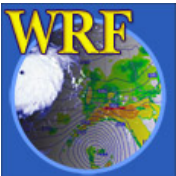




Post-processing Tools

Cindy Bruyère

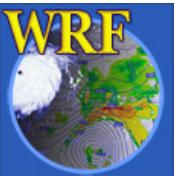


Graphical Packages

- **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



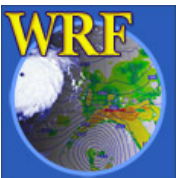
Graphical Packages

	NCL	RIP4	ARWpost (GrADS / Vis5D)	WPP	VAPOR
Directly ingest WRF data	Y	N <i>converter</i>	N / (Y) <i>converter</i>	N <i>converter</i>	N <i>converter</i>
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	<i>netCDF</i>	<i>netCDF</i>	<i>netCDF / GRIB1</i>	<i>netCDF / binary</i>	<i>netCDF</i>
Vertical Output Coordinate	eta pressure height	eta pressure height	eta pressure height	pressure	eta
Software required (All binaries are free)	<i>NCL</i>	<i>NCARG</i>	<i>GrADS/vis5d</i>	<i>GrADS / GEMPAK</i>	<i>VAPOR</i>
Diagnostics	<i>some</i>	<i>> 100</i>	<i>some</i>	<i>some</i>	<i>limited</i>



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: 4.6
 - configure / compile



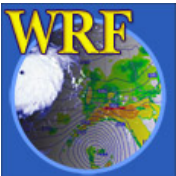
RIP4 - General Information

- 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

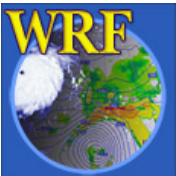
- OnLine Tutorial:

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

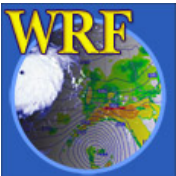
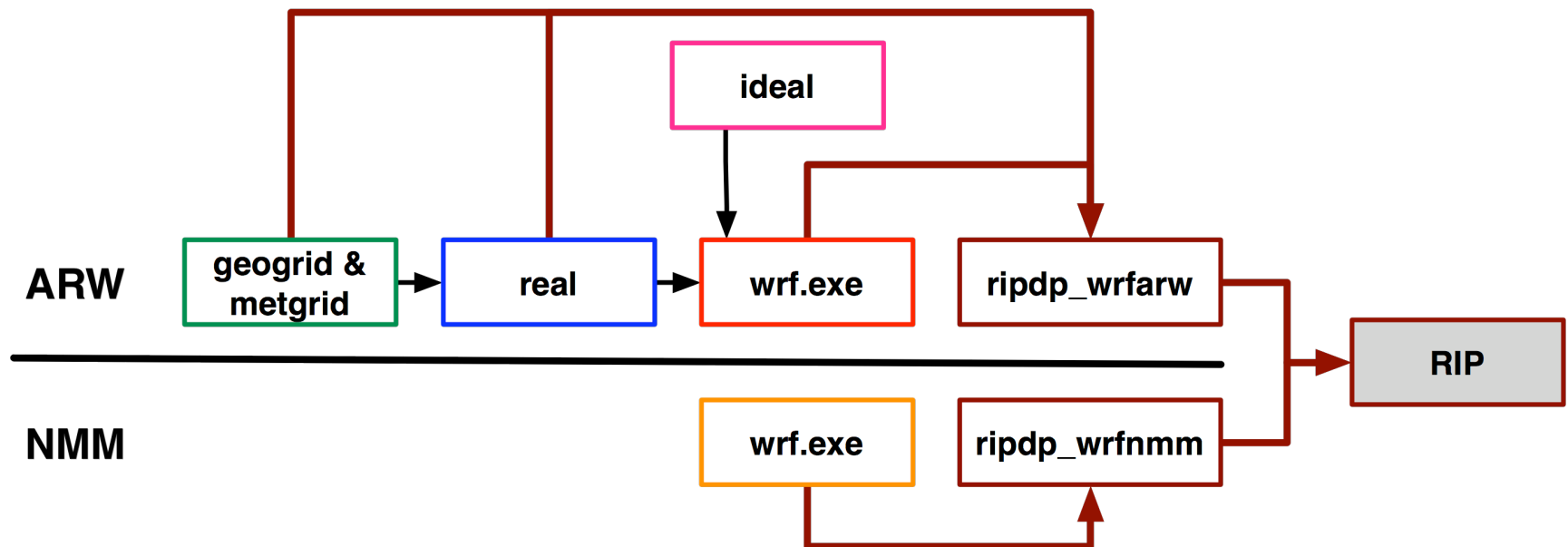


RIP4 - General Information

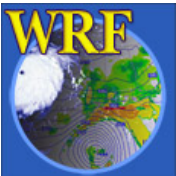
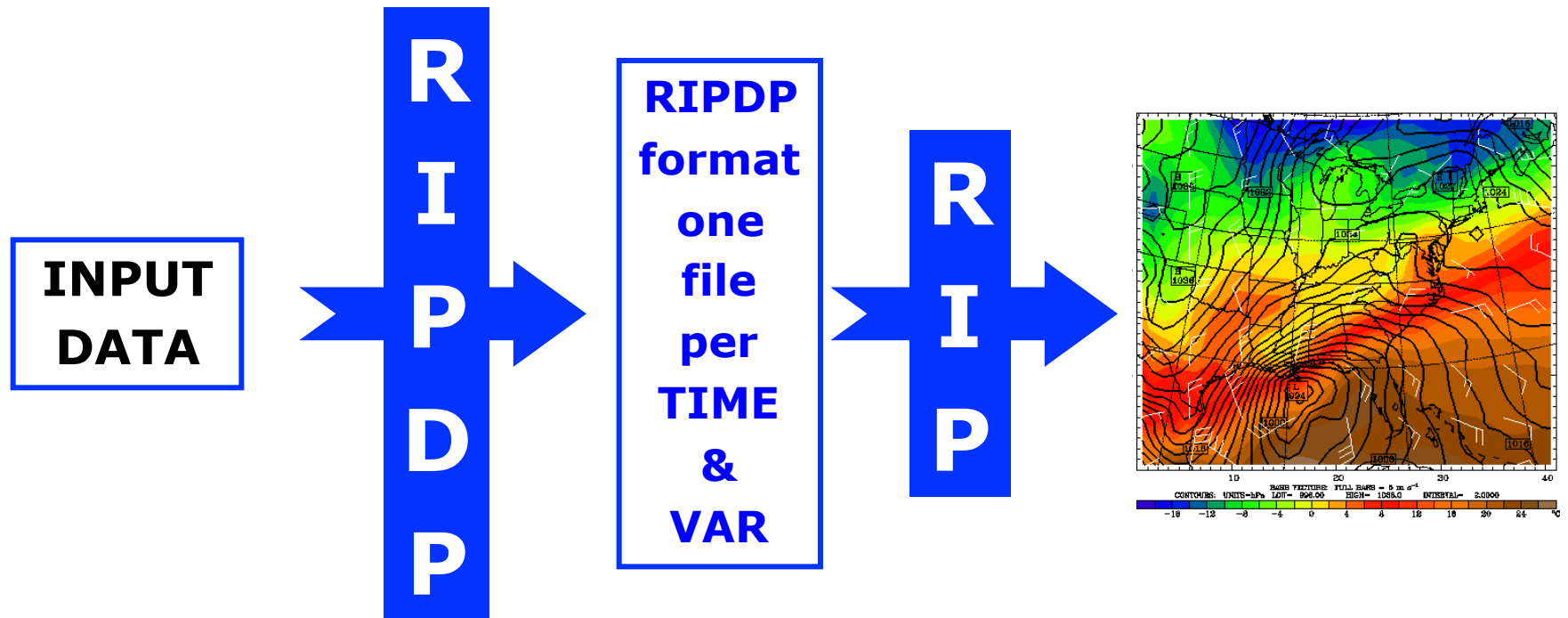
- Requires NCAR Graphics low-level routines
 - <http://ngwww.ucar.edu>
- NCL Version 5:
 - <http://www.ncl.ucar.edu>
 - Released November 2007
 - Combine NCL and NCAR Graphics
 - Open Source
 - Recommended
- Download Code:
 - http://www.mmm.ucar.edu/wrf/users/download/get_source.html
 - <http://www.dtcenter.org/wrf-nmm/users/downloads/index.php>



