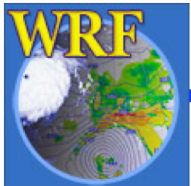

WRF Utilities

Cindy Bruyère



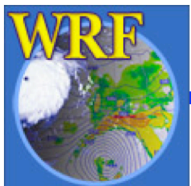
Utilities

UG: Chapter 3 & 10

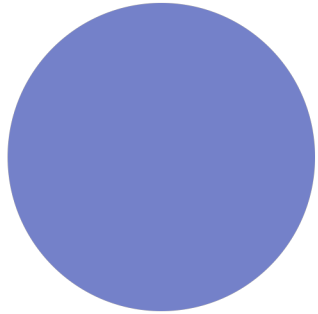
- Graphics
- Designing a model domain
- Data

Input	Intermediate	Output
grib 1&2	intermediate format	netcdf
<i>netcdf</i>		

- netCDF tools
- Other utilities
- MET

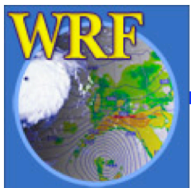
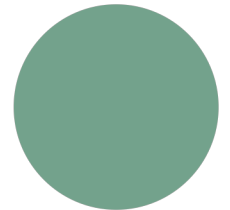


Graphics: compiling with ncl

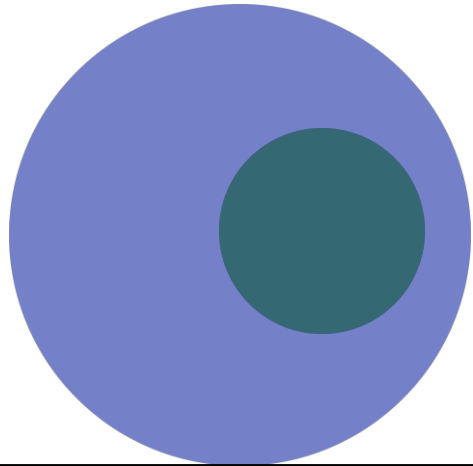


```
ncl myscript.ncl  
NCARG_ROOT  
/usr/local/ncl
```

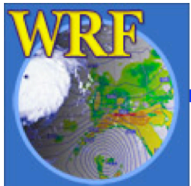
```
compile <util>  
NCARG_ROOT  
/usr/local/ncarg
```



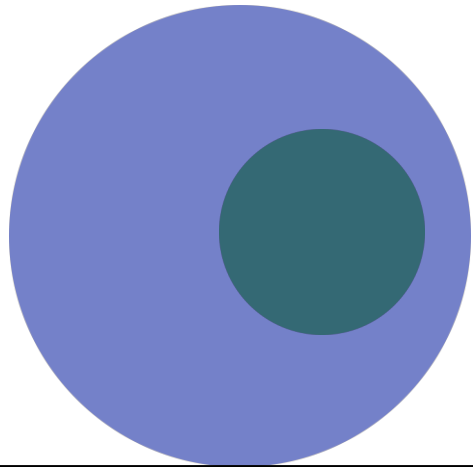
Graphics: compiling with ncl



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



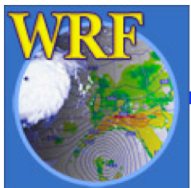
Graphics: compiling with ncl



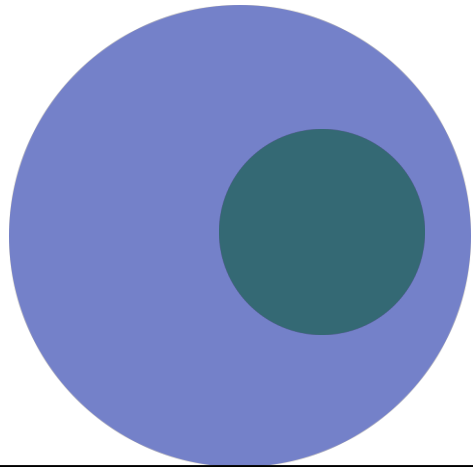
```
ncl myscript.ncl  
compile <util>  
NCARG_ROOT  
/usr/local/ncl
```

```
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
```



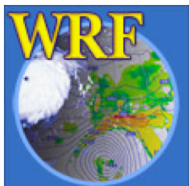
Graphics: compiling with ncl



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

```
/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'
```

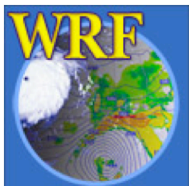
```
-L<path_to_gfortran_lib> -lgfortran
```



Graphics : ImageMagick

- **Convert graphical files from one format to another**
 - Many options available (*rotate* frames, *trim* white space, etc.)
 - Can be used for files with single or multiple frames
 - Cannot deal with **.ncgm** files
 - <http://www.imagemagick.org>

convert	<i>file.pdf</i>	<i>file.png</i>
convert	<i>file.png</i>	<i>file.bmp</i>
convert	<i>file.pdf</i>	<i>file.gif</i>
convert	<i>file.ras</i>	<i>file.png</i>



Graphics : *ctrans*

- **Convert NCAR Graphics files (.ncgm) to ras format**

- Single Frame in **.ncgm** file

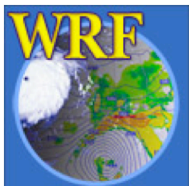
`ctrans -d sun file.ncgm > file.ras`

- Multiple Frames in **.ncgm** file

(med = metafile frame editor)

