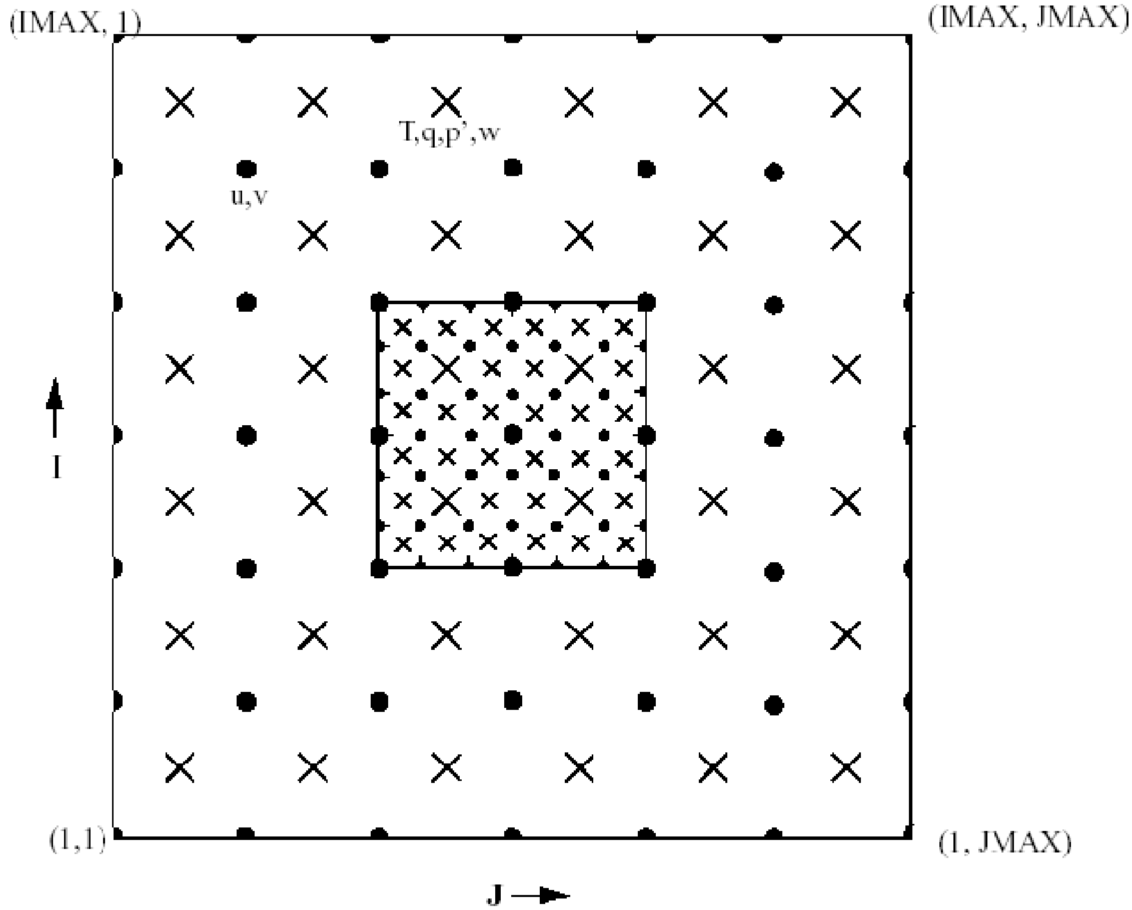


Figure D-1. MM5 horizontal grid (Arakawa B-grid) showing the staggering of the dot (.) and cross (x) grid points. The smaller inner box is a representative mesh staggering for a 3:1 coarse-grid distance to fine-grid distance ratio (from NCAR, 1998).

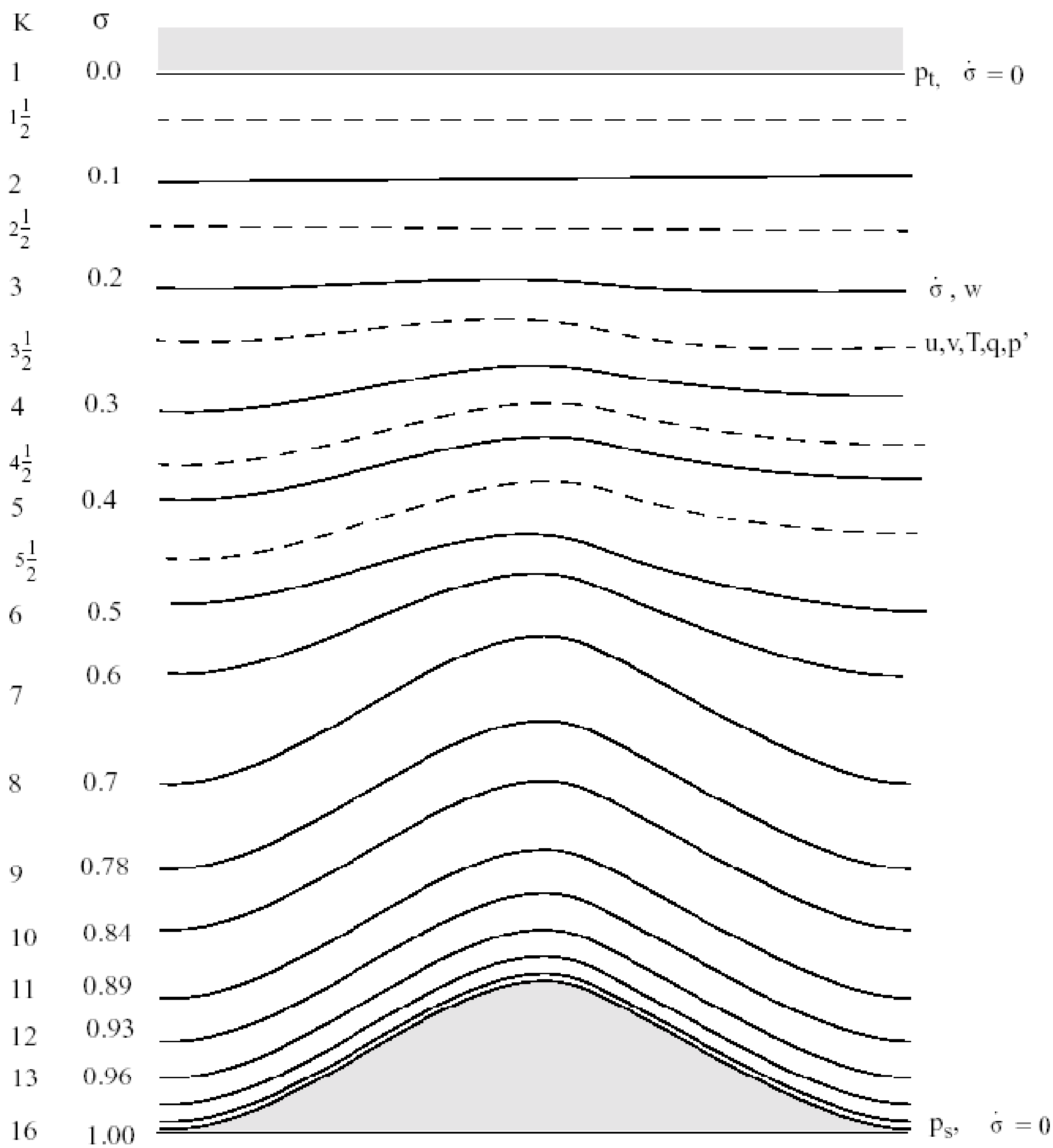


Figure D-2. Schematic representation of the vertical structure used in MM5. The example is for 15 vertical layers. Dashed lines denote half-sigma levels, solid lines denote full-sigma levels (from NCAR, 1998).

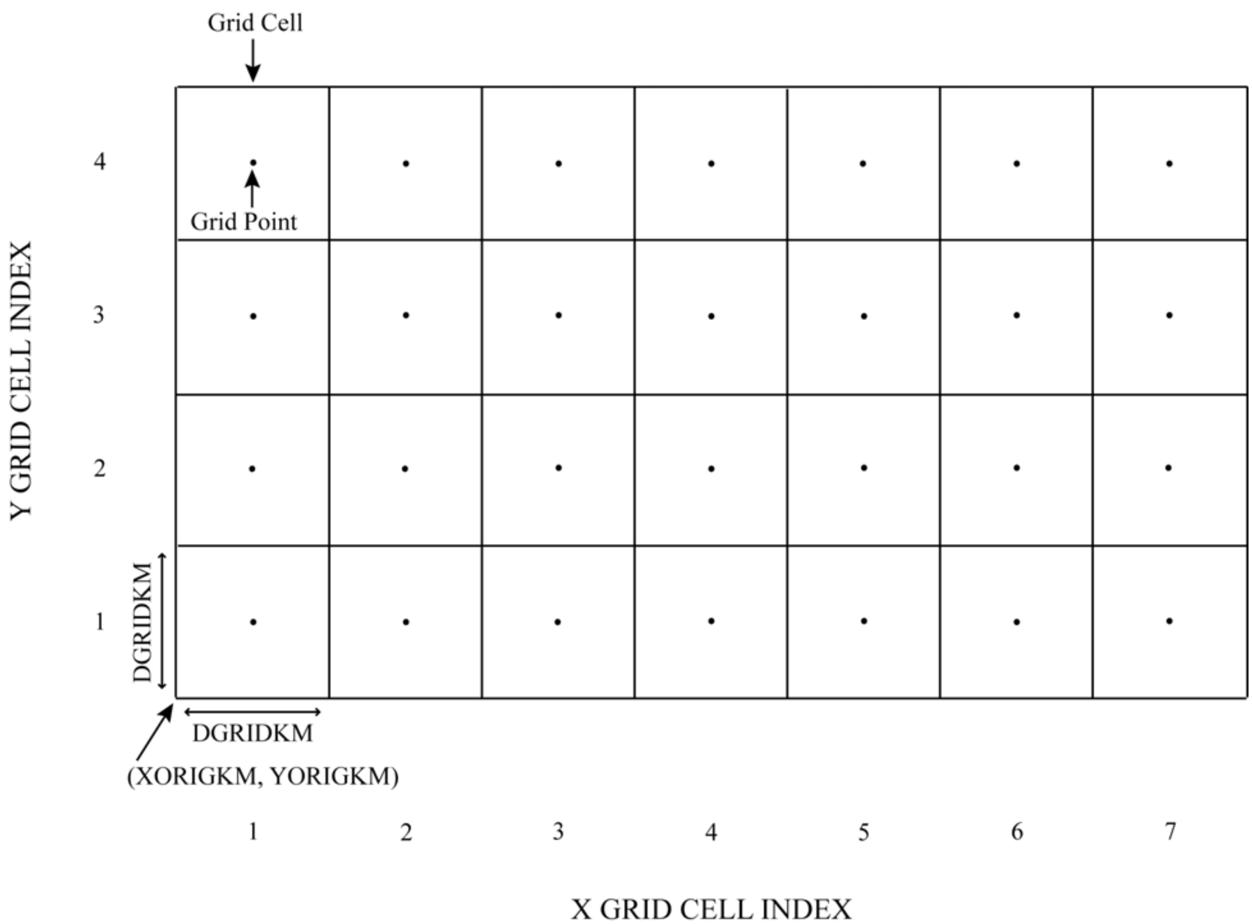


Figure D-3. CALMET non-staggered horizontal grid system. All variables are defined at the grid points located in the center of each grid cell. The grid origin (X_o, Y_o) is also shown.

CALMM5 must be run on the platform where MM5 was initially run or a system with compatible binary format. This constraint arises from the fact that MM5 output is binary and therefore may be machine-dependent. Compilation options (Fortran) for CALMM5 are also machine-dependent (e.g., on a Dec Alpha: *f77 -convert big_endian calmm5.f*). But the CALMM5 output files is itself machine-independent (currently only in ASCII format).

Detailed information about MM5 settings is included in the list file (CALMM5.LST). Information needed for consistency in CALMET is included in the 3D.DAT header records as well. In particular, the type of map projection used in MM5 is listed. Note that CALMET does not handle polar stereographic projection and, in that case, CALMM5 simply converts (U, V) to wind speed and wind direction without further processing of the wind direction. For Lambert conformal projection however, CALMM5 converts the MM5 (U, V) to wind speed and wind direction with respect to true North.

CALMM5 preprocessor requires a set of common block and parameter files for compiling. It needs one user-input file to run (CALMM5.INP, hard-wired filename), and produces two or three output files (CALMM5.LST and 3D.DAT, and 2D.DAT if users select). Output filenames are determined by users.

<u>CALMM5 Input Files</u>

MM5 binary output file

Standard MM5 binary output file of the type: MMOUT_DOMAIN#.

CALMM5.INP

In CALMM5.INP, the user can specify the input and output file names, the period and the boundaries of the subdomain to extract, the output format (3D.DAT), and which of the optional variables are output.

There are six sets of variables a user can request, in addition to the default output variables (pressure, elevation, temperature, wind speed and wind direction):

1. Vertical velocity
2. Relative humidity and vapor mixing ratio
3. Cloud and rain mixing ratios (only combined with option 2)
4. Ice and snow mixing ratios (only combined with options 2+3)
5. Graupel mixing ratio (only combined with options 2+3+4)
6. Surface 2-D variables

If the user requests output variables unavailable in MM5, CALMM5 issues a warning in the list file (CALMM5.LST or user-defined filename) and stops. For example, vertical velocity is only available in non-hydrostatic MM5 runs.

A sample CALMM5.INP is shown in Table D-5 and a description of each input variable is provided in Table D-6.

CALMM5 Output Files

CALMM5.LST

The list file contains information about the MM5 file and reports on CALMM5 processing, including warnings and error messages. A sample list file is shown in Table D-7.

3D.DAT, 2D.DAT

A sample 2D.DAT file is shown in Table D-8 and each variable is described in Table D-9. A sample 3D.DAT file is shown and described in section (D.5).

Table D-5

CALMM5 Sample Control File

(CALMM5.INP)

```
CALMM5 VER3 for MM5 Domain 1
2               ! Number of MM5 input files (filenames follow)
MMOUT_DOMAIN1A ! MM5 input file name (no space before or within filename)
MMOUT_DOMAIN1B ! MM5 input file name (no space before or within filename)
Samp3D.dat     ! CALMM5 output file name  (no space before or within filename)
calmm5.lst     ! CALMM5 list file name (no space before or within filename)
2              ! Options for selecting a region (1 = use lat/long; 2 = use J/I)
3              ! Southernmost latitude (in decimal, positive for NH), or J1/Y1
6              ! Northermost  latitude (in decimal, positive for NH), or J2/Y2
5              ! Westernmost  longitude (in decimal, negative for WH), or I1/X1
8              ! Easternmost  longitude (in decimal, negative for WH), or I2/X2
2001122912     ! Starting UTC date-hour (YYYYMMDDHH)
2001122913     ! Ending UTC date-hour (YYYYMMDDHH)
1              ! Output format (1-3D.DAT, 2-MM4, 3-GrADS, 4-void, 5- void, 6-GRIB)
Keep this line - The following lines vary depending on the output format selected
1 1 1 0 0      ! Output W, RH, cloud and rain, ice and snow, graupel (0=no;
1              ! Flag for 2-D variables output (0 = no 2-D output ; 1 = 2-D output)
samp2D.dat     ! File name for 2-D variable output (needed only if 2-D Flag=1)
1              ! Lowest extraction level in MM5
32             ! Highest extraction level in MM5
```

Table D-6

CALMM5 Control File Inputs (CALMM5.INP)

Line	Variable	Type	Description
1	TITLE	character*80	Title line for CALMM5.INP
2	NFILE	integer	Number of MM5 files to process
3	INFILE	character*80	Name of MM5 binary input file(s) (NFILE records)
3+NFILE	OUTFILE	character*80	Name of output data file
4+NFILE	LOGFILE	character*80	Name of output list file
5+NFILE	ISELECT	integer	Sub-domain selection method: 1 = Use latitudes and longitudes to select a sub-domain 2 = Use (I,J) to select a sub-domain
6+NFILE	RLATMIN/ JMIN	real/integer	Southernmost latitude or J of the sub-domain to extract (in degrees)
7+NFILE	RLATMAX/ JMAX	real/integer	Northernmost latitude or J of the sub-domain to extract (in degrees)
8+NFILE	RLONMIN/ IMIN	real/integer	Westernmost longitude or I of the sub-domain to extract (negative in Western hemisphere; in degrees)
9+NFILE	RLONMAX/ IMAX	real/integer	Easternmost longitude or I of the sub-domain to extract (negative in Western hemisphere; in degrees)
10+NFILE	IBEG	integer	Beginning date-hour of the period to extract (UTC) - Format: YYYYMMDDHH
11+NFILE	IEND	integer	Ending date-hour of the period to extract (UTC) - Format: YYYYMMDDHH
12+NFILE	IFORMAT	integer	Output data file format: 1 = 3D.DAT (for CALMET) 2 = MM4.DAT 3 = GrADS 4 = invalid 5 = invalid 6 = GRIB

Table D-6 (Concluded)
CALMM5 Control File Inputs (CALMM5.INP)

Line	Variable	Type	Description
13+NFILE	CNOTE	character*80	Indicator for additional information for different output formats
14+NFILE	IOUTW	integer	Flag to output vertical velocity
	IOUTQ	integer	Flag to output relative humidity and vapor mixing ratio
	IOUTC*	integer	Flag to output cloud and rain mixing ratios
	IOUTI*	integer	Flag to output ice and snow mixing ratios
	IOUTG*	integer	Flag to output graupel mixing ratio
15+NFILE	IOSRF	integer	Flag to output surface 2-D variables
16+NFILE	SRFILE	character*80	Name of surface 2-D output file (IOSRF=1 only)
17+NFILE	NZ1	integer	Lowest sigma layer extracted (1 for first layer)
18+NFILE	NZ2	integer	Highest sigma layer extracted (1 for first layer)

IOUTC=1 only if IOUTQ=1
IOUTI=1 only if IOUTC=IOUTQ=1
IOUTG=1 only if IOUTI=IOUTC=IOUTQ=1

Table D-7
Example CALMM5 List File (CALMM5.LST)

```
CALMM5 Version: 2.1                Level: 040112


 Output Data Set Name: 3D.DAT
 Data Set Version: 2.0                Level: 040112


CALMM5 VER3 for MM5 Domain 1

Input file:   MMOUT_DOMAIN1
Output file:  samp.m3d

Log file:     calmm5.lst


Select region based on (1, lat/lon; 2, J/I):   2
Selected I/J range from Input:     5    8    3    6
 beginning date:   2001122912
 ending    date:   2001122913

output format:  1 -- MM5

 ----- Output File -----
Output File Name:samp.m3d

 2-D output flag:            1
 2-D output file: samp.m2d
   ioutw: 1
   ioutq: 1
   ioutc: 1
   iouti: 0
   ioutg: 0
   iosrf: 1

 Vertical range extracted:           1           32
  Porcessing mm5 big header

  starting date of mm5 output data:   2001122900

  Model initial hour:            1           12           29             0

 mm5 options:

 Fake dry run:            0
    non hydrostatic run
      reference pressure p0 :   100000.0 pa
      reference temperature :      275.0 k
      ref. temperature lapse rate : 50.0 k/500mb

 Model Top Pressure:     100.0000
 mm5 domain id:            1
```

Table D-7 (Concluded)
Example CALMM5 List File (CALMM5.LST)

```
 lambert conformal map projection
    center latitude  (degrees):     47.00000
    center longitude (degrees):     52.50000
    true latitude 1  (degrees):     60.00000
    true latitude 2  (degrees):     30.00000
    cone factor:    0.7155668
    SW dot point X/Y:    -1360.000       -1360.000

 nx in MM5 (east)    :            35
 ny in MM5 (north)   :            35
 nz in MM5 (vertical):            32
 dxy in MM5 (km)     :     80.00000

Selected domain I:     5    8
                J:     3    6
  Number of Grids:     4    4
Selected domain SW lat/lon:       35.170      40.796
Selected domain SW     X/Y:    -1040.013   -1200.089
   from grid point x=   5  to    8
   from grid point y=   3  to    6
   latitude  range:     35.170  to:     37.648
   longitude range:     40.390  to:     43.471

 Data Created

 ---- Successful Calmm5 Run -----
```

Table D-8
Sample of MM5 Derived Gridded Surface 2-D Variables

```
2D.DAT          2.0             Header Structure with Comment Lines
   1
Produced by CALMM5 Version: 2.1     , Level: 040112
  1  1  1  0  0  1
LCC    47.0000    52.5000  60.00  30.00 -1360.000 -1360.000  80.000  35  35 32
  1  4  1  5  2  1  1  0  1  1  1  1  1  1  1  1  1  1  1  1 25
2001122912    2   4   4  32
   5   3   8   6   1  32   40.3905   43.4707  35.1695  37.6475
 0.998
 0.995
 0.992
 0.988
 0.983
 0.978
 0.972
 0.966
 0.959
 0.951
 0.942
 0.931
 0.920
 0.907
 0.892
 0.876
 0.857
 0.837
 0.813
 0.787
 0.758
 0.725
 0.688
 0.646
 0.599
 0.547
 0.487
 0.421
 0.346
 0.262
 0.168
 0.059
   5   3  35.1695   40.7959  274 19   35.5861   41.1768  266
   6   3  35.2723   41.6849  236  8   35.6855   42.0720  272
   7   3  35.3671   42.5765  194  8   35.7768   42.9698  209
   8   3  35.4537   43.4707  192  8   35.8599   43.8701  293
   5   4  35.8957   40.6638  330  8   36.3136   41.0481  388
   6   4  35.9999   41.5625  333  8   36.4144   41.9532  405
   7   4  36.0959   42.4641  337  8   36.5069   42.8611  462
   8   4  36.1837   43.3681  440  6   36.5912   43.7715  796
   5   5  36.6232   40.5287  445  6   37.0424   40.9165  510
   6   5  36.7287   41.4374  470  2   37.1445   41.8318  577
   7   5  36.8260   42.3490  614  6   37.2383   42.7499 1011
   8   5  36.9150   43.2632  976 10   37.3237   43.6706 1637
   5   6  37.3518   40.3905  684  6   37.7724   40.7818  814
   6   6  37.4588   41.3094  718  6   37.8758   41.7075  970
   7   6  37.5574   42.2313 1035  7   37.9708   42.6360 1582
   8   6  37.6475   43.1559 1600  6   38.0574   43.5673 2172
```

Table D-8 (Concluded)
Sample of MM5 Derived Gridded Surface 2-D Variables

```
2001122912  GROUND T
   283.313   283.112   281.149   277.878
   286.168   285.459   284.243   281.851
   287.755   287.333   286.963   286.019
   288.913   289.806   289.942   289.571
2001122912  PBL HGT
   705.050   631.557   673.477   864.322
   595.731   434.415   389.173   502.431
   406.427   320.297   313.579   317.165
   323.061   255.215   205.607   329.696
2001122912  SHFLUX
    -1.269    -4.073    -3.807     0.320
     4.609    -1.589    -2.952    -1.557
     4.200     1.176    -1.228    -1.915
     2.375     3.327     0.784    -2.030
2001122912  LHFLUX
    11.769    14.301    10.768     2.953
    15.595    15.261    12.458     5.726
     4.389     5.470     8.807     7.591
     4.104     3.340     6.409     7.585
2001122912  UST
     0.322     0.415     0.411     0.432
     0.239     0.304     0.340     0.288
     0.129     0.180     0.242     0.208
     0.118     0.118     0.135     0.142
2001122912  SWDOWN
    60.960    58.894    47.135    25.467
   110.909    71.010    44.944    28.382
    93.124    56.395    41.772    31.818
    71.378    59.747    59.475    42.385
2001122912  LWDOWN
   347.519   346.362   341.203   334.386
   344.357   353.104   354.527   348.864
   355.508   363.698   367.030   366.451
   366.351   373.049   375.877   380.738
2001122912  T2
   283.360   283.205   281.250   277.917
   286.005   285.499   284.339   281.925
   287.394   287.186   287.038   286.141
   288.660   289.507   289.850   289.919
2001122912  Q2
     7.899     7.788     7.184     6.346
     8.475     8.350     7.938     7.394
     8.843     8.819     8.655     8.460
     8.766     8.958     8.886     8.489
2001122912  U10
    -0.795    -2.630    -2.086     0.795
    -0.621    -3.063    -3.624    -1.749
    -0.133    -2.153    -3.236    -2.766
     0.754    -0.480    -1.581    -2.042
2001122912  V10
     3.266     3.591     3.807     4.077
     2.310     2.142     1.870     2.067
     0.982     0.524     0.013     0.016
    -0.763    -1.064    -0.813    -0.093
2001122912  TSEASFC
   281.832   280.856   278.425   275.254
   282.847   282.850   282.031   279.004
   283.728   284.459   284.794   283.493
   285.112   286.237   286.885   287.299
```

Table D-9
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

HEADER RECORDS

Header Record #1

Variable No.	Variable	Type	Description
1	CNAME	char*16	Data set name
2	DATAVER	char*16	Data set version
3	DATAMODD	char*64	Data set mod
			Format(2a16,a64)

Header Record #2

Variable No.	Variable	Type	Description
1	NCOMM	integer	Number of comment lines
			Format(i4)

Header Records #3 – N (N=3+NCOMM-1)

Variable No.	Variable	Type	Description
1	COMMENT	char*132	Comment lines
			Format(a132)

Header Record #N+1

Variable No.	Variable	Type	Description
1	IOUTW	Integer	Flag indicating if vertical velocity is recorded.
2	IOUTQ	Integer	Flag indicating if relative humidity and vapor mixing ratio are recorded
3	IOUTC	Integer	Flag indicating if cloud and rain mixing ratios are recorded.
4	IOUTI	Integer	Flag indicating if ice and snow mixing ratios are recorded.
5	IOUTG	Integer	Flag indicating if graupel mixing ratio is recorded.
6	IOSRF	Integer	Flag indicating if surface 2-D variables is recorded
			Format (6i3)

Table D-9 (Continued)
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

HEADER RECORDS

Header Record #N+2

Variable No.	Variable	Type	Description
1	MAPTXT	char*3	Map projection in MM5 LCC: Lambert Land Conformal Projection
2	rlatc	real	Center latitude (positive for northern hemisphere)
3	rlonc	real	Center longitude (positive for eastern hemisphere)
4	truelat1	real	First true latitude
5	truelat2	real	Second true latitude
6	x1dmn	real	SW dot point X coordinate (km, Grid 1,1) in MM5
7	y1dmn	real	SW dot point Y coordinate (km, Grid 1,1) in MM5
8	dxy	real	Grid size (km)
9	nx	integer	Number of grids in X-direction (West-East) in MM5
10	ny	integer	Number of grids in Y-direction (South-North) in MM5
11	nz	integer	Number of sigma layers in MM5
			Format(a4,f9.4,f10.4,2f7.2,2f10.3,f8.3,2i4,i3)

Header Record #N+3

Variable No.	Variable	Type	Description
1	INHYD	integer	0: hydrostatic MM5 run - 1: non-hydrostatic
2	IMPHYS	integer	MM5 moisture options. 1: dry 2: removal of super saturation 3: warm rain (Hsie) 4: simple ice scheme (Dudhia) 5: mixed phase (Reisner) 6: mixed phase with graupel (Goddard) 7: mixed phase with graupel (Reisner)
3	ICUPA	integer	MM5 cumulus parameterization 1: none 2: Anthes-Kuo 3: Grell 4: Arakawa-Schubert 5: Fritsch-Chappel 6: Kain-Fritsch 7: Betts-Miller

Table D-9 (Continued)
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

HEADER RECORDS

Header Record #N+3

Variable No.	Variable	Type	Description
4	IBLTYP	integer	MM5 planetary boundary layer (PBL) scheme 0: no PBL 1: bulk PBL 2: Blackadar PBL 3: Burk-Thompson PBL 5: MRF PBL
5	IFRAD	integer	MM5 atmospheric radiation scheme 0: none 1: simple cooling 2: cloud-radiation (Dudhia) 3: CCM2
6	ISOIL	integer	MM5 soil model- 0: none - 1: multi-layer
7	IFDDAN	integer	1: FDDA grid analysis nudging - 0: no FDDA
8	IFDDAOB	integer	1: FDDA observation nudging - 0: no FDDA
9	IGRDT	integer	2D output flag for ground temperature (1/0)
10	IPBL	integer	2D output f lag for PBL height (1/0)
11	ISHF	integer	2D output f lag for sensible heat flux (1/0)
12	ILHF	integer	2D output f lag for latent heat flux (1/0)
13	IUSTR	integer	2D output f lag for frictional velocity (1/0)
14	ISWDN	integer	2D output f lag for short wave downward flux (1/0)
15	ILWDN	integer	2D output f lag for long wave flux (1/0)
16	IT2	integer	2D output f lag for air temperature at 2 m (1/0)
17	IQ2	integer	2D output f lag for specific humidity at 2 m (1/0)
18	IU10	integer	2D output f lag for U-wind at 10 m (1/0)
19	IV10	integer	2D output f lag for V-wind at 10 m (1/0)
20	ISST	integer	2D output f lag for SST (1/0)
21	NLAND	integer	Number of land use categories used in MM5

Format(30i3)

Table D-9 (Continued)
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

HEADER RECORDS

Header Record #N+4

Variable No.	Variable	Type	Description
1	IBYRM	integer	Beginning year of the data in the file
2	IBMOM	integer	Beginning month of the data in the file
3	IBDYM	integer	Beginning day of the data in the file
4	IBHRM	integer	Beginning hour (UTC) of the data in the file
5	NHRSMM5	integer	Length of period (hours) of the data in the file
6	NXP	integer	Number of grid cells in the X direction in the extracted sub-domain
7	NYP	integer	Number of grid cells in the Y direction in the extracted sub-domain
8	NZP	integer	Number of sigma layers in the extracted sub-domain

Format (i4,3i2,i5,4i4)

Header Record #N+5

Variable No.	Variable	Type	Description
1	NX1	integer	I-index (X direction) of the lower left corner of sub-domain
2	NY1	integer	J-index (Y direction) of the lower left corner of sub-domain
3	NX2	integer	I-index (X direction) of the upper right corner of sub-domain
4	NY2	integer	J-index (Y direction) of the upper right corner of sub-domain
5	NZ1	integer	k-index (Z direction) of lowest extracted layer
6	NZ2	integer	k-index (Z direction) of hightest extracted layer
7	RXMIN	real	Westernmost E. longitude (degrees) in the sub-domain
8	RXMAX	real	Easternmost E. longitude (degrees) in the sub-domain
9	RYMIN	real	Southernmost N. latitude (degrees) in the sub-domain
10	RYMAX	real	Northernmost N. latitude (degrees) in the sub-domain

Format (6i4,2f10.4,2f9.4)

Table D-9 (Continued)
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

HEADER RECORDS

Next NZP Records

Variable No.	Variable	Type	Description

1	SIGMA	real array	Sigma values used by MM5 to define each of the NZP layers (half-sigma levels) read as:
			`do 10 I=1,NZP`
			`10 READ (iomm4,20) SIGMA(I)`
			`20 FORMAT (F6.3)`

Next NXP*NYP Records

Variable No.	Variable	Type	Description
1	IINDEX	integer	I-index (X direction) of the extracted grid point in original MM5 domain.
2	JINDEX	integer	J-index (Y direction) of the extracted grid point in original MM5 domain.
3	XLATDOT	real array	Latitude (degrees) of the extracted grid point, positive values for the Northern Hemisphere, negative values for the Southern Hemisphere. –999. for missing values.
4	XLONGDOT	real array	Longitude (degrees) of the extracted grid point, positive values for the Eastern Hemisphere, negative values for the Western Hemisphere. –999. for missing values.
5	IELEVDOT	integer array	Terrain elevation of the extracted grid point at dot position (m MSL)
6	ILAND	integer array	MM5 landuse categories at extracted cross points (-9 for missing values)
7	XLATCRS	real array	Same as XLATDOT but at cross point
8	XLATCRS	real array	Same as XLATDOT but at cross point
9	IELEVCRS	integer array	Same as IELEVDOT but at cross point

Format (2i4, f9.4, f10.4, i5, i3, 1x, f9.4, f10.4,i5)

Table D-9 (Concluded)
MM5 Derived Surface 2-D Variables File Format (2D.DAT)

DATA RECORDS

Next N2D Record Pairs
(N2D: Number of output 2-D variables given in Header Record #N+3)

Data Record #1

Variable No.	Variable	Type	Description
1	MYR	integer	Year of the 2-D variable (YYYY)
2	MMO	integer	Month of the 2-D variable
3	MDAY	integer	Day of the 2-D variable
4	MHR	integer	UTC Hour of the 2-D variable
5	Vname	char*8	Name of 2-D variable

Data Record #2

Variable No.	Variable	Type	Description

1	xvar	real array (nxp by nyp)	Values of named 2-D variable
			Read using :
			`do j=ny2,ny1,-1`
			`Read(iunit,1010)(xx(i,j),I=nx1,nx2)`
			`enddo`
			`1010 format(8f10.3)`
			
			Units: K for temperature, m for PBL height, w/m**2 for heat flux, m/s for frictional velocity

D.2 CALETA Preprocessor

CALETA operates on the output from the National Centers for Environmental Prediction (NCEP) operational North American Mesoscale (NAM) model, formerly known as the Eta model, and the high-resolution simulation products from the Weather Research and Forecasting (WRF) model. Eta/NAM/WRF model output files are produced for use by the Advanced Weather Interactive Processing System (AWIPS) in various AWIPS grids. Gridded model output is stored in GRIB format, and consists of analysis and forecast fields for multiple parameters and levels. CALETA extracts and reformats a subset of these fields, and creates a 3D.DAT file for CALMET (see section D.5).

Several datasets are available, corresponding to AWIPS grids that cover the United States at various spatial resolutions:

- AWIPS Grid 212 -- Continental U.S., 40km (NAM)
- AWIPS Grid 218 -- Continental U.S., 12km (NAM)
- AWIPS Grid 245 -- Eastern U.S., 8km (WRF)
- AWIPS Grid 246 -- Western U.S., 8km (WRF)
- AWIPS Grid 247 -- Central U.S., 8km (WRF)
- AWIPS Grid 248 -- Puerto Rico, 8km (WRF)
- AWIPS Grid 249 -- Alaska, 10km (WRF)
- AWIPS Grid 250 -- Hawaii, ~8km (WRF)

Maps of these domains are reproduced in Figures D-4 and D-5. Due to large size of files, the AWIPS 218 domain is processed into 54 tiles shown in Figure D-6. Characteristics of each of these AWIPS grid products are summarized in Table D-10. For AWIPS 212, 218, and 245, the vertical resolution is 25 hPa from 1000 hPa to 50 hPa, for a total of 39 levels. Nine vertical levels are available (1000, 925, 850, 700, 600, 500, 400, 300 and to 200 hPa.) for the other AWIPS grids.

The run frequency is four times per day for AWIPS 212 and 218, at initial hours of 00, 06, 12, and 18 UTC. It is once per day for AWIPS 245, 246, 247, and 249; and twice per day for AWIPS 248 and 250. The initial time is 00 UTC for Alaska (AWIPS 249), 06 UTC for the western US (AWIPS 246), 12 UTC for the central US (AWIPS 247), and 18 UTC for the eastern US (AWIPS 245). The initial time is 00, 12 UTC for Hawaii (AWIPS 250) and 06, 18UTC for Puerto Rico (AWIPS 248).

