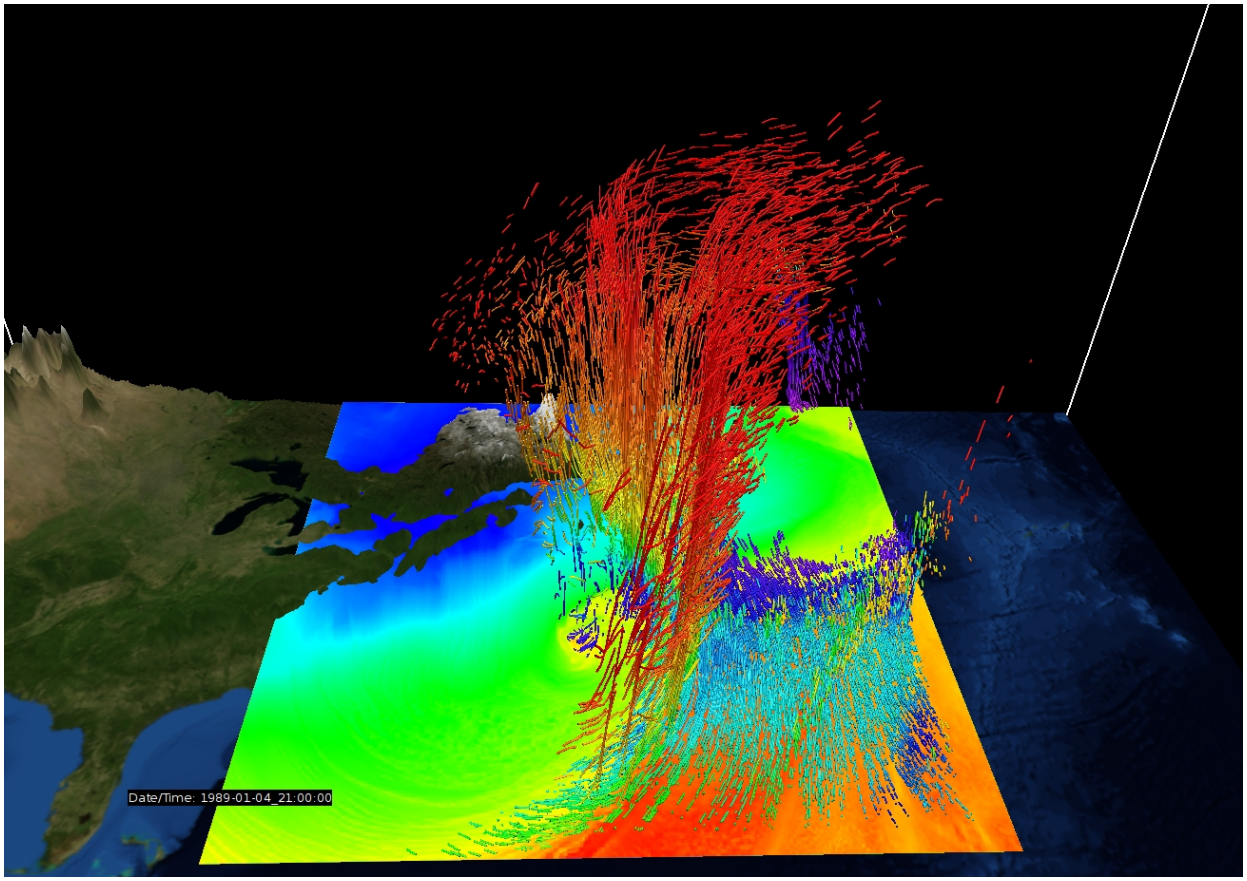
Post-processing Tools

Cindy Bruyère



Supported Post-Processing Packages

- **NCL** — UG: 9-2
  - Graphical package
- **ARWpost** — UG: 9-28
  - Converter (GrADS)
- **RIP4** — UG: 9-19
  - Converter and interface to graphical package NCAR Graphics
- **UPP** — UG: 9-35
  - Converter (GrADS & GEMPAK)
- **VAPOR** — UG: 9-58
  - Converter and graphical package
  - *Support: VAPOR*
- **IDV** — unidata.ucar.edu
  - GRIB (from UPP)
  - GEMPAK (from wrf2gem)
  - Vis5d
  - CF complaint data (from wrf_to_cf)
  - *Support: unidata*
- **GEMPAK**
  - Data from wrf2gem or UPP
  - *Support: unidata*

MatLab; IDL; R; ferret; panoply; python

Picking a Post-Processing Tool

- Can it read your data
  - netCDF (CF), GRIB, ASCII, shapefiles
- Do you have to first pre-process the data
- Can it handle big datasets
- Is it purely a visualization tool, or can you do post-processing as well
- Which diagnostic / statistical functions does it have
- 3D or 2D visualization
- Can it deal with staggered grids
- How easy is it to add diagnostics
- How is data below ground handled
- Vertical grids
- How is model time stamps handled
- Easy of use
- Cost of package
- Support

Data Handing

	NCL	RIP4	GrADS	UPP	VAPOR	IDV
netCDF		ripdp	ARWpost	converter	converter	converter
GRIB						
ASCII						
shapefiles						
geogrid & metgrid output						
intermediate file format	***V6.2.0*** ***V6.3.0***					
wrfinput data						
Idealized data						
wrfoutput						
big data						

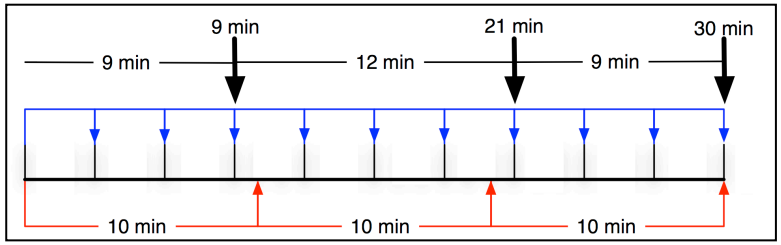
Post-Processing

	NCL	RIP4	GrADS	UPP	VAPOR	IDV
post-processing						
data output						
3D						
diagnostics	Some	Lots	Some	Some	Limited	Limited
add diagnostics	Very Easy	Easy	Easy	Relatively Easy	Less Easy	Less Easy
vertical output coordinate	model pressure height	model pressure height	model pressure height	pressure	model	model
extrapolate below ground						

wrfout Timestamps

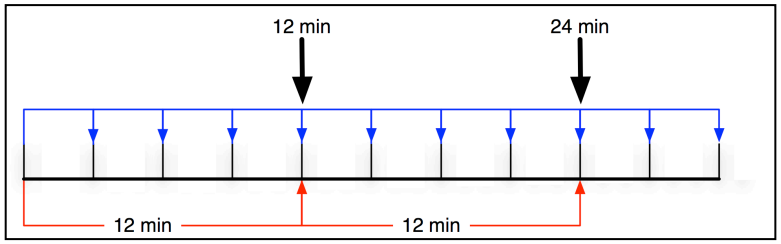
- *output files **not** on exact times*
  - 2013-01-31_00
    2013-01-31_09
    2013-01-31_21
    2013-01-31_30
  - Delta Times =
    9 ; 12 ; 9 minutes

history_interval=10 ; time_step=180 (3 min)