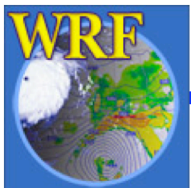
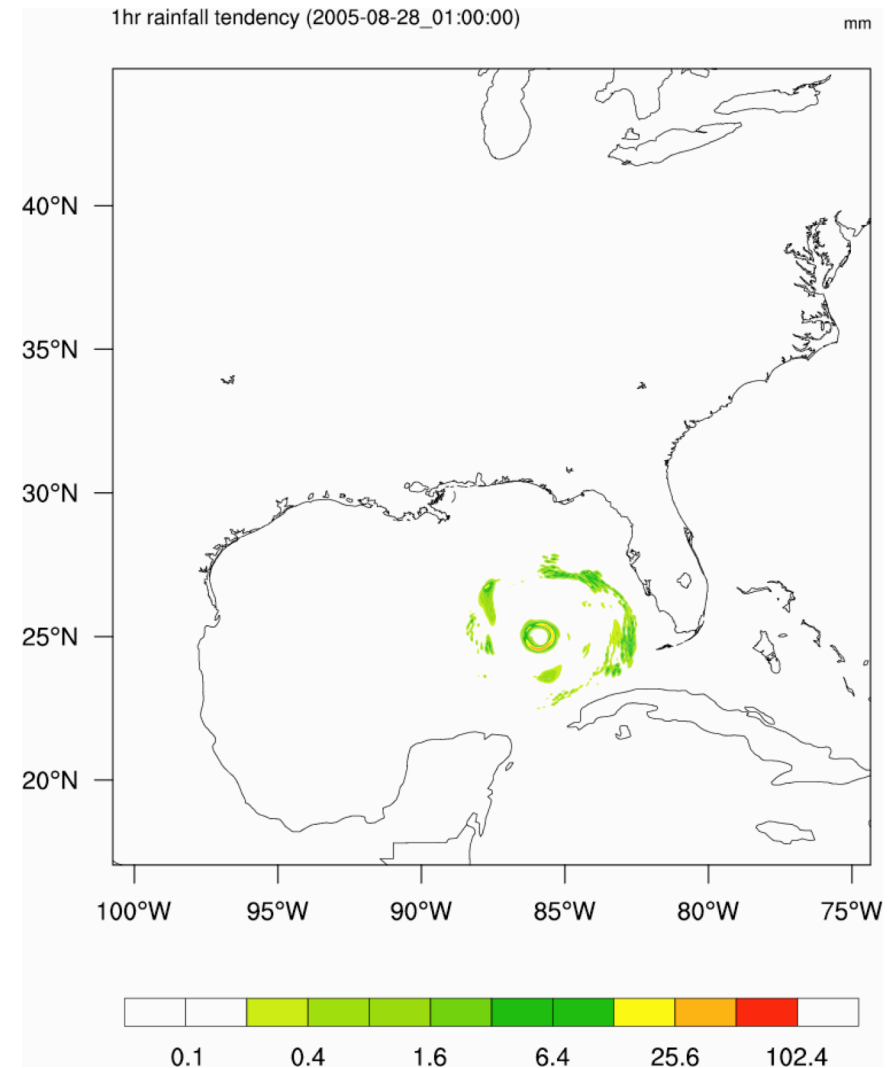
`med -e '1,$ split $' file.cgm`

`ctrans -d sun med001.ncgm > med001.ras`



Make Cool Movies

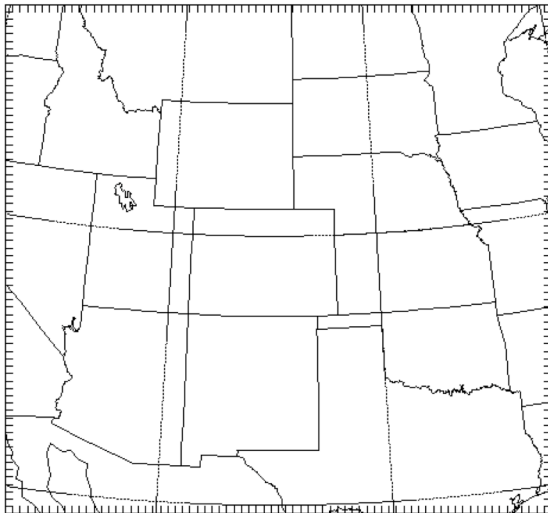
- Run NCL and create a .pdf file
- Use ImageMagick to split frames and convert to .png file
- Use a movie making tool to create movie
 - {GIF Movie Gear ; Windows ; commercial software }



WRF Model Domain Design

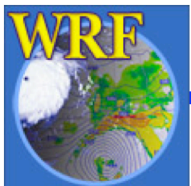
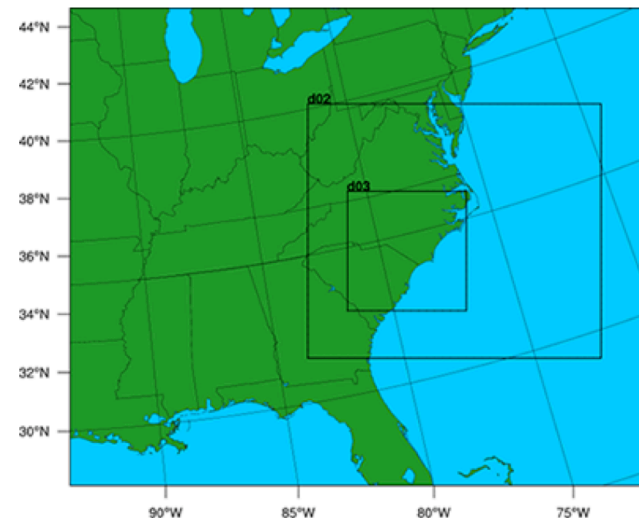
- **WPS util/ directory**

- **plotgrids.exe**
- reads namelist information to generate plot
- create an NCAR Graphics file called 'gmeta'
- use 'idt' to view

