A Set of Diagnostic and File Utilities for MM5

Jay Larson

Mathematics and Computer Science Division / Argonne National Laboratory

Outline

- Motivation: both as MM5 user and participant in the Project to Intercompare Regional Climate Simulations (PIRCS)
- File manipulation utilities **`V3_Tools`**
- Diagnostics Library **`met_utils`**
- Future work—invitation to the MM5 community to participate in an open-source project

Motivation and Requirements

Our own MM5 work:

- Analysis of results /output quality control
- Calculation of common diagnostics (*e.g.*, PSL)
- Time averaging / time statistics
- Support for sensitivity experiments

Our participation in PIRCS:

- Calculation of PIRCS diagnostics
- Conversion of data to PIRCS format

MCS/ANL PIRCS Experience

- Most groups with long histories have legacy codes for computing diagnostics—we did not
- MCS has software design as one of its core competencies—approach this problem as a software project

The Software

Products:

- A library of diagnostic routines **met_utils**
- A set of tools—**V3_Tools**—for manipulating MM5V3 history files

Features of the software:

- Modular Fortran 90 code
- Self-documenting using **ProTeX**, which generates **LaTeX** from source code

File Manipulation Tools

- Designed to read MM5V3 files, perform certain operations on them, and then write MM5V3 files as output
- Uses extended version of the V3 f90 header module—this module came from the MMM products **v32v2** and **v22v3**

File Manipulation Tools, Cont'd
Extensions to `v3_header_module.F`

Added new public data members:

- Big header data structures **`bhi`**, **`bhr`**, **`bhic`** and **`bhrc`**.
- Definition of header flag.
- Constants defining the possible types of grid orderings and staggerings.
- Definition of integer and real versions of the MM5 missing data flag.

File Manipulation Tools, Cont'd
Extensions to `v3_header_module.F`

Added Functionality— ability to query MM5 date variable **`current_date`**:

- **`V3_date_to_year()`** – return year
- **`V3_date_to_month()`** – return month
- **`V3_date_to_day()`** – return day of month
- **`V3_date_to_hour()`** – return hour

File Manipulation Tools, Cont'd...

- **`V3_list_fields`** ***`file`*** – list of output fields
- **`V3_probe`** ***`file`*** –subheader listing for each field at each time, with field sample values
- **`V3_stats`** ***`file`*** – produces subheader listing for each field at each time, along with minimum, maximum, average, standard deviation
- **`V3_grid`** ***`file`*** – reports type of horizontal grid, its resolution, vertical levels, and latitude and longitude at the corners of the domain
- **`V3_times`** ***`file`*** – produces a listing of output time periods

File Manipulation Tools, Cont'd...

- **V3_time_average** ***file av_file*** **–** produces a time-averaged field for each field in file and writes it in MM5V3 format to ***av_file***
- **V3_compare** ***file1 file2*** **–** compares the contents of ***file1*** and ***file2*** to see if they have the same output fields, grids, and times
- **V3_diff** ***file1 file2 file3*** **–**subtracts the values in ***file2*** from ***file1*** and writes the result to ***file3*****.** The data files ***file1*** and ***file2*** must have the same spatiotemporal sampling as defined by **V3_compare.**

Diagnostics Library `met_utils`

Computation of Diagnostic fields:

- Pressure
- Geopotential height
- Specific humidity from mixing ratio
- Surface and sea-level pressures
- Total precipitable water
- Radiative fluxes from albedo, skin temperature, and emissivity
- Surface heat budget

Diagnostics Library `met_utils`

In addition to diagnostics calculations, Low-level Functionality supplied includes:

- Time averaging and integration
- Time min/max
- Vertical integrals

Intended uses of `met_utils`:

- Library support for user-written analysis and visualization codes
- Plug-ins to MM5

Further Development

- Software release later this year (2000)
- Expand functionality of met_utils library—perhaps as an open source project
- Interpolation tools—ease calculation of profiles for comparison with station data
- Extension of V3_Tools to include translation to NetCDF format

Possible Open-Source Mechanism

- Participants submit diagnostics subroutines that work with MM5V3 formulation (nonhydrostatic)
- Core developers of **`met_utils`** add **`ProTeX`** compliant prologue, and do general clean-up of code (*e.g.*, use dynamic memory where possible, remove GOTO statements, *et cetera*)—much the way newspaper and magazine editors operate
- Resulting code is released with all participants as co-authors

On-line Documentation

- For an example of automatically generated documentation of **`met_utils`** library routines, see the site **`www.mcs.anl.gov/~larson/met_utils`**

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