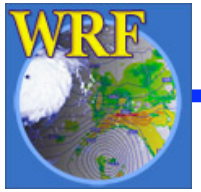
# Post-processing Tools

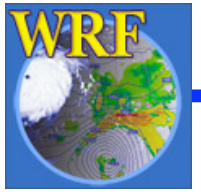
***Cindy Bruyère***



# Graphical Packages

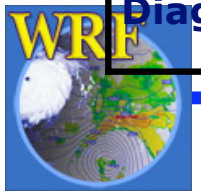
- **NCL** — UG: 9-2
  - Graphical package
- **ARWpost** — UG: 9-28
  - Converter (GrADS & vis5d)
- **RIP4** — UG: 9-19
  - Converter and interface to graphical package NCAR Graphics
- **WPP** — UG: 9-35
  - Converter (GrADS & GEMPAK)
- **VAPOR** — UG: 9-50
  - Converter and graphical package
  - *Support: VAPOR*
- **IDV** — unidata.ucar.edu
  - GRIB (from WPP)
  - GEMPAK (from wrf2gem)
  - vis5d (from ARWpost)
  - CF complaint data (from wrf_to_cf)
  - *Support: unidata*
- **GEMPAK**
  - Data from wrf2gem or WPP
  - *Support: unidata*

**MatLab / IDL / R / ferret**



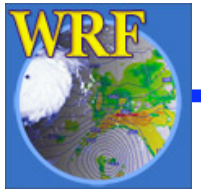
# Graphical Packages

| | NCL | RIP4 | ARWpost (GrADS / Vis5D) | WPP | VAPOR |
|---|---|---|---|---|---|
| **Directly ingest WRF data** | ***Y*** | **N** *converter* | **N /** ***(Y)*** *converter* | **N** *converter* | **N** *converter* |
| **Intermediate files** | ***N*** | lots | large file | **Y** | large file |
| **WPS DATA** | ***Y*** | ***Y*** | ***Y*** | **N** | **N** |
| **wrfinput data** | ***Y*** | ***Y*** | ***Y*** | **N** | **N** |
| **Idealized data files** | ***Y*** | ***Y*** | ***Y*** | **N** | **N** |
| **Input format** | *netCDF* | *netCDF* | *netCDF / GRIB1* | *netCDF / binary* | *netCDF* |
| **Vertical Output Coordinate** | eta pressure height | eta pressure height | eta pressure height | pressure | eta |
| **Software required** ***(All binaries are free)*** | *NCL* | *NCARG* | *GrADS/vis5d* | *GrADS / GEMPAK* | *VAPOR* |
| **Diagnostics** | *some* | *> 100* | *some* | *some* | *limited* |

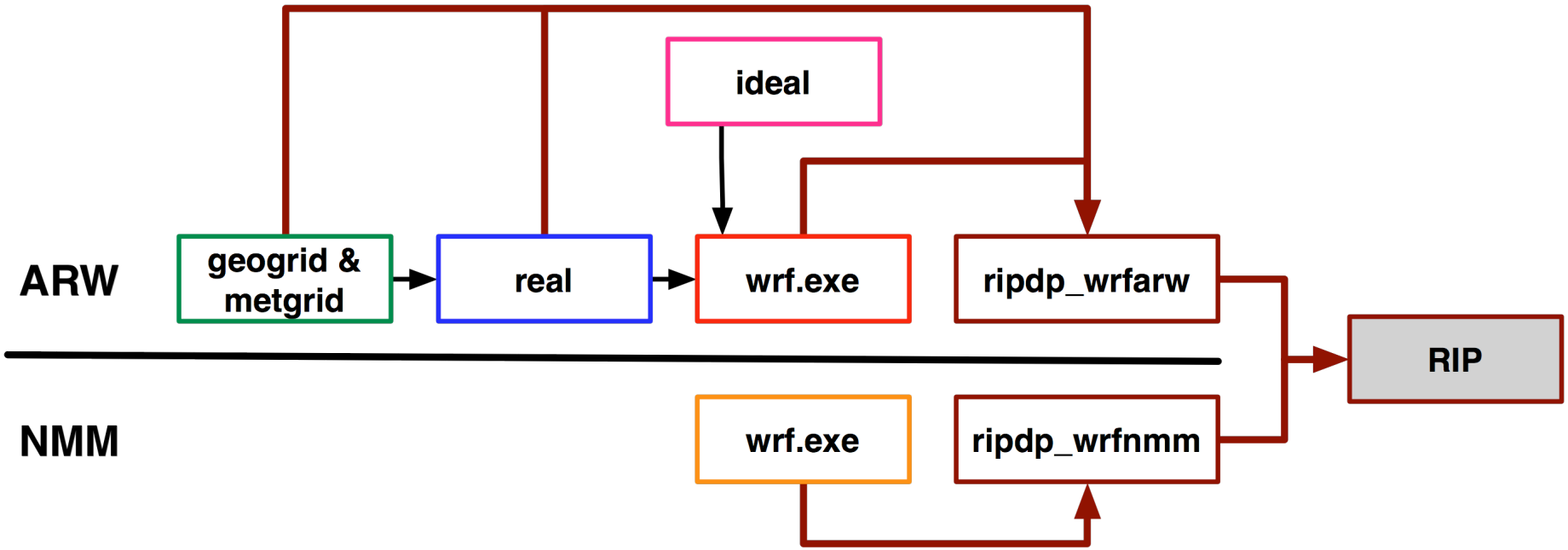


# RIP4

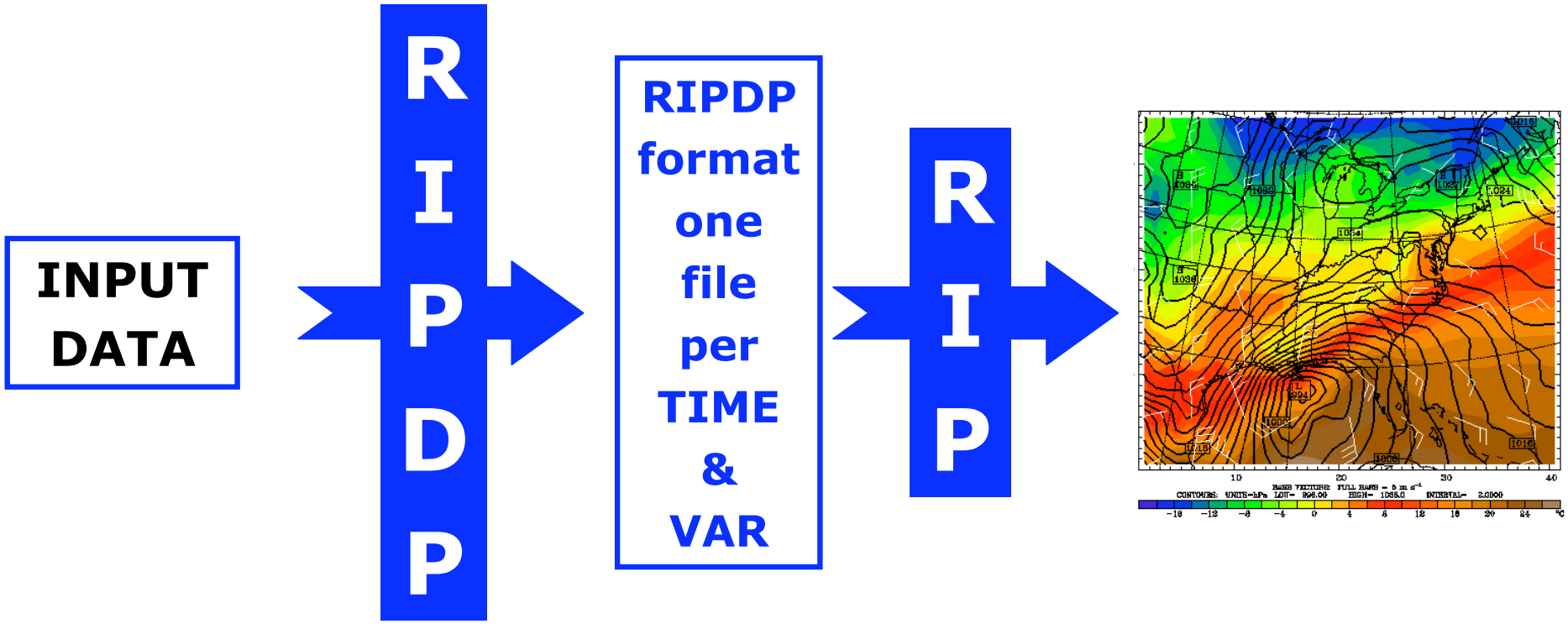
- **Read Interpolate Plot version 4**
- **Develop by Mark Stoelinga (3TIER/UW/NCAR) & MMM/NCAR Staff**
- **Originally developed for the MM5 model**
- **Generate a number of graphical plots**
  - Horizontal, cross-section, skewT
- **Current Version: 4.5**
  - configure / compile



