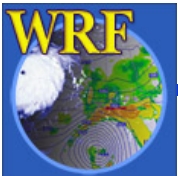


WRF Utilities

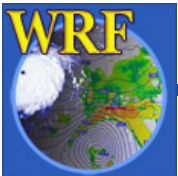
Cindy Bruyère



- Graphics
- Designing a model domain
- Data

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

- netCDF tools
- Other utilities
- MET



Graphics : ImageMagick

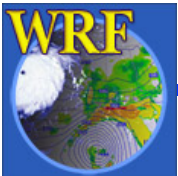
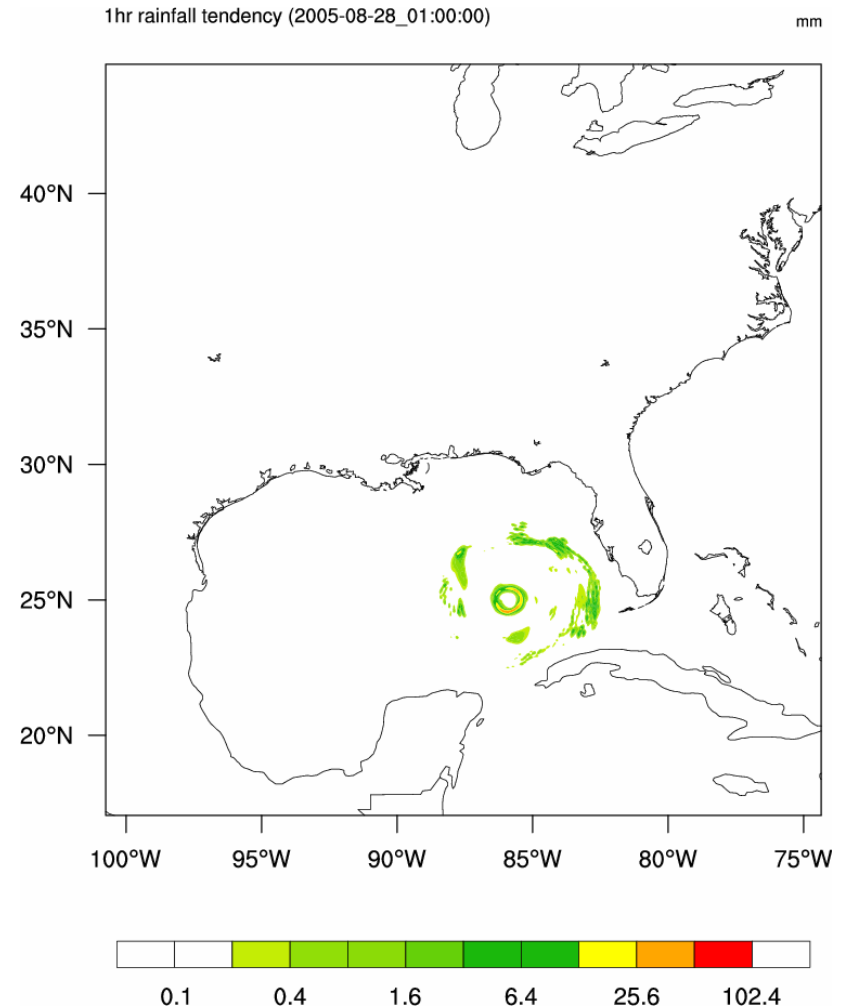
- Convert graphical files from one format to another
 - Many options available (*rotate* frames, *trim* white space, etc.)
 - Can be used for files with single or multiple frames
 - *Cannot deal with .ncgm files*
 - <http://www.imagemagick.org>