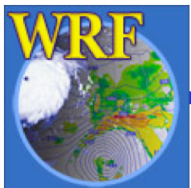
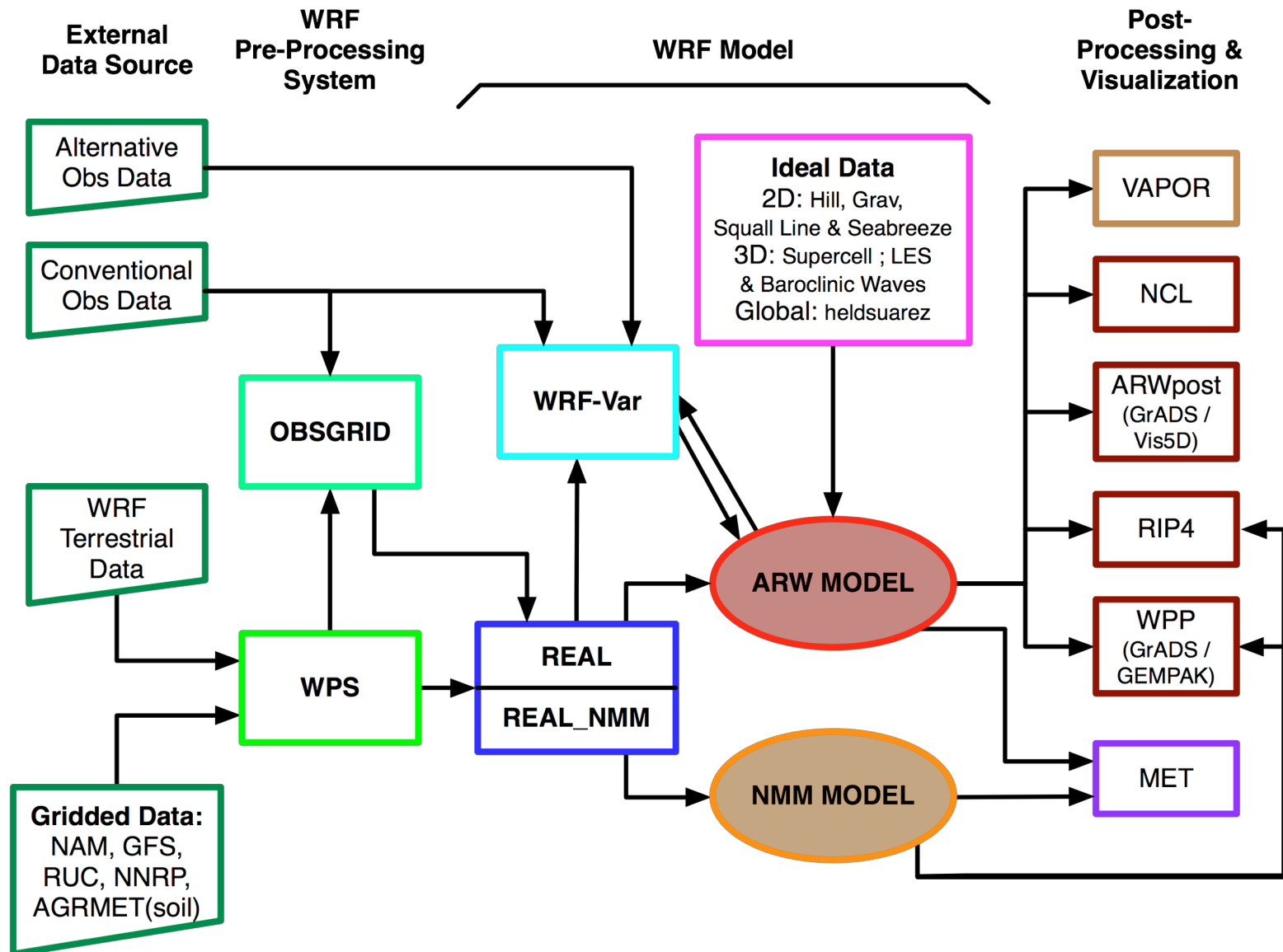


- **NCL**

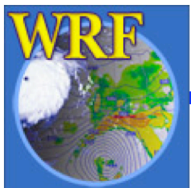
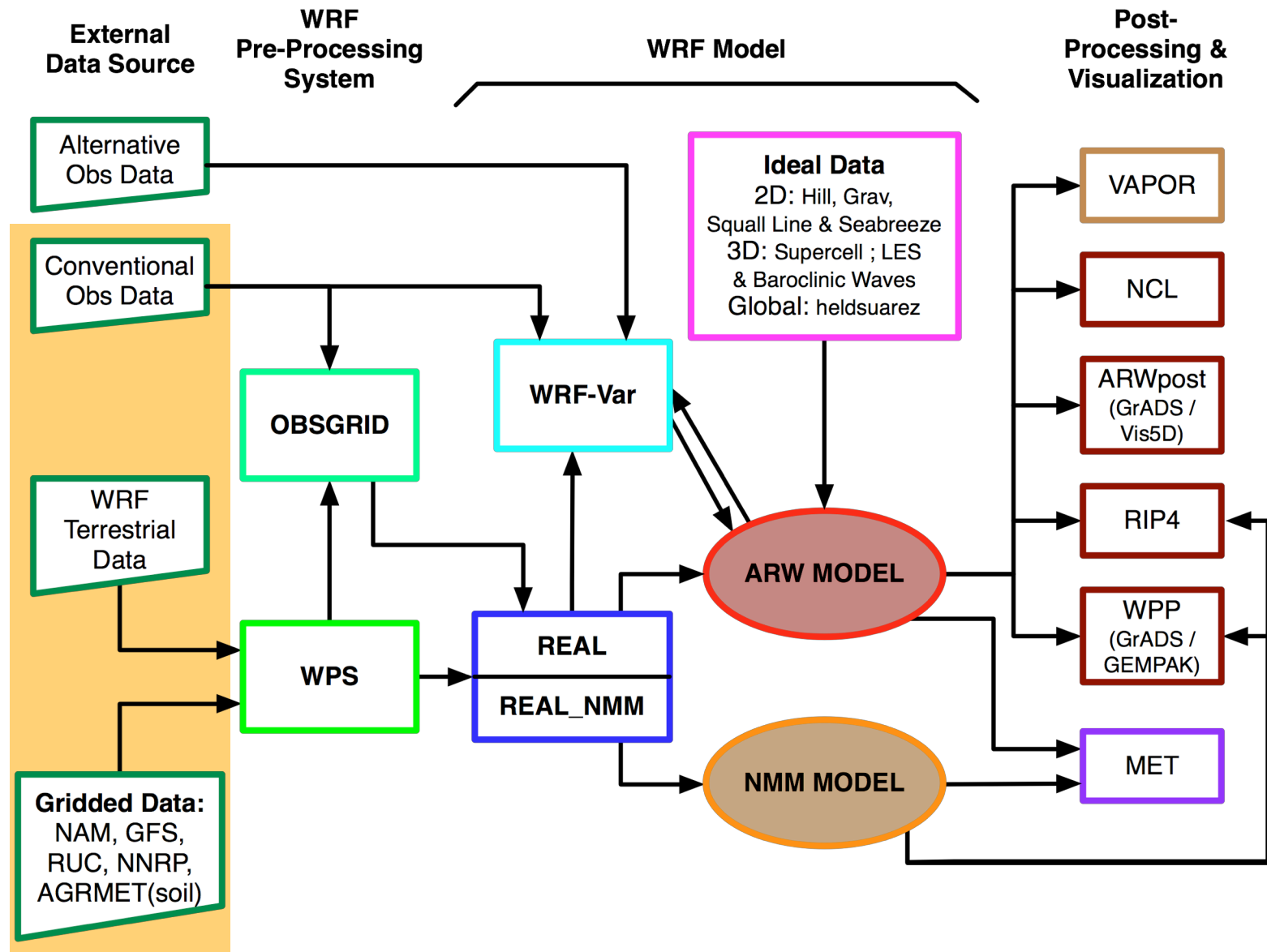
- **mp = wrf_wps_dom (wks, \mpres, lnres, txres)**
- reads namelist information to generate plot