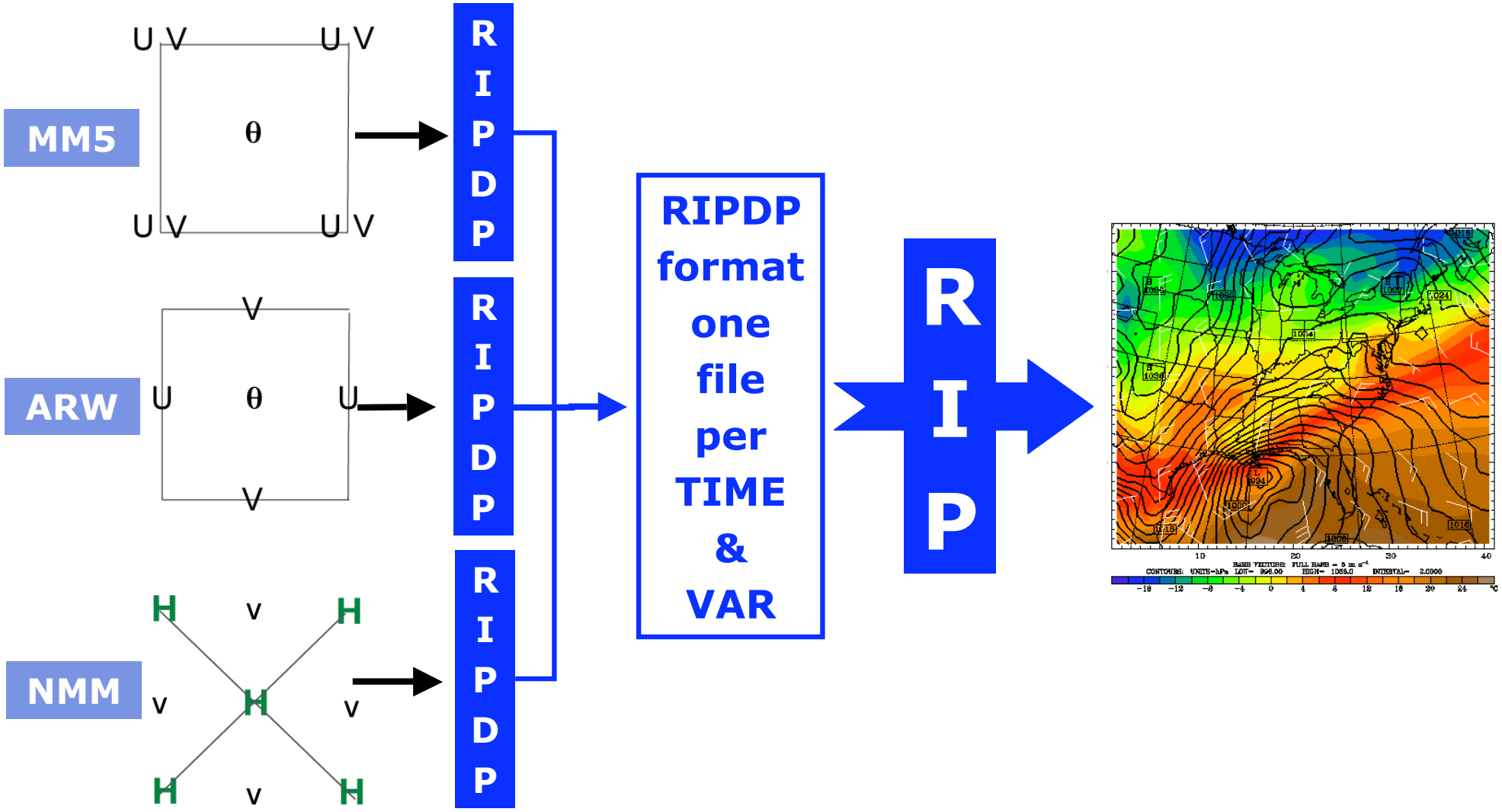
# RIP4 Input Data



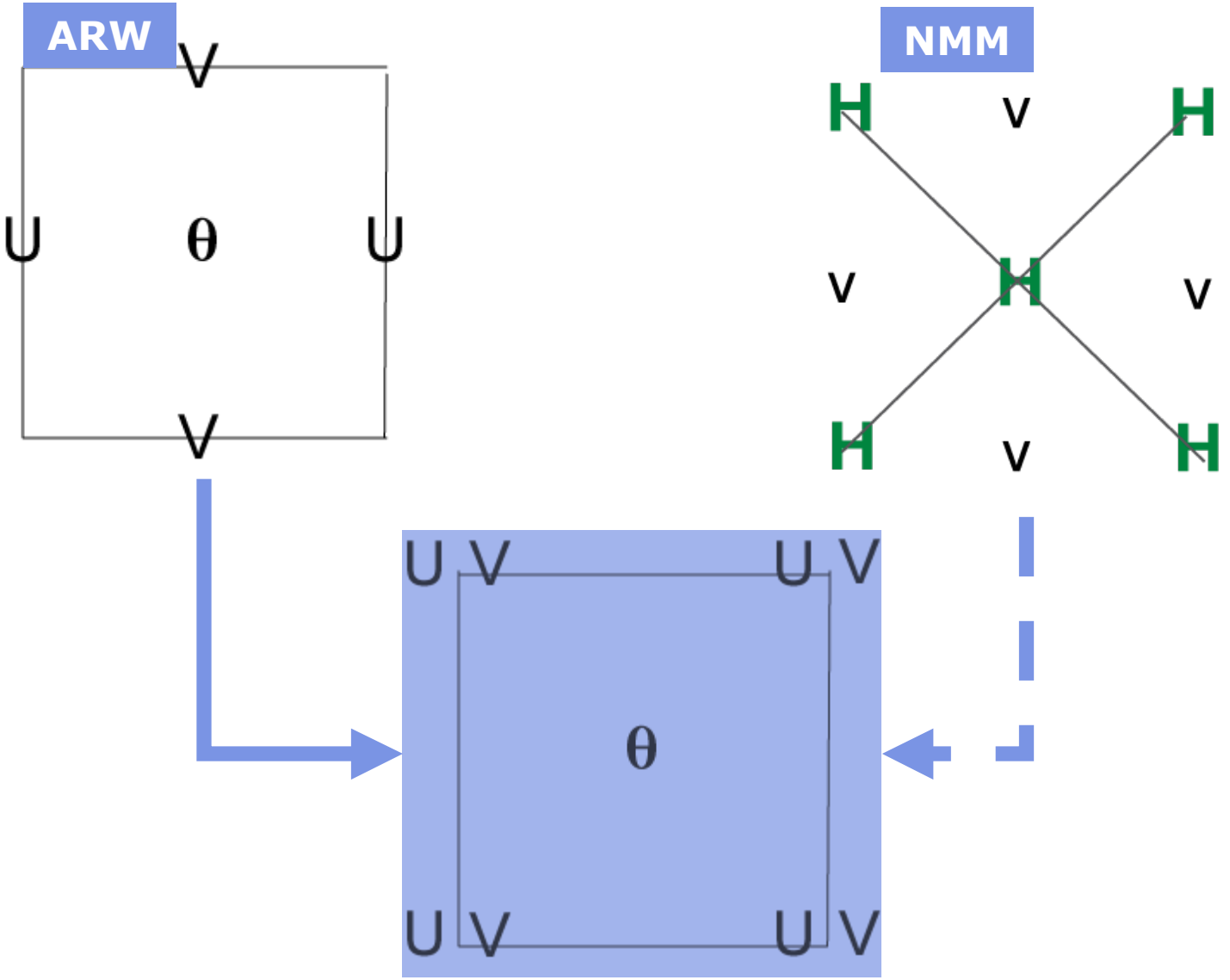
# RIP4



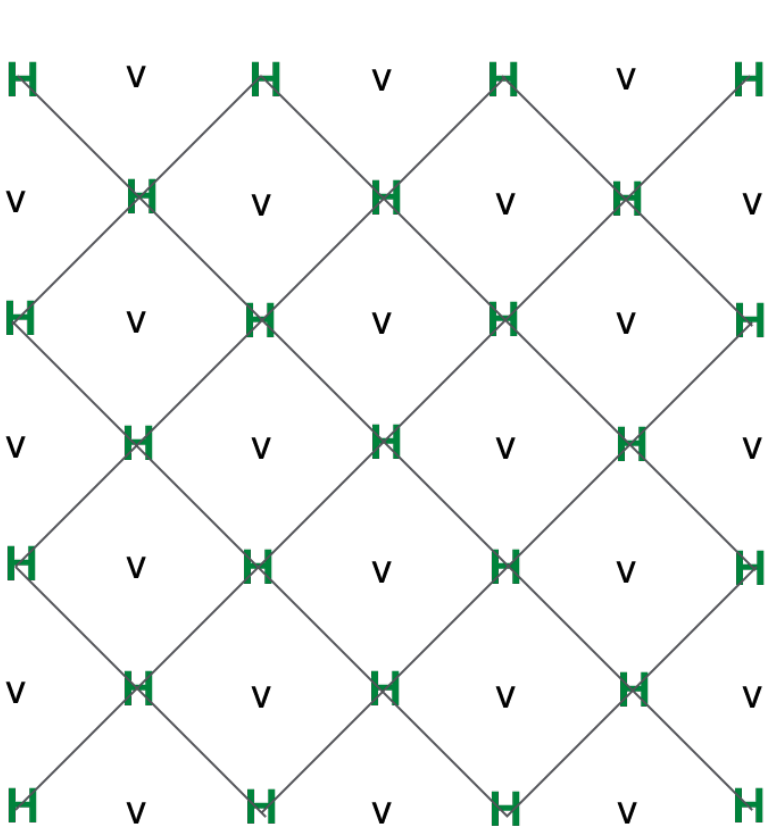
# RIP4 - Grids

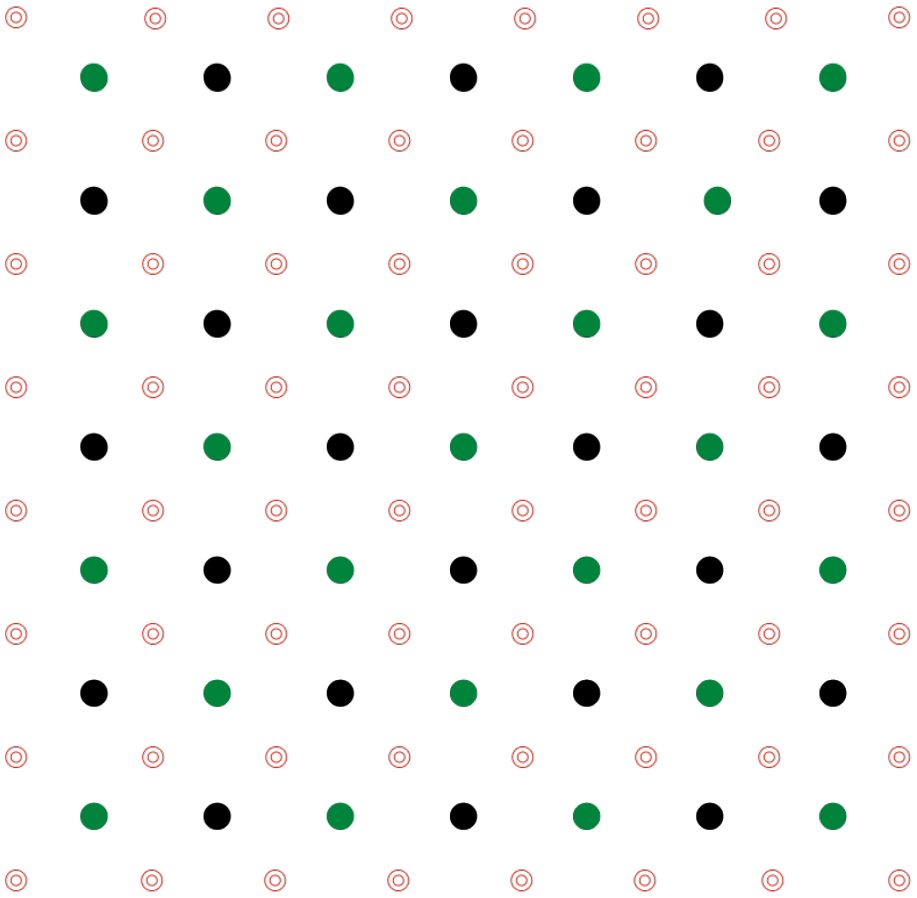

MM5
U V
θ
U V
U V
U V
ARW
V
U
θ
U
V
NMM
H
v
H
v
H
v
H
v
H
RIPDP
RIPDP
RIPDP
RIPDP format one file per TIME & VAR
RIP