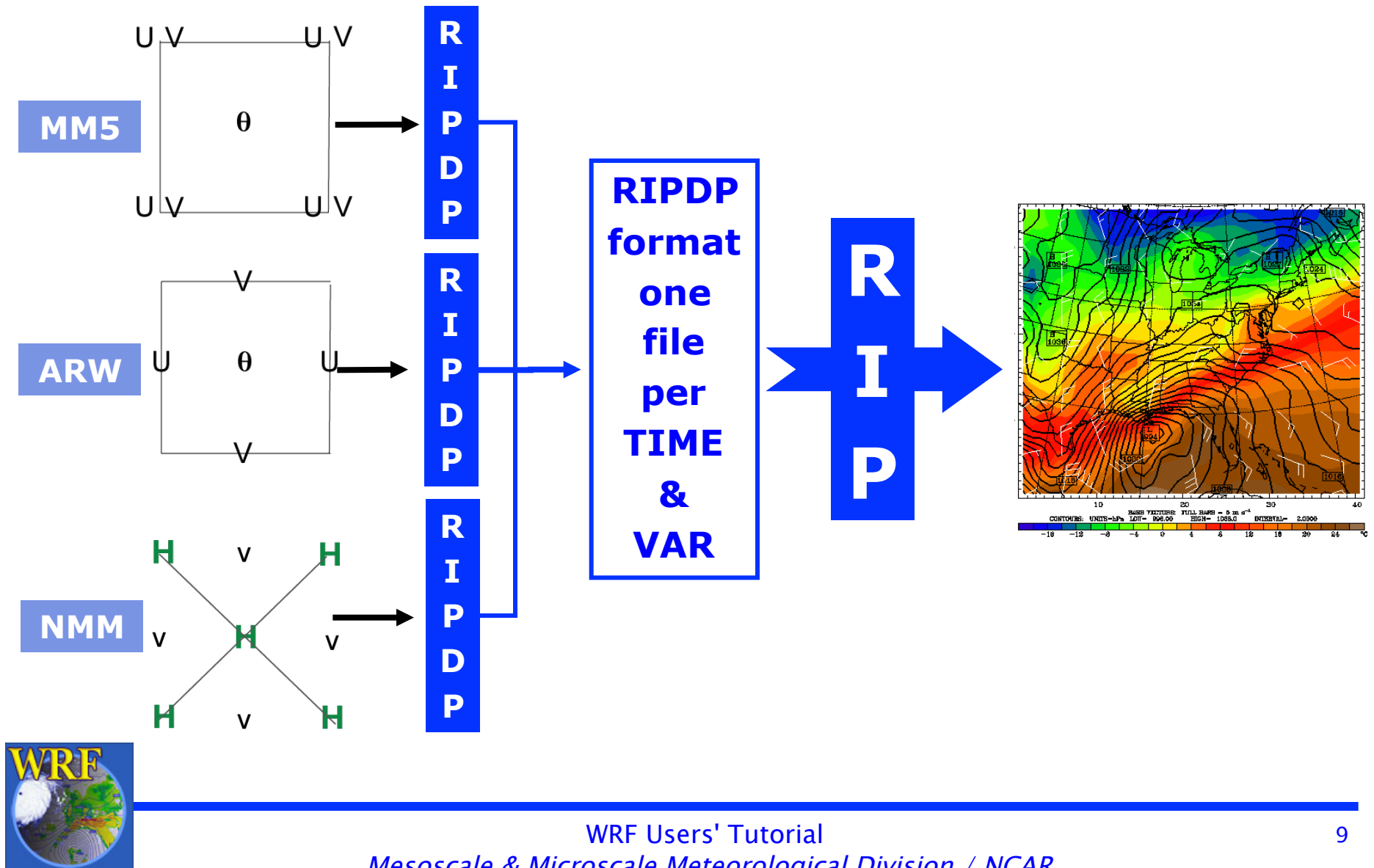
RIP4 Input Data



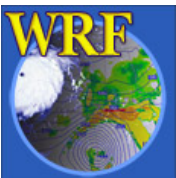
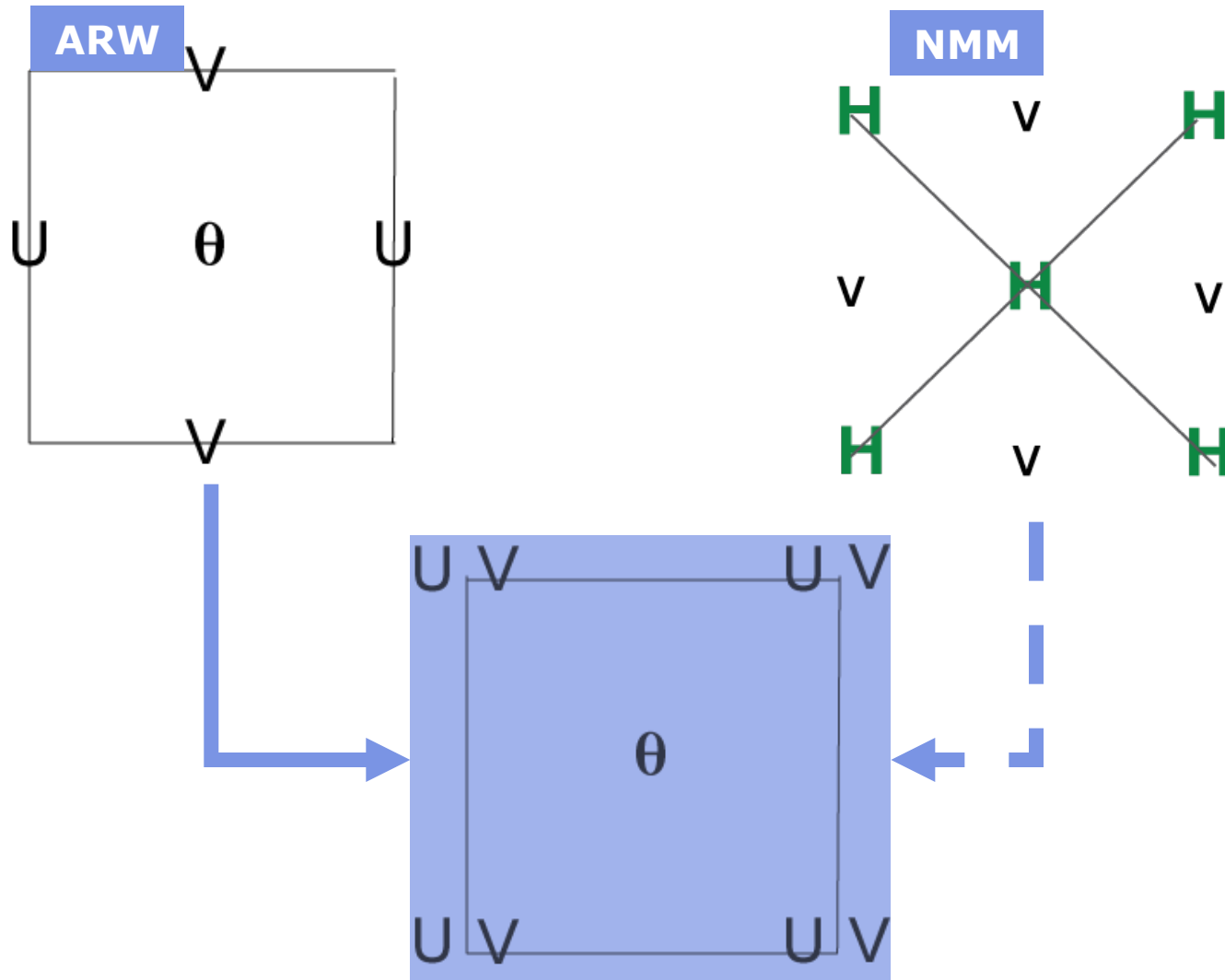
RIP4



