Post-processing Tools

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Graphical Packages

- **NCL**
  - Graphical package
- **ARWpost**
  - Converter (GrADS & vis5d)
- **RIP4**
  - Converter and interface to graphical package NCAR Graphics
- **WPP**
  - Converter (GrADS & GEMPAK)

MatLab / IDL

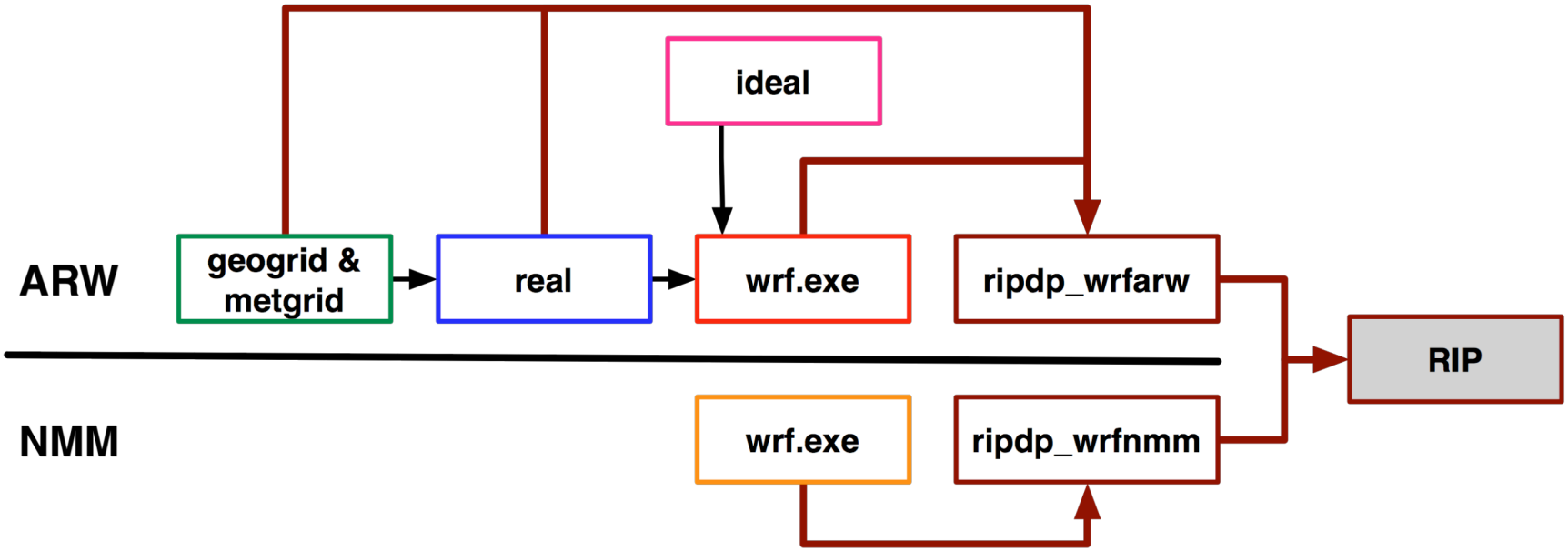
- **VAPOR**
  - Converter and graphical package
  - *Support: VAPOR*
- **IDV**
  - GRIB (from WPP)
  - GEMPAK (from wrf2gem)
  - vis5d (from ARWpost)
  - CF complaint data (from wrf_to_cf)
  - *Support: unidata*
- **GEMPAK**
  - Data from wrf2gem or WPP
  - *Support: unidata*

RIP4 *(WRF-ARW & WRF-NMM)*

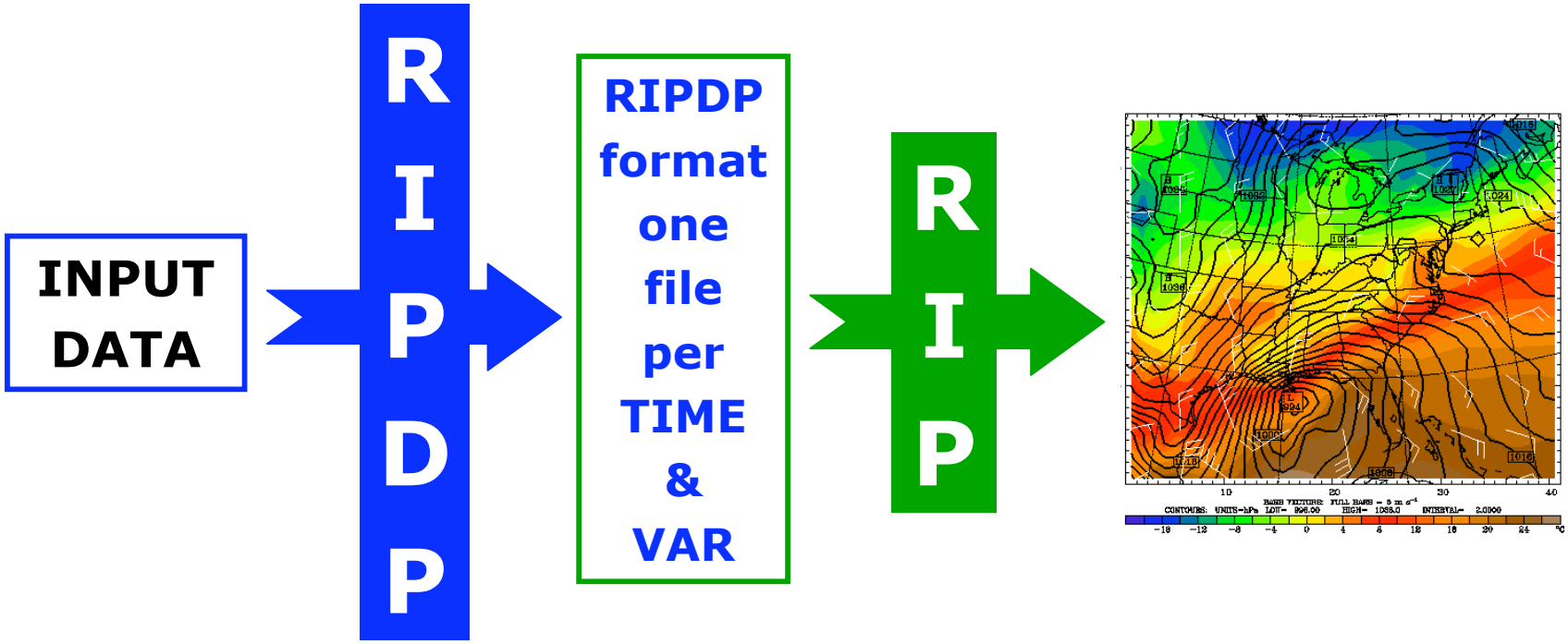
RIP4

- **Read Interpolate Plot version 4**
- **Develop by Mark Stoelinga (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*