# RIP4 - WRF Grids

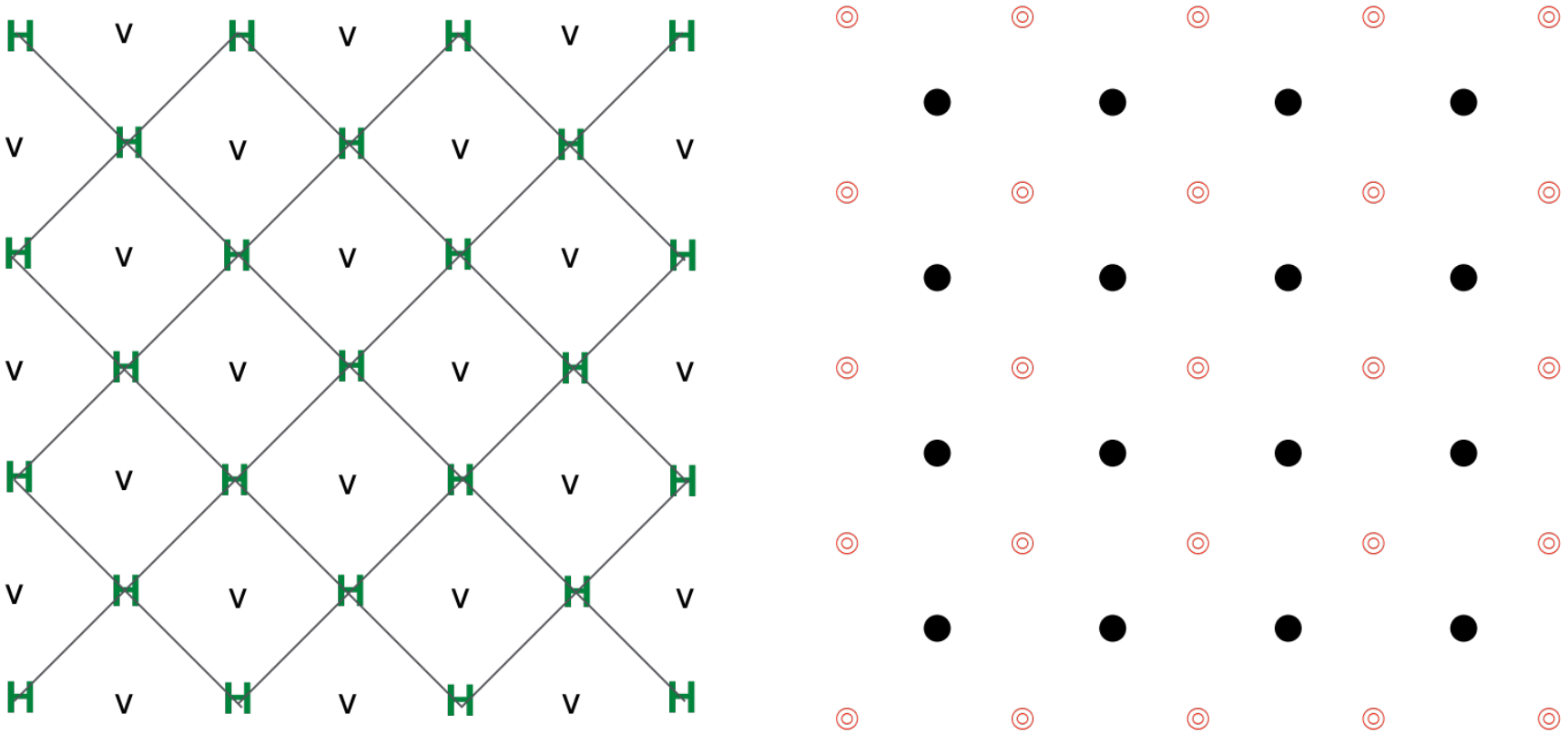


# RIP4 - NMM Grid *(iinterp 0)*



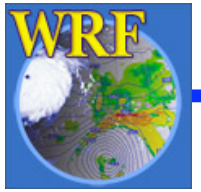
# RIP4 - NMM Grid *(iinterp 1)*




**new projection ; no direct relationship**

# General

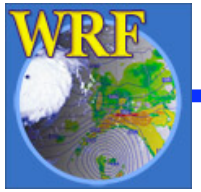
- **Requires NCAR Graphics low-level routines**
  - ***http://ngwww.ucar.edu***
- **NCL Version 5:**
  - ***http://www.ncl.ucar.edu***
  - Released November 2007
  - Combine NCL and NCAR Graphics
  - Open Source
  - Recommended
- **Download Code:**
  - ***http://www.mmm.ucar.edu/wrf/users/download/get_source.html***
  - ***http://www.dtcenter.org/wrf-nmm/users/downloads/index.php***



# General

- **Documentation**
  - In program tar file under the Doc/ directory
  - ***http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm***
  - ***http://www.dtcenter.org/wrf-nmm/users/docs/user_guide/RIP/ripug.htm***

- **OnLine Tutorial:**
  - ***http://www.mmm.ucar.edu/wrf/users/graphics/RIP4/RIP4.htm***
  - ***http://www.dtcenter.org/wrf-nmm/users/OnLineTutorial/NMM/RIP/index.php***



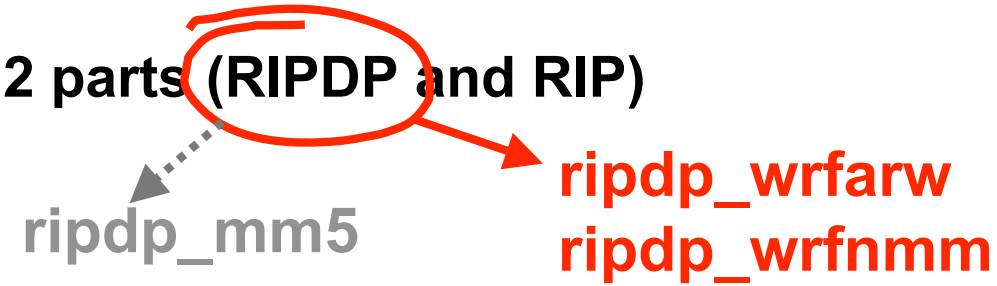
# RIP4 on your computer

- **set environment variables**
  setenv RIP_ROOT /usr/$USER/RIP4 ***(rip_root)***
  setenv NCARG_ROOT /usr/local/ncarg ***(/usr/local/ncl)***

- **Configure**
  *./configure*
  ***(check configure.rip to ensure netCDF paths are correct)***

- **Compile**
  *./compile*

- **RIP4 has 2 parts (RIPDP and RIP)**

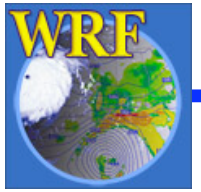


# ripdp & rip

- **ripdp**
  - RIP Data Preparation
  - Converter
    RIPDP converts WRF formatted data (*netCDF*) into RIP format (*B - grid*)
  - Output
    RIPDP puts each Variable at each Time into a separate file
    Creates LOTS of files

**mkdir RIPDP**

- **rip**
  - Reads the output generated by *ripdp*
  - Makes use of a User Input File (UIF) *(rip_sample.in)* to control plots
  - Output
    X11, pdf, ps, cgm



# Running ripdp

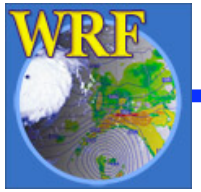
Optional

```
ripdp_wrfxxx   [–n namelist-file]          \
      <model_data_name>     [basic/all]   \
      <input_file1 input_file2>
```

**Example:**

```
ripdp_wrfarw   RIPDP/arw   all   wrfout*
```

use directory as part of the model_data_name

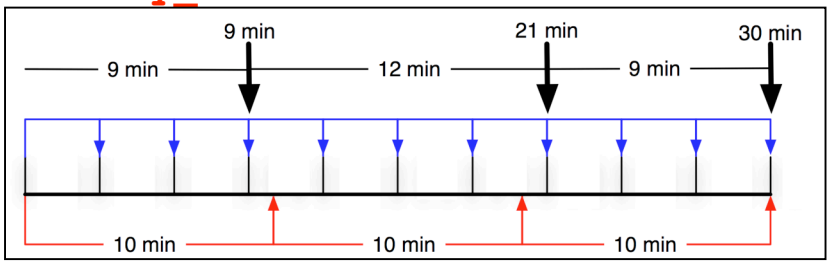


# ripdp namelist

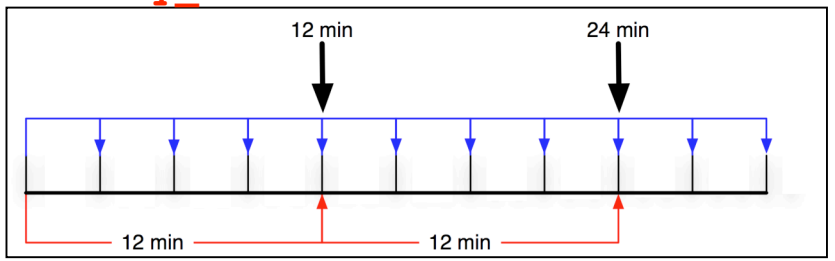
- **ptimes** *(times for ripdp to process)*
  - `0,1,2,3,4,5,6` (0,1,2,3,4,5,6)
  - `0,-6,1` (0,1,2,3,4,5,6)
  - `0,  2,-4,1,  6` (0, 2,3,4, 6)

