

WRF Data, Utilities, & Post-processing

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Basic WRF Tutorial



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Data



Input Data: Mandatory Fields

3-D Data (for data on constant pressure levels)

- Temperature
- U and V components of wind
- Geopotential height
- Relative Humidity (or Specific Humidity)

3-D Data (for data on native model levels)

- Temperature
- U and V components of wind
- Geopotential height
- Relative Humidity (or Specific Humidity)
- Pressure

2-D 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
- Additional SST data

External Data Sources: Global

Name	Resolution	Coverage	Temporal Availability	Website
NCEP/NCAR Reanalysis (R1/NNRP)	209 km 6-hourly	Global	Jan 1948 – present	http://rda.ucar.edu/datasets/ds090.0
NCEP/DOE Reanalysis (R2)	209 km 6-hourly	Global	Jan 1979 – present	http://rda.ucar.edu/datasets/ds091.0
ERA Interim Data	1.125° - 0.703° 6-hourly	Global	Jan 1979 – present	http://rda.ucar.edu/datasets/ds627.0
ECMWF's Operational Model Analysis	Varying	Global	Jan 2011 – present	http://rda.ucar.edu/datasets/ds113.0
NCEP GDAS/FNL Reanalysis	0.25° 6-hourly	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° 6-hourly	Global	Aug 1999 – present	http://rda.ucar.edu/datasets/ds083.2
GFS Gridded Model Data	0.5° 24-hourly	Global	Dec 2002 – present	http://rda.ucar.edu/datasets/ds335.0
NCEP GFS 0.25°	0.25° 3-hourly & 12-hourly	Global	Jan 2015 – present	http://rda.ucar.edu/datasets/ds084.1

External Data Sources: North America

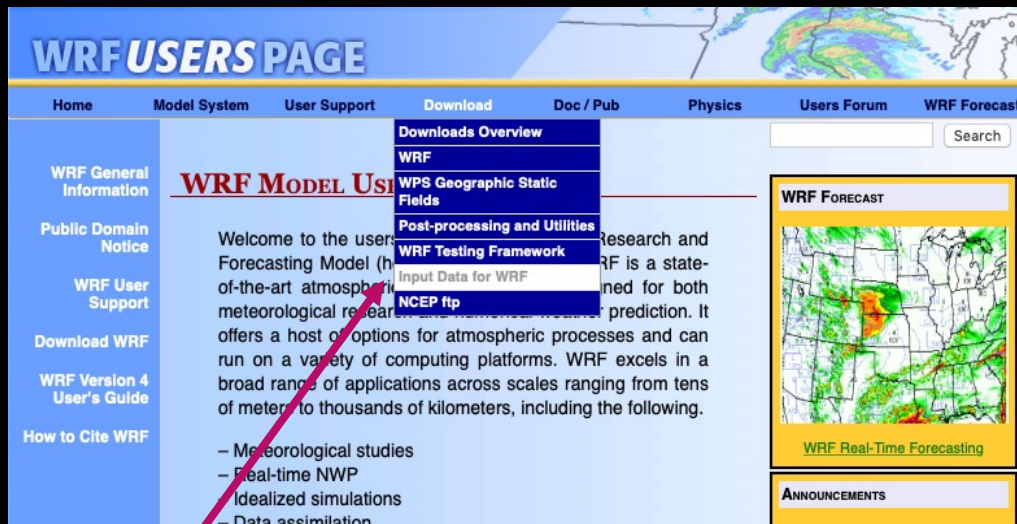
Name	Resolution	Coverage	Temporal Availability	Website
NAM Real-time	32/12 km 6-hourly	North America		ftp://ftpprd.ncep.noaa.gov/pub/data/nccf/com/nam
NAM Analysis	12 km 6-hourly	North America	Jan 2012 – present	http://rda.ucar.edu/datasets/ds609.0
GCIP NCEP Eta	40 km 3-hourly & 6-hourly	North America	April 1995 – present	http://rda.ucar.edu/datasets/ds609.2
NCEP NARR	32 km 3-hourly	North America	Nov 1979 – present	http://rda.ucar.edu/datasets/ds608.0

External Data Sources: Climate Applications

Name	Resolution	Coverage	Temporal Availability	Website
NCEP Climate Forecast System Reanalysis (CFSR)	0.3° to 2.5° 6-hourly	Global	Jan 1979 – Dec 2010	http://rda.ucar.edu/datasets/ds093.0
NCEP Climate Forecast System Reanalysis II (CFSv2)	0.2° to 2.5° 6-hourly	Global	Jan 2011 – present	http://rda.ucar.edu/datasets/ds094.0
NCAR CESM CMIP5 data (netCDF format)	6-hourly	Global	Jan 1950 – 2100	http://rda.ucar.edu/datasets/ds316.0
NCAR CESM CMIP5 data (IM – Bias Corrected)	6-hourly	Global	Jan 1951 – 2100	http://rda.ucar.edu/datasets/ds316.1
SST DATA				
NCEP SST Analysis	1° - 1/12°	Global		https://www.nco.ncep.noaa.gov/pmb/products/sst/
NOAH SST	1° - 0.25°	Global	Jan 1854 – present (depending which product)	https://psl.noaa.gov/data/gridded/tables/sst.html
NCEP & NCDC Reconstructed SST	1° - 2°	Global	Jan 1854 – Dec 2015	http://rda.ucar.edu/datasets/ds277.0

Downloading Data (1)

From the WRF Users' Page
<http://www2.mmm.ucar.edu/wrf/users>



Step 1 Click 'Download,' then scroll down and Click 'Input Data for WRF.'

Available GRIB Datasets from NCAR

Dataset	Spatial Resolution	Temporal Resolution	Temporal Availability	Vtable
NCEP Final Analysis (GFS-FNL) ds083.0	2.5 degree	12-hourly	1997-04-01 to 2007-06-30	Vtable.GFS
NCEP Final Analysis (GFS-FNL) ds083.2	1 degree	6-hourly	1999-07-30 to current	
NCEP GDAS Final Analysis ds083.3	0.25 degree	6-hourly	2015-07-08 to current	
NCEP GFS ds084.1	0.25 degree	3-hourly (for first 240 hrs) 12-hourly (hrs 240-384)	2015-01-15 to current	
NCEP/NCAR Reanalysis (NNRP) ds090.0	209 km	6-hourly	1948-01-01 to current	Vtable.NNRP
NCEP Climate Forecast System Reanalysis (CFSr) ds093.0	0.3, 0.5, 1.0, 1.9, & 2.5 degree	6-hourly	1979-01-01 to 2011-01-01	Vtable.CFSR_press_pgbh06 & Vtable.CFSR_sfc_flf06
NCEP Climate Forecast System Version 2 (CFSv2) ds094.0	0.2, 0.5, 1.0, and 2.5 degree	6-hourly	2011-01-01 to current	
ECMWF Operational Model Analysis ds113.0	varying		2011-01-01 to 2016-03-09	Vtable.ECMWF

Step 2 Choose the dataset you wish to use.
For this example, we will use "NCEP GFS"

Downloading Data (2)

Step 3

Register (or sign-in if you already have an account)

NCAR | RESEARCH DATA ARCHIVE

Contact UsSIGN IN

DATASETS ▼RESOURCES ▼SUPPORT ▼NEWS

Search

Home / Datasets / Ds084.1



NCEP GFS 0.25 Degree Global Forecast Grids Historical Archive

ds084.1 | DOI: 10.5065/D65D8PWK ☆

ASK A QUESTION >

DESCRIPTION

DATA ACCESS

CITATION

DOCUMENTATION

SOFTWARE

METRICS

ABSTRACT:

The NCEP operational Global Forecast System analysis and forecast grids are on a 0.25 by 0.25 global latitude longitude grid. Grids include analysis and forecast time steps at a 3 hourly interval from 0 to 240, and a 12 hourly interval from 240 to 384. Model forecast runs occur at 00, 06, 12, and 18 UTC daily. For real-time data access please use the [NCEP data server](#).

TEMPORAL RANGE:

2015-01-15 00:00 +0000 to 2023-08-04 12:00 +0000 (Entire dataset)

PERIOD DETAILS BY DATASET PRODUCT ▼

UPDATES:

Daily

VARIABLES:

Air Temperature	Albedo	Cloud Frequency	Cloud Liquid Water/Ice
Dew Point Temperature	Evaporation	Geopotential Height	Gravity Wave

Step 4

Click 'Data Access'

Step 5

Click 'Web File Listing'

DATA FILE DOWNLOADS			CUSTOMIZABLE DATA REQUESTS	OTHER ACCESS METHODS	NCAR-ONLY ACCESS
<u>Web Server Holdings</u>	<u>Globus Transfer Service (GridFTP)</u>	<u>Data Format Conversion</u>	<u>Subsetting</u>	<u>THREDDS Data Server</u>	<u>Central File System (GLADE) Holdings</u>
Web File Listing	Globus Transfer	Get Converted Files	Get a Subset	TDS Access	GLADE File Listing

Downloading Data (3)

Faceted Browse

Interactively browse the Internet-accessible collection of data files and make selections to create a list of only the files you need. **Please note** that this is not a subsetting service. You will still receive whole data files as they exist in our archive.

[LINK >](#)

Complete File List

View a hierarchical listing of the full collection of data files.