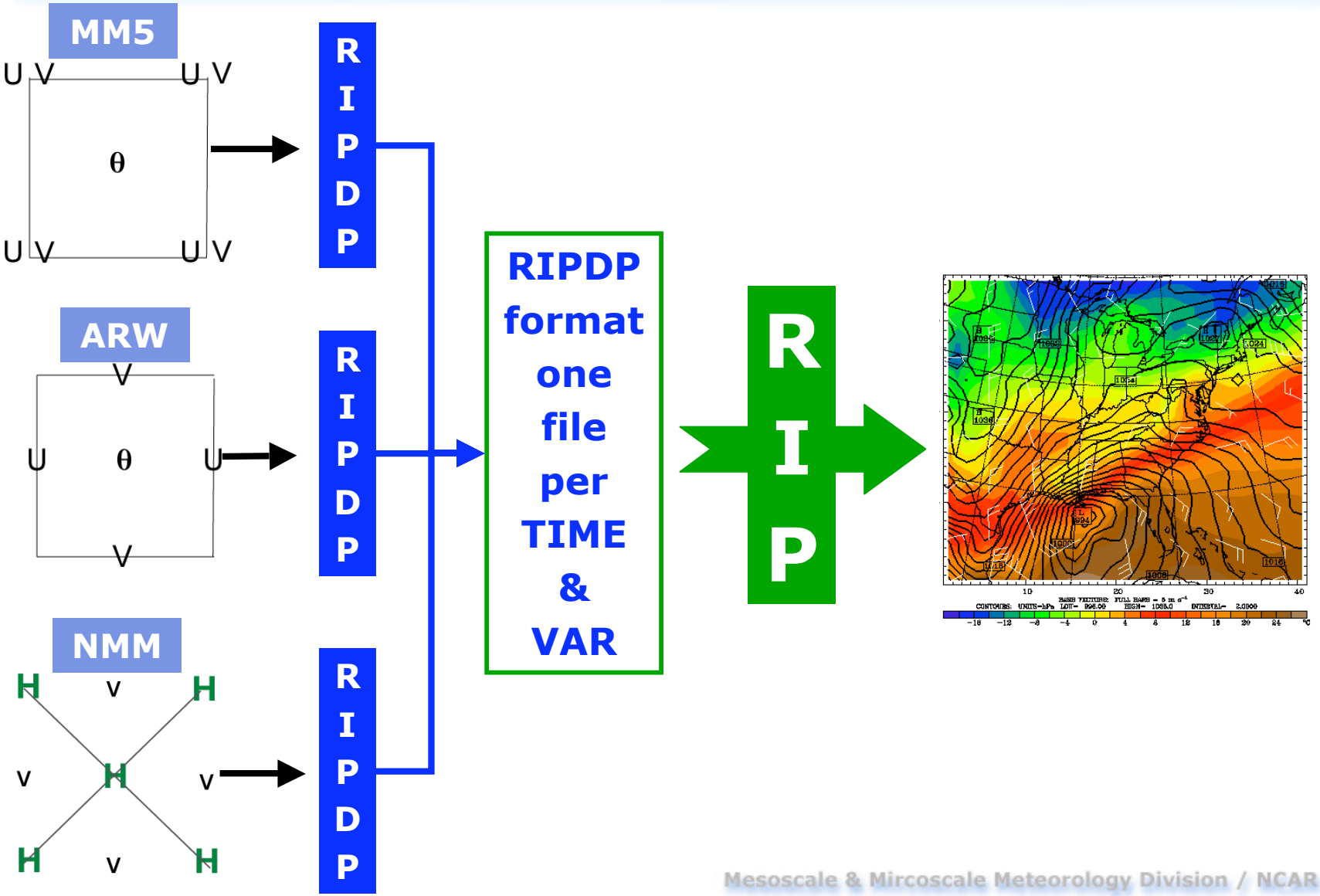
RIP4 Input Data



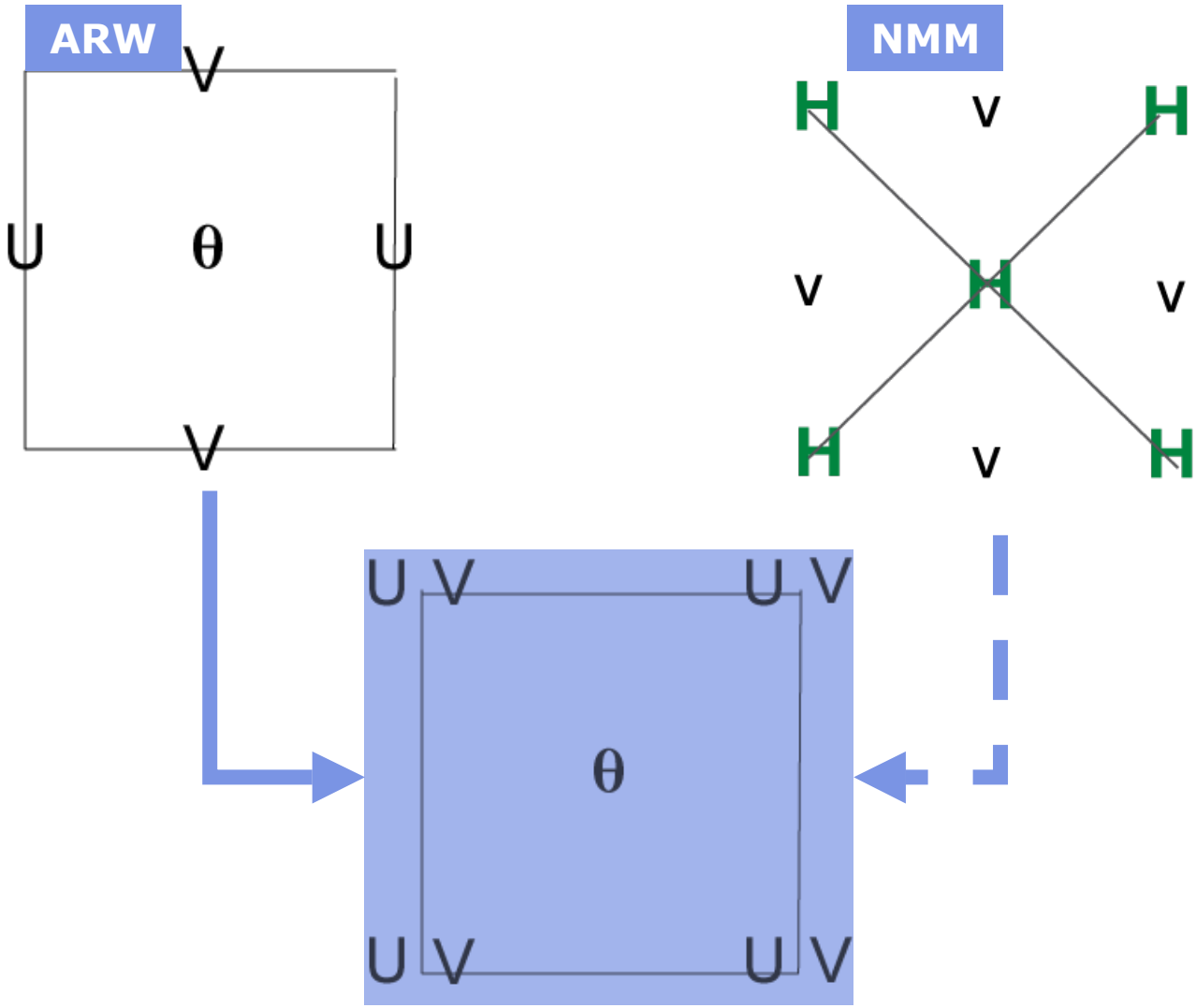
RIP4



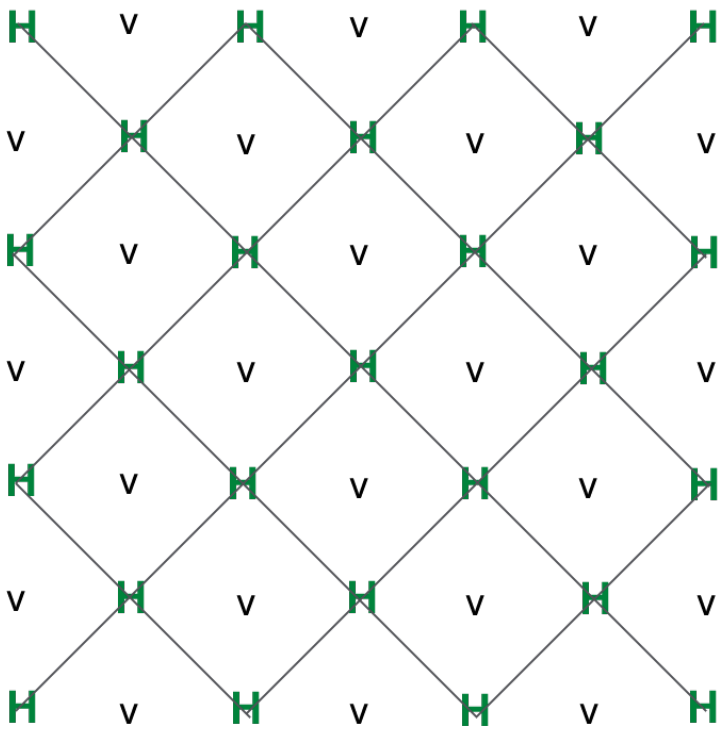
RIP4 - Grids

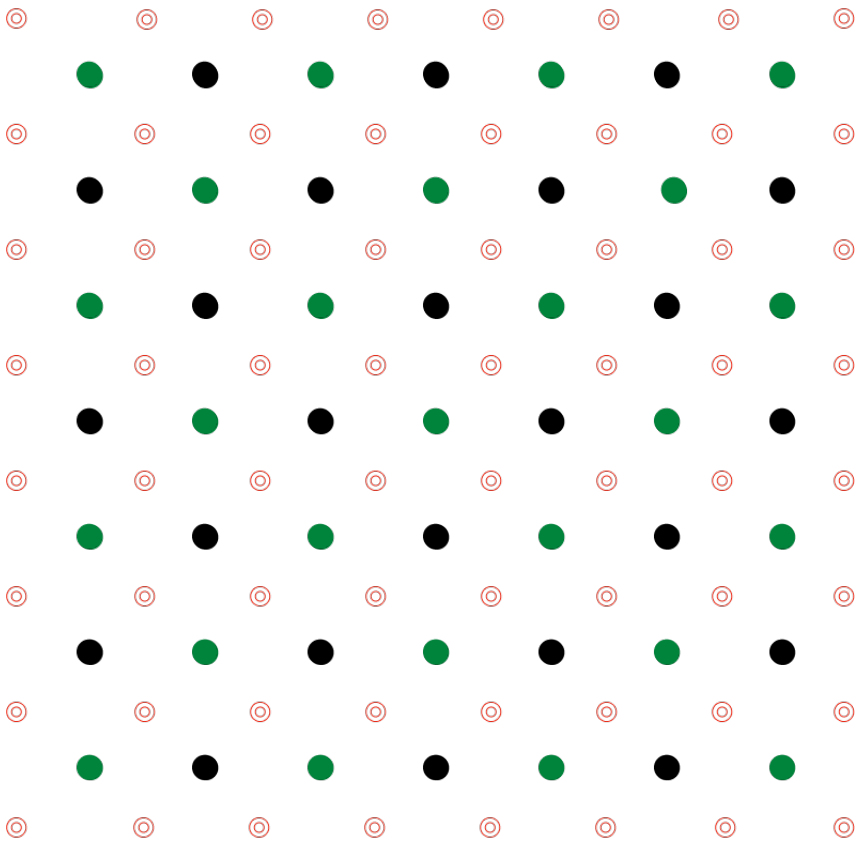

MM5
U V
U V
θ
U V
U V
ARW
V
U
θ
U
V
NMM
H
v
H
v
H
v
H
v
H
RIPDP
RIPDP
RIPDP
RIPDP format one file per TIME & VAR
RIP

RIP4 - WRF Grids

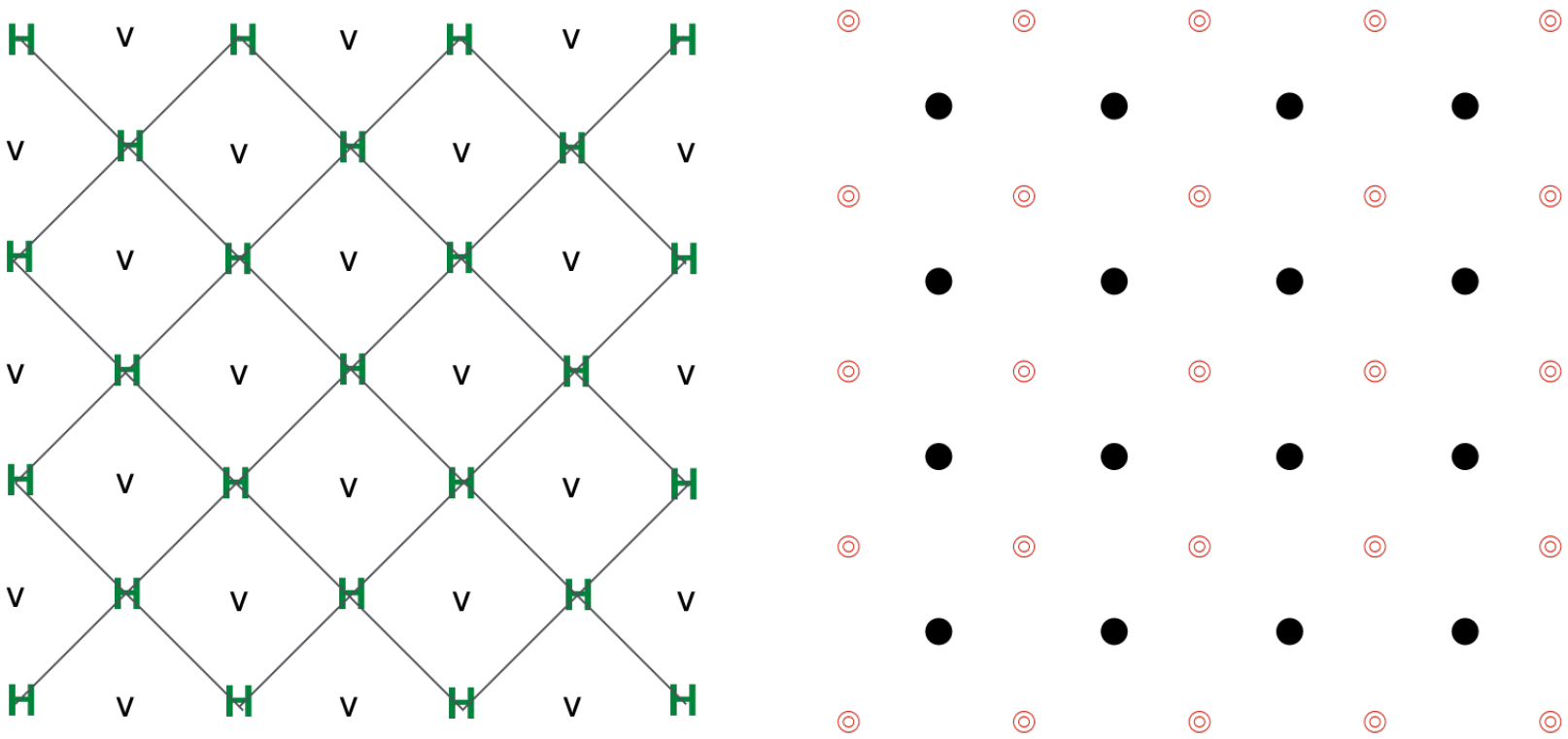


RIP4 - NMM Grid *(iinterp 0)*





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

- **ripdp_wrf*xxx***
  RIP Data Preparation for WRF (ARW / NMM)

- **RIPDP** converts different input file formats *(WRF - netCDF)* into RIP input format *(B - grid)*

- **RIPDP** puts each **Variable** at each **Time** into a separate file – **LOTS** of files

  → **mkdir RIPDP**

Running ripdp

Optional

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

Example

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

use directory as part of the model_data_name

ripdp namelist

- **Use namelist to add control**
  - **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*

    history_interval=10 ; time_step=180 (*3 min*)