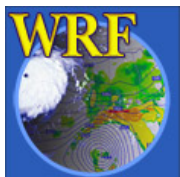
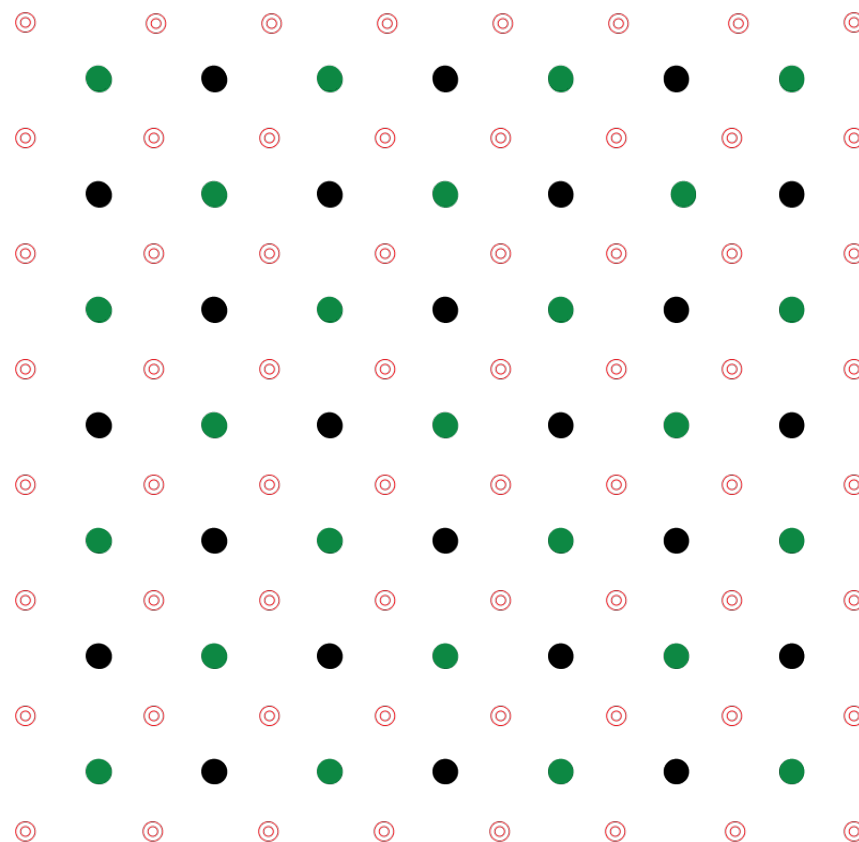
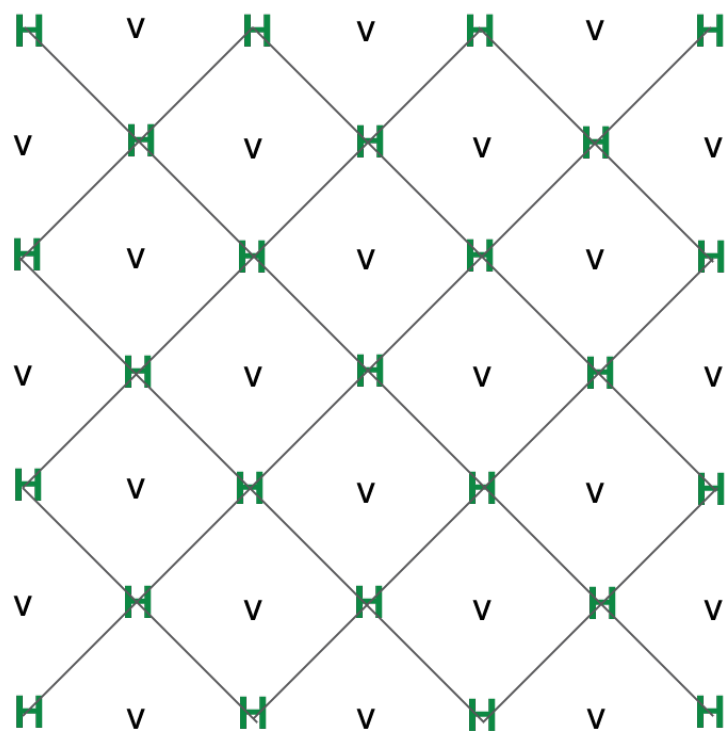
RIP4 - Grids



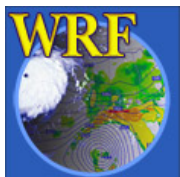
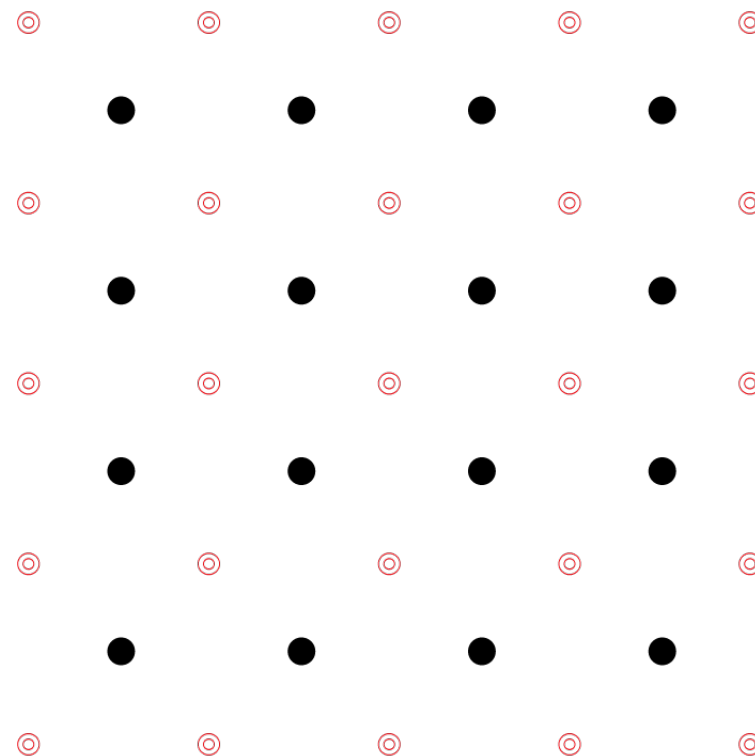
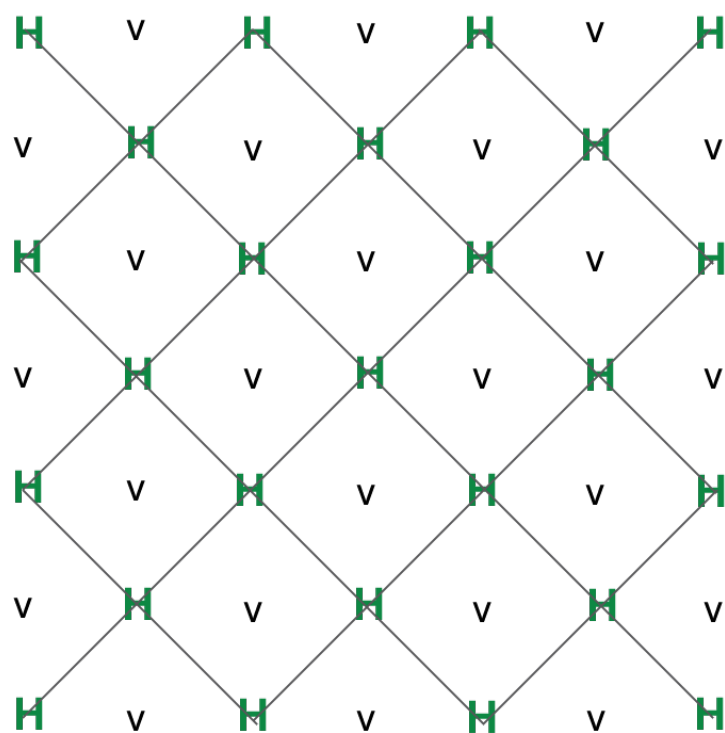
RIP4 - WRF Grids