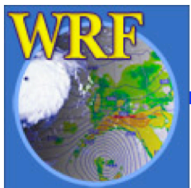
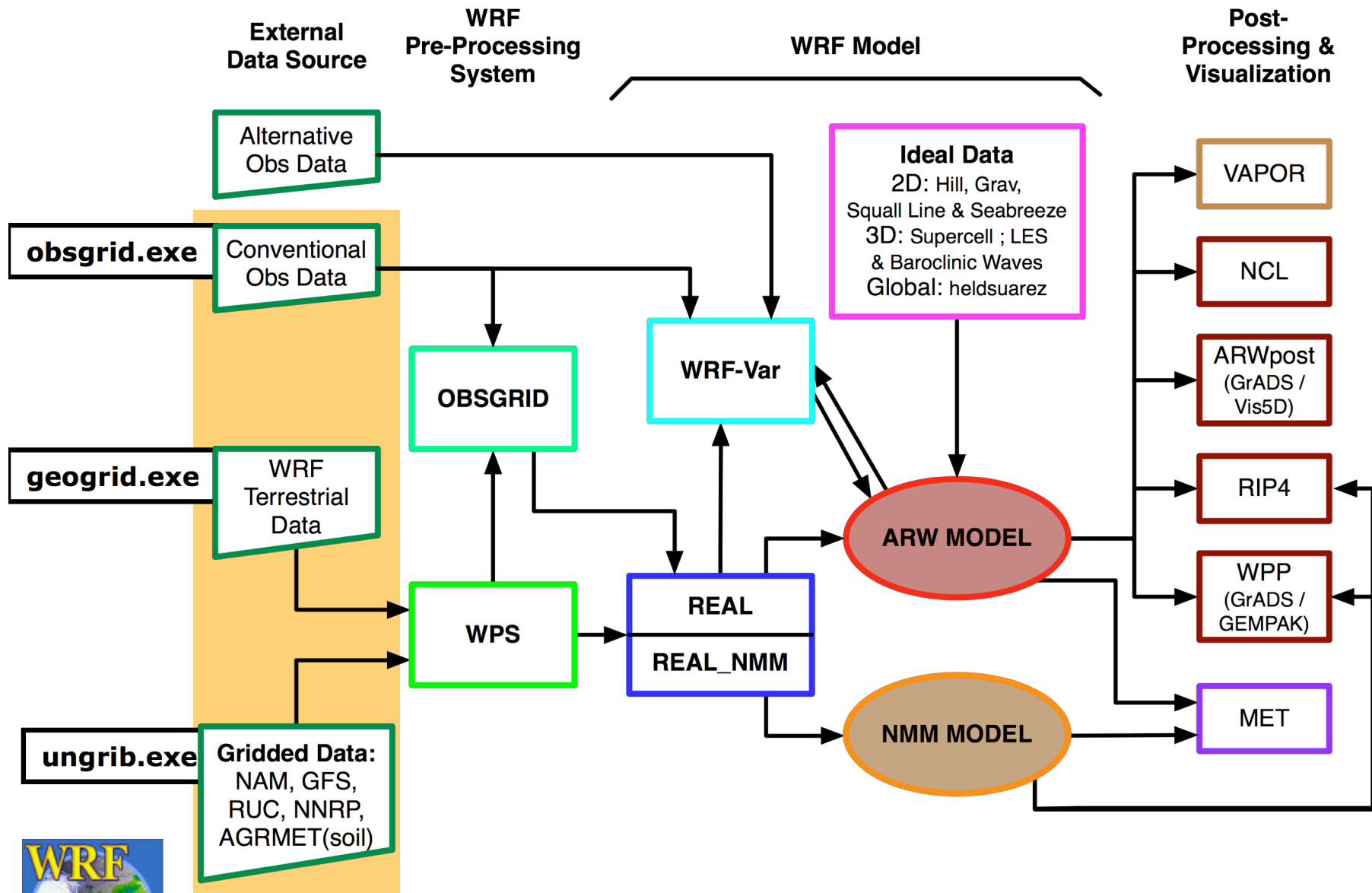
WRF Modeling System Flow Chart