    Output times **uneven** (29_00:00, 29_00:09,
    29_00:21, 29_00:30)

    history_ interval=12 ;time_step=180 *(3 min)*
    Output times **even** (29_00:00, 29_00:12,
    29_00:24, 29_00:36:00)

  - **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

rip

- **read the output generated by *ripdp***
- **read User Input File (UIF) *(rip_sample.in)***
  - **First** section is a list of general parameters *(namelist format)*
  - **Second** section is a series of plots in the Plot Specification Table (PST)
- **generate meta file**

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*

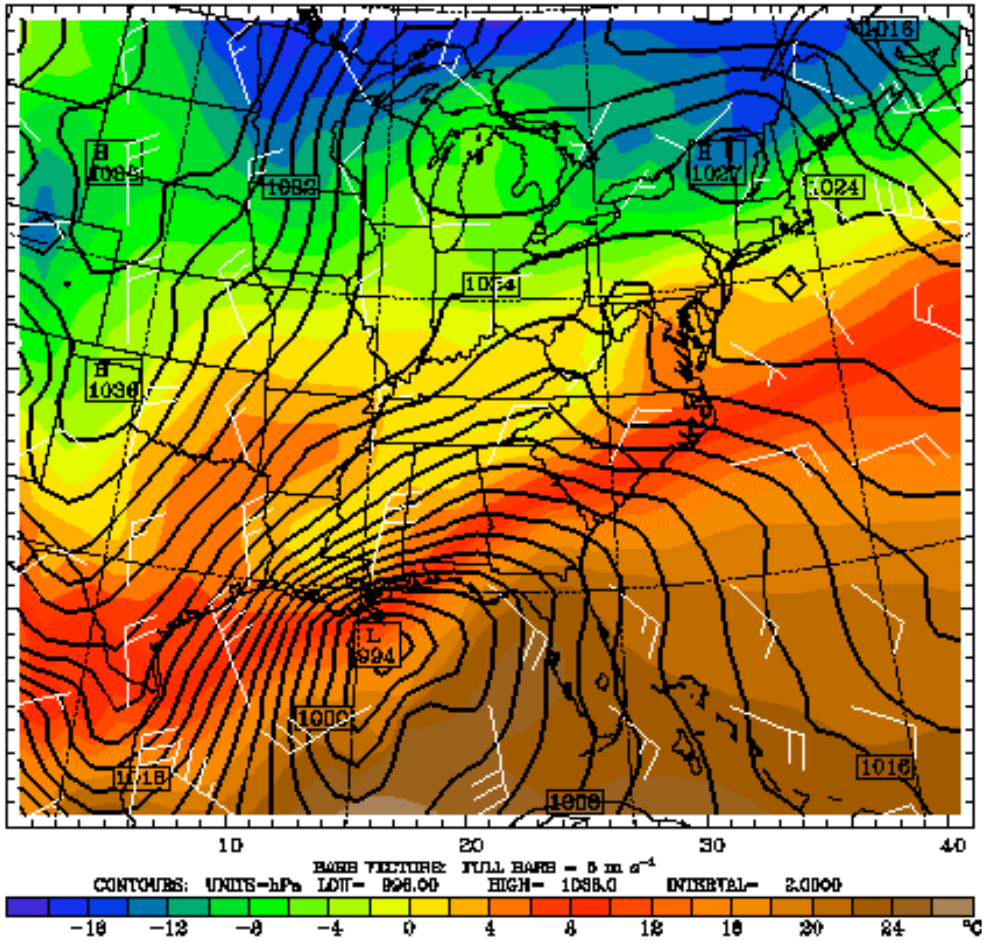
- idotitle – first part of first title line
- titlecolor – color of title lines
- ptimes, ptimeunits – times to process
- tacc – tolerance for processing data
- timezone –display of local time
- iusedaylightrule – 1 applied, 0 not applied
- iinittime – plotting of initial time
- ivalidtime – plotting 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 of the MM5 forecast is considered hour 0 by you
- 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

