

WRF Data and Utilities

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Supported Post-processing Packages

http://www2.mmm.ucar.edu/wrf/users/docs/user_guide_V3.8/contents.html

Package	Users' Guide Page #	Information
NCL	9-2	Graphical package Supported by NCAR/CISL (wrfhelp@ucar.edu and ncl-talk@ucar.edu)
ARWpost	9-29	Converter (GrADS) (wrfhelp@ucar.edu)
RIP4	9-20	Converter and interface to graphical Package, NCAR graphics (wrfhelp@ucar.edu)
UPP	9-36	Converter (GrADS & GEMPAK) (upp-help@ucar.edu)
VAPOR	9-38	Converter and graphical package Supported by VAPOR (vapor@ucar.edu)
IDV	None – see unidata.ucar.edu	GRIB (from UPP) GEMPAK (from wrf2gem) Vis5d CF compliant data (from wrf_to_cf) Supported by unidata (support@unidata.ucar.edu)
GEMPAK	None - see: unidata.ucar.edu/ software/gempak	Data from wrf2gem or UPP Supported by unidata (support@unidata.ucar.edu)

Choosing the Right Tool

- Can it read your data?
- Will you need to pre-process the data first?
- Is it purely a visualization tool, or does it include post-processing?
- Can it handle big datasets?
- Which diagnostic/statistical functions does it have?
- How easy is it to add diagnostics?
- 3D or 2D visualization?
- Can it handle staggered grids?
- How are data below the ground handled?
- Vertical grids?
- How are model time stamps handled?
- Easy to use?
- Cost of package?
- How well supported is it?

Data Handling

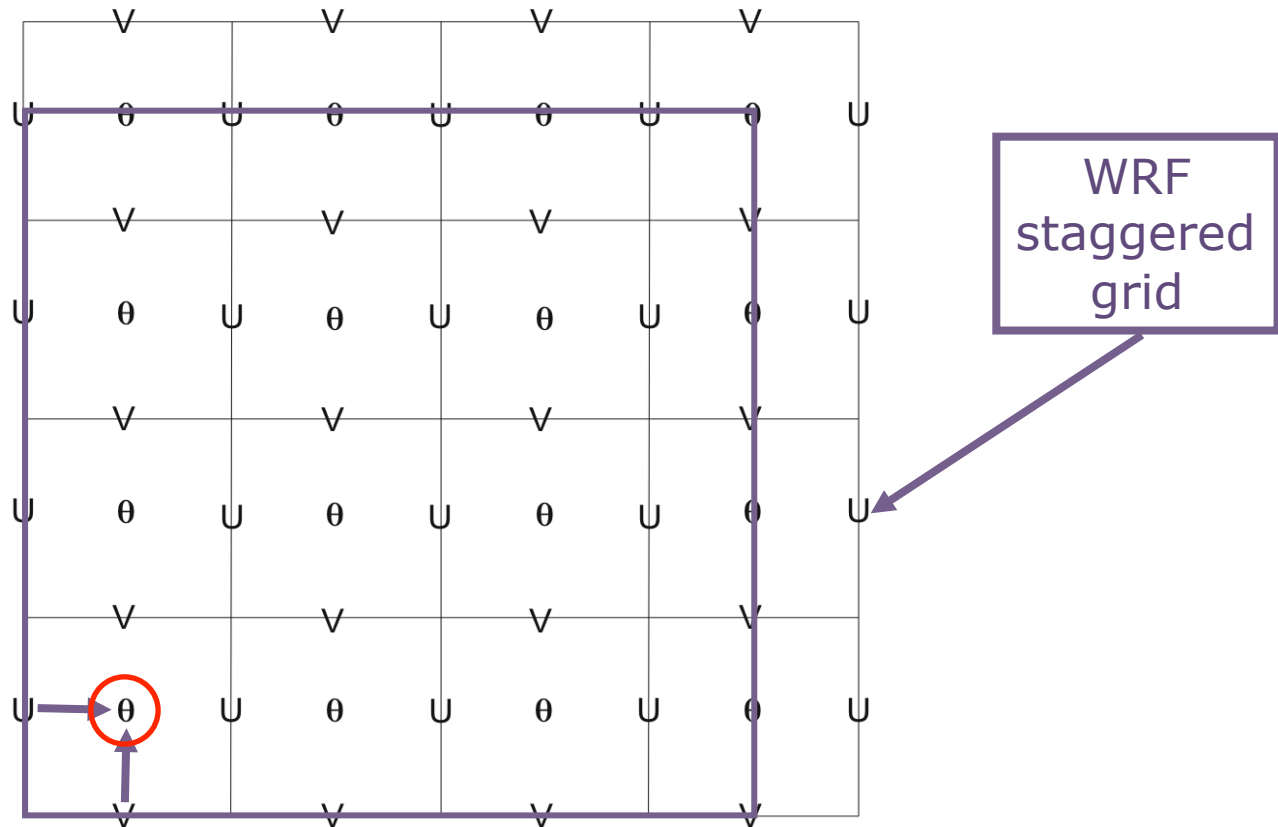
	NCL	RIP4	GrADS	UPP	VAPOR	IDV
netCDF		ripdp	ARWpost	converter	converter	converter
GRIB						
ASCII						
shapefiles						
geogrid & metgrid output						
intermediate file format	V6.2.0 V6.3.0					
wrfinput data						
Idealized data						
wrfoutput						
big data						

Post-processing

	NCL	RIP4	GrADS	UPP	VAPOR	IDV
Post-processing						
Data output						
3D						
diagnostics	some	a lot	some	some	limited	limited
Add diagnostics	Very easy	easy	easy	Relatively easy	Not as easy	Not as easy
Vertical output Coordinate	Model pressure height	Model pressure height	Model pressure height	pressure	model	model
Extrapolate Below ground						

Model Staggering

Why is a converter necessary if a package can display netCDF files?



Converter co-locates data to mass points

ARWpost

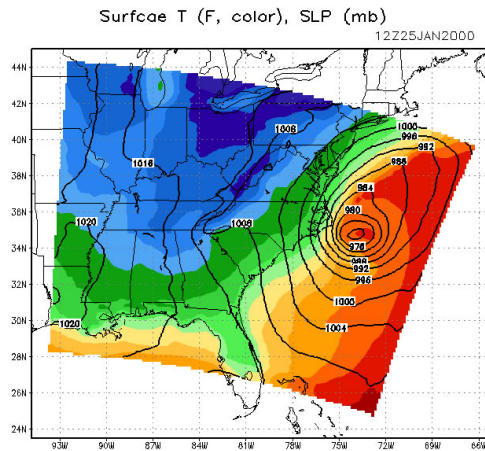


ARWpost: General Information

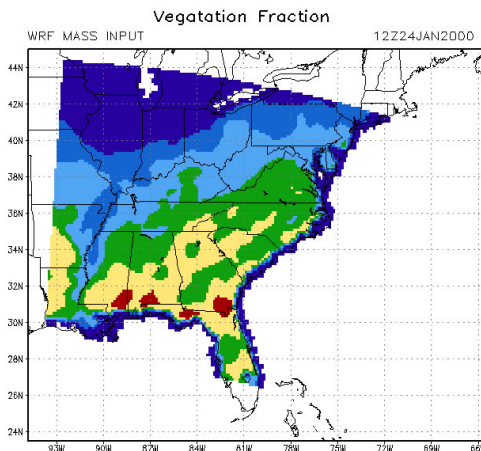
- Converter
 - Reads in wrf-arw model data, creates GrADS output files
 - Requires GrADS to display
- GrADS software is only needed to display data, not needed to compile the code
 - <http://www.iges.org/grads/grads.html>
- Generate a number of graphical plots
 - Horizontal
 - Cross-section
 - skewT
 - Meteogram
 - Panel
- Download Code
 - http://www2.mmm.ucar.edu/wrf/users/download/get_sources.html
- Online Tutorial
 - <http://www2.mmm.ucar.edu/wrf/users/graphics/ARWpost/ARWpost.htm>