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`



WRF Model Domain Design

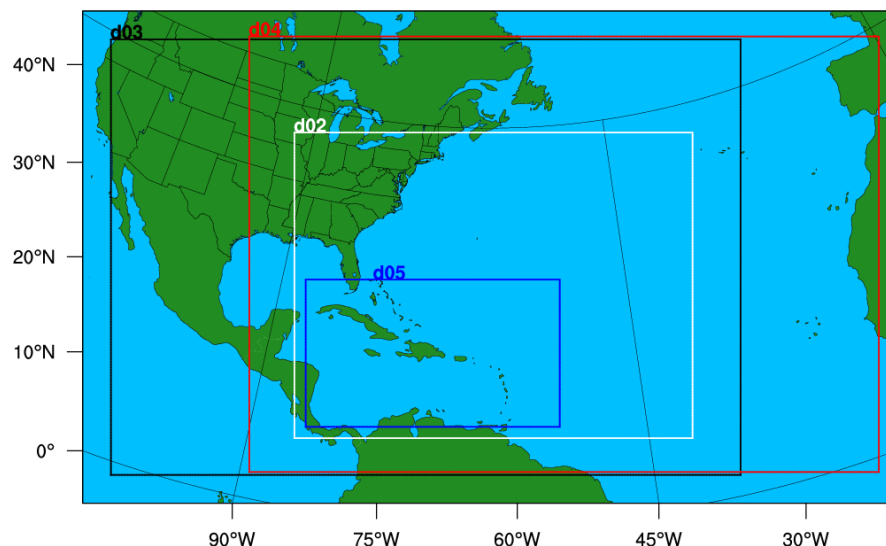
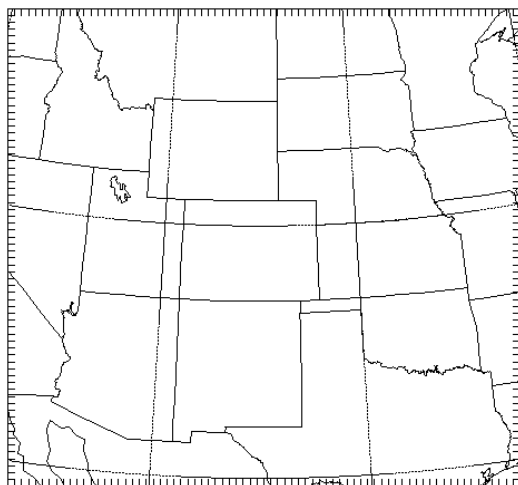
- Fortran Code