Temperature @ lowest sigma level
Sea Level Pressure
Winds @ lowest sigma level



Creating a Plot

```
&userin
   ……
&end
&trajcalc
   …….
&end
=============================================
----      Plot Specification Table       ----
=============================================
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
=============================================
```

feld=
diagnostics - tmc
native - PSFC

levs=2fb
levs=1,2,3
levs=800,500
levs=800,-300,100

Summary: How to run RIP4?

- **configure / compile**
- **Run ripdp_wrf*xxx***
  Create a new directory for the output
- **Set environment variables**
  setenv NCARG_ROOT /usr/local/ncarg *(/usr/local/ncl)*
  setenv RIP_ROOT *your-rip-directory* *(or in namelist)*
- **Edit the User Input File (UIF)**
- **Run rip**

ARWpost *(WRF-ARW)*

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

General

- **MUST have WRF compiled *(similar to WPS)***

- **For GrADS output**
  - GrADS libraries only needed to display data
  - ***http://grads.iges.org/grads/grads.html***
  - GrADS libraries are free

- **For vis5d output**
  - vis5d libraries needed for compilation
  - ***http://www.ssec.wisc.edu/~billh/vis5d.html***
  - vis5d libraries are free

Configure & Compile

./configure

Make sure this is correct. If not, set environment variable NETCDF

```
Will use NETCDF in dir: /usr/local/netcdf-pgi
-----------------------------------------------
Please select from among the following supported
platforms.
1. PC Linux i486 i586 i686, PGI compiler
   (no vis5d)
2. PC Linux i486 i586 i686, PGI compiler
   (vis5d)
3. PC Linux i486 i586 i686, Intel compiler
   (no vis5d)
4. PC Linux i486 i586 i686, Intel compiler
   (vis5d)

Enter selection [1-4] :
```

Configure & Compile

- **configure.arwp,** will be created
- If your WRF code is not compiled under **../WRFV3,** edit **configure.arwp,** and set **"WRF_DIR"** to the correct location of your WRFV3 code
- **./compile**
  - This will create **ARWpost.exe**

namelist.ARWpost

&datetime	
start_date ***end_date***	Start & end date 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 next time if within *tacc* seconds of time requested. *2008-04-10_12:00:00* *2008-04-10_13:00:10* *tacc=10*
debug_level	Set high for extra information

namelist.ARWpost

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

namelist.ARWpost

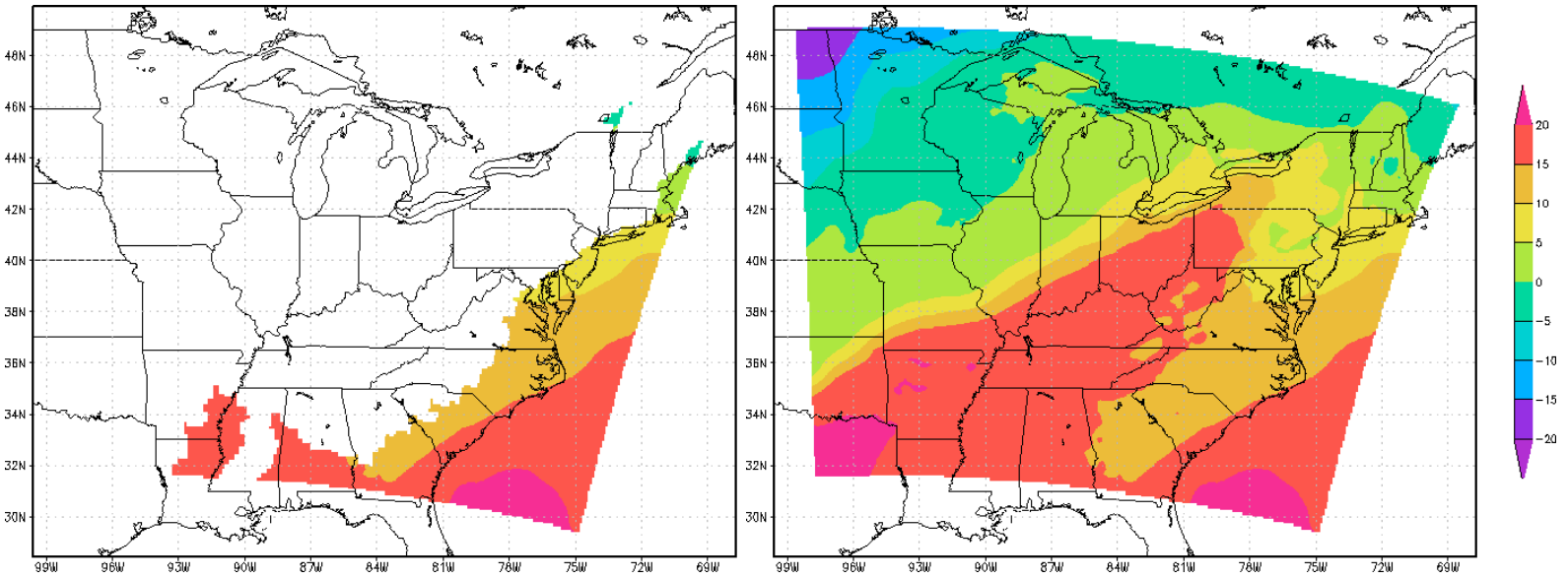
&io	
split_output	Split your GrADS output files into a number of smaller files *(a common .ctl file will be used for all .dat files).*
frames_per_outfile	If *split_output* is **.True.**, how many time periods are required per output (.dat) file.
plot	Which fields to process. *all, list, all_list* Order has no effect, i.e., "all_list" and "list_all" are similar. "**list**" - list variables in "**fields**"
fields	Fields to plot. Only used is list was used in the "plot" variable.
***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	
interp_method	0 = sigma levels, -1 = code defined "nice" height levels, 1 = user defined height or pressure levels
interp_levels	Only used if interp_method=1 Supply levels to interpolate to, in hPa (*pressure*) or km (*height above sea level*) Supply levels bottom to top
extrapolate	Extrapolate below ground *(default .false.)* New since April 2009

April 2009 Release

- **ARWpost**
  - This now has an “extrapolate” option
  - This will extrapolate below ground