[LINK >](#)

Step 6

Click the link for 'Complete File List'

Step 7

Choose the year

NCEP GFS 0.25 Degree Analysis and Forecast Grids

Group Name ↕	Description ↕
2015	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2015
2016	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2016
2017	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2017
2018	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2018
2019	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019

NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019

Group Name ↕	Description ↕
2019-01-01	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-01
2019-01-02	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-02
2019-01-03	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-03
2019-01-04	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-04
2019-01-05	NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-05

Step 8 Choose your date(s) of interest

Downloading Data (4)

Step 10

Once you have chosen all your times, choose a method to download the files

Step 9

Choose the box for each time you need

NCEP GFS 0.25 Degree Analysis and Forecast Grids for 2019-01-04

[CSH DOWNLOAD SCRIPT](#) [PYTHON DOWNLOAD SCRIPT](#) [JUPYTER NOTEBOOK DOWNLOAD SCRIPT](#)

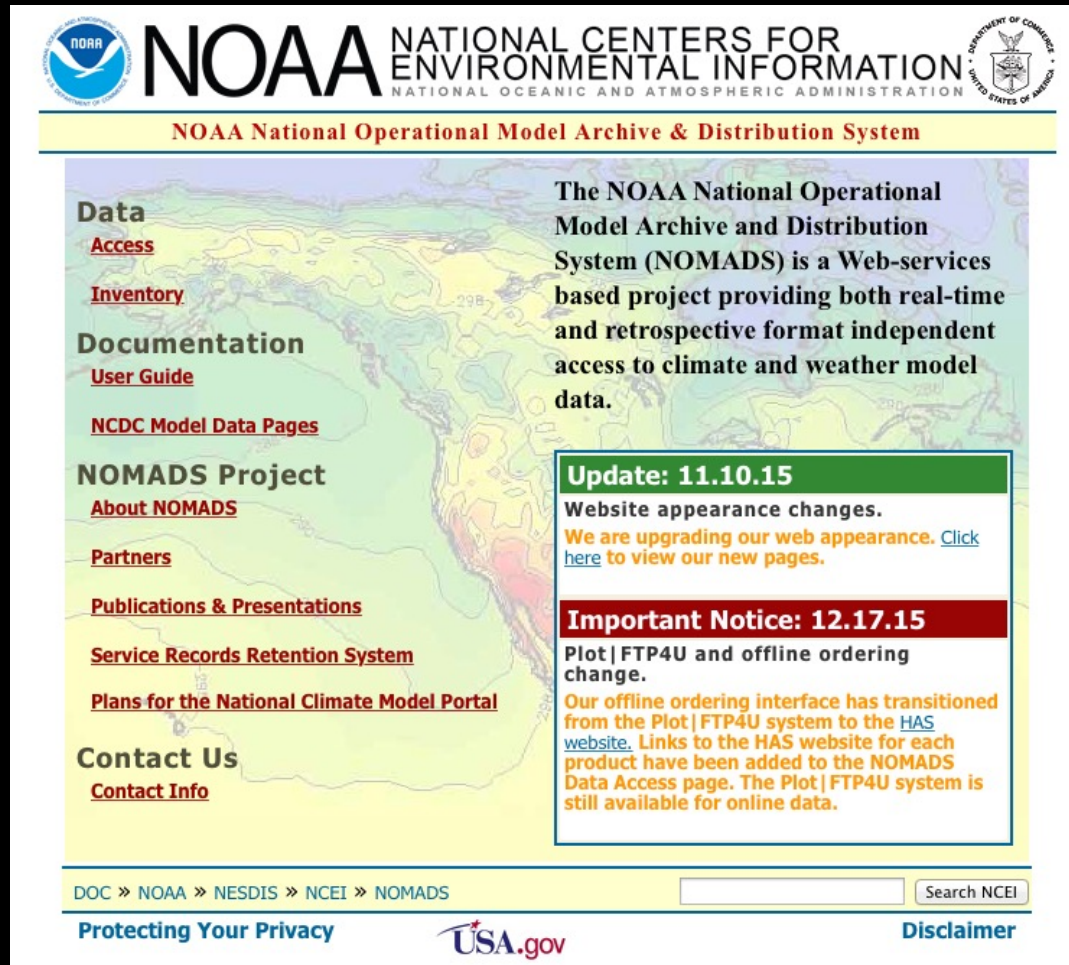
[GLOBUS DOWNLOAD](#)

372 Files are listed below
Click a filename to download or select multiple files and generate a download script.
Currently **4 Files (764.73M)** selected

[CLEAR SELECTIONS](#)

☐ Index	File Name ↕	Size ↕	Data Format ↕
☒ 1	gfs.0p25.2019010400.f000.grib2 ⓘ	177.88 MB	GRIB2
☒ 2	gfs.0p25.2019010400.f003.grib2 ⓘ	192.95 MB	GRIB2
☒ 3	gfs.0p25.2019010400.f006.grib2 ⓘ	196.94 MB	GRIB2
☒ 4	gfs.0p25.2019010400.f009.grib2 ⓘ	196.95 MB	GRIB2
☐ 5	gfs.0p25.2019010400.f012.grib2 ⓘ	200.4 MB	GRIB2

NOMADS Data



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](#)

NOMADS Project
[About NOMADS](#)
[Partners](#)
[Publications & Presentations](#)
[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.

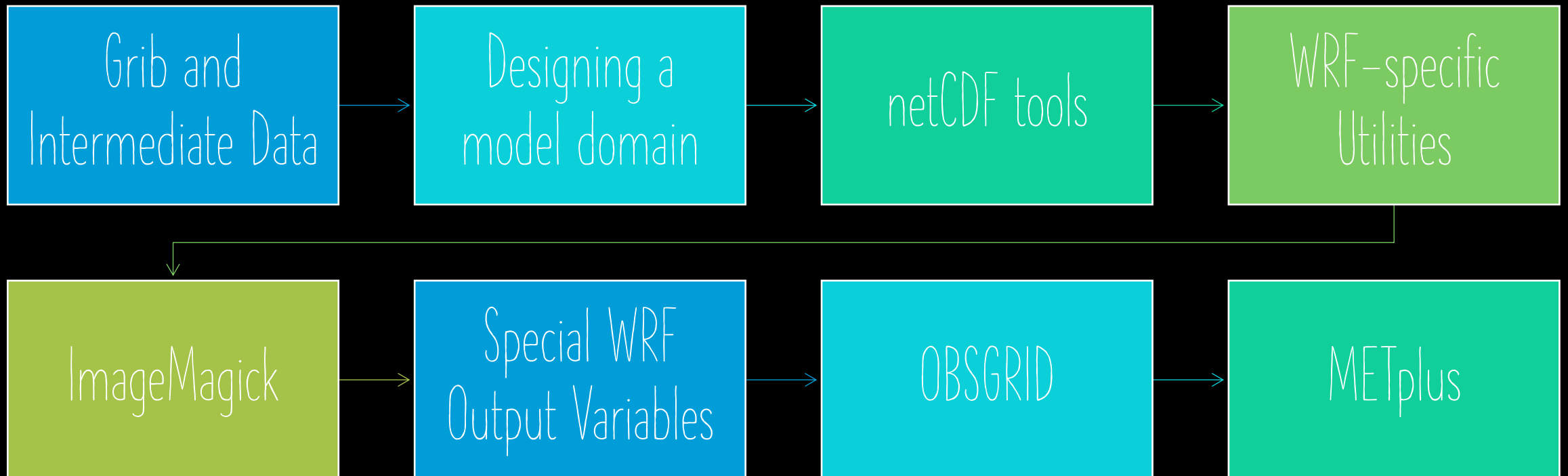
DOC » NOAA » NESDIS » NCEI » NOMADS

Protecting Your Privacy  [Disclaimer](#)

NAM
GFS
RUC
CFS
NARR
R1/R2
SST

<https://nomads.ncep.noaa.gov/>

Utilities



GRIB Data Handling (1)

Documents

(GRIB1 data) <https://rda.ucar.edu/index.html#gribdoc>

(GRIB2 data) <https://rda.ucar.edu/index.html#grib2doc>

Decoders

- wgrib, wgrib2, unpackgrib2.c, grib2to1.c
<http://rda.ucar.edu/#!/GRIB>
<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html>
<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2>
- g1print.exe and g2print.exe
 - Show data available in GRIB1 and GRIB2 files
 - Available from util/ directory in WPS

GRIB Data Handling (2)

Formatting

`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`

- Converts from grib format to netcdf format

http://www.ncl.ucar.edu/Document/Tools/ncl_convert2nc.shtml

Writing Intermediate File Format

https://www2.mmm.ucar.edu/wrf/users/wrf_users_guide/build/html/wps.html#writing-meteorological-data-to-the-intermediate-format

```
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 File Format

NCL Code

