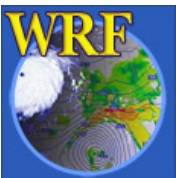
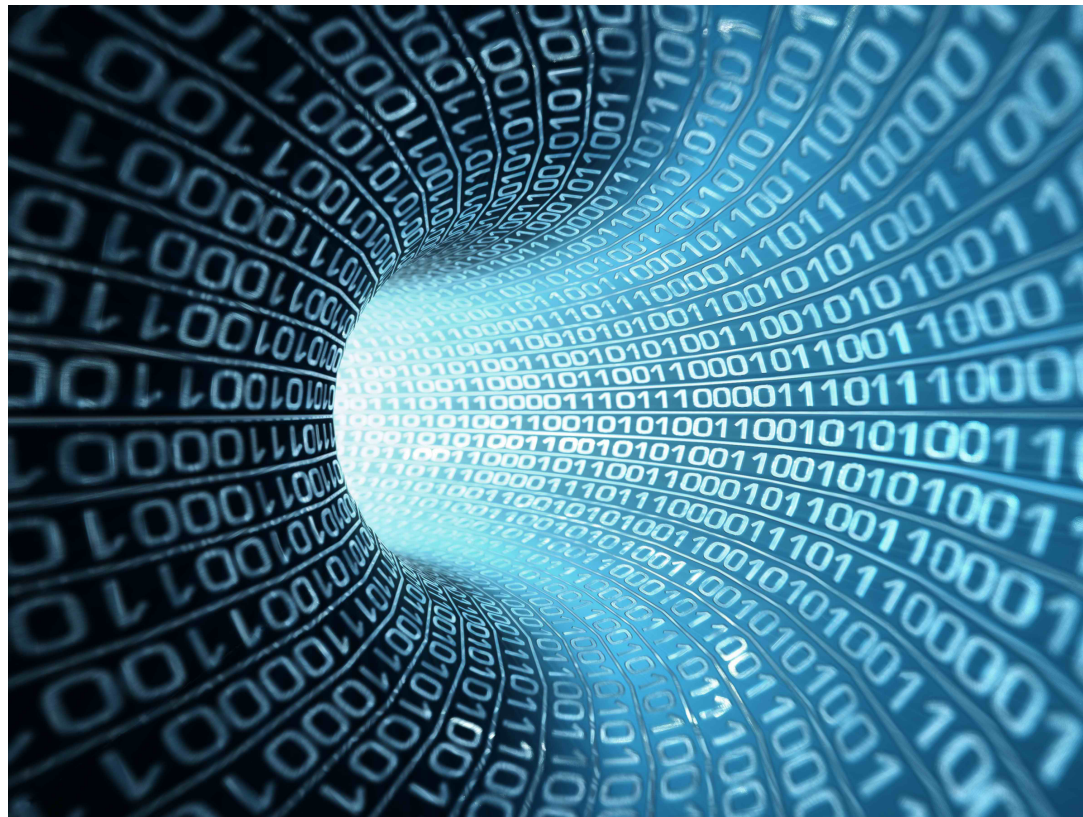


WRF Utilities

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
- MET



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>

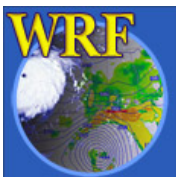
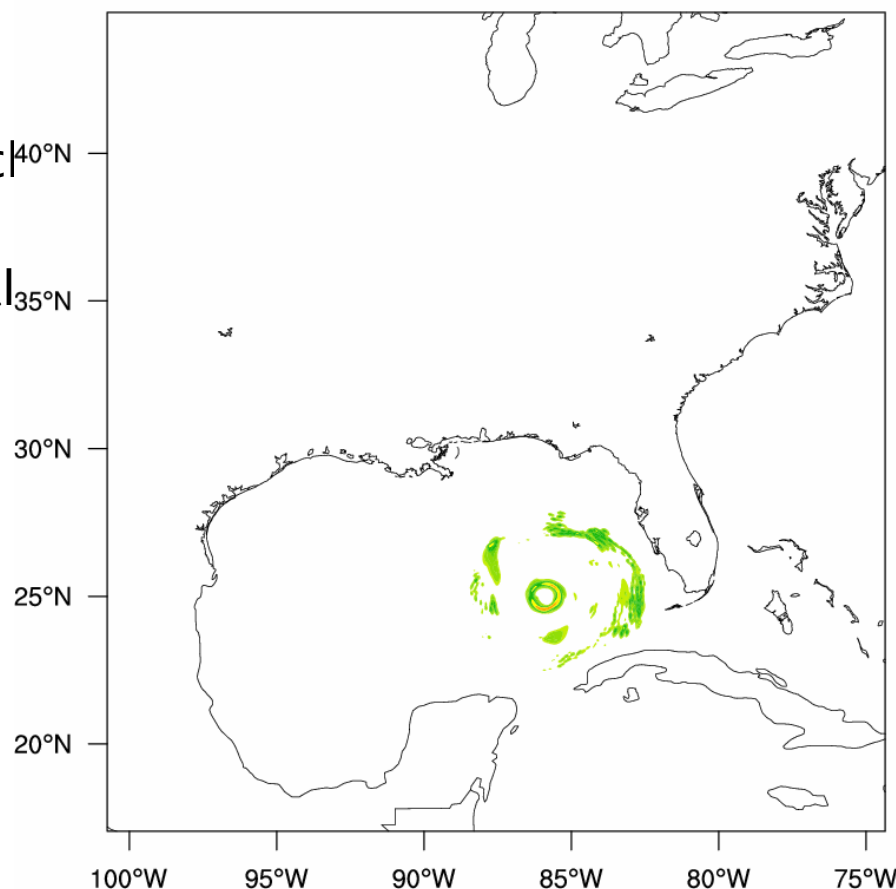


Making Movies

- Run graphical package
- Create individual frames for each image
 - Either directly from graphical package;
 - Or with a tool like ImageMagick
- Use a movie making tool to create movie
 - {GIF Movie Gear ; Windows ; commercial software }
- `convert -delay 20 *png movie.gif`