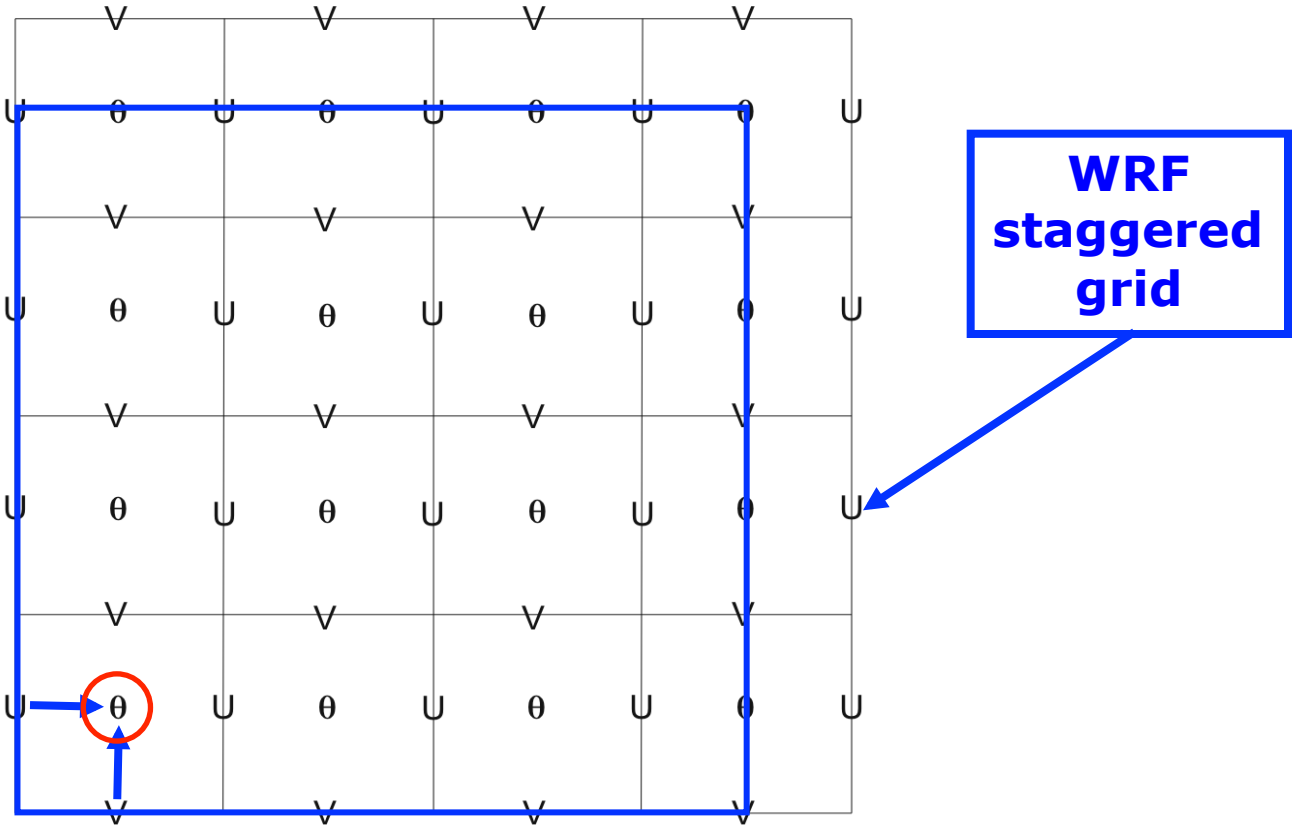
- *output files **on** exact times*
  - 2013-01-31_00
    2013-01-31_10
    2013-01-31_20
    2013-01-31_30
  - Delta Times =
    10; 10; 10minutes

history_interval=12 ; time_step=180 (3 min)