WRF Modeling System Flow Chart

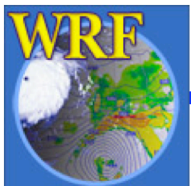
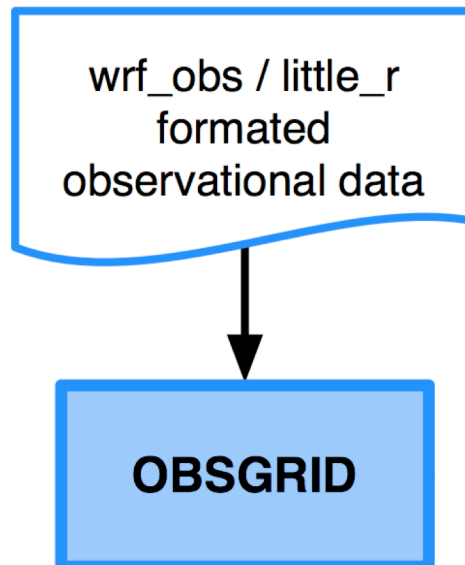


WRF Modeling System Flow Chart



Observational Data

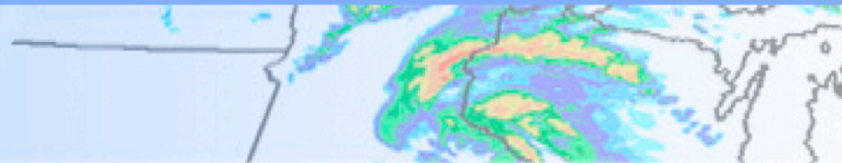
- <http://dss.ucar.edu/datasets/ds353.4/>
 - <http://dss.ucar.edu/datasets/ds464.0/>
 - <http://dss.ucar.edu/datasets/ds351.0/>
 - <http://dss.ucar.edu/datasets/ds461.0/>
- } ADP or ON29
- } NCEP dump-bufr



ungrib.exe

<http://www.mmm.ucar.edu/wrf/OnLineTutorial/index.htm>

WRF ARW OnLineTutorial



Home Introduction Compilation Basics Case Studies Graphics Tools **Data**

Available test data sets for the Online Tutorial:

North American data sets

- [AWIP](#)
 - [NAM](#)
 - [NARR](#)
- <http://dss.ucar.edu/datasets/ds609.2/>
 - <http://www.emc.ncep.noaa.gov/>
 - <http://dss.ucar.edu/pub/narr/>

Global data sets

- [GFS](#)
 - [FNL](#)
 - [NNRP](#)
- <http://www.emc.ncep.noaa.gov/>
 - <http://dss.ucar.edu/datasets/ds083.2>
 - <http://dss.ucar.edu/datasets/ds090.0/>

Global SST data

- [SST](#)
- <http://polar.ncep.noaa.gov/sst/oper/Welcome.html>



ungrib.exe

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

NOAA Satellite and Information Service
National Environmental Satellite, Data, and Information Service (NESDIS)

National Climatic Data Center
U.S. Department of Commerce

NOAA National Operational Model Archive & Distribution System

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

Documentation
[User Guide](#)

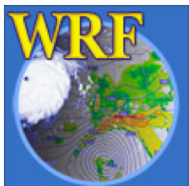
NOMADS Project
[About NOMADS](#)
[Partners](#)
[Publications & Presentations](#)
[Service Records Retention System](#)

Contact Us
[Contact Info](#)

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.

DOC > NOAA > NESDIS > NCDC

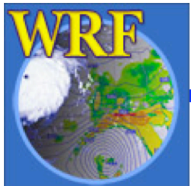
Search Field:



GRIB

- <http://dss.ucar.edu/docs/formats/grib/gribdoc/>
- **g1print.exe & g2print.exe**
 - Show data available in GRIB1 & GRIB2 files
 - Available from util/ directory in WPS
- **grib2ctl.pl**
 - Create .ctl and .idx files, so one can plot GRIB files with GrADS (available on web)
- **wgrib (for GRIB 1 data files)**
 - wgrib -v file
 - wgrib -V file

<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html>



GRIB2

- **Documentation**

http://www.nco.ncep.noaa.gov/pmb/docs/grib2/grib2_doc.shtml

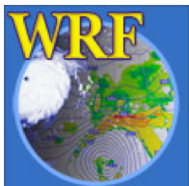
- **GRIB2 - GRIB1 parameter conversion table**

http://www.nco.ncep.noaa.gov/pmb/docs/grib2/GRIB2_parmeter_conversion_table.html

Product	Category	Parameter		Parameter
0	2	2	U	33
0	2	3	V	34

- **wgrib2**

<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/>



Utility: g1print and g2print

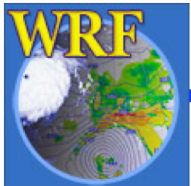
The *g1print* and *g2print* programs list the contents of a GRIB1 or GRIB2 file:

rec num	Prod Disc	Cat	Param num	Lvl code	Lvl one	Lvl two	Name	Time	Fcst hour
1	0	3	5	100	100000	0	HGT	2006-08-16_12:00:00	00
2	0	3	5	100	97500	0	HGT	2006-08-16_12:00:00	00
3	0	3	5	100	95000	0	HGT	2006-08-16_12:00:00	00
4	0	3	5	100	92500	0	HGT	2006-08-16_12:00:00	00
5	0	3	5	100	90000	0	HGT	2006-08-16_12:00:00	00
6	0	3	5	100	85000	0	HGT	2006-08-16_12:00:00	00
7	0	3	5	100	80000	0	HGT	2006-08-16_12:00:00	00
8	0	3	5	100	75000	0	HGT	2006-08-16_12:00:00	00
9	0	3	5	100	70000	0	HGT	2006-08-16_12:00:00	00
10	0	3	5	100	65000	0	HGT	2006-08-16_12:00:00	00