1hr rainfall tendency (2005-08-28_01:00:00)

mm



WRF Model Domain Design

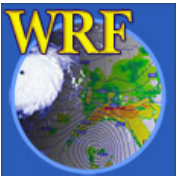
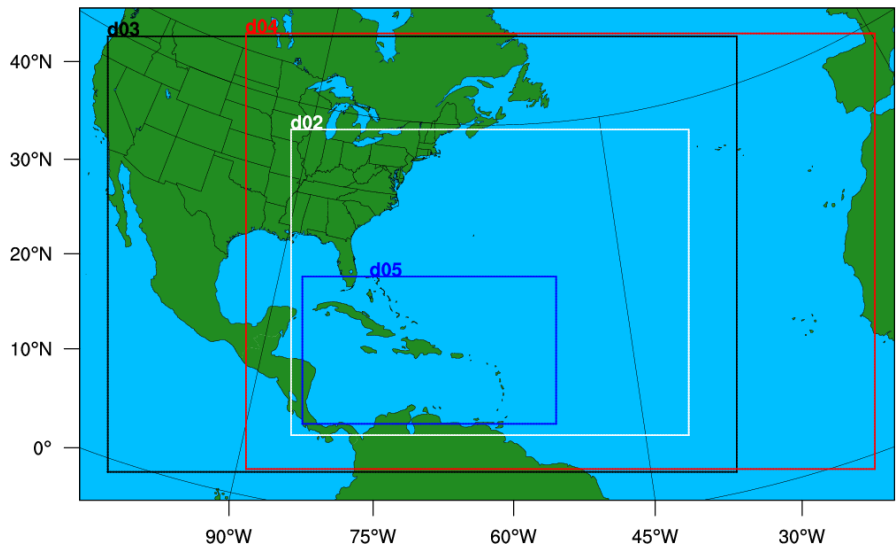
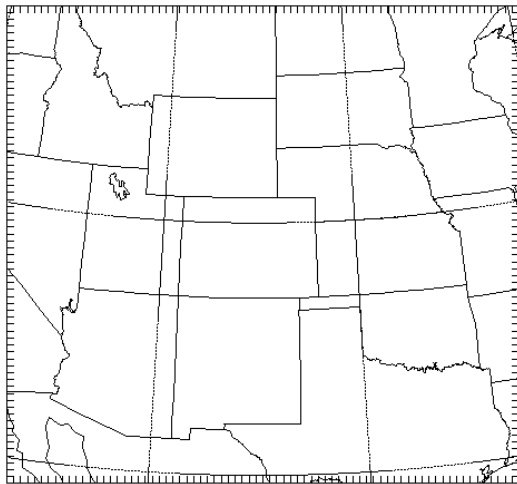
- Fortran Code

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

- NCL

- WPS/util/plotgrids.ncl
- *plotgrids_new.ncl* (NCL 6.1.0+)
- reads namelist information to generate plot
- create plot x11/png/pdf

Test Domain

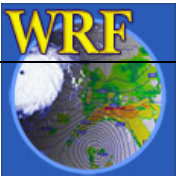
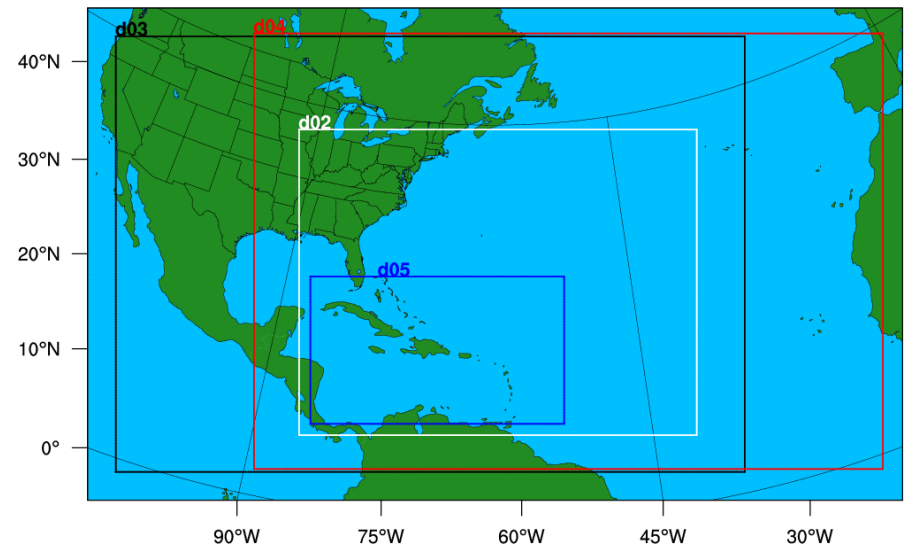


WRF Model Domain Design

```
mpres@mpFillColor =  
  (/ "background", "DeepSkyBlue",  
    "ForestGreen", "DeepSkyBlue",  
    "transparent" / )  
  
mpres@mpGridSpacingF = 45  
  
lnres@domLineColors = (/ "white",  
  "Red" , "Red" , "Blue" / )  
  
mpres@mpOutlineBoundarySets  
  "NoBoundaries" ; "Geophysical"  
  "National" ; "USStates"  
  "GeophysicalAndUSStates"  
  "AllBoundaries"  
  
pares = True  
pmres@gsMarkerColor = "White"  
pmres@gsMarkerIndex = 16  
pmres@gsMarkerSizeF = 0.01  
gsn_polymarker(wks,mp,-77.26,38.56,  
  pmres)
```

- NCL
 - WPS/util/plotgrids.ncl
 - *plotgrids_new.ncl* (NCL 6.1.0+)
 - reads namelist information to generate plot
 - create plot x11/png/pdf

Test Domain



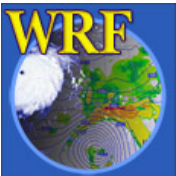
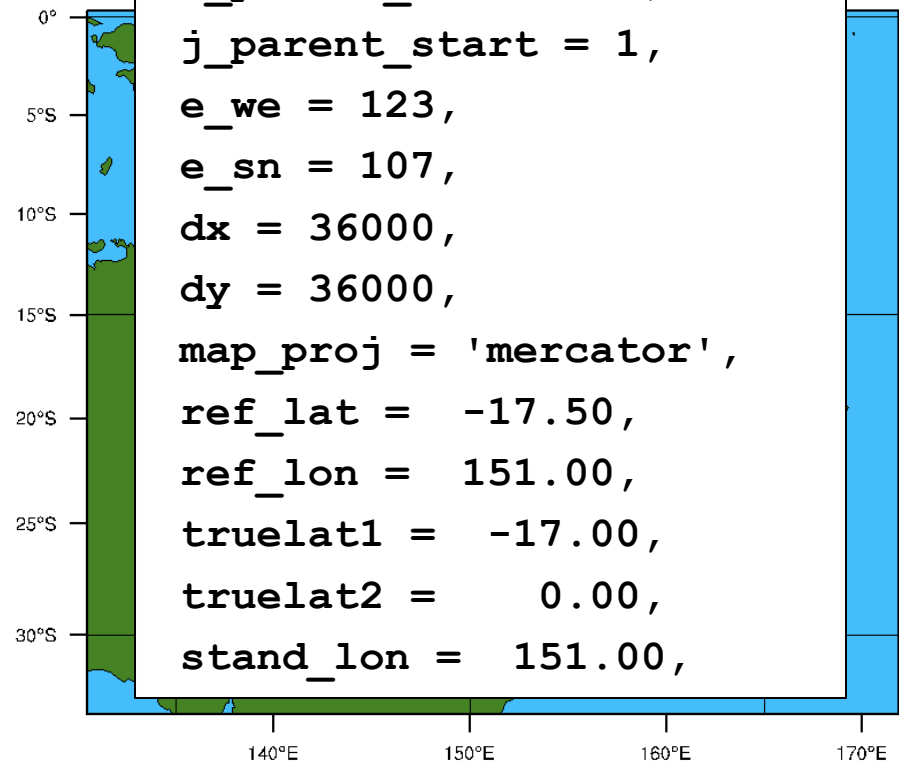
WRF Model Domain Design

```
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 /)
```