```
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
```

Found in WPS/util

```
rd_intermediate.exe

=====

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

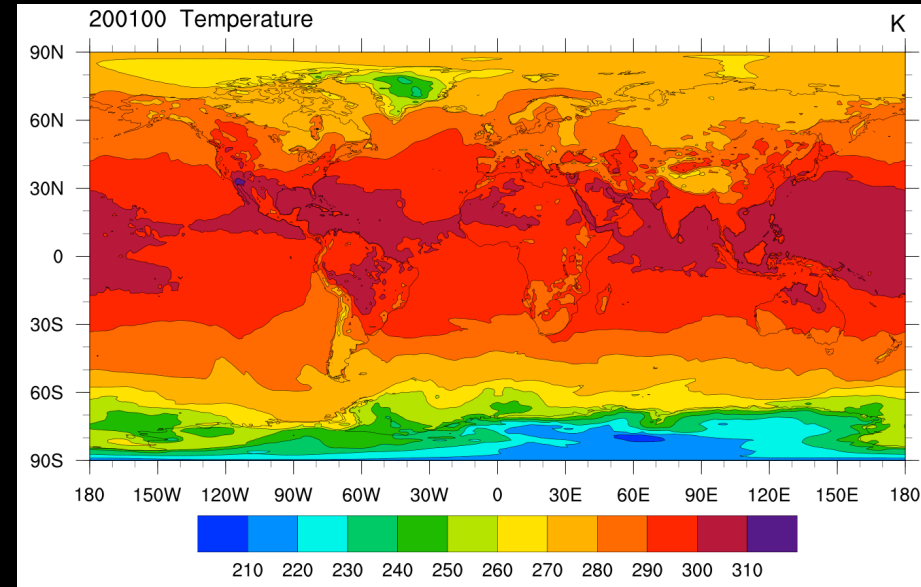
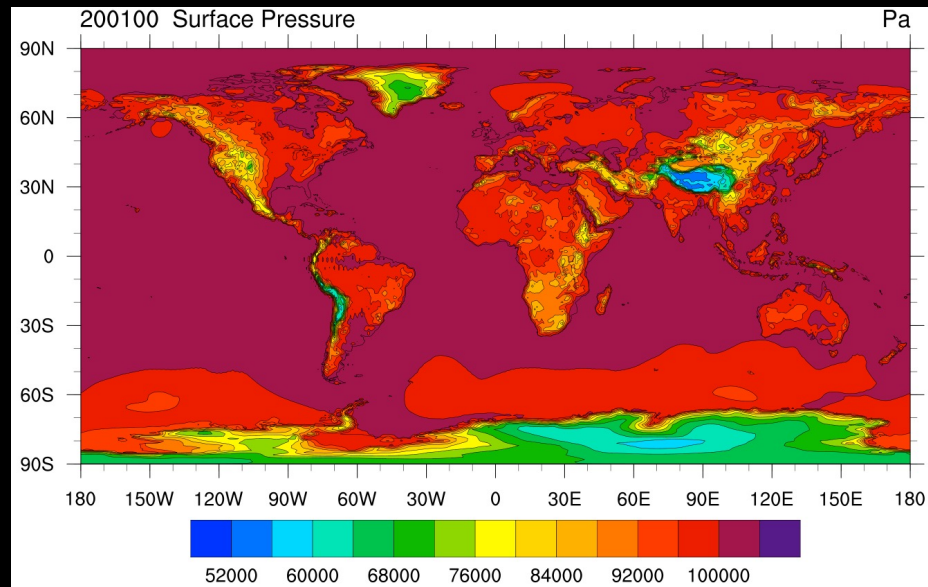
=====
```


Plotting Intermediate Files

plotfmt.ncl

Plots the fields in
the ungribbed
intermediate files

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



Found in WPS/util/

int2nc.exe

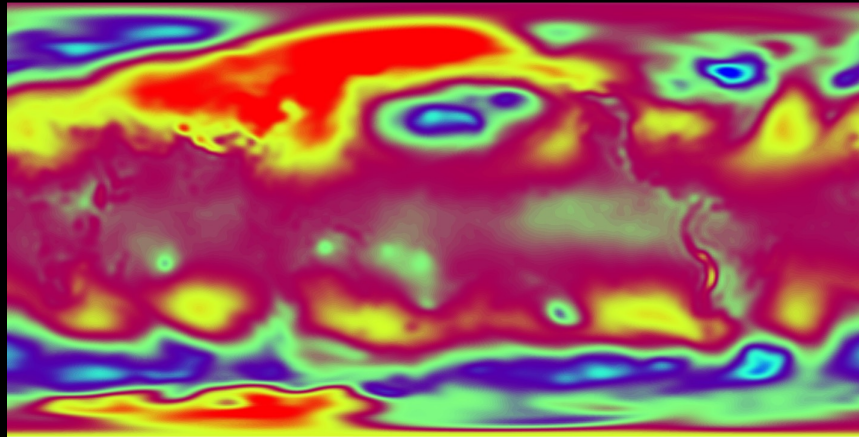
Converts
intermediate
files to netCDF
format

Plot Intermediate Files in netCDF Format

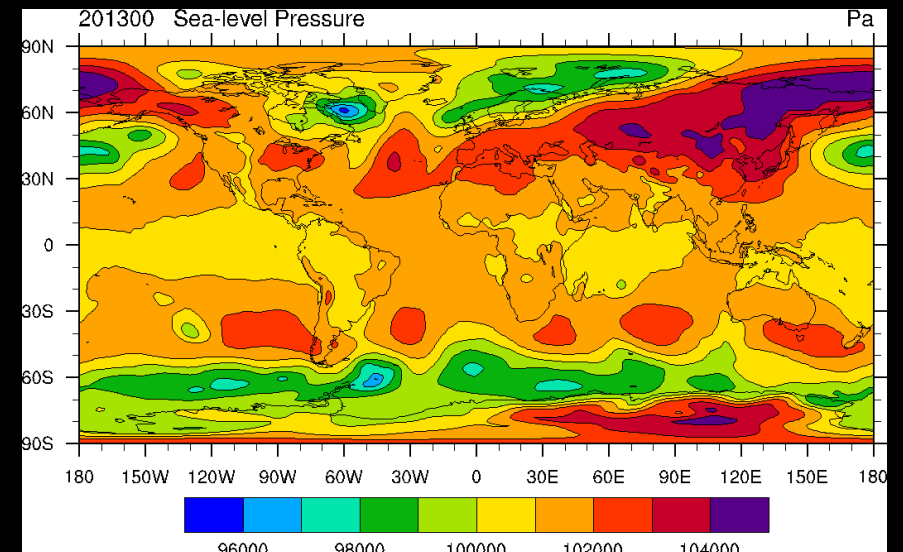
```
> ./int2nc.exe FILE:yyyy-mm-dd_hh
```

```
> ncl plotfmt_nc.ncl `inputFILE="FNL:YYYY-MM-DD_HH.nc"``
```

Plotted with ncview



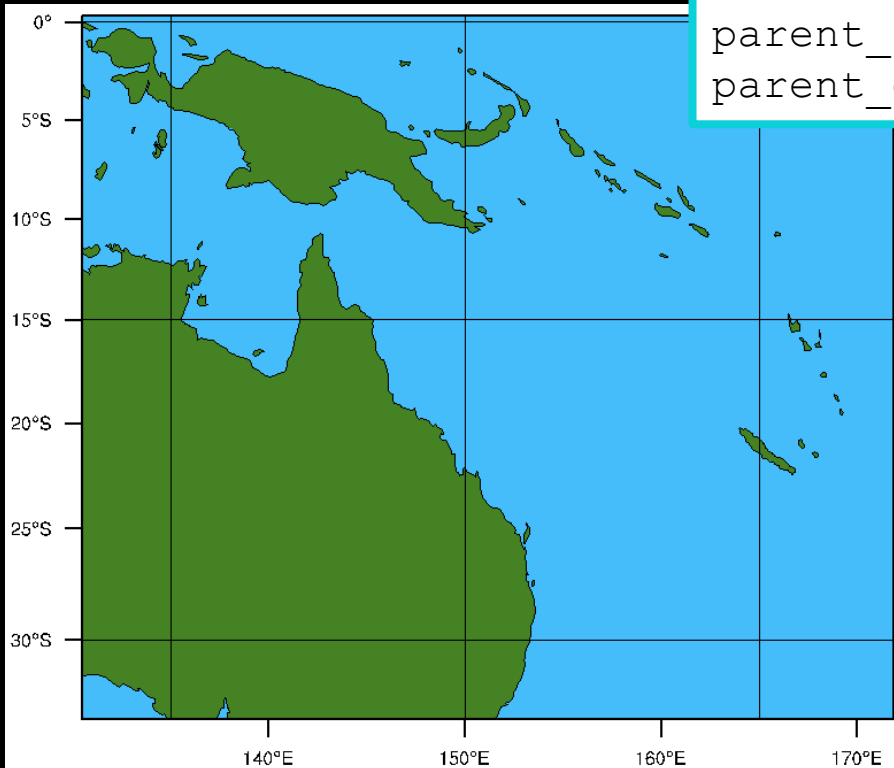
Plotted with plotfmt_nc.ncl



Domain Design

design_grids.ncl

```
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 /)
```



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,
```

http://www2.mmm.ucar.edu/wrf/users/special_code.html

netCDF Tools



netCDF Operators (NCO)

netCDF Operators

- Command-line programs
- Take netCDF input -> perform operation -> output in various formats

ncdiff

Shows the difference between two files

```
> ncdiff file1.nc file2.nc diff.nc
```

ncrcat

- Writes specified variables & times to a new file

```
> ncrcat -d Time,0,231 -v RAINNC wrfout* RAINNC.nc
```

- Concatenates files

```
> ncrcat file1.nc file2.nc combined.nc
```

<http://nco.sourceforge.net>

netCDF Operators (NCO)

netCDF Operators

- Command-line programs
- Take netCDF input -> perform operation -> output in various formats

ncrename

Renames variables, dimensions, attributes

```
> ncrename -v LANDUSE, LAND -a missing_value, _FillValue file.nc
```

ncks

Combination of several NCO tools to allow cutting/pasting subsets of data into a new file