ARWpost: Example Plots

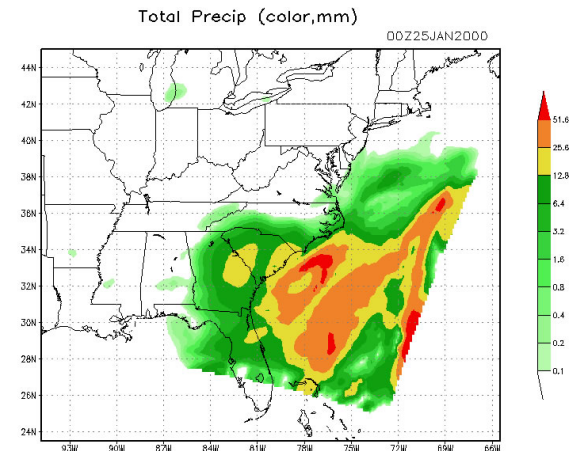
Surface Temp



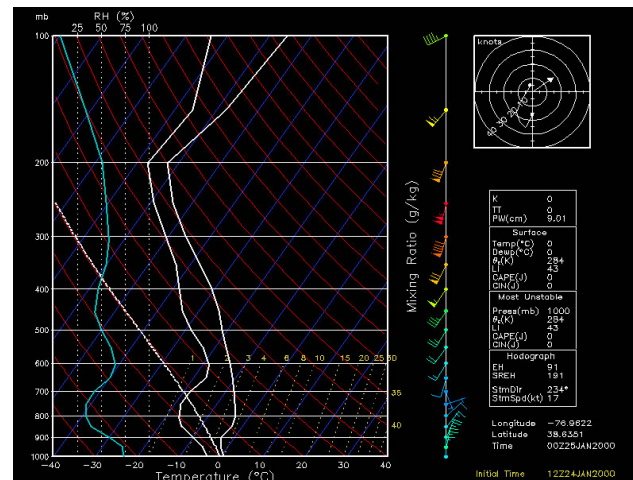
Vegetation Fraction



Total Precipitation

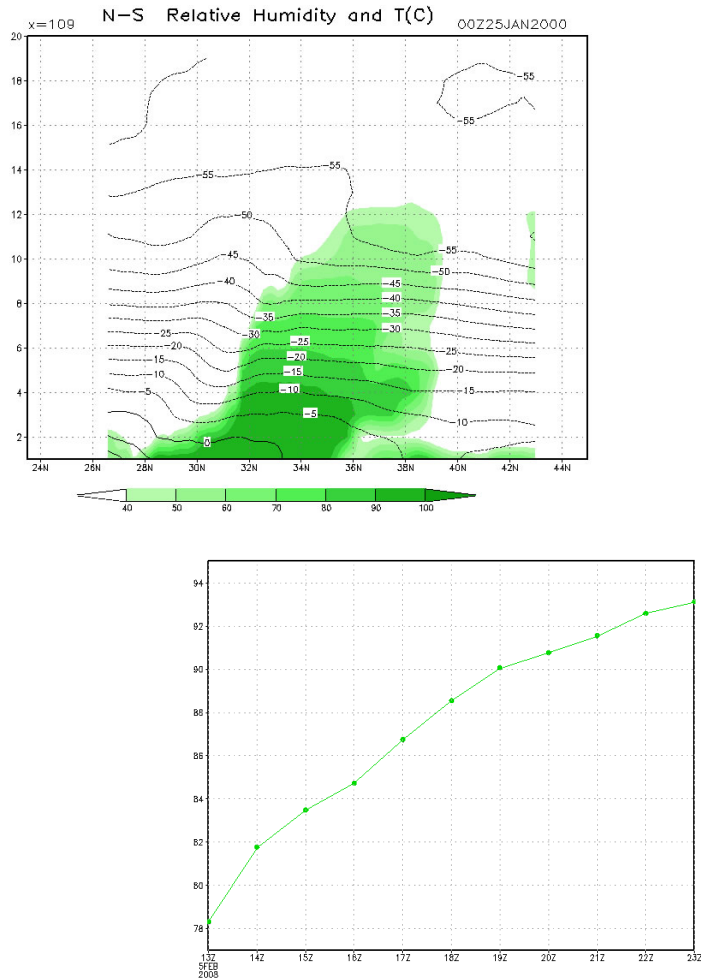


Skew-T Diagram

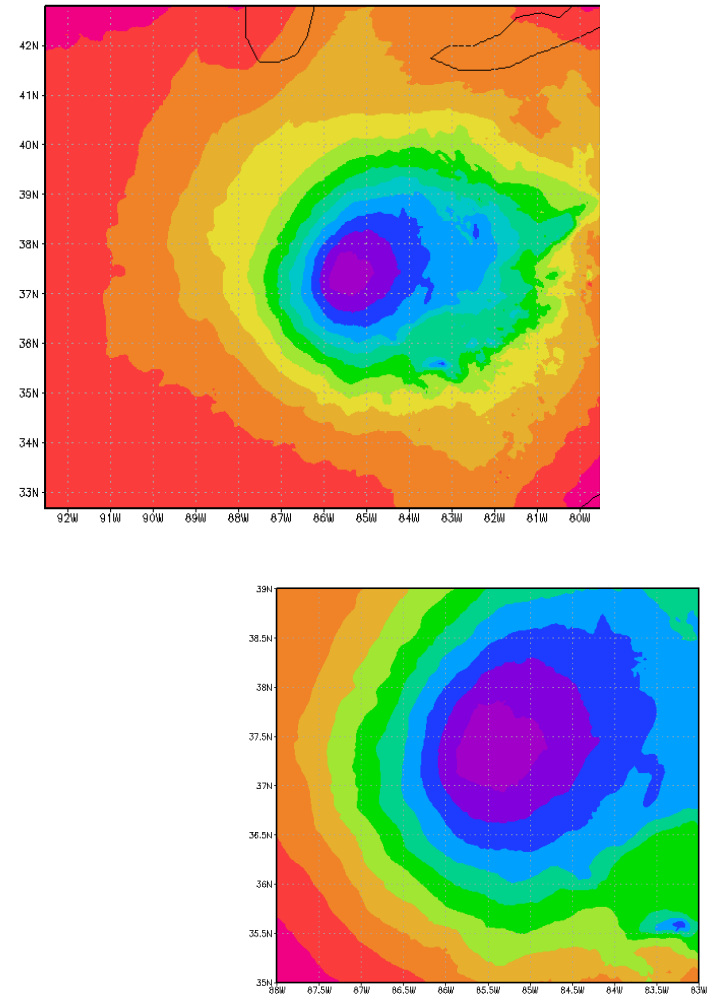


ARWpost: Example Functions

Cross-Sections



Zooming



ARWpost: Diagnostics

- cape – 3d cape
- cin – 3d cin
- mcape – maximum cape
- mcin – minimum cin
- clfr – low/middle/high cloud fraction
- dbz – 3d reflectivity
- max_dbz – maximum reflectivity
- geopt – geopotential
- height – model height in km
- lcl – lifting condensation level
- lfc – level of free convection
- pressure – full model pressure in hPa
- rh – relative humidity
- rh2 – 2 m relative humidity
- theta – potential temperature
- tc – temperature in degrees C
- tk – temperature in degrees K
- td – dew point temperature in degrees C
- td2 – 2m dew point temperature in degrees C
- slp – sea level pressure
- umet & vmet – winds rotated to Earth coordinates
- u10m & v10m – 10 m winds rotated to Earth coordinates
- wdir – wind direction
- wspd – wind speed coordinates
- wd10 – 10 m wind direction
- ws10 – 10 m wind speed

ARWpost: Scripts

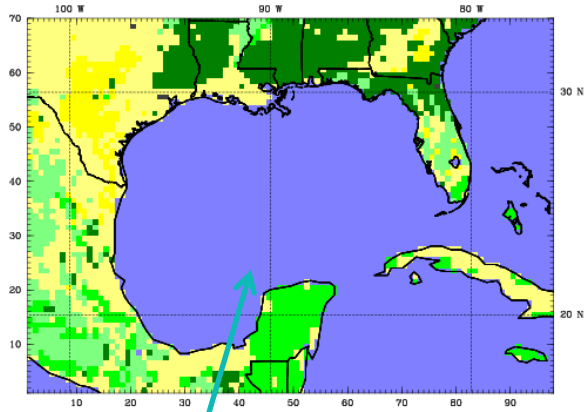
Script Name	Description
cbar.gs	Plots a color bar on shaded plots
rgbset.gs	Allows you to add/change colors from color # 20 – 99
skew.gs	Program to plot a skewT
plot_all.gs	Automatically finds all .ctl files in the directory and lists them so the user can pick when to use, will plot all fields chosen
rain.gs (real data only)	Plots total rainfall (must have data that contain fields RAINC and RAINNC)
cross_z.gs (real data only)	Plots a NS and EW cross section of RH and T (C)