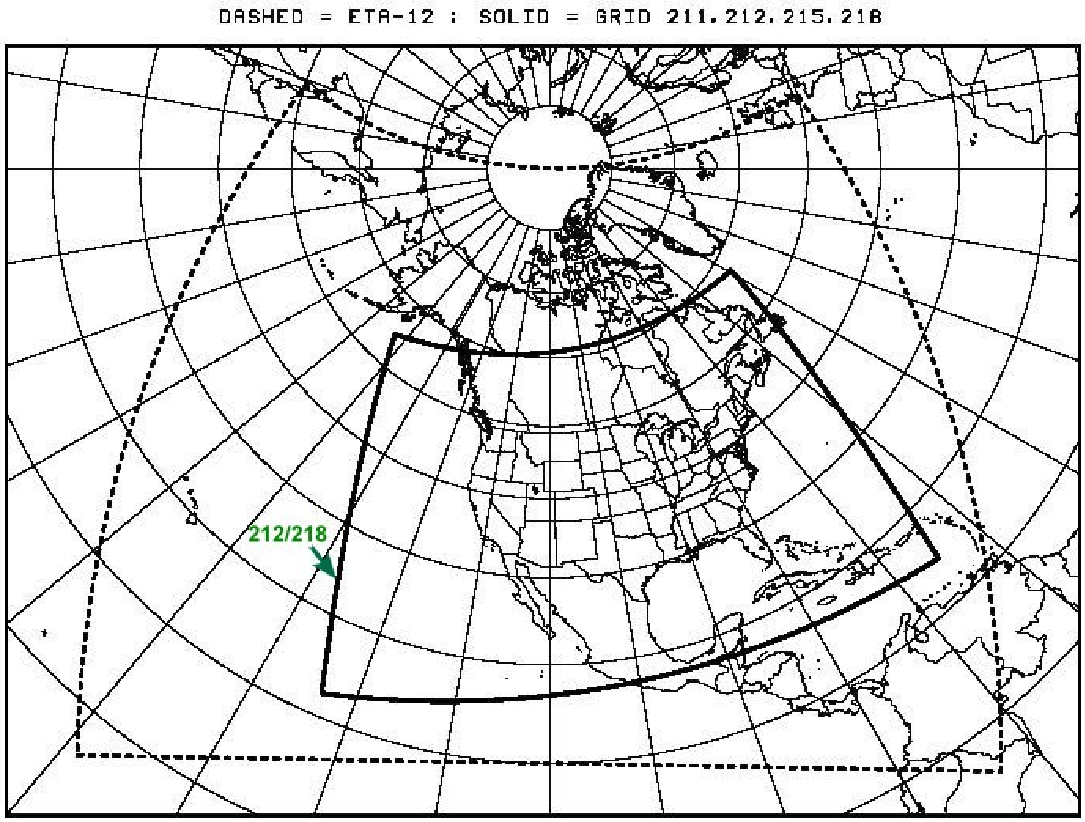


Figure D-4. Domain coverage for AWIPS 212 and 218 grids.

AWIP Domains for 245,246,247,248,249, and 250 Grids

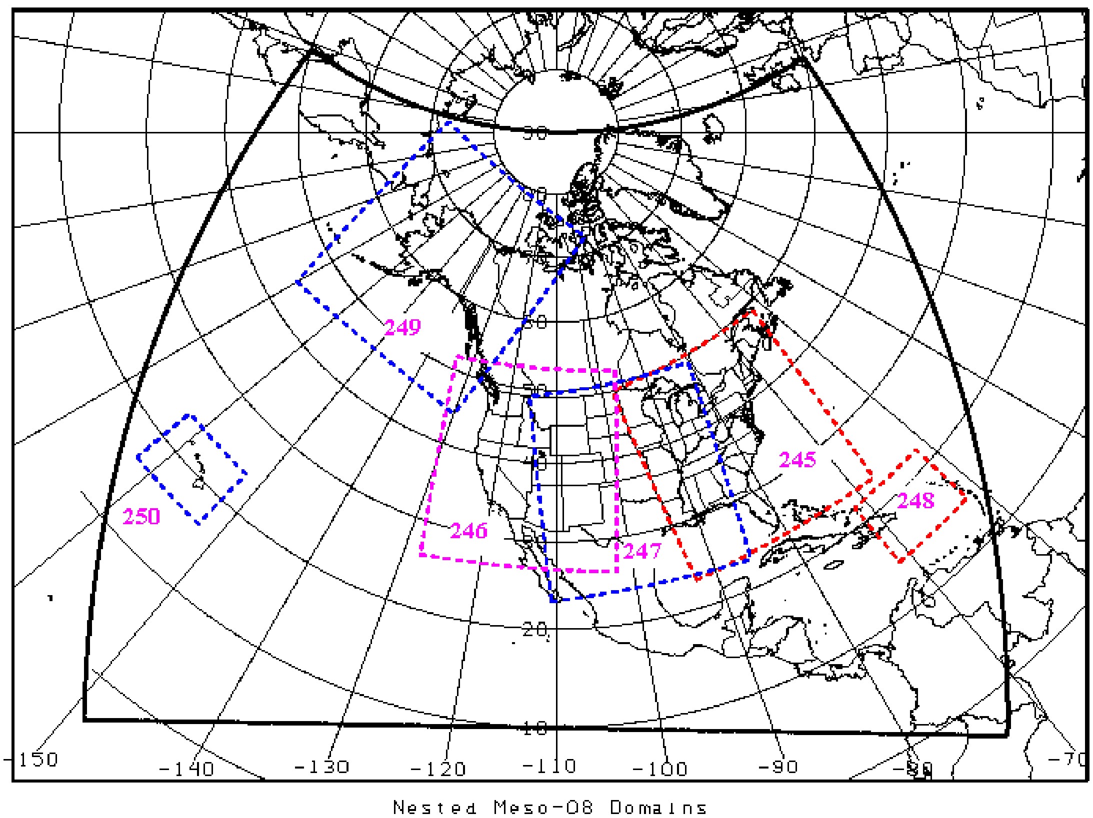


Figure D-5. Domain coverage for AWIPS 245, 246, 247, 248, 249, and 250 grids.

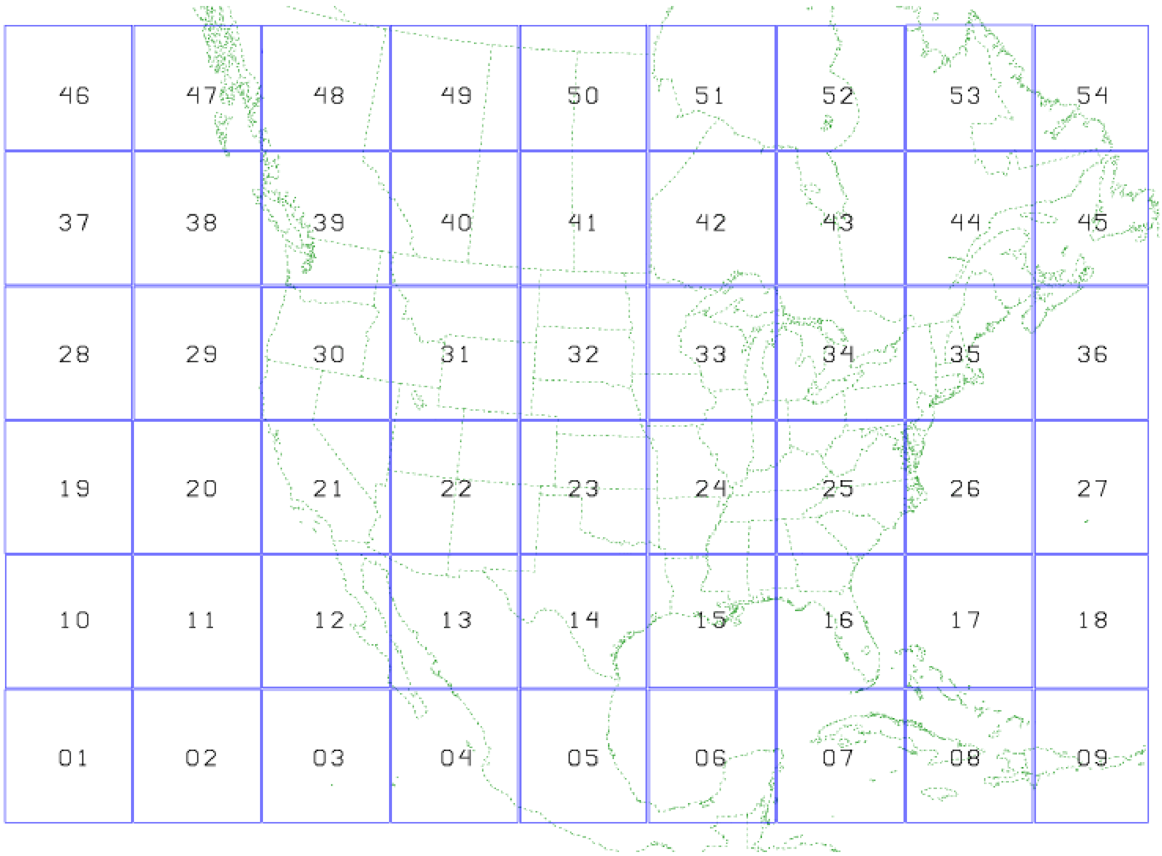


Figure D-6. Tiles for AWIPS 218 grid.

Table D-10

AWIPS Grid Formats Processed by CALETA.

Model	Output Grid Format (AWIPS)	Covered Area	Grid Resolution	Vertical Levels	Run Time (UTC)
ETA/NAM	212	North America	40 km Lambert Conformal	Surface, 1000-50 hPa, every 25 hPa	00, 06, 12, 18
ETA/NAM	218	North America (54 tiles)	12 km Lambert Conformal	Surface, 1000-50 hPa, every 25 hPa	00, 06, 12, 18
WRF/ETA	245	Eastern US	8 km Lambert Conformal	Surface, 1000-50 hPa, every 25 hPa	18
WRF/ETA	246	Western US	8 km Lambert Conformal	Surface, 1000-200 hPa in nine levels	06
WRF/ETA	247	Central US	8 km Lambert Conformal	Surface, 1000-200 hPa in nine levels	12
WRF/ETA	248	Puerto Rico	0.075^o X 0.075^o Latitude/Longitude	Surface, 1000-200 hPa in nine levels	06, 18
WRF/ETA	249	Alaska	10 km Polar Stereographic	Surface, 1000-200 hPa in nine levels	00
WRF/ETA	250	Hawaii	0.075^o X 0.075^o Latitude/Longitude	Surface, 1000-200 hPa in nine levels	00, 12

CALETA Input Files

AWIPS GRIB file

All AWIPS files used by CALETA can be downloaded for the NCEP web site:

ftpprd.ncep.noaa.gov:/pub/data/nccf/com/nam/prod/

AWIPS 212 files also exist at the NWS web site:

tgftp.nws.noaa.gov:/SL.us008001/ST.opnl.

The content of AWIPS212 files on these two web sites is the same, but the naming convention is different. Examples of file names on these web sites are listed in Table D-11. These names do not contain the date associated with the start of each model application period. Therefore, the files must either be stored in separate folders or renamed. If files are not renamed, they should be placed in folders that carry the date and time of the run in the form: YYYYMMDDHH. If they are renamed, CALETA expects an extension at the end of the original name. The form of this extension is "AWIPSXXX_YYYYMMDD" for files downloaded from the NCEP web site, and "AWIPSXXX_YYYYMMDDHH" for files downloaded from the NWS web site, where "XXX" is the AWIPS grid and "YYYYMMDDHH" is the UTC year, month, day and hour of initial date and time. Examples of renamed files are also listed in Table D-11.

CALETA.INP

In CALETA.INP, the user specifies the path of input AWIPS files, output file name, horizontal and vertical ranges for extraction, the AWIPS grid format, beginning and ending dates, time interval of initial hours of the runs, and three flags identifying the running mode and file naming convention. An example of CALETA.INP is given in Table D-12 and described in Table D-13. In CALETA.INP, the content after "!"is made up of comments that are not read by the program. There should be no blank space at the beginning of any records, but there should be at least on blank space before "!" if it exists.

Record 2 of CALETA.INP is the path of downloaded AWIPS files. For original AWIPS file names, files must reside in subdirectories of this path with a name of the form YYYYMMDDHH. For example, if Record 2 is "d:\task2\eta\" and users want to create a 3D.DAT file using the simulation run at initial hour 06 UTC on April 2, 2005, AWIPS GRIB files should reside in the directory "d:\task2\eta\2005040206\". The subdirectory "2005040206" should not be included in Record 2, since the code will add this subdirectory name to the path listed in Record 2. For renamed AWIPS file names, Record 2 is the actual path of renamed files. For example, all files should be in the "d:\task2\eta\" if downloaded files have been renamed. The back slash ("\") at the end of the path is needed; otherwise errors will occur. If the path is current directory, ".\" should be used.

Table D-11
Sample Names of AWIPS GRIB Files

AWIPS Grid	Downloaded File Name	Renamed File Name
212	nam.tHHz.awip3dFH.tm00	nam.tHHz.awip3dFH.tm00.awips212_YYYYMMDD
212(NWS)	fh.00FH_tl.press_gr.awip3d	fh.00FH_tl.press_gr.awip3d.awips212_YYYYMMDDHH
218	nam.tHHz.awip218FH.TL	nam.tHHz.awip218FH.TL.awips218_YYYYMMDD
245	eastnmm.tHHz.awfullFH.tm00	eastnmm.tHHz.awfullFH.tm00.awips245_YYYYMMDD
246	westnmm.tHHz.awpregFH.tm00	westnmm.tHHz.awpregFH.tm00.awips246_YYYYMMDD
247	centnmm.tHHz.awpregFH.tm00	centnmm.tHHz.awpregFH.tm00.awips247_YYYYMMDD
248	prnmm.tHHz.awpregFH.tm00	prnmm.tHHz.awpregFH.tm00.awips248_YYYYMMDD
249	aknmm.tHHz.awpregFH.tm00	aknmm.tHHz.awpregFH.tm00.awips249_YYYYMMDD
250	hinmm.tHHz.awpregFH.tm00	hinmm.tHHz.awpregFH.tm00.awips250_YYYYMMDD

HH is the initial hour in UTC for ETA/NAM runs
FH is the forecast hours from initial hour
TL is tile number for AWIPS 218 tiled files
YYYYMMDDHH is the 4-digit year and 2-digit month, day, and hour (UTC)

Table D-12

Example CALETA Control File (CALETA.INP)

```
ETA Model in AWIPS 212 Grid
E:\data\all\    ! Directory of Input ETA GRIB files
.\test3D.dat    ! Output 3D.DAT file name (no space before or within filename)
caleta.lst      ! List file name  (no space before or within filename)
30,31           ! Range of Lat (positive for Northern Hemisphere),grid size
-98,-96.5       ! Range of Lon (negative for Western Hemisphere),grid size
1,25            ! Range of vertical levels selected
212             ! AWIPS Flag (212,218,245,246,247,248,249,250)
2005041418      ! Beginning UTC Date-Hour (YYYYMMDDHH) for 3D.DAT file
2005041600      ! Ending UTC Date-Hour (YYYYMMDDHH) for 3D.DAT file
6               ! Time interval (hours) between ETA runs
1               ! File naming convention (1 = renamed; 0 = original)
1               ! Run mode (1 = Hybrid; 0 = Forecast)
1               ! Web site (1 = NCEP; 0 = NWS) where ETA GRIB file downloaded
```

Table D-13

CALETA Control File Inputs (CALETA.INP)

Line	Variable	Type	Description
1	TITLE	character*80	Title for CALETA application
2	INFILE	character*80	Path name of AWIPS input files
3	OUTFILE	character*80	Output 3D.DAT file name
4	LOGFILE	character*80	Output list file name
5	RLATMIN/ RLATMAX	real	Southernmost and northernmost latitudes of the sub-domain to extract (positive in Northern hemisphere; in degrees)
6	RLONMIN/ RLONMAX	real	Westernmost and Easternmost longitude of the sub-domain to extract (negative in Western hemisphere; in degrees)
7	NZMIN/ NXMAX	integer	Lowest and highest vertical levels of the sub-domain to extract
8	IDAWP	integer	AWIPS grid format (212, 218, 245-250)
9	IDATEB	integer	Beginning UTC date-hour of 3D.DAT
10	IDATEE	integer	Ending UTC date-hour of 3D.DAT
11	IHRRUN	integer	Hours between ETA runs (6 hours for AWIPS 212, 218; 24 hours for AWIPS 245-247, 249; 12 hours for AWIPS 248,250)
12	IDFRMT	integer	Flag of file naming convention: 0 = original file name; 1 = renamed file name
13	IDRUN	integer	Flag of CALETA run mode: 0 = Forecast mode; 1= Hybrid mode.
14	IDWEB	integer	Flag of web site for AWIPS file downloading: 0 = NWS site; 1 = NCEP site

Users are responsible for choosing correct horizontal and vertical ranges and correct AWIPS grid format in Records 5-8, especially for the high-resolution WRF domains, although the code will check for consistency. Extracted horizontal and vertical ranges should be within corresponding AWIPS domains. Users should consult Figures D-4 and D-5 for geographical coverage. Vertical levels in current AWIPS files are listed in Table D-10. Selected vertical range in Line 7 should be within these limits.

Line 11 is the time interval in hours of initial ETA/NAM runs. The interval is 6 hours for AWIPS 212 and 218, 24 hours for AWIPS 245-247, 249, and 12 hours for AWIPS 248 and 250.

Line 12 is the flag for file naming convention. It should be "1" if file names have been renamed following the rule in Table D-11. It should be "0" if files keep their downloaded names; again users are reminded to put files in date-hour subdirectories in this case.

Line 13 is the flag for run mode. The flag is "0" if running CALETA in the forecast mode, and it is "1" for the hybrid mode (see below).

Line 14 is the flag for the web site, where AWIPS files are downloaded. This flag should be "1" if files are downloaded from the NCEP wet site, and it is "0" for files from the NWS web site. Since only AWIPS 212 files from the NWS web site can be used to create 3D.DAT file, this flag may be set to zero only for AWIPS 212 files. For all other AWIPS files, this flag must be set to "1".

CALETA can be applied in both forecast mode and historical mode (hybrid mode). In the forecast mode, CALETA uses AWIPS files from ***one*** run to create a 3D.DAT file. Table D-14 gives an example for AWIPS 212 GRIB files used in a 24-hour 3D.DAT file in this mode. In the hybrid mode, CALETA uses the latest AWIPS files from multiple ETA/NAM runs to create a 3D.DAT file (Table D-15). In this mode, if there are any missing files in the processing period, the latest existing files from previous runs will be used as substitutes within a 48-hour limit (Table D-16).

CALETA Output Files

CALETA.LST

The list file of CALETA records various information from processing, including user-specified input controls, configurations of AWIPS files, processed files etc. This file should be consulted if CALETA fails to produce a complete 3D.DAT. An example of list file is given in Table D-17.

3D.DAT

A sample 3D.DAT file is shown and described in section (D.5).

Table D-14

AWIPS 212 Files in CALETA Forecast Mode for 24-Hour Period Starting at 00 Z

(Files in red are those used to create 3D.DAT)

Hour	ETA - 00	ETA - 06	ETA - 12	ETA - 18
00	00			
03	03			
06	06	00		
09	09	03		
12	12	06	00	
15	15	09	03	
18	18	12	06	00
21	21	15	09	03
00	24	18	12	06
03	27	21	15	09
06	30	24	18	12
09	33	27	21	15
12	36	30	24	18
15	39	33	27	21
18	42	36	30	24
21	45	39	33	27
00	48	42	36	30
03		45	39	33
06		48	42	36
09			45	39
12			48	42
15				45
18				48

Table D-15

AWIPS 212 Files in CALETA Hybrid Mode for 24-Hour Period Starting at 00Z

(Files in red are those used to create 3D.DAT)

Hour	ETA – 00 Z	ETA – 06 Z	ETA – 12 Z	ETA – 18 Z	ETA – 00 Z
00	00				
03	03				
06	06	00			
09	09	03			
12	12	06	00		
15	15	09	03		
18	18	12	06	00	
21	21	15	09	03	
00	24	18	12	06	00
03	27	21	15	09	03
06	30	24	18	12	06
09	33	27	21	15	09
12	36	30	24	18	12
15	39	33	27	21	15
18	42	36	30	24	18
21	45	39	33	27	21
00	48	42	36	30	24
03		45	39	33	27
06		48	42	36	30
09			45	39	33
12			48	42	36
15				45	39
18				48	42

Table D-16
AWIPS 212 Files in CALETA Hybrid Mode for 24-Hour Period Starting at 00Z with Missing Files
(Files in red are those used to create 3D.DAT)

Hour	ETA – 00 Z	ETA – 06 Z	ETA – 12 Z	ETA – 18 Z	ETA – 00 Z
00	00				
03	03				
06	06	00			
09	09	03			
12	12	06	00		
15	15	09	X		
18	18	12	06	00	
21	21	15	09	X	
00	24	18	12	06	00
03	27	21	15	09	03
06	30	24	18	12	06
09	33	27	21	15	09
12	36	30	24	18	12
15	39	33	27	21	15
18	42	36	30	24	18
21	45	39	33	27	21
00	48	42	36	30	24
03		45	39	33	27
06		48	42	36	30
09			45	39	33
12			48	42	36
15				45	39
18				48	42

The missing file at ETA-12Z 3-hour forecast is substituted using the file at ETA –06Z 9-hour forecast. X marks a missing file.

Table D-17
Example CALETA List File (CALETA.LST)

```
CALETA - Version: 2.2        Level: 050414

ETA Model in AWIPS 212 Grid
Output 3D.DAT base or file: .\test.m3d
CALETA log file:     caleta.lst

Control file:caleta_212.inp
latitude  range:      30.00      31.00
longitude range:     -98.00     -96.50
Vertical Levels:        1       25
AWIPS Grid Format:    212

  Beginning date:          2005041418
  Ending Date:             2005041600
  Hours between ETA Runs:  6
  File name (Ren/Org):     1
  Run mode (Ana/Frst):     1
  Wet site (NCEP/NWS):     1
 Required starting date:    2005    4   14   18  104
 Required ending date:      2005    4   16    0  106
 Required hours/grib files:   31   11
  AWIPS format: 212 1
  Vertical levels: 39
  Vertical pressure levels:
 1 1000.00000
 2 975.000000
 3 950.000000
 4 925.000000
 5 900.000000
 6 875.000000
 7 850.000000
 8 825.000000
 9 800.000000
 10 775.000000
 11 750.000000
 12 725.000000
 13 700.000000
 14 675.000000
 15 650.000000
 16 625.000000
 17 600.000000
 18 575.000000
 19 550.000000
 20 525.000000
 21 500.000000
 22 475.000000
 23 450.000000
 24 425.000000
 25 400.000000
 26 375.000000
 27 350.000000
 28 325.000000
 29 300.000000
 30 275.000000
 31 250.000000
 32 225.000000
 33 200.000000
 34 175.000000
 35 150.000000
 36 125.000000
 37 100.000000
 38 75.0000000
 39 50.0000000
```

Table D-17 (Concluded)
Example CALETA List File

```
       Output file:.\test.m3d

       AWIPS Grid File:awips212.dat
       Selected domain I:    98  101
                       J:    36   38
         Number of Grids:     4    3
       Selected domain SW lat/lon:       30.266     -97.949
       Selected domain SW     X/Y:     -289.092    -517.491
       SWIPS domain Grids (NX/NY):   185  129
       SWIPS domain SW lat/lon:       12.190    -133.459
       SWIPS domain SW     X/Y:    -4230.687   -1939.716
        Processing:  1th file -
d:\util_wu\caleta\Data\all\nam.t18z.awip3d00.tm00.awips212_20050414
          ioutw: 1
          ioutq: 1
          ioutc: 0
          iouti: 0
          ioutg: 0
          iosrf: 0

        Output to M3D at  2005041418
        Processing:  2th file -
d:\util_wu\caleta\Data\all\nam.t18z.awip3d03.tm00.awips212_20050414
        Output to M3D at  2005041421
        Processing:  3th file -
d:\util_wu\caleta\Data\all\nam.t00z.awip3d00.tm00.awips212_20050415
        Output to M3D at  2005041500
        Processing:  4th file -
d:\util_wu\caleta\Data\all\nam.t00z.awip3d03.tm00.awips212_20050415
        Output to M3D at  2005041503
        Processing:  5th file -
d:\util_wu\caleta\Data\all\nam.t06z.awip3d00.tm00.awips212_20050415
        Output to M3D at  2005041506
        Processing:  6th file -
d:\util_wu\caleta\Data\all\nam.t06z.awip3d03.tm00.awips212_20050415
        Output to M3D at  2005041509
        Processing:  7th file -
d:\util_wu\caleta\Data\all\nam.t12z.awip3d00.tm00.awips212_20050415
        Output to M3D at  2005041512
        Processing:  8th file -
d:\util_wu\caleta\Data\all\nam.t12z.awip3d03.tm00.awips212_20050415
        Output to M3D at  2005041515
        Processing:  9th file -
d:\util_wu\caleta\Data\all\nam.t12z.awip3d06.tm00.awips212_20050415  Substitute
        Output to M3D at  2005041518
        Processing: 10th file -
d:\util_wu\caleta\Data\all\nam.t12z.awip3d09.tm00.awips212_20050415  Substitute
        Output to M3D at  2005041521
        Processing: 11th file -
d:\util_wu\caleta\Data\all\nam.t12z.awip3d12.tm00.awips212_20050415  Substitute
        Output to M3D at  2005041600
         Processing succeeded
         --------------------
```

D.3 CALRUC Preprocessor

CALRUC operates on the output from the National Centers for Environmental Prediction (NCEP) operational Rapid Update Cycle (RUC) model. Gridded model output is stored in GRIB format, and consists of analysis and forecast fields for multiple parameters and levels. CALRUC extracts and reformats a subset of these fields, and creates a 3D.DAT file for CALMET (see section D.5).

RUC datasets are available at 20km and 40km resolution, covering the same domain. A map of the domain is reproduced in Figure D-7. The NOAA/Earth System Research Laboratory RUC development group report that the key features of RUC include:

- high-frequency (every hour) short-range weather model forecasts (out to 12+ hours)
- high-frequency (every hour) 3-D objective analyses over the contiguous United States, assimilating the following types of observations:
    - commercial aircraft
    - wind profilers
    - rawinsondes and special dropwinsondes
    - surface reporting stations and buoys (including cloud, visibility, current weather)
    - GPS total precipitable water estimates
    - VAD (velocity-azimuth display) winds from NWS WSR-88D radars
    - RASS (Radio Acoustic Sounding System) - experimental
    - GOES total precipitable water estimates
    - SSM/I total precipitable water estimates
    - GOES high-density visible and IR cloud drift winds
- hybrid isentropic-sigma vertical coordinate system.

The run frequency is hourly, with hourly analysis fields. Forecast fields are produced for the subsequent 3 hours. Additional forecasts for +6, +9, and +12 hours are made every 3 hours starting at 00 UTC.

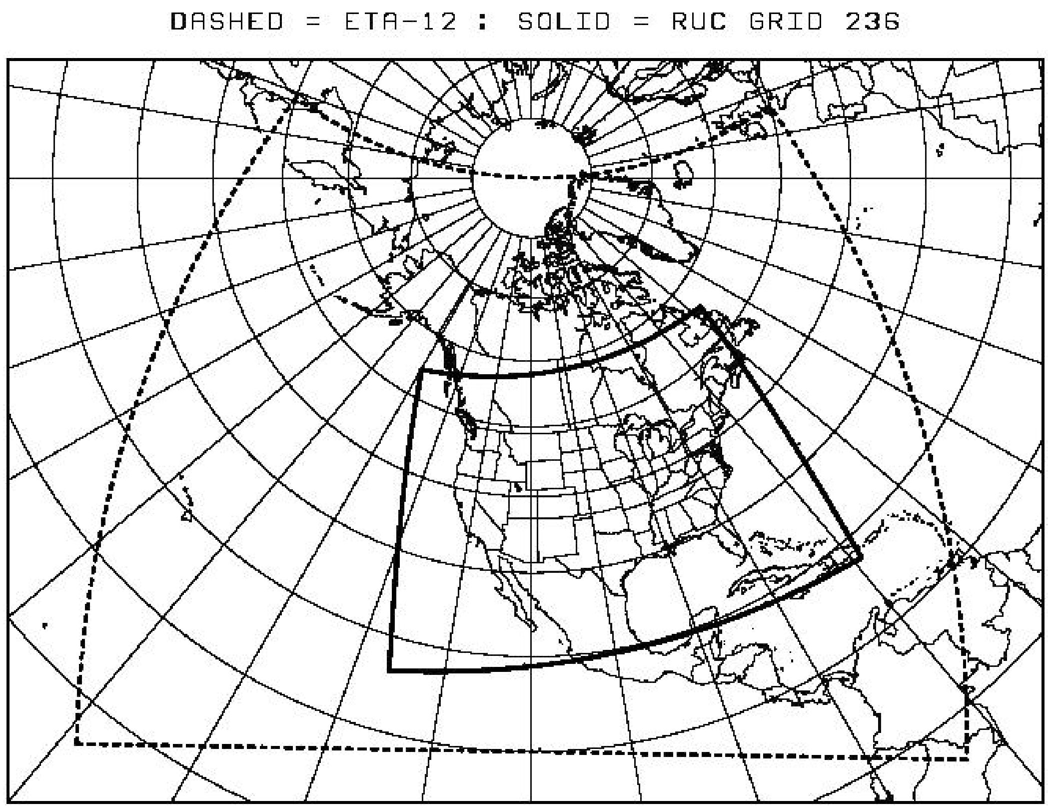


Figure D-7. Domain coverage for RUC 20km and 40km grids. Both are denoted by the solid-line boundary. The dashed-line boundary is the NAM/ETA computational domain.

CALRUC Input Files

RUC GRIB file

RUC model output files can be downloaded directly from the NCEP or NWS web site. The NCEP web site address is

ftpprd.ncep.noaa.gov:/pub/data/nccf/com/ruc/prod/

The NWS web site address is

tgftp.nws.noaa.gov:/SL.us008001/ST.opnl.

The files at the NCEP web site reside in sub-directories named:

ruc2a.YYYYMMDD

or

ruc2b.YYYYMMDD

where YYYY is the 4-digit year, MM is the two-digit month, and DD is the two-digit day. Use the data in ruc2b.YYYYMMDD if it exists.

The files at the NWS web site reside in sub-directories named:

MT.ruc_CY.HH/RD.YYYYMMDD/PT.grid.DF.gr1

where HH is the initial hour of RUC run in UTC, and YYYY is the 4-digit year, MM is the two-digit month, and DD is the two-digit day.

File names at NCEP and NMS are different, but the contents of corresponding files are the same. Table D-18 lists the file name formats. In the table, HH represents initial time of RUC runs, and hh or hhhh represents valid forecast hours corresponding to the initial hour of the RUC run. The current version of CALRUC uses a different naming convention, as indicated in Table D-18. Files downloaded from NCEP or NWS web sites must be renamed as indicated prior to running CALRUC. Note that the hybrid level versions of the RUC GRIB files are preferred for preparing 3D.DAT files for CALMET.

CALRUC.INP

In CALRUC.INP, the user specifies the beginning and ending dates, output time interval, path of input CALRUC files, output file names, the RUC grid and data type, the output format, horizontal and vertical ranges for extraction, and a user-defined shift to apply to geopotential heights. An example of CALRUC.INP is given in Table D-19 and described in Table D-20. In CALRUC.INP, the content after "!" is made up of comments that are not read by the program. There should be no blank space at the beginning of any records, but there should be at least on blank space before "!" if it exists.

Table D-18

RUC File-Naming Conventions

Web Site	Hybrid Level	Pressure Level
NCEP	Ruc2.tHHz.bgrb20anl (Analysis-20km)	Ruc2.tHHz.pgrb20anl (Analysis-20km)
	Ruc2.tHHz.bgrb20fhh (forecast-20km)	Ruc2.tHHz.pgrb20fhh (forecast-20km)
	Ruc2.tHHz.bgrbanl (Analysis-40km)	Ruc2.tHHz.pgrbanl (Analysis-40km)
	Ruc2.tHHz.bgrbfhh (forecast-40km)	Ruc2.tHHz.pgrbfhh (forecast-40km)
NWS	Fh.anal_tl.press_gr.bgrib20 (Analysis-20km)	fh.anal_tl.press_gr.us20 (Analysis-20km)
	fh.hhhh_tl.press_gr.bgrib20 (Forecast-20km)	fh.hhhh_tl.press_gr.us20 (Forecast-20km)
	fh.anal_tl.press_gr.bgrib (Analysis-40km)	fh.anal_tl.press_gr.us20 (Analysis-40km)
	fh.hhhh_tl.press_gr.bgrib (Forecast-40km)	fh.hhhh_tl.press_gr.us40 (Forecast-40km)

Rename for use in CALRUC:

CALRUC	sgpallruc20hybrX1.00.YYYMMDD.HH0000.raw.grb	sgpallruc20isobX1.00.YYYMMDD.HH0000.raw.grb
	sgpallruc40hybrX1.00.YYYMMDD.HH0000.raw.grb	sgpallruc40isobX1.00.YYYMMDD.HH0000.raw.grb

HH is the initial hour in UTC for RUC runs; hh or hhhh is the forecast hours corresponding to an initial hour RUC run. YYYYMMDD in file names is the 4-digit year, and 2-digit month and day.

Table D-19

Example CALRUC Control File (CALRUC.INP)

```
3D.DAT file Created from RUC hourly data
2005070620          ! Beginning UTC Date-Hour to process (YYYYMMDDHH)
2005070621          ! Ending UTC Date-Hour to process (YYYYMMDDHH)
1                   ! Process every X hours
.\                  ! Directory of Input RUC GRIB files
TEST3D.dat          ! Output 3D.DAT file (no space before or within filename)
TEST.lst            ! List file name  (no space before or within filename)
1                   ! Resolution of Input Data (0 = 20 km ; 1 = 40 km)
0                   ! Type of Input File (0 = hybrid ; 1 = pressure)
0                   ! Type of application (0 = analysis ; 1 = forecast)
1                   ! Output Format (0 = MM5.DAT ; 1 = 3D.DAT)
1                   ! Compress (0 = No ; 1 = Yes)
0                   ! Grid selection type (0 = i,j ; 1 = Lat/Lon)
10,15               ! Range of Lat/J (positive for Northern Hemisphere)
10,15               ! Range of Lon/I (negative for Western Hemisphere)
1,50                ! Range of vertical levels selected
5                   ! User defined shift in vertical geopotential height
```

Table D-20

CALRUC Control File Inputs (CALRUC.INP)

Line	Variable	Type	Description
1	TITLE	character*80	Title for CALRUC application
2	IDATEB	integer	Beginning UTC date-hour of 3D.DAT
3	IDATEE	integer	Ending UTC date-hour of 3D.DAT
4	NPROC	integer	Processing interval (hours)
5	INPATH	character*80	Path name of CALRUC input file directory
6	OUTFILE	character*80	Output 3D.DAT file name
7	LOGFILE	character*80	Output list file name
8	IXYGRID	integer	RUC grid resolution (0 = 20km; 1 = 40km)
9	IZGRID	integer	RUC vertical grid (0 = hybrid; 1 = pressure)
10	ITYPE	integer	Application type (0 = analysis; 1 = forecast)
11	IFORM	integer	Output format (0 = MM5.DAT; 1 = 3D.DAT) ** Select 3D.DAT for CALMET**
12	ICMPRS	integer	Compress output fields (0 = no; 1 = yes)
13	ISELECT	integer	Sub-domain selection method: 0 = Use (I,J) to select a sub-domain 1 = Use latitudes and longitudes to select a sub-domain
14	RLATMIN/ RLATMAX or JMIN/JMAX	real or integer	Southernmost and northernmost latitudes of the sub-domain to extract (<u>positive</u> in Northern hemisphere, in degrees) or minimum and maximum northing cell index
15	RLONMIN/ RLONMAX or IMIN/IMAX	real or integer	Westernmost and Easternmost longitude of the sub-domain to extract (<u>negative</u> in Western hemisphere; in degrees) or minimum and maximum easting cell index
16	NZMIN/ NXMAX	integer	Lowest and highest vertical levels of the sub-domain to extract
17	ZSHIFT	real	Shift in vertical geopotential height

CALRUC Output Files

CALRUC.LST

The list file of CALRUC records various information from processing, including user-specified input controls, configurations of RUC files, processed files etc. This file should be consulted if CALRUC fails to produce a complete 3D.DAT. An example of list file is given in Table D-21.