- **tacc**: *input files not on exact times* [`time_step=180` (3 min)]

`history_interval=10`




`history_interval=12`



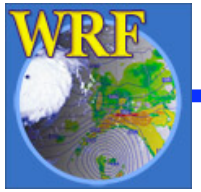

- **discard**: fields if '**all**' is selected on the command line
- **retain**: fields if '**basic**' is selected on the command line

NMM only

# ripdp namelist

- **iinterp = 1:** interpolate to a new B-grid
- **dskmcib:** grid spacing, in km, of the coarse domain on which the new B-grid will be based
- **miycorsib, mjxcorsib:** number of grid points in the y and x directions of new B-grid
- **nprojib:** map projection number (0: none/ideal, 1: LC, 2: PS, 3: ME, 4: SRCE) of new B-grid
- **xlatcib, xloncib:** central latitude and longitude of new B-grid
- **truelat1ib, truelat2ib:** two true latitudes of new B-grid

- **miyib, mjxib:** number of grid points in the y and x directions, of the fine domain
- **yicornib, xjcornib:** coarse domain y and x locations of the lower left corner point of the fine domain
- **dskmib:** grid spacing, in km, of the fine domain



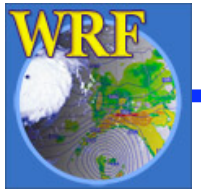
# Running rip

- **Edit the User Input File (UIF)**

- **setenv NCARG_ROOT /usr/local/ncarg**

  **setenv NCARG_ROOT /usr/local/ncl**
  ***(if you installed NCL version 5)***

- **setenv RIP_ROOT *your-rip-directory***
  - *Can overwrite this with **rip_root** in input namelist*



# Running rip

created by ripdp

**rip [-f] model-data-set-name **

**rip-execution-name**

**User Input File (UIF)**

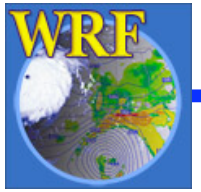
**Example:**

**rip [-f] RIPDP/*xxx* rip_sample.in**

**use directory as part of the model_data_set_name**

**output**

***[rip_sample.out]***
***rip_sample.TYPE***



# rip UIF

```
&userin
    .......
&end
```

**Namelist controlling general parameters**

```
&trajcalc
    .......
&end
```

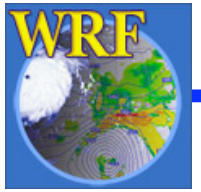
**Namelist for trajectory calculations**
***Only used if itrajcalc=1, in userin namelist***

```
==================================
---------    Plot Specification Table   ----------
==================================
feld= .........
feld= .........
==================================
feld= .........
feld= .........
==================================
```

**Frame specification group (FSG)**

**Plot specification line (PSL)**

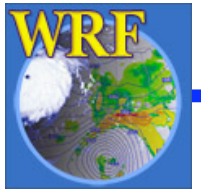
**Plot Specification Table (PST)**



# rip namelist - *&userin*

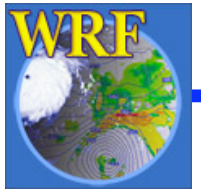
- **Use namelist to control**
  - processing times, intervals
  - title information
  - text quality on a plot
  - whether to do time series, trajectory, or to write output for Vis5D

- **Full explanation for namelist variables is available in the user document**



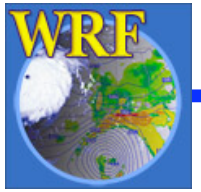
# rip namelist - *&userin*

- **idotitle – first part of first title line**
- **titlecolor – color of title lines**
- **ptimes, ptimeunits – times to process**
- **tacc – tolerance for processing data**
- **timezone –display of local time**
- **iusedaylightrule – 1 applied, 0 not applied**
- **iinittime – plotting of initial time**
- **ivalidtime – plotting of valid time**
- **inearsth – plot times as 2 / 4 digits**
- **flmin, frmax, fbmin, ftmax – frame size**
- **ntextq – text quality**



# rip namelist - *&userin*

- **ntextcd – text font**
- **fcoffset – 12 means, hour 12 WRF forecast is considered hour 0 by RIP**
- **idotser – generate time series output**
- **idescriptive – more descriptive titles**
- **icgmsplit – split metacode into several files**
- **maxfld – reserve memory for RIP (10-15)**
- **itrajcalc – 0, 1 ONLY when doing trajectory calculations *(use also namelist trajcalc)***
- **imakev5d – 0, 1 generate Vis5D data**
- **rip_root - override RIP_ROOT**
- **ncarg_root - output type: X11, cgm, pdf, ps**

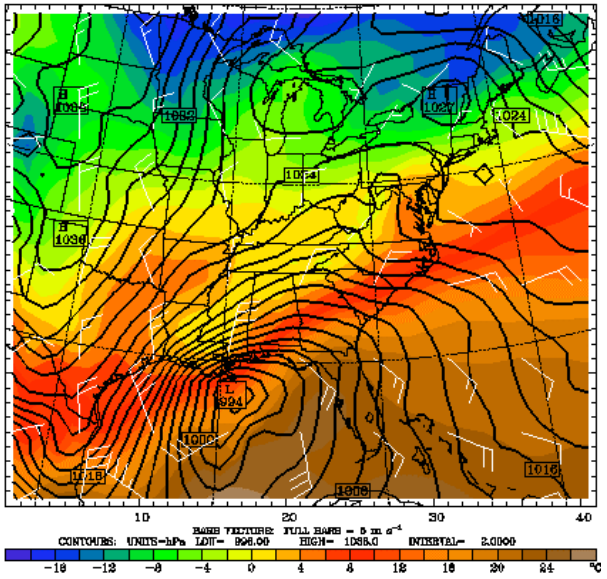


# Creating a Plot

**feld=**
- **diagnostics - *tmc***
- **native - *PSFC***

vcor=s; **levs=2fb**
vcor=s; **levs=1,2,3**
vcor=p; **levs=800,500**
vcor=p; **levs=800,-300,100**

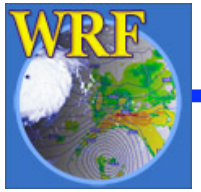
```
=============================================
feld=tmc; ptyp=hc; vcor=s; levs=1fb; >
   cint=2; cmth=fill; >
   cosq=32,light.violet,-16,blue, >
   0,yellow,16,orange,32,light.gray
feld=slp; ptyp=hc; cint=2; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=1; >
    colr=white;intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb
=============================================
```



# Common Error Message

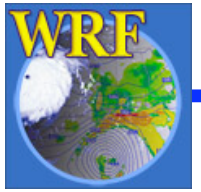
- **Most often this is NOT a graphics error.**
- **More often this is an error with the times you are asking RIP to process**
  - Check the ptimes in your .in file
  - Check the xtimes files created by RIPDP

**GKS ERROR NUMBER 2 ISSUED FROM SUBROUTINE GCLKS :--GKS NOT IN PROPER STATE: GKS SHALL BE IN STATE GKOPFORTRAN STOP**



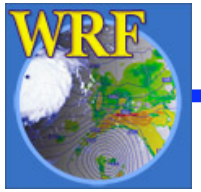
# ARWpost

- **Converter**
  - Requires GrADS / vis5d to display data.
- **GrADS software only needed to display data.**
- **If vis5d output is required, vis5sd libraries are needed to compile the code.**
- **Generate a number of graphical plots**
  - Horizontal, cross-section, skewT, meteogram, panel

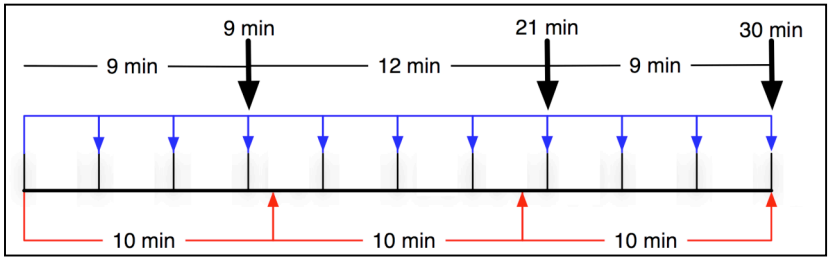


# General

- **Download Code** (http://www.mmm.ucar.edu/wrf/users)
- **OnLine Tutorial**
  http://www.mmm.ucar.edu/wrf/users/graphics/ARWpost/ARWpost.htm
- **MUST have WRF compiled *(similar to WPS)***
  *./configure & ./compile*
- **For GrADS output**
  - GrADS libraries only needed to display data *(freely available)*
  - http://grads.iges.org/grads/grads.html
- **For vis5d output**
  - vis5d libraries needed for compilation *(freely available)*
  - http://www.ssec.wisc.edu/~billh/vis5d.html

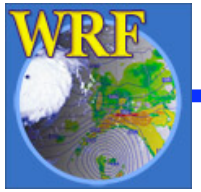


# namelist.ARWpost

| | |
|---|---|
| ***start_date***<br>***end_date*** | Start & end date<br>Format: *YYYY-MM-DD_HH:mm:ss* |
| ***interval_seconds*** | Seconds between times to process. *Code will skip times not required. Data can be in multiple files.* |
| ***tacc*** | If model output is not at regular intervals, use closest time within *tacc* seconds of time requested. *(150 sec)*<br>  |
| ***debug_level*** | Set high for extra information |