RIP4



RIP4: Example Plots

Dataset: katrina RIP: katrina Init: 0000 UTC Sun 28 Aug 05
Fcst: 0.00 h Valid: 0000 UTC Sun 28 Aug 05 (1800 MDT Sat 27 Aug 05)
Land use category



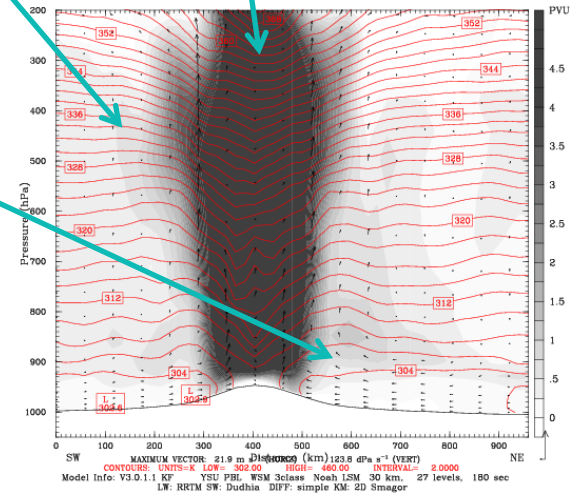
Landuse Category

Potential Temp

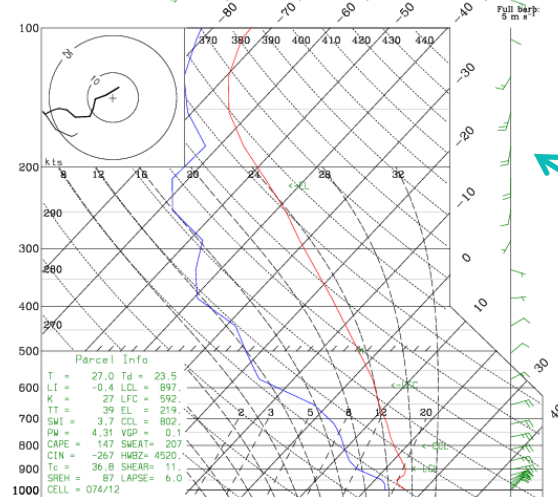
Potential Vorticity

Circulation Vectors

Dataset: katrina RIP: katrina Init: 0000 UTC Sun 28 Aug 05
Fcst: 12.00 h Valid: 1200 UTC Sun 28 Aug 05 (0600 MDT Sun 28 Aug 05)
Potential vorticity XY = 45.0, 30.0 to 70.0, 50.0
Potential temperature XY = 45.0, 30.0 to 70.0, 50.0
Circulation vectors XY = 45.0, 30.0 to 70.0, 50.0



Dataset: katrina RIP: katrina Init: 0000 UTC Sun 28 Aug 05
Fcst: 12.00 h Valid: 1200 UTC Sun 28 Aug 05 (0600 MDT Sun 28 Aug 05)
Temperature x,y = 44.86, 56.37 lat,lon = 29.99, -90.25 stn=KMSY,72231
Dewpoint temperature x,y = 44.86, 56.37 lat,lon = 29.99, -90.25 stn=KMSY,72231
Horizontal wind vectors x,y = 44.86, 56.37 lat,lon = 29.99, -90.25 stn=KMSY,72231



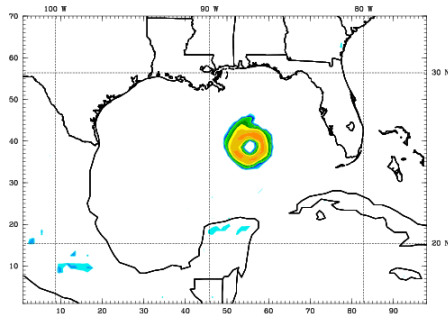
Skew-T Diagram

RIP4: Example Plots

Dataset: katrina RIP: typhoon Init: 0000 UTC Sun 28 Aug 05
Fcst: 0.00 h Valid: 0000 UTC Sun 28 Aug 05 (1800 MDT Sat 27 Aug 05)
Typhoon Track

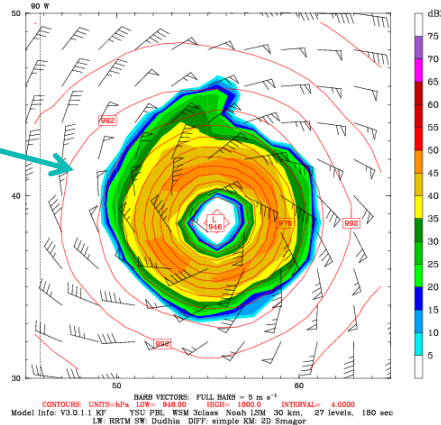
Cyclone Tracking

Dataset: katrina RIP: katrina Init: 0000 UTC Sun 28 Aug 05
Fcst: 12.00 h Valid: 1200 UTC Sun 28 Aug 05 (0600 MDT Sun 28 Aug 05)
Reflectivity () at k-index = 27



Model Info: V3.0.1.1 KF YSU PBL WSM ScatS Noah LSM 30 km, 27 levels, 180 sec
LW: RRTM SW: Dudhia DIFF: simple KM: 2D Smagor

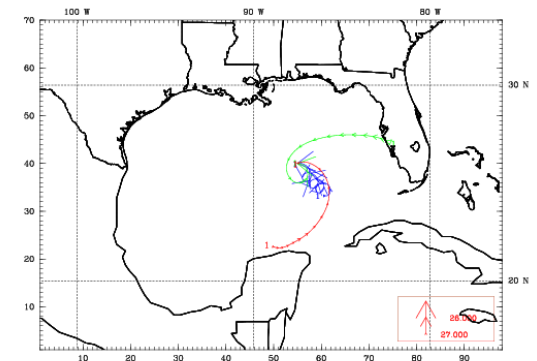
Dataset: katrina RIP: zoom Init: 0000 UTC Sun 28 Aug 05
Fcst: 12.00 h Valid: 1200 UTC Sun 28 Aug 05 (0600 MDT Sun 28 Aug 05)
Reflectivity () at k-index = 27
Sea-level pressure
Horizontal wind vectors



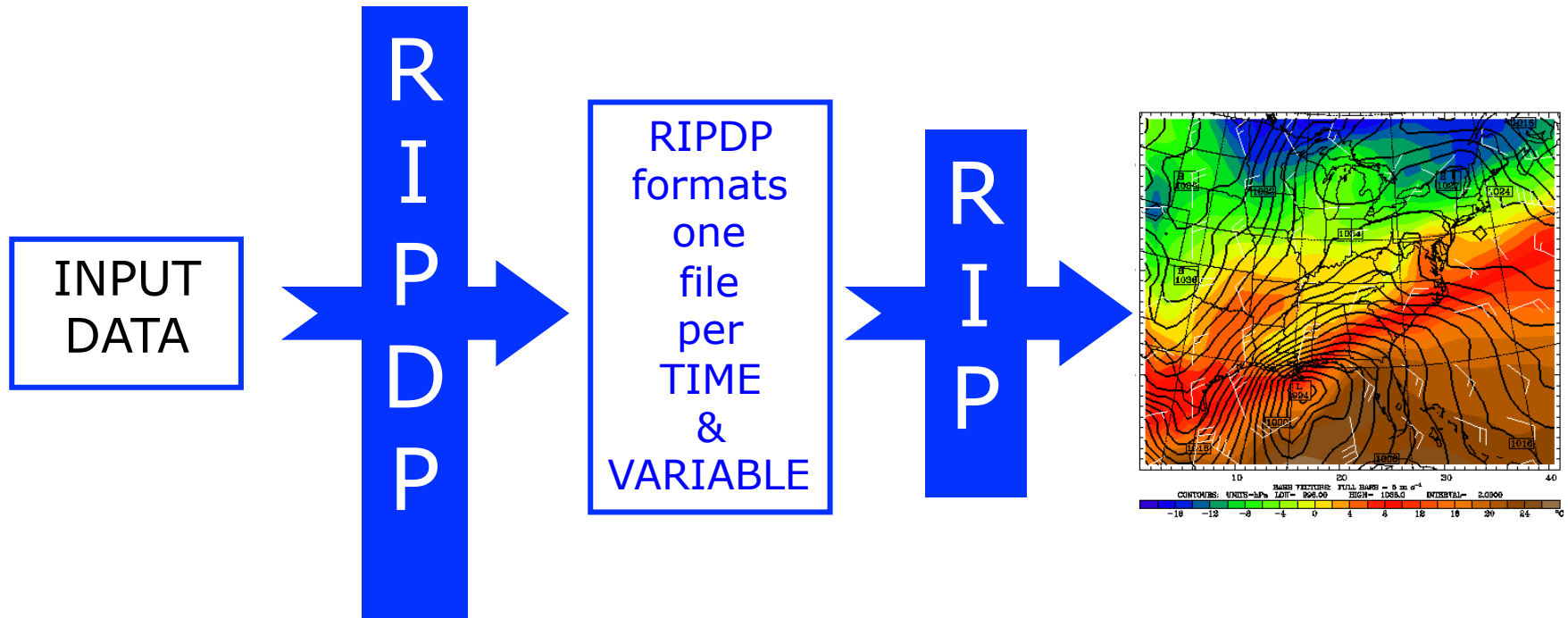
Zooming Capability

Trajectories

Dataset: katrina RIP: traj plot Init: 0000 UTC Sun 28 Aug 05
Fcst: 0.00 h Valid: 0000 UTC Sun 28 Aug 05 (1800 MDT Sat 27 Aug 05)
Trajectories from hour 0.000 to 12.000
Trajectories from hour 0.000 to 12.000
Trajectories from hour 0.000 to 12.000