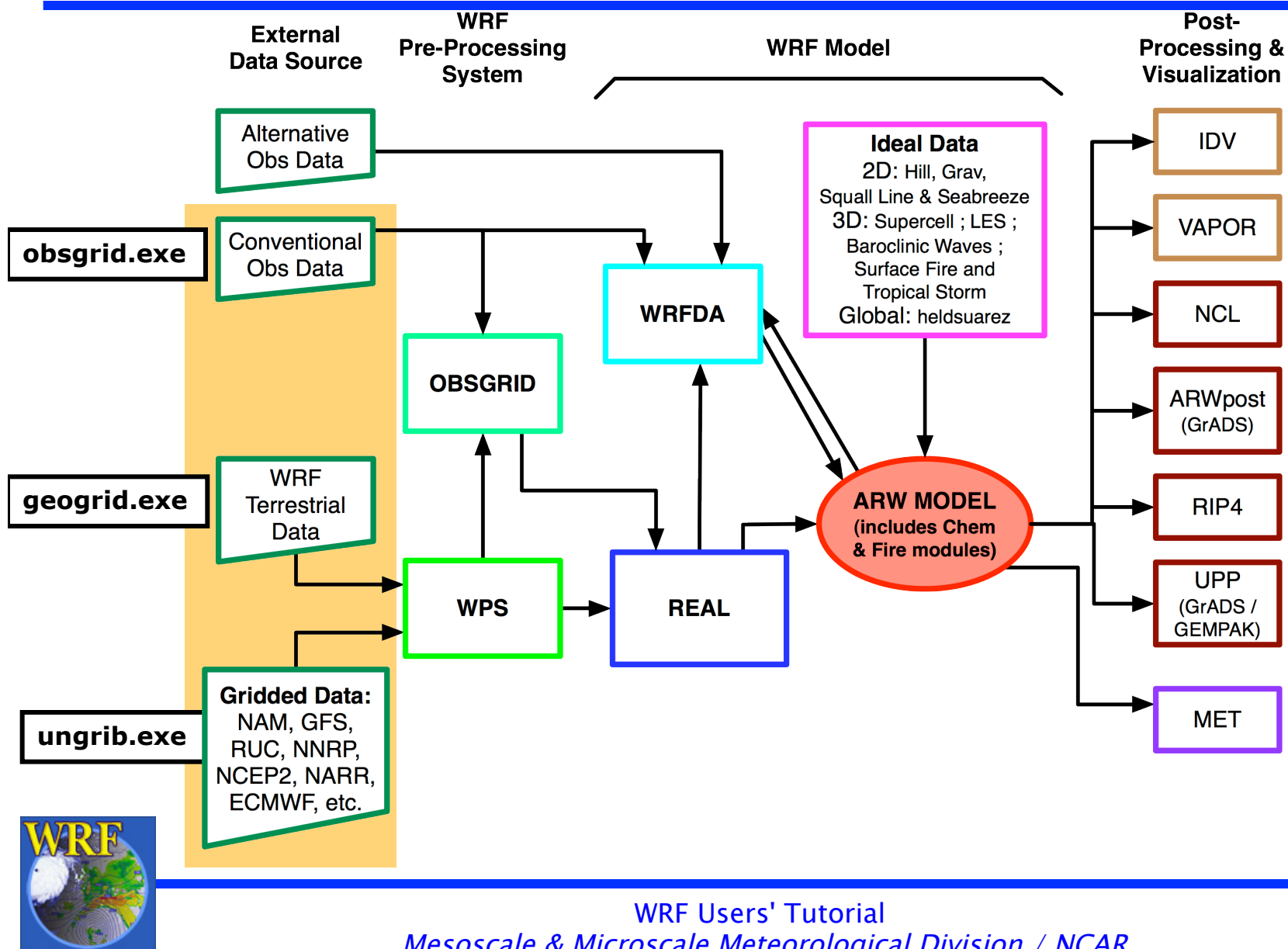
ncl design_grids.ncl

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,
```

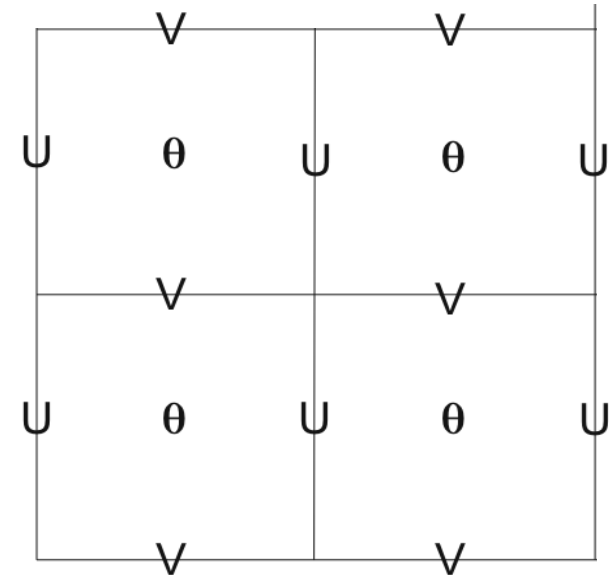


WRF Modeling System Flow Chart

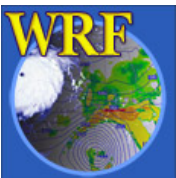


Fields in geo_em files

- All invariant (static) data
 - XLAT & XLONG
 - MAPFAC
 - LANDMASK
 - HGT
 - GREENFRAC
 - LANDUSEF & LU_INDEX
 - ALBEDO12M & SNOALB
 - SOILTEMP; SOILCTOP & SOILCBOT



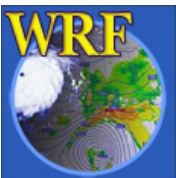
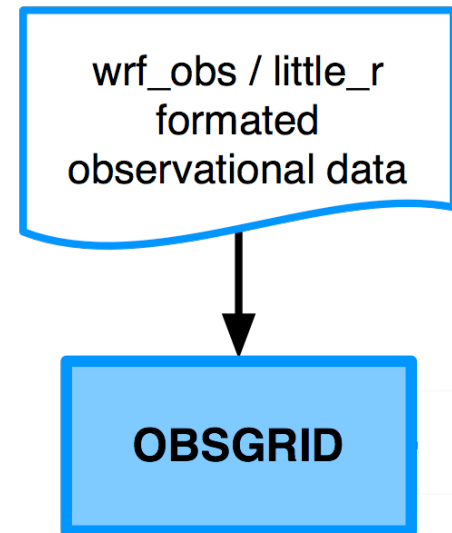
Data availability: <http://www.mmm.ucar.edu/wrf/users/>



Observational Data

- <http://rda.ucar.edu/datasets/ds353.4>
 - <http://rda.ucar.edu/datasets/ds464.0>
- } ADP or ON29

- <http://rda.ucar.edu/datasets/ds351.0>
*BUFRdecode_ADPrprair_littlr.tar is available at:
<http://rda.ucar.edu/datasets/ds351.0/software>*
 - <http://rda.ucar.edu/datasets/ds461.0>
*BUFRdecode_ADPsfc_littlr.tar is available at:
<http://rda.ucar.edu/datasets/ds461.0/software>*
- } NCEP dump-bufr



Fields needed for IM files – 6hourly

3D Data (e.g. data on pressure levels)

Temperature ; U and V components of Wind

Geopotential Height; Relative Humidity

2D Data

Surface Pressure; Mean Sea Level Pressure

Skin Temperature

2 meter Temperature and Relative Humidity

10 meter U and V components of wind

Recommended

LANDSEA

Soil data (temperature and moisture) & soil height

SST (climate runs – requires)

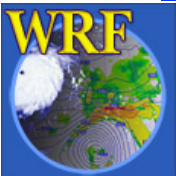