3D.DAT

A sample 3D.DAT file is shown and described in section (D.5).

Table D-21

Example CALRUC List File (CALRUC.LST)

```
CALRUC - Version: 1.92       Level: 050707

3D
Output CALRUC/3D.DAT file: TEST.dat
calruc log file:     TEST.lst

Resolution of Input Data (0 - 20 km, 1 - 40 km) :        1
Type of Input File (0 - hybrid, 1 - pressure) :          0
Application Type (0 - analysis, 1 - forecast):           0
Format of Output (0 - MM5.DAT, 1 - 3D.DAT):              1
Selection type (0 - i,j , 1 - Lat/Lon) :                 0
J range:                                                10  15
I range:                                                10  15
Vertical Levels:                                          1   50
Used desired shift in Geopotential Height =   5 m

Selected domain I:    10   15
                J:    10   15
  Number of Grids:     6    6
Selected domain SW lat/lon:       20.181    -123.533
Selected domain SW     X/Y:    -2681.928   -1909.858
SWIPS domain Grids (NX/NY):   151  113
SWIPS domain SW lat/lon:       16.281    -126.138
SWIPS domain SW     X/Y:    -3332.034   -2214.661
AWIPS Fake Center I/J & Latc/Lonc:    76   57     39.4600    -95.0000
AWIPS True Lat1/Lat2 & Lon_ref:      25.0000     25.0000     95.0000
AWIPS Grid size:      40.6353

 Number of Grib files: 2
Input RUC file #   1 .\sgpallruc40hybrX1.00.20050706.200000.raw.grb
3D Variable selected:      1   109     1  2005070620
2D Variable selected:      1   109     1
3D Variable selected:      1   109     2  2005070620
2D Variable selected:      1   109     2
3D Variable selected:      1   109     3  2005070620
2D Variable selected:      1   109     3
3D Variable selected:      1   109     4  2005070620
2D Variable selected:      1   109     4

( … Records omitted for clarity …)
```

Table D-21 (Concluded)

Example CALRUC List File (CALRUC.LST)

```
2D Variable selected:     53   105     2
2D Variable selected:     33   105    10
2D Variable selected:     34   105    10
   ioutw: 1
   ioutq: 1
   ioutc: 1
   iouti: 1
   ioutg: 1
   iosrf: 0
 Output to 3D.DAT at  2005070620

Input RUC file #   2 .\sgpallruc40hybrX1.00.20050706.210000.raw.grb
3D Variable selected:      1   109     1  2005070621
2D Variable selected:      1   109     1
3D Variable selected:      1   109     2  2005070621
2D Variable selected:      1   109     2
3D Variable selected:      1   109     3  2005070621
2D Variable selected:      1   109     3
3D Variable selected:      1   109     4  2005070621
2D Variable selected:      1   109     4

( … Records omitted for clarity …)

2D Variable selected:     53   105     2
2D Variable selected:     33   105    10
2D Variable selected:     34   105    10
 Output to 3D.DAT at  2005070621
```

D.4 CALRAMS Preprocessor

CALRAMS operates on the output from the NOAA Air Resources Laboratory (ARL) Regional Atmospheric Modeling System (RAMS), Version 4.3. It extracts and reformats a subset of the gridded model output fields, and creates a 3D.DAT file for CALMET (see section D.5).

RAMS was developed at the Colorado State University and the *ASTeR division of Mission Research Corporation in the 1980's. The main goal of the modeling system is for simulating and forecasting mesoscale meteorological fields, although it may be applied at both smaller and global scales. Specialized studies have applied RAMS at scales as small as 1m for boundary layer simulations and flows around individual buildings. RAMS can be initialized from NCEP model fields (Eta, AVN, NGM, etc.) in ARL packed form. Many different spatially varying surface variables such as soil moisture, soil and vegetation type, canopy temperature and water content, terrain height, land roughness, land percentage and sea surface temperature (SST) are ingested into RAMS on the model grid.

The horizontal coordinate used in RAMS is the Arakawa-C staggered grid of thermodynamic and momentum variables. The advantage of this staggered grid coordinating is to reduce finite differencing errors. The grid configuration is shown in Figure D-8. The momentum variables of wind U and V components are defined at * points, while the thermodynamic variables of temperature (T), specific humidity (Q), pressure (P) are defined at + points.

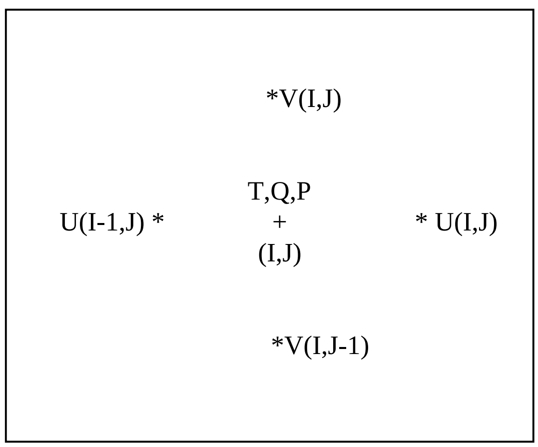


Figure D-8. Arakawa-C grid used in RAMS.

The vertical coordinate is the terrain-following height Z* system, with Z* is defined as

$$Z^* = \frac{Z_{agl}}{1 - \dfrac{Z_{terr}}{Z_{top}}} \qquad \text{D-4}$$

where Z_{agl} is the height above the ground, the Z_{terr} is the topographical height at grid, and Z_{top} is the height of model top. In this coordinate system, each level is a given fraction of the distance between the surface and the model top. The variables are staggered in vertical. The horizontal momentum of U and V components and all thermodynamic variables are defined at the full Z* levels, while the vertical velocity (W) is defined at half-Z* levels. The model top height is usually about 15-20 km above the ground.

The 3D.DAT file for CALMET needs a uniform coordinate system in both horizontal and vertical directions. Since most variables are at thermodynamic points, a two-grid averaging is used to interpolate momentum variables of U, V, and W in the staggered Arakawa-C coordinate system to its thermodynamic point. The set of thermodynamic point coordinates is used in the 3D.DAT file.

The CALRAMS processor runs on a UNIX platform and includes a host program called CALRAMS.F90 and a set of subroutines that perform various functions.

CALRAMS Input Files

RAMS Output file

CALRAMS was designed for a particular application of RAMS, with specific file names. Each RAMS file consists of one hour of model output for one nest. The naming convention is:

iw-A-YYYY-MM-DD-HH0000-g1.vfm
iw-A-YYYY-MM-DD-HH0000-g2.vfm
iw-A-YYYY-MM-DD-HH0000-g3.vfm
iw-A-YYYY-MM-DD-HH0000-g4.vfm
iw-A-YYYY-MM-DD-HH0000-head.txt

where YYYY is the 4-digit year, MM is the 2-digit month, DD is the 2-digit day, and HH is the 2-digit hour. The file with “head.txt” is the header file providing the RAMS configuration and output variables. The part “-g1 –g2 –g3 –g4” represents the nesting levels for the output. Because many hours are typically processed in one simulation, creating a 3D.DAT file requires many RAMS files. These file names are constructed by CALRAMS for the processing period, so all RAMS files for the period must reside in a single directory. Applications that use different file names will require changes to the CALRAMS code.

CALRAMS.INP

In CALRUC.INP, the user specifies the names of the output 3D.DAT file and list file, and the directory that contains the RAMS output files. The user may extract a subset of both the RAMS grid and the RAMS simulation period by specifying the beginning and ending indices of the RAMS grid in the easting (X), northing (Y), and surface to top (Z) directions and the beginning and ending dates for the desired processing period. There is more than one nesting in RAMS, and each nested domain usually covers a different area. The nest must be identified in the control file.

An example of CALRAMS.INP is given in Table D-22 and is described in Table D-23. In CALRAMS.INP, the content after "!" is made up of comments that are not read by the program. There should be no blank space at the beginning of any records, but there should be at least on blank space before "!" if it exists.

CALRAMS Output Files

CALRAMS.LST

The list file of CALRAMS records various information from processing, including user-specified input controls, configurations of RAMS files, processed files etc. This file should be consulted if CALRAMS fails to produce a complete 3D.DAT. An example list file is given in Table D-24.

3D.DAT

A sample 3D.DAT file is shown and described in section (D.5).

Table D-22

Example CALRAMS Control File (CALRAMS.INP)

```
Convert RAMS to CALMET 3D.DAT file
calrams.m3d      ! Output 3D.DAT file name (no space before or within filename)
/usr1/RAMS/Data  ! Directory for RAMS input data (./ for current directory)
calrams.lst      ! List file name (no space before or within filename)
15 40            ! Beg/End I in RAMS for output to 3D.DAT file
5 10             ! Beg/End J in RAMS for output to 3D.DAT file
1 17             ! Beg/End K in RAMS for output to 3D.DAT file
2001041404       ! Begining date (YYYYMMDDHH - UTC)
2001041406       ! Ending date   (YYYYMMDDHH - UTC)
1                ! RAMS nesting grid ID (1-4)
```

Table D-23

CALRAMS Control File Inputs (CALRAMS.INP)

Line	Variable	Type	Description
1	TITLE	character*80	Header of the output 3D.DAT file
2	FIO	character*80	Name of output 3D.DAT
3	FBAS	character*80	Directory containing RAMS output files
4	FLG	character*80	List file name
5	NXB, NXE	integer	Beginning and Ending I (Easting) indices in RAMS domain extracted to 3D.DAT
6	NYB, NYE	integer	Beginning and Ending J (Northing) indices in RAMS domain extracted to 3D.DAT
7	NZB, NZE	integer	Beginning and Ending K (Surface to top) indices in RAMS domain extracted to 3D.DAT
8	NDATB	integer	Beginning UTC date-hour (YYYYYMMDDHH)
9	NDATE	integer	Ending UTC date-hour (YYYYMMDDHH)
10	INGRID	integer	Nesting level in RAMS (e.g., 1, 2, etc.)

Table D-24

Example CALRAMS List File (CALRAMS.LST)

```
Convert RAMS to CALMET 3D.DAT file
calrams.m3d
/usr1/RAMS/Data
calrams.lst
M3D I/J/K ranges:    15   40    5   10    1   17
M3D beg/end times: 2001041404  2001041406
RAMS nesting grid ID:   1
Start/end dates         01104         4     01104         6
RAMS Header file:/usr1/RAMS/Data/iw-A-2001-04-14-040000-head.txt


 Grid parameters for the input RAMS domain
          NEST ID:         1
         NX,NY,NZ:        50        50        33
               DX:       64.
     Pole lon/lat:  -111.000    39.500
    SW x/y corner:   -1704.0   -1536.0
    NE x/y corner:    1368.0    1536.0
  SW thermo point:   -1672.0   -1504.0
  NE thermo point:    1336.0    1504.0
Date in Processing :   2001   4  14   4
     RAMS file: /usr1/RAMS/Data/iw-A-2001-04-14-040000-g1.vfm
 2-D output flag:            0
   ioutw: 1
   ioutq: 1
   ioutc: 1
   iouti: 1
   ioutg: 1
   iosrf: 0

 Vertical range extracted:           0           0
 nx in RAMS (east)    :           50
 ny in RAMS (north)   :           50
 nz in RAMS (vertical):           33
 dxy in RAMS (km)     :    64.00000

Date in Processing :   2001   4  14   5
     RAMS file: /usr1/RAMS/Data/iw-A-2001-04-14-050000-g1.vfm
Date in Processing :   2001   4  14   6
     RAMS file: /usr1/RAMS/Data/iw-A-2001-04-14-060000-g1.vfm
```

D.5 3D.DAT File Format

The 3D.DAT file is the primary output from CALMM5, CALETA, CALRUC, and CALRAMS, and provides CALMET with a common mesoscale model data input format for all of the corresponding models (MM5, Eta, RUC, and RAMS). The format of the 3D.DAT file originated with the CALMM5 processor and contains some information from MM5 that is not provided or needed to document other models. When this is the case, such fields are either set to zero, or to missing values (usually negative numbers).

A sample 3D.DAT file is provided in Table D-25 and described in Table D-26.

Table D-25
Sample Mesoscale Model 3-D Data File (3D.DAT)

```
3D.DAT          2.1             Header Structure with Comment Lines
1
Produced by CALMM5 Version: 2.5     , Level: 050607
1  1  1  1  0  1
LCC   21.8530   45.0000   7.00  36.00 -1944.000 -1944.000  36.000 109 109 40
  1  4  3  5  2  2  1  0  1  1  1  1  1  1  1  1  1  1  1  1 25
2004013006    2   6   6  29
  25  10  30  15   1  29   35.1243   36.8535   6.6576   8.3718
 0.998
 0.995
 0.992
 0.988
 0.983
 0.978
 0.972
 0.966
 0.959
 0.951
 0.942
 0.931
 0.920
 0.907
 0.892
 0.876
 0.857
 0.837
 0.813
 0.787
 0.758
 0.725
 0.688
 0.646
 0.599
 0.547
 0.494
 0.449
 0.408
  25  10   6.6576   35.2281 1120 13    6.8291   35.3805 1283
  26  10   6.6777   35.5531 1264 13    6.8489   35.7058 1426
  27  10   6.6971   35.8780 1250 13    6.8680   36.0311 1422
  28  10   6.7158   36.2031 1251 13    6.8864   36.3566 1430
  29  10   6.7338   36.5283 1365 13    6.9042   36.6821 1456
  30  10   6.7512   36.8535 1458 13    6.9212   37.0077 1433
  25  11   6.9805   35.2076 1166 13    7.1523   35.3602 1415
  26  11   7.0006   35.5331 1467 13    7.1721   35.6861 1745
  27  11   7.0201   35.8588 1605 13    7.1913   36.0122 1828
  28  11   7.0389   36.1846 1622 13    7.2098   36.3383 1807
  29  11   7.0570   36.5104 1603 13    7.2276   36.6645 1721
  30  11   7.0744   36.8363 1550 10    7.2447   36.9908 1590
  25  12   7.3038   35.1869 1274 10    7.4759   35.3398 1668
  26  12   7.3241   35.5131 1718  6    7.4958   35.6664 2045
  27  12   7.3436   35.8395 1927 13    7.5151   35.9932 2090
  28  12   7.3624   36.1659 1935 13    7.5336   36.3200 2014
  29  12   7.3806   36.4924 1867  2    7.5515   36.6469 1925
```

Table D-25 (Concluded)
Sample Mesoscale Model 3-D Data File (3D.DAT)

```
  30   12    7.3981    36.8190 1770  2     7.5687    36.9739 1843
  25   13    7.6276    35.1661 1424  2     7.8000    35.3193 1768
  26   13    7.6479    35.4930 1893 13     7.8200    35.6467 2089
  27   13    7.6675    35.8201 2107  2     7.8393    35.9741 2205
  28   13    7.6865    36.1472 2102  2     7.8579    36.3016 2099
  29   13    7.7047    36.4744 1996 13     7.8758    36.6292 1945
  30   13    7.7222    36.8017 1912 13     7.8930    36.9568 1934
  25   14    7.9519    35.1452 1441  2     8.1245    35.2987 1567
  26   14    7.9722    35.4729 1819  2     8.1445    35.6268 1851
  27   14    7.9919    35.8006 2064 13     8.1639    35.9549 2110
  28   14    8.0109    36.1284 2123 13     8.1826    36.2831 2079
  29   14    8.0292    36.4563 1995 10     8.2005    36.6114 1856
  30   14    8.0468    36.7843 1887 10     8.2179    36.9398 1811
  25   15    8.2765    35.1243 1372 10     8.4494    35.2781 1420
  26   15    8.2970    35.4526 1618 10     8.4695    35.6068 1636
  27   15    8.3167    35.7810 1871 13     8.4889    35.9356 1887
  28   15    8.3358    36.1096 2001 10     8.5077    36.2645 1930
  29   15    8.3541    36.4381 1911 10     8.5257    36.5935 1779
  30   15    8.3718    36.7668 1785 10     8.5431    36.9226 1695
2004013006 25 10 1012.3 0.03 0     26.5    406.8    293.1    14.17     62.2      2.1    291.0
 890   1130 292.9  62   2.3 -0.01 8613.89-4.000
 887   1154 292.8  62   2.8 -0.02 8513.60-4.000
 884   1180 292.8  61   2.9 -0.02 8313.44-4.000
 881   1210 292.8  60   3.1 -0.02 8213.29-4.000
 878   1244 292.8  59   3.3 -0.02 8113.09-4.000
 874   1282 292.7  58   3.5 -0.02 7912.85-4.000
 870   1325 292.6  58   3.5 -0.02 7812.67-4.000
 865   1373 292.5  58   3.4 -0.02 7812.52 0.000 0.005 0.000 0.000
 859   1429 292.2  58   3.3 -0.02 7812.41 0.000 0.008 0.000 0.000
 853   1491 291.9  59   3.1 -0.02 7812.33 0.000 0.010 0.000 0.000
 846   1561 291.6  62   3.0 -0.02 7912.25 0.000 0.013 0.000 0.000
 838   1641 291.1  68   2.9 -0.02 8012.17 0.000 0.015 0.000 0.000
 830   1731 290.6  75   2.9 -0.02 8112.07 0.000 0.019 0.000 0.000
 820   1834 289.9  83   2.9 -0.02 8311.98 0.000 0.021 0.000 0.000
 809   1950 289.1  93   3.0 -0.02 8511.88 0.000 0.024 0.000 0.000
 796   2083 288.2 102   3.2 -0.02 8811.73 0.000 0.026 0.000 0.000
 782   2235 287.1 110   3.6 -0.01 9111.56 0.000 0.027 0.000 0.000
 766   2408 285.9 118   4.1 -0.01 9411.29 0.000 0.027 0.000 0.000
 748   2607 284.5 123   4.9  0.00 9810.90 0.000 0.029 0.000 0.000
 728   2835 283.2 124   6.4  0.01 94 9.87 0.002 0.033 0.000 0.000
 705   3099 281.4 124   7.5  0.02 92 8.92 0.028 0.036 0.000 0.000
 680   3404 279.2 122   8.0  0.03100 8.62 0.182 0.033 0.000 0.000
 651   3760 277.3 118   8.6  0.04100 7.96 0.433 0.028 0.000 0.000
 618   4178 275.3 110   8.4  0.05 98 7.01 0.342 0.027 0.000 0.000
 581   4671 272.9  96   7.7  0.04 90 5.77 0.009 0.059 0.000 0.000
 540   5260 269.1  87   7.2  0.03 99 5.15 0.024 0.123 0.000 0.000
 498   5894 265.4  78   7.3  0.01 93 3.96 0.023 0.071 0.000 0.000
 462   6474 262.3  79   8.4 -0.01 66 2.37-4.000
 430   7028 259.8  88   9.9 -0.02 57 1.82-4.000
2004013006 26 10 1012.3 0.01 0     40.2    402.0    292.5    14.16     50.4      2.0    290.7
 875   1275 292.3  52   2.4 -0.01 8813.88-4.000
 873   1298 292.1  52   2.9 -0.01 8713.58-4.000
 ......
```

Table D-26

Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #1

Variable No.	Variable	Type	Description
1	DATASET	Char*16	Dataset name (3D.DAT)
2	DATAVER	Char*16	Dataset version
3	DATAMOD	Char*64	Dataset message field
			Format(2a16,a64)

Header Record #2 to NCOMM+2

1	NCOMM	Integer	Number of comment records
1	COMMENT	Char*132	Comments (repeated NCOMM times)
			Format(a132)

Header Record # NCOMM+3

Variable No.	Variable	Type	Description
1	IOUTW	Integer	Flag indicating if vertical velocity is recorded.
1	IOUTQ	Integer	Flag indicating if relative humidity and vapor mixing ratios are recorded
1	IOUTC	Integer	Flag indicating if cloud and rain mixing ratios are recorded.
1	IOUTI	Integer	Flag indicating if ice and snow mixing ratios are recorded.
1	IOUTG	Integer	Flag indicating if graupel mixing ratio is recorded.
1	IOSRF	Integer	Flag indicating if surface 2-D files are created.
			Format(6i3)

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record # NCOMM+4

Variable No.	Variable	Type	Description
1	MAPTXT	char*3	Map projection LCC: Lambert Land Conformal Projection
2	RLATC	real	Center latitude (positive for northern hemisphere)
3	RLONC	real	Center longitude (positive for eastern hemisphere)
4	TRUELAT1	real	First true latitude
5	TRUELAT2	real	Second true latitude
6	X1DMN	real	SW dot point X coordinate (km, Grid 1,1) in original domain
7	Y1DMN	real	SW dot point Y coordinate (km, Grid 1,1) in original domain
8	DXY	real	Grid size (km)
9	NX	integer	Number of grids in X-direction (West-East) in original domain
10	NY	integer	Number of grids in Y-direction (South-North) in original domain
11	NZ	integer	Number of sigma layers in original domain
			Format(a4,f9.4,f10.4,2f7.2,2f10.3,f8.3,2i4,i3)

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+5

(Note: Values set to zero for models other than MM5)

Variable No.	Variable	Type	Description
1	INHYD	Integer	0: hydrostatic MM5 run - 1: non-hydrostatic
2	IMPHYS	Integer	MM5 moisture options. 1: dry 2: removal of super saturation 3: warm rain (Hsie) 4: simple ice scheme (Dudhia) 5: mixed phase (Reisner) 6: mixed phase with graupel (Goddard) 7: mixed phase with graupel (Reisner) 8: mixed phase with graupel (Schultz)
3	ICUPA	Integer	MM5 cumulus parameterization 1: none 2: Anthes-Kuo 3: Grell 4: Arakawa-Schubert 5: Fritsch-Chappel 6: Kain-Fritsch 7: Betts-Miller 8: Kain-Fritsch
4	IBLTYP	Integer	MM5 planetary boundary layer (PBL) scheme 0: no PBL 1: bulk PBL 2: Blackadar PBL 3: Burk-Thompson PBL 4: ETA PBL 5: MRF PBL 6: Gayno-Seaman PBL 7: Pleim-Chang PBL
5	IFRAD	Integer	MM5 atmospheric radiation scheme 0: none 1: simple cooling 2: cloud-radiation (Dudhia) 3: CCM2 4: RRTM longwave
6	ISOIL	Integer	MM5 soil model 0: none 1: multi-layer 2: Noah LS model 3: Pleim-Xiu LSM

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+5 (Continued)

(Note: Values set to zero for models other than MM5)

7	IFDDAN	Integer	1: FDDA grid analysis nudging - 0: no FDDA
8	IFDDAOB	Integer	1: FDDA observation nudging - 0: no FDDA
9-20	FLAGS_2D	Integer	1/0: Flags for output variables in 2D.DAT (not used in 3D.DAT)
21	NLAND	Integer	Number of land use categories
			Format(30i3)

Header Record #NCOMM+6

Variable No.	Variable	Type	Description
1	IBYRM	integer	Beginning year of the data in the file
2	IBMOM	integer	Beginning month of the data in the file
3	IBDYM	integer	Beginning day of the data in the file
4	IBHRM	integer	Beginning hour (GMT) of the data in the file
5	NHRSMM5	integer	Length of period (hours) of the data in the file
6	NXP	integer	Number of grid cells in the X direction in the extraction subdomain
7	NYP	integer	Number of grid cells in the Y direction in the extraction subdomain
8	NZP	integer	Number of layers in the MM5 domain (half sigma levels) (same as number of vertical levels in data records)
			Format (i4, 3i2,i5,3i4)

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+7

Variable No.	Variable	Type	Description
1	NX1	integer	I-index (X direction) of the lower left corner of the extraction subdomain
2	NY1	integer	J-index (Y direction) of the lower left corner of the extraction subdomain
3	NX2	integer	I-index (X direction) of the upper right corner of the extraction subdomain
4	NY2	integer	J-index (Y direction) of the upper right corner of the extraction subdomain
5	NZ1	integer	k-index (Z direction) of lowest extracted layer
6	NZ2	integer	k-index (Z direction) of hightest extracted layer
7	RXMIN	real	Westernmost E. longitude (degrees) in the subdomain
8	RXMAX	real	Easternmost E. longitude (degrees) in the subdomain
9	RYMIN	real	Southernmost N. latitude (degrees) in the subdomain
10	RYMAX	real	Northernmost N. latitude (degrees) in the subdomain

format (6i4,2f10.4,2f9.4)

Next NZP Records

Variable No.	Variable	Type	Description

1	SIGMA	real array	Sigma-p values used by MM5 to define each of the NZP layers (half-sigma levels)
			Read as:
			`     do 10 I=1,NZP`
			`10   READ (iomm4,20) SIGMA(I)`
			`20   FORMAT (F6.3)`

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Next NXP*NYP Records

Variable No.	Variable	Type	Description
1	IINDEX	integer	I-index (X direction) of the grid point in the extraction subdomain
2	JINDEX	integer	J-index (Y direction) of the grid point in the extraction subdomain
3	XLATDOT	real array	N. Latitude (degrees) of the grid point in the extraction subdomain (positive for the Northern Hemisphere, negative for Southern Hemisphere)
4	XLONGDOT	real array	E. Longitude (degrees) of the grid point in the extraction subdomain (positive for the Eastern Hemisphere, negative for Western Hemisphere)
5	IELEVDOT	integer array	Terrain elevation of the grid point in the extraction subdomain (m MSL)
6	ILAND	integer array	Landuse categories at cross points
7	XLATCRS	real array	Same as XLATDOT but at cross point
8	XLATCRS	real array	Same as XLATDOT but at cross point
9	IELEVCRS	integer array	Same as IELEVDOT but at cross point
			Format (2i4, f9.4, f10.4, i5, i3, 1x, f9.4, f10.4,i5)

Table D-26 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

Data Record

Variable No.	Variable	Type	Description
1	MYR	integer	Year of MM5 wind data (YYYY)
2	MMO	integer	Month of MM5 wind data (MM)
3	MDAY	integer	Day of MM5 wind data (DD)
4	MHR	integer	Hour (GMT) of MM5 wind data (HH)
5	IX	integer	I-index (X direction) of grid cell
6	JX	integer	J-index (Y direction) of grid cell
7	PRES	real	sea level pressure (hPa)
8	RAIN	real	total rainfall accumulated on the ground for the past hour (cm)
9	SC	integer	snow cover indicator (0 or 1, where 1 = snow cover was determined to be present for the MM5 simulation)
10*	RADSW	real	Short wave radiation at the surface (W/m**2)
11*	RADLW	real	long wave radiation at the top (W/m**2)
12*	T2	real	Air temperature at 2 m (K), zero or blank if not exist
13*	Q2	real	Specific humidity at 2 m (g/kg), zero or blank if not exist
14*	WD10	real	Wind direction of 10-m wind (m/s), zero or blank if not exist
15*	WS10	Real	Wind speed of 10-m wind (m/s), zero or blank if not exist
16*	SST	real	Sea surface temperature (K), zero or blank if not exist
			format(i4,3i2,2i3,f7.1,f5.2,i2,3f8.1,f8.2,3f8.1)

* Set to all zero if not existing in output of MM5 or other models

MM5 Note: WD10 and WS10 are MM5 output at dot points, other meteorological variables are interpolated in CALMM5 to dot points from MM5 output at cross points.

Table D-26 (Concluded)
Mesoscale Model 3-D Data File (3D.DAT)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

NZP*Data Records

Variable No.	Variable	Type	Description
1	PRES	integer	Pressure (in millibars)
2	Z	integer	Elevation (meters above m.s.l.)
3	TEMPK	integer	Temperature (^{o} K)
4	WD	integer	Wind direction (degrees)
5	WS	real	Wind speed (m/s)
6[w]	W	real	Vertical velocity (m/s)
7[q]	RH	integer	Relative humidity (%)
8[q]	VAPMR	real	Vapor mixing ratio (g/kg)
9[c] *	CLDMR	real	Cloud mixing ratio (g/kg)
10[c] *	RAINMR	real	Rain mixing ratio (g/kg)
11[i] *	ICEMR	real	Ice mixing ratio (g/kg)
12[i] *	SNOWMR	real	Snow mixing ratio (g/kg)
13[g] *	GRPMR	real	Graupel mixing ratio (g/kg)

Format(i4,i6,f6.1,i4,f5.1,f6.2,i3,f5.2,5f6.3)

MM5 Note: WD and WS are MM5 output at dot points, other variables are interpolated in CALMM5 to dot points from MM5 output at cross points.

---

[w] Variable present in the record only if IOUTW = 1
[q] Variable present in the record only if IOUTQ = 1
[c] Variable present in the record only if IOUTC = 1 (possible only if IOUTQ=1)
[I] Variable present in the record only if IOUTI = 1 (possible only if IOUTQ = IOUTC = 1)
[g] Variable present in the record only if IOUTG = 1 (possible only if IOUTQ = IOUTC = IOUTI=1)
* Output for variables 9 – 13 will be compressed using a negative number if ALL are zero. -5.0 represents all five variables are zero.

E. CALMET MODEL FILES

The CALMET model obtains the necessary control information and input meteorological data from a number of different input files. The control file (CALMET.INP) contains the data that define a particular model run, such as starting date and time, horizontal and vertical grid data, and model option flags. Geophysical data, including terrain elevations, land use, and surface characteristics, are read from a formatted data file called GEO.DAT.

The hourly surface meteorological observations are contained in the surface data file (SURF.DAT). If overwater temperatures are being calculated separately, this file must contain only land stations. This file can be either a formatted or an unformatted file generated by the SMERGE preprocessor program or a free-formatted, user-prepared file, depending on options specified in the control file. Upper air meteorological data are read from a series of data files called UPn.DAT, where n is the upper air station number (e.g., n=1,2,3,...). The data for each upper air station are stored in a separate data file.

Hourly precipitation observations are contained in a file called PRECIP.DAT. This file can be a formatted or an unformatted file generated by the PMERGE preprocessor program or a free-formatted, user-prepared file. Overwater meteorological data are read from a series of data files called SEAn.DAT, where n is the overwater station number (e.g., n= 1,2,3,...). The data for each overwater station are stored in a separate file. If overwater default parameters for temperature, air-sea temperature difference, etc. are being used and separate overwater temperatures are not being calculated, then overwater stations can be placed in the SURF.DAT file.

CALMET contains an option to use gridded prognostic model output. Output from CSUMM, or reformatted output from MM4, MM5, NAM(Eta), RUC or RAMS can be accepted. If this option is selected, the CSUMM gridded prognostic model wind fields are read from an unformatted data file called PROG.DAT; reformatted MM4/MM5 prognostic output may read from a formatted data file called MM4.DAT; or reformatted MM5, NAM(Eta), RUC and RAMS fields may be read from a generic formatted file called 3D.DAT (formerly MM5.DAT).

In its default mode, CALMET computes domain-averaged winds, temperature lapse rates and surface temperatures from the hourly surface observations and twice-daily upper air data contained in the SURF.DAT, UPn.DAT, and, if present, SEAn.DAT files. However, the model contains an option for the user to specify pre-computed values for these parameters from an optional file DIAG.DAT.

The main CALMET output files are a list file (CALMET.LST) containing a listing of the model inputs and user-selected printouts of the output meteorological values and an optional, unformatted disk file (CALMET.DAT or PACOUT.DAT) containing the hourly gridded meteorological data produced by the model. In addition, several additional optional list files (TEST.PRT, TEST.OUT, TEST.KIN, TEST.FRD, and TEST.SLP) can be created. These files, provided primarily for model testing purposes, contain intermediate versions of the wind fields at various points in the diagnostic wind field analysis

(e.g., after evaluation of kinematic effects, slope flows, terrain blocking effects, divergence minimization, etc.).
The CALMET input and output files are listed in Table E-1. The table shows the FORTRAN unit numbers associated with each file. These unit numbers are specified in a parameter file, PARAMS.MET, and can easily be modified to accommodate system-dependent restrictions on allowable unit numbers. The user should make sure that the beginning and total number of UPn.DAT and SEAn.DAT files are defined such that there is no overlap among unit numbers.

The name and full path of each of the CALMET input and output files (except one) is assigned in the control file (CALMET.INP) which is specified on the command line. For example, on a DOS system,

CALMET d:\CALMET\CALMET.INP

will execute the CALMET code (CALMET.EXE) and read the input and output filenames from d:\CALMET\CALMET.INP. If not specified on the command line, the default name of the control file is CALMET.INP in the current working directory.

In the following sections, the contents and format of each CALMET input file are described in detail.

Table E-1
CALMET Input and Output Files

Unit	Default File Name	Type	Format	Description
IO2	DIAG.DAT	input	formatted	File containing preprocessed meteorological data for diagnostic wind field module. (Used only if IDIOPT1, IDIOPT2, IDIOPT3, IDIOPT4, or IDIOPT5 = 1.)
IO5	CALMET.INP	input	formatted	Control file containing user inputs.
IO6	CALMET.LST	output	formatted	List file (line printer output file) created by CALMET.
IO7	CALMET.DAT or PACOUT.DAT	output	unformatted	Output data file created by CALMET containing hourly gridded fields of meteorological data. (Created only if LSAVE=T.)
IO8	GEO.DAT	input	formatted	Geophysical data fields (land use, elevation, surface characteristics, anthropogenic heat fluxes).
IO10	SURF.DAT	input	unformatted (if IFORMS=1) or formatted (if IFORMS=2)	Hourly surface observations (Used only if IDIOPT4=0.) If IFORMS=1, use the unformatted output file of the SMERGE program. If IFORMS=2, use a free-formatted input file generated either by SMERGE or the user.
IO12	PRECIP.DAT	input	unformatted (if IFORMP=1) or formatted (if IFORMP=2)	Hourly precipitation data (used if NPSTA > 0). If IFORMP=1, PRECIP.DAT is the unformatted output file of the PMERGE program. If IFORMP=2, PRECIP.DAT is a free-formatted input file generated either by PMERGE or the user.
IO14	WT.DAT	input	formatted	Gridded fields of terrain weighting factors used to weight the observed winds and the MM4 winds in the interpolation process

(CALMET Input and Output Files Continued)

Table E-1 (Concluded)

CALMET Input and Output Files

Unit	Default File Name	Type	Format	Description
IO30 IO30+1 IO30+2	UP1.DAT UP2.DAT UP3.DAT . . .. UPn.DAT	input	formatted	Upper air data (READ62 output) for upper air station #n. (Used only if IDIOPT5=0.)

(Up to "MAXUS" upper air stations allowed. MAXUS currently = 50).

Unit	Default File Name	Type	Format	Description
IO80 IO80+1 IO80+2	SEA1.DAT SEA2.DAT SEA3.DAT . . . SEAn.DAT	input	formatted	Overwater meteorological data for station #n. (Used only if NOWSTA > 0).