RIP4: Program Flow



RIP4: General Information

- Requires NCAR Graphics Libraries
 - <http://www.ncl.ucar.edu>
- Source Code
 - http://www2.mmm.ucar.edu/wrf/users/download/get_source.html
- Documentation
 - Included in program's tar file (in Doc/ directory)
 - <http://www2.mmm.ucar.edu/wrf/users/docs/ripug.htm>
- Online Tutorial
 - <http://www2.mmm.ucar.edu/wrf/users/graphics/RIP4/RIP4.htm>

Utilities

- Graphics
- Designing a model domain
- OBSGRID
- netCDF tools
- Data
- MET

Graphics: ImageMagick

<http://www.imagemagick.org>

- Converts graphical files from one format to another
 - convert file.pdf file.png*
 - convert file.png file.bmp*
- Many options available
 - Rotate frames, trim white space, etc.
- Can make movies
 - Can create individual frames for each image
- Maintains high resolution – great for publishing!
- Cannot deal with .ncgm files

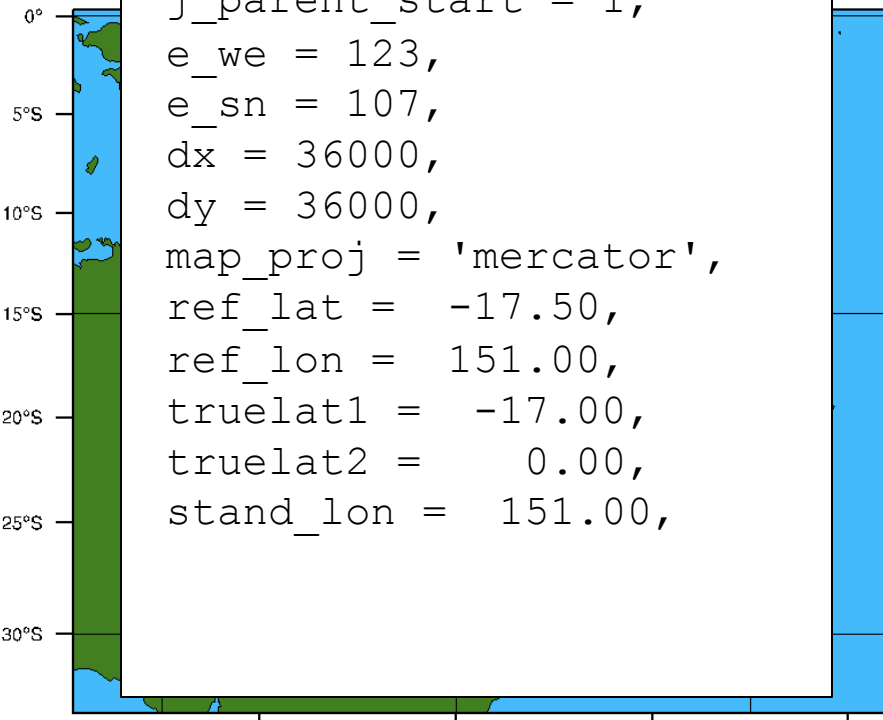
Model Domain Design

```
DOMS = 1
DX = 36.
MAP = "mercator"
LAT1 = (/ -35.0, -45., -27. /)
LAT2 = (/ 0., -20., -23. /)
LON1 = (/ 131., 121., 125./)
LON2 = (/ 171., 159., 131./)
parent_id = (/ 0, 1, 2 /)
parent_grid_ratio = (/ 1, 3, 3 /)
```

design_grids.ncl

Suggested namelist options

```
parent_id = 0,
parent_grid_ratio = 1,
i_parent_start = 1,
j_parent_start = 1,
e_we = 123,
e_sn = 107,
dx = 36000,
dy = 36000,
map_proj = 'mercator',
ref_lat = -17.50,
ref_lon = 151.00,
truelat1 = -17.00,
truelat2 = 0.00,
stand_lon = 151.00,
```



0°
5°S
10°S
15°S
20°S
25°S
30°S

140°E 150°E 160°E 170°E

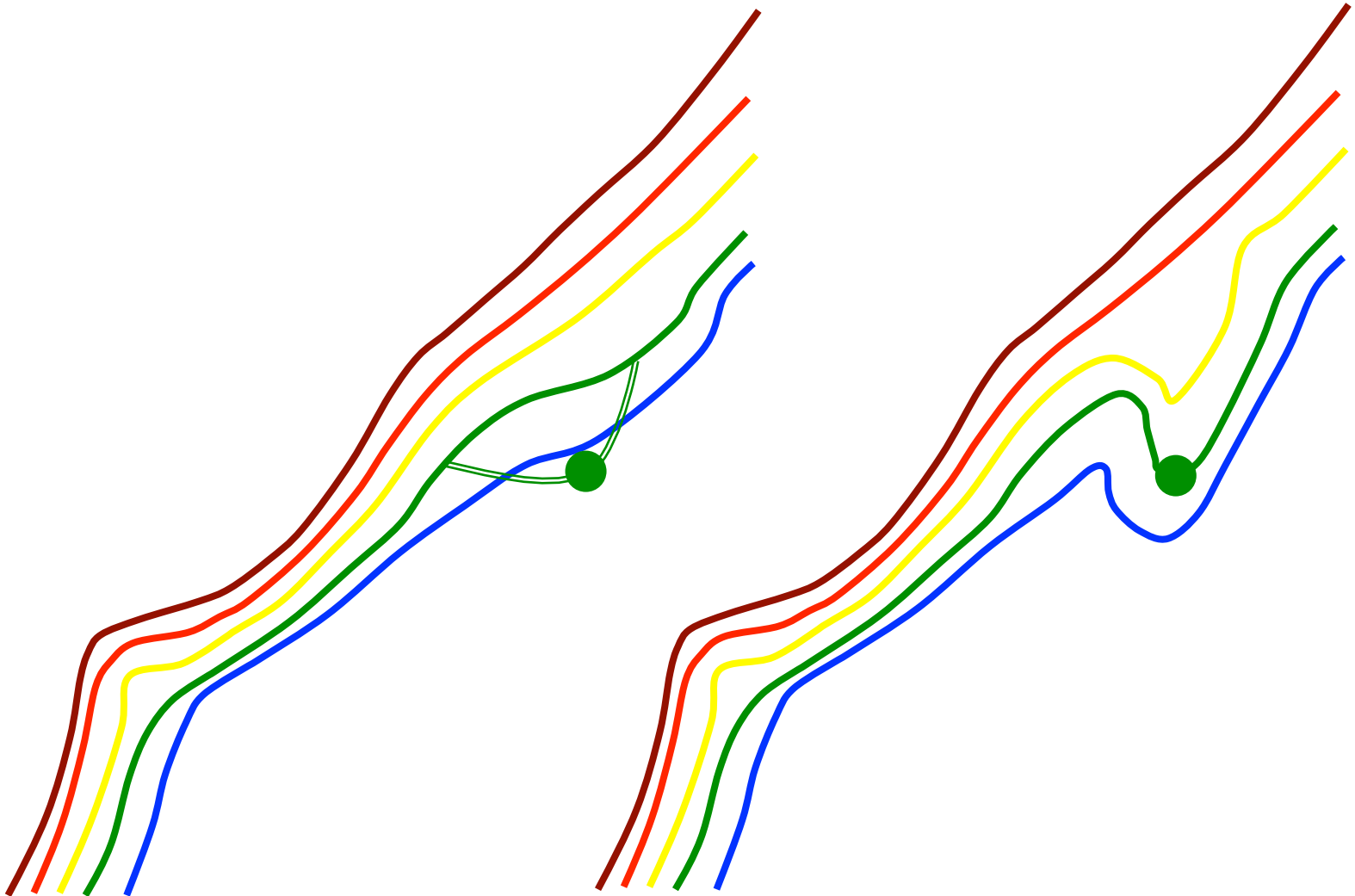
OBSGRID



OBSGRID

- To improve a first-guess gridded analysis by incorporating additional observational information
 - Traditionally first-guess analysis came from low-resolution global analysis and forecast grids
 - These days, higher-resolution, regional scale analyses are more readily available
- When is this method useful?
 - When using very coarse resolution first-guess input data
 - If you conducted a field campaign and have acquired very high-resolution station data (for example)