Run

- **./ARWpost.exe**
- **Will create either,**

***output_root_name*.dat & *output_root_name*.ctl**

OR

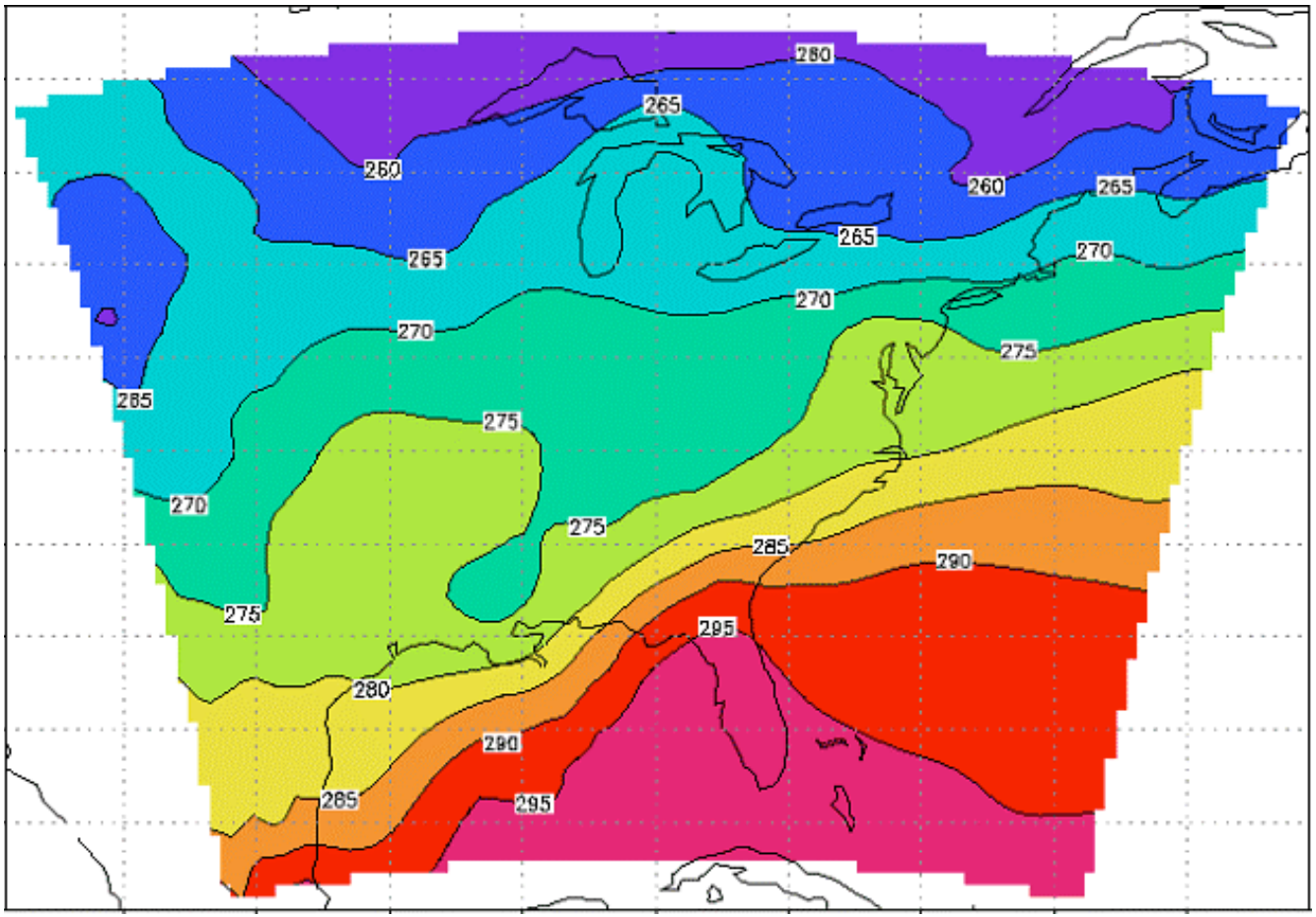
***output_root_name*.v5d**

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

GrADS - projections



GrADS - .ctl file

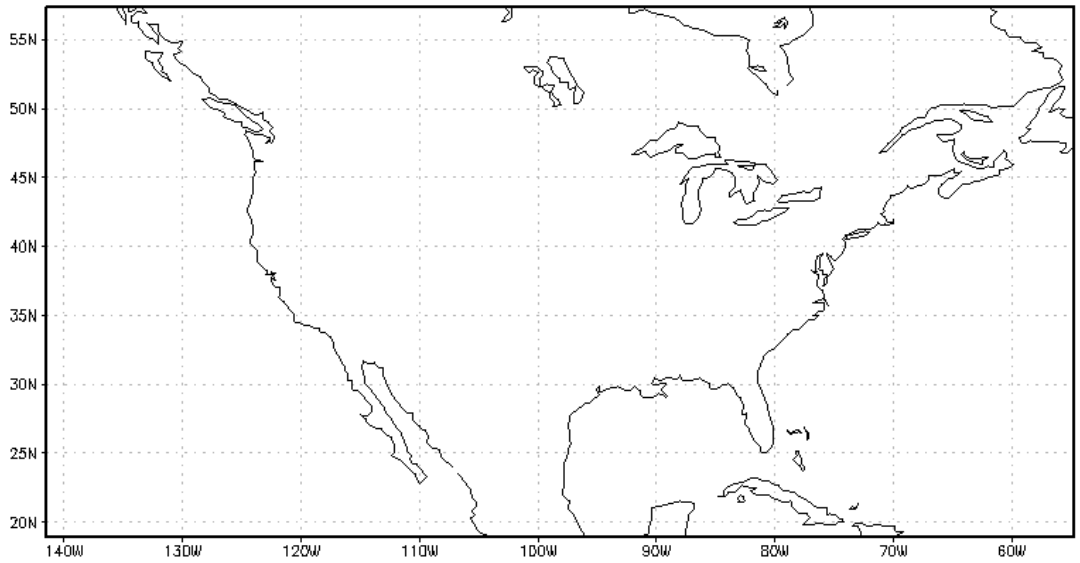
```
dset ^test.dat
options byteswapped
undef 1.e37
title  OUTPUT FROM WRF V2.2 MODEL
pdef  259 163 lcc  40.000  -98.000  130.000   82.000
      60.00000  30.00000  -98.00000  22000.000  22000.000
xdef  877 linear -141.49254   0.09909910
ydef  389 linear   18.88639   0.09909910
```

options byteswapped

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

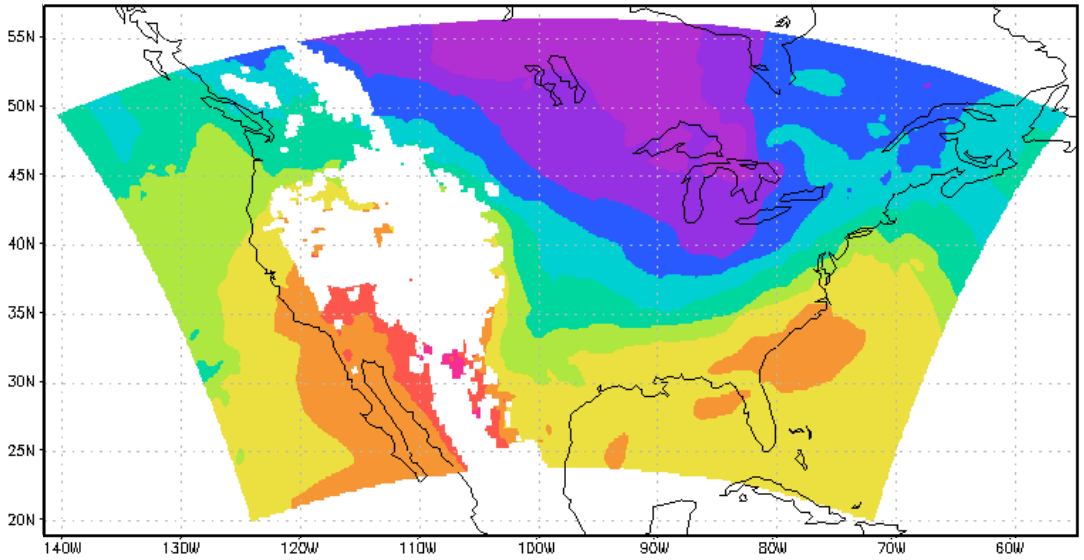
GrADS - .ctl file

```
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
```