(Up to "MXOWS" overwater stations allowed. MXOWS currently = 15).

Unit	Default File Name	Type	Format	Description
IO20	PROG.DAT (CSUMM) or	input	unformatted	Gridded fields of prognostic wind data to use as input to the diagnostic wind field module. (Used only if IPROG > 0.)
IO20	3D.DAT (MM4/MM5/3D)	input	formatted	

Wind Field Module Test and Debug Files

Unit	Default File Name	Type	Format	Description
IO21	TEST.PRT	output	unformatted	Intermediate winds and misc. input and internal variables. (Created only if at least one wind field print option activated (IPR0-IPR8).)
IO22	TEST.OUT	output	formatted	Final wind fields. (Created only if IPR8=1 and IOUTD=1.)
IO23	TEST.KIN	output	formatted	Wind fields after kinematic effects. (Created only if IPR5=1 and IOUTD=1.)
IO24	TEST.FRD	output	formatted	Wind fields after Froude No. effects. (Created only if IPR6=1 and IOUTD=1.)
IO25	TEST.SLP	output	formatted	Wind fields after slope flow effects. (Created only if IPR7=1 and IOUTD=1.)

E.1 User Control File (CALMET.INP)

The selection and control of CALMET options are determined by user-specified inputs contained in a file called the control file. This file, CALMET.INP, contains all the information necessary to define a model run (e.g., starting date, run length, grid specifications, technical options, output options, etc.). CALMET.inp may be created/edited directly using a conventional editor, or it may be created/edited indirectly by means of the PC-based, Windows-compatible Graphical User Interface (GUI) developed for CALMET.

The CALMET GUI not only prepares the control file, it also executes the model and facilitates file management functions; and it contains an extensive help system that makes much of the information in this manual available to the user on-line. Although the model can be set up and run entirely within the GUI system, the interface is designed to always create the ASCII CALMET.INP file. This allows runs to be set up on PC-based systems and the control file transferred to a workstation or a mainframe computer for computationally intensive applications. The ASCII CALMET.INP file should be directly transportable to virtually any non-PC system.

When CALMET is setup and run entirely on a non-PC system, or if the GUI is not used on a PC, the control file CALMET.INP may be configured by using a conventional editor. This is facilitated by the extensive self-documenting statements contained in the standard file. As explained further below, more comments can be readily added by the user to document specific parameter choices used in the run. These comments remain in the file, and are reported to the CALMET list file when CALMET is executed from the command line. Note, however, that the GUI always writes the standard comments to CALMET.INP, and ignores any additional text. Furthermore, the control file is always updated by the GUI, even if the GUI is only used to run CALMET without altering the technical content of the control file. Thus, the user must save the control file to another filename prior to using the GUI if non-standard comments are to be saved. This feature of the GUI can be used to create a new copy of the standard control file by merely saving a “new file” to disk, so a fresh version of the control file is always available.

The control file is organized into 10 major Input Groups preceded by a three line run title (see Table E-2). The Input Groups must appear in order, i.e., Input Group 0 followed by Input Group 1, etc. However, the variables within an Input Group may appear in any order. Each Input Group must end with an Input Group terminator consisting of the word END between two delimiters (i.e., !END!). Even a blank Input Group (i.e., one in which no variables are included) must end with an Input Group terminator in order to signal the end of that Input Group and the beginning of another. Note that Input Group 0 consists of four subgroups.

A sample control file is shown in Table E-3. It is designed to be flexible and easy to use. The control file is read by a set of FORTRAN text processing routines contained within CALMET which allow the user considerable flexibility in designing and customizing the input file. An unlimited amount of optional descriptive text can be inserted within the control file to make it self-documenting. For example, the definition, allowed values, units, and default value of each input variable can be included within the control file.

The control file processor searches for pairs of special delimiter characters (!). All text outside the delimiters is assumed to be user comment information and is echoed back but otherwise ignored by the input module. Only data within the delimiter characters are processed. The input data consist of a leading delimiter followed by the variable name, equals sign, input value or values, and a terminating delimiter (e.g., !XX = 12.5 !). The variable name can be lower or upper case, or a mixture of both (i.e., XX, xx, Xx are all equivalent). The variable can be a real, integer or logical array or scalar. The use of repetition factors for arrays is allowed (e.g., ! XARRAY = 3 * 1.5 ! instead of ! XARRAY = 1.5, 1.5, 1.5 !). Different values must be separated by commas. Spaces within the delimiter pair are ignored. Exponential notation (E format) for real numbers is allowed. However, the optional plus sign should be omitted (e.g., enter +1.5E+10 as 1.5E10). The data may be extended over more than one line. The line being continued must end with a comma. Each leading delimiter must be paired with a terminating delimiter. All text between the delimiters is assumed to be data, so no user comment information is allowed to appear within the delimiters. The inclusion in the control file of any variable that is being assigned its default value is optional.

The control file reader expects that logical variables will be assigned using only a one character representation (i.e., 'T' or 'F'). Input Groups 7-9 are handled differently (making use of FORTRAN free reads), because they contain Character*4 input data. The data portion of each record in Input Groups 7-9 must start in Column 9 or greater of the record.

Each CALMET control file input variable is described in Table E-4. The control file module has a list of the variable names and array dimensions for each Input Group. Checks are performed to ensure that the proper variable names are entered by the user, and that no array dimensions are exceeded. Error messages result if an unrecognized variable name is encountered or too many values are entered for a variable.

Note that if LLCONF=T, then all x,y coordinates in the CALMET.INP file must be specified on the chosen Lambert Conformal projection grid, rather than in UTM coordinates.

A standard control file is provided along with the CALMET test case run. It is recommended that a copy of the standard control file be permanently stored as a backup. Working copies of the control file may be made and then edited and customized by the user for a particular application.

Table E-2

CALMET Control File Input Groups

Input Group	Description
*	Run Title First three lines of control file (up to 80 characters/line)
0	Input and Output File Names
1	General Run Control Parameters Starting date and hour, run length, base time zone, and run type options
2	Map Projection and Grid Control Parameters Grid spacing, number of cells, vertical layer structure, and reference coordinates
3	Output Options Printer control variables, and disk output control variables
4	Meteorological Data Options Number of surface, upper air, over water, and precipitation stations, input file formats, and precipitation options
5	Wind Field Options and Parameters Model option flags, radius of influence parameters, weighting factors, barrier data, diagnostic module input flags, and lake breeze information
6	Mixing Height, Temperature, and Precipitation Parameters Empirical constants for the mixing height scheme, spatial averaging parameters, minimum/maximum overland and overwater mixing heights, temperature options, and precipitation interpolation options
7	Surface Meteorological Station Parameters Station name, coordinates, time zone, and anemometer height
8	Upper Air Station Parameters Station name, coordinates, and time zone
9	Precipitation Station Parameters Station name, station code, and coordinates

Table E-3

Sample CALMET Control File (CALMET.INP)

Run Title and Input Group 0

```
CALMET TEST CASE - New input parameters: NM3D - M3DDAT - KBAR
17 x 17  20 km meteorological grid - No MM4DAT anymore
Met. stations used: 12 surface, 3 upper air, 0 precip., 3 overwater
---------------- 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=GEO.DAT       !
SURF.DAT      input    ! SRFDAT=SURF.DAT      !
CLOUD.DAT     input    * CLDDAT=            *
PRECIP.DAT    input    * PRCDAT=            *
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 = T !
         F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS and MM4-MM5-3D.DAT FILES:

    Number of upper air stations (NUSTA)  No default     !  NUSTA =  3  !
    Number of overwater met stations
                                 (NOWSTA) No default     ! NOWSTA =  3  !
    Number of MM4/MM5/3D.DAT files
                                   (NM3D) No default     !   NM3D =  0  !


                       !END!
--------------------------------------------------------------------------------
Subgroup (b)
---------------------------------
Upper air files (one per station)
---------------------------------
Default Name  Type       File Name
------------  ----       ---------
UP1.DAT       input     1  ! UPDAT=UP1.DAT!    !END!
UP2.DAT       input     2  ! UPDAT=UP2.DAT!    !END!
UP3.DAT       input     3  ! UPDAT=UP3.DAT!    !END!
--------------------------------------------------------------------------------
Subgroup (c)
-----------------------------------------
Overwater station files (one per station)
-----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
SEA1.DAT       input     1  ! SEADAT=SEA1.DAT!    !END!
SEA2.DAT       input     2  ! SEADAT=SEA2.DAT!    !END!
SEA3.DAT       input     3  ! SEADAT=SEA3.DAT!    !END!
--------------------------------------------------------------------------------
```

Table E-3 (continued)

Sample CALMET Control File (CALMET.INP)

Run Title and Input Group 0

```
Subgroup (d)
----------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
MM51.DAT       input     1  * M3DDAT=MM5.DAT*    *END*

-------------------------------------------------------------------------------
Subgroup (e)
----------------
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=                  *
DCST.GRD      output     * DCSTGD=                  *
--------------------------------------------------------------------------------
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!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Run Title and Input Group 1

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

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

     Starting date:   Year (IBYR) -- No default       ! IBYR=  1988  !
                     Month (IBMO) -- No default       ! IBMO=  7  !
                       Day (IBDY) -- No default       ! IBDY=  7  !
                      Hour (IBHR) -- No default       ! IBHR=  1  !

     Base time zone        (IBTZ) -- No default       ! IBTZ=  5  !
        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!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 2

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

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

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

         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  = 0.0 !
     (FNORTH)                  Default=0.0     ! FNORTH = 0.0 !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                  No Default      ! IUTMZN = 19 !

     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 = 40.0N !
     (RLON0)                   No Default      ! RLON0 = 74.0W !

         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 = 35.0N !
     (XLAT2)                   No Default      ! XLAT2 = 45.0N !

         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 =   17  !
            No. Y grid cells (NY)      No default     ! NY =   17  !

     Grid spacing (DGRIDKM)            No default     ! DGRIDKM = 20. !
                                       Units: km

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

        X coordinate (XORIGKM)         No default     ! XORIGKM = 120.000 !
        Y coordinate (YORIGKM)         No default     ! YORIGKM = 4570.000 !
                                       Units: km

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

        No. of vertical layers (NZ)    No default     ! NZ =  6  !

        Cell face heights in arbitrary
        vertical grid (ZFACE(NZ+1))    No defaults
                                       Units: m
        ! ZFACE = 0.,20.,50.,100.,500.,2000.,3300. !


!END!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 3

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

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

       Print interval
       (IPRINF) in hours                   Default: 1     ! IPRINF =  6  !
       (Meteorological fields are printed
        every  6  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 =  1 ,  0 ,  0 ,  0 ,  0 ,  0  !
       -----------------------


       Specify which levels of the W wind component to print
       (NOTE: W defined at TOP cell face --  6  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  !


       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 =  1 ,  0 ,  0 ,  0 ,  0 ,  0  !
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 3

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


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

      !  STABILITY  =           1           ! - PGT stability class
      !  USTAR      =           1           ! - Friction velocity
      !  MONIN      =           1           ! - Monin-Obukhov length
      !  MIXHT      =           1           ! - Mixing height
      !  WSTAR      =           1           ! - Convective velocity scale
      !  PRECIP     =           1           ! - 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 =  1  !


       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 =  0  !

          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  !
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 3

```
          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!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 4

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

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


    NO OBSERVATION MODE             (NOOBS)  Default: 0     ! NOOBS = 0  !
          0 = Use surface, overwater, and upper air stations
          1 = Use surface and overwater stations (no upper air observations)
              Use MM4/MM5/M3D for upper air data
          2 = No surface, overwater, or upper air observations
              Use MM4/MM5/M3D for surface, overwater, and upper air data

    NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

       Number of surface stations   (NSSTA)  No default     ! NSSTA =  12  !

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

    CLOUD DATA OPTIONS
       Griddid 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 =  1  !
       (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 =  4  !
       (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 =  0 ,  0 ,  0 ,  0 ,  0 ,  0  !

       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 !
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 5

```
Use gridded prognostic wind field model
       output fields as input to the diagnostic
       wind field model (IPROG)            Default: 0      ! IPROG =  0  !
       (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 = 1  !


    RADIUS OF INFLUENCE PARAMETERS

       Use varying radius of influence     Default: F      ! LVARY =  T!
       (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 = 100. !
                                           Units: km
       Maximum radius of influence over land
       aloft (RMAX2)                       No default      ! RMAX2 = 500. !
                                           Units: km
       Maximum radius of influence over water
       (RMAX3)                             No default      ! RMAX3 = 500. !
                                           Units: km


    OTHER WIND FIELD INPUT PARAMETERS

       Minimum radius of influence used in
       the wind field interpolation (RMIN)   Default: 0.1    ! RMIN = 2. !
                                           Units: km
       Radius of influence of terrain
       features (TERRAD)                   No default      ! TERRAD = 10. !

                                           Units: km
       Relative weighting of the first
       guess field and observations in the
       SURFACE layer (R1)                  No default      ! R1 = 100. !
       (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 = 500. !
       (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 = 54. !
       (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 ,  8 ,  8 ,  12 ,  12 ,  12  !

      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  !

      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. !
      (Used only if IEXTRP = 3 or -3)


   BARRIER INFORMATION

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

      Level (1 to NZ) up to which barriers
      apply (KBAR)                         Default: NZ     ! KBAR =  6  !

      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)
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 5

```
Surface met. station to use for
   the surface temperature (ISURFT)   No default     ! ISURFT =  5  !
   (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   =  1  !
   (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., 2000. !
   (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)
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 5

```
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!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)

Input Group 6

```
-------------------------------------------------------------------------------
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 =  3  !
                                             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)


    CONVECTIVE MIXING HEIGHT OPTIONS:
       Method to compute the convective      Default: 1      ! IMIXH = 1  !
       mixing height (IMIHXH)
           1: Maul-Carson for land and water cells
          -1: Maul-Carson for land cells only -
              OCD mixing height overwater
           2: Batchvarova and Gryning for land and water cells
          -2: Batchvarova and Gryning for land cells only
              OCD mixing height overwater

       Threshold buoyancy flux required to
       sustain convective mixing height growth
       overland (THRESHL)                   Default: 0.05   !THRESHL = 0.05 !
       (expressed as a heat flux per meter of   (units: W/m3)
       boundary layer  i.e. W/m3;)


       Threshold buoyancy flux required to
       sustain convective mixing height growth
       overwater (THRESHW)                   Default: 0.05   !THRESHW = 0.05 !
       (expressed as a heat flux per meter of   (units: W/m3)
       marine boundary layer  i.e. W/m3;)


       Option for overwater lapse rates used                   !ITWPROG=1 !
       in convective mixing height growth (ITWPROG)
       0 : use SEA.DAT (or default constant) lapse rates
       1 : use prognostic lapse rates (only if IPROG>2)
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 6

```
    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 = 100. !
       (ZIMIN)                               Units: meters
       Maximum overland mixing height        Default: 3000.  ! ZIMAX = 3200. !
       (ZIMAX)                               Units: meters
       Minimum overwater mixing height       Default:   50.  ! ZIMINW = 100. !
       (ZIMINW) -- (Not used if observed     Units: meters
       overwater mixing hts. are used)
       Maximum overwater mixing height       Default: 3000.  ! ZIMAXW = 3200. !
       (ZIMAXW) -- (Not used if observed     Units: meters
       overwater mixing hts. are used)

    OVERWATER SURFACE FLUXES METHOD and PARAMETERS
          (ICOARE)                           Default: 10     !ICOARE=10!
           0: original deltaT method (OCD)
          10: COARE with no wave parameterization (jwave=0, Charnock)
          11: COARE with wave option jwave=1 (Oost et al)
              and default wave properties
         -11: COARE with wave option jwave=1 (Oost et al)
              and observed wave properties (must be in SEA.DAT files)
          12: COARE with wave option 2 (Taylor and Yelland)
               and default wave properties
         -12: COARE with wave option 2 (Taylor and Yelland)
              and observed wave properties (must be in SEA.DAT files)

          Coastal/Shallow water length scale (DSHELF)
          (for modified z0 in shallow water)
          ( COARE fluxes only)
                                          Default : 0.       !DSHELF=0.!
                                             Units: km

           COARE warm layer computation (IWARM)              !IWARM=1!
           1: on - 0: off (must be off if SST measured with
           IR radiometer)                 Default: 1

           COARE cool skin layer computation (ICOOL)         !ICOOL=1!
           1: on - 0: off (must be off if SST measured with
           IR radiometer)                 Default: 1

TEMPERATURE PARAMETERS

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

          0 = Use Surface and upper air stations
              (only if NOOBS = 0)
          1 = Use Surface stations (no upper air observations)
              Use MM5/M3D for upper air data
              (only if NOOBS = 0,1)
          2 = No surface or upper air observations
              Use MM5/M3D for surface and upper air data
              (only if NOOBS = 0,1,2)
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)
Input Group 6

```
      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 = 5  !

      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 = -0.0035 !
      above the mixing height over
      water (K/m) (TGDEFA)

      Beginning (JWAT1) and ending (JWAT2)
      land use categories for temperature                  ! JWAT1 =  55  !
      interpolation over water -- Make                     ! JWAT2 =  55  !
      bigger than largest land use to disable

   PRECIP INTERPOLATION PARAMETERS

      Method of interpolation (NFLAGP)      Default = 2    ! NFLAGP =  3  !
       (1=1/R,2=1/R**2,3=EXP/R**2)
      Radius of Influence (km) (SIGMAP)     Default = 100.0  ! SIGMAP = 1. !
       (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 = 1. !
       (values < CUTP = 0.0 mm/hr)
!END!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)

Input Group 7

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

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

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


             1     2
         Name   ID            X coord.   Y coord.   Time   Anem.
                               (km)       (km)      zone   Ht.(m)
       ----------------------------------------------------------
! SS1  ='ORH '   94746       263.540     4683.190    5    10  !
! SS2  ='HYA '   94720       393.190     4613.390    5    10  !
! SS3  ='PVD '   14765       297.650     4622.780    5    10  !
! SS4  ='BOS '   14739       332.600     4692.310    5    10  !
! SS5  ='CON '   14745       296.880     4785.840    5    10  !
! SS6  ='LEB '   94765       232.410     4836.240    5    10  !
! SS7  ='GFL '   14750       125.790     4809.830    5    10  !
! SS8  ='ALB '   14735       107.130     4744.020    5    10  !
! SS9  ='BDL '   14740       194.630     4648.690    5    10  !
! SS10 ='BDR '   94702       153.240     4565.320    5    10  !
! SS11 ='BTV '   14742       169.880     4931.910    5    10  !
! SS12 ='PWM '   14764       393.550     4833.630    5    10  !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)

Input Group 8

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

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

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

             1     2
         Name    ID      X coord.   Y coord.  Time zone
                           (km)       (km)
        --------------------------------------------------
! US1  ='ALB '   14735    108.638   4741.709    5  !
! US2  ='PWM '   14764    395.124   4831.385    5  !
! US3  ='CHH '   14684    420.891   4611.141    5  !
-------------------
      1
        Four character string for station name
        (MUST START IN COLUMN 9)

      2
        Five digit integer for station ID

!END!
```

Table E-3 (Continued)
Sample CALMET Control File (CALMET.INP)

Input Group 9

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

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

     PRECIPITATION STATION VARIABLES
     (One record per station --  NPSTA  records in all)

            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!
```

Table E-4
CALMET Control File Inputs

Run Title

Variable	Type	Description	Default Value
TITLE(3)	char*80 array	Run title (first three lines of CALMET control file). Read with FORTRAN A80 format.	-

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 0

Variable	Type	Description	Default Value
Subgroup (a)			
GEODAT	C*70	Geophysical data input file	GEO.DAT
SRFDAT	C*70	Hourly surface meteorological file	SURF.DAT
CLDDAT	C*70	Gridded cloud file	CLOUD.DAT
PRCDAT	C*70	Precipitation data file	PRECIP.DAT
M3DDAT	C*70	MM4/MM5/3D data file	3D.DAT
WTDAT	C*70	Gridded weighting obs. vs. MM4 data file	WT.DAT
METLST	C*70	CALMET output list file	CALMET.LST
METDAT	C*70	Output meteorological data file (CALMET format)	CALMET.DAT
		Output meteorological data file (MESOPAC/MESOPUFF format)	PACOUT.DAT
NUSTA	integer	Number of upper air stations	-
NOWSTA	integer	Number of overwater stations	-
LCFILES	logical	Convert files names to lower case (T = yes, F = no)	T
Subgroup (b)			
UPDAT	C*70	Upper air data files (repeated NUSTA times)	UPn.DAT
Subgroup (c)			
SEADAT	C*70	Overwater station files (repeated NOWSTA times)	SEAn.DAT
Subgroup (d)			
M3DDAT	C*70	M3D.DAT files files (repeated NM3D times)	MM5n.DAT
Subgroup (e)			
DIADAT	C*70	Preprocessed input met data	DIAG.DAT
PRGDAT	C*70	Gridded prognostic wind data file (CSUMM)	PROG.DAT
TSTPRT	C*70	Test file containing debug variables	TEST.PRT
TSTOUT	C*70	Test file containing final winds fields	TEST.OUT
TSTKIN	C*70	Test file containing winds after kinematic effects	TEST.KIN
TSTFRD	C*70	Test file containing winds after Froude number effects	TEST.FRD
TSTSLP	C*70	Test file containing winds after slope flow effects	TEST.SLP

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 1

Variable	Type	Description	Default Value
IBYR	integer	Starting year of the run (four digits)	-
IBMO	integer	Starting month of the run	-
IBDY	integer	Starting day of the run	-
IBHR	integer	Starting hour (00-23) of the run	-
IBTZ	integer	Base time zone (05=EST, 06=CST, 07=MST, 08=PST)	-
IRLG	integer	Length of the run (hours)	-
IRTYPE	integer	Run type 0=compute wind fields only 1=compute wind fields and micrometeorological variables (IRTYPE must be 1 to run CALPUFF or CALGRID)	1
LCALGRD	logical	Store extra data fields required by special modules in CALPUFF and in CALGRID (enter T or F) T=3-D fields of vertical velocity and temperature stored in output file F=these data fields are not stored in the output file (LCALGRD must be T to run CALGRID or to use the subgrid scale complex terrain option in CALPUFF)	T
ITEST	integer	Flag to stop run after setup phase (1 = stops run after SETUP, 2 = run continues)	2

Table E-4 (Continued)

CALMET Control File Inputs

Input Group 2 - Grid Control Parameters

Variable	Type	Description	Default Value
PMAP*	character*8	Map projection UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA : Lambert Azimuthal Equal Area	UTM
FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA	0.0
FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA	0.0
IUTMZN	integer	UTM zone for PMAP = UTM	-
UTMHEM	character*1	Hemisphere for UTM projection (N or S)	N
RLAT0	character*16	Reference latitude (degrees) of origin of map projection. Enter numerical value followed by N for North Latitude or S for South Latitude. Used only if PMAP= TTM, LCC, PS, EM, or LAZA	-
RLON0	character*16	Reference longitude (degrees) of origin of map projection. Enter numerical value followed by E for East Longitude or W for West Longitude. Used only if PMAP= TTM, LCC, PS, EM, or LAZA	-
XLAT1 XLAT2	character*16	Latitudes (degrees) of the two matching parallels for map projection (Used only if PMAP= LCC or PS). Enter numerical value followed by N for North Latitude or S for South Latitude.	-
DATUM	character*8	DATUM Code for grid coordinates.	WGS-G
NX	integer	Number of grid cells in the X direction	-
NY	integer	Number of grid cells in the Y direction	-
DGRIDKM	real	Horizontal grid spacing (km)	-
XORIGKM	real	Reference X coordinate* (km) of the southwest corner of grid cell (1,1)	-
YORIGKM	real	Reference Y coordinate* (km) of the southwest corner of grid cell (1,1)	-
NZ	integer	Number of vertical layers	-
ZFACE	real array	Cell face heights (m). Note: Cell center height of layer "i" is (ZFACE(i+1) + ZFACE(i))/2. NZ+1 values must be entered.	-

* PMAP projections PS, EM, and LAZA are NOT AVAILABLE in CALMET

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 3 - Output Options

Variable	Type	Description	Default Value
LSAVE	logical	Disk output control variable. If LSAVE=T, the gridded wind fields are stored in an output disk file (CALMET.DAT).	T
IFORMO	integer	Unformatted output file type variable. If IFORMO=1, a file suitable for input to CALPUFF or CALGRID is generated. If IFORMO=2, a file suitable for input to MESOPUFF II is generated. (Used only if LSAVE=T.)	1
LPRINT	logical	Printer output control variable. If LPRINT=T, the gridded wind fields are printed every "IPRINF" hours to the output list file (CALMET.LST).	F
IPRINF	integer	Printing interval for the output wind fields. Winds are printed every "IPRINF" hours. (Used only if LPRINT=T.)	1
IUVOUT	integer array	Control variable determining which layers of U and V horizontal wind components are printed. NZ values must be entered, corresponding to layers 1-NZ. (0=do not print layer, 1=print layer.) Used only if LPRINT=T.)	NZ*0
IWOUT	integer array	Control variable determining which layers of W vertical wind components are printed. NZ values must be entered, corresponding to cell face heights 2 to NZ+1. Note that W at the ground (cell face height 1) is zero. (0=do not print layer, 1=print layer.) (Used only if LPRINT=T and LCALGRD=T.)	NZ*0
ITOUT	integer array	Control variable determining which layers of temperature fields are printed. NZ values must be entered, corresponding to cell face heights 2 to NZ+1. (0=do not print layer, 1=print layer.) (Used only if LPRINT=T and LCALGRD=T.)	NZ*0

(Input Group 3 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 3 - Output Options

Variable	Type	Description	Default Value
STABILITY	integer	Control variable determining if gridded fields of PGT stability classes are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
USTAR	integer	Control variable determining if gridded fields of surface friction velocities are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
MONIN	integer	Control variable determining if gridded fields of Monin-Obukhov lengths are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
MIXHT	integer	Control variable determining if gridded fields of mixing heights are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
WSTAR	integer	Control variable determining if gridded fields of convective velocity scales are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
PRECIP	integer	Control variable determining if gridded fields of hourly precipitation rates are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
SENSHEAT	integer	Control variable determining if gridded fields of sensible heat fluxes are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0
CONVZI	integer	Control variable determining if gridded fields of convective mixing heights are printed. (0=do not print, 1=print.) (Used only if LPRINT=T.)	0

(Input Group 3 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 3 - Output Options

Variable	Type	Description	Default Value
LDB*	logical	Control variable for printing of input meteorological data and internal control parameters. Useful for program testing and debugging. If LDB=T, data will be printed for time steps "NN1" through "NN2" to the output list file (CALMET.LST).	F
NN1*	integer	First time step for which data controlled by LDB switch are printed. (Used only if LDB=T.) Note: IF NN1=NN2=0 and LDB=T, only time-independent data will be printed.	0
NN2*	integer	Last time step for which data controlled by LDB switch are printed. (Used only if LDB=T.)	0
IOUTD*	integer	Control variable for writing the computed wind fields to the wind field test disk files. (0=do not write, 1=write.)	0
NZPRN2*	integer	Number of levels, starting at the surface, printed to the wind field testing and debug files (Units 41-45).	1
IPR0*	integer	Control variable for printing to the wind field test files the interpolated wind components. (0=do not print, 1=print.)	0

* Testing and debugging print options.

(Input Group 3 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 3 - Output Options

Variable	Type	Description	Default Value
IPR1*	integer	Control variable for printing to the wind field test files the terrain adjusted surface wind components. (0=do not print, 1=print.) Used only with objective analysis.	0
IPR2*	integer	Control variable for printing to the wind field test files the smoothed wind components and initial divergence fields. (0=do not print, 1=print).	0
IPR3*	integer	Control variable for printing to the wind field test files the final wind speed and direction fields. (0=do not print, 1=print.)	0
IPR4*	integer	Control variable for printing to the wind field test files the final divergence fields. (0=do not print, 1=print.)	0
IPR5*	integer	Control variable for printing to the wind field test files the wind fields after kinematic effects are added. (0=do not print, 1=print.)	0
IPR6*	integer	Control variable for printing to the wind field test files the wind fields after the Froude number adjustment is made. (0=do not print, 1=print.)	0
IPR7*	integer	Control variable for printing to the wind field test files the wind fields after the slope flows are added. (0=do not print, 1=print.)	0
IPR8*	integer	Control variable for printing to the wind field test files the final wind component fields. (0=do not print, 1=print.)	0

* Testing and debugging print options.

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 4 - Meteorological Data Options

Variable	Type	Description	Default Value
NOOBS	integer	No-Observation mode flag: 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	0
NSSTA	integer	Number of surface meteorological stations	-
NPSTA	integer	Number of precipitation stations; (NPSTA=-1: flag for use of MM5 precipitation data in place of observations)	-
ICLOUD	integer	Cloud data file options (0 = Gridded clouds not used 1 = Gridded CLOUD.DAT generated as output 2 = Gridded CLOUD.DAT read as input 3 = Gridded cloud cover from prognostic relative humidity)	0
IFORMS	integer	Control variable determining the format of the input surface meteorological data (1=unformatted, i.e., SMERGE output) (2=formatted, i.e., free-formatted user input or formatted SMERGE output)	2
IFORMP	integer	Control variable determining the format of the input precipitation data (1=unformatted, i.e., PMERGE output) (2=formatted, i.e., free-formatted user input or formatted PMERGE output)	2
IFORMC	integer	Control variable determining the format of the CLOUD.DAT file (1 = unformatted - CALMET unformatted output) 2 = free formatted CALMET output or user input)	2

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
IWFCOD	integer	Control variable determining which wind field module is used. (0=objective analysis only, 1=diagnostic wind module.)	1
IFRADJ	integer	Control variable for computing Froude number adjustment effects. (0=do not compute, 1=compute.) (used only if IWFCOD=1).	1
IKINE	integer	Control variable for computing kinematic effects. (0=do not compute, 1=compute.) (used only if IWFCOD=1).	0
IOBR	integer	Control variable for using the O'Brien vertical velocity adjustment procedure. (0=do not use, 1=use.)	0
ISLOPE	integer	Control variable for computing slope flow effects. (0 = do not compute, 1 = compute).	1
IEXTRP	integer	Control variable for vertical extrapolation. If ABS(IEXTRP)=1, no vertical extrapolation from the surface wind data takes place. If ABS(IEXTRP)=2, extrapolation is done using a power law profile. If ABS(IEXTRP) = 3, extrapolation is done using the values provided in the FEXTRP array for each layer. If ABS(IEXTRP) = 4 similarity theory is used. If IEXTRP < 0, Layer 1 data at the upper air stations are ignored. Layer 1 at an upper air station is also ignored if the four-character station name of the upper air station matches that of a surface station.	-4
ICALM	integer	Control variable for extrapolation of calm surface winds to layers aloft. (0 = do not extrapolate calms, 1 = extrapolate calms)	0
BIAS	real array	Layer-dependent biases modifying the weights of surface and upper air stations. NZ values must be entered. (-1 # BIAS # +1) Negative BIAS reduces the weight of upper air stations (e.g., BIAS = -0.1 reduces their weight by 10%). Positive BIAS reduces the weight of surface stations (e.g., BIAS = 0.2 reduces their weight by 20%). Zero BIAS leaves weights unchanged.	NZ*0

Table E-4 (Continued)

CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
IPROG	integer	Control variable determining if gridded prognostic model field winds are used as input. 0 = No, (IWFCOD = 0 or 1) 1 = Yes, use CSUMM winds as Step 1 field, (IWFCOD=0) 2 = Yes, use CSUMM 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=0 or 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=0 or 1)	0
ISTEPPG	integer	Timestep (hours) of the prognostic model input data	1
LVARY	logical	Control variable for use of varying radius of influence. If no stations with valid data are found within the specified radius of influence, then the closest station with valid data will be used. (T=use, F=do not use.)	F
RMAX1	real	Maximum radius of influence over land in the surface layer (km). This parameter should reflect the limiting influence of terrain features on the interpolation at this level.	-
RMAX2	real	Maximum radius of influence over land in layers aloft (km). RMAX2 is generally larger than RMAX1 because the effects of terrain decrease with height.	-
RMAX3	real	Maximum radius of influence overwater (km). RMAX3 is used for all layers overwater. It must be large enough to ensure that all grid points over water are large enough to be within the radius of influence of at least one observation.	-
RMIN	real	Minimum radius of influence used in the wind field interpolation (km). This parameter should be assigned a small value (e.g., <1 km) to avoid possible divide by zero errors in the inverse-distance-squared weighting scheme.	0.1
RMIN2	real	Distance (km) from an upper air station within which vertical extrapolation of surface station data will be excluded. Used only if *IEXTRP* > 1.	4.0
TERRAD	real	Radius of influence of terrain features (km)	-

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
R1	real	Weighting parameter for the diagnostic wind field in the surface layer (km). This parameter controls the relative weighting of the first-guess wind field produced by the diagnostic wind field model and the observations. R1 is the distance from an observational station at which the observation and the first-guess field are equally weighted.	-
R2	real	Weighting parameter for the diagnostic wind field in the layers aloft (km). R2 is applied in the upper layers in the same manner as R1 is used in the surface layer.	-
RPROG	real	Weighting parameter (km) for the prognostic wind field data	-
DIVLIM	real	Convergence criterion for the divergence minimization procedure	5.0E-6
NITER	integer	Maximum number of iterations for the divergence minimization procedure	50
NSMTH	integer array	Number of smoothing passes in each layer NZ values must be entered.	2,(MXNZ-1)*4
NINTR2	integer array	Maximum number of stations used in the interpolation of data to a grid point for each layer 1-NZ. This allows only the "NINTR2" closest stations to be included in the interpolation. The effect of increasing NINTR2 is similar to smoothing. NZ values must be entered.	99
CRITFN	real	Critical Froude number used in the evaluation of terrain blocking effects	1.0
ALPHA	real	Empirical parameter controlling the influence of kinematic effects	0.1

(Input Group 5 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
FEXTR2	integer array	Extrapolation values for layers 2 through NZ (FEXTR2(1) must be entered but is not used). Used only if ABS(IEXTRP) $ 3.	NZ*0.0
NBAR	integer	Number of wind field interpolation barriers	0
KBAR	integer	Level (1 to NZ) up to which barriers apply	NZ
XBBAR	real array	X coordinate (km) of the beginning of each barrier. "NBAR" values must be entered. (Used only if NBAR > 0.)	-
YBBAR	real array	Y coordinate (km) of the beginning of each barrier. "NBAR" values must be entered. (Used only if NBAR > 0.)	-
XEBAR	real array	X coordinate (km) of the end of each barrier. "NBAR" values must be entered. (Used only if NBAR > 0.)	-
YEBAR	real array	Y coordinate (km) of the end of each barrier. "NBAR" values must be entered. (Used only if NBAR > 0.)	-
IDIOPT1	integer	Control variable for surface temperature input to diagnostic wind field module. (0=compute internally from surface data, 1=read preprocessed values from the file DIAG.DAT.)	0
ISURFT	integer	Surface station number (between 1 and NSSTA) used for the surface temperature for the diagnostic wind field module	-
IDIOPT2	integer	Control variable for domain-averaged temperature lapse rate. (0=compute internally from upper air data, 1=read preprocessed values from the file DIAG.DAT.)	0
IUPT	integer	Upper air station number (between 1 and NUSTA) used to compute the domain-scale temperature lapse rate for the diagnostic wind field module	-
ZUPT	real	Depth (m) through which the domain-scale temperature lapse rate is computed	200.