Extracting a specific variable

```
> ncks -v RAINNC wrfout_d01_2015-06-01_00:00:00 RAINNC.nc
```

Splitting files

```
> ncks -d Time, 1, 1 wrfout_d01_2015-06-01_00:00:00 -o wrfout1.nc
```

<http://nco.sourceforge.net>

Other Available Operators (NCO)

ncap2 : arithmetic processor

ncatted : ATtribute editor

ncbo : binary operator (includes ncadd, ncsubtract, ncmultiply, ncdivide)

ncea : ensemble average

ncecat : ensemble concatenator

ncflint : FiLe INTerpolator

ncpdq : permute dimensions quickly, pack data quietly

ncwa : weighted averager

<http://nco.sourceforge.net>

ncview

Graphical interface that allows quick viewing of netCDF files

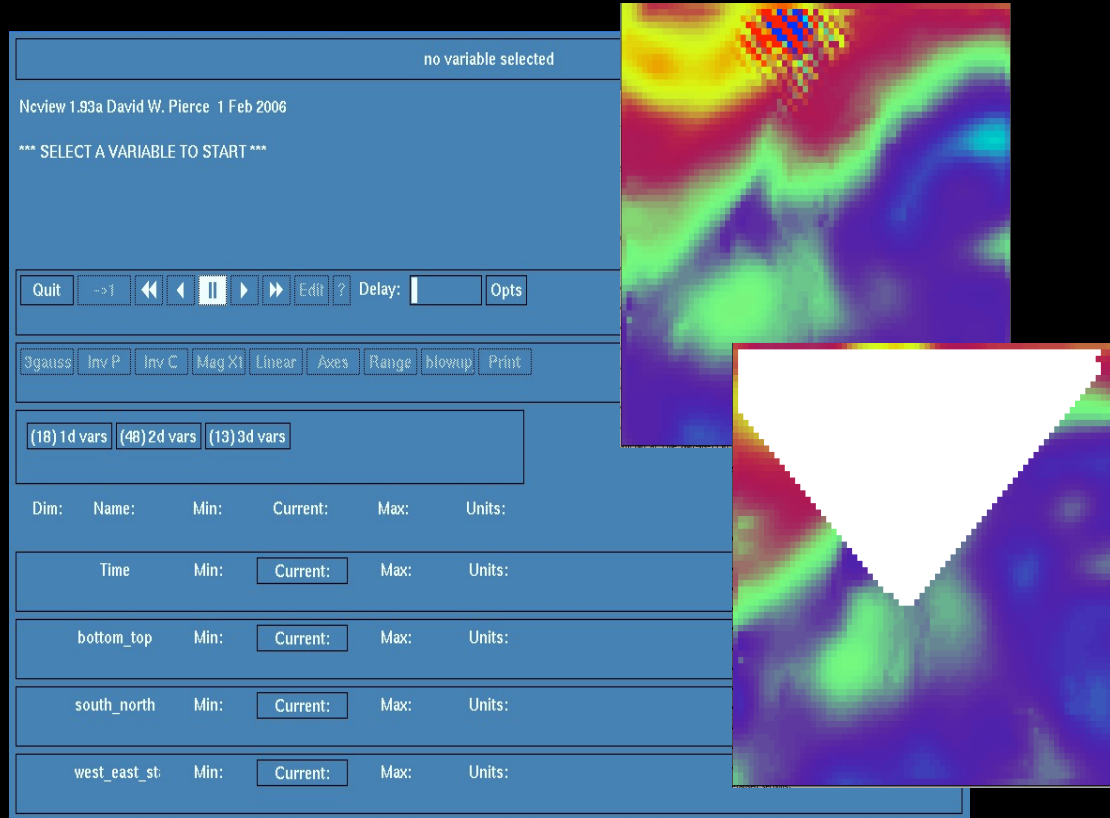
- All variables found in file
- Detect where things go wrong

Other options

- Time series
- Vertical Cross Section

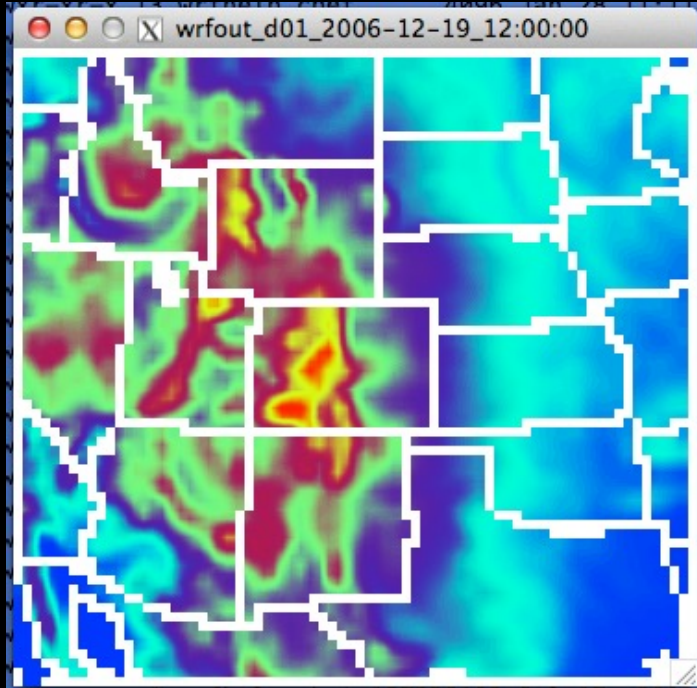
Any netCDF format file

geo_em.d0*
met_em.d0*
wrfinput_d0*
wrfout.d0*
wrfrst.d0*

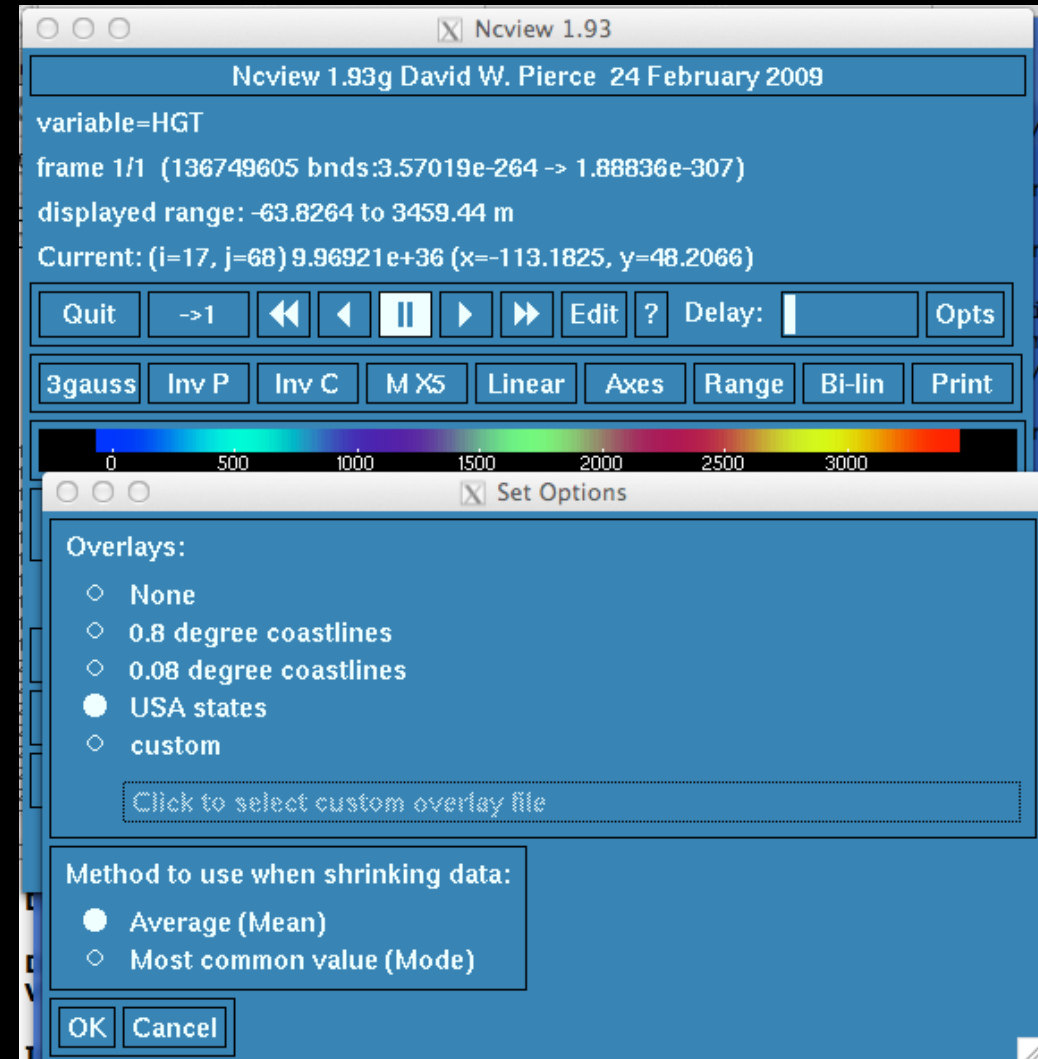


http://meteora.ucsd.edu/~pierce/ncview_home_page.html

ncview



- Works with wrfinput* and wrfout* files
- Must have 1 time period per file



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

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 specific data for the variable 'VAR'