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

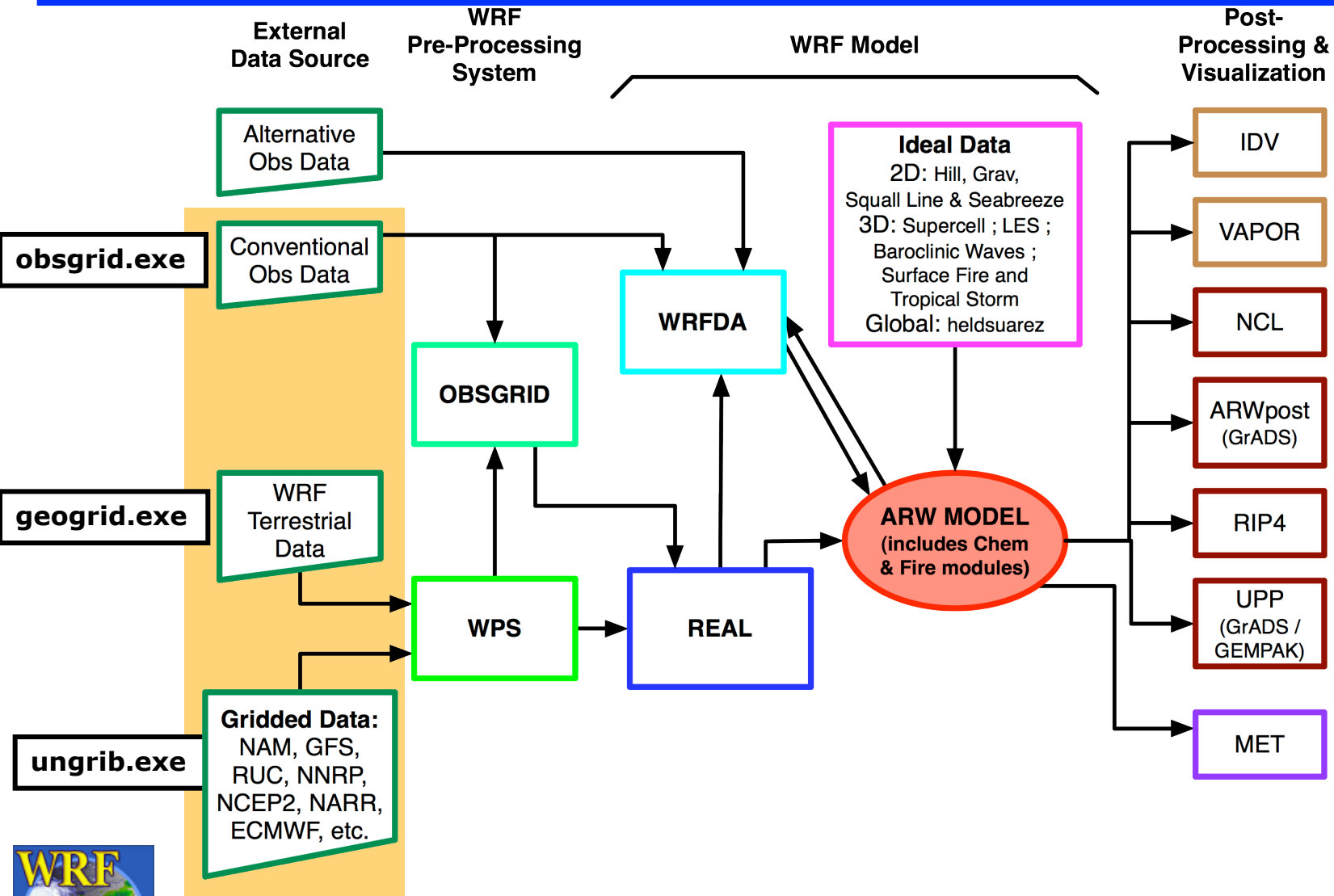
- NCL

- WPS/util/plotgrids.ncl
- mp = wrf_wps_dom (wks, \mpres, lnres, txres)
- reads namelist information to generate plot

Test Domain

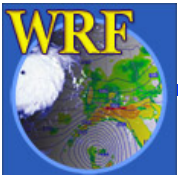
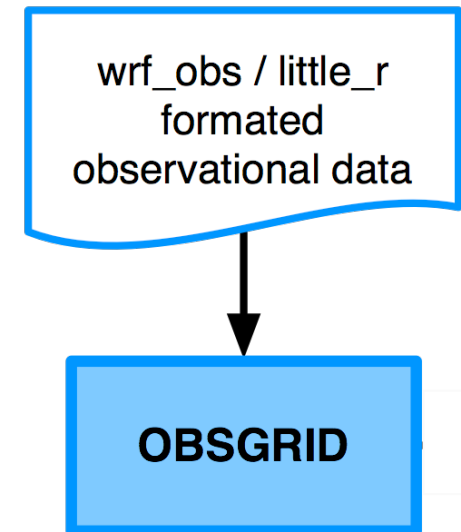


WRF Modeling System Flow Chart



Observational Data

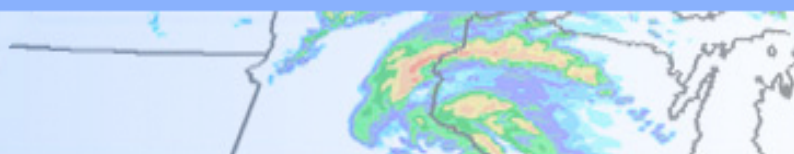
- <http://dss.ucar.edu/datasets/ds353.4/>
 - <http://dss.ucar.edu/datasets/ds464.0/>
- } ADP or ON29
- <http://dss.ucar.edu/datasets/ds351.0/>
*BUFRdecode_ADPUprair_little_r.tar is available at:
<http://dss.ucar.edu/datasets/ds351.0/software/>*
 - <http://dss.ucar.edu/datasets/ds461.0/>
*BUFRdecode_ADPsfc_little_r.tar is available at:
<http://dss.ucar.edu/datasets/ds461.0/software/>*
- } 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