(Input Group 5 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
IDIOPT3	integer	Control variable for initial-guess wind components. (0=compute internally from upper air, 1=read preprocessed values from the file DIAG.DAT.)	0
IUPWND	integer	Upper air station number used to compute the initial-guess wind components for the diagnostic wind field module. Either specify one station from 1 to nusta or specify -1 indicating the use of $1/r^2$ interpolation to generate a spatially-variable initial guess field.	-1
ZUPWND	real array	Bottom and top of layer through which the initial-guess winds are computed. Units: meters. (Used only if IDIOPT3=0.) Note: Two values must be entered (e.g., ! ZUPWND=1.0, 2000. !).	1.0 1000.
IDIOPT4	integer	Control variable for surface wind components. (0=compute internally from surface data, 1=read preprocessed values from the file DIAG.DAT.)	0
IDIOPT5	integer	Control variable for upper air wind components. (0=compute internally from upper air data, 1=read preprocessed values from the file DIAG.DAT.)	0
LLBREZE	logical	Control variable for lake breeze region option. LLBREZE=T, region interpolation is performed. LLBREZE=F, no region interpolation is performed.	F
NBOX	integer	Number of boxes defining region (used only if LLBREZE=T)	-
XG1	real array	1st x-grid line to define box. (Used only if LLBREZE=T.) (One for each box.)	-
XG2	real array	2nd x-grid line to define box. (Used only if LLBREZE=T.) (One for each box.)	-
YG1	real array	1st y-grid line to define box. (Used only if LLBREZE=T.) (One for each box.)	-

(Input Group 5 Continued)

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 5 - Wind Field Options and Parameters

Variable	Type	Description	Default Value
YG2	real array	2nd y-grid line to define box. (Used only if LLBREZE=T.) (One for each box.)	-
XBCST	real array	Beginning x coordinate (km) of user defined coastline (straight line). (Used only if LLBREZE=T.) (One for each box.)	-
YBCST	real array	Beiginning y coordinate (km) of user defined coastline (straight line). (Used only if LLBREZE=T.) (One for each box.)	-
XECST	real array	Beginning x coordinate (km) of user defined coastline (straight line). (Used only if LLBREZE=T.) (One for each box.)	-
YECST	real array	Beginning y coordinate (km) of user defined coastline (straight line). (Used only if LLBREZE=T.) (One for each box.)	-
NLB	integer	Number of meteorological stations (surface and upper air stations) in a box. (Used only if LLBREZE=T.) (One for each box.)	-
METBXID	integer	Station ids of the meteorological stations within each box (surface stations first, then upper air stations). (Used only if LLBREZE=T.) (One set per box.)	-

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 6 - Mixing Height, Temperature, and Precipitation Parameters

Variable	Type	Description	Default Value
CONSTB	real	Neutral mechanical mixing height constant	1.41
CONSTE	real	Convective mixing height constant	0.15
CONSTN	real	Stable mixing height constant	2400.
CONSTW	real	Overwater mixing height constant	0.16
FCORIOL	real	Absolute value of Coriolis parameter (1/s)	1.E-4
DPTMIN	real	Minimum potential temperature lapse rate in the stable layer above the current convective mixing height (deg. K/m)	0.001
DZZI	real	Depth of layer (m) above current convective mixing height in which lapse rate is computed.	200.
ZIMAX	real	Maximum overland mixing height (m)	3000.
ZIMIN	real	Minimum overland mixing height (m)	50.
ZIMAXW	real	Maximum overwater mixing height (m) (Not used if observed overwater mixing heights are used)	3000.
ZIMINW	real	Minimum overwater mixing height (m) (Not used if observed overwater mixing heights are used)	50.
IAVEZI	integer	Conduct spatial averaging of mixing heights (0=no, 1=yes)	1
MNMDAV	integer	Maximum search distance (in grid cells) in the spatial averaging process. The square box of cells averaged is 2 x MNMDAV in length.	1
HAFANG	real	Half-angle of upwind-looking cone for spatial averaging (deg.)	30.
ILEVZI	integer	Layer of winds used in upwind averaging of mixing heights. (Must be between 1 and NZ.)	1

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 6 - Mixing Height, Temperature, and Precipitation Parameters

IMIXH	integer	Method to compute the convective mixing height 1: Maul-Carson for land and water cells -1: Maul-Carson for land cells only - OCD mixing height overwater 2: Batchvarova and Gryning for land and water cells -2: Batchvarova and Gryning for land cells only OCD mixing height overwater	1
THRESHL	real	Threshold buoyancy flux required to sustain convective mixing height growth overland (expressed as a heat flux per meter of boundary layer i.e. W/m3)	0.05
THRESHW	real	Threshold buoyancy flux required to sustain convective mixing height growth overwater (expressed as a heat flux per meter of boundary layer i.e. W/m3)	0.05
ITWPROG	integer	Option for overwater lapse rates used in convective mixing height growth 0 : use SEA.DAT (or default constant) lapse rates 1 : use prognostic lapse rates (only if IPROG>2)	1
ICOARE	integer	Overwater surface fluxes method and parameters 0: original deltaT method (OCD) 10: COARE with no wave parameterization (jwave=0, Charnock) 11: COARE with wave option jwave=1 (Oost et al) and default wave properties -11: COARE with wave option jwave=1 (Oost et al) and observed wave properties (must be in SEA.DAT files) 12: COARE with wave option 2 (Taylor and Yelland) and default wave properties -12: COARE with wave option 2 (Taylor and Yelland) and observed wave properties (must be in SEA.DAT files)	10
DSHELF	real	Coastal/Shallow water length scale (km) for modified z0 in shallow water (0 for deep-water form)	0.
IWARM	integer	COARE warm layer computation (1: on - 0: off) must be off if SST measured with IR radiometer	1
ICOOL	integer	COARE cool skin layer computation (1: on - 0: off) must be off if SST measured with IR radiometer	1

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 6 - Mixing Height, Temperature, and Precipitation Parameters

Variable	Type	Description	Default Value
ITPROG	integer	3D temperature from observations or from prognostic data? 0 = Use surface and upper air stations (if NOOBS = 0) 1 = Use Surface stations (no upper air observations); Use MM5 for upper air data (if NOOBS = 0,1) 2 = No surface or upper air observations; use MM5 for surface and upper air data (if NOOBS = 0,1,2)	0
IRAD	integer	Type of temperature interpolation (1 = 1/radius) (2 = 1/radius^2)	1
IAVET	integer	Conduct spatial averaging of temperatures (0 = no; 1 = yes) (Will use MNMDAV and HAFANG)	1
TRADKM	real	Radius of influence for temperature interpolation (km)	500.
NUMTS	integer	Maximum number of stations to include in temperature interpolation	5
TGDEFB	real	Default temperature lapse rate (K/m) below mixing height over water	-0.0098
TGDEFA	real	Default temperature lapse rate (K/m) above mixing height over water	-0.0045
JWAT1, JWAT2	integers	Beginning land use category for temperature interpolation overwater. Range of land use categories associated with major water bodies. Used for overwater temperature interpolation	999, 999
NFLAGP	integer	Method of precipitation interpolation (1 = 1/radius interpolation) (2 = 1/radius^2 interpolation) (3 = 1/radius^2 * exponential function) Method 3 is based on a Thiessen method for non-continuous fields where the exponential function = exponent [-radius^2/SIGMAP^2] and SIGMAP is defined below	2
SIGMAP	real	If NFLAGP=1 or 2, SIGMAP is the radius of influence for precipitation (km); if NFLAGP=3, SIGMAP is the sigma weighting factor (km); if NFLAGP=3 and SIGMAP=0.0, SIGMAP will be computed internally as half of the minimum distance between any non-zero precipitation station and any zero precipitation station.	100.0
CUTP	real	Cutoff precipitation rate (mm/hr); values < CUTP are set to 0.0 mm/hr	0.01

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 7 - Surface Meteorological Station Parameters

One line of data is entered for each surface station. If separate land/water interpolation is desired, this group must include only land stations. Overwater data will be in SEAn.DAT files. Each line contains the following parameters read in free format: CSNAM, IDSSTA, XSSTA, YSSTA, XSTZ, ZANEM. The data for each station are preceded by ! SSn=..., where n is the station number (e.g., ! SS1=... for station #1, ! SS2=... for station #2, etc.). The station variables (SS1, SS2, etc.) must start in Column 3. The data must start in Column 9 or greater of each record. See the sample control file for an example.

(Repeated for each of "NSSTA" Stations)

Variable	Type	Description
CSNAM	char*4	Four-character station name. Must be enclosed within single quotation marks (e.g., 'STA1', 'STA2', etc.). The opening quotation mark must be in Column 9 or greater of each record.
IDSSTA	integer	Station identification number
XSSTA	real	X coordinate* (km) of surface station
YSSTA	real	Y coordinate* (km) of surface station
XSTZ	real	Time zone of the station (e.g., 05=EST, 06=CST, 07=MST, 08=PST.)
ZANEM	real	Anemometer height (m)

* Coordinates are PMAP projection coordinates (see Input Group 2).

Table E-4 (Continued)
CALMET Control File Inputs

Input Group 8 - Upper Air Station Parameters

One line of data is entered for each upper air station. Each line contains the following parameters read in free format: CUNAM, IDUSTA, XUSTA, YUSTA, XUTZ. The data for each station are preceded by ! USn=..., where n is the upper air station number (e.g., ! US1=... for station #1, ! US2=... for station #2, etc.). The station variables (US1, US2, etc.) must start in Column 3. The data must start in Column 9 or greater of each record. See the sample control file for an example.

(Repeated for each of "NUSTA" Stations)

Variable	Type	Description
CUNAM	char*4	Four-character upper air station name. Must be enclosed within single quotation marks (e.g., ' STA1', ' STA2', etc.). The opening quotation mark must be in Column 9 or greater of each record.
IDUSTA	integer	Station identification number
XUSTA	real	X coordinate* (km) of upper air station
YUSTA	real	Y coordinate* (km) of upper air station
XUTZ	real	Time zone of the station (e.g., 05=EST, 06=CST, 07=MST, 08=PST.)

* Coordinates are PMAP projection coordinates (see Input Group 2).

Table E-4 (Concluded)

CALMET Control File Inputs

Input Group 9 - Precipitation Station Parameters

One line of data is entered for each precipitation station. Each line contains the following parameters read in free format: CPNAM, IDPSTA, XPSTA, and YPSTA. The data for each station are preceded by ! PSn=..., where n is the station number (e.g., ! PS1=... for station #1, ! PS2=... for station #2, etc.). The station variables (PS1, PS2, etc.) must start in Column 3. The data must start in Column 9 or greater of each record. See the sample control file for an example.

(Repeated for each of "NPSTA" Stations)

Variable	Type	Description
CPNAM	char*4	Four-character station name. Must be enclosed within single quotation marks (e.g., ' PS1', 'PS2', etc.). The opening quotation mark must be in Column 9 or greater of each record.
IDPSTA	integer	Station identification number
XPSTA	real	X coordinate* (km) of surface station
YPSTA	real	Y coordinate* (km) of surface station

* Coordinates are PMAP projection coordinates (see Input Group 2).

E.2 Geophysical Data File (GEO.DAT)

The GEO.DAT data file contains the geophysical data inputs required by the CALMET model. These inputs include land use type, elevation, surface parameters (surface roughness, length, albedo, Bowen ratio, soil heat flux parameter, and vegetation leaf area index) and anthropogenic heat flux. The land use and elevation data are entered as gridded fields. The surface parameters and anthropogenic heat flux can be entered either as gridded fields or computed from the land use data at each grid point. Default values relating each of these parameters to land use are provided in the model.

A sample GEO.DAT file is shown in Table E-5. The first line of the file identifies the file and its format to CALMET. The second line provides the number of comment lines (character strings of up to 80 characters in length) to follow that are read but are not interpreted by the model. One of these may typically contain a title to identify the data set. The next block of 5 to 6 lines contains map projection, datum, and grid information such as the number of grid cells, grid spacing, and reference coordinates. These variables define the mapping coordinates used for the modeling and are checked by CALMET for consistency and compatibility with the CALMET control file inputs. Eight sets of flags and data records follow for the land use, elevation, surface parameters, and anthropogenic heat flux data.

The default CALMET land use scheme is based on the U.S. Geological Survey (USGS) land use classification system. The USGS primary land use categories are shown in Table E-6. Two Level I USGS categories (water and wetlands) are subdivided into subcategories. Along with the default CALMET land use, the default values of the other geophysical parameters for each land use type are also shown. The default land use classification scheme contains 14 land use types. Note that a negative value of land use by CALMET is used as a flag to indicate irrigated land. Irrigated land may be assigned a different Bowen ratio than unirrigated land, and the CALPUFF dry deposition module uses the irrigated land use flag in computing the effect of moisture stress on stomatal resistance. (If the land is irrigated, it is assumed that the vegetation is not moisture stressed.)

CALMET allows a more detailed breakdown of land use or a totally different classification scheme to be used by providing the option for user-defined land use categories. Currently, up to 52 user-specified land use categories are allowed. An extended 52-class land use scheme based on the USGS Level I and Level II land use categories is shown in Table E-7. The user can specify up to "MXLU" land use categories along with new values of the other geophysical parameters for each land use type. The parameter MXLU is specified in the CALMET parameter file (PARAMS.MET).

CALMET contains an option, in which temperatures over water bodies such as the ocean or large lakes are calculated by using data from only those observation stations (SEA.DAT files, usually buoys) located in it, while only land stations (SURF.DAT file) will be used to calculate temperatures over the rest of the grid. The variables JWAT1 and JWAT2 in CALMET.INP Input Group #6 specify the range of land use categories defining the water body for which this land/water temperature scheme will be implemented. A range is specified to allow inclusion of multiple categories, for example "bay" and "ocean," in the definition of the water body. To disable the overwater option, JWAT1 and JWAT2 are set to values greater than the highest land use category listed in the GEO.DAT file. The default values of JWAT1 and JWAT2 are both 999, indicating the overwater interpolation scheme is not applied in default mode.

Because the temperature of any grid cell whose land use is included in the range defined by JWAT1 and JWAT2 will be determined by a weighting of all overwater data (SEA#.DAT files), it is recommended that smaller or distant water bodies be assigned land use categories that are distinct from those used in JWAT1 and JWAT2, to avoid use of inappropriate data in determining their surface temperatures. Thus a small reservoir will have its temperature determined by surrounding land stations, rather than by ocean buoy data. After viewing the initial temperature field that results from the CALMET run, the user may wish to "fine tune" the fields using the extended, 52-class land use system in Table E-7 and by altering the land use assignments of particular grid cells or changing the land uses included in the JWAT1-JWAT2 range. For instance, by limiting the range to "ocean" only and then changing which near-shore cells are considered to be "bay" and which are "ocean" the user can control the appearance of the temperature field in the vicinity of the coastline.

The values of IWAT1 and IWAT2 (GEO.DAT Input File) are used to determine whether the overland or overwater method will be used to produce a mixing height value for a particular grid cell. The default values of IWAT1 and IWAT2 are both 55, restricting the overwater mixing height scheme to "large" bodies of water. The user may change the values of IWAT1 and IWAT2 on a case-by-case basis to include or exclude other water bodies from being considered as overwater. For instance, the user's domain may have a bay where the mixing height should be determined using the overwater method but a series of small lakes where the overland method would be more appropriate, so the "lake" category would be excluded from the IWAT range. Alternatively, if one has a large lake that should be considered to be "overwater" and a smaller lake that should be considered to be "overland", then the land use category for the smaller lake could be changed to reflect some other category not in the IWAT range, such as forest or wetland. It is recommended that if the user creates his or her own GEO.DAT fields for roughness length, albedo, etc., they be weighted by the actual percentage of each land use in a given cell. That method is more accurate and, if one subsequently changes the dominant land use category, the variables used to calculate mixing height will still reflect the fact that there is water present in the grid cell.

The surface elevation data field is entered in "user units" along with a scaling factor to convert user units to meters. The sample GEO.DAT file shown in Table E-5 contains elevations in meters.

The gridded fields are entered with the 'NXM' values on a line. NXM is the number of grid cells in the X direction. The data from left to right correspond to X=1 through NXM. The top line of a gridded field correspond to Y=NYM, the next line to Y=NYM-1, etc. All of the GEO.DAT inputs are read in FORTRAN free format. A detailed description of the GEO.DAT variables is contained in Table E-8.

Table E-5

Sample GEO.DAT Geophysical Data File

```
GEO.DAT         2.0             Header structure with coordinate parameters
   2
Produced by MAKEGEO Version: 2.26  Level: 041230
Demo Application
UTM
  16N
NAS-C   02-21-2003
      10      10     -54.000   -621.000       54.000       54.000
KM  M
   0            - LAND USE DATA -- 0=default lu categories, 1=new categories
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
  40  40  40  40  40  40  40  40  40  40
1.0          - TERRAIN HEIGHTS - HTFAC - conversion to meters
    185.078        147.205        146.924        156.446        139.487
    138.010        173.812        203.405        232.758        222.710
    221.813        144.507        142.191        136.302        123.083
    133.693        158.348        192.281        224.074        247.634
    316.083        189.884        139.814        144.073        122.189
    123.002        146.333        195.571        215.208        263.082
    253.774        157.182        121.245        121.407        137.051
    144.876        152.340        200.471        246.724        318.109
    182.808        98.6778        91.7038        129.091        138.407
    165.023        190.390        225.489        253.910        314.988
    114.193        77.9254        93.2705        115.583        141.910
    190.386        187.382        204.256        306.503        448.922
    78.3998        71.2785        95.3602        129.989        148.870
    208.477        227.053        260.169        393.913        421.927
    64.1938        79.1642        117.264        139.864        158.785
    253.950        254.195        324.301        434.496        277.916
    53.5650        84.5807        134.072        148.030        162.781
    185.386        203.171        281.656        288.990        312.717
    42.8075        71.3265        111.239        96.0823        122.349
    189.143        181.916        249.689        271.627        278.849
0   - z0 --(0=default z0-lu table, 1=new z0-lu table, 2=gridded z0 field
0   - albedo --(0=default albedo-lu table,1=new albedo-lu table,2=gridded albedo field
0   - Bowen ratio --(0=default Bowen-lu table,1=new Bowen-lu table,2=gridded Bowen field
0   - soil heat flux param (HCG) --(0=default HCG-lu table,1=new HCG-lu table,2=gridded field
0   - anthropogenic heat flux (QF) --(0=default QF-lu table,1=new QF-lu table,2=gridded field
0   - leaf area index (XLAI) --(0=default XLAI-lu table,1=new XLAI-lu table,2=gridded field
```

Table E-6
Default CALMET Land Use Categories and Associated Geophysical Parameters
Based on the U.S. Geological Survey Land Use Classification System
(14-Category System)

Land Use Type	Description	Surface Roughness (m)	Albedo	Bowen Ratio	Soil Heat Flux Parameter	Anthropogenic Heat Flux (W/m^2)	Leaf Area Index
10	Urban or Built-up Land	1.0	0.18	1.5	.25	0.0	0.2
20	Agricultural Land - Unirrigated	0.25	0.15	1.0	.15	0.0	3.0
-20*	Agricultural Land - Irrigated	0.25	0.15	0.5	.15	0.0	3.0
30	Rangeland	0.05	0.25	1.0	.15	0.0	0.5
40	Forest Land	1.0	0.10	1.0	.15	0.0	7.0
51	Small Water Body	0.001	0.10	0.0	1.0	0.0	0.0
54	Bays and Estuaries	0.001	0.01	0.0	1.0	0.0	0.0
55	Large Water Body	0.001	0.10	0.0	1.0	0.0	0.0
60	Wetland	1.0	0.10	0.5	.25	0.0	2.0
61	Forested Wetland	1.0	0.1	0.5	0.25	0.0	2.0
62	Nonforested Wetland	0.2	0.1	0.1	0.25	0.0	1.0
70	Barren Land	0.05	0.30	1.0	.15	0.0	0.05
80	Tundra	.20	0.30	0.5	.15	0.0	0.0
90	Perennial Snow or Ice	.05	0.70	0.5	.15	0.0	0.0

* Negative values indicate "irrigated" land use

Table E-7

Extended CALMET Land Use Categories Based on the U.S. Geological Survey Land Use and Land Cover Classification System (52-Category System)

	Level I		Level II
10	Urban or Built-up Land	11	Residential
		12	Commercial and Services
		13	Industrial
		14	Transportation, Communications and Utilities
		15	Industrial and Commercial Complexes
		16	Mixed Urban or Built-up Land
		17	Other Urban or Built-up Land
20	Agricultural Land — Unirrigated	21	Cropland and Pasture
		22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		23	Confined Feeding Operations
		24	Other Agricultural Land
!20	Agricultural Land — Irrigated	!21	Cropland and Pasture
		!22	Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas
		!23	Confined Feeding Operations
		!24	Other Agricultural Land
30	Rangeland	31	Herbaceous Rangeland
		32	Shrub and Brush Rangeland
		33	Mixed Rangeland
40	Forest Land	41	Deciduous Forest Land
		42	Evergreen Forest Land
		43	Mixed Forest Land
50	Water	51	Streams and Canals
		52	Lakes
		53	Reservoirs
		54	Bays and Estuaries
		55	Oceans and Seas
60	Wetland	61	Forested Wetland
		62	Nonforested Wetland
70	Barren Land	71	Dry Salt Flats
		72	Beaches
		73	Sandy Areas Other than Beaches
		74	Bare Exposed Rock
		75	Strip Mines, Quarries, and Gravel Pits
		76	Transitional Areas
		77	Mixed Barren Land
80	Tundra	81	Shrub and Brush Tundra
		82	Herbaceous Tundra
		83	Bare Ground
		84	Wet Tundra
		85	Mixed Tundra
90	Perennial Snow or Ice	91	Perennial Snowfields
		92	Glaciers

Note: Negative values indicate irrigated land use.

*Values used for JWAT (Input Group 6) or IWAT (GEO.DAT Input File)

Table E-8

GEO.DAT File Format

Record	Variable	Type	Description
1	DATASET	character*16	Dataset name (GEO.DAT)
1	DATAVER	character*16	Dataset version
1	DATAMOD	character*64	Dataset message field
2	NCOMM	integer	Number of comment records to follow
NEXT NCOMM Lines	TITLEGE	character *80	Title of file (up to 80 characters) and any other documentation for QA
NCOMM +3	PMAP *	character*8	Map projection UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA : Lambert Azimuthal Equal Area
NCOMM +4	IUTMZN, UTMHEM	integer, character*1	UTM zone, Hemisphere (N or S) read as format (i4,a1) ONLY for PMAP = UTM
NCOMM +4	RLAT0, RLON0, XLAT1, XLAT2	character*16	Latitude, Longitude of map projection origin, and one or two Matching Latitude Parallels. (Degrees with either N, S, E, or W, e.g., 45.6N). ONLY for PMAP = LCC, LAZA, TTM, PS, or EM
NCOMM +5	FEAST, FNORTH	real	False Easting and Northing (km). Included only if PMAP = TTM, LCC, or LAZA
NCOMM +5 or 6	DATUM	character*8	DATUM Code
NCOMM +5 or 6	DATEN	character*12	NIMA date (MM-DD-YYYY) for datum definitions
NCOMM +6 or 7	NXG	integer	Number of grid cells in the X direction
NCOMM +6 or 7	NYG	integer	Number of grid cells in the Y direction
NCOMM +6 or 7	XORG	real	Reference X coordinate of southwest corner of grid cell (1,1)
NCOMM +6 or 7	YORG	real	Reference Y coordinate of southwest corner of grid cell (1,1)
NCOMM +6 or 7	DGRIDX	real	Horizontal grid spacing: Easting

* PMAP projections PS, EM, and LAZA are NOT AVAILABLE in CALMET

(GEO.DAT File Format Continued)

Table E-8 (Continued)
GEO.DAT File Format

Record	Variable	Type	Description
NCOMM +6 or 7	DGRIDY	real	Horizontal grid spacing: Northing (= DGRIDX)
NCOMM +7 or 8	XYUNIT	character*4	Units for horizontal coordinates (KM)
NCOMM+ 8 or 9	IOPT1	integer	Option flag for land use categories (0=to use default land use categories) (1=to specify new land use categories)
NCOMM +9 or 10**	NLU	integer	Number of land use categories
NCOMM +9 or 10**	IWAT1, IWAT2	integer	Range of land use categories associated with water (i.e., land use categories IWAT1 to IWAT2, inclusive, are assumed to represent water surfaces)
NCOMM +10 or 11**	ILUCAT	integer array	Array of "NLU" new user specified land use categories
NEXT NY lines	ILANDU	integer array	Land use types for cell grid point (NX values per line). The following statements are used to read the data: do 20 J=NY,1,-1 20 READ (iogeo,*)(ILANDU(n,j), n=1, nx)
NEXT line	HTFAC	real	Multiplicative scaling factor to convert terrain heights from user units to meters (e.g., HTFAC = 0.3048 for user units of ft, 1.0 for user units of meters)
NEXT NY lines	ELEV	real array	Terrain elevations (user units) for each grid point (NX values for line). The following statements are used to read the data: do 30 J=NY,1,-1 30 READ(iogeo,*)(ELEV(n,j),n=1,NX)
NEXT line	IOPT2	integer	Option flag for input of surface roughness lengths (z0) 0=compute gridded z0 values from land use types using default z0 land use table 1=compute gridded z0 values from land use types using new, user-specified z0 land use table 2=input a gridded z0 field
NEXT** NLU lines	{ ILU ZOLU	integer real array	Land use type and associated surface roughness lengths (m). Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,ZOLU(I)
NEXT*** NY lines	ZO	real array	Surface roughness length (m) at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(ZO(n,j),n=1,NX)

** Included only if IOPT2 = 1
*** Included only if IOPT2 = 2

Table E-8 (Continued)
GEO.DAT File Format

Record	Variable	Type	Description
NEXT line	IOPT3	integer	Option flat for input of albedo 0=compute gridded albedo values from land use types using the default albedo-land use table 1=compute gridded albedo values from land use types using a new, user-specified albedo-land use table 2=input a gridded albedo field
NEXT** NLU lines	{ ILU ALBLU	integer real array	Land use type and associated albedo. Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,ALBLU(I)
NEXT*** NY lines	ALBEDO	real array	Albedo at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(ALBEDO(n,j),n=1,NX)

** Included only if IOPT3 = 1
*** Included only if IOPT3 = 2

Table E-8 (Continued)
GEO.DAT File Format

Record	Variable	Type	Description
NEXT line	IOPT4	integer	Option flag for input of Bowen ratio 0=compute gridded Bowen ratio values from land use types using default Bowen ratio-land use table 1=compute gridded Bowen ratio values from land use types using new, user-specified Bowen ratio-land use table 2=input a gridded Bowen ratio field
NEXT** NLU lines	{ ILU BOWLU	integer real array	Land use type and associated Bowen ratio. Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,BOWLU(I)
NEXT*** NY lines	BOWEN	real array	Bowen ratio at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(BOWEN(n,j),n=1,NX)

** Included only if IOPT4 = 1
*** Included only if IOPT4 = 2

Table E-8 (Continued)
GEO.DAT File Format

Record	Variable	Type	Description
NEXT line	IOPT5	integer	Option flag for input of soil heat flux constant 0=compute gridded soil heat flux constant values from land use types using the default soil heat flux constant-land use table 1=compute gridded soil heat flux constant values from land use types using new, user-specified soil heat flux constant-land use table 2=input a gridded soil heat flux constant field
NEXT** NLU lines	{ ILU HCGLU	integer real array	Land use type and associated soil heat flux constant. Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,HCGLU(I)
NEXT*** NY lines	HCG	real array	Soil heat flux constant at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(HCG(n,j),n=1,NX)

** Included only if IOPT5 = 1
*** Included only if IOPT5 = 2

Table E-8 (Continued)
GEO.DAT File Format

Record	Variable	Type	Description
NEXT line	IOPT6	integer	Option flag for input of anthropogenic heat flux (W/m^2) 0=compute gridded anthropogenic heat flux values from land use types using default anthropogenic heat flux-land use table 1=compute gridded anthropogenic heat flux values from land use types using new, user-specified anthropogenic heat flux-land use table 2=input a gridded anthropogenic heat flux field
NEXT** NLU lines	{ ILU QFLU	integer real array	Land use type and associated anthropogenic heat flux (W/m^2). Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,QFLU(I)
NEXT*** NY lines	QF	real array	Anthropogenic heat flux (W/m^2) at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(QF(n,j),n=1,NX)

** Included only if IOPT6 = 1
*** Included only if IOPT6 = 2

Table E-8 (Concluded)
GEO.DAT File Format

Record	Variable	Type	Description
NEXT line	IOPT7	integer	Option flag for input of leaf area index 0=compute gridded leaf area index values from land use types using default leaf area index-land use table 1=compute gridded leaf area index values from land use types using new, user-specified leaf area index-land use table 2=input a gridded leaf area index field
NEXT** NLU lines	{ ILU XLAILU	integer real array	Land use type and associated leaf area index values. Two variables per line read as: do 120 I=1,NLU 120 READ(iogeo,*)ILU,XLAILU(I)
NEXT*** NY lines	XLAI	real array	Leaf area index value at each grid point (NX values per line). The following statements are used to read the data: do 150 J=NY,1,-1 150 READ(iogeo,*)(XLAI(n,j),n=1,NX)

** Included only if IOPT7 = 1
*** Included only if IOPT7 = 2

E.3 Upper Air Data Files (UP1.DAT, UP2.DAT,...)

The upper air data used by CALMET are read from upper air data files called UPn.dat, where n is the upper air station number (n=1,2,3, etc.). The upper air data files can be created by the READ62 preprocessor program from standard NCDC upper air data formats or by application-specific reformatting programs. Observations made at non-standard sounding times can be used by CALMET.

The UPn.DAT files are formatted, user-editable files containing at least five header records followed by groups of data records. A sample upper air data file generated by READ62 and hand-edited to remove informational messages and to fill in missing soundings is shown in Table E-9. The first line of the file identifies the file and its format to CALMET. The second line provides the number of comment lines (character strings of up to 80 characters in length) to follow that are read but are not interpreted by the model. One of these may typically contain a title to identify the data set. The next line after all comment records identifies the map projection for any locations provided in the file. Presently, the projection is NONE as no locations are provided. The next record contains the starting and ending dates of data contained in the file and the top pressure level of the sounding data. The last header record contains the READ62 data processing options used in the creation of the file.

The data records consist of a one-record header listing the origin of the data (6201 for NCDC data or 9999 for non-NCDC data), station ID number, date and time, and information on the number of sounding levels. Following this are the pressure, elevation, temperature, wind direction, and wind speed for each sounding level. The format of the UPn.dat file is shown in Table E-10.

As discussed in Section 3.0, the model allows missing values of wind speed, wind direction, and temperature in the UP.DAT files at intermediate levels. The model will linearly interpolate between valid levels to fill in the missing data. The user is cautioned against using soundings for which this interpolation would be inappropriate. Missing soundings should be replaced with soundings for the same time period from a representative substitute station. Each data set must be processed on a case-by-case basis with careful consideration given to how to deal with missing data.