> **ncdump -v Times file**

Prints the times that are included in the file

ncdump

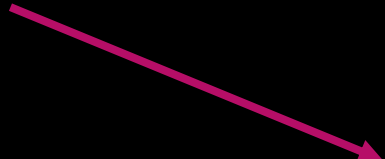
```
netcdf wrfout_d01_2000-01-24_12:00:00 {
dimensions:
    Time = UNLIMITED ; // (3 currently)
    DateStrLen = 19 ;
    west_east = 73 ;
    south_north = 60 ;
    west_east_stag = 74 ;
    bottom_top = 27 ;
    south_north_stag = 61 ;
    bottom_top_stag = 28 ;
variables:
    char Times(Time, DateStrLen) ;
    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"
```



WRF-specific Utilities

Additional Information:

[http://www2.mmm.ucar.edu/
wrf/users/utilities/util.htm](http://www2.mmm.ucar.edu/wrf/users/utilities/util.htm)

Download utilities:

[http://www2.mmm.ucar.edu/
wrf/users/download/get_sour
ces.html](http://www2.mmm.ucar.edu/wrf/users/download/get_sources.html)

`read_wrf_nc`

reads WRF netCDF file, outputs various data

`iowrf`

extracts a box from WRF netCDF files, thin or destagger data

`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 (from sigma levels) 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 (available in WRF/external/io_netcdf/)

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.
- 2 ways to use
 - 1) point & click (e.g. *display plot.png*)
 - 2) command line (e.g., *convert -trim +repage -background white -flatten plot.pdf plot.png*)

Can make movies

- Can create individual frames for each image

Maintains high resolution – great for publishing!

Cannot deal with .ncgm files

ImageMagick

<http://www.imagemagick.org>

Special WRF Output Variables

See
WRF/Registry/Registry.EM_COMMON
for description of variables

- WRF model outputs state variables (defined in the Registry)
 - Used in model's prognostic equations
 - Some are perturbation fields and the following definitions for reconstructing meteorological variables are necessary:

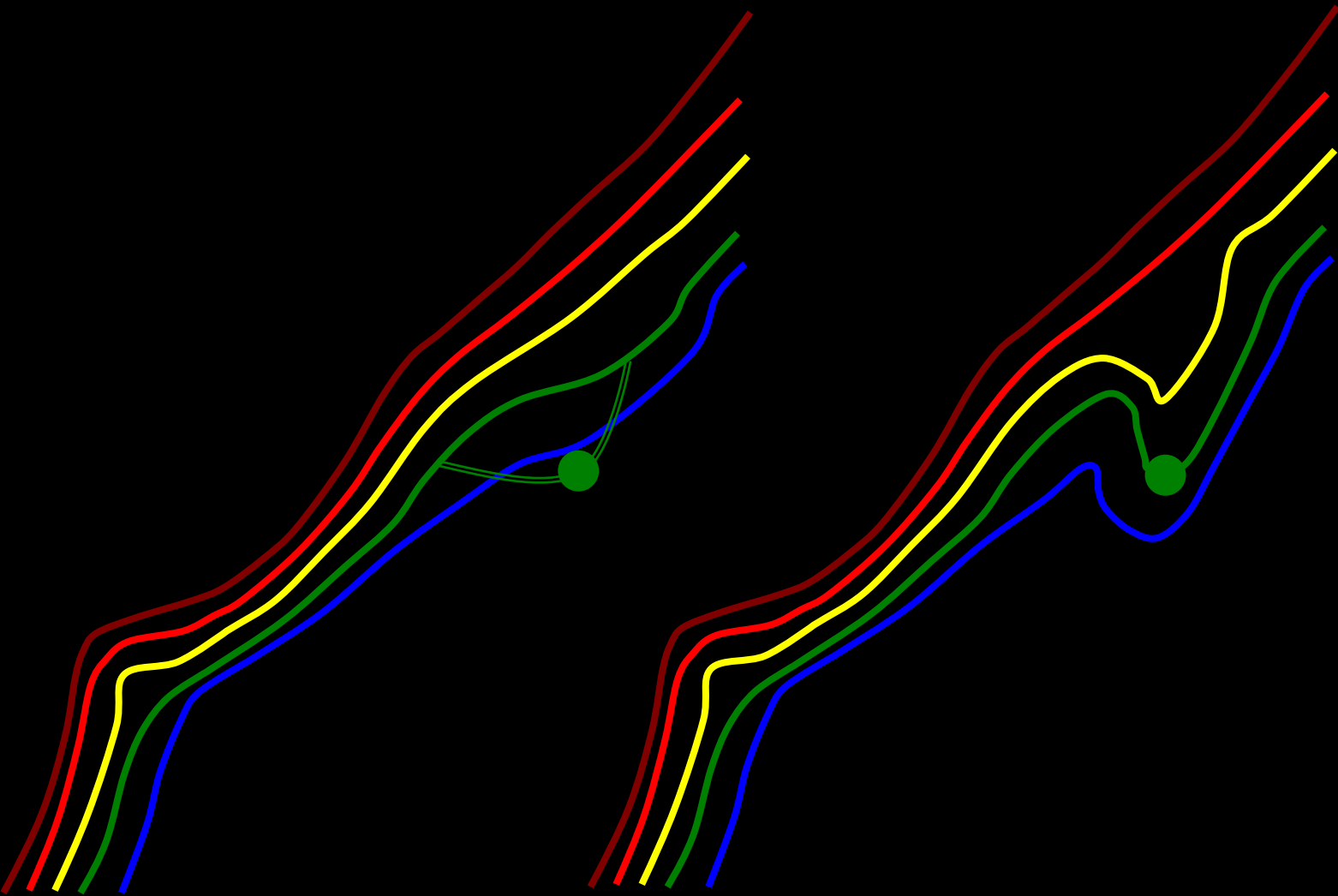
Total geopotential	$PH + PHB$
Total geopotential height in m	$(PH + PHB) / 9.81$
Total potential temp in K	$T + 300$
Total pressure in mb	$(P + PB) * 0.01$
Wind components, grid relative	U, V
Surface pressure in Pa	$Psfc$
Surface winds, grid relative	$U10, V10$ (valid at mass points)
Surface temp and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

OBSGRID



OBSGRID

Improves first-guess gridded analysis by incorporating additional observational data



This method is useful...

- When forced to use very coarse-resolution first-guess input data
- If you have access to very high-resolution point data

Running OBSGRID

1. Get the source code <http://www2.mmm.ucar.edu/wrf/users/downloads.html>
2. Compile (serially)
3. Prepare observation files
4. Edit the namelist.oa
5. Link in met_em* files from WPS
6. Run the program

```
> ./obsgrid.exe
```
7. Check your output

See chapter 7 of the V4
WRF Users' Guide for
detailed information

https://www2.mmm.ucar.edu/wrf/users/docs/user_guide_v4/v4.4/users_guide_chap7.html

OBSGRID Output

metoa_em*

- Final analysis files at sfc and pressure levels
- Can be used to replace met_em* files during real.exe for analysis nudging

wrfsfdda_d0*

- Contains sfc analyses and observations within 250 km of each grid point
- Use as input for surface analysis nudging (in &fdda section of namelist, set grid_fdda = 1 and grid_sfdda = 1)

OBS_DOMAIN101

- List of all observations available
- Used during WRF for observational nudging
- Will have files (in odd numbers) for each time period (e.g., OBS_DOMAIN101, OBS_DOMAIN103, etc.)
 - Must all be concatenated into a single file (OBS_DOMAIN101)
 - Use 'run_cat_obs_files.csh' to do this

See chapter 7 of the V4
WRF Users' Guide for
detailed information

https://www2.mmm.ucar.edu/wrf/users/docs/user_guide_v4/v4.4/users_guide_chap7.html

METPLUS Package

MET (Model Evaluation Tools)

- Basics statistical tools (e.g., RMSE, bias, skill scores)
 - Advanced spatial methods (wavelets, objects)
 - Confidence intervals

METviewer and METexpress

Associated database & display systems

Python Wrappers

Provide low-level automation and examples

Documentation,
Downloading and Support
Information

[http://www.dtcenter.org/
community-code/metplus](http://www.dtcenter.org/community-code/metplus)

Post-processing



Supported Post-processing Packages

Package	Documentation	Information
NCL	See WRF Users' Guide Chapter on Post Processing https://www2.mmm.ucar.edu/wrf/users/wrf_users_guide/build/html/post_processing.html	Graphical package supported by NCAR/CISL (http://forum.mmm.ucar.edu/ and ncl-talk@ucar.edu)
ARWpost		Converter (GrADS); ARWpost supported by wrfhelp: http://forum.mmm.ucar.edu/
RIP		Converter and interface to graphical package, NCAR graphics, supported by wrfhelp: (http://forum.mmm.ucar.edu/)
UPP		Converter (GrADS & GEMPAK) – standard method to get data into GRIB format; supported by UPP Help: (http://forum.mmm.ucar.edu/)
VAPOR		Converter and graphical package Supported by VAPOR (vapor@ucar.edu)
IDV	None – see https://www.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: https://www.unidata.ucar.edu/software/gempak/	Data from wrf2gem or UPP Supported by unidata (support@unidata.ucar.edu)

Choosing the Right Tool

- Can it handle staggered grids?
- How is data below the ground handled?
- Vertical grids?
- How are model time stamps handled?
- Easy to use?
- Cost of package?
- How well supported is it?
- 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?

How Does the Graphical Tool Handle Data?