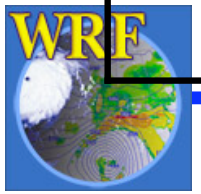
# namelist.ARWpost

| | |
|---|---|
| ***io_form_input*** | 2=netCDF, 5=GRIB1 |
| ***input_root_name*** | **Path** and **root** name of files to use as input.<br>*Do not only provide directory name.*<br>Can use wild characters. |
| ***output_root_name*** | Output root name.<br>output_root_name.**dat** &<br>output_root_name.**ctl**, OR<br>output_root_name.**v5d** |
| ***output_type*** | Options are 'grads' (*default*) or 'v5d' |
| ***mercator_defs*** | Set to true if mercator plots are distorted |

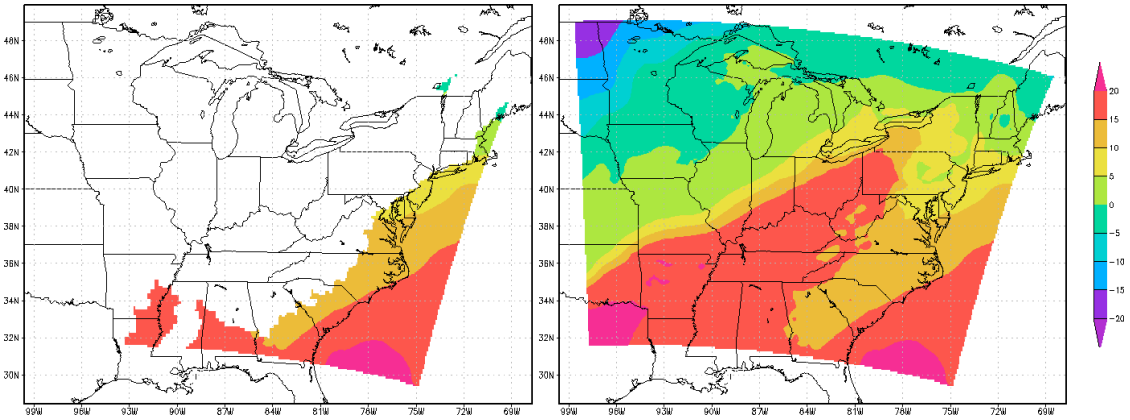


# namelist.ARWpost

| | |
|---|---|
| ***split_output*** | Split your GrADS output files into a number of smaller files *(a common .ctl file will be used for all .dat files).* |
| ***frames_per_outfile*** | If *split_output* is .**True**., how many time periods are required per output (.dat) file. |
| ***plot*** | Which fields to process. (*all, list, all_list)*<br>Order has no effect, i.e., "all_list" and "list_all"<br>"**list**" - list variables in "**fields**" |
| **fields** | Fields to plot. Only used is list was used in the "plot" variable. **Must use to generate diagnostics.** |
| ***Available diagnostics***: cape, cin, mcape, mcin, clfr, dbz, max_dbz, geopt, height, lcl, lfc, pressure, rh, rh2, theta ,tc, tk, td, td2, slp, umet, vmet, u10m, v10m, wdir, wspd, wd10, ws10 | |



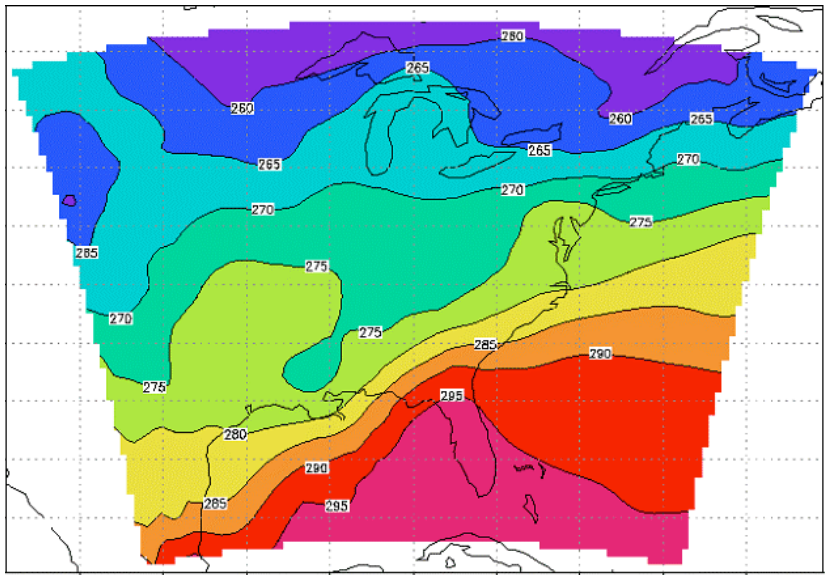
# namelist.ARWpost

| | |
|---|---|
| **interp_method** | 0 = sigma levels,<br>-1 = code defined "nice" height levels,<br>1 = user defined height or pressure levels |
| **interp_levels** | Only used if interp_method=1<br>Supply levels to interpolate to, in hPa (*pressure*) or km (*height above sea level*)<br>Supply levels bottom to top |
| ***extrapolate*** | Extrapolate below ground *(default .false.)*  |

# GrADS specific notes

- **To display images**
  - Requires GrADS software
  - Freely available from: http://grads.iges.org/grads/grads.html
  - Documentation: http://grads.iges.org/grads/gadoc/index.html

- **Projection**
  - Data is plotted on model projection

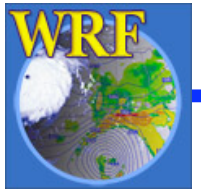


# GrADS - .ctl file

```
dset ^test.dat
options byteswapped
undef 1.e37
title  OUTPUT FROM WRF V2.2 MODEL
pdef  259 163 lcc  40.000  -98.000  130.000   82.000
      60.00000  30.00000  -98.00000  22000.000  22000.000
xdef  877 linear -141.49254   0.09909910
ydef  389 linear   18.88639   0.09909910
```

**options byteswapped**

*Needed on some machines - if you get NaNs when you plot,* ***remove*** *this line from .ctl file*



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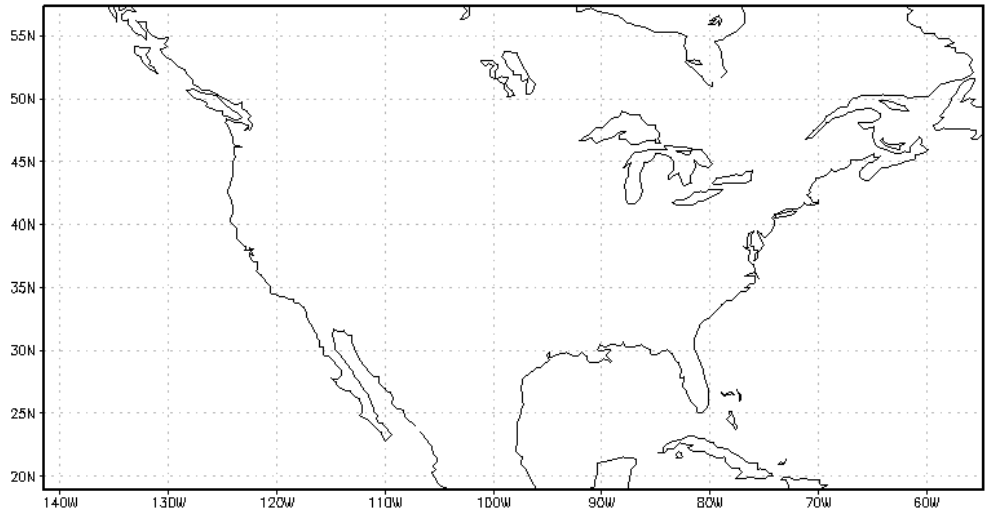
ydef  389 linear   18.88639   0.09909910
```



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ydef  389 linear   18.88639   0.09909910
```
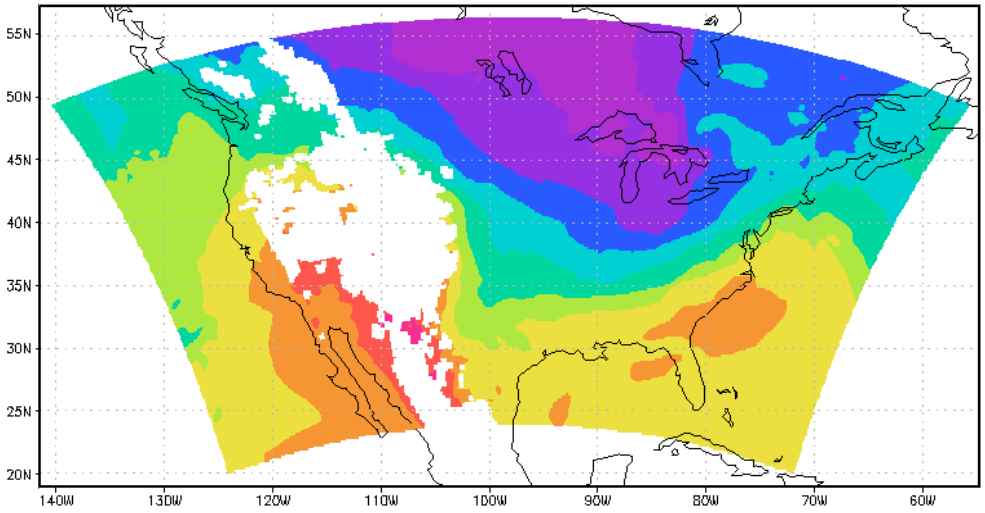
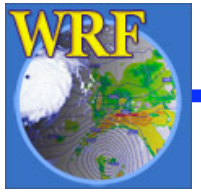