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

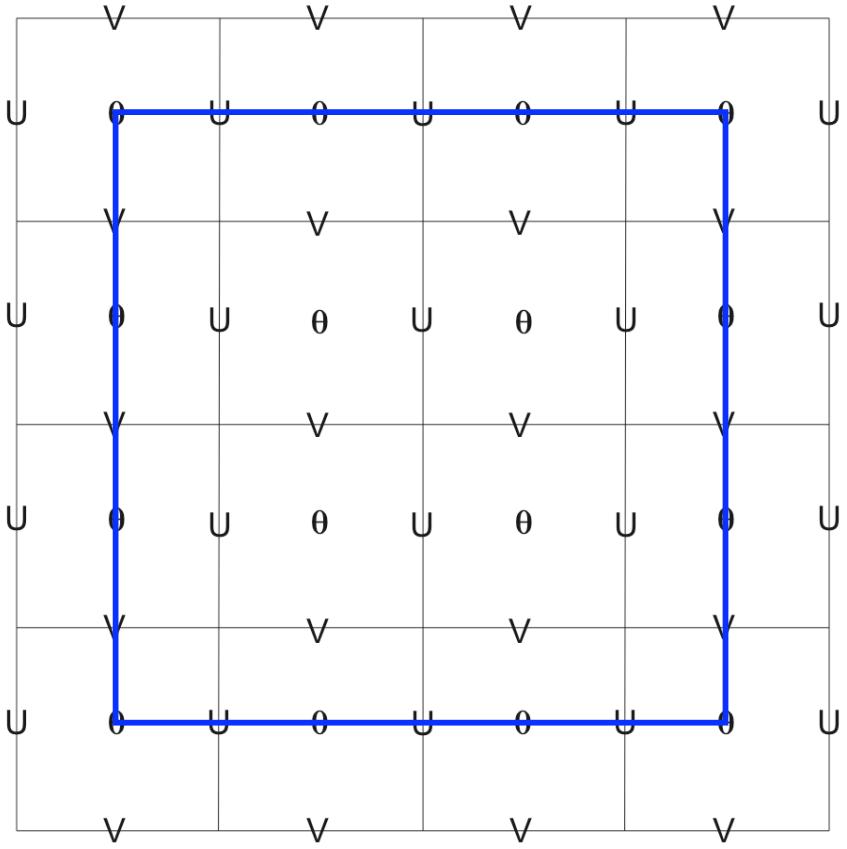


GrADS conversion - question

- **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

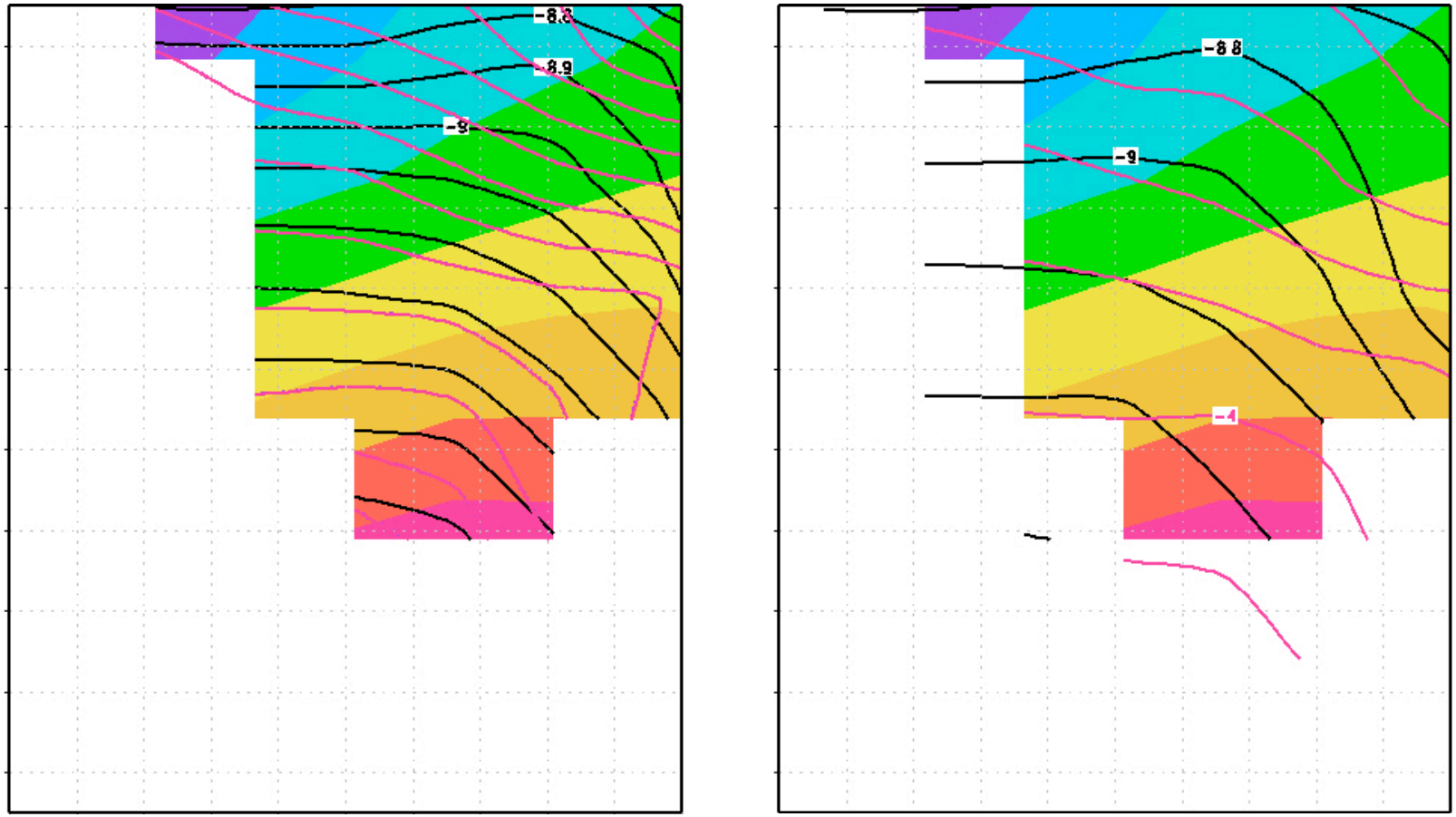
- **Why is a converter needed if GrADS can display netCDF files?**



WRF staggered grid

Staggering

shaded=T ; black=U ; red=V

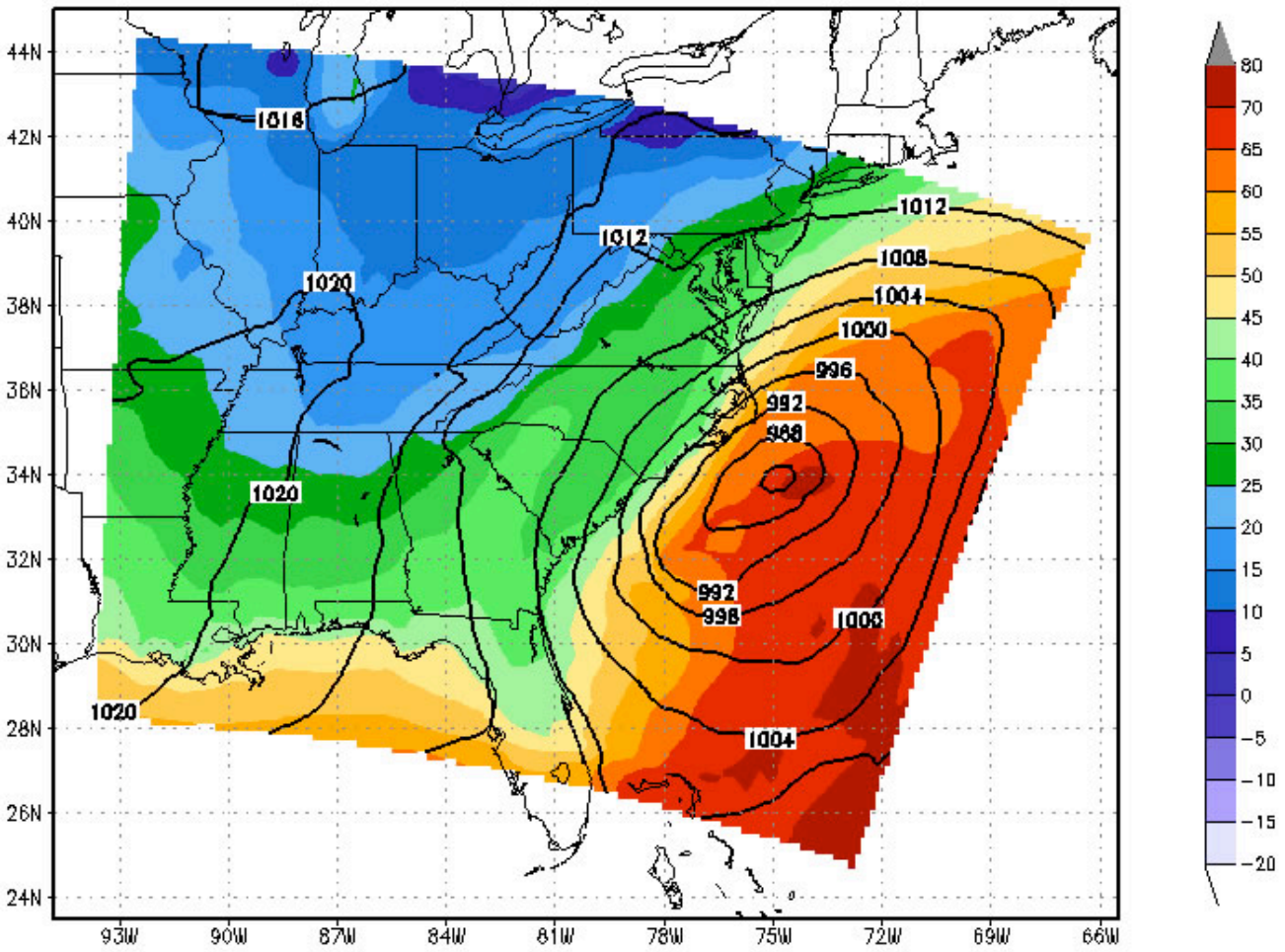


Staggering

- **Since GrADS version 1.9**
  - a new **gradsnc** interface is available *created by GrADS developers for WRF*
- **To USE**
  - must create 4 .ctl files (M ; U ; V ; W)
  - must open the all at once
- **Utility**
  - ARWpost/util/WRFnc2ctl.f