Water equivalent snow depth & SEAICE





ungrib : External Data Sources

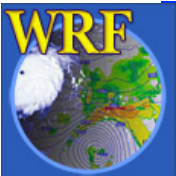
- NCEP/NCAR Global Reanalysis (NNRP / R1)
(~ 2.5° Global; Jan 1948 to present)
<http://rda.ucar.edu/datasets/ds090.0>
- NCEP / DOE Reanalysis II (~ 2.5° Global; Jan 1979 to present)
<http://rda.ucar.edu/datasets/ds091.0>
- GFS 0.5° Global data (Dec 2002 to present)
<http://rda.ucar.edu/datasets/ds335.0>
- ERA Interim Data (~ 0.7° Global; Jan 1979 to present)
<http://rda.ucar.edu/datasets/ds627.0>
- Final Analysis (~ 1.0° Global; FNL; Aug 1999 to present)
<http://rda.ucar.edu/datasets/ds083.2>





ungrib : External Data Sources

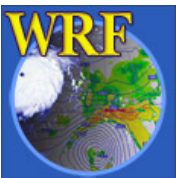
- NCEP Climate Forecast System Reanalysis (CFSR)
(~38km, *Global; Jan 1979 to Dec 2010*)
<http://rda.ucar.edu/datasets/ds093.0>
- NCEP Climate Forecast System Reanalysis (CFSR2)
(0.2°, *Global; Jan 2011 to present*)
<http://rda.ucar.edu/datasets/ds094.0>
- SST data
<http://polar.ncep.noaa.gov/sst> (Weekly to Daily; 1° to 1/12°)
<http://nomad3.ncep.noaa.gov/pub/sst> (Monthly to Weekly)
<http://rda.ucar.edu/datasets/277.0> (1894–present; Weekly)
- NCAR CESM – CMIP5 data (*netCDF*)
<http://rda.ucar.edu/datasets/ds316.0/>





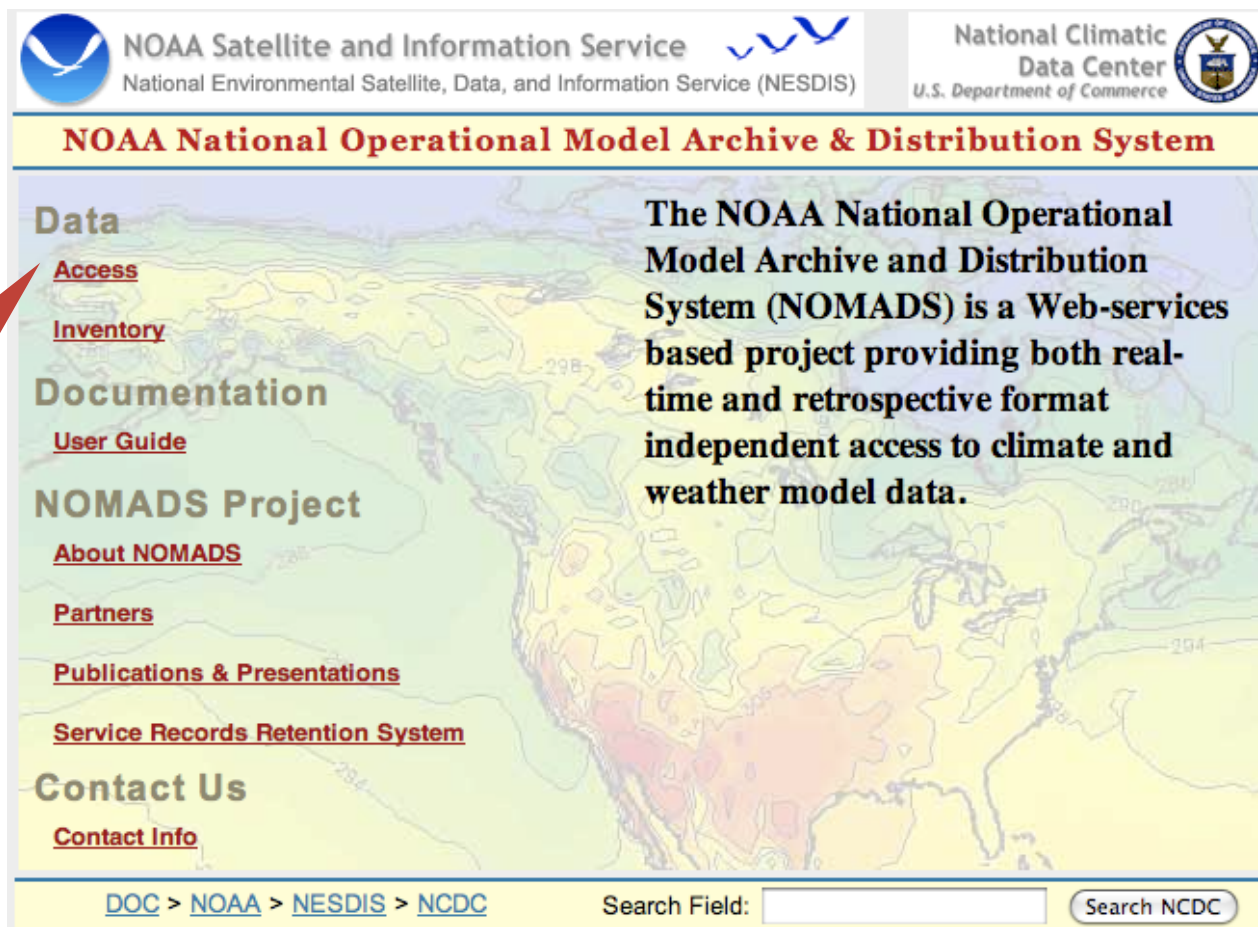
ungrib : External Data Sources

- GFS Real-time 1° Global
<http://www.emc.ncep.noaa.gov>
- NAM Real-time 32/12km North America
<http://www.emc.ncep.noaa.gov>
- GCIP NCEP Eta model output 40km North America