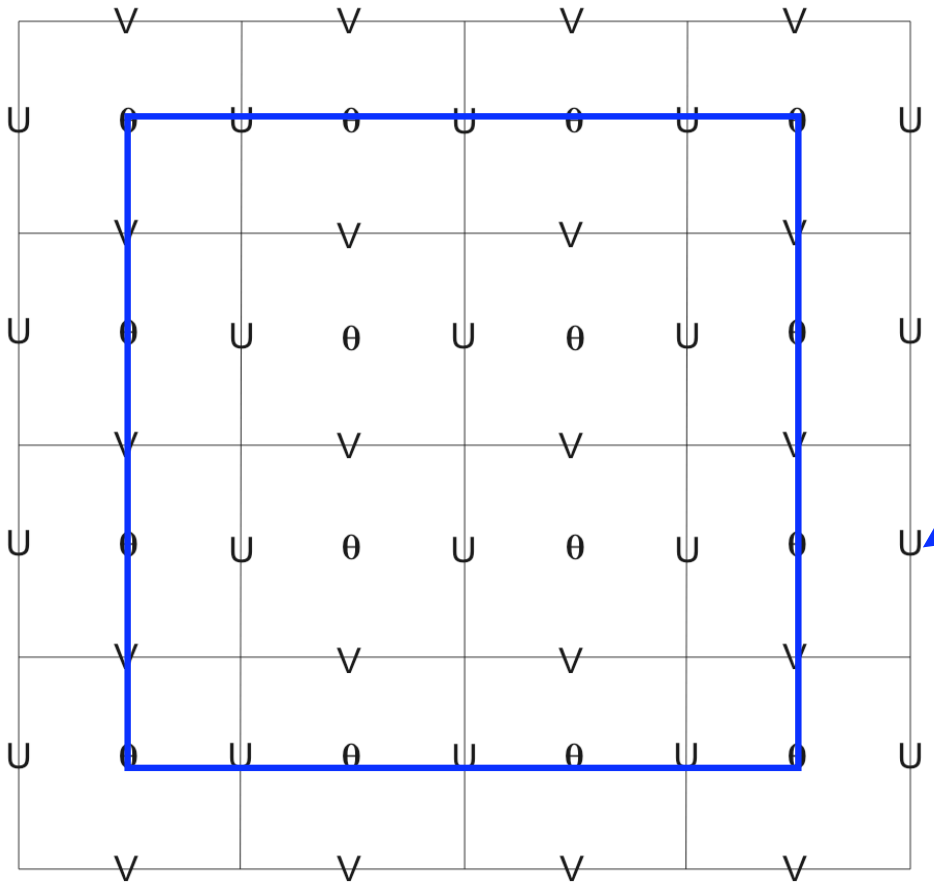
# GrADS conversion - question

- **Why is a converter needed if GrADS can display netCDF files?**
  - Can only display model surface coordinates
  - Cannot interpolate to height or pressure levels
  - All diagnostics must be added via GrADS script files
  - GRIB1 model output can also be read directly by GrADS, but above issues are still valid
  - For GRIB1, there is also a stagger problem



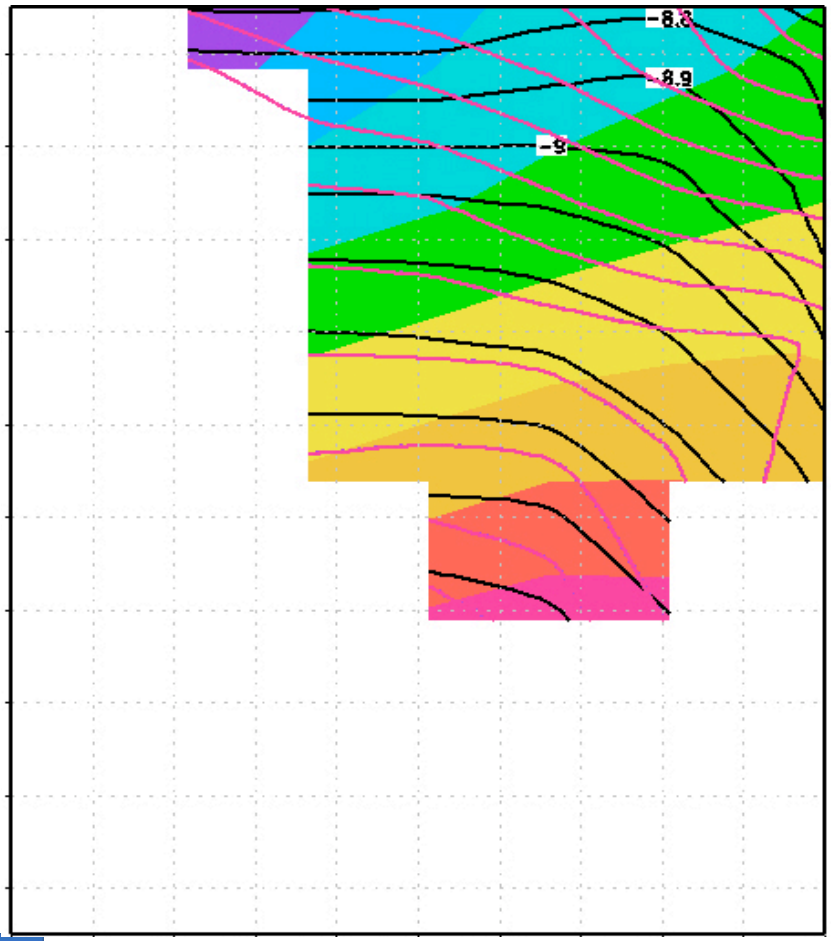
# GrADS conversion - question

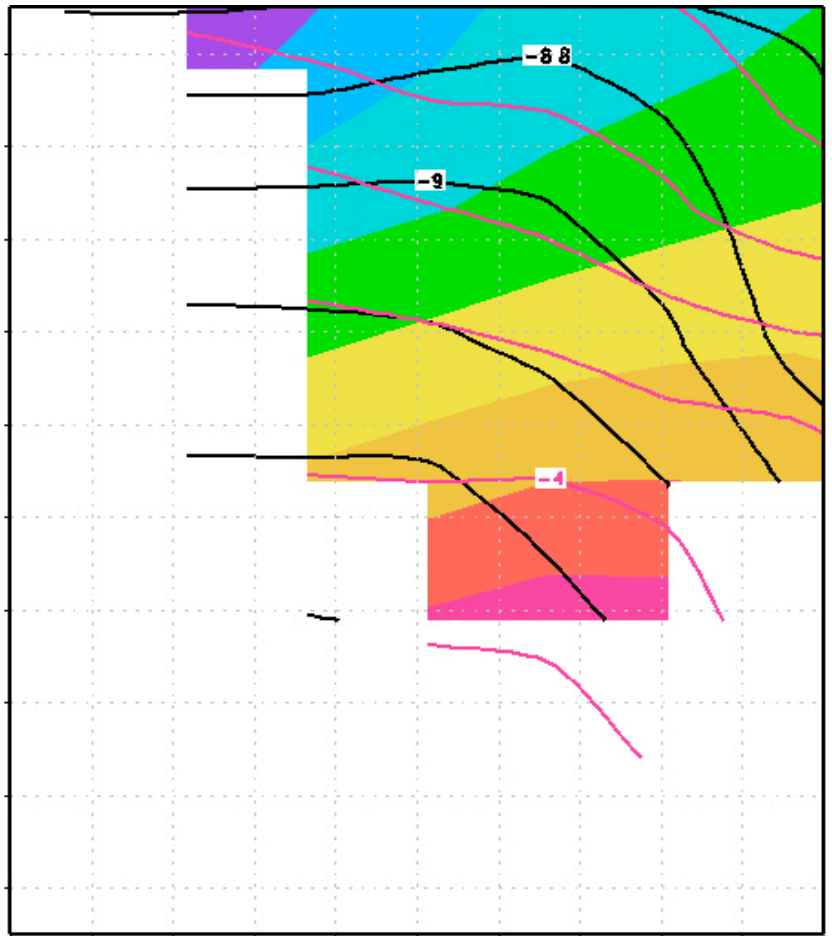
- **Why is a converter needed if GrADS can display netCDF files?**



# Staggering

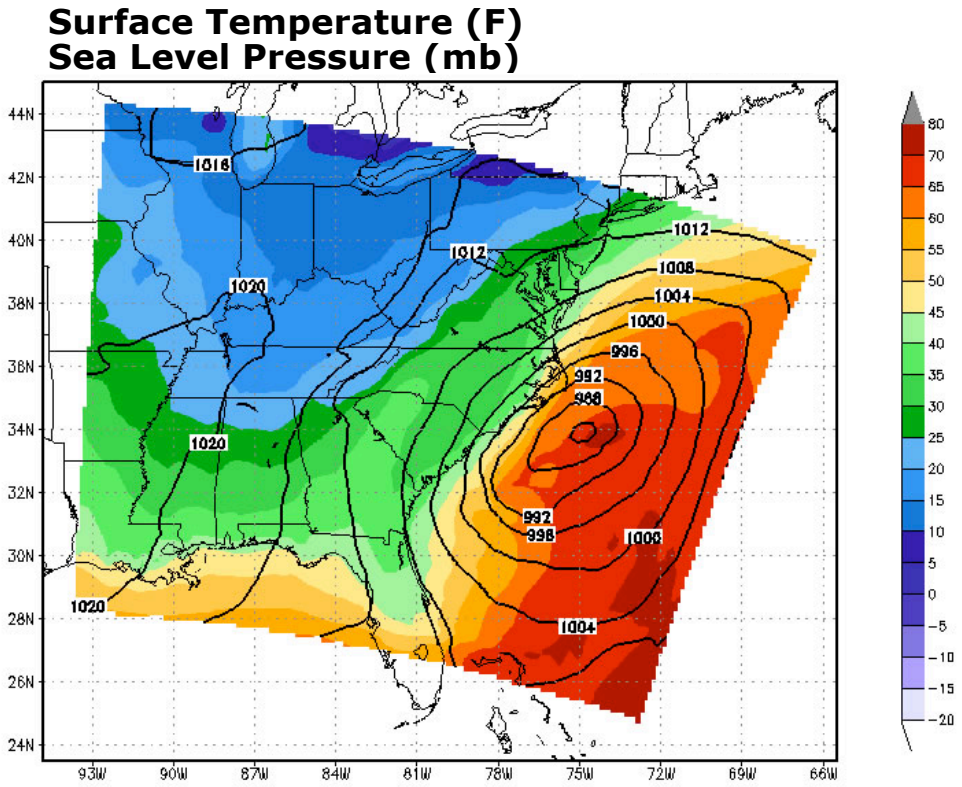
**shaded=T ; black=U ; red=V**



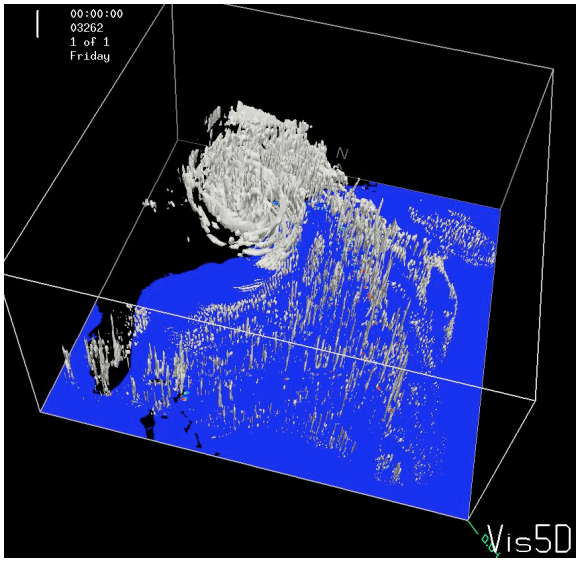
# Creating a Plot

```
open em_real.ctl
set mpdset hires
set display color white

define tf=1.8*tc + 32
set gxout shaded
set z 1
d tf
run cbar.gs

set gxout contour
set ccolor 1
set cint 4
d slvl
```