Creating a Plot

Surface Temperature (F)
Sea Level Pressure (mb)



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
```

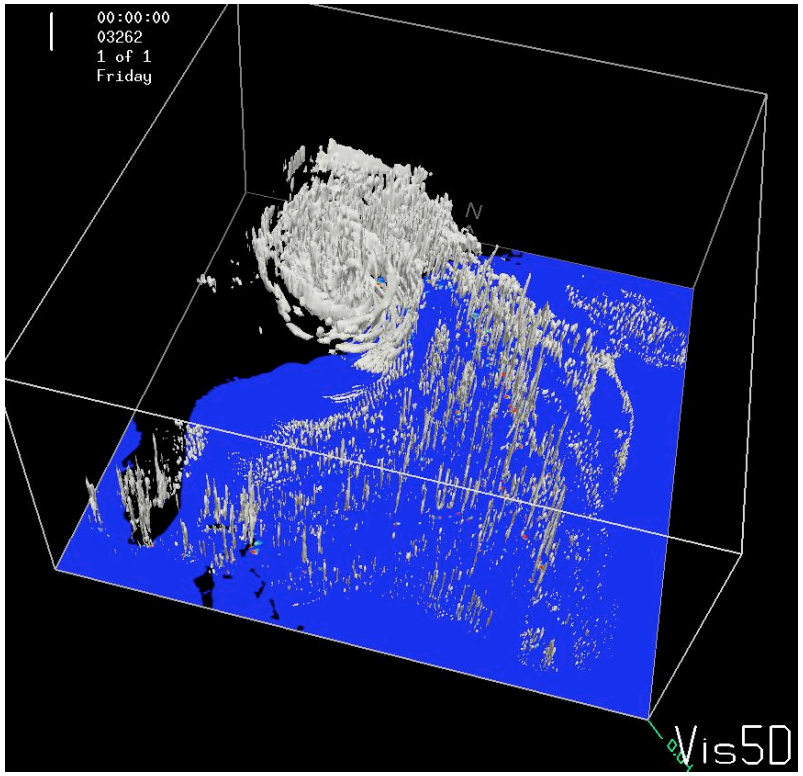
vis5d specific notes

- **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**

vis5d graphical interface



Other Post-processing Tools

VAPOR

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

- **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**

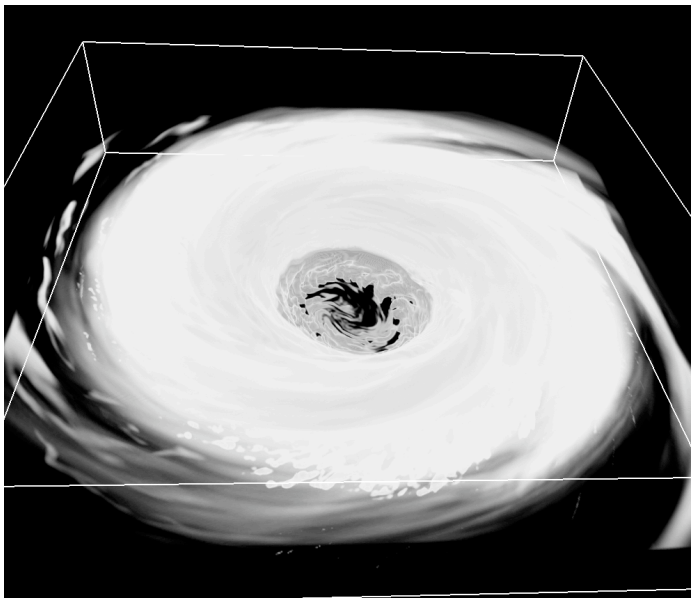
WRF in VAPOR

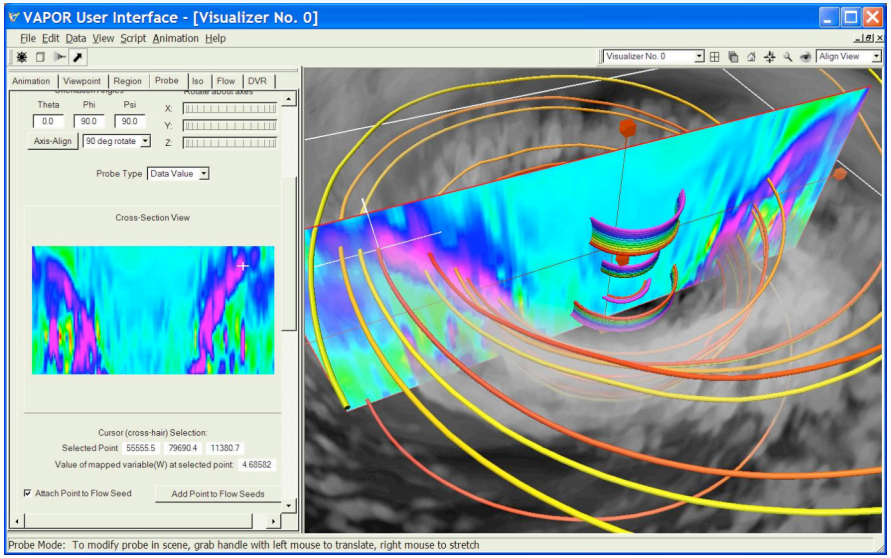
- Steady and unsteady flow integration
- Interactive seed placement
- Data probing
- Contour plotting
- Terrain surface image render
- Interactive performance on terabyte datasets

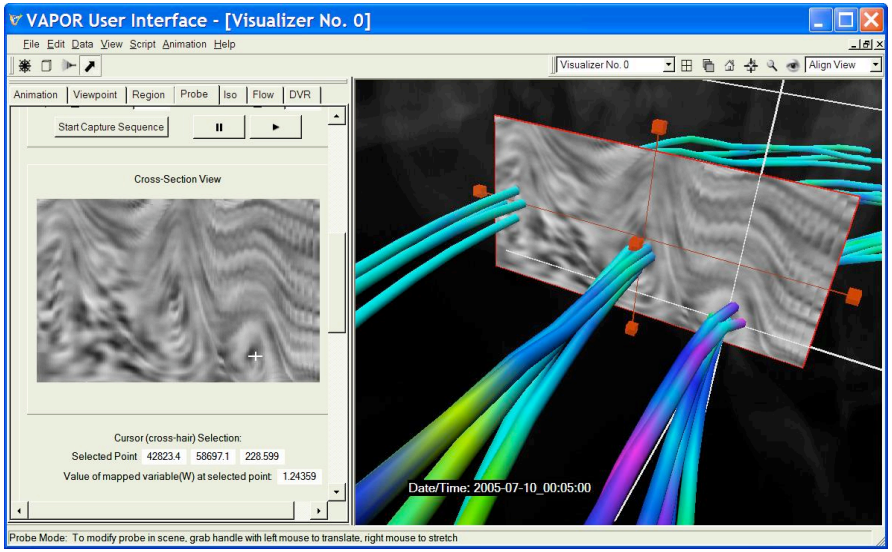
- Downloads, documentation, examples at: http://www.vapor.ucar.edu

- http://www.vapor.ucar.edu/doc/WRFsupport.pdf

WRF in VAPOR




VAPOR User Interface - [Visualizer No. 0]
File Edit Data View Script Animation Help
Animation Viewpoint Region Probe Iso Flow DVR
Theta Phi Psi
Axis-Align
Probe Type Data Value
Cross-Section View
Cursor (cross-hair) Selection:
Selected Point
Value of mapped variable(W) at selected point
Attach Point to Flow Seed
Add Point to Flow Seeds
Probe Mode: To modify probe in scene, grab handle with left mouse to translate, right mouse to stretch