OBSGRID: Basic Concept



OBSGRID: How to Run

- Get the source code

<http://www2.mmm.ucar.edu/wrf/users/downloads.html>

- Compile
- Prepare observation files
- Edit the namelist.oa
- Link in met_em* files from WPS
- Run the program
 - ./obsgrid.exe
- Check your output

See the WRF Users' Guide for detailed information
http://www2.mmm.ucar.edu/wrf/users/docs/user_guide_V3/users_guide_chap7.htm

OBSGRID: How to Use to Run WRF

- Link the 'metoa_em*' files to WRF running directory

```
ln -sf ../../../../OBSGRID/metoa_em.d01.* .
```

- Add the following to the &time_control section of the namelist

```
auxinput1_inname = "metoa_em.d<domain>.<date>"
```

- Run real.exe
- Run wrf.exe

OBSGRID - Grid Nudging - Surface

- If you are interested in doing surface analysis nudging
- OBSGRID creates a file called wrfsfdda_d0*
- How to use this:
 - In &fdda, set grid_fdda = 1 and grid_sfdda = 1
 - Run real.exe and get a file called wrffdda_d01, and use with wrfsfdda_d01, wrfinput_d01, and wrfbdy_d01
 - Run wrf.exe
- For more information, refer to Jimmy Dudhia's ARW Nudging talk

OBSGRID – Observation Nudging

- Allows for input observation data & quality control
- Used if you have a large number of extra observations, and a single case study (not recommended for climate studies)
- Can get obs data from CISL (little R format)
- How to use this
 - OBSGRID creates a files called OBSDOMAIN_XXX (can concatenate files into 1: OBSDOMAIN_101)
 - In &fdda, add obs_nudge_opt = 1
 - In &time_control, add auxinput11_interval_s = 180, auxinput11_end_h = 24
 - Will need OBSDOMAIN_101, wrfinput_d01 and wrfbdy_d01 files
 - Run real.exe and wrf.exe as usual
- For more information, see http://www2.mmm.ucar.edu/wrf/users/wrfv3.1/How_to_run_obs_fdda.html and Jimy Dudhia's ARW Nudging talk

NCO Tools

<http://nco.sourceforge.net>

- netCDF Operators are command-line programs that take netCDF (HDF and/or DAP) files as input, then operate (e.g., derive new data, compute stats, print, manipulate metadata) and output to the screen or files in various formats (text, binary, netCDF, etc.)
- ncdiff
 - Shows the differences between 2 files

```
ncdiff input1.nc input2.nc output.nc
```
- nccat (nc cat)
 - Writes specified variables/times to a new file

```
nccat -d Time,0,231 -v RAINNC wrfout* RAINNC.nc
```
- ncra (nc average)
 - Averages variables and writes to a new file

```
ncra -v OLR wrfout* -o OLR.nc
```
- ncks (nc kitchen sink)
 - Combination of all NCO tools in 1
 - Specifically nice for splitting files

```
ncks -d Time,1,1 wrfout -o wrfout1.nc
```

NCO Tools: Other Available Operators

- **ncap2**: arithmetic processor
- **ncatted**: ATtribute editor
- **ncbo**: binary operator (includes ncadd, ncsubtract, ncmultiply, ncdivide)
- **ncea**: ensemble averager
- **ncecat**: ensemble conCATenator
- **ncflint**: FiLe INTerpolator
- **ncpdq**: permute dimensions quickly, pack data quietly
- **ncrename**: RENAME-er
- **ncwa**: weighted averager

ncview

http://meteora.ucsd.edu/~pierce/ncview_home_page.html

no variable selected

Ncview 1.93a David W. Pierce 1 Feb 2006

*** SELECT A VARIABLE TO START ***

Quit

→1

⏮

⏪

⏸

⏩

⏭

Edit

?

Delay:

Opts

3gauss

Inv P

Inv C

Mag X1

Linear

Axes

Range

blowup

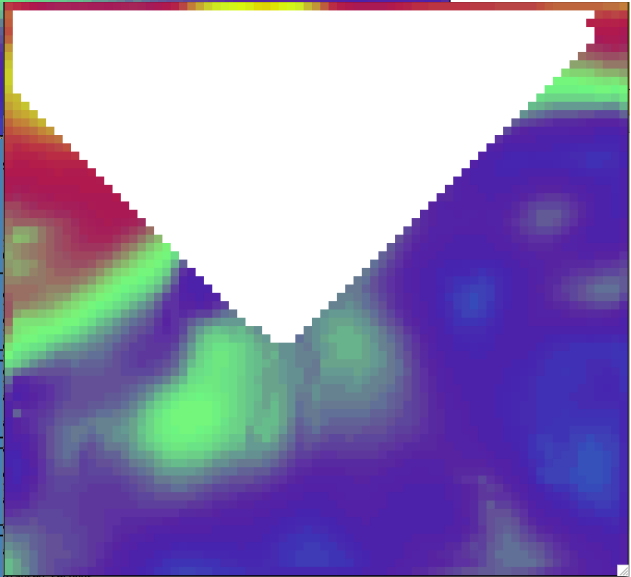
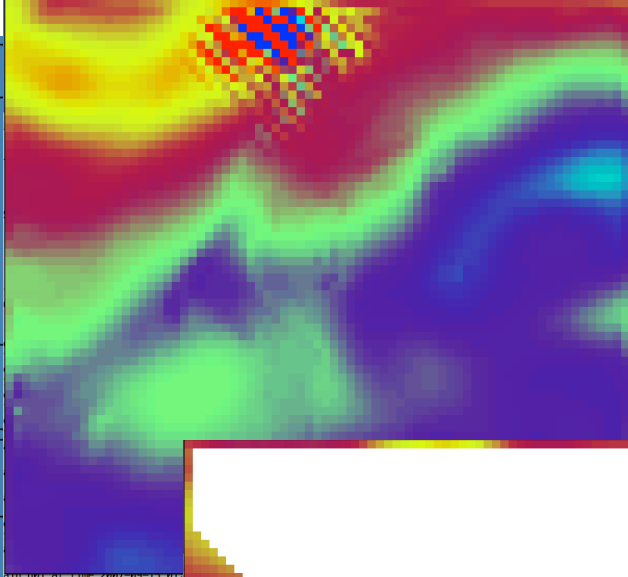
Print

(18) 1d vars

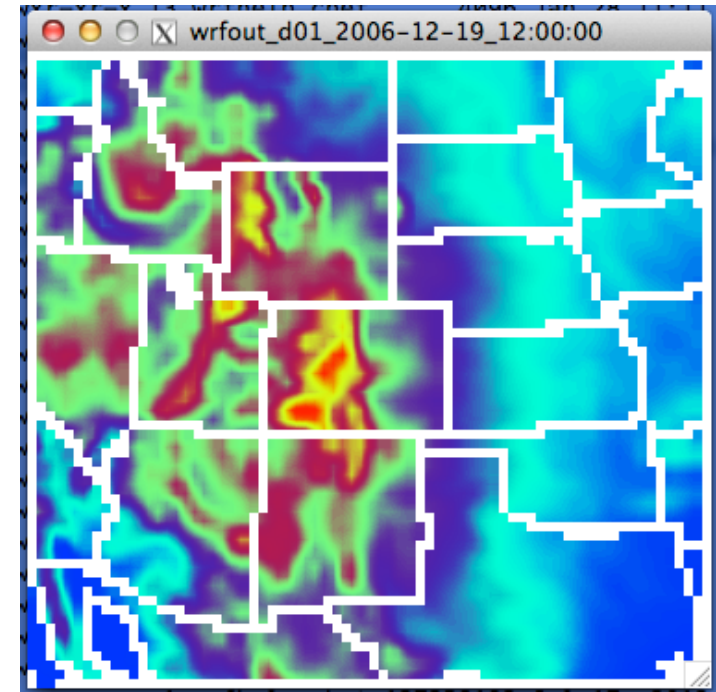
(48) 2d vars

(13) 3d vars

Dim:	Name:	Min:	Current:	Max:	Units:
	Time	Min:	<input type="text" value="Current:"/>	Max:	Units:
	bottom_top	Min:	<input type="text" value="Current:"/>	Max:	Units:
	south_north	Min:	<input type="text" value="Current:"/>	Max:	Units:
	west_east_st	Min:	<input type="text" value="Current:"/>	Max:	Units:



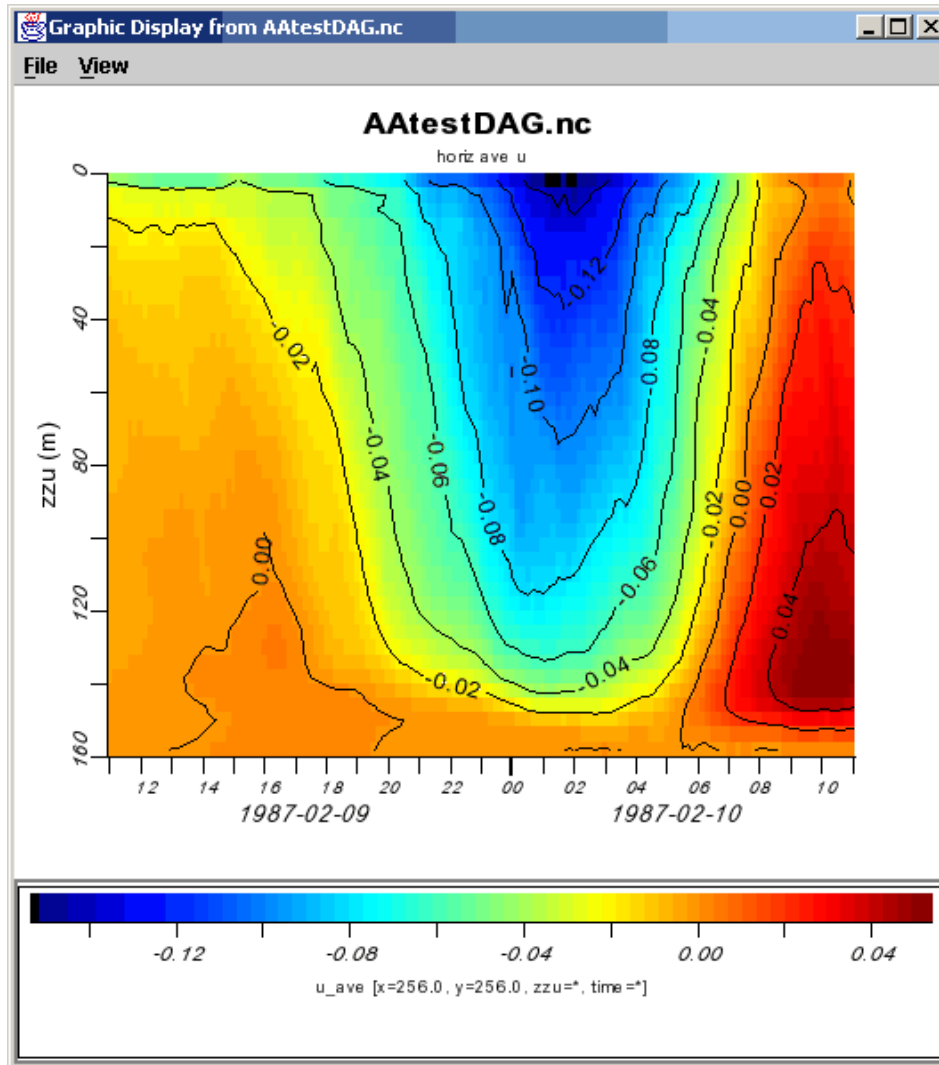
ncview



- Beginning V3.7
- Works with all WRF .nc output files (geo_em*, met_em*, wrfinput*, etc.)
- Must have 1 time period per file

ncBrowse

<http://www.epic.noaa.gov/java/ncBrowse/>



ncdump

- Reads a netCDF dataset and prints information from that dataset
- `ncdump -h file`
 - Prints header (inclusive list of variables in the file)
- `ncdump -v VAR file`
 - Prints data for the variable 'VAR'
- `ncdump -v Times file`
 - Prints the times that are included in the file

ncdump -v Times

```
netcdf wrfout_d01_2000-01-24_12:00:00 {
dimensions:
    Time = UNLIMITED ; // (3 currently)
    DateStrLen = 19 ;
    west_east = 73 ;
    south_north = 60 ;
    west_east_stag = 74 ;
    bottom_top = 27 ;
    south_north_stag = 61 ;
    bottom_top_stag = 28 ;
variables:
    char Times(Time, DateStrLen) ;
    float LU_INDEX(Time, south_north, west_east) ;
        LU_INDEX:FieldType = 104 ;
        LU_INDEX:MemoryOrder = "XY " ;
    LU_INDEX:description = "LAND USE CATEGORY" ;
        LU_INDEX:units = "" ;
        LU_INDEX:stagger = "" ;

.....

global attributes:

        :TITLE = " OUTPUT FROM WRF V3.4.1 MODEL";
        :START_DATE = "2000-01-24_12:00:00" ;
        :WEST-EAST_GRID_DIMENSION = 74 ;
        :SOUTH-NORTH_GRID_DIMENSION = 61 ;
        :BOTTOM-TOP_GRID_DIMENSION = 28 ;
        :DX = 30000.f ;
        :DY = 30000.f ;

.....

data:
    Times =
        "2000-01-24_12:00:00",
        "2000-01-24_18:00:00",
        "2000-01-25_00:00:00"
```

Input Data



Input Data: Mandatory Fields

- **3D Data (data on pressure levels, for example)**

- Temperature

- U and V components of wind

- Geopotential Height

- Relative Humidity/Specific Humidity

- **2D Data**

- Surface pressure

- Mean sea-level pressure

- Skin temperature/SST

- 2 meter temperature and relative humidity

- 10 meter U and V components of wind

- Soil data (temperature and moisture) and soil height

- **Recommended Fields**

- LANDSEA mask field for input data

- Water equivalent snow depth

- SEAICE

External Data Sources: Global

Name	Resolution	Coverage	Temporal Availability	Website
NCEP/NCAR Reanalysis (R1)	2.5°	Global	Jan 1948 – present	http://rda.ucar.edu/datasets/ds090.0
NCEP/DOE Reanalysis (R2)	2.5°	Global	Jan 1979 – present	http://rda.ucar.edu/datasets/ds091.0
ERA Interim Data	0.7°	Global	Jan 1979 – present	http://rda.ucar.edu/datasets/ds627.0
ECMWF's Operational Model Analysis	Highest Resolution of the DA and forecast system		Jan 2011 – present	http://rda.ucar.edu/datasets/ds113.0
NCEP GDAS/FNL Reanalysis	0.25°	Global	July 2015 – present	http://rda.ucar.edu/datasets/ds083.3
GFS Real-time	1°	Global		ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/gfs
NCEP GFS/FNL Reanalysis	1°	Global	Aug 1999 – present	http://rda.ucar.edu/datasets/ds083.2
GFS Gridded Model Data	0.5°	Global	Dec 2002 – present	http://rda.ucar.edu/datasets/ds335.0
NCEP GFS 0.25°	0.25°	Global	Jan 2015 – present	http://rda.ucar.edu/datasets/ds084.1

External Data Sources: North America

Name	Resolution	Coverage	Temporal Availability	Website
NAM Real-time	32/12 km	North America		ftp:// ftpprd.ncep.noaa.go v /pub/data/nccf/ com/nam
NAM Analysis	12 km	North America	Jan 2012 – present	http://rda.ucar.edu/ datasets/ds609.0
GCIP NCEP Eta	40 km	North America	April 1995 – present	http://rda.ucar.edu/ datasets/ds609.2
NCEP NARR	32 km	North America	Nov 1979 – present	http://rda.ucar.edu/ datasets/ds608.0