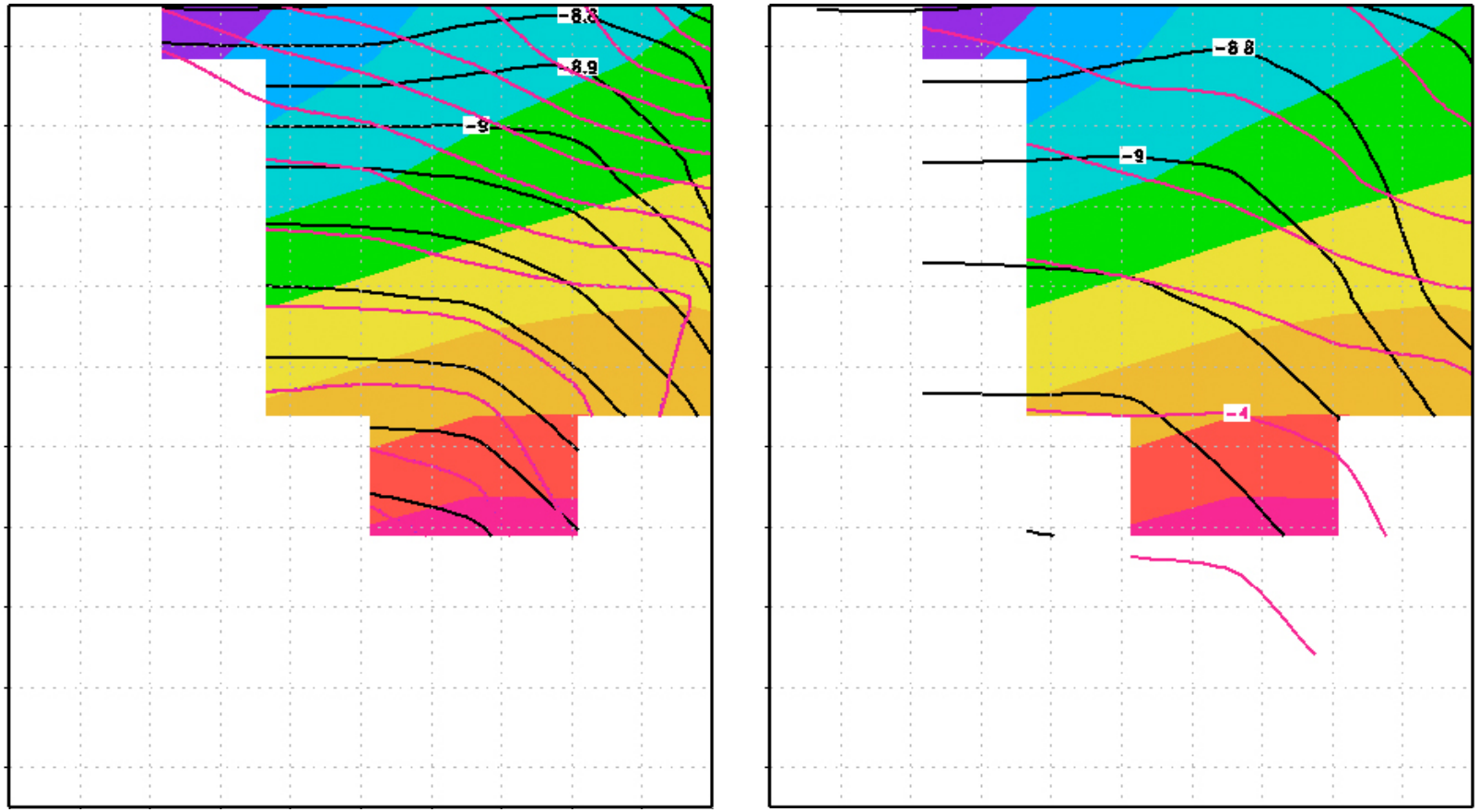
Model Staggering

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

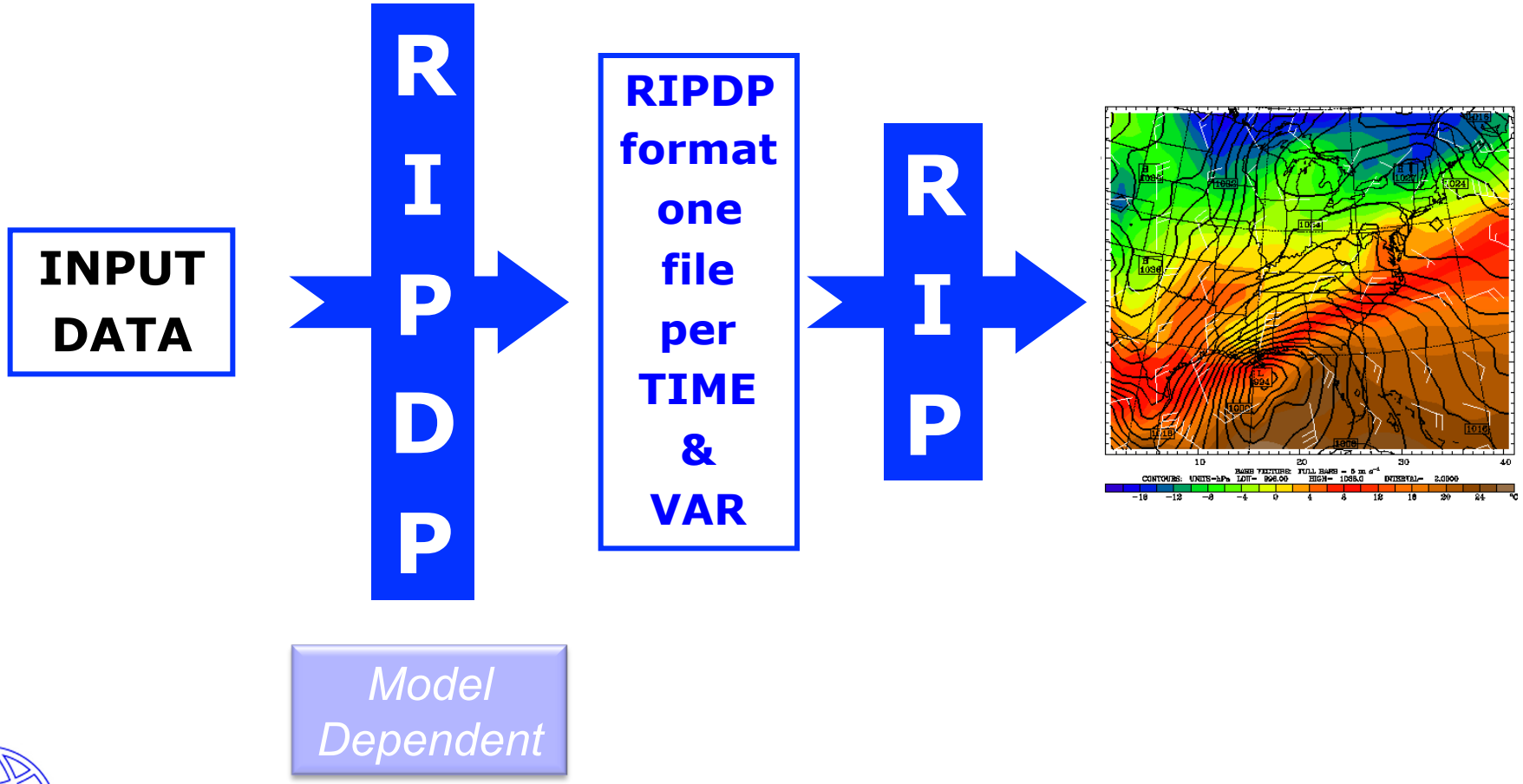


Model Staggering

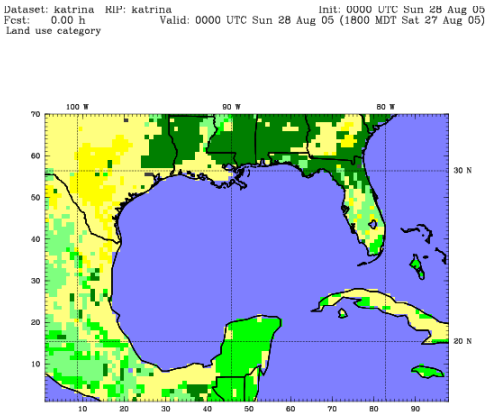
shaded=T ; black=U ; red=V

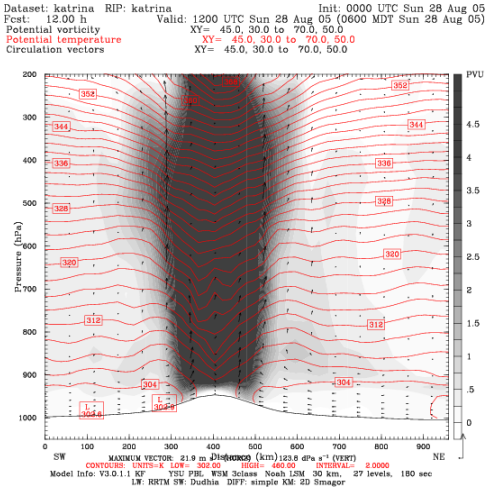


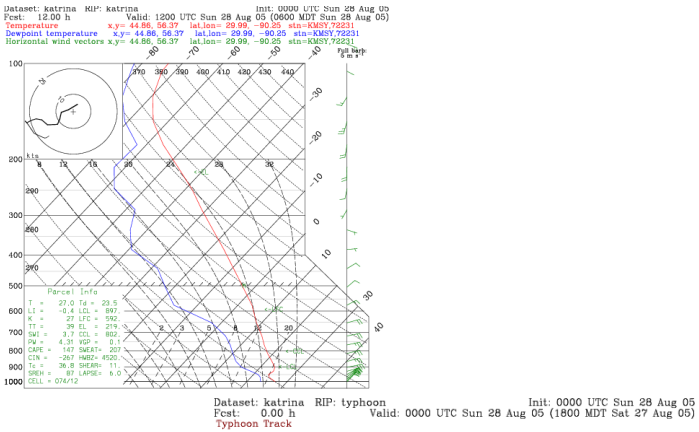
RIP4

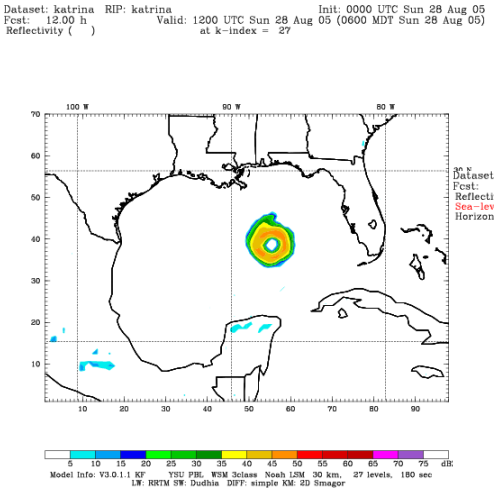

INPUT DATA
R I P D P
RIPDP format one file per TIME & VAR
R I P
Model Dependent

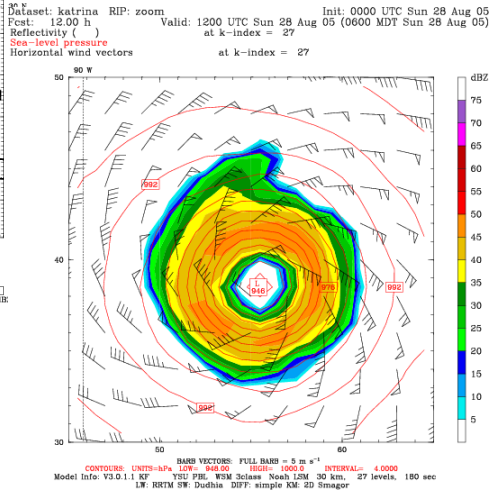
RIP4 - Examples

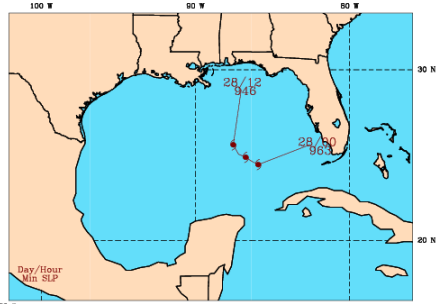


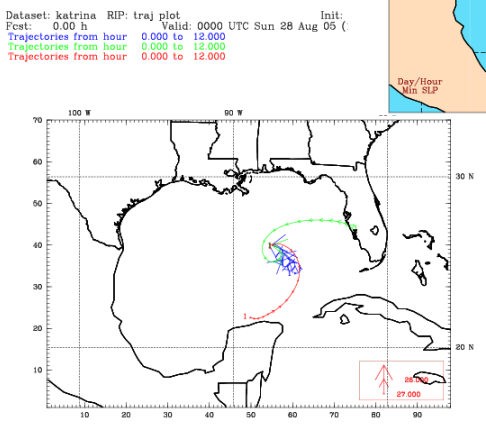












RIP4 General Information

- Requires NCL
  - *http://www.ncl.ucar.edu*
- Source Code:
  - *http://www.mmm.ucar.edu/wrf/users/download/get_source.html*
- Documentation
  - In program tar file under the Doc/ directory
  - *http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm*
- OnLine Tutorial:
  - *http://www.mmm.ucar.edu/wrf/users/graphics/RIP4/RIP4.htm*

RIP4 on your computer

- **set environment variables**
  setenv RIP_ROOT /usr/$USER/RIP4
  setenv NCARG_ROOT /usr/local/ncl