VAPOR User Interface - [Visualizer No. 0]
File Edit Data View Script Animation Help
Animation Viewpoint Region Probe Iso Flow DVR
Start Capture Sequence
Cross-Section View
Cursor (cross-hair) Selection:
Selected Point 42823.4 58697.1 228.599
Value of mapped variable(W) at selected point 1.24359
Date/Time: 2005-07-10_00:05:00
Probe Mode: To modify probe in scene, grab handle with left mouse to translate, right mouse to stretch

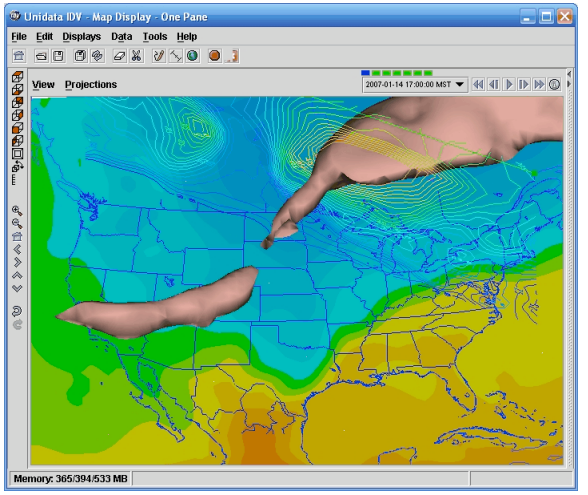
IDV

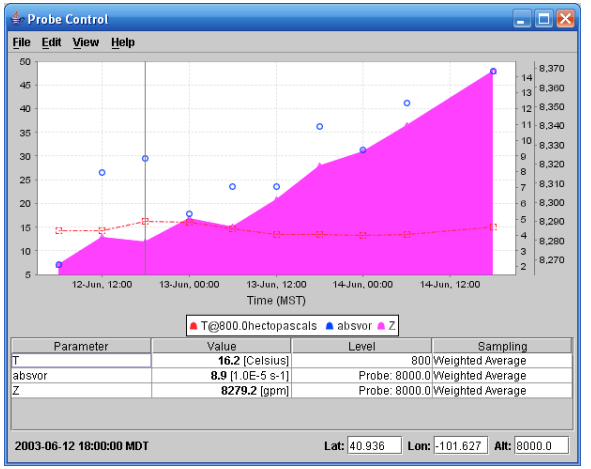
Integrated Data Viewer

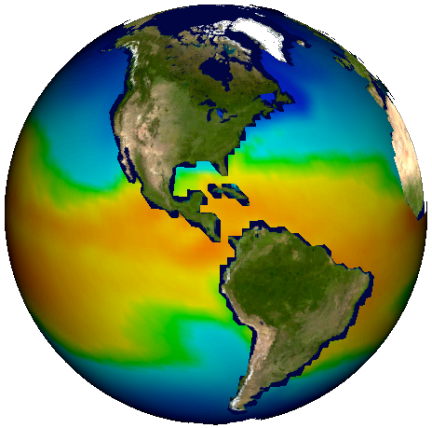
Don Murray and Jeff McWhirter
Unidata Program Center/UCAR

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**

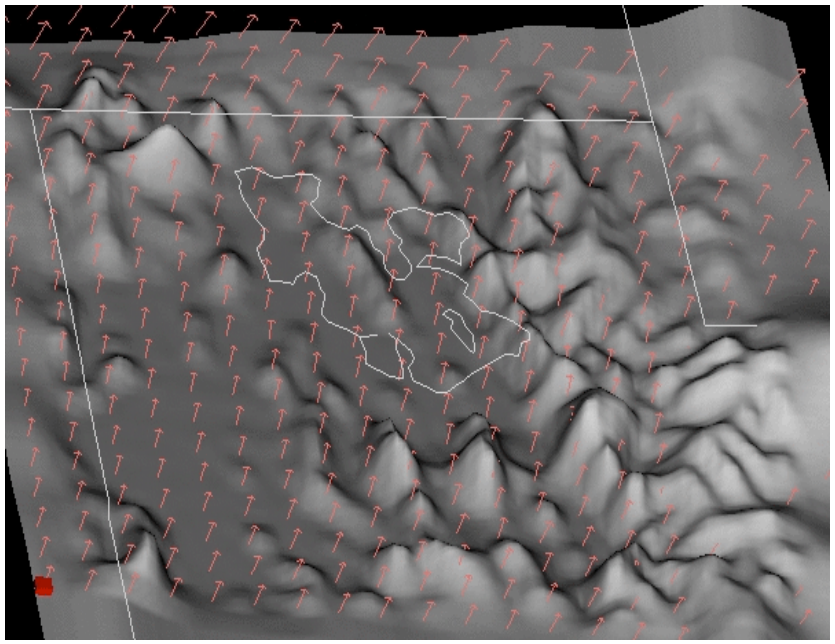






IDV Strengths

- 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

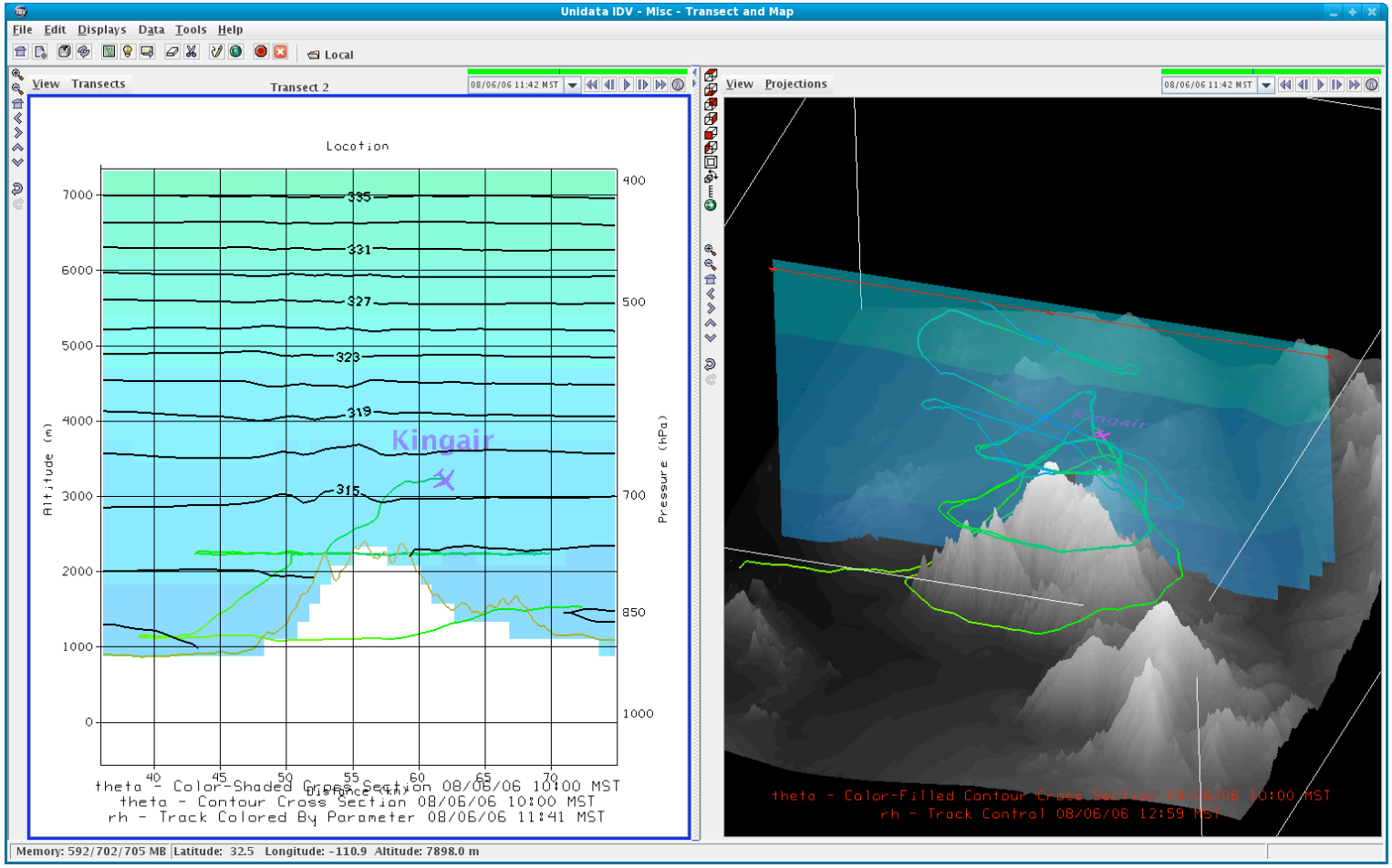
- **Data Types:**
  - Gridded model output
  - Satellite imagery
  - Radar data
  - Point observations
  - Balloon soundings
  - NOAA Profiler Network winds
  - Aircraft Tracks
  - Fronts
  - GIS data (WMS, shapefile)
  - Quick Time movies
  - Web Cams
- **Vertical Coordinates**
  - Pressure
  - Height/Depth
  - 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