Graphical Tool

Data Type		NCL/WRF-python	RIP	GrADS	UPP	VAPOR	IDV
	netCDF		ripdp	ARWpost	converter	converter	converter
	GRIB						
	ASCII						
	shapefiles						
	geogrid & metgrid output						
	intermediate file format						
	wrfinput data						
	Idealized data						
	wrfoutput						
	big data						

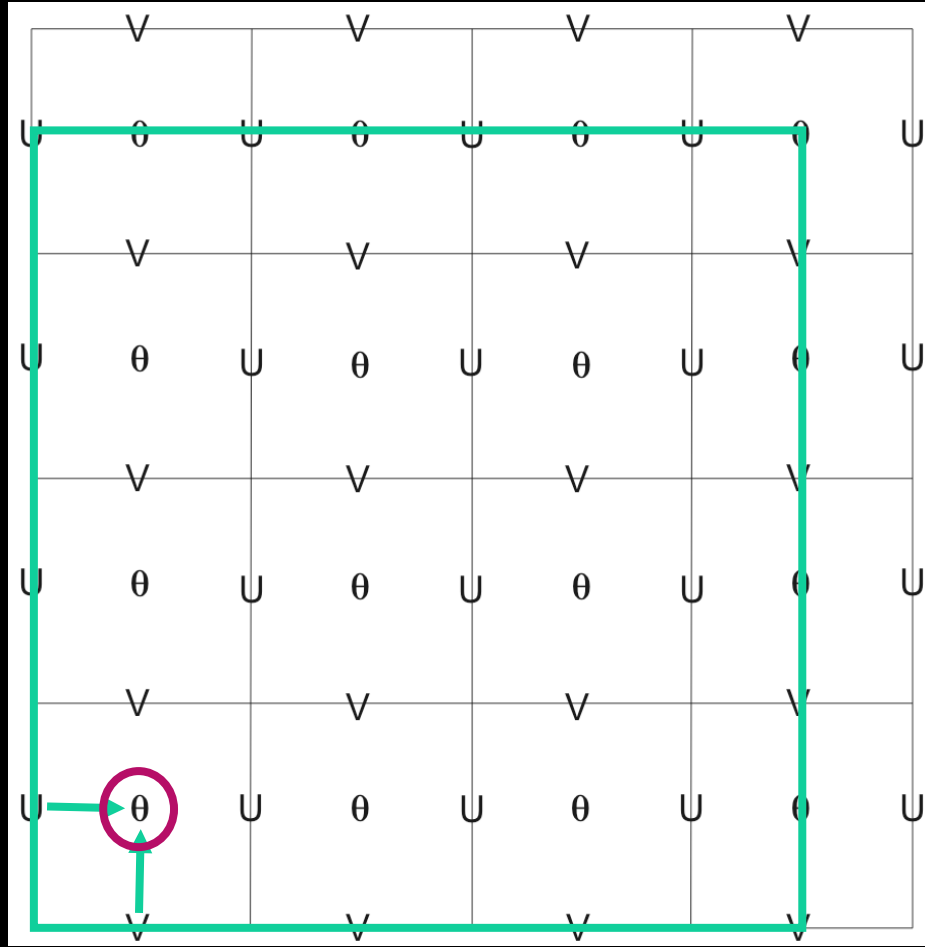
- Handles it well
 - Handles it okay, but not great
 - Is not capable of handling it

How Does the Graphical Tool Handle Post-processing?

Processing Capabilities	Graphical Tool						
		NCL/WRF- python	RIP	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							

-  - Handles it well
-  - Handles it okay, but not great
-  - Is not capable of handling it

Why is a Converter Necessary?



WRF
staggered
grid

A converter co-locates data to mass points

A converter translates variables
E.g., "T" is not really temp.
Must add 300 for actual temp (K)

ARWpost

ARWpost: General Information

ARWpost

- A converter that generates graphical plots
- Reads-in WRF model data, creates GrADS output files
- GrADS software is required to display data (but not to compile ARWpost)
 - <http://www.iges.org/grads/grads.html>

Download Code

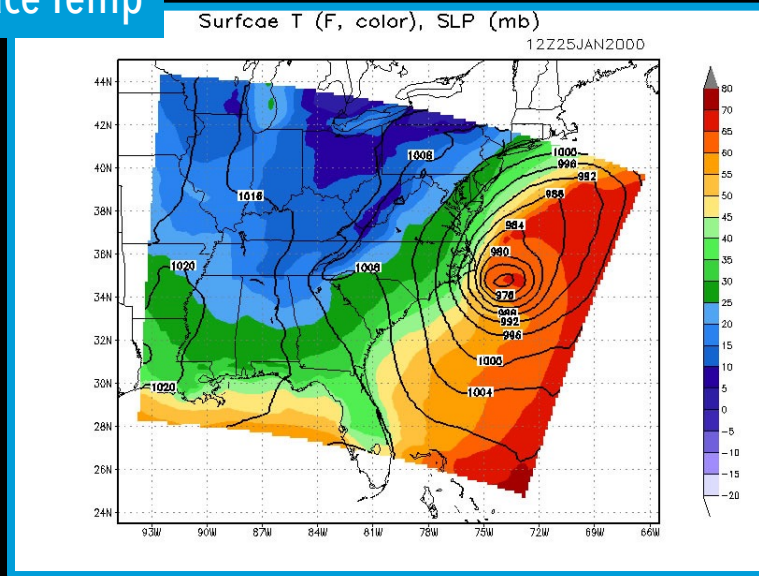
http://www2.mmm.ucar.edu/wrf/users/download/get_sources.html

Online Tutorial

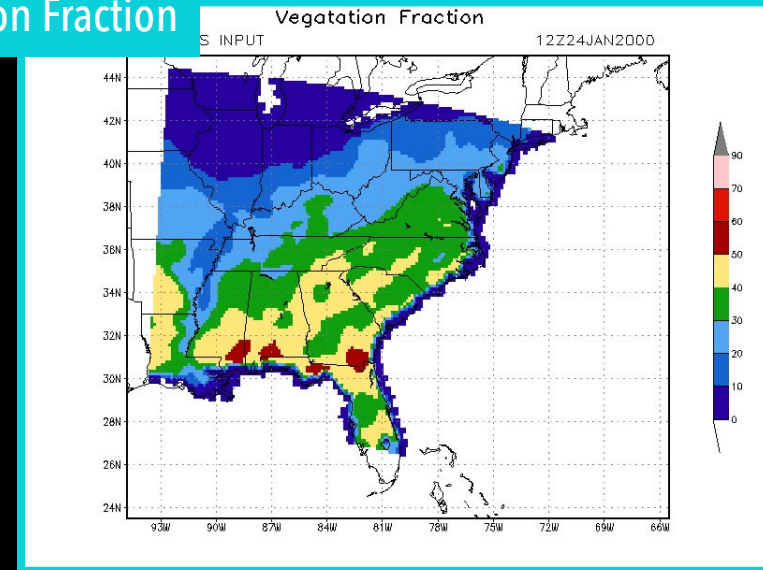
<http://www2.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/ARWpost/index.php>