- **Configure**
  ./configure
  check configure.rip to ensure netCDF paths are correct
  gfortran ; z and png libraries may be required

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

- **Compile**
  ./compile

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

Running ripdp & rip

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

optional

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

Example:

ripdp_wrfarw RIPDP/CaseX all wrfout*

rip [-f] RIPDP/CaseX rip_sample.in

output

[rip_sample.out]
rip_sample.TYPE

RIP4 User Input File

```
&userin
     .......
/
&trajcalc
     .......
/
```

Namelists

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

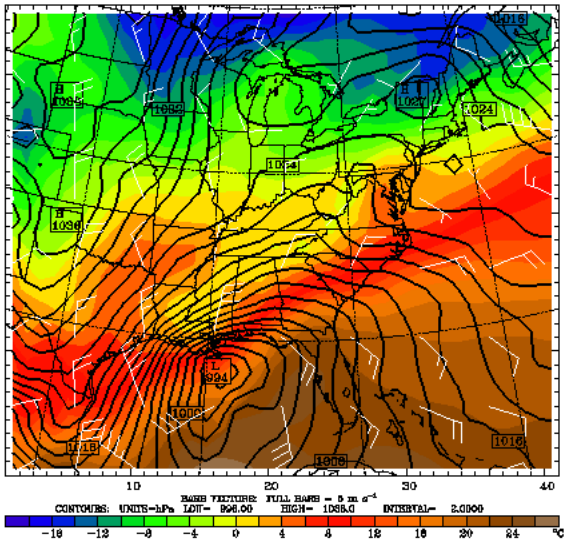
Graphics

Creating a Plot with RIP4

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**

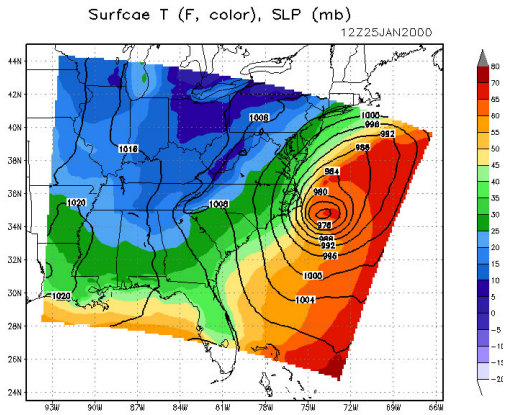
```
==========================================
feld=tmc; ptyp=hc; vcor=s; levs=1fb; >
   cint=2; cmth=fill; >
   cosq=32,light.violet,-16,blue, >
   0,yellow,16,orange,32,light.gray
feld=slp; ptyp=hc; cint=2; linw=2
feld=uuu,vvv; ptyp=hv; vcmx=1; >
    colr=white;intv=5
feld=map; ptyp=hb
feld=tic; ptyp=hb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

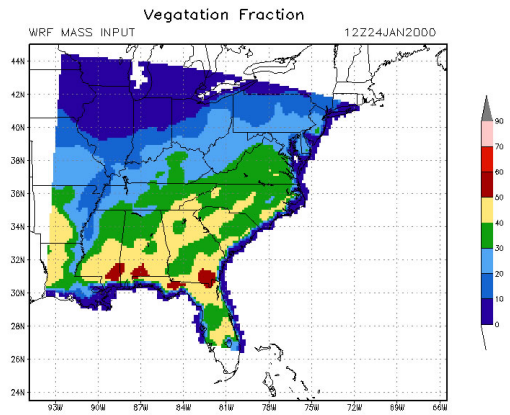


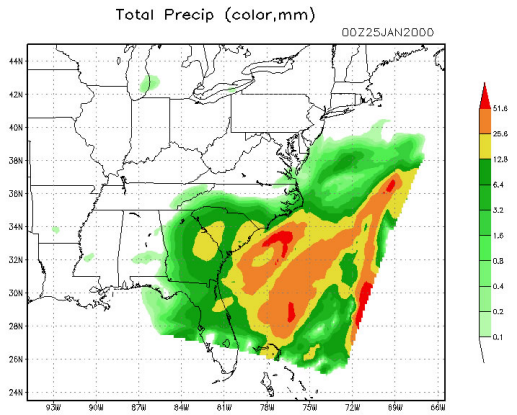
ARWpost

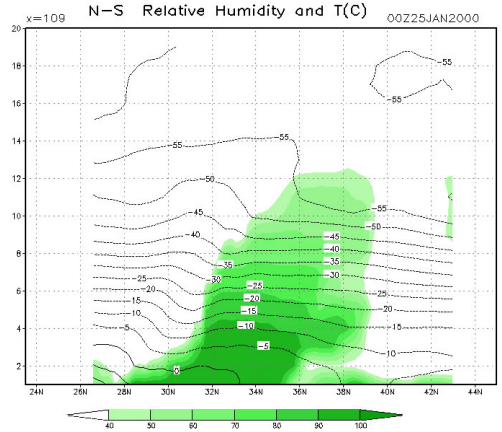
- Converter
  - Requires GrADS to display data
- GrADS software only needed to display data, not needed to compile the code
- Generate a number of graphical plots
  - Horizontal, cross-section, skewT, meteogram, panel
- Version 2 (old – not recommended)
  - Could produce vis5d output
  - Needed WRFV3 complied

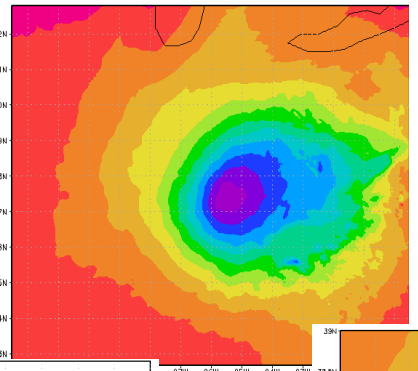
ARWpost - Examples

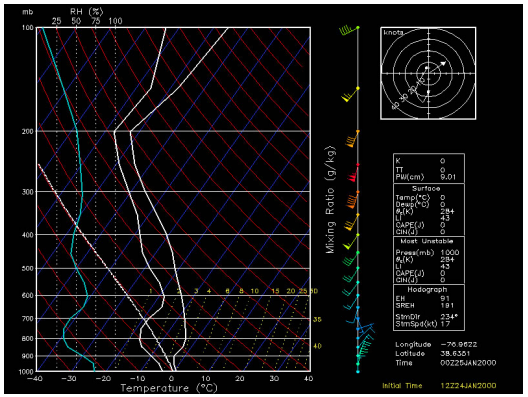


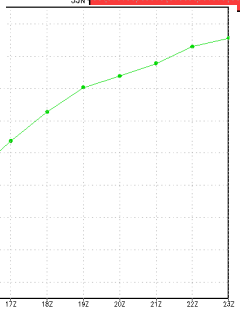


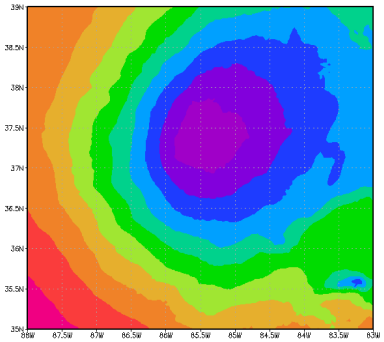












ARWpost - *converter*

- **Download Code** (http://www.mmm.ucar.edu/wrf/users)
- **OnLine Tutorial**
  http://www.mmm.ucar.edu/wrf/users/graphics/ARWpost/ARWpost.htm
- **Compile** ***(similar to WPS)***
  ./configure & ./compile
- **For GrADS output**
  - GrADS libraries only needed to display data *(freely available)*
  - http://grads.iges.org/grads/grads.html

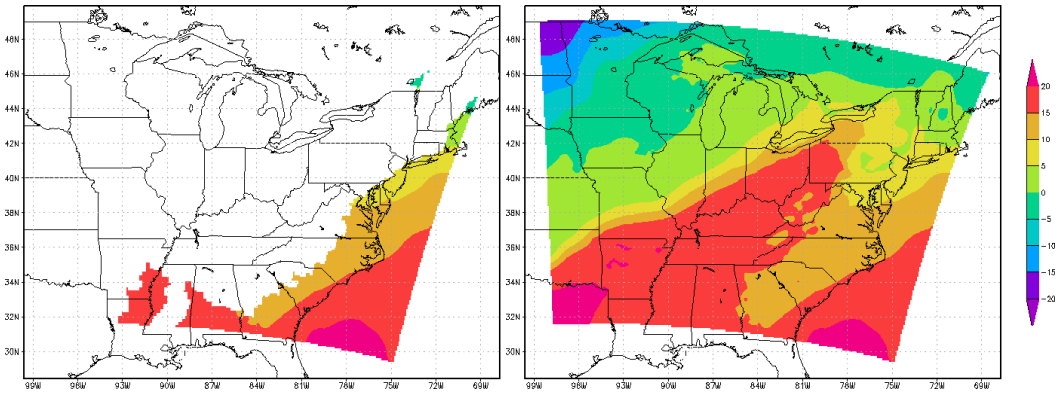
namelist.ARWpost

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**
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.

namelist.ARWpost

plot	Which fields to process. (*all, list, all_list)* 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. Can be used for model output.**
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 = 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.)* 

GrADS - .ctl file

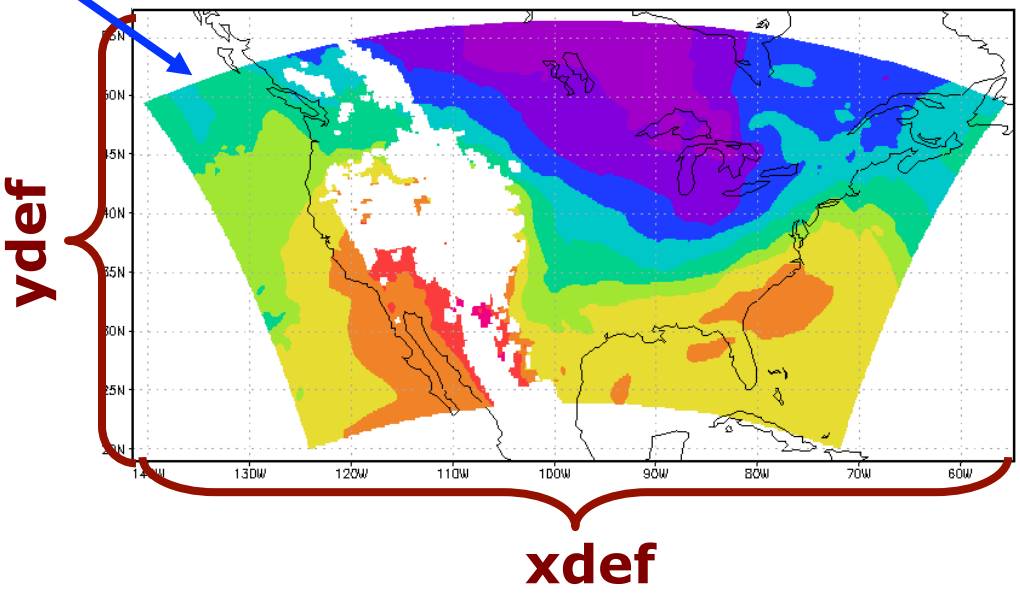
```
dset ^test.dat
options byteswapped
undef 1.e37
title  OUTPUT FROM WRF V2.2 MODEL
pdef  259 163 lcc  40.000  -98.000  130.000   82.000
      60.00000  30.00000  -98.00000  22000.000  22000.000
xdef  877 linear -141.49254   0.09909910
ydef  389 linear   18.88639   0.09909910
```

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
60.00000  30.00000  -98.00000  22000.000  22000.000
xdef  277 linear -141.49254   0.09909910
ydef  389 linear   18.88639   0.09909910
```