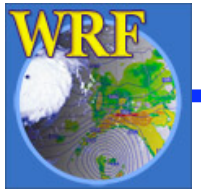


# vis5d specific notes

- **vis5d is a three-dimensional visualization software**
- **vis5d is free and can be downloaded from:**
  **http://www.ssec.wisc.edu/~billh/vis5d.html**
- **Run**
  *vis5d output_root_name.v5d*
- **Graphical Interface**




# Other Post-processing Tools

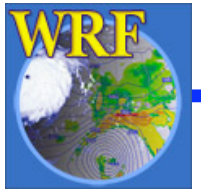


# VAPOR


Computational and Information Systems Laboratory
National Center for Atmospheric Research

## Visualization and Analysis Platform for Oceanic, atmospheric and solar Research

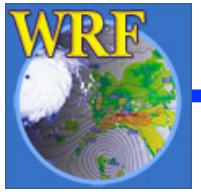
*Alan Norton*
*alan@ucar.edu*
*vapor@ucar.edu*
*National Center for Atmospheric Research*



# WRF in VAPOR


Computational and Information Systems Laboratory
National Center for Atmospheric Research

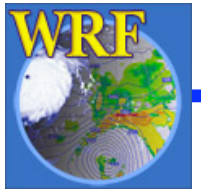
- **Interactive 3D visualization of WRF-ARW data *(wrfout files only)***
- **WRF functionality has been added in v1.2**
- **Available free on Linux, Windows, Mac**
- **Interactive rendering and animation (using GPU acceleration)**
- **Simple 2-step data conversion from WRF output to VAPOR**
  - wrfvdfcreate & wrf2vdf
- **Volume rendering**
- **Intuitive color/opacity editor**
- **Isosurface rendering**



# WRF in VAPOR

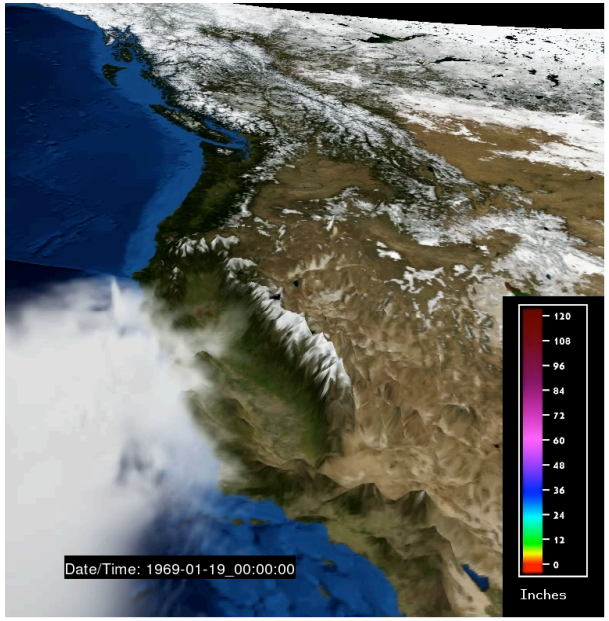

Computational and Information Systems Laboratory
National Center for Atmospheric Research

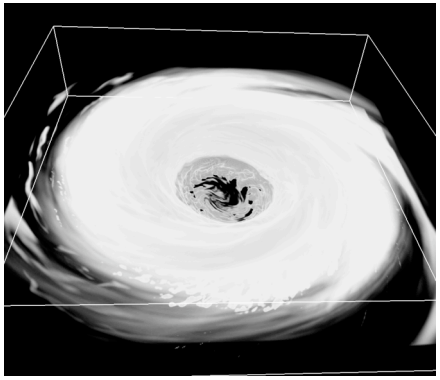
- **Steady and unsteady flow integration**
- **Interactive seed placement**
- **Data probing**
- **Contour plotting**
- **Terrain surface image render**
- **Interactive performance on terabyte datasets**
- **Downloads, documentation, examples at: http://www.vapor.ucar.edu**
- **http://www.vapor.ucar.edu/doc/WRFsupport.pdf**

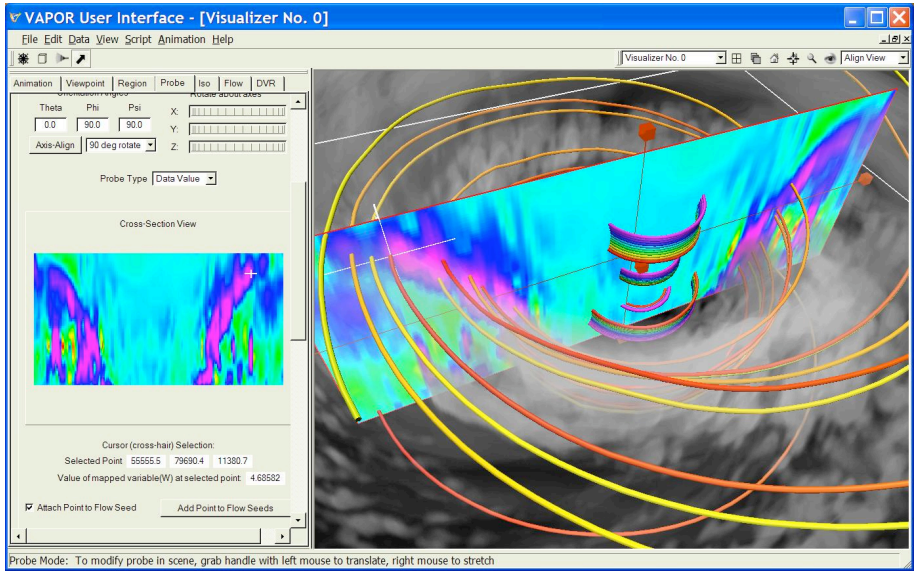


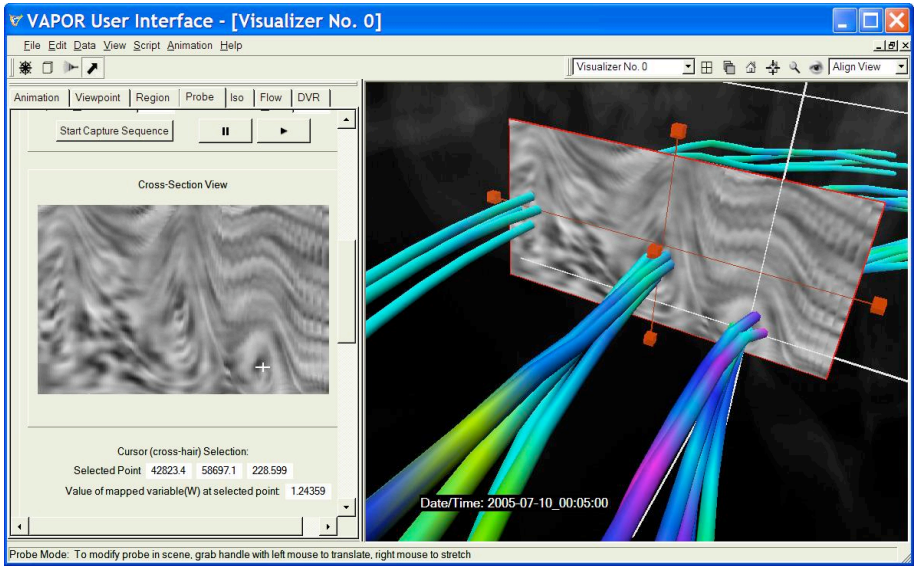
# WRF in VAPOR

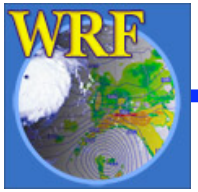

Computational and Information Systems Laboratory
National Center for Atmospheric Research