RIP4 - NMM Grid (*iinterp 0*)



RIP4 - NMM Grid (*iinterp 1*)



new projection ; no direct relationship

RIP4 on your computer

- set environment variables

setenv RIP_ROOT /usr/\$USER/RIP4 (*rip_root*)

setenv NCARG_ROOT /usr/local/ncl (*/usr/local/ncarg*)

- Configure

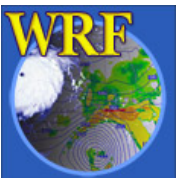
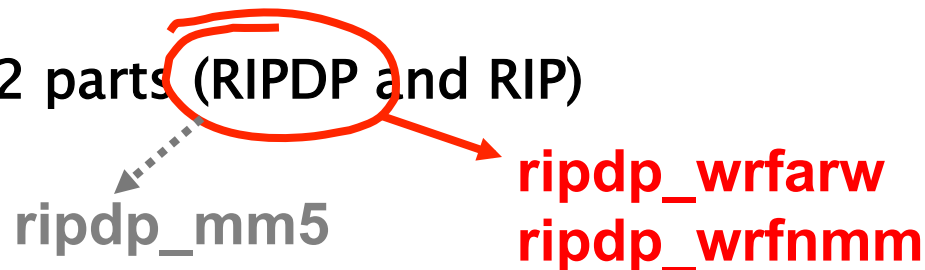
./configure

(check configure.rip to ensure netCDF paths are correct)

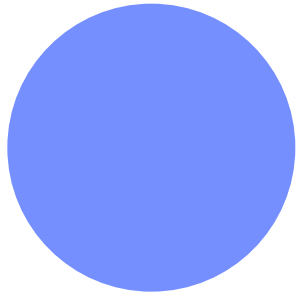
- Compile

./compile

- RIP4 has 2 parts (RIPDP and RIP)

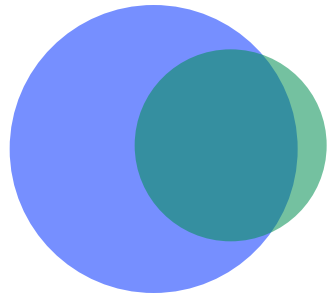
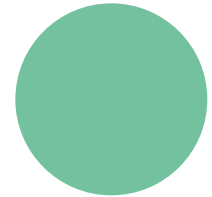


Compiling with ncl

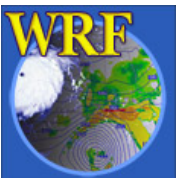


```
ncl myscript.ncl  
NCARG_ROOT  
/usr/local/ncl
```

```
compile <util>  
NCARG_ROOT  
/usr/local/ncarg
```



```
ncl myscript.ncl  
compile <util>  
NCARG_ROOT  
/usr/local/ncl
```



Compiling with ncl

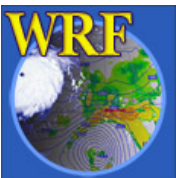
In function `write_png':

```
undefined reference to `png_create_write_struct'
undefined reference to `png_create_info_struct'
undefined reference to `png_destroy_write_struct'
undefined reference to `png_destroy_write_struct'
```

```
-L<path_to_png_lib> -lpng -L<path_to_z_lib> -lz
```

```
/usr/local/ncl/lib/libncarg.a(agcurv.o): In function `agcurv_':
agcurv.f:(.text+0x69): undefined reference to `_gfortran_copy_string'
/usr/local/ncl/lib/libncarg.a(aggtch.o): In function `aggtch_':
aggtch.f:(.text+0x3e): undefined reference to `_gfortran_copy_string'
aggtch.f:(.text+0x7b): undefined reference to `_gfortran_copy_string'
```

```
-L<path_to_gfortran_lib> -lgfortran
```



ripdp & rip

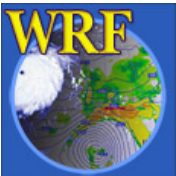
- ripdp

- 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



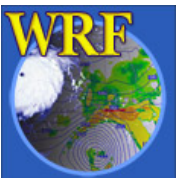
Running ripdp & rip

```
ripdp_wrfxxx [-n namelist-file]
             <model_data_name> \      [basic/all]
             <input_file(s)>
```

```
rip [-f] <model_data_name> rip-execution-name
```

Example:

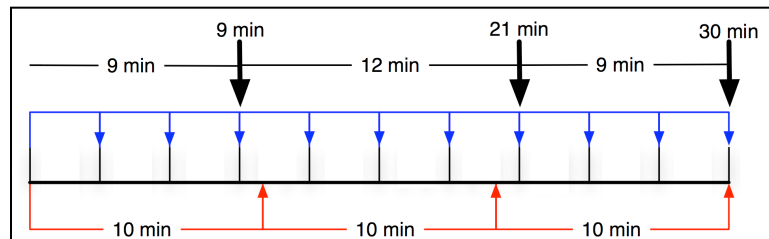
```
ripdp_wrfarw RIPDP/test all wrfout*
rip [-f]      RIPDP/test rip_sample.in
```



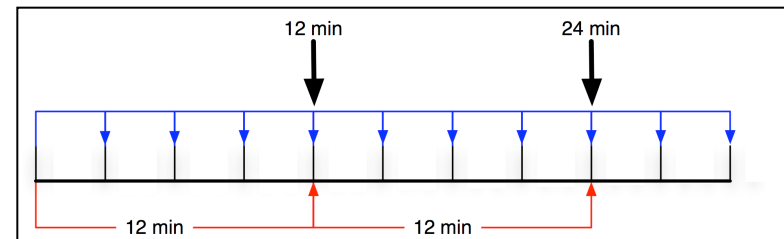
ripdp namelist

- **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)]

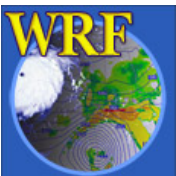
history_interval=10



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



rip UIF

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

Namelist controlling general parameters

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

```
=====
```

----- Plot Specification Table -----

```
=====
```

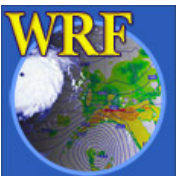
```
feld= .....  
feld= .....  
=====
```

Frame specification group (FSG)

```
feld= .....  
feld= .....  
=====
```

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*
- **ptimes, ptimeunits** – times to process
- **tacc** – tolerance for processing data
- **iusedaylightrule** – 1 applied, 0 not applied
- **idotser** – generate time series output
- **icgmsplit** – split metacode into several files
- **itrajcalc** – 0, 1 ONLY when doing trajectory calculations
- **rip_root** – override RIP_ROOT
- **ncarg_root** – output type: X11, cgm, pdf, ps