How to add diagnostics

- **RIP4**
  - Create a subroutine (note RIP4 expects the code to be in "j/I/-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

NCAR

Visualization and Analysis Platform for Oceanic, atmospheric and solar Research

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CISL

VAPOR Visualization & Analysis Platform

•**WRF Users'**

VAPOR visualization of WRF-ARW data

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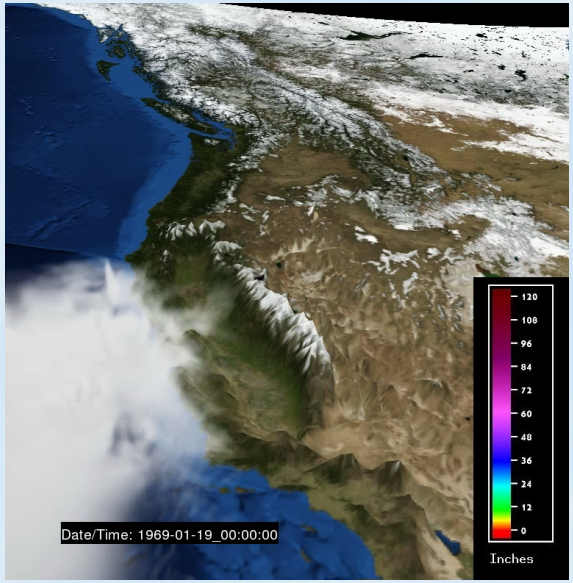

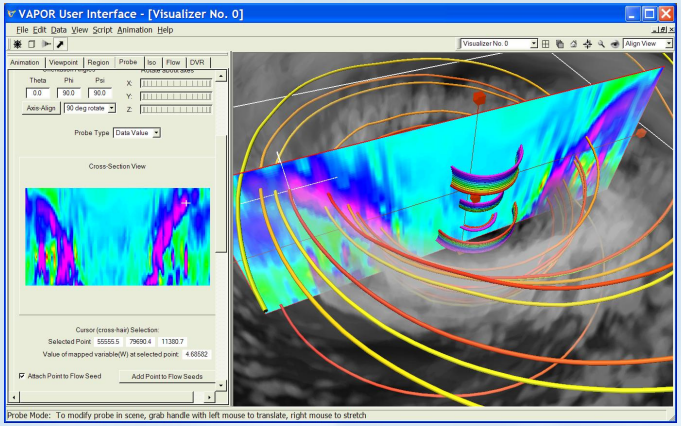

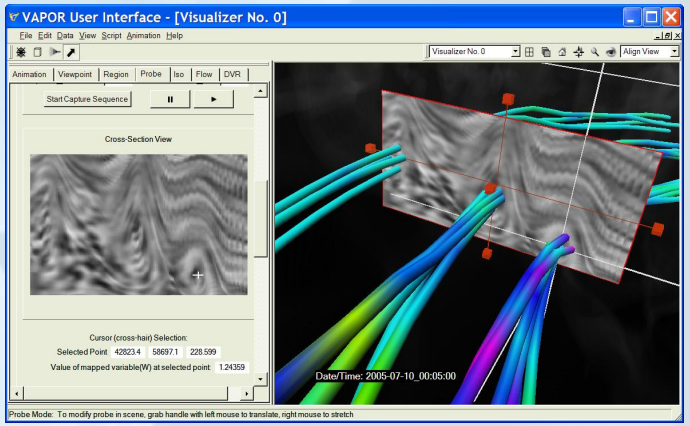

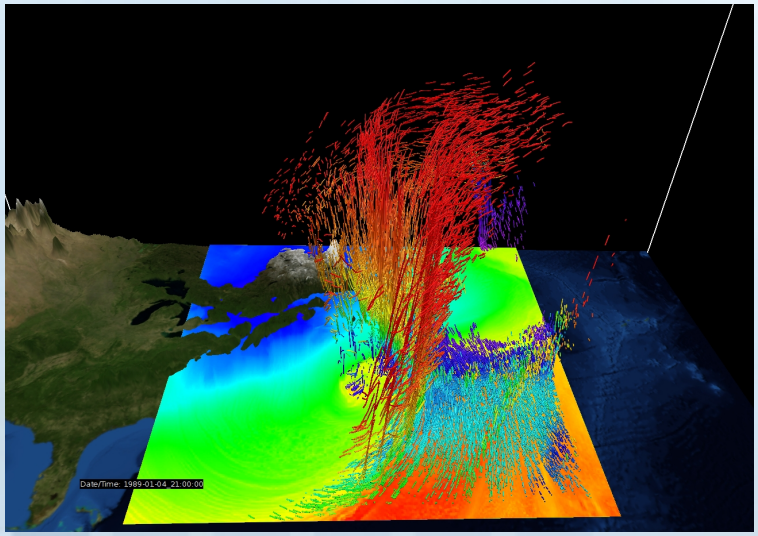

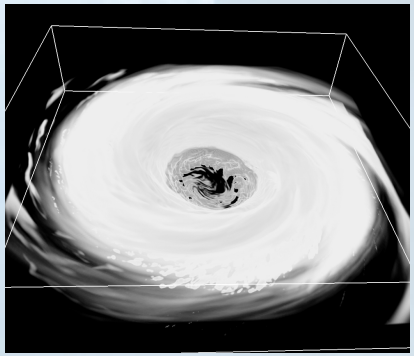

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VAPOR Visualization & Analysis Platform