Other Commonly used Data from DSS

- NCEP / DOE Reanalysis II (*Jan 1979 to present*)
<http://dss.ucar.edu> (datasets – ds091.0)
- GFS 0.5° Global data (*Dec 2002 to present*)
<http://dss.ucar.edu> (datasets – ds335.0)
- ERA Interim Data (*~ 0.7° Global data; Jan 1979 to Nov 2012*)
<http://dss.ucar.edu> (datasets – ds627.0)
- NCEP Climate Forecast System Reanalysis (CFSR)
(*~38km, global data; Jan 1979 to Dec 2010*)
<http://dss.ucar.edu> (datasets – ds093.0)
- NCEP Climate Forecast System Reanalysis (CFSR2)
(*.2 degree, global data; Jan 2011 to present*)
<http://dss.ucar.edu> (datasets – ds094.0)



• 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](#)

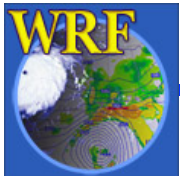
Contact Us
[Contact Info](#)

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

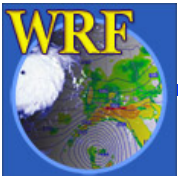
Search Field:

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



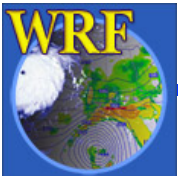
GRIB

- <http://dss.ucar.edu/docs/formats/grib/gribdoc/> (GRIB1)
http://www.nco.ncep.noaa.gov/pmb/docs/grib2/grib2_doc.shtml (GRIB2)
- 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*)
<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib.html>
- wgrib2
<http://www.cpc.ncep.noaa.gov/products/wesley/wgrib2/>



WPS Intermediate Files

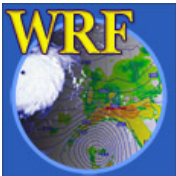
- Output format of ungrid
- WPS util/ directory
 - plotfmt.exe (*graphical interface to view intermediate file*)
 - rd_intermediate
- Create your own intermediate files
 - example if you have input data in netCDF format
 - http://www.mmm.ucar.edu/wrf/OnLineTutorial/WPS/IM_files.htm