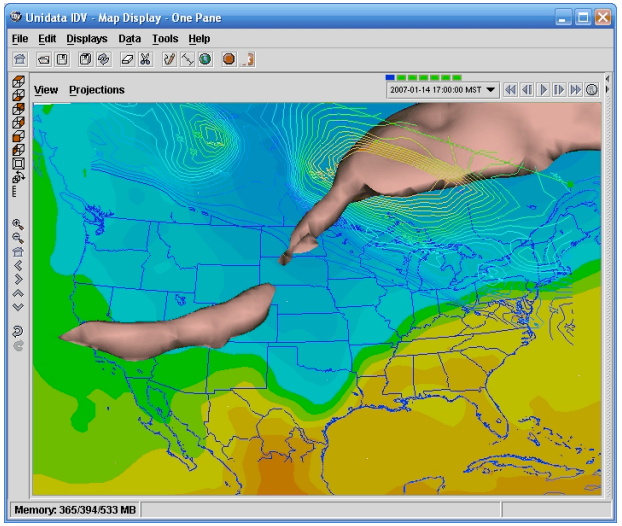
# IDV

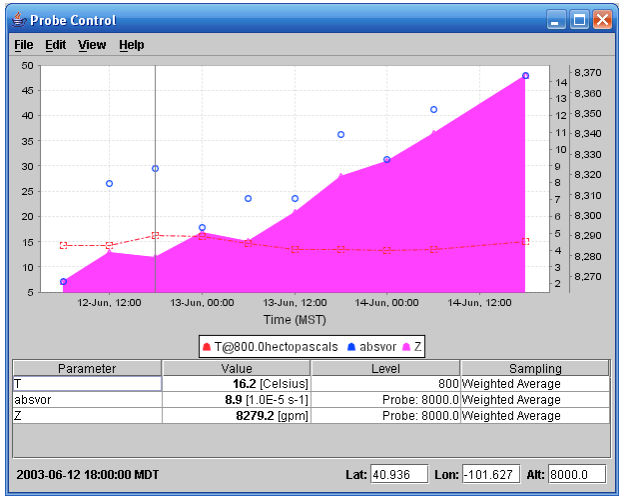
## Integrated Data Viewer

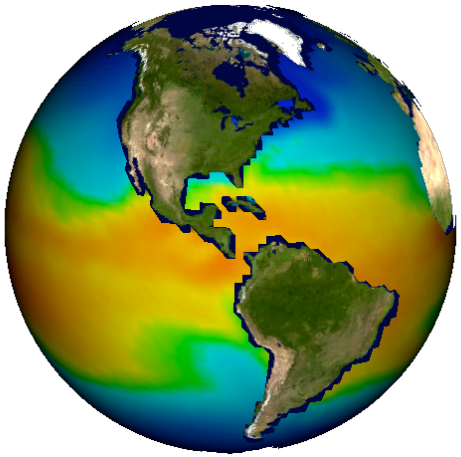
Don Murray and Jeff McWhirter
Unidata Program Center/UCAR

# What is the IDV?

- **Visualization and analysis tool for geoscience data developed and supported by Unidata**
- **Freely available Java™ framework and application**
- **Integrated 2D/3D displays of a wide range of data**
- **Built on VisAD library**

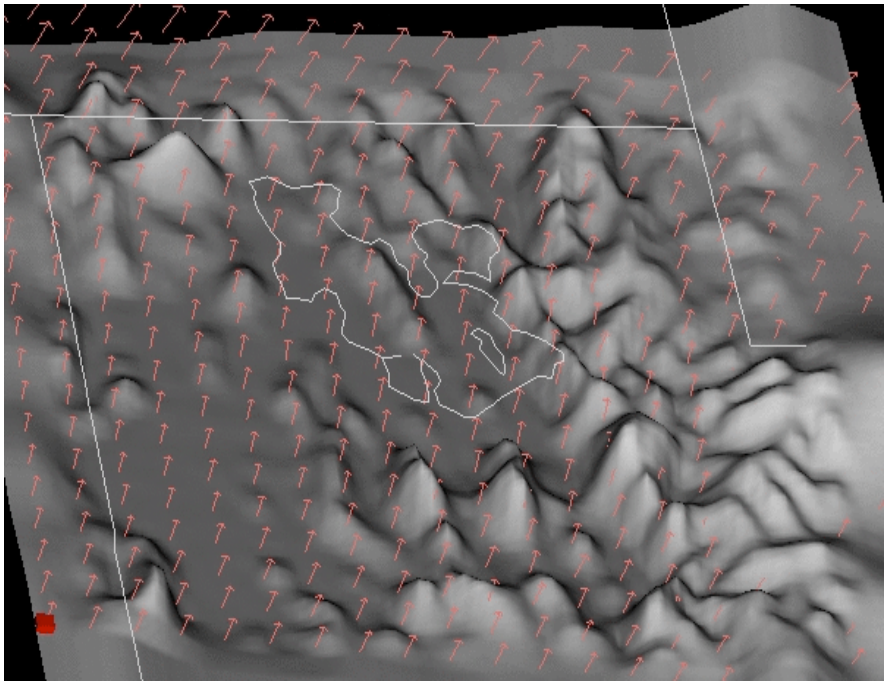


# IDV Strengths

- **Easy to download and install on any platform**
- **Remote and local access to datasets**
- **2D/3D visualization**
- **Bundle mechanism**
- **Support for multi-disciplinary datasets integrated from a variety of sources**
- **Flexible framework supports customization (GEON-IDV, field projects, McIDAS-V)**
- **Extensive documentation**
- **Community driven development**



Model simulation of wind, isentropic potential vorticity and low level moisture flow over the Great Salt Lake basin

# Supported Data Sources

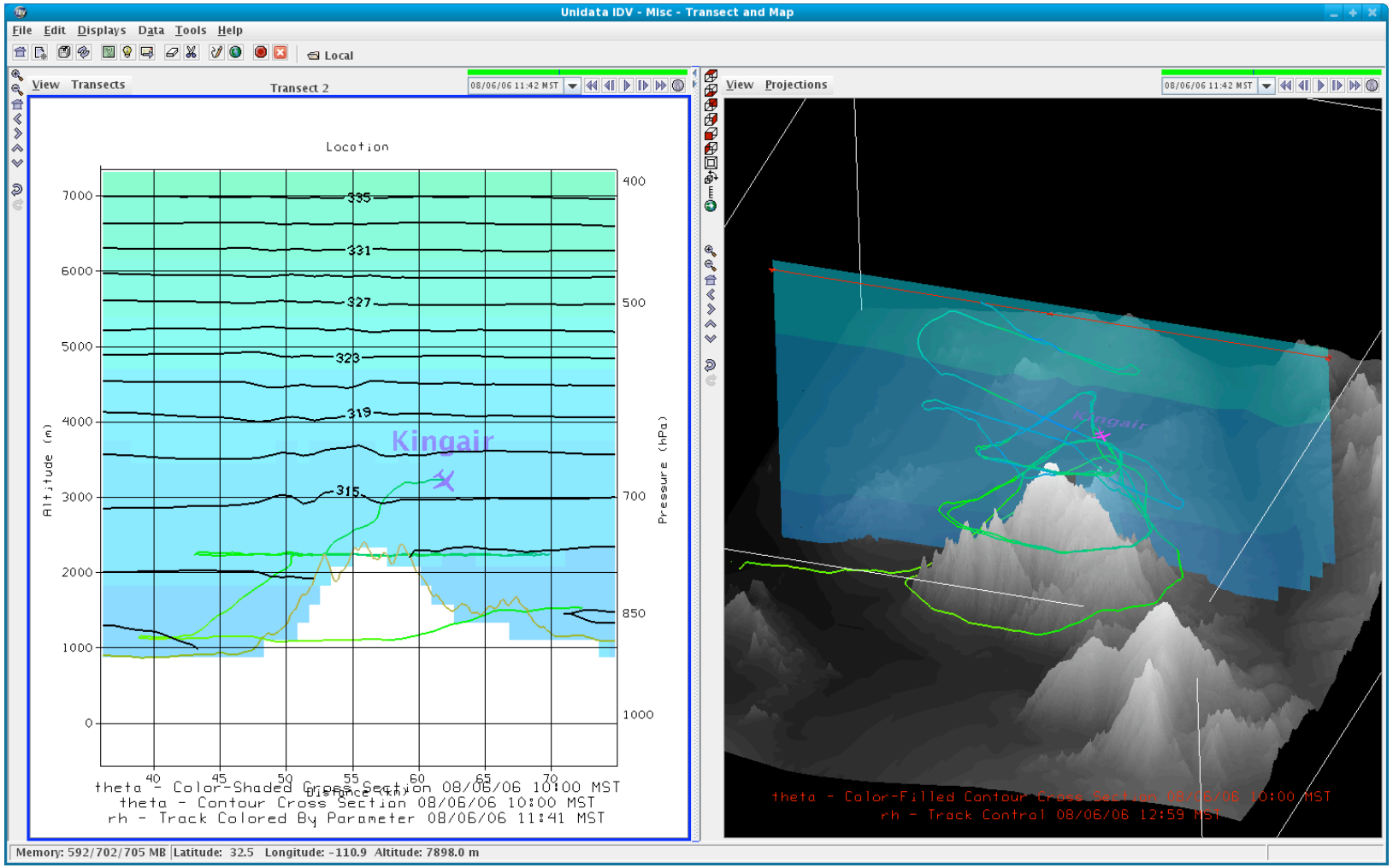
- **Data Types:**
  - Gridded model output
  - Satellite imagery
  - Radar data
  - Point observations
  - Balloon soundings
  - NOAA Profiler Network winds
  - Aircraft Tracks
  - Fronts
  - GIS data (WMS, shapefile)
  - Quick Time movies
  - Web Cams
- **Vertical Coordinates**
  - Pressure
  - Height/Depth
  - Other (2D only)
- **Sample of Supported Formats:**
  - netCDF
  - GRIB
  - Vis5D
  - KML
  - CSV
  - GEMPAK grid
  - ADDE
- **Access Methods:**
  - Local files
  - HTTP
  - ADDE, TDS and OPeNDAP servers
  - WMS

**ADDE** = Abstract Data Distribution Environment
**TDS (THREDDS) =** Thematic Realtime Environmental Distributed Data Services

# Commonly Used Displays

- **Contours**
- **Flow vectors**
- **Vertical Cross Sections**
- **Isosurfaces**
- **Volume Rendering**
- **Charts**
- **Data probes**
- **Non-lat/lon projections**
- **Multiple views (e.g.  Plan and cross section)**
- **Subsurface (mantle, ocean)**

# CuPIDO Obs with WRF Simulation




**Data source: Bart Geerts, U. Wyoming**

# For Further Information

- **Integrated Data Viewer homepage**
  - http://www.unidata.ucar.edu/software/idv
- **RAMADDA homepage**
  - http://www.unidata.ucar.edu/software/ramadda/
- **VisAD homepage**
  - http://www.ssec.wisc.edu/~billh/visad.html
- **All IDV questions/comments**
  - support-idv@unidata.ucar.edu