External Data Sources: Climate

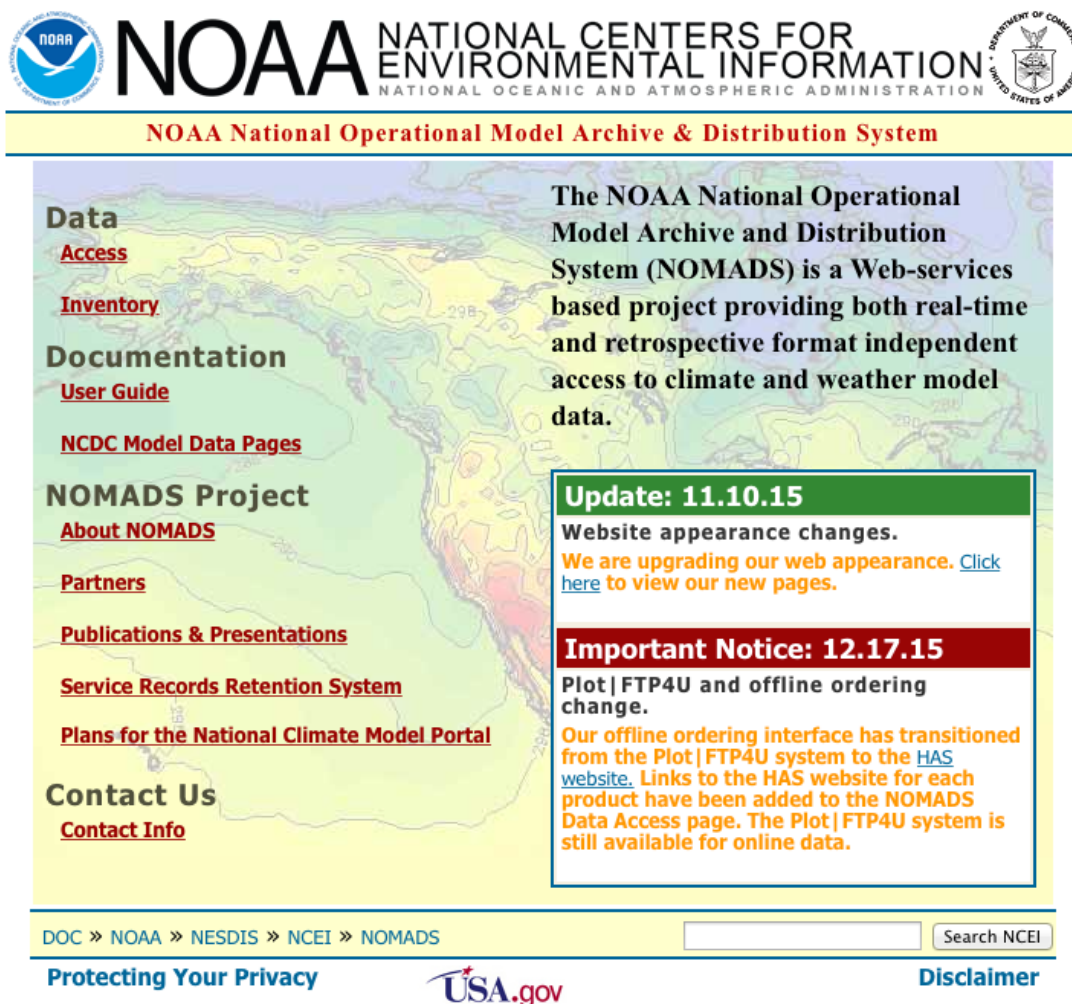
Name	Resolution	Coverage	Temporal Availability	Website
NCEP Climate Forecast System Reanalysis (CFSR)	38 km	Global	Jan 1979 – Dec 2010	http://rda.ucar.edu/datasets/ds093.0
NCEP Climate Forecast System Reanalysis II (CFSR2)	0.2°	Global	Jan 2011 – present	http://rda.ucar.edu/datasets/ds094.0
NCAR CESM CMIP5 data (netCDF format)		Global	Jan 1950 – 2100	http://rda.ucar.edu/datasets/ds316.0
NCAR CESM CMIP5 data (IM – Bias Corrected)		Global	Jan 1951 – 2100	http://rda.ucar.edu/datasets/ds316.1

SST DATA

NCEP SST Analysis	1° - 1/12°	Global		http://polar.ncep.noaa.gov/sst
NOMAD3 SST	1° - 0.25°	Global	Jan 1854 – present (depending which product)	http://nomads.ncdc.noaa.gov/data.php
NCEP & NCDC Reconstructed SST	1°	Global	Jan 1854 – Dec 2015	http://rda.ucar.edu/datasets/ds277.0

External Data Sources: NOMADS

<http://nomads.ncdc.noaa.gov>



NOAA NATIONAL CENTERS FOR ENVIRONMENTAL INFORMATION
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

NOAA National Operational Model Archive & Distribution System

Data
[Access](#)
[Inventory](#)

Documentation
[User Guide](#)
[NCDC Model Data Pages](#)

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[Service Records Retention System](#)
[Plans for the National Climate Model Portal](#)


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The NOAA National Operational Model Archive and Distribution System (NOMADS) is a Web-services based project providing both real-time and retrospective format independent access to climate and weather model data.

Update: 11.10.15
Website appearance changes.
We are upgrading our web appearance. [Click here](#) to view our new pages.

Important Notice: 12.17.15
Plot|FTP4U and offline ordering change.
Our offline ordering interface has transitioned from the Plot|FTP4U system to the [HAS website](#). Links to the HAS website for each product have been added to the NOMADS Data Access page. The Plot|FTP4U system is still available for online data.

DOC » NOAA » NESDIS » NCEI » NOMADS

Protecting Your Privacy  Disclaimer

NAM
GFS
RUC
CFS
NARR
R1/R2
SST

GRIB Data Handling

- Documents and decoders
 - GRIB1 and GRIB2
 - wgrib, wgrib2, unpackgrib2.c, grib2to1.c**
 - <http://rda.ucar.edu/#!/GRIB>
- **g1print.exe** and **g2print.exe**
 - Show data available in GRIB1 and GRIB2 files
 - Available from util/ directory in WPS
- **grib2ctl.pl**
 - Create .ctl and .idx files, so that you can plot GRIB files with GrADS
 - <http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html>
- **ncl_convert2nc**
 - http://www.ncl.ucar.edu/Document/Tools/ncl_convert2nc.shtml

Writing Intermediate File Format

- [http://www2.ucar.edu/wrf/users/docs/user_guide_V3/users_guide_chap3.htm# Writing Meteorological Data](http://www2.ucar.edu/wrf/users/docs/user_guide_V3/users_guide_chap3.htm#_Writing_Meteorological_Data)

- **wrf_wps_write_int**

FIELD = "SST"

UNITS = "K"

DESC = "Sea Surface Temperature"

opt = True

opt@map_source = "ERA-I Data"

opt@projection = 0

opt@startloc = "SWCORNER"

opt@startlon = 0.0

opt@startlat = -90.0

opt@deltalon = 1.25

opt@deltalat = 0.942408

opt@is_wind_earth_relative = False

opt@date = "2015-07-26_00:00:00"

opt@level = 200100.

wrf_wps_wrtie_int(IM_name, FIELD, UNITS, DESC, VAR(:, :), opt)

Reading Intermediate Format Files

- **wrf_wps_read_int**

! opens file

```
istatus = wrf_wps_open_int(filename)
```

! reads header

```
wrf_wps_rdhead_int(istatus,head_real,field,h  
date, \  
units,map_source,desc)
```