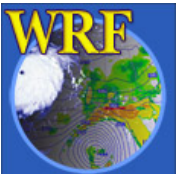
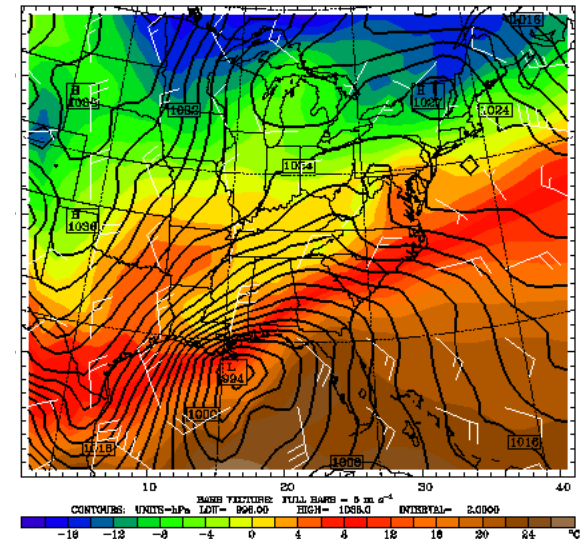


Creating a Plot

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

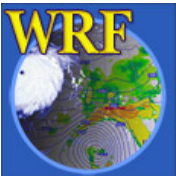
```
=====
feld=tmc; ptyp=hc; vcor=s; levs=1fb; >
  cint=2; cmth=fill; >
  cosq=32,light.violet,-16,blue, >
  0,yellow,16,orange,32,light.gray
feld=slp; ptyp=hc; cint=2; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=1; >
  colr=white;intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb
=====
```



Common Error Message

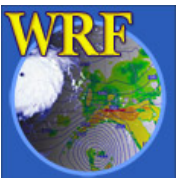
- Most often this is NOT a graphics error.
- More often this is an error with the times you are asking RIP to process
 - Check the ptimes in your .in file
 - Check the xtimes files created by RIPDP

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



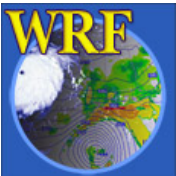
ARWpost

- 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 (*not recommended*)
- Generate a number of graphical plots
 - Horizontal, cross-section, skewT, meteogram, panel

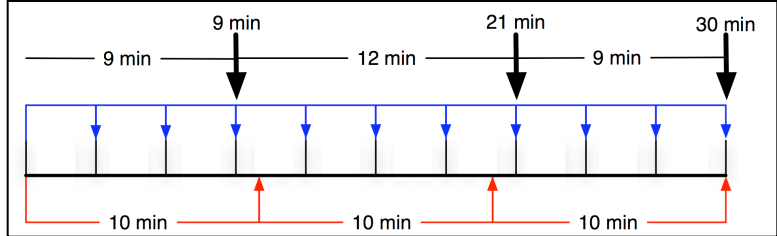


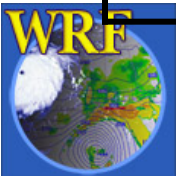
ARWpost - converter

- 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

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



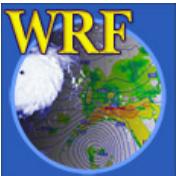
namelist.ARWpost

<i>input_root_name</i>	Path and root name of files to use as input. <i>Do not only provide directory name.</i> Can use wild characters.
<i>output_root_name</i>	Output root name. output_root_name.dat & output_root_name.ctl
<i>mercator_defs</i>	Set to true if mercator plots are distorted

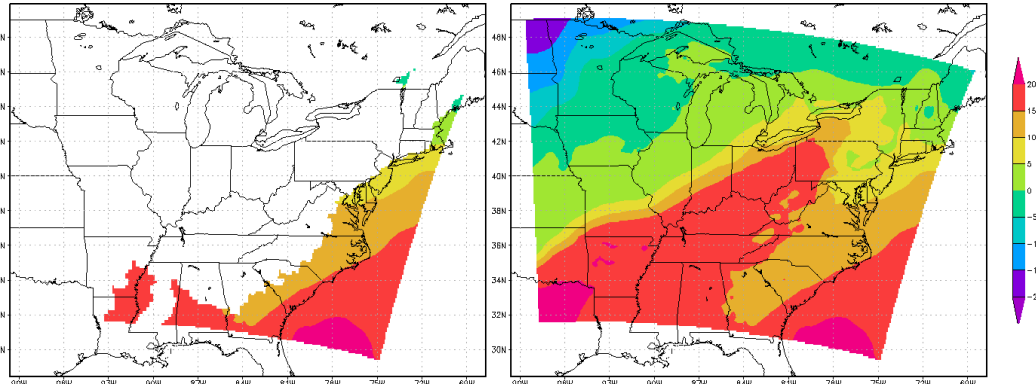


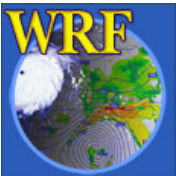
namelist.ARWpost

<i>split_output</i>	Split your GrADS output files into a number of smaller files (<i>a common .ctl file will be used for all .dat files</i>).
<i>frames_per_outfile</i>	If <i>split_output</i> is .True. , how many time periods are required per output (.dat) file.
<i>plot</i>	Which fields to process. (<i>all, list, all_list</i>) Order has no effect, i.e., “all_list” and “list_all” “list” – list variables in “fields”
fields	Fields to plot. Only used if 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	



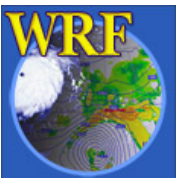
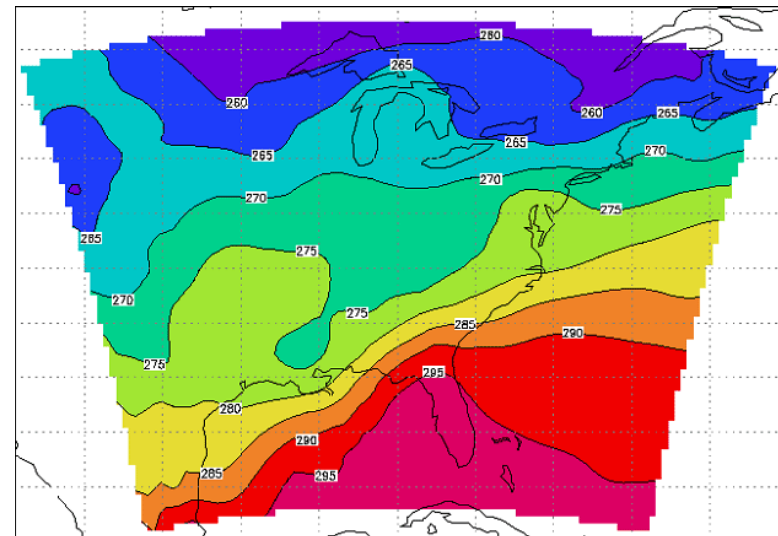
namelist.ARWpost

interp_method	0 = sigma levels, -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 (<i>pressure</i>) or km (<i>height above sea level</i>) Supply levels bottom to top
extrapolate	Extrapolate below ground (<i>default .false.</i>) 