Table E-9
Sample READ62 Output Data File
(UPn.DAT)

(a) UP.DAT - Slash-delimited format

```
UP.DAT          2.0             Header structure with coordinate parameters
   1
Produced by READ62 Version: 5.53  Level: 040109
NONE
  1990    1    0 1990   15   12 500.    2    1
     F    F    F    F
   6201     14684   1990 1 1 0     54                          28
   1007.0/  16./279.3/160/ 10   1000.0/  77./281.0/174/ 13    983.0/ 221./284.6/186/ 19    973.0/ 304./999.9/190/ 21
    959.0/ 427./285.2/199/ 23    950.0/ 507./284.9/203/ 24    938.0/ 609./999.9/210/ 26    905.0/ 914./999.9/220/ 29
    900.0/ 959./283.1/222/ 30    872.0/1219./999.9/225/ 31    850.0/1433./281.2/222/ 31    822.0/1710./278.5/223/ 30
    810.0/1827./999.9/225/ 30    800.0/1931./277.6/226/ 29    780.0/2132./999.9/225/ 29    752.0/2437./999.9/225/ 28
    750.0/2456./275.3/226/ 28    724.0/2742./999.9/230/ 27    708.0/2920./273.2/230/ 26    700.0/3011./272.9/231/ 26
    697.0/3047./999.9/230/ 26    650.0/3601./269.6/236/ 27    645.0/3657./999.9/235/ 27    600.0/4230./266.1/240/ 31
    597.0/4267./999.9/240/ 32    552.0/4875./999.9/240/ 36    550.0/4905./262.2/241/ 36    500.0/5630./257.9/240/ 38
   6201     14684   1990 1 112     38                          19
    994.0/  16./276.5/240/  7    979.0/ 140./279.7/250/ 11    968.0/ 233./280.3/254/ 14    950.0/ 388./280.0/254/ 18
    933.0/ 536./279.6/250/ 19    900.0/ 832./280.4/243/ 22    898.0/ 852./280.5/242/ 22    850.0/1303./277.8/244/ 24
    800.0/1795./275.8/251/ 29    750.0/2316./273.5/256/ 35    742.0/2402./273.1/256/ 36    728.0/2554./272.3/254/ 38
    707.0/2787./273.0/249/ 39    700.0/2868./272.5/248/ 39    650.0/3457./268.6/241/ 35    603.0/4042./264.5/230/ 30
    600.0/4081./264.4/230/ 30    550.0/4754./262.3/222/ 38    500.0/5482./259.9/219/ 53

          (... records removed for clarity)

   6201     14684   1990 11512     66                          34
   1029.0/  16./273.1/150/  4   1025.0/  46./273.1/154/  4   1000.0/ 243./271.4/170/  6    992.0/ 304./999.9/175/  7
    956.0/ 601./269.3/200/  8    955.0/ 609./999.9/200/  8    950.0/ 651./269.0/202/  8    919.0/ 914./999.9/225/  8
    900.0/1075./266.1/243/  9    890.0/1162./267.5/251/ 10    884.0/1219./999.9/255/ 10    883.0/1224./268.4/254/ 10
    850.0/1523./267.4/254/ 13    824.0/1766./267.0/246/ 14    818.0/1827./999.9/245/ 14    804.0/1959./268.3/239/ 14
    800.0/1997./268.0/238/ 15    786.0/2132./999.9/235/ 15    776.0/2236./265.8/232/ 16    756.0/2437./999.9/230/ 18
    750.0/2502./264.0/230/ 18    727.0/2742./999.9/230/ 18    700.0/3031./260.2/233/ 18    691.0/3130./261.1/236/ 19
    685.0/3197./263.6/237/ 19    674.0/3323./263.9/240/ 20    650.0/3603./262.0/247/ 20    645.0/3657./999.9/250/ 20
    600.0/4213./257.8/256/ 19    596.0/4267./999.9/255/ 19    550.0/4864./253.2/255/ 20    549.0/4875./999.9/255/ 21
    527.0/5180./999.9/255/ 22    500.0/5564./248.1/258/ 23
```

(b) UP.DAT - Comma-delimited format

```
UP.DAT          2.0             Header structure with coordinate parameters
   1
Produced by READ62 Version: 5.53  Level: 040109
NONE
  1990    1    0 1990   15   12 500.    2    2
     F    F    F    F
   6201     14684   1990 1 1 0     54                          28
   1007.0,  16.,279.3,160, 10.0,   1000.0,  77.,281.0,174, 13.0,    983.0, 221.,284.6,186, 19.0,    973.0, 304.,999.9,190, 21.1,
    959.0, 427.,285.2,199, 23.0,    950.0, 507.,284.9,203, 24.0,    938.0, 609.,999.9,210, 26.2,    905.0, 914.,999.9,220, 29.8,
    900.0, 959.,283.1,222, 30.0,    872.0,1219.,999.9,225, 31.3,    850.0,1433.,281.2,222, 31.0,    822.0,1710.,278.5,223, 30.0,
    810.0,1827.,999.9,225, 30.3,    800.0,1931.,277.6,226, 29.0,    780.0,2132.,999.9,225, 29.8,    752.0,2437.,999.9,225, 28.8,
    750.0,2456.,275.3,226, 28.0,    724.0,2742.,999.9,230, 27.2,    708.0,2920.,273.2,230, 26.0,    700.0,3011.,272.9,231, 26.0,
    697.0,3047.,999.9,230, 26.7,    650.0,3601.,269.6,236, 27.0,    645.0,3657.,999.9,235, 27.7,    600.0,4230.,266.1,240, 31.0,
    597.0,4267.,999.9,240, 32.4,    552.0,4875.,999.9,240, 36.0,    550.0,4905.,262.2,241, 36.0,    500.0,5630.,257.9,240, 38.0
   6201     14684   1990 1 112     38                          19
    994.0,  16.,276.5,240,  7.0,    979.0, 140.,279.7,250, 11.0,    968.0, 233.,280.3,254, 14.0,    950.0, 388.,280.0,254, 18.0,
    933.0, 536.,279.6,250, 19.0,    900.0, 832.,280.4,243, 22.0,    898.0, 852.,280.5,242, 22.0,    850.0,1303.,277.8,244, 24.0,
    800.0,1795.,275.8,251, 29.0,    750.0,2316.,273.5,256, 35.0,    742.0,2402.,273.1,256, 36.0,    728.0,2554.,272.3,254, 38.0,
    707.0,2787.,273.0,249, 39.0,    700.0,2868.,272.5,248, 39.0,    650.0,3457.,268.6,241, 35.0,    603.0,4042.,264.5,230, 30.0,
    600.0,4081.,264.4,230, 30.0,    550.0,4754.,262.3,222, 38.0,    500.0,5482.,259.9,219, 53.0

          (... records removed for clarity)

   6201     14684   1990 11512     66                          34
   1029.0,  16.,273.1,150,  4.0,   1025.0,  46.,273.1,154,  4.0,   1000.0, 243.,271.4,170,  6.0,    992.0, 304.,999.9,175,  7.2,
    956.0, 601.,269.3,200,  8.0,    955.0, 609.,999.9,200,  8.2,    950.0, 651.,269.0,202,  8.0,    919.0, 914.,999.9,225,  8.7,
    900.0,1075.,266.1,243,  9.0,    890.0,1162.,267.5,251, 10.0,    884.0,1219.,999.9,255, 10.2,    883.0,1224.,268.4,254, 10.0,
    850.0,1523.,267.4,254, 13.0,    824.0,1766.,267.0,246, 14.0,    818.0,1827.,999.9,245, 14.4,    804.0,1959.,268.3,239, 14.0,
    800.0,1997.,268.0,238, 15.0,    786.0,2132.,999.9,235, 15.9,    776.0,2236.,265.8,232, 16.0,    756.0,2437.,999.9,230, 18.0,
    750.0,2502.,264.0,230, 18.0,    727.0,2742.,999.9,230, 18.0,    700.0,3031.,260.2,233, 18.0,    691.0,3130.,261.1,236, 19.0,
    685.0,3197.,263.6,237, 19.0,    674.0,3323.,263.9,240, 20.0,    650.0,3603.,262.0,247, 20.0,    645.0,3657.,999.9,250, 20.5,
    600.0,4213.,257.8,256, 19.0,    596.0,4267.,999.9,255, 19.0,    550.0,4864.,253.2,255, 20.0,    549.0,4875.,999.9,255, 21.1,
    527.0,5180.,999.9,255, 22.6,    500.0,5564.,248.1,258, 23.0
```

Table E-10
READ62 Output File Format
(Upn.DAT)

FILE HEADER RECORD #1

Columns	Format	Variable	Description
1-16	A16	DATASET	Dataset name (UP.DAT)
17-32	A16	DATAVER	Dataset version
33-96	A64	DATAMOD	Dataset message field

FILE HEADER RECORD #2 to NCOMM+2

Columns	Format	Variable	Description
1-4	I4	NCOMM	Number of comment records
1-80	A80	TITLE	Comment (repeated NCOMM times)

FILE HEADER RECORD # NCOMM+3

Columns	Format	Variable	Description
1-8	A8	PMAP	Map projection (NONE)

FILE HEADER RECORD # NCOMM+4

Columns	Format	Variable	Description
2-6	I5	IBYR	Starting year of data in the file (YYYY)
7-11	I5	IBDAY	Starting Julian day of data in the file
12-16	I5	IBHR	Starting hour (UTC) of data in the file
17-21	I5	IEYR	Ending year of data in the file (YYYY)
22-26	I5	IEDAY	Ending Julian day of data in the file
27-31	I5	IEHR	Ending hour (UTC) of data in the file
32-36	F5.0	PSTOP	Top pressure level (mb) of data in the file (possible values are 850 mb, 700 mb, or 500 mb)
37-41	I5	JDAT	Original data file type (1 = TD-6201 format 2=NCDC CD-ROM format)
42-46	I5	IFMT	Delimiter used in the UP.DAT file (1 = slash (/) delimiter, 2= comma (,) delimiter)

(READ62 Output File Format Continued)

Table E-10 (Continued)
READ62 Output File Format
(Upn.DAT)

FILE HEADER RECORD # NCOMM+5

Columns	Format	Variable	Description
6	L1	LHT	Sounding level eliminated if height missing ? (T=yes, F=no)
11	L1	LTEMP	Sounding level eliminated if temperature missing ? (T=yes, F=no)
16	L1	LWD	Sounding level eliminated if wind direction missing ? (T=yes, F=no)
21	L1	LWS	Sounding level eliminated if wind speed missing ? (T=yes, F=no)

DATA RECORDS

For each 00 or 12 UTC sounding, a one-record data header is used followed by "N" records of data. Each record contains up to four sounding levels.

DATA HEADER RECORD

Columns	Format*	Variable	Description
4-7	I4	ITPDK	Label identifying data format of original data (e.g., 5600 or 6201 for NCDC data or 9999 for non-NCDC data)
13-17	A5	STNID	Station ID number
21-24	I4	YEAR	Year of data
25-26	I2	MONTH	Month of data
27-28	I2	DAY	Day of data
29-30	I2	HOUR	Hour of data (UTC)
36-37	I2	MLEV	Total number of levels in the original sounding
69-70	I2	ISTOP	Number of levels extracted from the original sounding and stored below

* Record format is (3x,i4,5x,a5,3x,i4,3i2,5x,i2,t69,i2)

(READ62 Output File Format Continued)

Table E-10 (Concluded)
READ62 Output File Format
(UPn.DAT)

DATA RECORDS (Slash-delimited format)
(Up to four levels per record)

Columns	Format*	Variable	Description
4-9	F6.1	PRES	Pressure (mb)
11-15	F5.0	HEIGHT	Height above sea level (m)
17-21	F5.1	TEMP	Temperature (deg. K)
23-25	I3	WD	Wind direction (degrees)
27-29	I3	WS	Wind speed (m/s)
33-38	F6.1	PRES	Pressure (mb)
40-44	F5.0	HEIGHT	Height above sea level (m)
46-50	F5.1	TEMP	Temperature (deg. K)
52-54	I3	WD	Wind direction (degrees)
56-58	I3	WS	Wind speed (m/s)
62-67	F6.1	PRES	Pressure (mb)
69-73	F5.0	HEIGHT	Height above sea level (m)
75-79	F5.1	TEMP	Temperature (deg. K)
81-83	I3	WD	Wind direction (degrees)
85-87	I3	WS	Wind speed (m/s)
91-96	F6.1	PRES	Pressure (mb)
98-102	F5.0	HEIGHT	Height above sea level (m)
104-108	F5.1	TEMP	Temperature (deg. K)
110-112	I3	WD	Wind direction (degrees)
114-116	I3	WS	Wind speed (m/s)

* Record format is (4(3x,f6.1,'/',f5.0,'/',f5.1,'/',i3,'/',i3))
Missing value indicators are !99.9 for pressure, 9999. for height, 999.9 for temperature, and 999 for wind speed and direction.

E.4 Surface Meteorological Data File (SURF.DAT)

CALMET provides two options for the format of the surface meteorological data input file, SURF.DAT. The first is to use the unformatted file created by the SMERGE meteorological preprocessor program. SMERGE processes and reformats hourly surface observations in standard NCDC formats into a form compatible with CALMET. It is best used for large data sets with many surface stations.

The second format allowed by CALMET for the SURF.DAT file is a free-formatted option. This option allows the user the flexibility of either running the SMERGE preprocessor to create a formatted data file or for short CALMET runs, manually entering the data.

The selection of which surface data input format is used by CALMET is made by the user with the control file variable, IFORMS (see Input Group 4 of the control file in Section 8.1).

A sample formatted SURF.DAT file is shown in Table E-11. A description of each variable in the formatted surface data file is contained in Table E-12. The first line of the file identifies the file and its format to CALMET. The second line provides the number of comment lines (character strings of up to 80 characters in length) to follow that are read but are not interpreted by the model. One of these may typically contain a title to identify the data set. The next line after all comment records identifies the map projection for any locations provided in the file. Presently, the projection is NONE as no locations are provided. The next line identifies the beginning and ending dates and times of data in the file, the reference time zone for these, and the number of stations. Finally, one record per station follows with the station ID for each. One data record per hour follows the header records. Each data record contains the date and time and for each station, the wind speed, wind direction, ceiling height, cloud cover, temperature, relative humidity, station pressure, and a precipitation code.

Buoy and other overwater data are normally input through the SEAn.DAT files. If the overwater method is not used, the buoy data can be either the SURF.DAT file or SEAn.DAT files. In any case, buoy data for a given station should not be in both files.

Table E-11
Sample SURF.DAT Output Data File
(SURF.DAT)

```
SURF.DAT        2.0             Header structure with coordinate parameters
   1
Produced by SMERGE Version: 5.55  Level: 050311
NONE
  1993   7   0  1993   7   5   7   4
   14606
   14611
   14745
   14742
1993   7   0
    3.087  220.000  999    0  263.706   98  956.997    0
    3.087  140.000  999    0  263.706   98  956.997    0
    3.087  180.000  999    0  263.706   98  956.997    0
    3.087   90.000  999    0  263.706   98  956.997    0
1993   7   1
    3.601  220.000  999    0  263.706   98  956.319    0
    3.601  140.000  999    0  263.706   98  956.319    0
    3.601  180.000  999    0  263.706   98  956.319    0
    3.601   90.000  999    0  263.706   98  956.319    0
1993   7   2
    3.087  220.000  999    0  263.150   99  955.642    0
    3.087  140.000  999    0  263.150   99  955.642    0
    3.087  180.000  999    0  263.150   99  955.642    0
    3.087   90.000  999    0  263.150   99  955.642    0
1993   7   3
    4.116  220.000  999    0  263.150   98  955.303    0
    4.116  140.000  999    0  263.150   98  955.303    0
    4.116  180.000  999    0  263.150   98  955.303    0
    4.116   90.000  999    0  263.150   98  955.303    0
1993   7   4
    3.087  220.000  999    0  262.594   98  955.303    0
    3.087  140.000  999    0  262.594   98  955.303    0
    3.087  180.000  999    0  262.594   98  955.303    0
    3.087   90.000  999    0  262.594   98  955.303    0
1993   7   5
    1.543  220.000  999    0  262.594   98  956.319    0
    1.543  140.000  999    0  262.594   98  956.319    0
    1.543  180.000  999    0  262.594   98  956.319    0
    1.543   90.000  999    0  262.594   98  956.319    0
```

Table E-12
Formatted SURF.DAT File - Header Records

FILE HEADER RECORD #1

Columns	Format	Variable	Description
1-16	A16	DATASET	Dataset name (SURF.DAT)
17-32	A16	DATAVER	Dataset version
33-96	A64	DATAMOD	Dataset message field

FILE HEADER RECORD #2 to NCOMM+2

Columns	Format	Variable	Description
1-4	I4	NCOMM	Number of comment records
1-80	A80	TITLE	Comment (repeated NCOMM times)

FILE HEADER RECORD # NCOMM+3

Columns	Format	Variable	Description
1-8	A8	PMAP	Map projection (NONE)

FILE HEADER RECORD # NCOMM+4

Variable No. *	Variable	Type	Description
1	IBYR	integer	Beginning year of the data in the file
2	IBJUL	integer	Beginning Julian day
3	IBHR	integer	Beginning hour (00-23 LST)
4	IEYR	integer	Ending year
5	IEJUL	integer	Ending Julian day
6	IEHR	integer	Ending hour (00-23 LST)
7	IBTZ	integer	Time zone (e.g., 05=EST, 06=CST, 07=MST, 08=PST)
8	NSTA	integer	Number of stations

* Variables are read in FORTRAN free-format

Next NSTA HEADER RECORDS

Columns	Fornat	Variable	Description
1-8	I8	IDSTA	Surface station ID number

Table E-12 (Continued)
Formatted SURF.DAT File - Data Records*

Variable No.	Variable	Type	Description
1	IYR	integer	Year of data
2	IJUL	integer	Julian day
3	IHR	integer	Hour (00-23 LST)
4	WS	real array	Wind speed (m/s)
5	WD	real array	Wind direction (degrees)
6	ICEIL	integer array	Ceiling height (hundreds of feet)
7	ICC	integer array	Opaque sky cover (tenths)
8	TEMPK	real array	Air temperature (degrees K)
9	IRH	integer array	Relative humidity (percent)
10	PRES	real array	Station pressure (mb)
11	IPCODE	integer array	Precipitation code (0=no precipitation, 1-18=liquid precipitation, 19-45=frozen precipitation)

---

* The data records are read in free format with the following statement:

```
    READ(io,*)IYR,IJUL,IHR,(WS(n),WD(n),ICEIL(n),
 1       ICC(n),TEMPK(n),IRH(n),PRES(n),IPCODE(n),
 1       n=1,NSTA)
```

Missing value indicators are 9999. (real variables) and 9999 (integer variables)

E.5 Overwater Data Files (SEA1.DAT, SEA2.DAT, ...)

If the modeling application involves overwater transport and dispersion, the CALMET boundary layer model requires observations of the air-sea temperature difference, air temperature, relative humidity and overwater mixing height. If the overwater temperature method is used, vertical temperature gradient information is also necessary, however defaults are specified in the CALMET.INP file. The special overwater observations, along with wind speed and direction, are contained in a set of files named SEAn.DAT, where n is a station number (1,2,3,...). If SEAn.DAT files are not used, the overwater station and its standard surface parameters (e.g., wind speed and direction, etc.) can be treated as a regular surface station. Additionally, any overwater site that should not be used in the overwater temperature interpolation scheme should be placed in the SURF.DAT file instead of a SEA.DAT file. For instance, a user may want to include wind information from a lake buoy but not have the buoy influence temperatures over the ocean.

The overwater data files are structured to allow the use of data with arbitrary time resolution. For example, hourly or daily air-sea temperature difference data, if available, can be entered into the files. Otherwise, monthly or seasonal data can be used. However, any station that is reporting non-missing wind speed and direction should use hourly data resolution or inaccuracies will be introduced into the wind field. The inaccuracy results from the fact that the variables retain their current values each hour until a new observation is encountered, at which time they are updated. Thus, long periods of missing wind data between valid observations should receive hourly records with the wind data set to missing. A similar argument applies to temperature and vertical temperature gradient information if the overwater temperature method is used. All times must match the base time zone of the CALMET run (variable IBTZ).

The location of the overwater site is specified for each observation. This allows the use of data collected from ships with time-varying locations. The data for each observation station (fixed or moving) must be stored in a separate overwater data file.

Table E-13 contains a sample overwater input file, which contains hourly overwater data. A description of each input variable and format is provided in Table E-14.

Table E-13

Sample Overwater Data File (SEA1.DAT)

```
SEA.DAT         2.1             Header structure with coordinate parameters
   2
Produced by BUOY Version:   1.1  Level: 050826
 Data values taken from NODC  Data Format 291
UTM
  15N
NAS-C   02-21-2003
KM
 42002 42002
  357.21 2783.99 10.0 2004   1  0 2004   1  0 -214.3  296.9   82.3 9999.0 9999.0 9999.0    6.6  115.0    6.3    1.1
  357.21 2783.99 10.0 2004   1  1 2004   1  1 -214.3  296.9   81.8 9999.0 9999.0 9999.0    6.1  109.0    6.7    1.1
  357.21 2783.99 10.0 2004   1  2 2004   1  2 -214.4  296.8   83.8 9999.0 9999.0 9999.0    6.0  101.0    5.6    1.2
  357.21 2783.99 10.0 2004   1  3 2004   1  3 -214.4  296.8   81.8 9999.0 9999.0 9999.0    7.3  101.0    4.8    1.1
  357.21 2783.99 10.0 2004   1  4 2004   1  4 -214.4  296.8   80.3 9999.0 9999.0 9999.0    6.9  104.0    5.9    1.1
  357.21 2783.99 10.0 2004   1  5 2004   1  5 -214.4  296.8   76.8 9999.0 9999.0 9999.0    5.8  111.0    4.5    1.0
  357.21 2783.99 10.0 2004   1  6 2004   1  6 -214.3  296.9   76.4 9999.0 9999.0 9999.0    7.5  107.0    5.9    1.1
  357.21 2783.99 10.0 2004   1  7 2004   1  7 -213.3  296.9   73.6 9999.0 9999.0 9999.0    7.6  115.0    7.1    1.1
  357.21 2783.99 10.0 2004   1  8 2004   1  8 -213.0  297.1   75.0 9999.0 9999.0 9999.0    6.9  121.0    5.6    1.1
  357.21 2783.99 10.0 2004   1  9 2004   1  9 -213.8  297.4   75.5 9999.0 9999.0 9999.0    8.1  124.0    5.0    1.1
  357.21 2783.99 10.0 2004   1 10 2004   1 10 -213.9  297.2   79.3 9999.0 9999.0 9999.0    7.7  123.0    5.6    1.1
  357.21 2783.99 10.0 2004   1 11 2004   1 11 -213.8  297.4   80.3 9999.0 9999.0 9999.0    7.7  127.0    5.0    1.1
  357.21 2783.99 10.0 2004   1 12 2004   1 12 -215.1  297.0   84.9 9999.0 9999.0 9999.0    7.0  120.0    5.6    1.1
  357.21 2783.99 10.0 2004   1 13 2004   1 13 -215.0  297.1   84.9 9999.0 9999.0 9999.0    7.0  123.0    5.6    1.2
  357.21 2783.99 10.0 2004   1 14 2004   1 14 -216.1  297.0   86.5 9999.0 9999.0 9999.0    8.0  127.0    5.6    1.2
  357.21 2783.99 10.0 2004   1 15 2004   1 15 -216.4  296.8   85.9 9999.0 9999.0 9999.0    9.4  126.0    5.0    1.1
  357.21 2783.99 10.0 2004   1 16 2004   1 16 -215.1  297.0   87.5 9999.0 9999.0 9999.0    8.1  120.0    5.6    1.3
  357.21 2783.99 10.0 2004   1 17 2004   1 17 -215.2  296.9   89.1 9999.0 9999.0 9999.0    7.8  120.0    5.6    1.2
  357.21 2783.99 10.0 2004   1 18 2004   1 18 -215.3  296.9   88.0 9999.0 9999.0 9999.0    7.8  122.0    5.6    1.2
  357.21 2783.99 10.0 2004   1 19 2004   1 19 -215.3  296.9   88.0 9999.0 9999.0 9999.0    7.0  122.0    6.3    1.2
  357.21 2783.99 10.0 2004   1 20 2004   1 20 -214.3  296.9   88.6 9999.0 9999.0 9999.0    7.1  116.0    5.9    1.1
  357.21 2783.99 10.0 2004   1 21 2004   1 21 -214.3  296.9   88.0 9999.0 9999.0 9999.0    6.7  118.0    5.9    1.1
  357.21 2783.99 10.0 2004   1 22 2004   1 22 -214.3  296.9   88.6 9999.0 9999.0 9999.0    7.1  119.0    6.3    1.2
  357.21 2783.99 10.0 2004   1 23 2004   1 23 -214.3  296.9   87.0 9999.0 9999.0 9999.0    7.0  122.0    5.9    1.0
```

Table E-14
Overwater Data File Format (SEA1.DAT)

HEADER RECORDS

Record	Variable	Type	Description
1	DATASET	character*16	Dataset name (SEA.DAT)
1	DATAVER	character*16	Dataset version
1	DATAMOD	character*64	Dataset message field
2	NCOMM	integer	Number of comment records to follow
NEXT NCOMM Lines	TITLE	character *80	Title of file (up to 80 characters) and any other documentation for QA
NCOMM +3	PMAP *	character*8	Map projection UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA : Lambert Azimuthal Equal Area
NCOMM +4	IUTMZN, UTMHEM	integer, character*1	UTM zone, Hemisphere (N or S) read as format (i4,a1) ONLY for PMAP = UTM
NCOMM +4	RLAT0, RLON0, XLAT1, XLAT2	character*16	Latitude, Longitude of map projection origin, and one or two Matching Latitude Parallels. (Degrees with either N, S, E, or W, e.g., 45.6N). ONLY for PMAP = LCC, LAZA, TTM, PS, or EM
NCOMM +5	FEAST, FNORTH	real	False Easting and Northing (km). Included only if PMAP = TTM, LCC, or LAZA
NCOMM +5 or 6	DATUM	character*8	DATUM Code
NCOMM +5 or 6	DATEN	character*12	NIMA date (MM-DD-YYYY) for datum definitions
NCOMM +6 or 7	XYUNIT	character*4	Units for horizontal coordinates (KM)
NCOMM +7 or 8	IDOWSTA	integer	5-digit station ID number
NCOMM +7 or 8	CHOWSTA	character*4	station name

* PMAP projections PS, EM, and LAZA are NOT AVAILABLE in CALMET

Table E-14 (Concluded)
Overwater Data File Format (SEA1.DAT)

DATA RECORDS

Variable No. *	Variable	Type	Description	Default Value
1	XUTM	real	X coordinate (km) of the observational site	-
2	YUTM	real	Y coordinate (km) of the observational site	-
3	XOWLON	real	Longitude (degrees) of the observational site. Positive for Western Hemisphere, negative for Eastern Hemisphere	-
4	ZOWSTA	real	Measurement height (m) above the surface of the water of the air temperature and air-sea temperature difference	-
5	I1YR	integer	Starting year of the data in this record	-
6	I1JUL	integer	Starting Julian day of the data in this record	-
7	I1HR	integer	Starting hour (00-23 LST) of the data in this record	-
8	I2YR	integer	Ending year of the data in this record	-
9	I2JUL	integer	Ending Julian day of the data in this record	-
10	I2HR	integer	Ending hour (00-23 LST) of the data in this record	-
11	DTOW	real	Air-sea surface temperature difference (K)	-
12	TAIROW	real	Air temperature (K)	288.7
13	RHOW	real	Relative humidity (%)	100
14	ZIOW	real	Overwater mixing height (m)	-
15	TGRADB	real	Temperature lapse rate below the mixing height overwater (K/m)	-0.0098
16	TGRADA	real	Temperature lapse rate above the mixing height overwater (K/m)	-0.0045
17	WSOW	real	Wind speed (m/s)	-
18	WDOW	real	Wind direction (degrees)	-
18	TWAVE	real	Dominant Wave Period	-
18	HWAVE	real	Significant Wave Height	-

* Variables are read in FORTRAN free-format
Missing value indicators are 9999. (real variables)

E.6 Precipitation Data File (PRECIP.DAT)

If the wet removal algorithm of the CALPUFF or MESOPUFF II models is to be applied, CALMET must produce gridded fields of hourly precipitation rates from observations. The PXTRACT and PMERGE preprocessing programs process and reformat the NWS precipitation data in TD-3240 format into a formatted or unformatted file called PRECIP.DAT. The output file of PMERGE is directly compatible with the input requirements of CALMET. The user needs to set the precipitation file format variable, IFORMP, in the CALMET control file to one when using PMERGE unformatted output. Otherwise, set IFORMP to two for a formatted file either prepared by the user or generated by PMERGE. This option is provided to allow the user an easy way to manually enter precipitation data for short CALMET runs.

A sample free-formatted PRECIP.DAT file is shown in Table E-15. A description of each variable in the formatted surface data file is contained in Table E-16. The first line of the file identifies the file and its format to CALMET. The second line provides the number of comment lines (character strings of up to 80 characters in length) to follow that are read but are not interpreted by the model. One of these may typically contain a title to identify the data set. The next line after all comment records identifies the map projection for any locations provided in the file. Presently, the projection is NONE as no locations are provided. The next line identifies the beginning and ending dates and times of data in the file, the reference time zone for these, and the number of stations. Finally, one record per station follows with the station ID for each. One data record must follow for each hour. Each data record contains the date and time and the precipitation rate (mm/hr) for each station.

Table E-15

Sample Precipitation Data File (PRECIP.DAT)

```
PRECIP.DAT      2.0             Header structure with coordinate parameters
   1
Produced by PMERGE Version: 5.31  Level: 030528
NONE
  1990   1   1  1990   2   6    5   16
  170273
  176905
  177325
  178641
  270741
  270998
  272842
  273182
  274732
  274808
  275639
  275780
  276234
  276818
  278885
  437054
 1990   1  1      0.000    0.000    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    0.000
                  0.254    0.000    0.000    0.000    0.000    0.000
 1990   1  2      0.000    0.000    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    0.000
                  0.762    0.000    0.000    2.540    0.000    0.000
 1990   1  3      0.000    0.000    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    0.000
                  0.762    0.000    0.000    0.000    0.000    0.000
 1990   1  4      0.000    0.000    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    2.540
                  1.016    0.000    0.000    0.000    0.000    0.000
 1990   1  5      0.000    0.000    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    0.000
                  0.762    2.540    2.540    2.540    0.000    0.000
 1990   1  6      0.000    0.254    0.000    0.000    0.000    2.540 9999.000    0.000    2.540    0.000
                  1.016    0.000    0.000    0.000    0.000    0.000
 1990   1  7      0.000    1.016    0.000    0.000    0.000    0.000 9999.000    0.000    0.000    0.000
                  1.524    0.000    0.000    0.000    0.000    0.000
 1990   1  8      2.540    0.000    0.000    0.000    2.540    0.000    0.000    2.540    0.000    0.000
                  2.032    0.000    0.000    0.000    0.000    0.000
 1990   1  9      0.000    0.000    2.540    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  2.540    0.000    0.000    0.000    0.000    0.000
 1990   1 10      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  2.794    0.000    0.000    0.000    0.000    0.000
 1990   1 11      0.000    0.000    0.000    2.540    0.000    0.000    0.000    0.000    0.000    0.000
                  2.540    0.000    0.000    0.000    0.000    0.000
 1990   1 12      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  2.286    0.000    0.000    0.000    0.000    0.000
 1990   1 13      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  2.032    0.000    0.000    0.000    0.000    0.000
 1990   1 14      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  1.524    0.000    0.000    2.540    0.000    0.000
 1990   1 15      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.762    0.000    0.000    0.000    0.000    0.000
 1990   1 16      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 17      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 18      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 19      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 20      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    2.540    0.000    0.000
 1990   1 21      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 22      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   1 23      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  0      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  1      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  2      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  3      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  4      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  5      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
 1990   2  6      0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000    0.000
                  0.000    0.000    0.000    0.000    0.000    0.000
```

Table E-16
Formatted Precipitation Data File Format (PRECIP.DAT)

HEADER RECORDS

FILE HEADER RECORD #1

Columns	Format	Variable	Description
1-16	A16	DATASET	Dataset name (PRECIP.DAT)
17-32	A16	DATAVER	Dataset version
33-96	A64	DATAMOD	Dataset message field

FILE HEADER RECORD #2 to NCOMM+2

Columns	Format	Variable	Description
1-4	I4	NCOMM	Number of comment records
1-80	A80	TITLE	Comment (repeated NCOMM times)

FILE HEADER RECORD # NCOMM+3

Columns	Format	Variable	Description
1-8	A8	PMAP	Map projection (NONE)

FILE HEADER RECORD # NCOMM+4

Variable No. *	Variable	Type	Description
1	IBYR	integer	Beginning year of the data in the file
2	IBJUL	integer	Beginning Julian day
3	IBHR	integer	Beginning hour (00-23 LST)
4	IEYR	integer	Ending year
5	IEJUL	integer	Ending Julian day
6	IEHR	integer	Ending hour (00-23 LST)
7	IBTZ	integer	Time zone (e.g., 05=EST, 06=CST, 07=MST, 08=PST)
8	NSTA	integer	Number of stations

* Variables are read in FORTRAN free-format

Next NSTA HEADER RECORDS

Columns	Fornat	Variable	Description
1-8	I8	IDSTA	Surface station ID number

Table E-16 (Concluded)
Formatted Precipitation Data File Format (PRECIP.DAT)

DATA RECORDS
(Repeated for each hour of data)

Variable *	Type	Description
IYR	integer	Year of data
IJUL	integer	Julian day of data
IHR	integer	Hour (0-23 LST) of data
XPREC	real array	Precipitation rates (mm/hr) for each precipitation station in the station order specified in the header records. Each data record is read as: READ(io12,*)iyr,ijul,ihr,(XPREC(n), n=1,NSTA)

* Variables are read in FORTRAN free-format
Missing value indicator is 9999.

E.7 Preprocessed Diagnostic Model Data File (DIAG.DAT)

The CALMET control file contains variables which determine how the meteorological data required by the diagnostic wind field module are entered into the program. The variables IDIOPT1 through IDIOPT5 of Input Group 5 in the control file determine whether the hourly station observation and domain-scale average surface temperature, lapse rate, and wind components are internally computed from the data in the surface and upper air data files or read directly from a separate file, DIAG.DAT.

The DIAG.DAT file allows the user to bypass the internal CALMET computation involving the interpolation and spatial averaging of the meteorological inputs to the model by specifying these inputs directly. This option has been retained in the operational version of the model although it was intended primarily as a testing tool. The use of the DIAG.DAT file requires that the time interpolation of the sounding data and routine averaging of upper layer winds through the depth of each vertical layer, as well as conversion of the wind components from wind speed and direction to U and V components, all be performed externally.

A sample DIAG.DAT file containing two hours of data is shown in Table E-17. A description of each variable in the file and its input format is contained in Table E-18. The variables included in the DIAG.DAT file depend on the option selected in the CALMET control file. A value of one for the following control file parameters is used to flag input of the corresponding meteorological variable via the DIAG.DAT file. A value of zero indicates the meteorological variable is internally computed by the model from the data in the SURF.DAT and UPn.DAT files. The default value for each control file parameter is set to compute the meteorological variables internally.

Control File Parameter	Meteorological Variable
IDIOPT1	Domain-average surface temperature
IDIOPT2	Domain-average vertical temperature lapse rate
IDIOPT3	Domain-average winds (U and V components)
IDIOPT4	Hourly surface station winds (U and V components)
IDIOPT5	Hourly upper air station winds (U and V components)

The wind observations in DIAG.DAT are entered with data for one station per line. The end of the surface data and upper air data are both flagged by a record with a station name of 'LAST'.

Table E-17

Sample DIAG.DAT Input Data File

```
TINF:     300.15
GAMMA hr 1  2.5
UM    hr 1 -1.8
VM    hr 1 -0.9
SURFACE WIND 0 PTM1    1.0 -0.6 -0.8
SURFACE WIND 0 PLGN    1.0  3.0 -2.6
SURFACE WIND 0 LAST
UPPER WIND 0 LCMB    1.0999.0999.0 -0.9  0.0 -1.1  0.2 -0.3  0.1 -0.2 -0.3
UPPER WIND 0 OFLT    1.0 -0.2 -0.1 -0.1 -0.5 -0.3 -0.8 -0.4 -0.5 -2.2 -1.5
UPPER WIND 0 LAST
TINF:     300.15
GAMMA hr 2  3.5
UM    hr 2 -1.8
VM    hr 2 -0.9
SURFACE WIND 1 PTM1    1.0  0.0  0.0
SURFACE WIND 1 PLGN    1.0  4.9 -3.3
SURFACE WIND 1 LAST
UPPER WIND 1 LCMB   1.0999.0999.0 -1.3 -0.2 -0.6  0.3 -0.9  0.8 -0.9  1.1
UPPER WIND 1 OFLT   1.0 -0.1  0.0  0.2  0.1 -0.3 -1.3 -0.2 -0.9  0.3 -0.4
UPPER WIND 1 LAST
```

Table E-18
DIAG.DAT Input File
(Records 1-6 reported for each hour)

Record	Variable No.	Variable	Type	Description
1[a]	1	TINF	real	Domain-average surface temperature (deg. K). Input format: (10X,F6.2).
2[b]	1	GAMMA	real	Domain-average temperature lapse rate (deg. K/km). Input format: (10X,F5.1).
3[c]	1	UM	real	Domain average U wind component (m/s). Input format: (10X,F5.1).
4[c]	1	VM	real	Domain average V wind component (m/s). Input format: (10X,F5.1).
5[d]	1	CNAM	char*4	Four-character surface station name ('LAST' indicates end of surface data)
5[d]	1	WT	real	Data weighting factor (usually set to 1.0)
5[d]	1	US	real	U component of surface wind (m/s)
5[d]	1	VS	real	V component of surface wind (m/s)
(Repeated one station per record)				Input format: (15X,A4,1X,3F5.1)

(DIAG.DAT Input File Continued)

[a] Record included only if control file variable IDIOPT1=1
[b] Record included only if control file variable IDIOPT2=1
[c] Record included only if control file variable IDIOPT3=1
[d] Record included only if control file variable IDIOPT4=1

Table E-18 (Concluded)
DIAG.DAT Input File

Record	Variable No.	Variable	Type	Description
6[e]	1	CUNAM	char*4	Four-character upper air station name. ('LAST' indicates end of upper air data.)
6[e]	2	WTU	real	Data weighting factor (usually set to 1.0)
6[e]	3	ULEV1	real	U component of wind (m/s) at upper air station for CALMET layer 1
6[e]	4	VELV1	real	V component of wind (m/s) at upper air station for CALMET layer 1
6[e]	5	ULEV2	real	U component of wind (m/s) at upper air station for CALMET layer 2
6[e]	6	VELV2	real	V component of wind (m/s) at upper air station for CALMET layer 2
@	@	@		
@	@	@		
@	@	@		

[e] Record included only if control file variable IDIOPT5=1

E.8 Prognostic Model Data File (PROG.DAT)

The CALMET model allows the use of gridded prognostic model (CSUMM) winds to be used as the initial guess field or Step 1 wind field in the diagnostic model analysis procedure as a substitute for the normal Step 1 analysis. The use of the prognostic wind field option is controlled by the variable IPROG in Input Group 5 of the CALMET control file. If IPROG is set equal to one or two, the gridded prognostic model wind fields are read from a file called PROG.DAT. These winds are interpolated from the prognostic model grid system to the CALMET grid to produce either the initial guess field or the Step 1 wind field.

The PROG.DAT file is an unformatted data file containing the time, grid specifications, vertical layer structure, and three-dimensional fields of U and V wind fields. Table E-19 contains a description of the variables included in each hourly set of winds.