<http://rda.ucar.edu/datasets/ds609.2>
- NCEP North American Regional Reanalysis (NARR)
32km North America
<http://rda.ucar.edu/datasets/ds608.2>



• 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

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

Documentation
[User Guide](#)

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

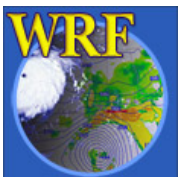
Contact Us
[Contact Info](#)

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

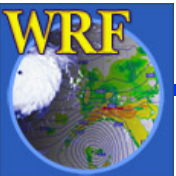
Search Field:

- NAM
- GFS
- RUC
- CFS
- NARR
- R1/R2
- SST



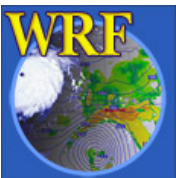
GRIB

- Documents and decoders:
 - GRIB1 and GRIB2
wgrib; wgrib2; unpackgrib2.c; grib2to1.c
<http://rda.ucar.edu/#!/GRIB>
- 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
<http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html>
- ncl_convert2nc
 - http://www.ncl.ucar.edu/Document/Tools/ncl_convert2nc.shtml



WPS Intermediate Files

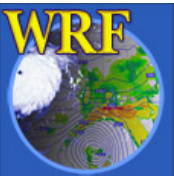
- Output format of ungrid
- WPS util/ directory
 - plotfmt.exe (*graphical interface to view intermediate file*)
 - rd_intermediate
- Create your own intermediate files
 - example if you have input data in netCDF format
 - http://www.mmm.ucar.edu/wrf/OnLineTutorial/WPS/IM_files.htm



Utility: rd_intermediate

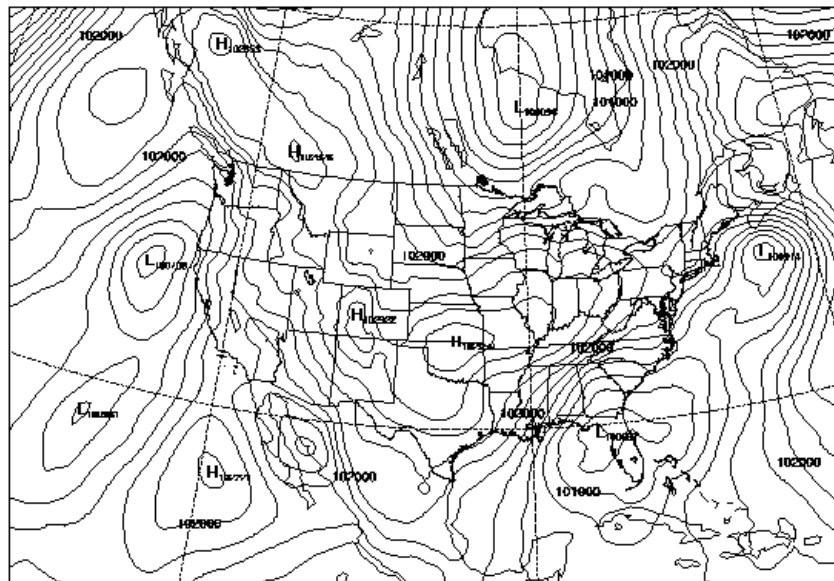
The rd_intermediate lists information about the fields found in an intermediate-format file