ARWpost: Example Plots

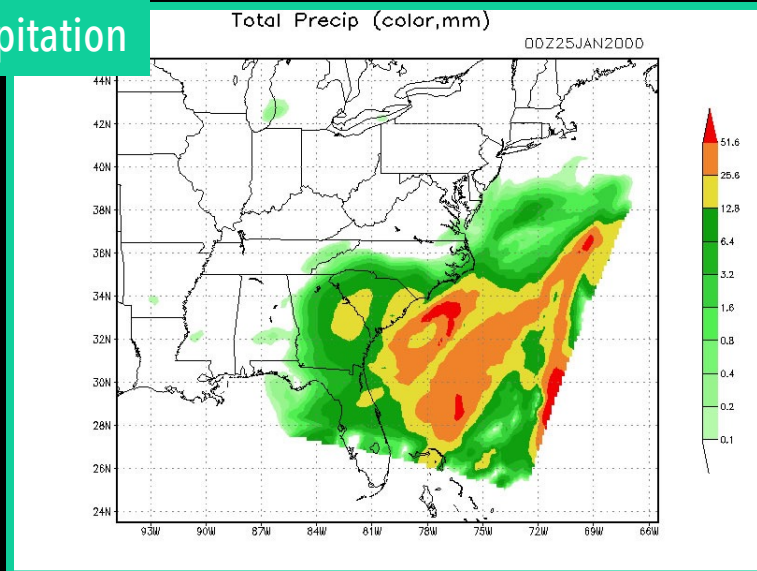
Surface Temp



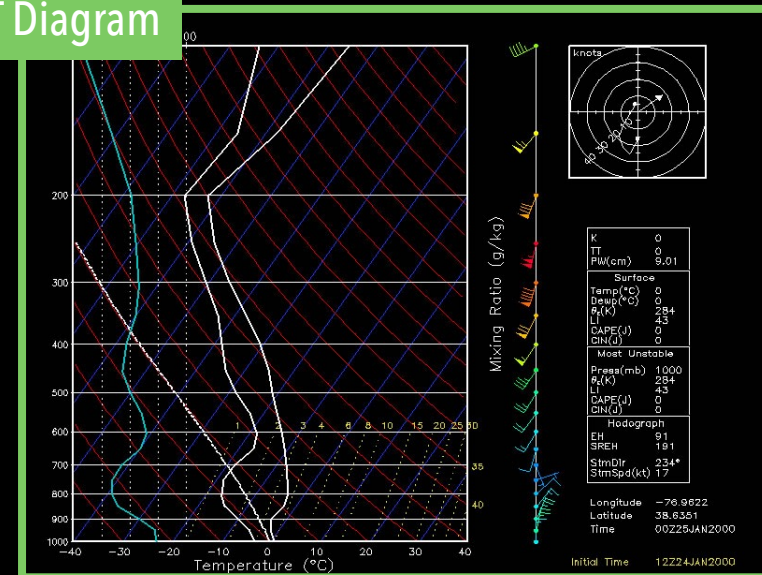
Vegetation Fraction



Total Precipitation

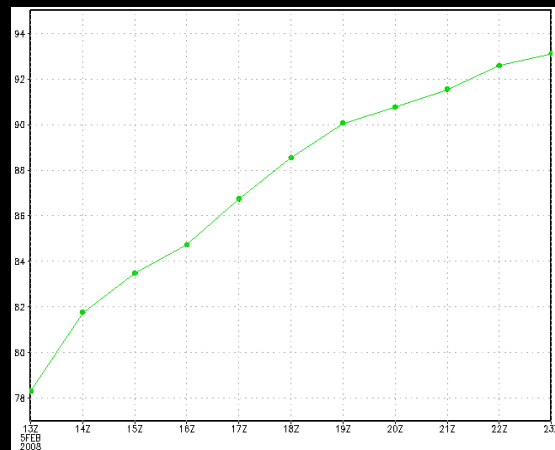
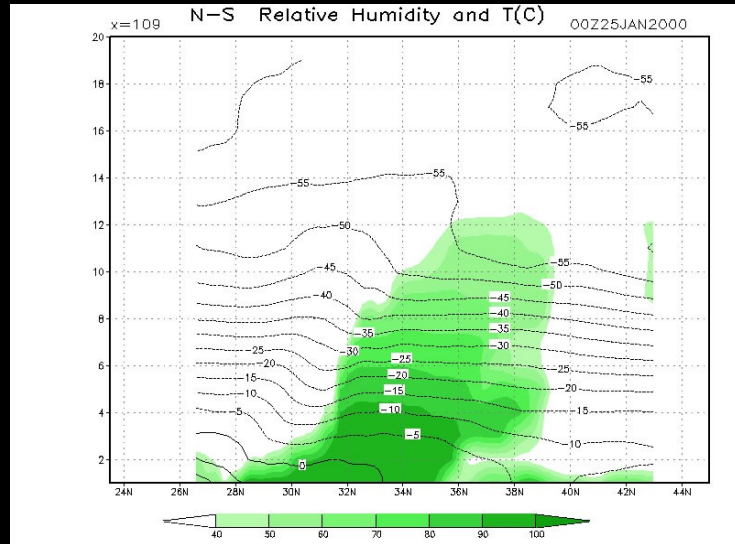


Skew-T Diagram

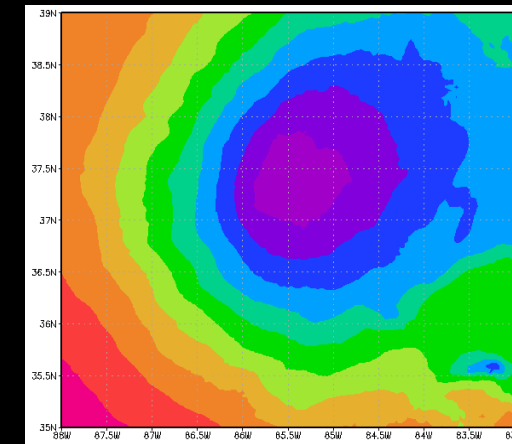
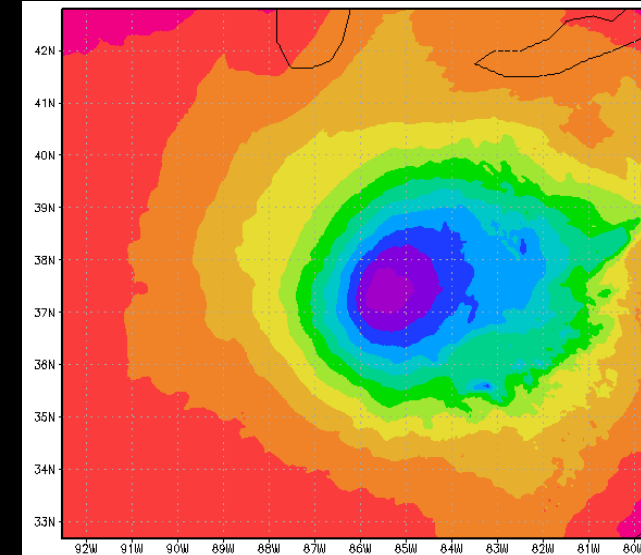


ARWpost: Example Functions

Cross-Sections



Zooming



Available ARWpost Diagnostics

cape : 3d cape

cin : 3d cin

mcape : max cape

mcin : min cin

clfr : low/middle/high cloud fraction

dbz : 3d reflectivity

max_dbz : max 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 temp

tc : temp (C)

tk : temp (K)

td : dew point temp (C)

td2 : 2-m dew point temp (C)

slp : sea-level pressure

umet/vmet : winds rotated to Earth Coordinates

u10m/v10m : 10-m winds rotated to Earth Coordinates

wdir : wind direction

wsp : wind speed coordinates

wd10 : 10-m wind direction

ws10 : 10-m wind speed

Available 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)

Read, Interpolate,
Plot (RIP)

RIP: General Information

RIP

- A post-processing tool that generates graphical plots
- Requires NCAR Graphics Libraries
<http://www.ncl.ucar.edu>
- Documentation:
 - Included in program's tar file (in "Doc" directory)
<http://www2.mmm.ucar.edu/wrf/users/docs/ripug.htm>

Download Code

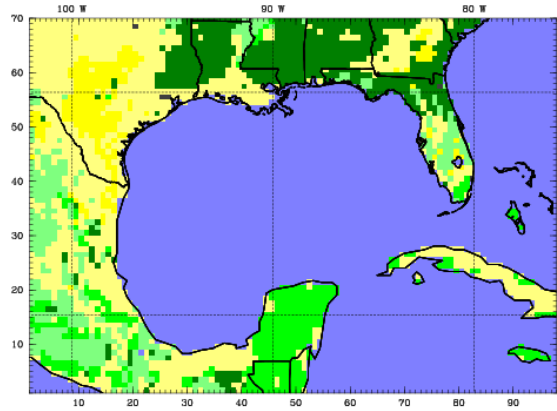
http://www2.mmm.ucar.edu/wrf/users/download/get_source.html