Note that CSUMM does not allow the use of a Lambert conformal projection, so the coordinate system must be a UTM system when CSUMM data are used (i.e., IPROG = 1 or 2).

Table E-19
Gridded Prognostic Model Wind Field Input File (PROG.DAT)

Record	Variable No.	Variable	Type	Description
1	1	TIMEH	real	Prognostic model simulation time (hours)
2	1	NXP	real	Number of prognostic model grid cells in the X direction
2	2	NYP	real	Number of prognostic model grid cells in the Y direction
2	3	NZP	real	Number of prognostic model vertical layers
3	1	UTMXOP	real	Reference UTM X coordinate of prognostic model grid origin
3	2	UTMYOP	real	Reference UTM Y coordinate of prognostic model grid origin
3	3	DXKP	real	Grid spacing (km)
4	1	Z	real array	Grid point heights (m) in prognostic model grid (NZP values)
Next NZP*NYP Records	1	UP	real array	Prognostic model U components (cm/s) of wind. The following statements are used to read the UP array: do 10 k=1,NZP do 10 j=1,NYP 10 READ(irdp)(UP(i,j,k),i=1,NXP)
Next NZP*NYP Records	1	VP	real array	Prognostic model V components (cm/s) of wind. The following statements are used to read the VP array: do 20 k=1,NZP do 20 j=1,NYP 20 READ(irdp)(VP(i,j,k)i=1,NXP)

(All records repeated each hour)

E.9 MM4/MM5/3D Model Data Files (MM4.DAT, MM5.DAT, 3D.DAT)

The CALMET model allows as input the use of gridded prognostic winds from MM4, MM5 or any weather forecasting model such as NAM(Eta), RUC, or RAMS. The use of the prognostic wind field option is controlled by the variable IPROG in Input Group 5 of the CALMET control file. A choice of six methods of incorporating the MM4/MM5/3D wind data into the model is available.

If	IPROG = 3	use MM4/MM5 (MM4.DAT) winds as the Step 1 field when using the objective analysis
	IPROG = 4	use MM4/MM5 (MM4.DAT) winds as the initial guess field when using the diagnostic module
	IPROG = 5	treat MM4/MM5 (MM4.DAT) winds as observations.
	IPROG = 13	use MM5/3D (MM5.DAT/3D.DAT) winds as the Step 1 field when using the objective analysis
	IPROG = 14	use MM5/3D (MM5.DAT/3D.DAT) winds as the initial guess field when using the diagnostic module
	IPROG = 15	treat MM5/3D (MM5.DAT/3D.DAT) winds as observations.

If one of the first three methods is chosen, the gridded MM4/MM5 fields are read from a file called MM4.DAT. If one of the second three methods is chosen, the gridded MM5/3D fields are read from a file called 3D.DAT (formerly MM5.DAT). Within CALMET these fields are interpolated from the prognostic model grid system to the CALMET grid. Note that the 3D.DAT file contains fields that are not provided by MM4, so the 3D.DAT file is preferred when it is available. Processors CALMM5, CALETA, CALRUC, and CALRAMS are available to extract model fields and create the 3D.DAT file.

The MM4.DAT file is a formatted data file containing header records describing the date, time, and domain of the prognostic model run. The extraction subdomain is defined in terms of (I,J) and latitude and longitude. Terrain elevation and land use description code are also provided for each grid cell in the subdomain. The sigma-p values used by MM4/MM5/3D to define each of the vertical layers are also contained in the header records of MM4.DAT.

The data records consist of a date and time record, then a data record consisting of elevation (m MSL) and winds at each grid cell for each vertical level. The surface level is followed by the mandatory levels of 1000, 925, 850, 700, 500, 400, and 300 mb. All subterranean mandatory levels will have wind direction and wind speed of 0.

A sample MM4.DAT file is presented in Table E-20, and a description of each record is presented in Table E-21.

The 3D.DAT file is also a formatted data file similar to the MM4.DAT file. Header records describe the prognostic model run and the subdomain and time period extracted to the 3D.DAT file. Data records for each time period are provided for each grid cell in the extracted subdomain. Sea level pressure, rainfall, and snow cover are provided for the surface, and pressure, elevation, temperature, wind speed, and wind direction are always provided at each vertical level. Other variables that may be provided at each vertical level include the vertical velocity, relative humidity, vapor mixing ratio, cloud mixing ratio, rain mixing ratio, ice mixing ratio, and grouped mixing ratio.

A sample 3D.DAT file is presented in Table E-22, and a description of each record is presented in Table E-23. Please note that the MM5.DAT file is similar to the 3D.DAT file with a minor exception. In the 3D.DAT file, the user can add comments to the file header. These comments are particularly useful in tracing the history of the file.

Table E-20

Sample MM4/MM5 Derived Gridded Wind Data File (MM4.DAT)

```
THIS FILE CREATED 17:17:33 04-21-92
88071500 744  60  45  15 100.0
  35  16   5   5
0.0500
0.1500
0.2500
0.3500
0.4500
0.5500
0.6500
0.7400
0.8100
0.8650
0.9100
0.9450
0.9700
0.9850
0.9950
 35 16 34.756 -85.988 0272 02
 36 16 34.715 -85.098 0321 06
 37 16 34.666 -84.210 0386 04
 38 16 34.609 -83.323 0406 04
 39 16 34.544 -82.438 0319 04
 35 17 35.488 -85.943 0277 04
 36 17 35.447 -85.043 0343 04
 37 17 35.397 -84.145 0464 04
 38 17 35.340 -83.248 0581 04
 39 17 35.274 -82.353 0539 04
 35 18 36.222 -85.897 0252 04
 36 18 36.180 -84.987 0323 04
 37 18 36.130 -84.078 0443 04
 38 18 36.071 -83.172 0609 04
 39 18 36.004 -82.266 0670 04
 35 19 36.957 -85.849 0217 02
 36 19 36.914 -84.929 0282 04
 37 19 36.863 -84.010 0365 04
 38 19 36.804 -83.093 0504 04
 39 19 36.737 -82.178 0639 04
 35 20 37.693 -85.801 0192 04
 36 20 37.650 -84.870 0244 02
 37 20 37.599 -83.941 0293 04
 38 20 37.539 -83.013 0373 04
 39 20 37.470 -82.087 0509 04
```

(Continued)

Table E-20 (Concluded)

Sample MM4/MM5 Derived Gridded Wind Data File (MM4.DAT)

```
88071500 35 16 1015.2 0.00 0
 9849 00272 30056 24507
10000 00136 30657 00000
 9250 00831 25232 26510
 8500 01571 19814 29009
 7000 03218 10661 03011
 5000 05943 04971 07013
 4000 07655 17170 05011
 3000 09747 32566 05012
 9805 00313 29656 24507
 9716 00394 28852 24508
 9584 00517 27846 25509
 9362 00724 26038 26510
 9053 01021 23823 27010
 8654 01414 21015 28509
 8168 01914 17612 30008
 7548 02586 14058 00007
 6752 03518 09064 03512
 5867 04668 02866 05012
 4982 05971 05171 07013
 4097 07475 15971 05011
 3212 09262 28767 05011
 2327 11485 46364 05517
 1442 14523 66159 02514
88071500 36 16 1015.2 0.00 0
 9796 00321 29456 25007
10000 00136 30656 00000
 9250 00831 25231 26511
 8500 01571 20015 30009
 7000 03217 10261 01510
 5000 05940 04775 06512
 4000 07654 17173 05513
 3000 09746 32567 05014
 9752 00361 29052 25007
 9664 00442 28246 25007
 9532 00565 27239 25509
 9312 00772 25634 26511
 9004 01068 23620 27010
 8608 01461 20816 29509
 8124 01960 17214 32009
 7509 02630 13458 35509
 6717 03559 08463 02011
 5838 04706 02667 04011
 4958 06006 05176 06513
 4078 07508 16173 05513
 3199 09290 28968 05012
 2319 11505 46565 05018
 1440 14530 66360 01515
```

Table E-21

MM4/MM5 Derived Gridded Wind Data File Format (MM4.DAT)

HEADER RECORDS

Header Record #1

Variable No.	Variable	Type	Description
1	CTEXT	char*36	Text date/time stamp for file creation

Header Record #2

Variable No.	Variable	Type	Description
1	IBYRM	integer	Beginning year of the data in the file
2	IBMOM	integer	Beginning month of the data in the file
3	IBDYM	integer	Beginning day of the data in the file
4	IBHRM	integer	Beginning hour (UTC) of the data in the file
5	NHRSMM4	integer	Length of period (hours) of the data in the file
6	NXMM4	integer	Number of columns in the MM4/MM5 domain
7	NYMM4	integer	Number of rows in the MM4/MM5 domain
8	NZP	integer	Number of layers in the MM4/MM5 domain
9	PTOPMM4	real	Top pressure level (mb) of the data in the file

format (4i2,4i4,f6.1)

Table E-21 (Continued)
MM4/MM5 Derived Gridded Wind Data File Format (MM4.DAT)

HEADER RECORDS

Header Record #3

Variable No.	Variable	Type	Description
1	I1	integer	I-index (X direction) of the lower left corner of the extraction subdomain
2	J1	integer	J-index (Y direction) of the lower left corner of the extraction subdomain
3	NXP	integer	Number of grid cells in the X direction in the extraction subdomain
4	NYP	integer	Number of grid cells in the Y direction in the extraction subdomain

format (4i4)

Next NZP Records

Variable No.	Variable	Type	Description
1	SIGMA	real array	Sigma-p values used by MM4/MM5 to define each of the NZP layers Read as: do 10 I=1,NZP 10 READ(iomm4,20)SIGMA(I) 20 FORMAT(F6.4)

Table E-21 (Continued)
MM4/MM5 Derived Gridded Wind Data File Format (MM4.DAT)

HEADER RECORDS

Next NXP*NYP Records

Variable No.	Variable	Type	Description
1	IINDEX	integer	I-index (X direction) of the grid point in the extraction subdomain
2	JINDEX	integer	J-index (Y direction) of the grid point in the extraction subdomain
3	XLATDOT	real array	N. Latitude (degrees) of the grid point in the extraction subdomain (positive for the Northern Hemisphere, negative for Southern Hemisphere)
4	XLONGDOT	real array	E. Longitude (degrees) of the grid point in the extraction subdomain (N.B., the MM4/MM5 convention is different than the CALMET convention: MM4/MM5 uses negative values for Western Hemisphere and positive values for Eastern Hemisphere. CALMET internally converts the longitudes in the MM4.DAT file, so the MM4/MM5 convention must be used in the MM4.DAT file)
5	IELEVDOT	integer array	Terrain elevation of the grid point in the extraction subdomain (m MSL)
6	ILUDOT	integer array	Land use description code of the grid point in the extraction subdomain

format (2i3,f7.3,f8.3,i5,i3)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

Data Record

Variable No.	Variable	Type	Description
1	MYR	integer	Year of MM4/MM5 wind data
2	MMO	integer	Month of MM4/MM5 wind data
3	MDAY	integer	Day of MM4/MM5 wind data
4	MHR	integer	Hour (UTC) of MM4/MM5 wind data
5	IX	integer	I-index (X direction) of grid cell
6	JX	integer	J-index (Y direction) of grid cell
7	PRES	real	surface pressure (mb)
8	RAIN	real	total rainfall for the past hour (cm)
9	SC	integer	snow cover indicator (0 or 1, where 1 = snow cover was determined to be present for the MM4 simulation

format (4i2,2i3,f7.1,f5.2,i2)

Table E-21 (Concluded)
MM4/MM5 Derived Gridded Wind Data File Format (MM4.DAT)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

Data Records (one record for each mandatory Level(8)* plus `NZP' significant levels)

Variable No.	Variable	Type	Description
1	-	integer	Pressure (tenths of millibars)
2	Z	integer	Elevation (meters above m.s.l.)
3**	-	integer	Temperature/dew point depression in NWS format (TTTDD)
4	WD	integer	Wind direction (degrees)
5	WS	integer	Wind speed (knots)

format of data (i5,3i6,5x)

format used by CALMET to read the data (5x,f6.0,6x,f4.0,f2.0)

---

* The surface level is followed by the mandatory levels of 1000, 925, 850, 700, 500, 400, and 300 mb. All subterranean mandatory levels will have wind direction and wind speed of 0.

** TTT = °C*10, odd number = negative temperature
even number = positive temperature
Examples: TTT = 202 → 20.2°C
TTT = 203 → -20.3°C

DD < 56 → °C*10
DD ≥ 56 → °C+50
Examples: DD = 55 → 5.5°C
DD = 56 → 6.0°C

Table E-22
Sample Mesoscale Model 3-D Data File (3D.DAT)

```
3D.DAT          2.1             Header Structure with Comment Lines
   1
Produced by CALMM5 Version: 2.5     , Level: 050607
  1  1  1  1  0  1
LCC    21.8530   45.0000   7.00  36.00 -1944.000 -1944.000  36.000 109 109 40
  1  4  3  5  2  2  1  0  1  1  1  1  1  1  1  1  1  1  1  1 25
2004013006    2   6   6  29
  25  10  30  15   1  29   35.1243   36.8535   6.6576   8.3718
 0.998
 0.995
 0.992
 0.988
 0.983
 0.978
 0.972
 0.966
 0.959
 0.951
 0.942
 0.931
 0.920
 0.907
 0.892
 0.876
 0.857
 0.837
 0.813
 0.787
 0.758
 0.725
 0.688
 0.646
 0.599
 0.547
 0.494
 0.449
 0.408
  25  10    6.6576   35.2281 1120 13    6.8291   35.3805 1283
  26  10    6.6777   35.5531 1264 13    6.8489   35.7058 1426
  27  10    6.6971   35.8780 1250 13    6.8680   36.0311 1422
  28  10    6.7158   36.2031 1251 13    6.8864   36.3566 1430
  29  10    6.7338   36.5283 1365 13    6.9042   36.6821 1456
  30  10    6.7512   36.8535 1458 13    6.9212   37.0077 1433
  25  11    6.9805   35.2076 1166 13    7.1523   35.3602 1415
  26  11    7.0006   35.5331 1467 13    7.1721   35.6861 1745
  27  11    7.0201   35.8588 1605 13    7.1913   36.0122 1828
  28  11    7.0389   36.1846 1622 13    7.2098   36.3383 1807
  29  11    7.0570   36.5104 1603 13    7.2276   36.6645 1721
  30  11    7.0744   36.8363 1550 10    7.2447   36.9908 1590
  25  12    7.3038   35.1869 1274 10    7.4759   35.3398 1668
  26  12    7.3241   35.5131 1718  6    7.4958   35.6664 2045
  27  12    7.3436   35.8395 1927 13    7.5151   35.9932 2090
  28  12    7.3624   36.1659 1935 13    7.5336   36.3200 2014
  29  12    7.3806   36.4924 1867  2    7.5515   36.6469 1925
  30  12    7.3981   36.8190 1770  2    7.5687   36.9739 1843
  25  13    7.6276   35.1661 1424  2    7.8000   35.3193 1768
  26  13    7.6479   35.4930 1893 13    7.8200   35.6467 2089
  27  13    7.6675   35.8201 2107  2    7.8393   35.9741 2205
  28  13    7.6865   36.1472 2102  2    7.8579   36.3016 2099
  29  13    7.7047   36.4744 1996 13    7.8758   36.6292 1945
  30  13    7.7222   36.8017 1912 13    7.8930   36.9568 1934
  25  14    7.9519   35.1452 1441  2    8.1245   35.2987 1567
  26  14    7.9722   35.4729 1819  2    8.1445   35.6268 1851
  27  14    7.9919   35.8006 2064 13    8.1639   35.9549 2110
  28  14    8.0109   36.1284 2123 13    8.1826   36.2831 2079
```

Table E-22 (Concluded)
Sample Mesoscale Model 3-D Data File (3D.DAT)

```
  29   14    8.0292    36.4563 1995 10     8.2005    36.6114 1856
  30   14    8.0468    36.7843 1887 10     8.2179    36.9398 1811
  25   15    8.2765    35.1243 1372 10     8.4494    35.2781 1420
  26   15    8.2970    35.4526 1618 10     8.4695    35.6068 1636
  27   15    8.3167    35.7810 1871 13     8.4889    35.9356 1887
  28   15    8.3358    36.1096 2001 10     8.5077    36.2645 1930
  29   15    8.3541    36.4381 1911 10     8.5257    36.5935 1779
  30   15    8.3718    36.7668 1785 10     8.5431    36.9226 1695
2004013006 25 10 1012.3 0.03 0    26.5   406.8   293.1   14.17    62.2     2.1   291.0
 890   1130 292.9  62   2.3 -0.01 8613.89-4.000
 887   1154 292.8  62   2.8 -0.02 8513.60-4.000
 884   1180 292.8  61   2.9 -0.02 8313.44-4.000
 881   1210 292.8  60   3.1 -0.02 8213.29-4.000
 878   1244 292.8  59   3.3 -0.02 8113.09-4.000
 874   1282 292.7  58   3.5 -0.02 7912.85-4.000
 870   1325 292.6  58   3.5 -0.02 7812.67-4.000
 865   1373 292.5  58   3.4 -0.02 7812.52 0.000 0.005 0.000 0.000
 859   1429 292.2  58   3.3 -0.02 7812.41 0.000 0.008 0.000 0.000
 853   1491 291.9  59   3.1 -0.02 7812.33 0.000 0.010 0.000 0.000
 846   1561 291.6  62   3.0 -0.02 7912.25 0.000 0.013 0.000 0.000
 838   1641 291.1  68   2.9 -0.02 8012.17 0.000 0.015 0.000 0.000
 830   1731 290.6  75   2.9 -0.02 8112.07 0.000 0.019 0.000 0.000
 820   1834 289.9  83   2.9 -0.02 8311.98 0.000 0.021 0.000 0.000
 809   1950 289.1  93   3.0 -0.02 8511.88 0.000 0.024 0.000 0.000
 796   2083 288.2 102   3.2 -0.02 8811.73 0.000 0.026 0.000 0.000
 782   2235 287.1 110   3.6 -0.01 9111.56 0.000 0.027 0.000 0.000
 766   2408 285.9 118   4.1 -0.01 9411.29 0.000 0.027 0.000 0.000
 748   2607 284.5 123   4.9  0.00 9810.90 0.000 0.029 0.000 0.000
 728   2835 283.2 124   6.4  0.01 94 9.87 0.002 0.033 0.000 0.000
 705   3099 281.4 124   7.5  0.02 92 8.92 0.028 0.036 0.000 0.000
 680   3404 279.2 122   8.0  0.03100 8.62 0.182 0.033 0.000 0.000
 651   3760 277.3 118   8.6  0.04100 7.96 0.433 0.028 0.000 0.000
 618   4178 275.3 110   8.4  0.05 98 7.01 0.342 0.027 0.000 0.000
 581   4671 272.9  96   7.7  0.04 90 5.77 0.009 0.059 0.000 0.000
 540   5260 269.1  87   7.2  0.03 99 5.15 0.024 0.123 0.000 0.000
 498   5894 265.4  78   7.3  0.01 93 3.96 0.023 0.071 0.000 0.000
 462   6474 262.3  79   8.4 -0.01 66 2.37-4.000
 430   7028 259.8  88   9.9 -0.02 57 1.82-4.000
2004013006 26 10 1012.3 0.01 0    40.2   402.0   292.5   14.16    50.4     2.0   290.7
 875   1275 292.3  52   2.4 -0.01 8813.88-4.000
 873   1298 292.1  52   2.9 -0.01 8713.58-4.000
 ……
```

Table E-23
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #1

Variable No.	Variable	Type	Description
1	DATASET	Char*16	Dataset name (3D.DAT)
2	DATAVER	Char*16	Dataset version
3	DATAMOD	Char*64	Dataset message field
			Format(2a16,a64)

Header Record #2 to NCOMM+2

1	NCOMM	Integer	Number of comment records
1	COMMENT	Char*132	Comments (repeated NCOMM times)
			Format(a132)

Header Record # NCOMM+3

Variable No.	Variable	Type	Description
1	IOUTW	Integer	Flag indicating if vertical velocity is recorded.
1	IOUTQ	Integer	Flag indicating if relative humidity and vapor mixing ratios are recorded
1	IOUTC	Integer	Flag indicating if cloud and rain mixing ratios are recorded.
1	IOUTI	Integer	Flag indicating if ice and snow mixing ratios are recorded.
1	IOUTG	Integer	Flag indicating if graupel mixing ratio is recorded.
1	IOSRF	Integer	Flag indicating if surface 2-D files are created.
			Format(6i3)

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record # NCOMM+4

Variable No.	Variable	Type	Description
1	MAPTXT	char*3	Map projection LCC: Lambert Land Conformal Projection
2	RLATC	real	Center latitude (positive for northern hemisphere)
3	RLONC	real	Center longitude (positive for eastern hemisphere)
4	TRUELAT1	real	First true latitude
5	TRUELAT2	real	Second true latitude
6	X1DMN	real	SW dot point X coordinate (km, Grid 1,1) in original domain
7	Y1DMN	real	SW dot point Y coordinate (km, Grid 1,1) in original domain
8	DXY	real	Grid size (km)
9	NX	integer	Number of grids in X-direction (West-East) in original domain
10	NY	integer	Number of grids in Y-direction (South-North) in original domain
11	NZ	integer	Number of sigma layers in original domain
			Format(a4,f9.4,f10.4,2f7.2,2f10.3,f8.3,2i4,i3)

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+5

(Note: Values set to zero for models other than MM5)

Variable No.	Variable	Type	Description
1	INHYD	Integer	0: hydrostatic MM5 run - 1: non-hydrostatic
2	IMPHYS	Integer	MM5 moisture options. 1: dry 2: removal of super saturation 3: warm rain (Hsie) 4: simple ice scheme (Dudhia) 5: mixed phase (Reisner) 6: mixed phase with graupel (Goddard) 7: mixed phase with graupel (Reisner) 8: mixed phase with graupel (Schultz)
3	ICUPA	Integer	MM5 cumulus parameterization 1: none 2: Anthes-Kuo 3: Grell 4: Arakawa-Schubert 5: Fritsch-Chappel 6: Kain-Fritsch 7: Betts-Miller 8: Kain-Fritsch
4	IBLTYP	Integer	MM5 planetary boundary layer (PBL) scheme 0: no PBL 1: bulk PBL 2: Blackadar PBL 3: Burk-Thompson PBL 4: ETA PBL 5: MRF PBL 6: Gayno-Seaman PBL 7: Pleim-Chang PBL
5	IFRAD	Integer	MM5 atmospheric radiation scheme 0: none 1: simple cooling 2: cloud-radiation (Dudhia) 3: CCM2 4: RRTM longwave
6	ISOIL	Integer	MM5 soil model 0: none 1: multi-layer 2: Noah LS model 3: Pleim-Xiu LSM

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+5 (Continued)

(Note: Values set to zero for models other than MM5)

7	IFDDAN	Integer	1: FDDA grid analysis nudging - 0: no FDDA
8	IFDDAOB	Integer	1: FDDA observation nudging - 0: no FDDA
9-20	FLAGS_2D	Integer	1/0: Flags for output variables in 2D.DAT (not used in 3D.DAT)
21	NLAND	Integer	Number of land use categories
			Format(30i3)

Header Record #NCOMM+6

Variable No.	Variable	Type	Description
1	IBYRM	integer	Beginning year of the data in the file
2	IBMOM	integer	Beginning month of the data in the file
3	IBDYM	integer	Beginning day of the data in the file
4	IBHRM	integer	Beginning hour (GMT) of the data in the file
5	NHRSMM5	integer	Length of period (hours) of the data in the file
6	NXP	integer	Number of grid cells in the X direction in the extraction subdomain
7	NYP	integer	Number of grid cells in the Y direction in the extraction subdomain
8	NZP	integer	Number of layers in the MM5 domain (half sigma levels) (same as number of vertical levels in data records)
			Format (i4, 3i2,i5,3i4)

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Header Record #NCOMM+7

Variable No.	Variable	Type	Description
1	NX1	integer	I-index (X direction) of the lower left corner of the extraction subdomain
2	NY1	integer	J-index (Y direction) of the lower left corner of the extraction subdomain
3	NX2	integer	I-index (X direction) of the upper right corner of the extraction subdomain
4	NY2	integer	J-index (Y direction) of the upper right corner of the extraction subdomain
5	NZ1	integer	k-index (Z direction) of lowest extracted layer
6	NZ2	integer	k-index (Z direction) of hightest extracted layer
7	RXMIN	real	Westernmost E. longitude (degrees) in the subdomain
8	RXMAX	real	Easternmost E. longitude (degrees) in the subdomain
9	RYMIN	real	Southernmost N. latitude (degrees) in the subdomain
10	RYMAX	real	Northernmost N. latitude (degrees) in the subdomain

format (6i4,2f10.4,2f9.4)

Next NZP Records

Variable No.	Variable	Type	Description

1	SIGMA	real array	Sigma-p values used by MM5 to define each of the NZP layers (half-sigma levels)
			Read as:
			`     do 10 I=1,NZP`
			`10   READ (iomm4,20) SIGMA(I)`
			`20   FORMAT (F6.3)`

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

HEADER RECORDS

Next NXP*NYP Records

Variable No.	Variable	Type	Description
1	IINDEX	integer	I-index (X direction) of the grid point in the extraction subdomain
2	JINDEX	integer	J-index (Y direction) of the grid point in the extraction subdomain
3	XLATDOT	real array	N. Latitude (degrees) of the grid point in the extraction subdomain (positive for the Northern Hemisphere, negative for Southern Hemisphere)
4	XLONGDOT	real array	E. Longitude (degrees) of the grid point in the extraction subdomain (positive for the Eastern Hemisphere, negative for Western Hemisphere)
5	IELEVDOT	integer array	Terrain elevation of the grid point in the extraction subdomain (m MSL)
6	ILAND	integer array	Landuse categories at cross points
7	XLATCRS	real array	Same as XLATDOT but at cross point
8	XLATCRS	real array	Same as XLATDOT but at cross point
9	IELEVCRS	integer array	Same as IELEVDOT but at cross point
			Format (2i4, f9.4, f10.4, i5, i3, 1x, f9.4, f10.4,i5)

Table E-23 (Continued)
Mesoscale Model 3-D Data File (3D.DAT)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

Data Record

Variable No.	Variable	Type	Description
1	MYR	integer	Year of MM5 wind data (YYYY)
2	MMO	integer	Month of MM5 wind data (MM)
3	MDAY	integer	Day of MM5 wind data (DD)
4	MHR	integer	Hour (GMT) of MM5 wind data (HH)
5	IX	integer	I-index (X direction) of grid cell
6	JX	integer	J-index (Y direction) of grid cell
7	PRES	real	sea level pressure (hPa)
8	RAIN	real	total rainfall accumulated on the ground for the past hour (cm)
9	SC	integer	snow cover indicator (0 or 1, where 1 = snow cover was determined to be present for the MM5 simulation)
10*	RADSW	real	Short wave radiation at the surface (W/m**2)
11*	RADLW	real	long wave radiation at the top (W/m**2)
12*	T2	real	Air temperature at 2 m (K), zero or blank if not exist
13*	Q2	real	Specific humidity at 2 m (g/kg), zero or blank if not exist
14*	WD10	real	Wind direction of 10-m wind (m/s), zero or blank if not exist
15*	WS10	Real	Wind speed of 10-m wind (m/s), zero or blank if not exist
16*	SST	real	Sea surface temperature (K), zero or blank if not exist
			format(i4,3i2,2i3,f7.1,f5.2,i2,3f8.1,f8.2,3f8.1)

* Set to all zero if not existing in output of MM5 or other models

MM5 Note: WD10 and WS10 are MM5 output at dot points, other meteorological variables are interpolated in CALMM5 to dot points from MM5 output at cross points.

Table E-23 (Concluded)
Mesoscale Model 3-D Data File (3D.DAT)

DATA RECORDS (repeated for each grid cell in extraction subdomain)

NZP*Data Records

Variable No.	Variable	Type	Description
1	PRES	integer	Pressure (in millibars)
2	Z	integer	Elevation (meters above m.s.l.)
3	TEMPK	integer	Temperature (^{o} K)
4	WD	integer	Wind direction (degrees)
5	WS	real	Wind speed (m/s)
6[w]	W	real	Vertical velocity (m/s)
7[q]	RH	integer	Relative humidity (%)
8[q]	VAPMR	real	Vapor mixing ratio (g/kg)
9[c] *	CLDMR	real	Cloud mixing ratio (g/kg)
10[c] *	RAINMR	real	Rain mixing ratio (g/kg)
11[i] *	ICEMR	real	Ice mixing ratio (g/kg)
12[i] *	SNOWMR	real	Snow mixing ratio (g/kg)
13[g] *	GRPMR	real	Graupel mixing ratio (g/kg)

Format(i4,i6,f6.1,i4,f5.1,f6.2,i3,f5.2,5f6.3)

<u>MM5 Note</u>: WD and WS are MM5 output at dot points, other variables are interpolated in CALMM5 to dot points from MM5 output at cross points.

---

[w] Variable present in the record only if IOUTW = 1
[q] Variable present in the record only if IOUTQ = 1
[c] Variable present in the record only if IOUTC = 1 (possible only if IOUTQ=1)
[I] Variable present in the record only if IOUTI = 1 (possible only if IOUTQ = IOUTC = 1)
[g] Variable present in the record only if IOUTG = 1 (possible only if IOUTQ = IOUTC = IOUTI=1)
* Output for variables 9 – 13 will be compressed using a negative number if ALL are zero. -5.0 represents all five variables are zero.

E.10 Terrain Weighting Factor Data File (WT.DAT)

CALMET contains several options for introducing MM4/MM5 winds into the calculation of the wind fields. These include the use of the MM4/MM5 winds as:

- Step 1 field (IPROG = 3 or 13)
- initial guess field (IPROG = 4 or 14)
- "observation" (IPROG = 5 or 15)

If the MM4/MM5 fields are used as an initial guess field for CALMET, the MM4/MM5 winds are subject to a full diagnostic adjustment for terrain effects on the fine-scale (CALMET) grid. But if the MM4/MM5 winds are used as either a Step 1 field or as "observations," CALMET does not perform additional terrain adjustment to the MM4/MM5 winds. When combining these MM4/MM5 winds with observed winds, local near-surface effects captured in the observations may be lost due to the scale of the terrain used in the MM4/MM5 simulations (e.g., 80 km resolution). To avoid this, CALMET accepts a three-dimensional grid of terrain weighting factors. The weight W_o is applied to the observation, and its complement ($1-W_o$) is applied to the MM4/MM5 wind. The factors used to determine this weighting are assumed to be a function of the fine-scale terrain unresolved by the MM4/MM5 grid, and height above the surface.

The WT.DAT file contains the terrain-weighting factor. This file is required only if IPROG = 3, 13 or IPROG = 5, 15 (i.e., MM4/MM5 data are used as the Step 1 field or as "observations").

Table E-24 contains a sample WT.DAT file for a 25 Η 23 18-km CALMET grid. A detailed description of the contents of the WT.DAT file are contained in Table E-25. The first three lines consist of descriptive information on the development of the weighting factor. Records 4 and 5 describe the fine-scale (CALMET) grid system and the coarse-scale (MM4/MM5) grid. These are followed by a set of NZ groups of records, one for each CALMET layer, which contain the actual weighting factors.