```
=====
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

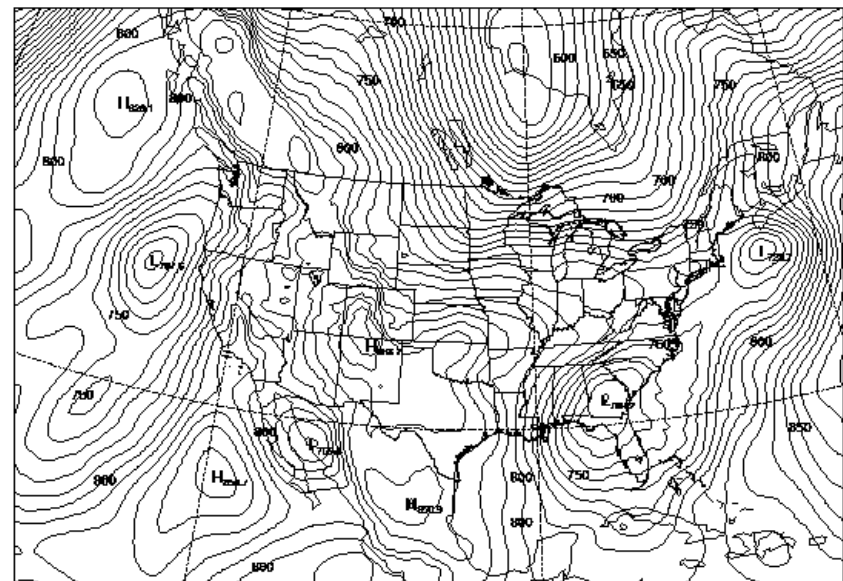
Pa

Sea-level Pressure

WPS intermediate format

CONTOUR FROM 100200 TO 103200 BY 200

unknown model from NCEP GRID 212



92500 GHT

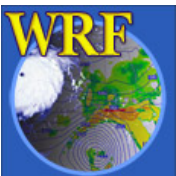
m

Height

WPS intermediate format

CONTOUR FROM 500 TO 880 BY 10

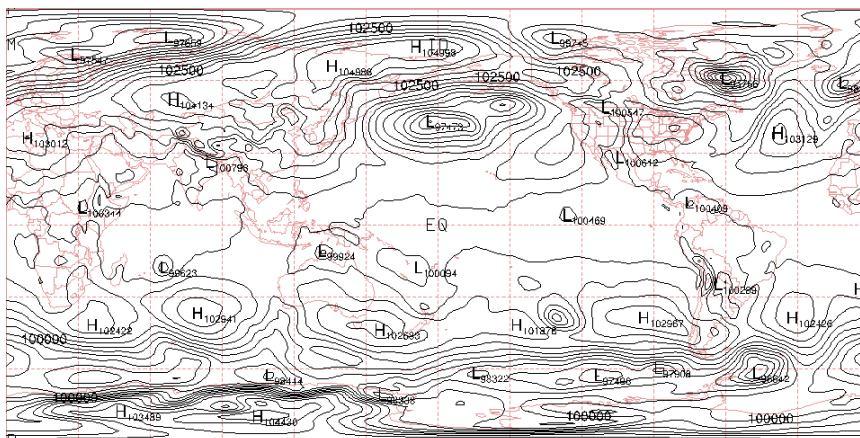
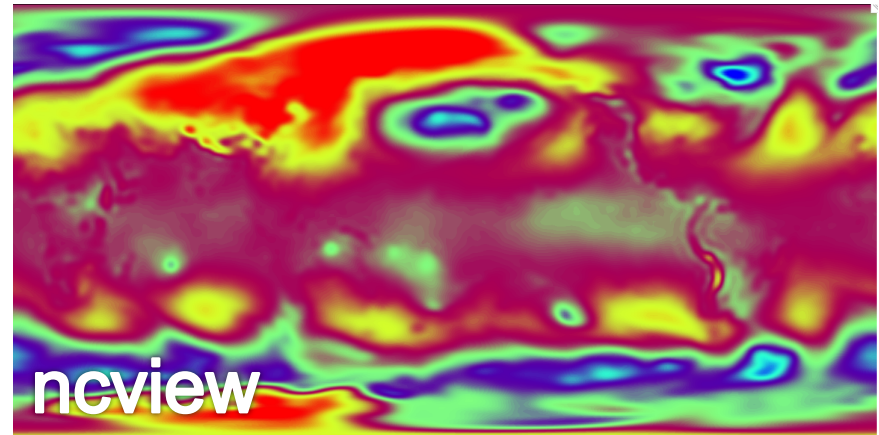
unknown model from NCEP GRID 212



Intermediate Files in netCDF Format

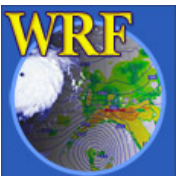
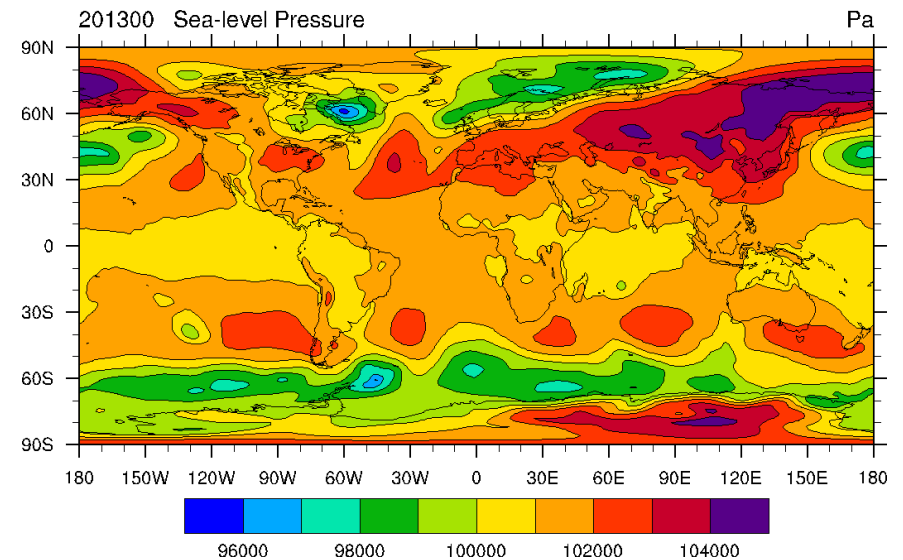
Utility: `int2nc.exe`

Plot: `plotfmt_nc.ncl`



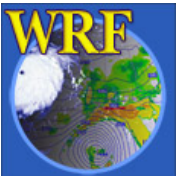
201300 PMSL

Pa
Sea-level Pressure
WPS intermediate format



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/docs/netcdf-f77.pdf>
<http://www.unidata.ucar.edu/software/netcdf/docs/netcdf-f90.pdf>
(*writing Fortran programs to read/write netCDF files*)



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

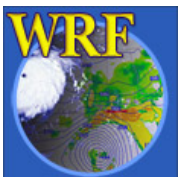
```
ncra -v OLR wrfout* -o OLR.nc
```

- **ncks (nc kitchen sink)**

- Combination of NCO tools all in one (handy: one tool for multiple operations)

Specifically handy to split files

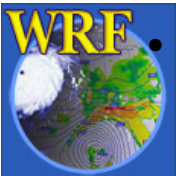
```
ncks -d Time,1,1 wrfout -o wrfout1.nc
```



NCO tools

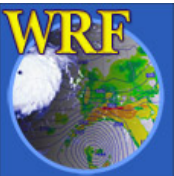
<http://nco.sourceforge.net/>

- **ncap2** Arithmetic Processor
- **ncatted** ATtribute Editor
- **ncbo** Binary Operator (includes ncadd, ncsubtract, ncmultiply, ncdivide)
- **ncea** Ensemble Averager
- **necat** Ensemble conCATenator
- **ncflint** FiLe INTerpolator
- **ncks** Kitchen Sink
- **ncpdq** Permute Dimensions Quickly, Pack Data Quietly
- **ncra** Record Averager
- **ncrcat** Record conCATenator
- **ncrename** RENAMEer
- **ncwa** Weighted Averager



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 -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 = "" ;

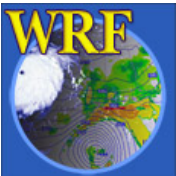
.....

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 ;

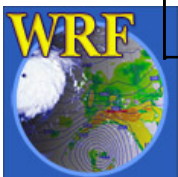
.....