! reads slab

```
Slab = wrf_wps_rddata_int(istatus,nx,ny)
```

! Loop until reaching the end of the file

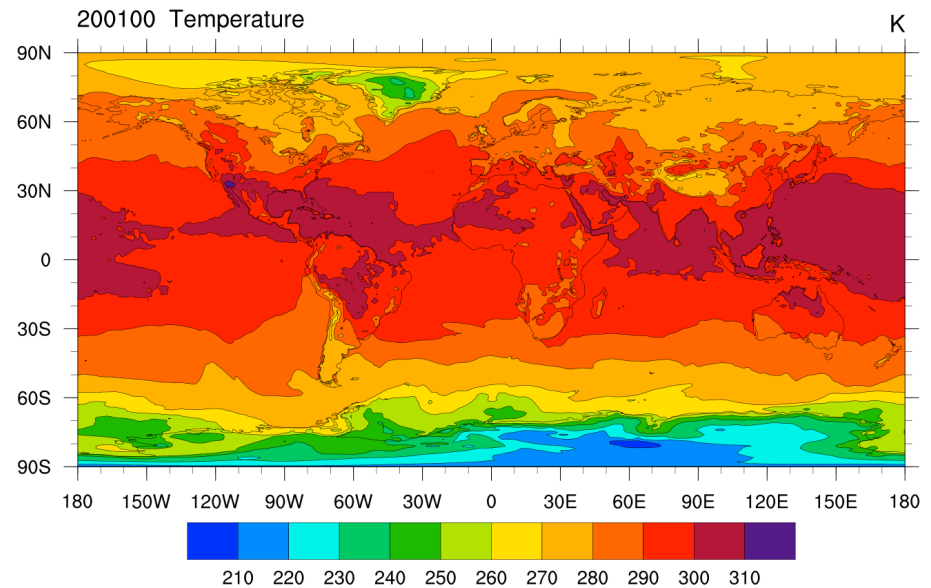
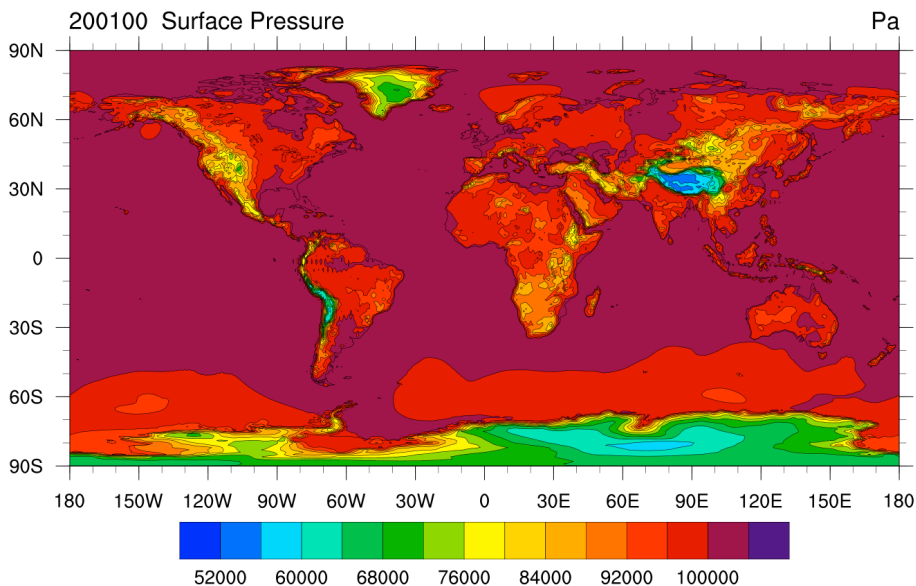
- **rd_intermediate**

```
=====
FIELD = TT
UNITS = K DESCRIPTION = TEMPERATURE
DATE = 2000-01-24_12:00:00 FCST = 0.000000
SOURCE = unknown model from NCEP GRID 212
LEVEL = 200100.000000
I,J DIMS = 185, 129
IPROJ = 1
      REF_X, REF_Y = 1.000000, 1.000000
      REF_LAT, REF_LON = 12.190000, -133.459000
      DX, DY = 40.635250, 40.635250
      TRUELAT1 = 25.000002
DATA(1,1) = 295.910950
=====
```

Utility: plotfmt

- The plotfmt program plots the fields in the ungribbed intermediate files

```
ncl plotfmt.ncl 'filename= FNL:2007-09-15_00''
```

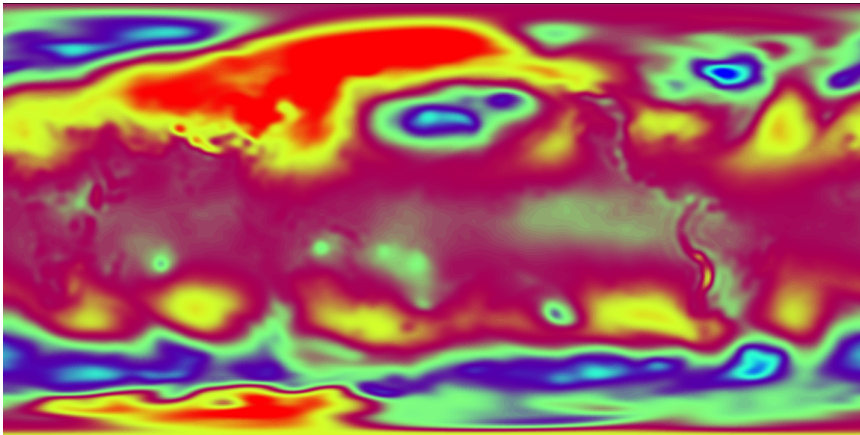


Plotting Intermediate Files in netCDF Format

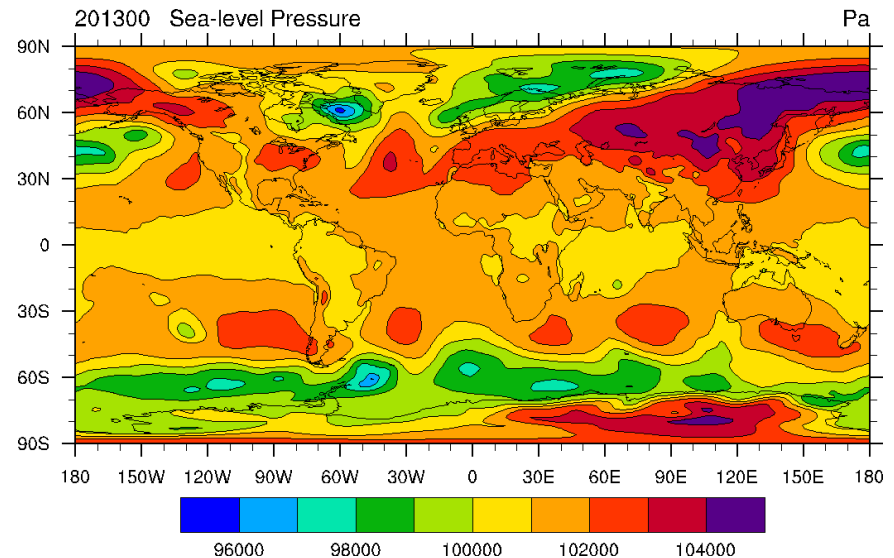
- Use the utility **int2nc.exe**
 - Converts intermediate files created by ungrib.exe to netcdf format
 - `./int2nc.exe`
- To plot: **plotfmt_nc.ncl**

```
ncl plotfmt_nc.ncl 'filename= FNL:2007-09-15_00'
```

Plot Using ncview



Plot Using plotfmt_nc.ncl



Other Utilities

- Additional utilities
 - **read_wrf_nc**: reads WRF netCDF file, outputs various data
 - **iowrf**: thins or extracts a box from WRF netCDF files
 - **wrf_interp**: interpolates WRF output files to pressure, height-agl, height-msl, potential temp, and equivalent potential temp, and can perform underground extrapolation
 - **p_interp**: converts wrfout data to pressure levels
 - **v_interp**: adds vertical levels in WRF input and boundary files
 - **diffwrf**: performs several functions, including making comparisons of two WRF files
 - For more details on the above utilities, see:
<http://www2.mmm.ucar.edu/wrf/users/utilities/util.htm>
- To download utilities:
http://www2.mmm.ucar.edu/wrf/users/download/get_sources.html

Special WRF Output Variables

- The WRF model outputs the state variables defined in the Registry file, and these state variables are used in the model's prognostic equations. Some of these variables are perturbation fields and therefore, the following definitions for reconstructing meteorological variables are necessary:

Total geopotential	$PH + PHB$
Total geopotential height in m	$(PH + PHB) / 9.81$
Total potential temp in K	$T + 300$
Total pressure in mb	$(P + PB) * 0.01$
Wind components, grid relative	U, V
Surface pressure in Pa	Psfc
Surface winds, grid relative	U10, V10 (valid at mass points)
Surface temp and mixing ratio	T2, Q2

See [WRFV3/Registry/Registry.EM_COMMON](#) for description of variables

MET Verification Software

- Model Evaluation Tools (MET)
- Provides all the basics (e.g., RMSE, bias, skill scores)
- Provides
 - Advanced spatial methods (wavelets, objects)
 - Confidence intervals
- Download it
<http://www.dtcenter.org/met/users/downloads/>
- Support
met_help@ucar.edu
- Documentation
<http://www.dtcenter.org/met/users/docs/overview.php>

Questions?