Online Tutorial

<http://www2.mmm.ucar.edu/wrf/OnLineTutorial/Graphics/RIP4/index.php>

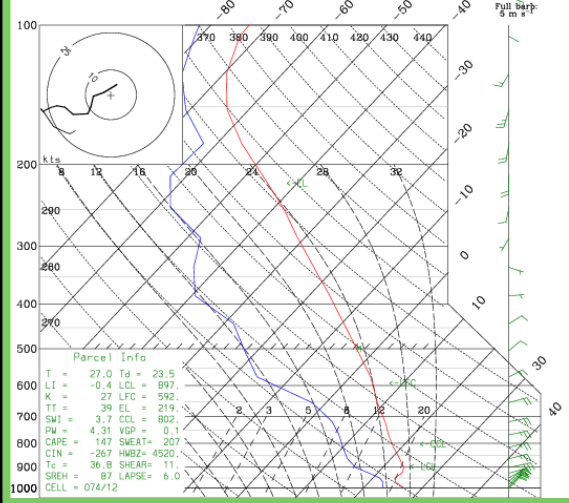
Landuse Category

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



Skew-T Diagram

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



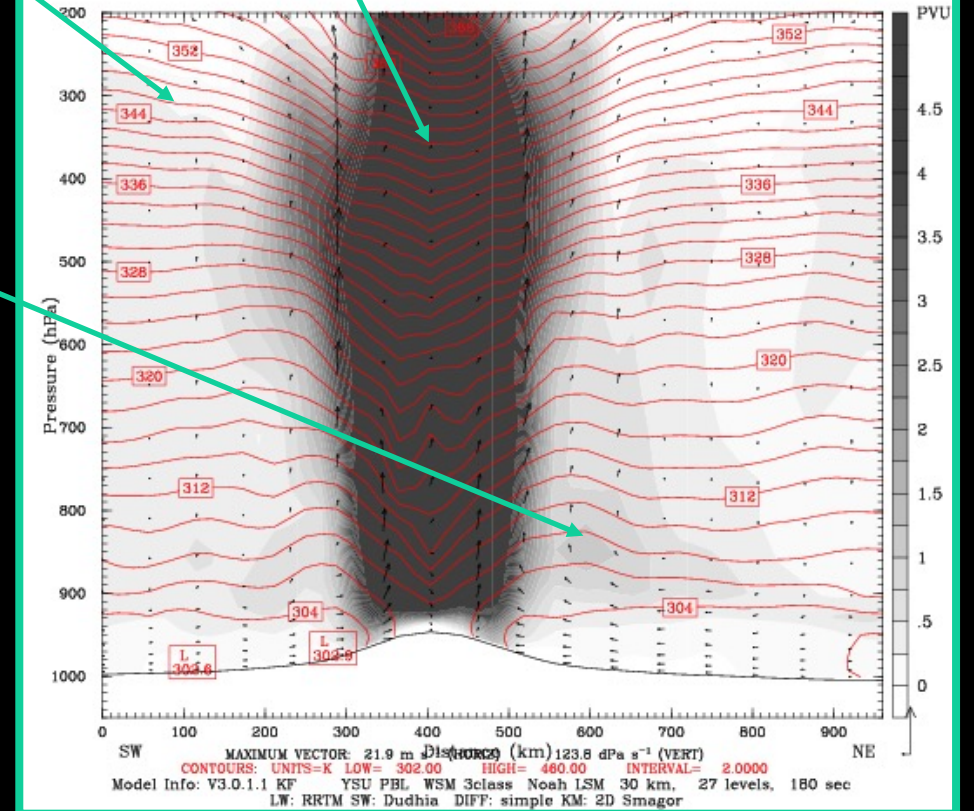
Potential Temp

Circulation Vectors

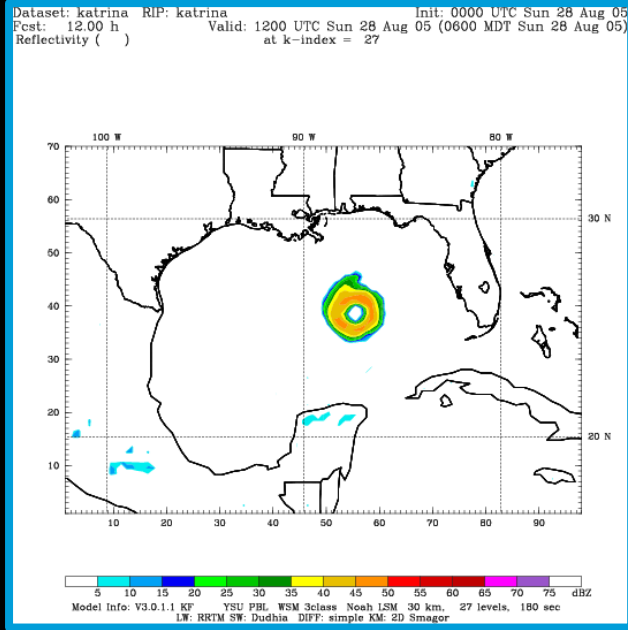
RIP: Example Plots

Potential Vorticity

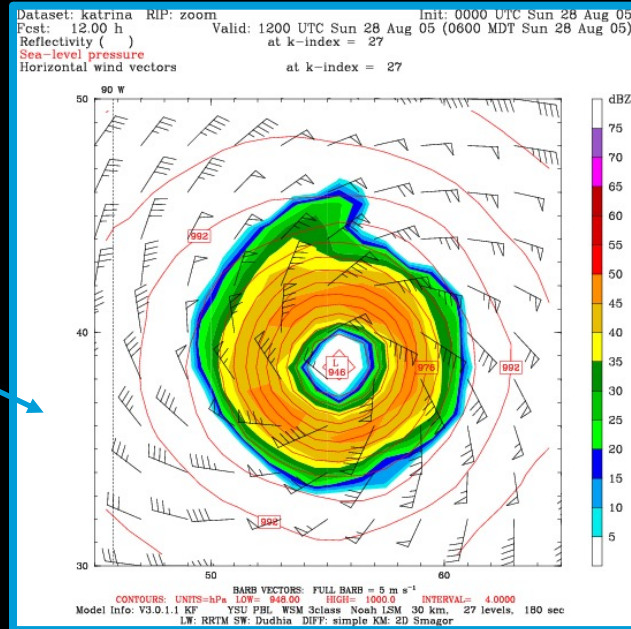
Dataset: katrina RIP: katrina Init: 0000 UTC Sun 28 Aug 05
Fcst: 12.00 h Valid: 1200 UTC Sun 28 Aug 05 (0600 MDT Sun 28 Aug 05)
Potential vorticity XY= 45.0, 30.0 to 70.0, 50.0
Potential temperature XY= 45.0, 30.0 to 70.0, 50.0
Circulation vectors XY= 45.0, 30.0 to 70.0, 50.0



RIP: Example Functions

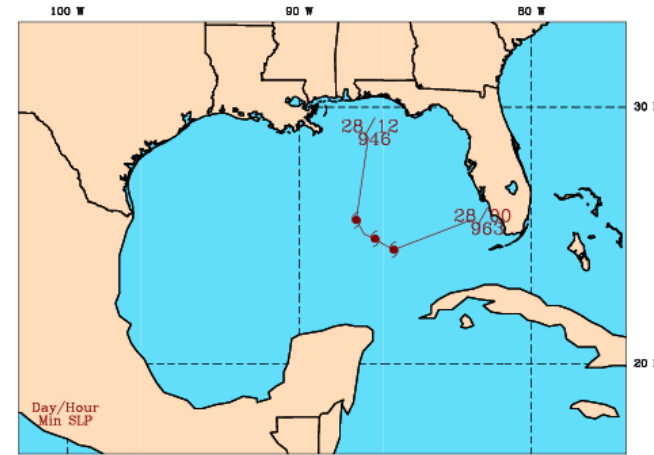


Zooming Capability



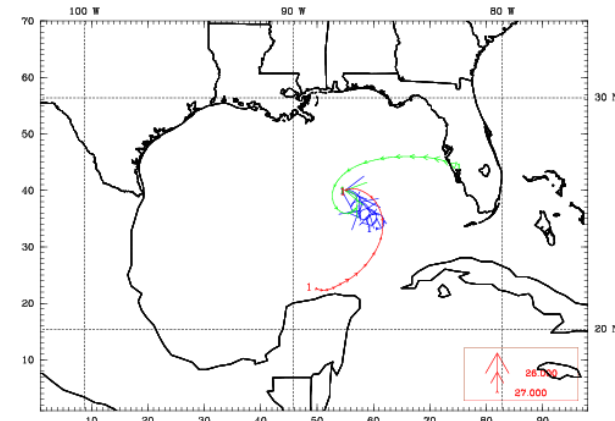
Dataset: katrina RIP: typhoon Init: 0000
Fest: 0.00 h Valid: 0000 UTC Sun 28 Aug 05 (1800 MDT Sat 27 Aug 05)
Typhoon Track

Cyclone Tracking

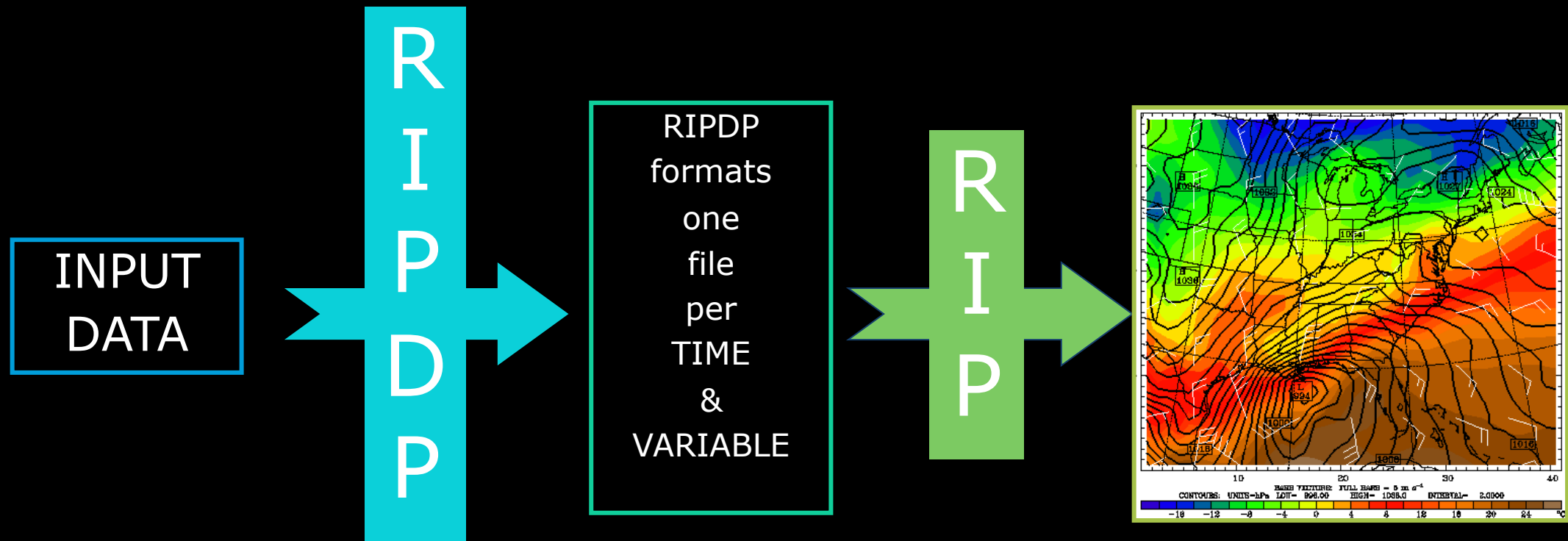


Dataset: katrina RIP: traj plot Init: 0000 UTC Sun 28 Aug 05
Fest: 0.00 h Valid: 0000 UTC Sun 28 Aug 05 (1800 MDT Sat 27 Aug 05)
Trajectories from hour 0.000 to 12.000
Trajectories from hour 0.000 to 12.000
Trajectories from hour 0.000 to 12.000

Trajectories



RIP Program Flow



Use the 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

`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

Thank you!