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

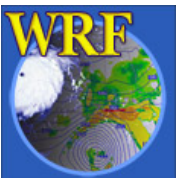


GrADS - .ctl file

```
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
```

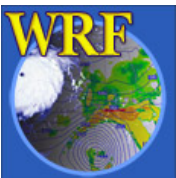
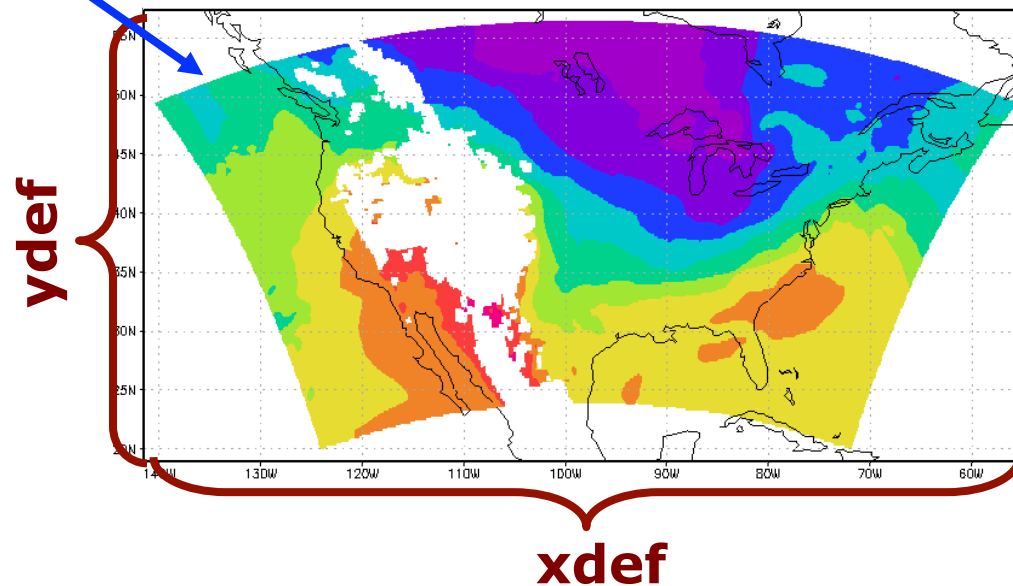
options byteswapped

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



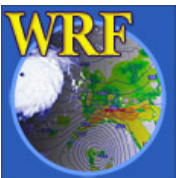
GrADS - .ctl file

```
dset ^test.dat
options byteswapped
title OUTPUT FROM WRF V3.2 MODEL
pdef 259 163 lcc 40.000 -98.000 130.000 82.000
60.000000 30.000000 -98.000000 22000.000 22000.000
xdef 877 linear -141.49254 0.09909910
ydef 389 linear 18.88639 0.09909910
```



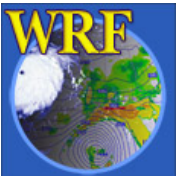
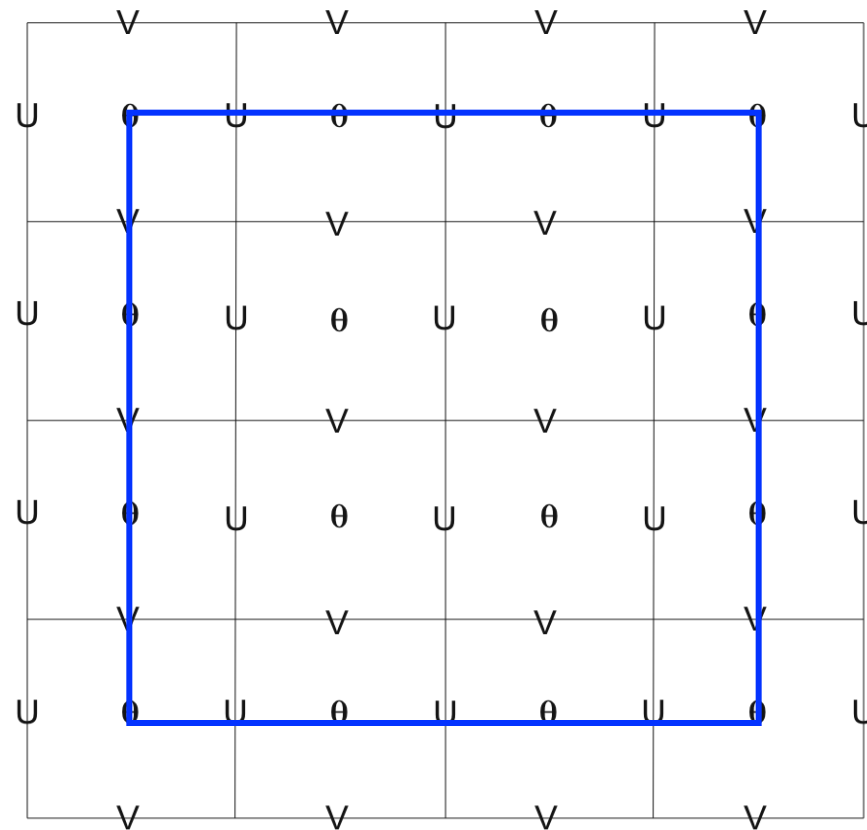
GrADS conversion - question

- 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



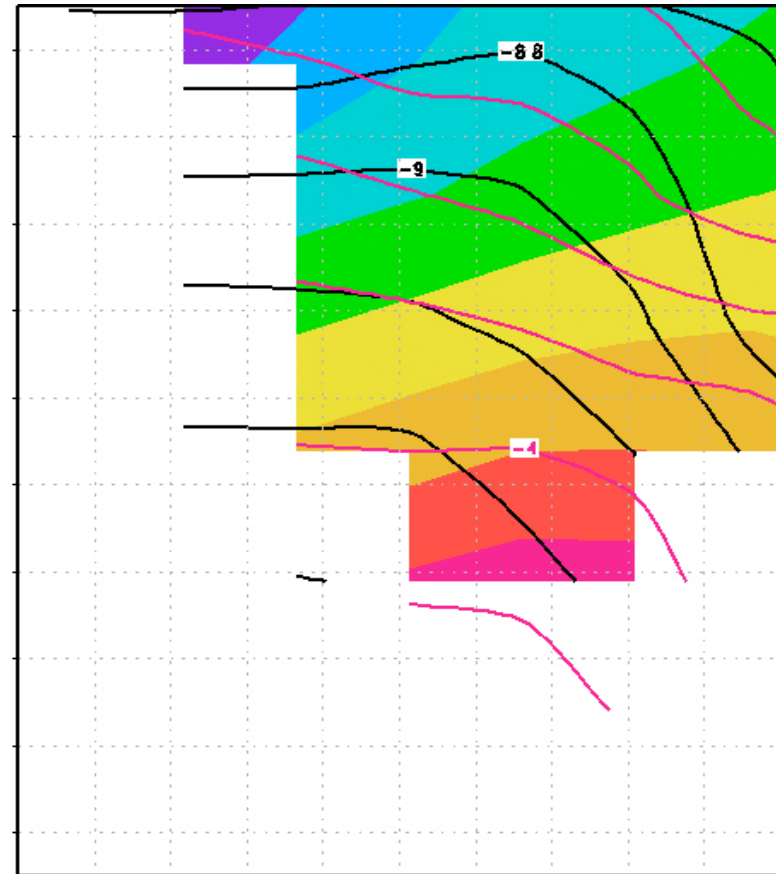
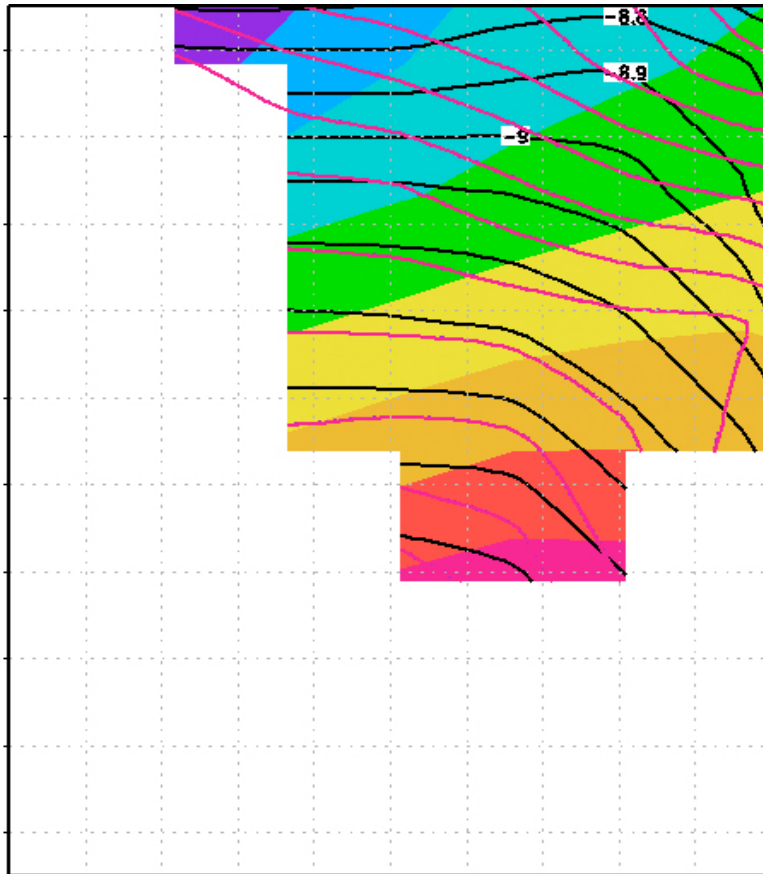
GrADS conversion - question