WPS Intermediate Files

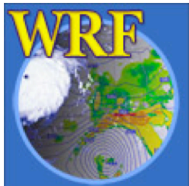
- **Output format of ungrid**
- **WPS util/ directory**
 - `plotfmt.exe` (*graphical interface to view intermediate file*)
 - `rd_intermediate`
- **Create your own intermediate files**
 - example if you have input data in netCDF format
 - http://www.mmm.ucar.edu/wrf/OnLineTutorial/WPS/IM_files.htm



Utility: rd_intermediate

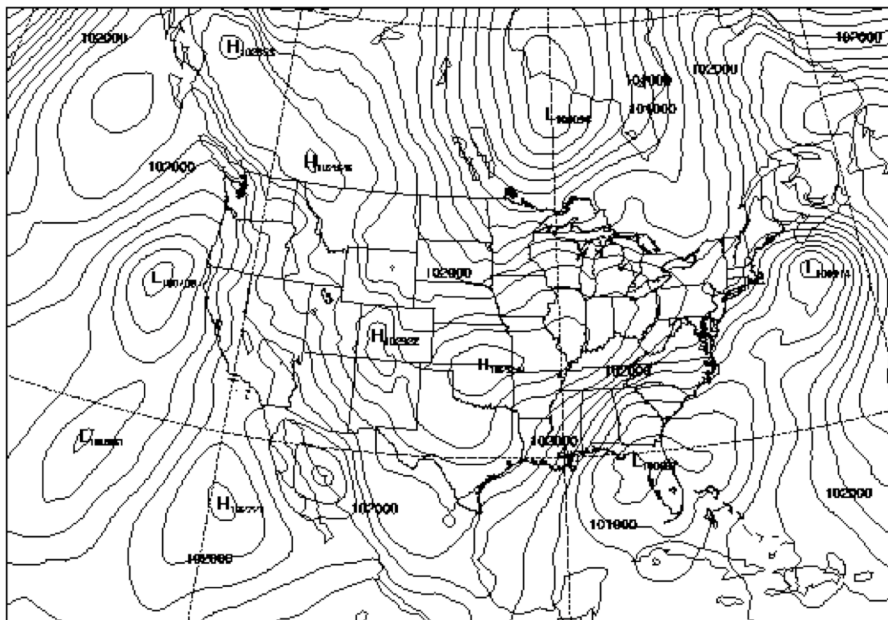
The rd_intermediate lists information about the fields found in an intermediate-format file

```
=====
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 ungrib intermediate-formatted files



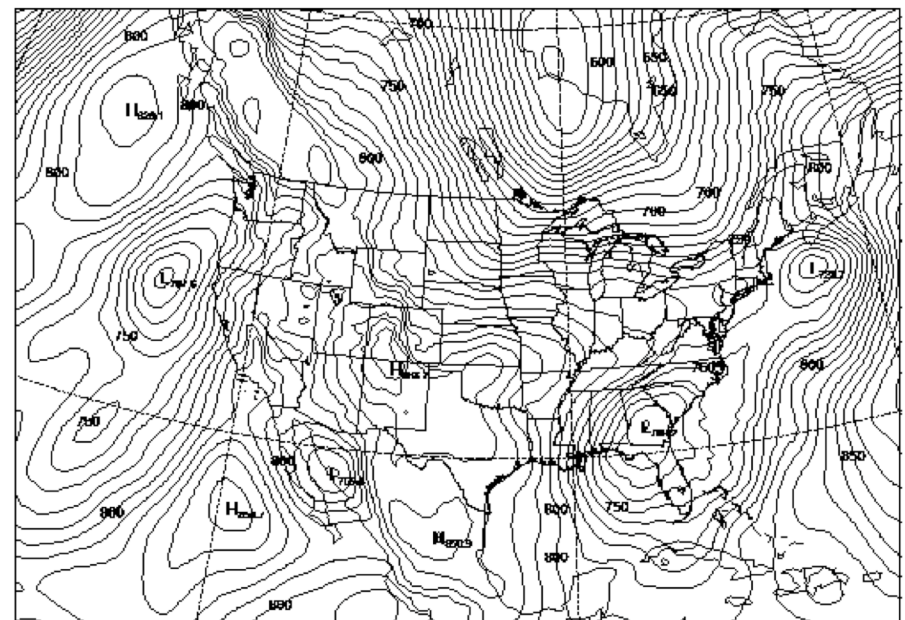
201300 PMSL

CONTOUR FROM 100200 TO 103200 BY 200

Pa

Sea-level Pressure
WPS intermediate format

unknown model from NCEP GRID 212



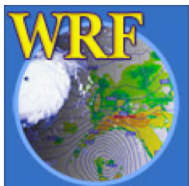
92500 GHT

CONTOUR FROM 580 TO 880 BY 10

m

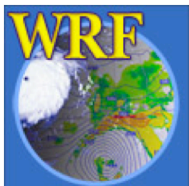
Height
WPS intermediate format

unknown model from NCEP GRID 212



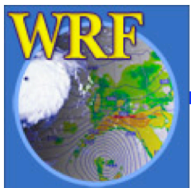
netCDF

- netCDF stands for *network Common Data Form*
- netCDF is one of the current supported data formats chosen for WRF I/O API
 - WRF I/O supports netCDF (*not fully CF compliant - Climate and Forecast Metadata Convention*)/ binary/GRIB/HDF
 - Most support graphical packages currently only support netCDF file format
- <http://www.unidata.ucar.edu> (*documentation*)
- <http://www.unidata.ucar.edu/software/netcdf/fguide.pdf>
(*writing Fortran programs to read/write netCDF files*)



netCDF

- **Advantages of using netCDF?**
 - Platform-independent (*big_endian* / *little_endian*)
 - A lot of software already exist which can be used to process netCDF data
- **netCDF operators**
 - <http://nco.sourceforge.net/>
 - Stand alone programs to, which can be used to manipulate data (*performing grid point averaging / file differencing / file 'appending'*)



Change fields in netCDF file

```
load "$NCARG_ROOT/lib/ncarg/nclscripts/csm/gsn_code.ncl"
```

Begin

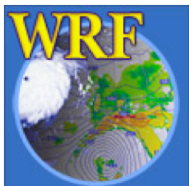
```
a = addfile("./met_em.d01.2000-01-24_12:00:00.nc","w")
```