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



Wrfout output fields (*ncdump -h*)

ALBBCK	ALBEDO	CANWAT	CF1	CF2
CF3	CFN	CFN1	COSALPHA	DN
DNW	DZS	E	EDT_OUT	EMISS
F	FNM	FNPF	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	RAINC_V	RAINNC	RDN
RDNW	RDX	RDY	RESM	RHOSN
SEAICE	SFROFF	SH2O	SINALPHA	SMOIS
SNOPCX	SNOW	SNOWC	SNOWH	SNOWNC
SOILTB	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 X1

Linear

Axes

Range

blowup

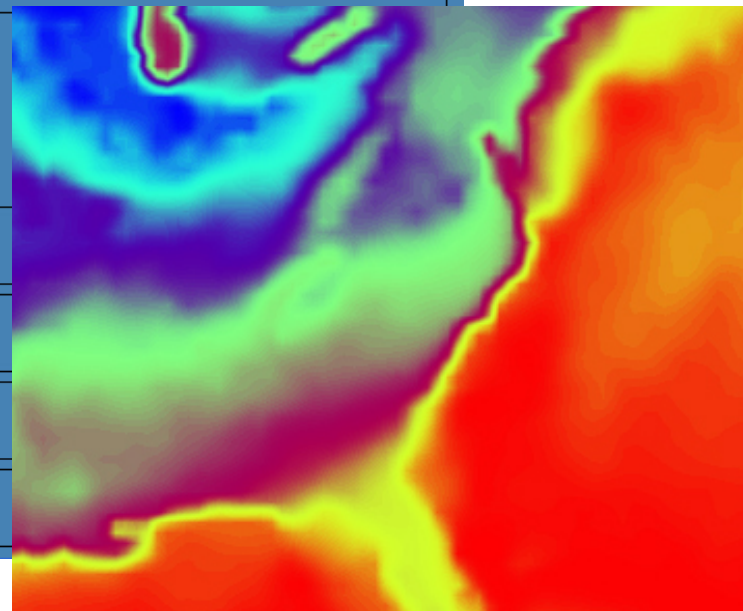
Print

(18) 1d vars

(48) 2d vars

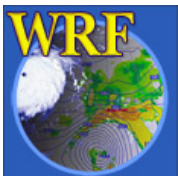
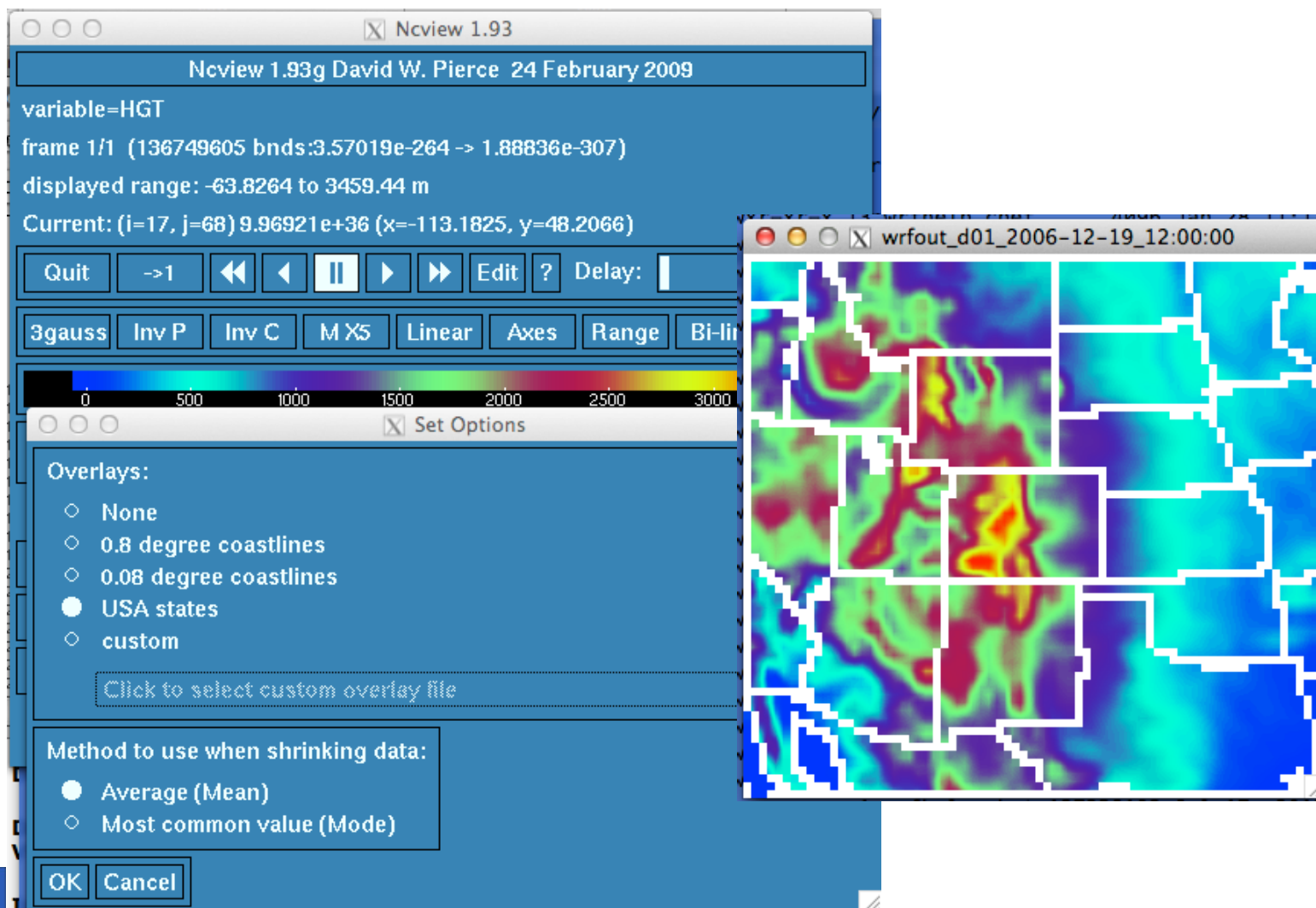
(13) 3d vars