VAPOR Installation

- Available for Linux, Windows, or Mac systems
- Should have a reasonably modern graphics card
  - nVidia, ATI or AMD graphics cards are good; others may not perform all visualizations.
- From the VAPOR website http://www.vapor.ucar.edu: Download appropriate binary installer from the VAPOR download page, follow the installation instructions.
- You will need Administrative privileges on Mac
- Note that on Linux and Mac you need to source vapor-install.csh in your shell before running any VAPOR commands.
- Run the vaporgui application to visualize your data

VAPOR visualization of WRF-ARW data

NCAR

A short summary of VAPOR capabilities

1. Read or convert WRF-ARW output files
2. Apply geo-referenced images to the terrain
3. Calculate 2D and 3D derived variables in Python
4. Volume render 3D variables
5. Display isosurfaces of 3D variables
6. Display color-mapped 2D variables on planes or terrain-mapped.
7. Use wind barbs to show flow direction and speed
8. Display streamlines or path lines in scene
9. Insert contour planes, use them to position flow seeds.
10. Image-based flow shows flow motion in 2D slices
11. Create animated 3D sequences

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VAPOR Visualization & Analysis Platform

Reading or converting WRF-ARW output files

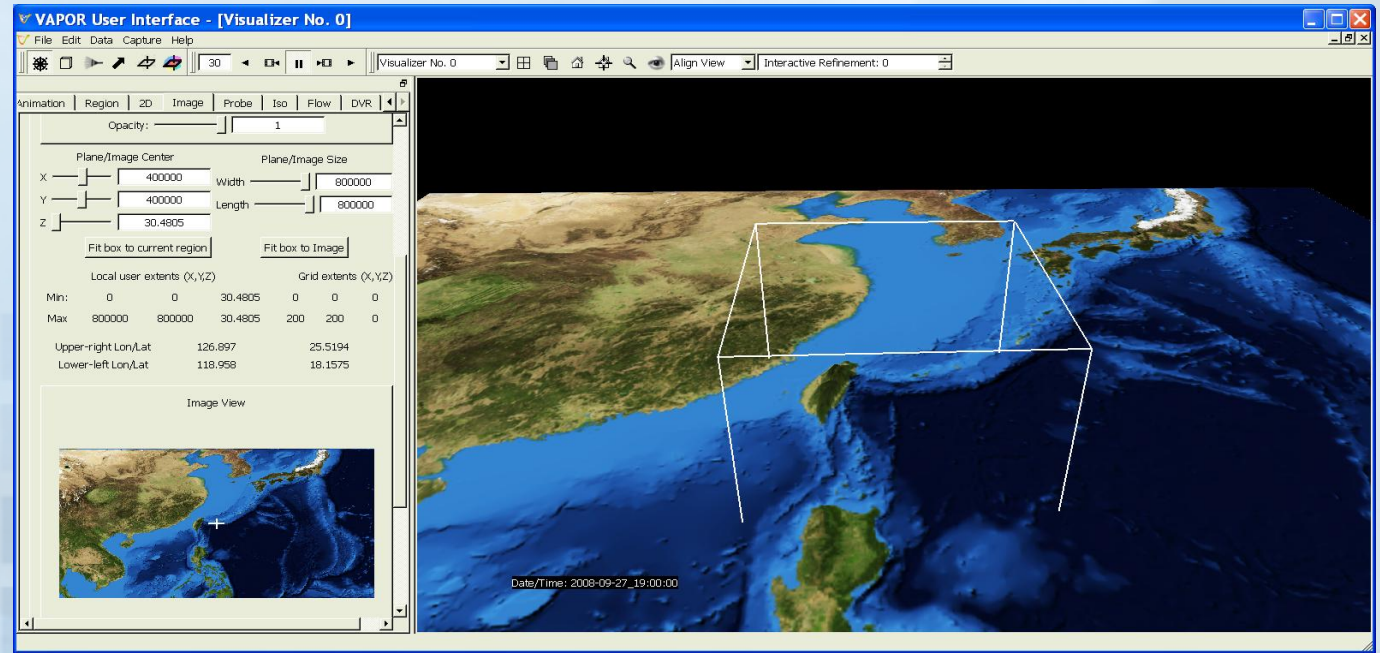
- To directly read WRF output:
  - Run vaporgui
  - All data must be on the same grid, using the same nesting level.
  - Specify "Import WRF-ARW output files" from the Data menu, and select all the wrfout files to visualize
- For interactive visualization of large WRF-ARW datasets, it's best to convert WRF data to the VAPOR data format, using wrfvdfcreate and wrf2vdf utilities.
  - `wrfvdfcreate wrfoutfiles… vdffile.vdf`

    creates a VAPOR metadata file "vdffile.vdf" that describes a set of wrfout files.
  - `wrf2vdf vdffile.vdf wrfoutfiles…`

    converts the specified wrfout files to a vapor data collection
  - From the vaporgui Data menu, load the file "vdffile.vdf" to visualize the converted data

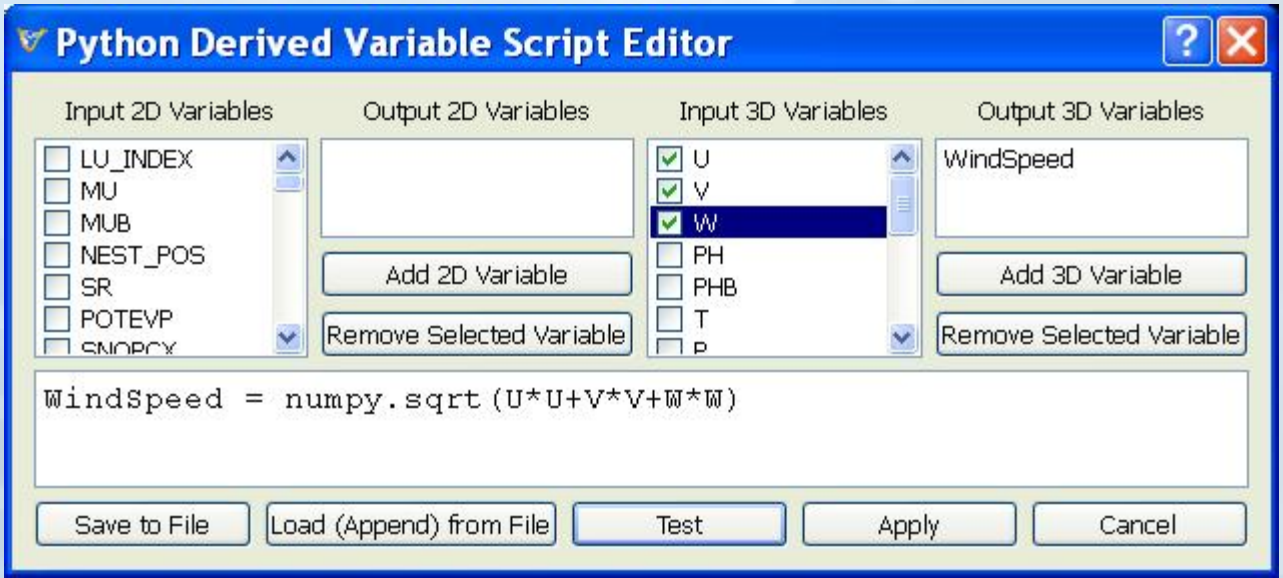
Apply images to use in the VAPOR scene

- Geo-referenced satellite images can be retrieved from the Web, and VAPOR will insert them at the correct world coordinates.
  - VAPOR provides a shell script “getWMSImage.sh” that can be used to retrieve Web Mapping Service images for a specified longitude/latitude rectangle
- Also, several useful images are installed with vapor; e.g. state or national boundary maps, NASA’s Blue Marble image of the earth.
- From the image panel, specify the image file, apply to terrain.