```
sst = a->SST      ; read a field
```

```
sst = sst + 10; change the field
```

```
a->SST = sst      ; write the field
```

end



NCO tools

<http://nco.sourceforge.net/>

- **ncdiff**

- Difference two file
`ncdiff input1.nc input2.nc -o output.nc`

- **ncrcat (nc cat)**

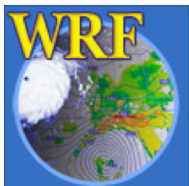
- Write specified variables / times to a new file
`ncrcat -v RAINNC wrfout* -o RAINNC.nc`
`ncrcat -d Time,0,231 -v RAINNC wrfout* -o RAINNC.nc`

- **ncra (nc average)**

- Average variables and write to a new file
`ncra -v OLR wrfout* -o OLR.nc`

- **ncks (nc kitchen sink)**

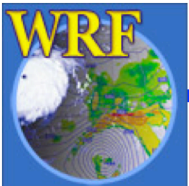
- Combination of NCO tools all in one (handy: one tool for multiple operations)
Specifically handy to split files
`ncks -d Time,1,1 wrfout -o wrfout1.nc`



netCDF : Utilities

- **ncdump**

- reads a netCDF dataset and prints information from the dataset
- `ncdump -h file`
print header (inc. list of variables in the file)
- `ncdump -v VAR file`
print data of the variable VAR
`ncdump -v Times file`



netCDF : *ncdump -h*

```
netcdf wrfinput_d01 {
dimensions:
    Time = UNLIMITED ; // (1 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 REAL EM V3.0 PREPROCESSOR";
    :START_DATE = "2000-01-24 12:00:00" ;
    :SIMULATION_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 ;
    :GRIDTYPE = "C" ; :MP_PHYSICS = 3 ;
    :SF_SFCLAY_PHYSICS = 1 ;
    :SF_SURFACE_PHYSICS = 1 ;
    :BL_PBL_PHYSICS = 1 ;
    :CU_PHYSICS = 1 ;

.....
.....
.....
```



netCDF : *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 = "" ;

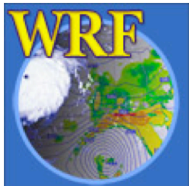
.....

global attributes:

        :TITLE = " OUTPUT FROM WRF V3.0.1.1 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"
```



Wrfout output fields (*ncdump -h*)

ALBBCK	ALBEDO	CANWAT	CF1	CF2
CF3	CFN	CFN1	COSALPHA	DN
DNW	DZS	E	EDT_OUT	EMISS
F	FNM	FNP	GLW	GRAUPELNC
GRDFLX	HFX	HGT	HGT_SHAD	ISLTYP
ISTEP	IVGTYP	LANDMASK	LH	LU_INDEX
MAPFAC_M	MAPFAC_MX	MAPFAC_MY	MAPFAC_U	MAPFAC_UX
MAPFAC_UY	MAPFAC_V	MAPFAC_VX	MAPFAC_VY	MAX_MSTFX
MAX_MSTFY	MF_VX_INV	MU	MUB	NEST_POS
OLR	P_TOP	P	PB	PBLH
PH	PHB	POTEVP	PRATEC	PSFC
Q2	QCLOUD	QFX	QNDROPSOURCE	QRAIN
QVAPOR	RAINC	RAINCV	RAINNC	RDN
RDNW	RDX	RDY	RESM	RHOSN
SEAICE	SFROFF	SH2O	SINALPHA	SMOIS
SNOPCX	SNOW	SNOWC	SNOWH	SNOWNC
SOILTBT	SR	SST	SWDOWN	T
T2	TH2	Times	TMN	TSK
TSLB	U	U10	UDROFF	UST
V	V10	VEGFRA	W	X
XICEM	XLAND	XLAT	XLAT_U	XLAT_V
XLONG	XLONG_U	XLONG_V	ZETATOP	ZNU
ZNW	ZS			
Total Geopotential, staggered (PH+PHB)		Total Pressure in Pa (P+PB)		
Wind components, grid relative, staggered (U & V)		Total Potential Temperature (T+300)		
10m wind components, grid relative, mass points (U10 & V10)		Surface temperature in K (T2)		



ncview

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

no variable selected

Ncview 1.93a David W. Pierce 1 Feb 2006

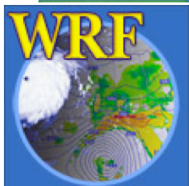
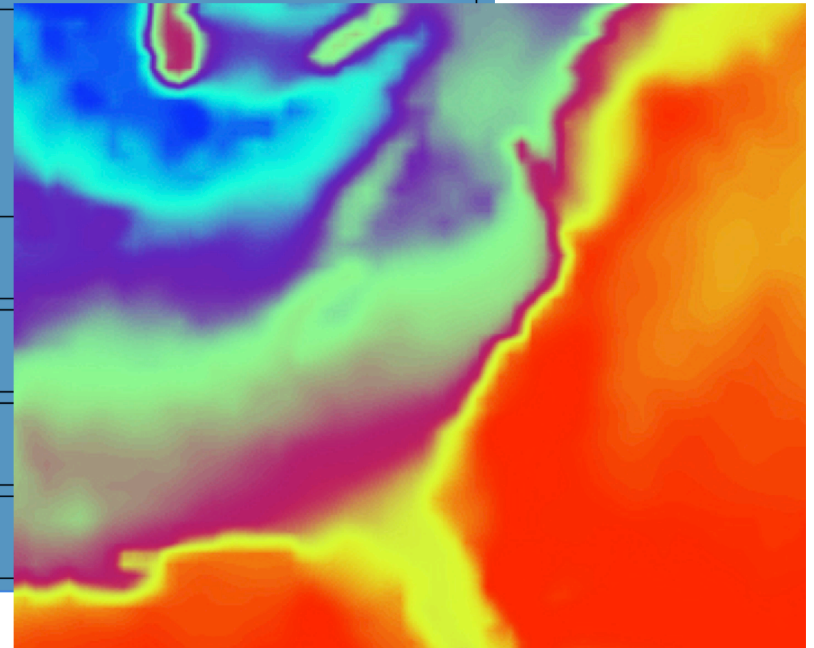
*** SELECT A VARIABLE TO START ***