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



Staggering

shaded=T ; black=U ; red=V



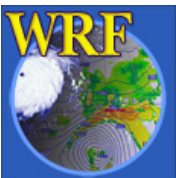
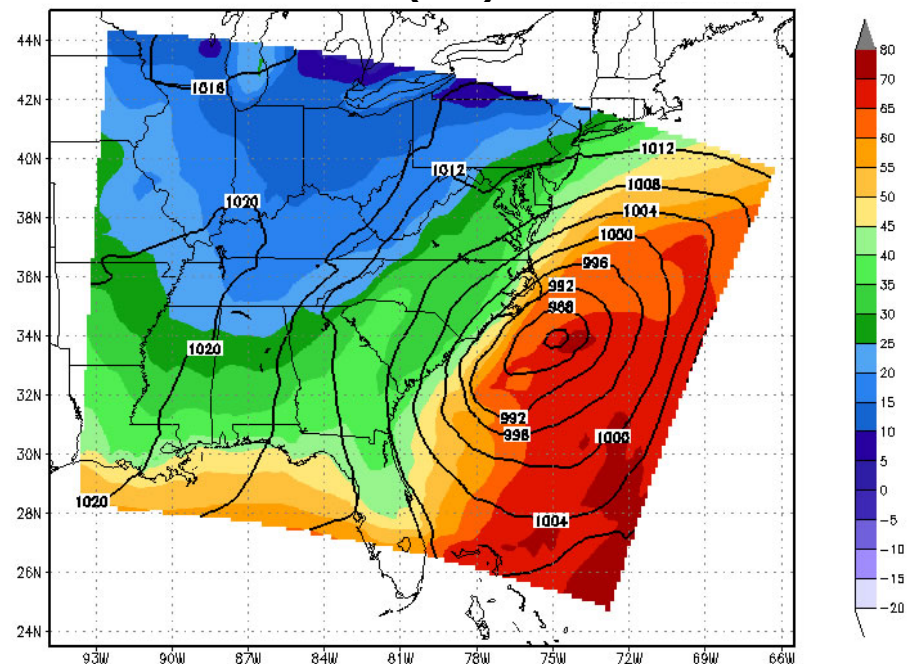
Creating a Plot

```
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
```

Surface Temperature (F)
Sea Level Pressure (mb)



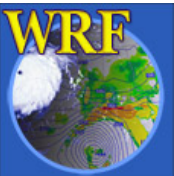
How to add diagnostics

- **RIP4**

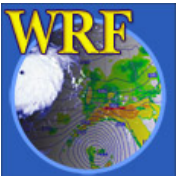
- Create a subroutine (note RIP4 expects the code to be in “j/l/-k” orientation)
- Add links to the RIP4/src/fields.f routine
- Add new subroutine to RIP4/src/Makefile

- **ARWpost**

- Create a subroutine
- Add links to ARWpost/src/module_diagnostics.f90
- Add new subroutine to ARWpost/src/Makefile



Other Post-processing Tools



VAPOR

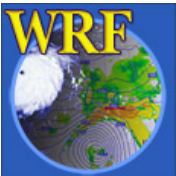


Computational and Information Systems Laboratory
National Center for Atmospheric Research

Visualization and Analysis Platform for Oceanic, atmospheric and solar Research

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National Center for Atmospheric Research



WRF in VAPOR



Computational and Information Systems Laboratory
National Center for Atmospheric Research

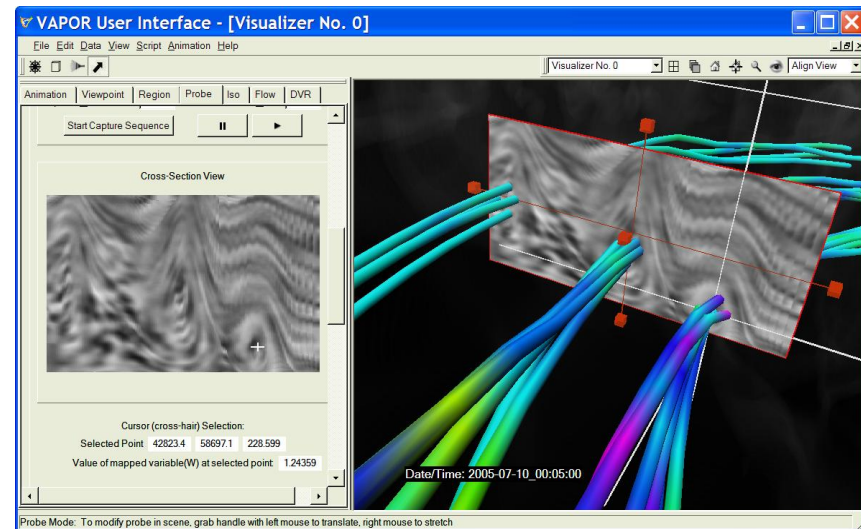
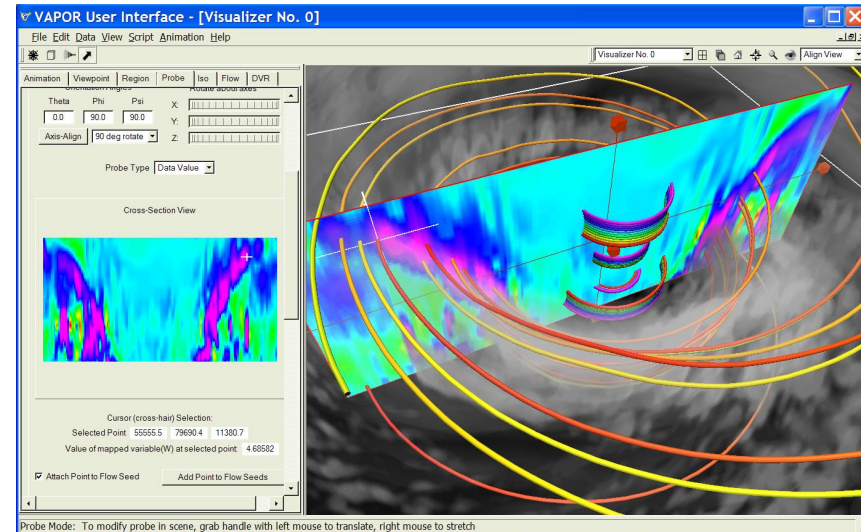
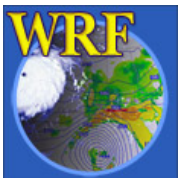
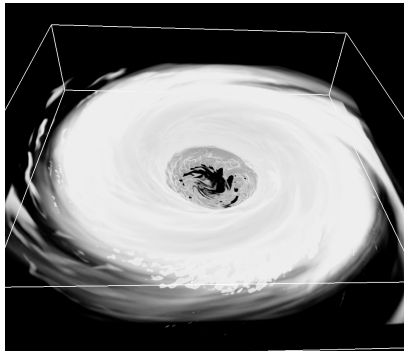
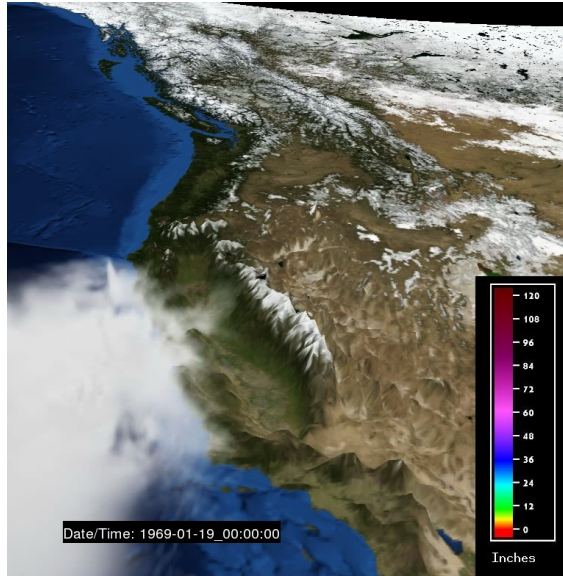
- Interactive 3D visualization of WRF–ARW data (*wrfout files only*)
- Available free on Linux, Windows, Mac
- Interactive rendering and animation (using GPU acceleration)
- Simple 2–step data conversion from WRF output to VAPOR
 - wrfvdcreate & wrf2vdf
- Steady and unsteady flow integration
- Data probing
- Downloads, documentation, examples at:
<http://www.vapor.ucar.edu>
<http://www.vapor.ucar.edu/doc/WRFsupport.pdf>