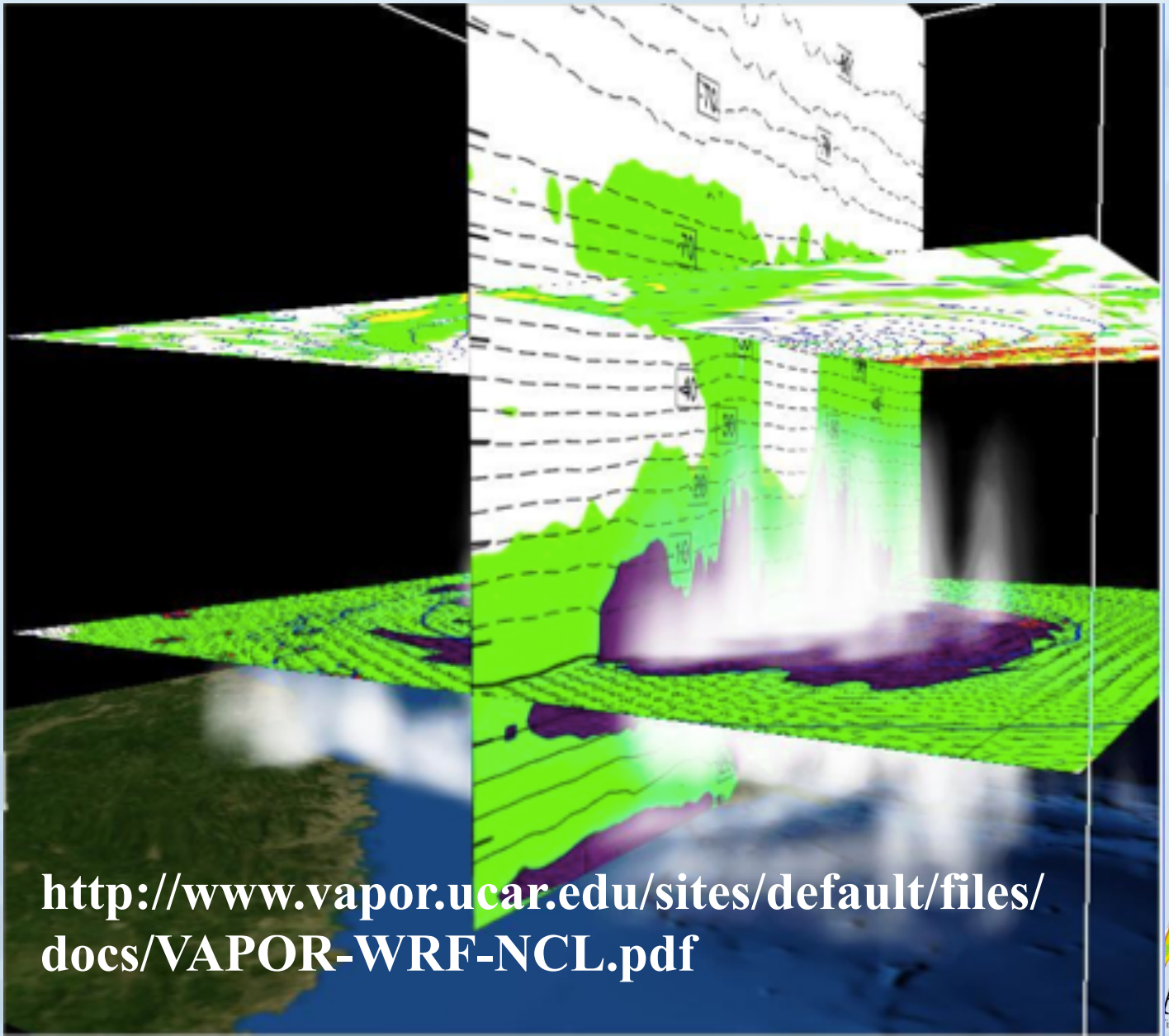


Create derived variables with Python

- From the Edit menu, “Edit Python program defining a new variable”
- Use Python script editor to define variables as arithmetic expressions of other variables.
- Variables are evaluated and cached as needed for visualization
- Python functions are also provided to derive several useful variables from WRF data; e.g. cloud-top temperature, relative humidity, potential vorticity, sea-level pressure, dewpoint temperature, radar reflectivity, equivalent potential temperature, wind shear, temperature in degrees Kelvin.