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



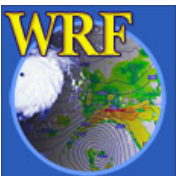
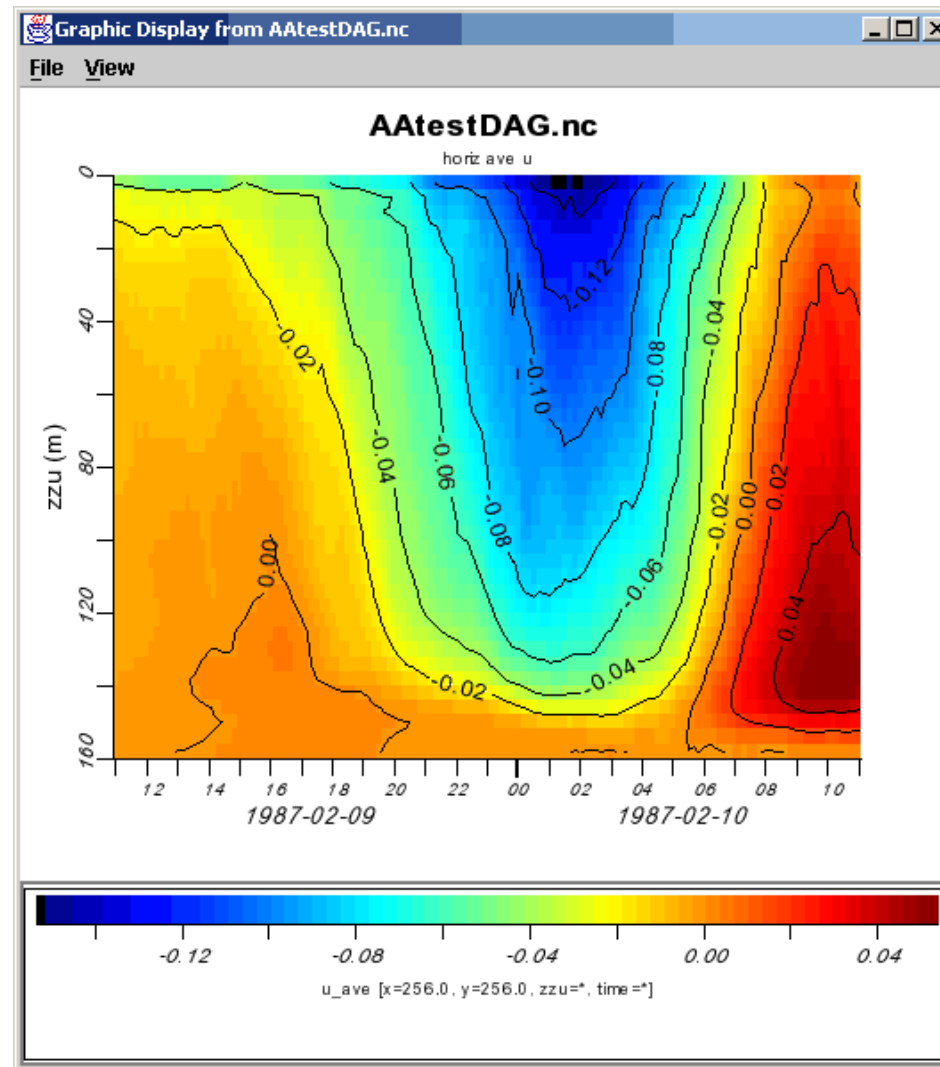
ncview

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



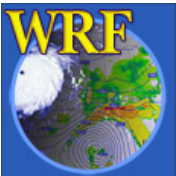
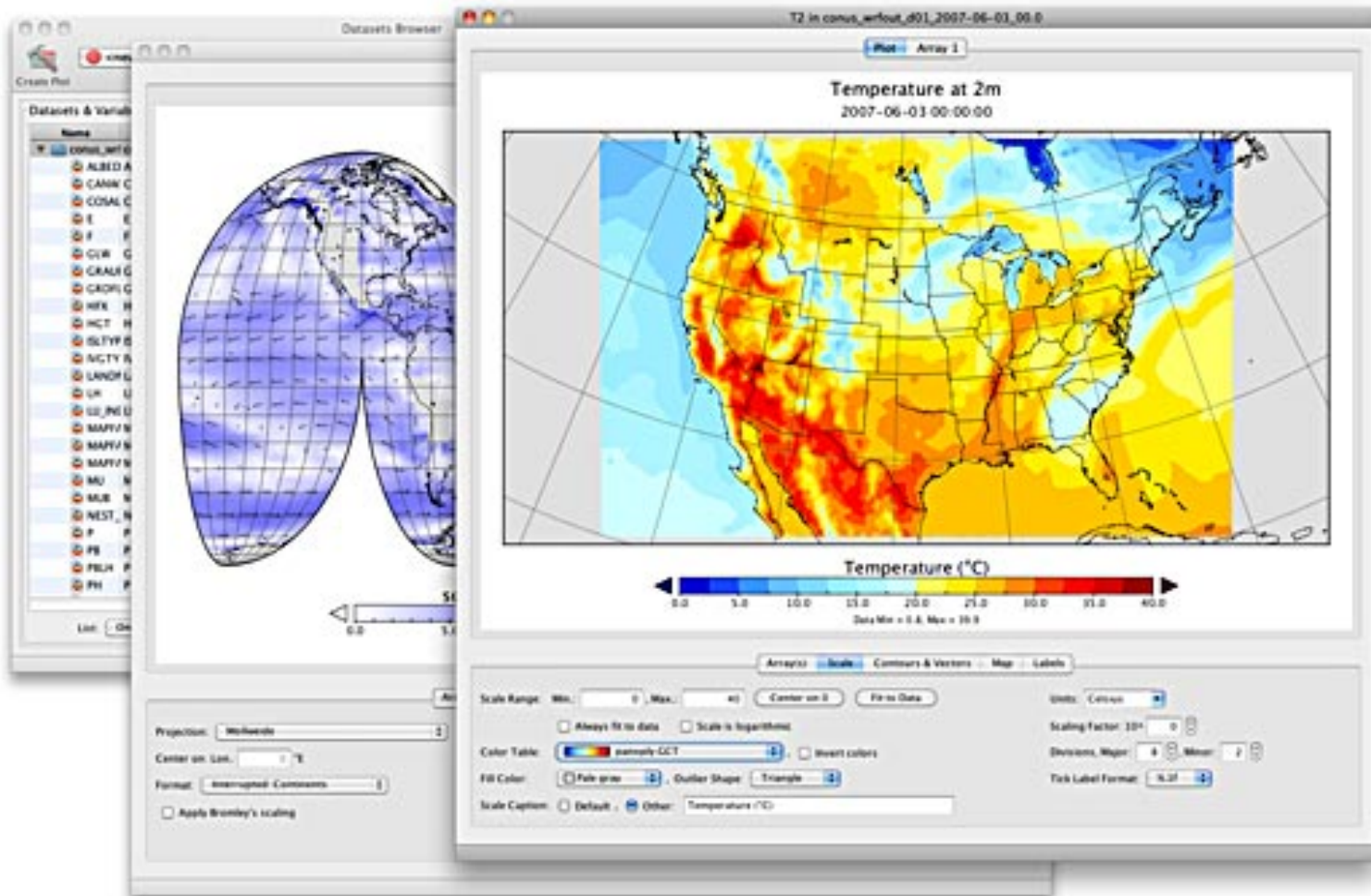
ncBrowse

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



Panoply

<http://www.giss.nasa.gov/tools/panoply/>



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