WRF in VAPOR



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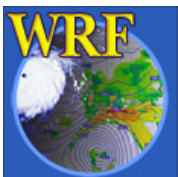




IDV

Integrated Data Viewer

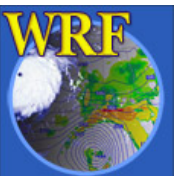
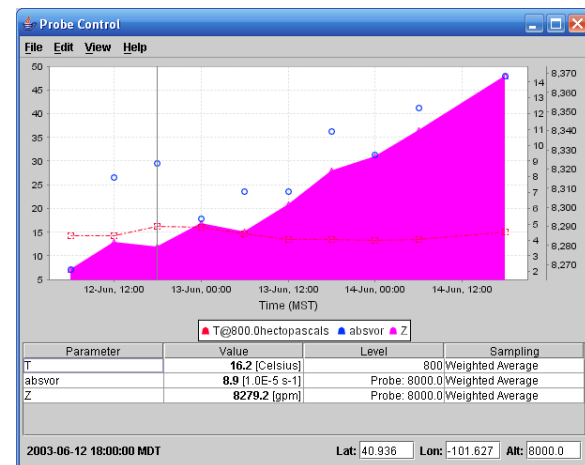
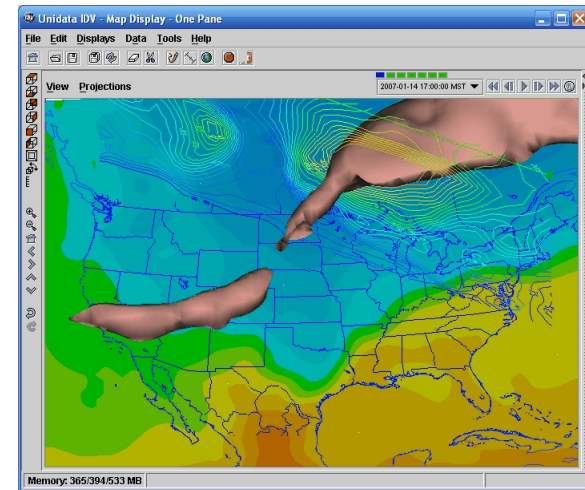
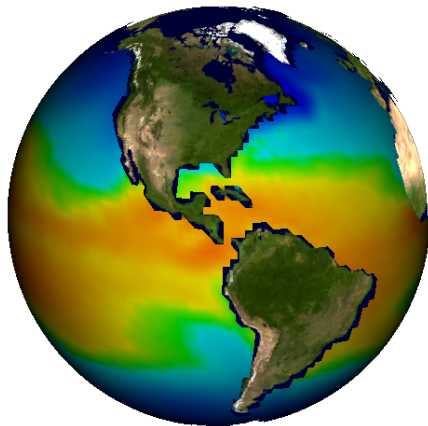
Don Murray and Jeff McWhirter
Unidata Program Center/UCAR





What is the IDV?

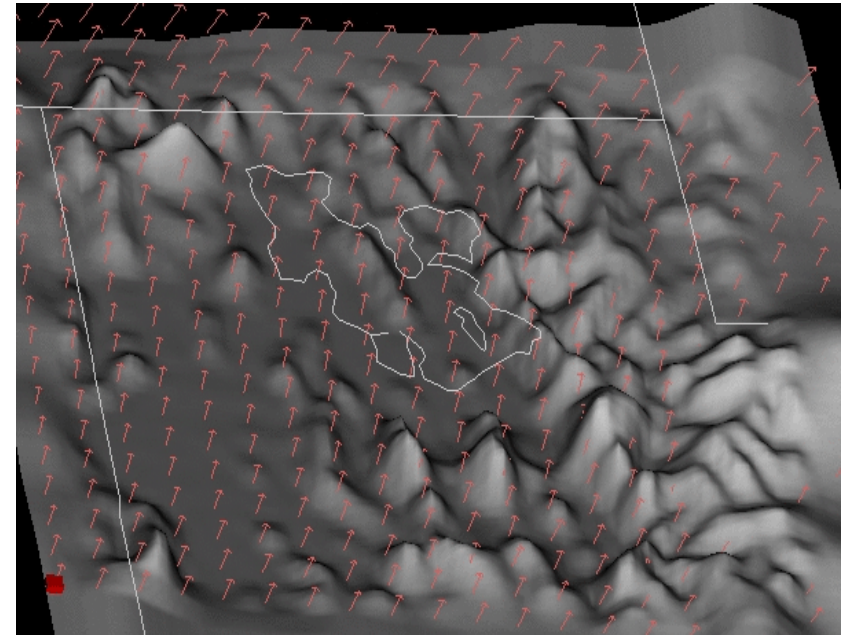
- Visualization and analysis tool for geoscience data developed and supported by Unidata
- Freely available Java™ framework and application
- Integrated 2D/3D displays of a wide range of data
- Built on VisAD library



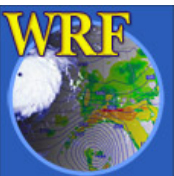


IDV Strengths

- 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



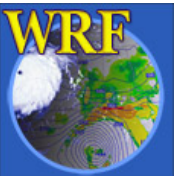
Model simulation of wind, isentropic potential vorticity and low level moisture flow over the Great Salt Lake basin





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



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