VAPOR / NCL

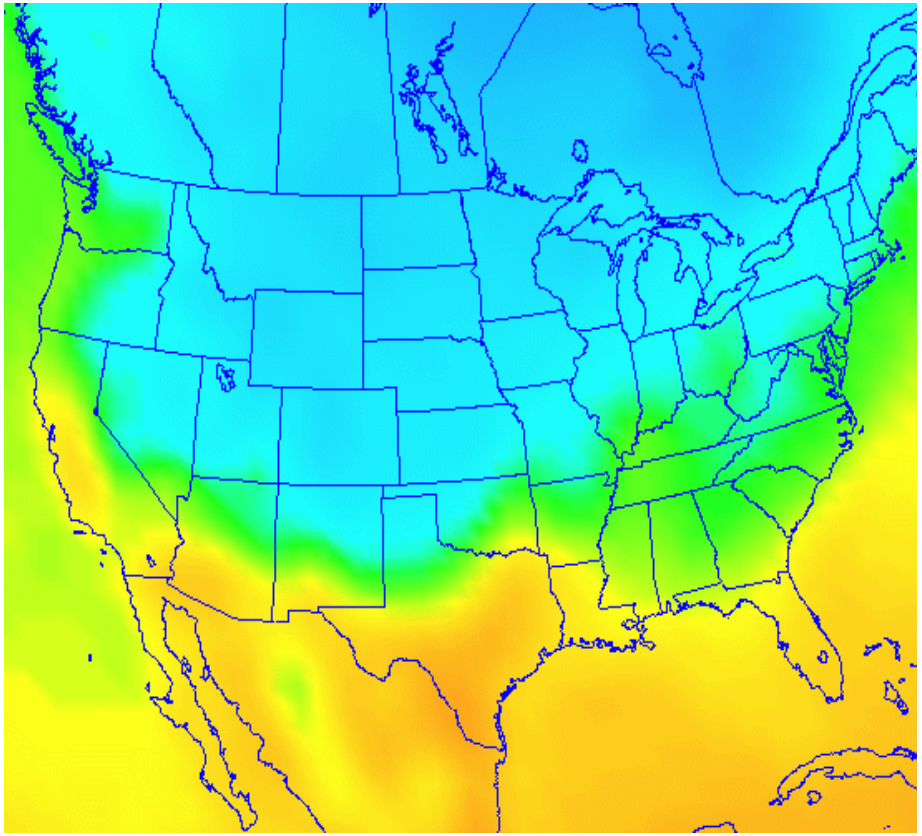


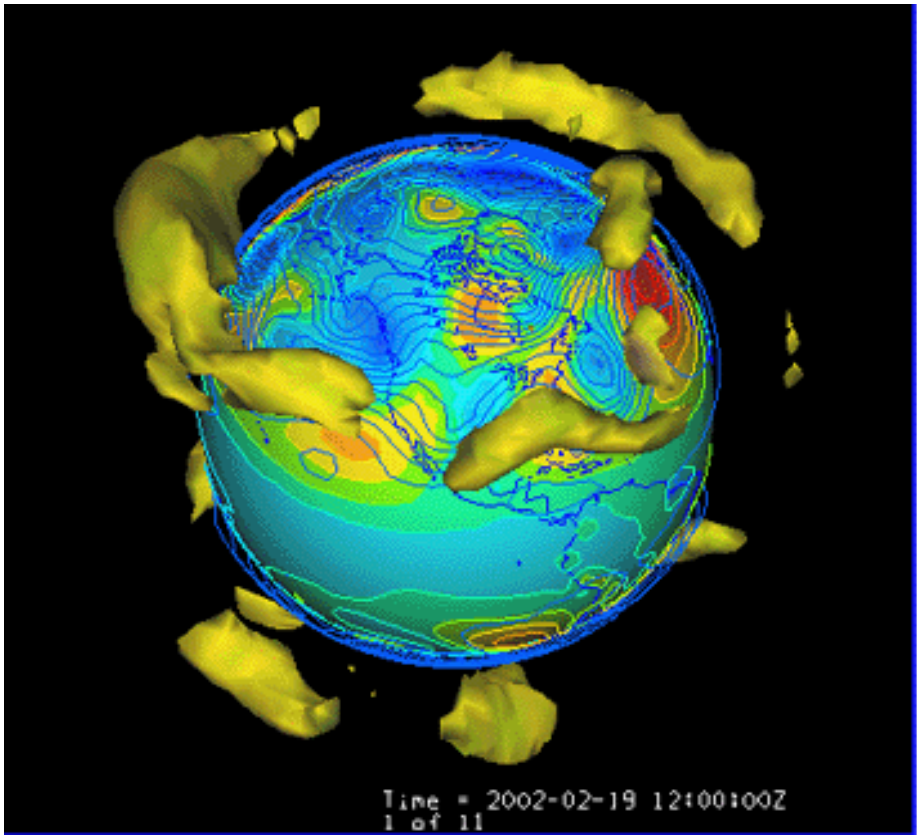
http://www.vapor.ucar.edu/sites/default/files/docs/VAPOR-WRF-NCL.pdf

Integrated Data Viewer

Yuan Ho and Julien Chastang
Unidata Program Center/UCAR

Unidata IDV – What can it do?





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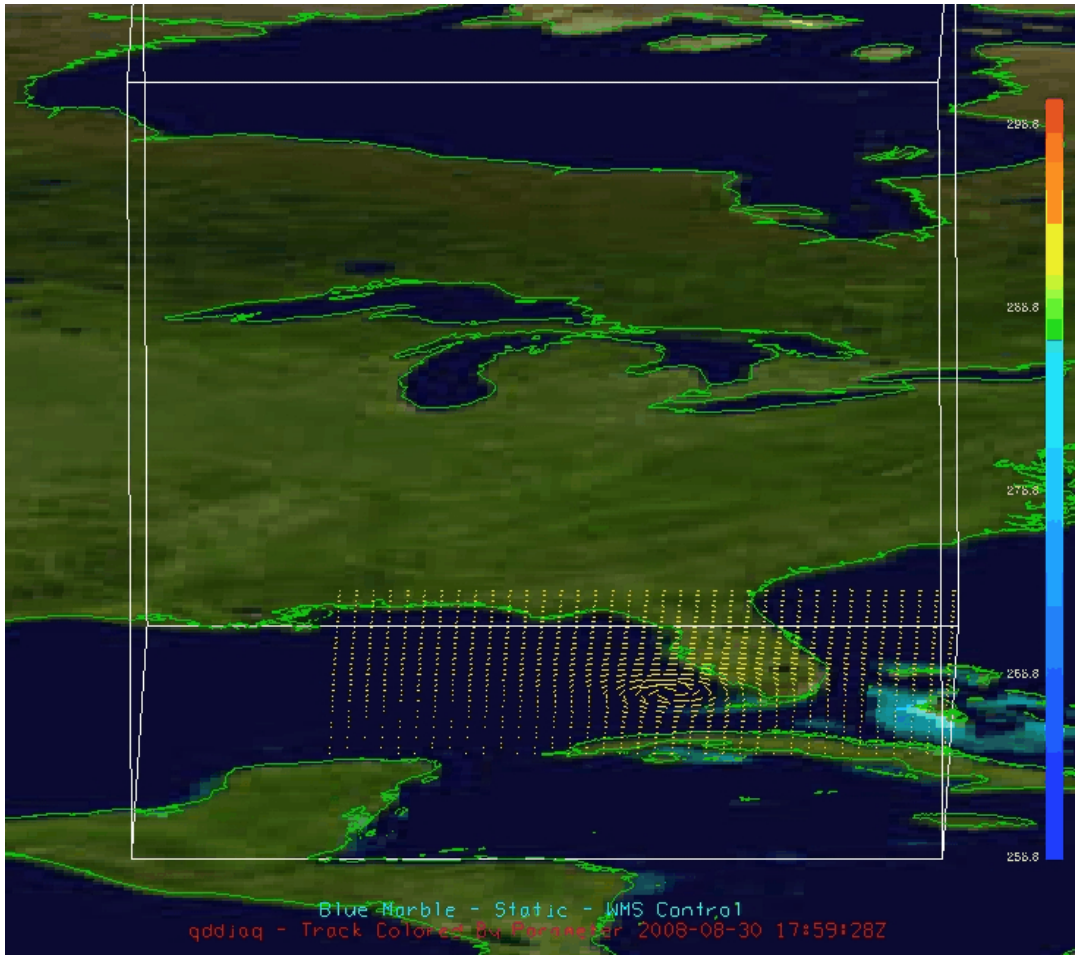
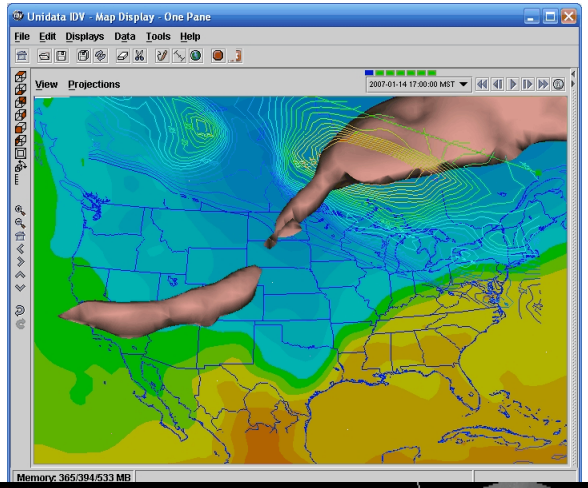
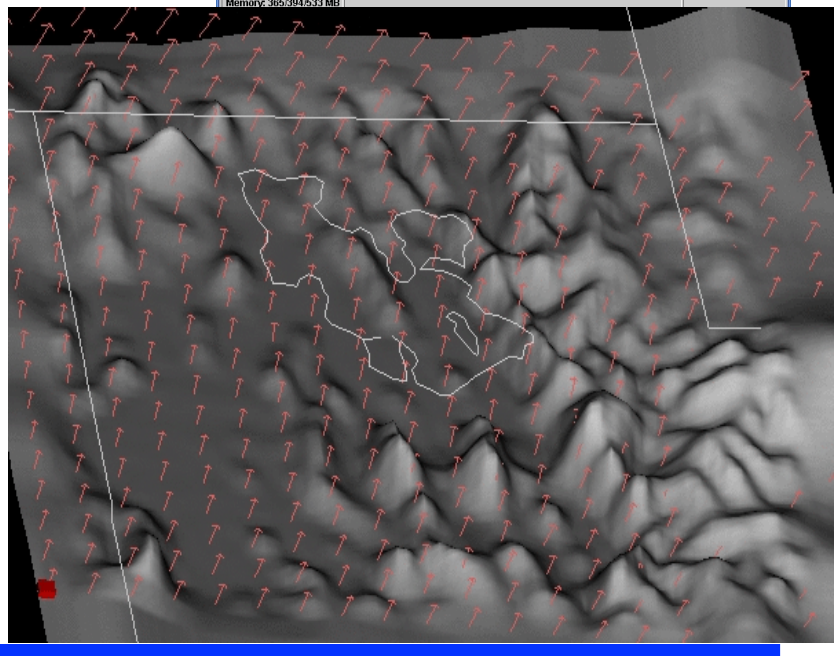


Unidata IDV – What is it?

- **Unidata Integrated Data Viewer**
  - 2D and 3D visualization
    - GUI or scripting (Jython, ISL) interface
  - Interactive probes for dataset exploration
    - Parameter readouts, vertical profiles, time/height displays, etc.
  - A rich set of analysis capabilities
  - Integrate model and observational data
  - Access local and remote datasets
  - Visualize and analyze post-processed WRF output
    - works best if grid is unstaggered





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

Unidata IDV – Where to get it?

- 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
- IDV Youtube Channel
  - https://www.youtube.com/playlist?list=PLQut5OXpV-0gqVk8LFD6Riv6X3QcAVw_U