Quit ->| << < || > >> Edit ? Delay: Opts

3gauss Inv P Inv C Mag XI Linear Axes Range blowup Print

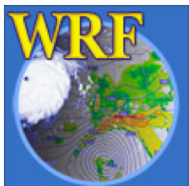
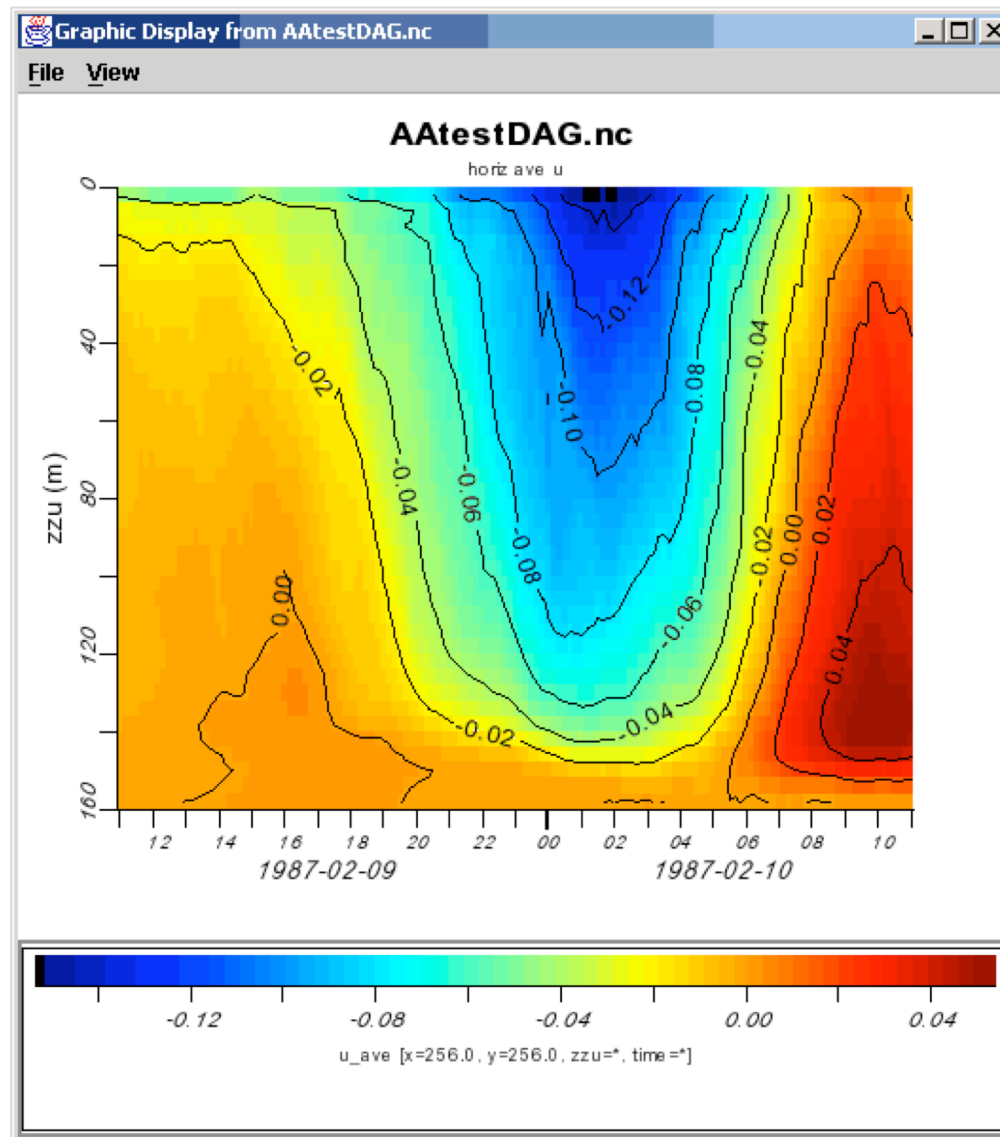
(18) 1d vars (48) 2d vars (13) 3d vars

Dim:	Name:	Min:	Current:	Max:	Units:
	Time	Min:	Current:	Max:	Units:
	bottom_top	Min:	Current:	Max:	Units:
	south_north	Min:	Current:	Max:	Units:
	west_east_st	Min:	Current:	Max:	Units:



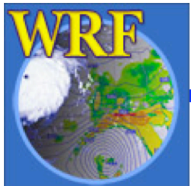
ncBrowse

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



Other Utilities

- **Developed / Supported by NCAR**
- **FORTRAN program**
 - Easy to use
 - Easy to add your own code
 - Only for netCDF datasets
- <http://www.mmm.ucar.edu/wrf/users/utilities/util.htm>



Other Utilities

- **read_wrf_nc**
 - Display data in a wrfout netCDF file
 - Specific points; min/max of fields; time series; edit data in file
- **iowrf**
 - Thinning of netCDF data; extracting a area; destaggering grid
- **p_interp**
 - Interpolate to pressure levels
- **v_interp**
 - Add vertical levels in wrf input and boundary files
 - For use with ndown
- **wrf_to_cf**
 - User contributed code (*not fully supported*)



MET verification software

- **Model Evaluation Tools**
- **All the basics (e.g. RMSE, bias, skill scores)**
- **Plus**
 - advanced spatial methods (wavelets, objects)
 - confidence intervals
- **Get it here: <http://www.dtcenter.org/met/users/downloads/>**
- **Get help from met_help@ucar.edu or the documentation**