Table E-24

Sample Terrain Weighting Factor Data File (WT.DAT)

```
Sensitivity Power for Wz     =     2.00000
Sensitivity Power for Ws     =     2.00000
Significant Length-Scale (m) =     10.0000
 Fine-Grid   :    342.0  -135.0   25   23  18.000
 Coarse-Grid :    -80.0  -680.0   24   21  80.000

 Height(m) =     10.0000
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
j= 23  .51 .56 .53 .51 .48 .45 .44 .43 .42 .41 .42 .45 .48 .52 .52 .40 .28 .16 .03 .00 .00 .00 .00 .00 .00
j= 22  .51 .56 .53 .51 .48 .45 .44 .43 .42 .41 .42 .45 .48 .52 .52 .40 .28 .16 .03 .00 .00 .00 .00 .00 .00
j= 21  .49 .54 .51 .49 .46 .44 .43 .41 .40 .38 .40 .43 .47 .50 .51 .40 .28 .17 .05 .02 .02 .02 .02 .02 .01
j= 20  .43 .48 .46 .44 .42 .40 .38 .36 .34 .32 .34 .38 .41 .45 .47 .38 .29 .21 .12 .09 .09 .08 .08 .07 .05
j= 19  .37 .41 .40 .39 .38 .37 .34 .31 .29 .26 .28 .32 .36 .41 .43 .37 .31 .24 .18 .16 .15 .14 .13 .12 .09
j= 18  .31 .35 .35 .34 .34 .33 .30 .27 .23 .20 .21 .26 .31 .36 .39 .35 .32 .28 .24 .22 .21 .20 .19 .17 .13
j= 17  .26 .29 .29 .29 .30 .30 .26 .22 .18 .14 .15 .21 .26 .31 .35 .34 .33 .32 .30 .29 .28 .26 .25 .22 .17
j= 16  .25 .29 .30 .31 .31 .32 .28 .25 .21 .18 .19 .24 .29 .33 .37 .35 .34 .32 .31 .30 .29 .29 .28 .26 .20
j= 15  .26 .30 .31 .33 .34 .35 .32 .29 .27 .24 .25 .29 .32 .36 .39 .37 .34 .32 .30 .30 .30 .30 .31 .29 .22
j= 14  .27 .31 .33 .35 .36 .38 .36 .34 .32 .29 .30 .33 .36 .39 .41 .38 .35 .32 .29 .30 .31 .32 .34 .32 .25
j= 13  .27 .32 .34 .37 .39 .41 .40 .38 .37 .35 .36 .38 .40 .42 .43 .40 .36 .32 .29 .29 .32 .34 .36 .36 .27
j= 12  .28 .33 .35 .38 .40 .42 .41 .41 .40 .39 .40 .41 .43 .44 .45 .41 .36 .32 .28 .29 .33 .36 .39 .39 .31
j= 11  .31 .35 .36 .38 .39 .40 .40 .40 .41 .41 .42 .43 .44 .45 .45 .41 .36 .32 .27 .29 .34 .38 .42 .44 .37
j= 10  .33 .37 .37 .37 .38 .38 .39 .40 .41 .43 .43 .44 .45 .46 .45 .41 .36 .31 .27 .29 .35 .40 .45 .48 .43
j=  9  .35 .39 .38 .37 .37 .36 .38 .40 .42 .44 .45 .46 .46 .46 .46 .41 .36 .31 .26 .29 .35 .42 .48 .52 .49
j=  8  .37 .41 .39 .37 .36 .34 .37 .40 .43 .46 .47 .47 .47 .47 .46 .41 .35 .30 .25 .29 .36 .44 .51 .56 .55
j=  7  .31 .35 .35 .34 .34 .34 .36 .39 .41 .44 .44 .44 .44 .44 .43 .41 .38 .36 .33 .37 .43 .49 .55 .59 .57
j=  6  .26 .30 .31 .32 .33 .34 .36 .37 .39 .41 .42 .42 .41 .41 .41 .41 .41 .41 .41 .45 .50 .55 .59 .62 .58
j=  5  .20 .24 .26 .29 .31 .33 .35 .36 .38 .39 .39 .39 .38 .38 .38 .41 .44 .47 .50 .53 .56 .60 .63 .65 .60
j=  4  .15 .18 .22 .26 .30 .33 .34 .35 .36 .37 .37 .36 .35 .35 .35 .41 .46 .52 .58 .61 .63 .65 .67 .68 .62
j=  3  .15 .19 .23 .27 .31 .35 .36 .36 .37 .37 .37 .37 .37 .36 .37 .43 .49 .55 .60 .63 .65 .66 .68 .68 .62
j=  2  .20 .25 .28 .32 .35 .39 .39 .39 .39 .40 .40 .41 .41 .42 .43 .47 .51 .55 .58 .61 .62 .64 .65 .65 .61
j=  1  .26 .31 .34 .37 .40 .42 .42 .42 .42 .42 .43 .45 .46 .48 .49 .51 .53 .55 .56 .58 .60 .61 .63 .63 .60
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
 Height(m) =     50.0000
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
j= 23  .11 .11 .10 .08 .07 .05 .05 .04 .04 .03 .03 .04 .05 .05 .06 .04 .03 .02 .00 .00 .00 .00 .00 .00 .00
j= 22  .11 .11 .10 .08 .07 .05 .05 .04 .04 .03 .03 .04 .05 .05 .06 .04 .03 .02 .00 .00 .00 .00 .00 .00 .00
j= 21  .10 .11 .09 .08 .07 .05 .05 .04 .03 .03 .03 .04 .04 .05 .05 .04 .03 .02 .01 .00 .00 .00 .00 .00 .00
j= 20  .09 .09 .08 .07 .06 .05 .04 .03 .03 .02 .02 .03 .03 .04 .04 .04 .03 .02 .01 .01 .01 .01 .00 .00 .00
j= 19  .07 .08 .07 .06 .05 .04 .03 .03 .02 .02 .02 .02 .03 .03 .03 .03 .03 .02 .02 .01 .01 .01 .01 .01 .00
j= 18  .06 .06 .05 .05 .04 .03 .03 .02 .02 .01 .01 .01 .02 .02 .02 .02 .02 .02 .02 .02 .02 .01 .01 .01 .01
j= 17  .04 .05 .04 .04 .03 .03 .02 .02 .01 .00 .00 .01 .01 .01 .01 .02 .02 .02 .03 .03 .02 .02 .01 .01 .01
j= 16  .06 .06 .06 .06 .05 .05 .04 .03 .02 .01 .01 .01 .02 .02 .02 .02 .02 .03 .03 .03 .02 .02 .02 .01 .01
j= 15  .08 .09 .08 .08 .08 .07 .06 .05 .04 .02 .02 .02 .02 .03 .03 .03 .03 .03 .03 .03 .02 .02 .02 .02 .01
j= 14  .09 .11 .11 .10 .10 .10 .08 .07 .05 .03 .03 .03 .03 .04 .04 .04 .03 .03 .03 .03 .03 .02 .02 .02 .01
j= 13  .11 .13 .13 .13 .13 .13 .11 .08 .06 .04 .04 .04 .04 .05 .05 .04 .04 .04 .03 .03 .03 .03 .02 .02 .02
j= 12  .12 .13 .13 .13 .14 .14 .12 .10 .08 .06 .05 .05 .05 .06 .06 .05 .04 .04 .03 .03 .03 .03 .03 .03 .03
j= 11  .10 .11 .11 .12 .12 .12 .11 .10 .09 .08 .07 .07 .07 .07 .07 .06 .05 .04 .03 .03 .03 .04 .04 .05 .04
j= 10  .08 .09 .10 .10 .10 .11 .11 .10 .10 .10 .10 .09 .09 .09 .08 .07 .05 .04 .02 .03 .03 .04 .05 .06 .06
j=  9  .06 .07 .08 .08 .09 .09 .10 .11 .11 .12 .12 .11 .11 .10 .09 .07 .05 .04 .02 .02 .04 .05 .07 .08 .08
j=  8  .05 .06 .06 .07 .07 .08 .10 .11 .13 .14 .14 .13 .12 .11 .10 .08 .06 .04 .01 .02 .04 .06 .08 .09 .10
j=  7  .04 .04 .05 .05 .06 .07 .08 .09 .11 .12 .12 .11 .11 .10 .09 .11 .12 .13 .15 .14 .14 .13 .13 .12 .12
j=  6  .03 .03 .04 .04 .05 .05 .06 .07 .09 .10 .10 .09 .09 .08 .09 .13 .18 .23 .28 .27 .24 .20 .17 .15 .14
j=  5  .02 .02 .03 .03 .03 .04 .05 .06 .07 .07 .08 .07 .07 .07 .08 .16 .24 .33 .41 .39 .33 .28 .22 .17 .16
j=  4  .01 .01 .01 .02 .02 .02 .03 .04 .04 .05 .06 .05 .05 .05 .07 .19 .31 .42 .54 .51 .43 .35 .27 .20 .18
j=  3  .02 .02 .02 .02 .02 .03 .03 .04 .05 .06 .07 .08 .09 .11 .14 .25 .36 .48 .59 .56 .48 .40 .33 .26 .22
j=  2  .04 .04 .04 .04 .05 .05 .06 .07 .07 .08 .11 .14 .18 .21 .26 .34 .42 .49 .57 .56 .50 .45 .39 .34 .28
j=  1  .06 .07 .07 .07 .07 .07 .08 .09 .10 .11 .15 .21 .27 .32 .38 .42 .47 .51 .56 .55 .52 .49 .46 .41 .35
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
```

```
 Height(m) =      100.000
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
j= 23   .03 .03 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00 .00
j= 22   .03 .03 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00 .00
j= 21   .03 .03 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00 .00
j= 20   .02 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00 .00
j= 19   .02 .02 .02 .01 .01 .01 .01 .01 .01 .00 .00 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00
j= 18   .01 .02 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00
j= 17   .01 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01 .01 .01 .01 .01 .00 .00 .00 .00
j= 16   .01 .02 .02 .01 .01 .01 .01 .01 .01 .00 .00 .00 .00 .00 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00
j= 15   .02 .02 .02 .02 .02 .02 .02 .01 .01 .01 .00 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00 .00
j= 14   .02 .03 .03 .03 .03 .03 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00 .00
j= 13   .03 .03 .03 .03 .03 .03 .03 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .00
j= 12   .03 .03 .03 .03 .03 .03 .03 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01
j= 11   .02 .03 .03 .03 .03 .03 .03 .02 .02 .02 .02 .02 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .01 .01 .01
j= 10   .02 .02 .02 .03 .03 .03 .03 .03 .03 .02 .02 .02 .02 .02 .02 .02 .01 .01 .01 .01 .01 .01 .01 .02 .02
j=  9   .02 .02 .02 .02 .02 .02 .03 .03 .03 .03 .03 .03 .03 .02 .02 .02 .01 .01 .00 .01 .01 .01 .02 .02 .02
j=  8   .01 .01 .02 .02 .02 .02 .02 .03 .03 .04 .04 .03 .03 .03 .03 .02 .01 .01 .00 .01 .01 .01 .02 .02 .02
j=  7   .01 .01 .01 .01 .01 .02 .02 .02 .03 .03 .03 .03 .03 .02 .02 .03 .03 .03 .04 .04 .03 .03 .03 .03 .03
j=  6   .01 .01 .01 .01 .01 .01 .02 .02 .02 .02 .02 .02 .02 .02 .02 .03 .05 .06 .07 .07 .06 .05 .04 .04 .03
j=  5   .00 .01 .01 .01 .01 .01 .01 .01 .02 .02 .02 .02 .02 .02 .02 .04 .06 .08 .10 .10 .08 .07 .06 .04 .04
j=  4   .00 .00 .00 .00 .00 .01 .01 .01 .01 .01 .01 .01 .01 .01 .02 .05 .08 .11 .14 .13 .11 .09 .07 .05 .04
j=  3   .00 .00 .01 .01 .01 .01 .01 .01 .01 .01 .02 .02 .02 .03 .04 .08 .12 .15 .19 .19 .17 .14 .12 .10 .08
j=  2   .01 .01 .01 .01 .01 .01 .01 .02 .02 .02 .03 .04 .05 .06 .08 .12 .17 .22 .27 .27 .25 .23 .21 .19 .15
j=  1   .01 .02 .02 .02 .02 .02 .02 .02 .02 .03 .04 .06 .07 .09 .11 .17 .23 .29 .35 .35 .34 .32 .30 .27 .22
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
 Height(m) =      400.000
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
j= 23   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 22   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 21   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 20   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 19   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 18   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 17   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 16   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 15   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 14   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 13   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 12   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 11   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j= 10   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j=  9   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j=  8   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j=  7   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j=  6   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00
j=  5   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01 .01 .01 .01 .00 .00 .00 .00
j=  4   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01 .01 .01 .01 .01 .00 .00 .00
j=  2   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01 .01 .01 .02 .02 .02 .01 .01 .01 .01
j=  1   .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .00 .01 .01 .01 .01 .02 .02 .02 .02 .02 .02 .02 .01
  i=     1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25
```

Table E-24 (Concluded)

Sample Terrain Weighting Factor Data File (WT.DAT)

Height(m) = 800.000

i=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
j= 23	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 11	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	.01	.01	.00	.00	.00	.00
i=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

:

:

Height(m) = 3500.00

i=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
j= 23	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 22	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 21	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 20	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 19	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 18	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 17	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 16	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 15	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 14	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 13	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 12	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 11	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
j= 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
i=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Table E-25

Terrain Weighting Factor Data File Format (WT.DAT)

HEADER RECORDS

Header Record #1

Variable No.	Variable	Type	Description
1	C1	char*42	Documentation for W_{zi}

Header Record #2

Variable No.	Variable	Type	Description
1	C2	char*42	Documentation for W_s

Header Record #3

Variable No.	Variable	Type	Description
1	C3	char*42	Documentation for RMS_o

Header Record #4

Variable No.	Variable	Type	Description
1	X0FIN	real	X coordinate (km) of fine grid origin (i.e., origin of CALMET grid)
2	Y0FIN	real	Y coordinate (km) of fine grid origin
3	NXFIN	integer	Number of columns in the fine grid domain
4	NYFIN	integer	Number of rows in the fine grid domain
5	DFIN	real	Horizontal grid spacing (km) of fine grid

format (15x,2f8.1,2i5,f8.3)

Table E-25 (Continued)
Terrain Weighting Factor Data File Format (WT.DAT)

HEADER RECORDS

Header Record #5

Variable No.	Variable	Type	Description
1	X0CRS	real	X (km) coordinate of coarse grid origin (i.e., origin of MM4 grid)
2	Y0CRS	real	Y coordinate (km) of coarse grid origin
3	NXCRS	integer	Number of columns in the coarse grid domain
4	NYCRS	integer	Number of rows in the coarse grid domain
5	DCRS	real	Horizontal grid spacing (km) of coarse grid

format (15x,2f8.1,2i5,f8.3,//)

Table E-25 (Concluded)
Terrain Weighting Factor Data File Format (WT.DAT)

DATA RECORDS (repeated for NZ layers)

Record	Variable No.	Variable	Type	Description
1	1	HT	real	Grid point height (m) of CALMET layers format (12x,f12.4/)
2*	-	-	-	Line of text containing i indices
Next NY records	1	WO	real array	Terrain weighting factors. The following statements are used to read the WO array: do 15 JJ=NYFIN,1,-1 15 READ (io99,113) (WO(i,jj,k),i=1,nxfin) 113 FORMAT (6x,150(1x,f3.2)/)
NY+3*	-	-	-	Line of text containing i indices

* Line skipped by CALMET

E.11 CALMET Output Files

E.11.1 CALMET.DAT

The CALMET.DAT file contains gridded meteorological data fields required to drive the CALPUFF model. It also contains certain geophysical fields, such as terrain elevations, surface roughness lengths, and land use types, used by both the CALMET meteorological model and CALPUFF. Although the input requirements of CALPUFF are designed to be directly compatible with CALMET, meteorological fields produced by other meteorological models can be substituted for the CALMET output as long as the required variables are produced and the output is reformatted to be consistent with the CALMET.DAT file specifications described in this section.

CALMET.DAT File - Header Records

The CALMET.DAT file consists of a set of up to fifteen header records, plus a variable number of comment records, followed by a set of hourly data records. The header records contain file identification labels, descriptive titles of the CALMET run (including a complete image of the CALMET control file) as comment records, information including the horizontal and vertical grid systems of the meteorological grid, the number, type, and coordinates of the meteorological stations included in the CALMET run, gridded fields of surface roughness lengths, land use, terrain elevations, leaf area indexes, and a pre-computed field of the closest surface meteorological station number to each grid point.

In addition to the variable number of comment records, the number of header records may also vary because records containing surface, upper air, and precipitation station coordinates are not included if these stations were not included in the run. A description of each variable in the header records is provided in Table E-26.

Sample FORTRAN write statements for the CALMET.DAT header records are:

```
c ---     Header record #1 - File Declaration -- 24 words
          write(iomet) DATASET,DATAVER,DATAMOD

c ---     Header record #2 - Number of comment lines -- 1 word
          write(iomet) NCOM

c ---     Header record #3 to NCOM+2 (Comment record section) -- 33 words each
          write(iomet) COMMENT

c ---     Header record #NCOM+3 - run control parameters -- 37 words
          write(iomet) IBYR,IBMO,IBDY,IBHR,IBTZ,IRLG,IRTYPE,
          1         NX,NY,NZ,DGRID,XORIGR,YORIGR, IWFCOD,NSSTA,
          2         NUSTA,NPSTA,NOWSTA,NLU,IWAT1,IWAT2,LCALGRD
          3         PMAP,DATUM,DATEN,FEAST,FNORTH,UTMHEM,IUTMZN,
          4         RNLAT0,RELON0,XLAT1,XLAT2

c ---     Header record #NCOM+4 - cell face heights (NZ + 1 words)
          write(iomet)CLAB1,IDUM,ZFACEM
```

```
c ---     Header records #NCOM+5 & 6 - x, y coordinates of surface stations
c ---     (NSSTA words each record)
          if(nssta.ge.1)then
            write(iomet)CLAB2,IDUM,XSSTA
            write(iomet)CLAB3,IDUM,YSSTA
          endif

c ---     Header records #NCOM+7 & 8 - x, y coordinates of upper air stations
c ---     (NUSTA words each record)
          if(nusta.ge.1)then
            write(iomet)CLAB4,IDUM,XUSTA
            write(iomet)CLAB5,IDUM,YUSTA
          endif

c ---     Header records #NCOM+9 & 10 - x, y coordinates of precipitation stations
c ---     (NPSTA words each record)
          if(npsta.ge.1)then
            write(iomet)CLAB6,IDUM,XPSTA
            write(iomet)CLAB7,IDUM,YPSTA
          endif

c ---     Header record #NCOM+11 - surface roughness lengths (NX * NY words)
          write(iomet)CLAB8,IDUM,Z0

c ---     Header record #NCOM+12 - land use categories (NX * NY words)
          write(iomet)CLAB9,IDUM,ILANDU

c ---     Header record #NCOM+13 - elevations (NX * NY words)
          write(iomet)CLAB10,IDUM,ELEV

c ---     Header record #NCOM+14 - leaf area index (NX * NY words)
          call wrtr2d(iomet,xlai,xbuf,mxnx,mxny,nx,ny,clabel,idum)
          write(iomet)CLAB11,IDUM,XLAI

c ---     Header record #NCOM+15 - nearest surface station no. to each
c ---     grid point (NX * NY words)
          if(nssta.ge.1)then
            write(iomet)CLAB12,IDUM,NEARS
          endif
```

where the following declarations apply:

```
real ZFACEM(nz+1),XSSTA(nssta),YSSTA(nssta),XUSTA(nusta),YUSTA(nusta)
real XPSTA(npsta),YPSTA(npsta)
real Z0(nx,ny),ELEV(nx,ny),XLAI(nx,ny)
integer ILANDU(nx,ny),NEARS(nx,ny)
character*132 COMMENT(ncom)
character*64 DATAMOD
character*16 DATASET,DATAVER
character*12 DATEN
character*8 PMAP,DATUM
character*8 CLAB1,CLAB2,CLAB3,CLAB4,CLAB5,CLAB6
character*8 CLAB7,CLAB8,CLAB9,CLAB10,CLAB11,CLAB12
character*4 UTMHEM
logical LCALGRD
```

Table E-26
CALMET.DAT file - Header Records

Header Record No.	Variable No.	Variable	Type[a]	Description
1	1	DATASET	char*16	Dataset name (CALMET.DAT)
1	2	DATAVER	char*16	Dataset version
1	3	DATAMOD	char*64	Dataset message field
2	1	NCOM	integer	Number of comment records to follow
3 to NCOM+2	1	COMMENT	char*132	Comment record (repeated NCOM times), each containing an image of one line of the CALMET control file, or other information
NCOM+3	1	IBYR	integer	Starting year of CALMET run
NCOM+3	2	IBMO	integer	Starting month
NCOM+3	3	IBDY	integer	Starting day
NCOM+3	4	IBHR	integer	Starting hour (time at end of hour)
NCOM+3	5	IBTZ	integer	Base time zone (e.g., 05=EST, 06=CST, 07=MST, 08=PST)
NCOM+3	6	IRLG	integer	Run length (hours)
NCOM+3	7	IRTYPE	integer	Run type (0=wind fields only, 1=wind and micrometeorological fields). IRTYPE must be run type 1 to drive CALGRID or options in CALPUFF that use boundary layer parameters
NCOM+3	8	NX	integer	Number of grid cells in the X direction
NCOM+3	9	NY	integer	Number of grid cells in the Y direction
NCOM+3	10	NZ	integer	Number of vertical layers
NCOM+3	11	DGRID	real	Grid spacing (m)
NCOM+3	12	XORIGR	real	X coordinate (m) of southwest corner of grid cell (1,1)
NCOM+3	13	YORIGR	real	Y coordinate (m) of southwest corner of grid cell (1,1)
NCOM+3	14	IWFCOD	integer	Wind field module used (0=objective analysis, 1=diagnostic model)
NCOM+3	15	NSSTA	integer	Number of surface meteorological stations
NCOM+3	16	NUSTA	integer	Number of upper air stations
NCOM+3	17	NPSTA	integer	Number of precipitation stations
NCOM+3	18	NOWSTA	integer	Number of over water stations

[a]char*N = Character*N

Table E-26 (Continued)
CALMET.DAT file - Header Records

Header Record No.	Variable No.	Variable	Type[a]	Description
NCOM+3	19	NLU	integer	Number of land use categories
NCOM+3	20	IWAT1	integer	Range of land use categories
NCOM+3	21	IWAT2	integer	Corresponding to water surfaces (IWAT1 or IWAT2, inclusive)
NCOM+3	22	LCALGRD	logical	Flag indicating if the full set of meteorological parameters required by CALGRID are contained in the file (LCALGRD is normally set to TRUE for CALPUFF applications)
NCOM+3	23	PMAP[b]	char*8	Map projection[b] UTM : Universal Transverse Mercator TTM : Tangential Transverse Mercator LCC : Lambert Conformal Conic PS : Polar Stereographic EM : Equatorial Mercator LAZA : Lambert Azimuthal Equal Area
NCOM+3	24	DATUM	char*8	DATUM Code for grid coordinates
NCOM+3	25	DATEN	char*12	NIMA date (MM-DD-YYYY) for datum definitions
NCOM+3	26	FEAST	real	False Easting (km) for PMAP = TTM, LCC, or LAZA
NCOM+3	27	FNORTH	real	False Northing (km) for PMAP = TTM, LCC, or LAZA
NCOM+3	28	UTMHEM	char*4	Hemisphere for UTM projection (N or S)
NCOM+3	29	IUTMZN	integer	UTM zone for PMAP = UTM
NCOM+3	30	RNLAT0	real	North latitude (degrees) for projection origin (for PMAP= TTM, LCC, PS, EM, or LAZA)
NCOM+3	31	RELON0	real	East longitude (degrees) for projection origin (for PMAP= TTM, LCC, PS, EM, or LAZA)
NCOM+3	32	XLAT1	real	North latitude (degrees) of matching parallel #1 for map projection PMAP= LCC or PS
NCOM+3	33	XLAT2	real	North latitude (degrees) of matching parallel #2 for map projection PMAP= LCC
NCOM+4	1	CLAB1	char*8	Variable label ('ZFACE')
NCOM+4	2	IDUM	integer	Variable not used
NCOM+4	3	ZFACEM	real array	Heights (m) of cell faces (NZ + 1 values)

[a] char*N = Character*N
[b] PMAP = EM, PS, and LAZA is NOT AVAILABLE in CALMET

Table E-26 (Continued)
CALMET.DAT file - Header Records

Header Record No.	Variable No.	Variable	Type[a]	Description
NCOM+5[b]	1	CLAB2	char*8	Variable label ('XSSTA')
NCOM+5[b]	2	IDUM	integer	Variable not used
NCOM+5[b]	3	XSSTA	real array	X coordinates (m) of each surface met. station
NCOM+6[b]	1	CLAB3	char*8	Variable label ('YSSTA')
NCOM+6[b]	2	IDUM	integer	Variable not used
NCOM+6[b]	3	YSSTA	real array	Y coordinates (m) of each surface met. station
NCOM+7[c]	1	CLAB4	char*8	Variable label ('XUSTA')
NCOM+7[c]	2	IDUM	integer	Variable not used
NCOM+7[c]	3	XUSTA	real array	X coordinates (m) of each upper air met. station
NCOM+8[c]	1	CLAB5	char*8	Variable label ('YUSTA')
NCOM+8[c]	2	IDUM	integer	Variable not used
NCOM+8[c]	3	YUSTA	real array	Y coordinate (m) of each upper air met. station
NCOM+9[d]	1	CLAB6	char*8	Variable label ('XPSTA')
NCOM+9[d]	2	IDUM	integer	Variable not used
NCOM+9[d]	3	XPSTA	real array	X coordinate (m) of each precipitation station
NCOM+10[d]	1	CLAB7	char*8	Variable label ('YPSTA')
NCOM+10[d]	2	IDUM	integer	Variable not used
NCOM+10[d]	3	YPSTA	real array	Y coordinate (m) of each precipitation station
NCOM+11	1	CLAB8	char*8	Variable label ('Z0')
NCOM+11	2	IDUM	integer	Variable not used
NCOM+11	3	Z0	real array	Gridded field of surface roughness lengths (m) for each grid cell

[a] char*N = Character*N
[b] Included only if NSSTA > 0
[c] Included only if NUSTA > 0
[d] Included only if NPSTA > 0

Table E-26 (Concluded)
CALMET.DAT file - Header Records

Header Record No.	Variable No.	Variable	Type[a]	Description
NCOM+12	1	CLAB9	char*8	Variable label ('ILANDU')
NCOM+12	2	IDUM	integer	Variable not used
NCOM+12	3	ILANDU	integer array	Gridded field of land use category for each grid cell
NCOM+13	1	CLAB10	char*8	Variable label ('ELEV')
NCOM+13	2	IDUM	integer	Variable not used
NCOM+13	3	ELEV	real array	Gridded field of terrain elevations for each grid cell
NCOM+14	1	CLAB11	char*8	Variable label ('XLAI')
NCOM+14	2	IDUM	integer	Variable not used
NCOM+14	3	XLAI	real array	Gridded field of leaf area index for each grid cell
NCOM+15	1	CLAB12	char*8	Variable label ('NEARS')
NCOM+15	2	IDUM	integer	Variable not used
NCOM+15	3	NEARS	integer array	Nearest surface meteorological station to each grid point

[a]char*N = Character*N

CALMET.DAT File - Data Records

The CALMET.DAT data records include hourly fields of winds and meteorological variables. In addition to the regular CALMET output variables, both CALGRID and CALPUFF require additional three-dimensional fields of air temperature and vertical velocity. The presence of these fields in the CALMET output file is flagged by the header record logical variable, LCALGRD, having a value of TRUE.

The data records contain three-dimensional gridded fields of U, V, and W wind components and air temperature, and two-dimensional fields of PGT stability class, surface friction velocity, mixing height, Monin-Obukhov length, convective velocity scale, precipitation rate (not used by CALGRID), near-surface temperature, air density, short-wave solar radiation, relative humidity, and precipitation type codes (not used by CALGRID). A description of each variable in the data records is provided in Table E-27.

Sample FORTRAN write statements for the CALMET.DAT data records are:

```
c ---     Write U, V, W wind components
          +)))              Loop over vertical layers, k
          *
          *                   write(iunit)CLABU,NDATHR,((U(i,j,k),i=1,nx),j=1,ny)
          *                   write(iunit)CLABV,NDATHR,((V(i,j,k),i=1,nx),j=1,ny)
          *                   if(LCALGRD)write(iunit)CLABW,NDATHR((W(i,j,k+1),i=1,nx),j=1,ny)
          *
          .)))              End loop over vertical layers

c ---     Write 3-D temperature field
          if(LCALGRD.and.irtype.eq.1) then
          +)))              Loop over vertical layers, k
          *
          *                   write(iunit)CLABT,NDATHR,((ZTEMP(i,j,k),i=1,nxm),j=1,nym)
          *
          .)))              End loop over vertical layers
          endif

c ---     Write 2-D meteorological fields
          if(irtype.eq.1) then

                write(iunit)CLABSC,NDATHR,IPGT
                write(iunit)CLABUS,NDATHR,USTAR
                write(iunit)CLABZI,NDATHR,ZI
                write(iunit)CLABL,NDATHR,EL
                write(iunit)CLABWS,NDATHR,WSTAR
                write(iunit)CLABRMM,NDATHR,RMM
                write(iunit)CLABTK,NDATHR,TEMPK
                write(iunit)CLABD,NDATHR,RHO
                write(iunit)CLABQ,NDATHR,QSW
                write(iunit)CLABRH,NDATHR,IRH
                write(iunit)CLABPC,NDATHR,IPCODE

          endif
```

where the following declarations apply:

```
real U(nx,ny,nz),V(nx,ny,nz),W(nx,ny,nz)
real ZTEMP(nx,ny,nz)
real USTAR(nx,ny),ZI(nx,ny),EL(nx,ny)
real WSTAR(nx,ny),RMM(nx,ny)
real TEMPK(nx,ny),RHO(nx,ny),QSW(nx,ny)
integer IPGT(nx,ny)
integer IRH(nx,ny),IPCODE(nx,ny)
character*8 CLABU, CLABV, CLABW, CLABT, CLABSC, CLABUS, CLABZI
character*8 CLABL, CLABWS, CLABRMM, CLABTK, CLABD, CLABQ, CLABRH
character*8 CLABPC
```

Table E-27
CALMET.DAT file - Data Records

Record Type	Variable No.	Variable Name	Type[a]	Description
1	1	CLABU	char*8	Variable label ('U-LEVxxx', where xxx indicates the layer number)
1	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
1	3	U	real array	U-component (m/s) of the winds at each grid point
2	1	CLABV	char*8	Variable label ('V-LEVxxx', where xxx indicates the layer number)
2	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
2	3	V	real array	V-component (m/s) of the winds at each grid point
3[b]	1	CLABW	char*8	Variable label ('WFACExxx"), where xxx indicates the layer number)
3[b]	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
3[b]	3	W	real array	W-component (m/s) of the winds at each grid point
(Record types 1,2,3 repeated NZ times (once per layer) as a set)				
4[b]	1	CLABT	char*8	Variable label ('T-LEVxxx', where xxx indicates the layer number)
4[b]	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
4[b]	3	ZTEMP	real array	Air temperature (deg. K) at each grid point
(Record type 4 repeated NZM times (once per layer))				

[a] char*8 = Character*8
[b] Record types 3 and 4 are included only if LCALGRD is TRUE

Table E-27 (Continued)
CALMET.DAT file - Data Records

Record Type	Variable No.	Variable Name	Type[a]	Description
5	1	CLABSC	char*8	Variable label ('IPGT')
5	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
5	3	IPGT	integer array	PGT stability class at each grid point
6	1	CLABUS	char*8	Variable label ('USTAR')
6	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
6	3	USTAR	real array	Surface friction velocity (m/s)
7	1	CLABZI	char*8	Variable label ('ZI')
7	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
7	3	ZI	real array	Mixing height (m)
8	1	CLABL	char*8	Variable label ('EL')
8	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
8	3	EL	real array	Monin-Obukhov length (m)
9	1	CLABWS	char*8	Variable label ('WSTAR')
9	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
9	3	WSTAR	real array	Convective velocity scale (m/s)
10	1	CLABRMM	char*8	Variable label ('RMM')
10	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
10	3	RMM	real array	Precipitation rate (mm/hr). Not used by CALGRID.

[a] char*8 = Character*8

Table E-27 (Concluded)
CALMET.DAT file - Data Records

Record Type	Variable No.	Variable Name	Type[a]	Description
11	1	CLABTK	char*8	Variable label ('TEMPK')
11	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
11	3	TEMPK	real array	Near-surface temperature (deg. K)
12	1	CLABD	char*8	Variable label ('RHO')
12	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
12	3	RHO	real array	Near-surface air density (kg/m^3)
13	1	CLABQ	char*8	Variable label ('QSW')
13	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
13	3	QSW	real array	Short-wave solar radiation (W/m^2)
14	1	CLABRH	char*8	Variable label ('IRH')
14	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
14	3	IRH	integer array	Near-surface relative humidity (percent)
15	1	CLABPC	char*8	Variable label ('IPCODE')
15	2	NDATHR	integer	Year, Julian day and hour in the form YYYYJJJHH (or YYJJJHH)
15	3	IPCODE	integer array	Precipitation type code (not used by CALGRID) 0 - no precipitation 1 to 18 - liquid precipitation 19 to 45 - frozen precipitation

[a] char*8 = Character*8

E.11.2 PACOUT.DAT

CALMET has the option to output the unformatted meteorological data file in a form compatible with MESOPUFF II. If IFORMO is set to two in Input Group 3 of the CALMET control file, the output data file is called PACOUT.DAT.

The PACOUT.DAT output meteorological file consists of six header records followed by a set of twelve data records for each hour. The header records contain the date and length of the run, grid size and spacing, land use categories and surface roughness lengths at each grid point, as well as other information required by MESOPUFF II. A description of each variable in the header records is provided in Table E-28. Sample FORTRAN write statements for the PACOUT.DAT header records are:

```
c ---   Header record 1 -- General run and grid information
        write(io7)NYR,IDYSTR,IHRMAX,NSSTA,NUSTA,IMAX,JMAX,IBTZ,
       1 ILWF,IUWF,DGRID,VK

c ---   Header record 2 -- Surface station coordinates
        write(io7)XSCOOR,YSCOOR

c ---   Header record 3 -- Upper air station coordinates
        write(io7)XUCOOR,YUCOOR

c ---   Header record 4  -- Surface roughness lengths
        write(io7)Z0

c ---   Header record 5 -- Nearest surface station to each grid point
        write(io7)NEARS

c ---   Header record 6 -- Land use categories
        write(io7)ILANDU
```

where the following declarations apply:

```
        real XSCOOR(nssta),YSCOOR(nssta),XUCOOR(nusta),YUCOOR(nusta)
        real Z0(nx,ny)
        integer ILANDU(nx,ny)NEARS(nx,ny)
```

The data records of the PACOUT.DAT are repeated once each hour. A description of each variable in the data records is provided in Table E-28. Sample FORTRAN write statements for the data records are:

```
c ---   Write date and time
          write(io7)KYR,KJUL,KHR

c ---   Write lower level wind components
        +))) Loop over grid cells
        *
        *         write(io7)((UL(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
        +)))   Loop over grid cells
        *
        *         write(io7)((VL(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
c ---   Write upper level wind components
        +))) Loop over grid cells
        *
        *         write(io7)((UUP(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
        +)))   Loop over grid cells
        *
        *         write(io7)((VUP(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
c ---   Write mixing height
        +))) Loop over grid cells
        *
        *         write(io7)((HTMIX(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
c ---   Write friction velocity
        +))) Loop over grid cells
        *
        *         write(io7)((USTAR(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
c ---   Write convective velocity scale
        +))) Loop over grid cells
        *
        *         write(io7)((WSTAR(i,j),i=1,nx,)j=1,ny)
        *
        .)))   End loop over grid cells
c ---   Write Monin-Obukhov length
```

```
+))) Loop over grid cells
*
*          write(io7)((XMONIN(i,j),i=1,nx,)j=1,ny)
*
.)))   End loop over grid cells
```

c --- Write PGT stability class

```
+))) Loop over grid cells
*
*          write(io7)((IPGT(i,j),i=1,nx,)j=1,ny)
*
.)))   End loop over grid cells
```

c --- Write precipitation code

```
+))) Loop over grid cells
*
*          write(io7)((RMM(i,j),i=1,nx,)j=1,ny)
*
.)))   End loop over grid cells
```

c --- Write average surface air density, air temperature, total solar radiation, relative humidity, and precipitation code

```
write(io7)AVRHO,TEMPK,SRAD,IRH,IPCODE
```

where the following declarations apply:

```
real UL(nx,ny),VL(nx,ny),UUP(nx,ny),VUP(nx,ny)
real HTMIX(nx,ny),USTAR(nx,ny),WSTAR(nx,ny)
real XMONIN(nx,ny),RMM(nx,ny)
real TEMPK(nssta),SRAD(nssta)
integer IPGT(nx,ny)
integer IRH(nssta),IPCODE(nssta)
```

Table E-28
PACOUT.DAT File - Format

HEADER RECORDS - First six records of output file

Header Record No.	Variable No.	Variable	Type	Description
1	1	NYR	integer	Starting year
1	2	IDYSTR	integer	Starting Julian day
1	3	IHRMAX	integer	Number of hours in run
1	4	NSSTA	integer	Number of surface stations
1	5	NUSTA	integer	Number of rawinsonde stations
1	6	IMAX	integer	Number of grid points in X direction
1	7	JMAX	integer	Number of grid points in Y direction
1	8	IBTZ	integer	Reference time zone
1	9	ILWF	integer	Lower-level wind field code
1	10	IUWF	integer	Upper-level wind field code
1	11	DGRID	real	Grid spacing (m)
1	12	VK	real	von Karman constant
2	1	XSCOOR	real array	Surface station X coordinates (grid units)
2	2	YSCOOR	real array	Surface station Y coordinates (grid units)
3	1	XUCOOR	real array	Upper air station X coordinates (grid units)
3	2	YUCOOR	real array	Upper air station Y coordinates (grid units)
4	1	Z0	real array	Surface roughness lengths (m)
5	1	NEARS	integer array	Station number of closest surface station to each grid point
6	1	ILANDU	integer array	Land use categories

Table E-28 (Concluded)
PACOUT.DAT File - Format

DATA RECORDS - Repeated for each hour of run

Header Record No.	Variable No.	Variable	Type	Description
7	1	KYR	integer	Year
7	2	KJUL	integer	Julian day
7	3	KHR	integer	Hour (00-23)
8	1	UL	real array	Lower-level u wind component (m/s)
9	1	VL	real array	Lower-level v wind component (m/s)
10	1	UUP	real array	Upper-level u wind component (m/s)
11	1	VUP	real array	Upper-level v wind component (m/s)
12	1	HTMIX	real array	Mixing height (m)
13	1	USTAR	real array	Friction velocity (m/s)
14	1	WSTAR	real array	Convective velocity scale (m/s)
15	1	XMONIN	real array	Monin-Obukhov length (m)
16	1	IPGT	integer array	PGT stability class
17	1	RMM	real array	Hourly precipitation rate (mm/hr)
18	1	AVRHO	real	Average surface air density (kg/m^3)
18	2	TEMPK	real array	Air temperature*(K)
18	3	SRAD	real array	Total solar radiation*(W/m^2)
18	4	IRH	integer array	Relative humidity*(%)
18	5	IPCODE	integer array	Precipitation code*

* At surface meteorological stations

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