Utility: rd_intermediate

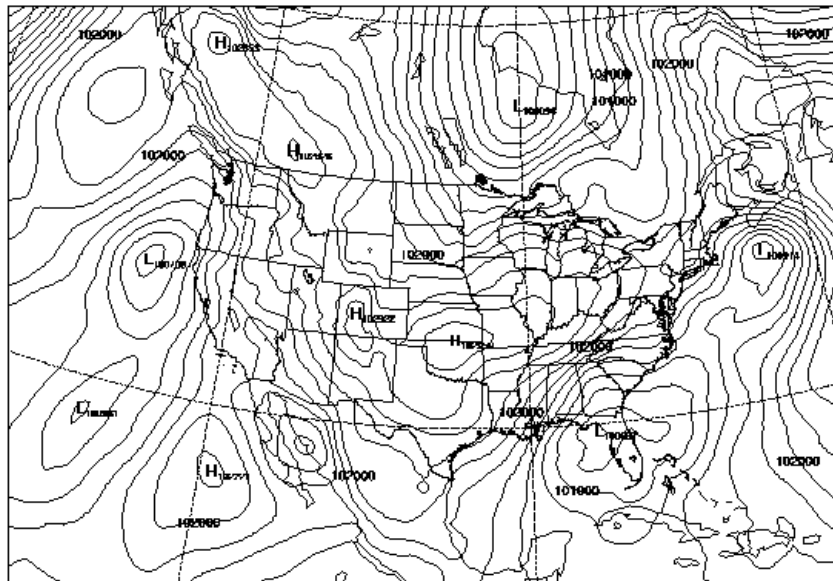
The rd_intermediate lists information about the fields found in an intermediate-format file

```
=====
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

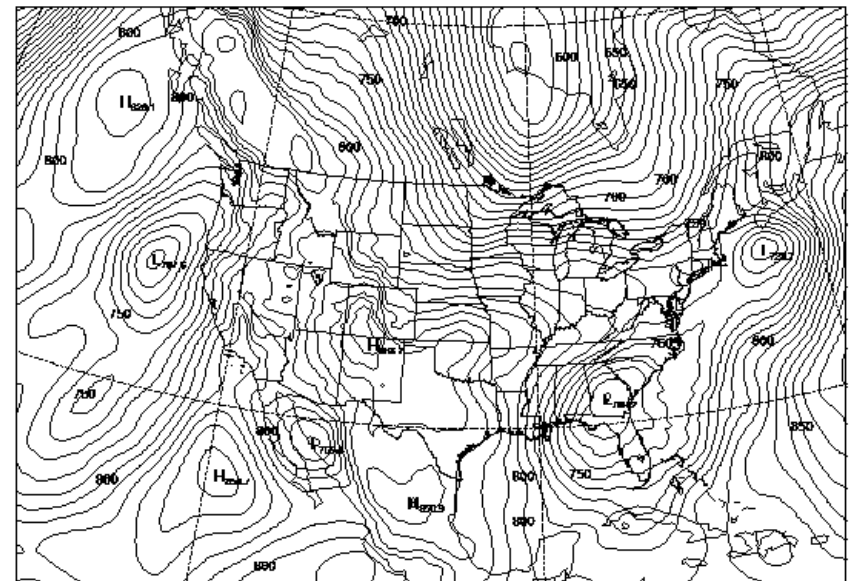
Pa

Sea-level Pressure

WPS intermediate format

CONTOUR FROM 100200 TO 103200 BY 200

unknown model from NCEP GRID 212



92500 GHT

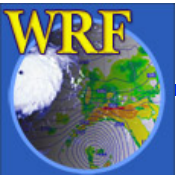
m

Height

WPS intermediate format

CONTOUR FROM 500 TO 880 BY 10

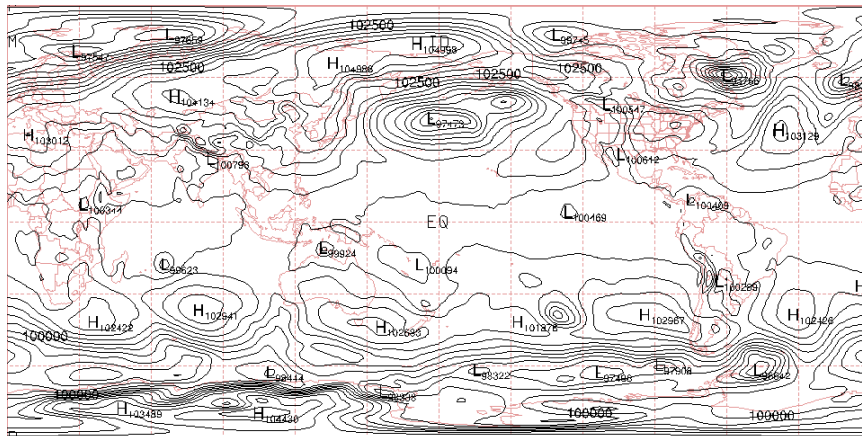
unknown model from NCEP GRID 212



Intermediate Files in netCDF Format

Utility: `int2nc.exe`

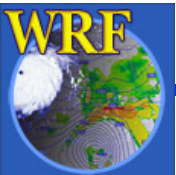
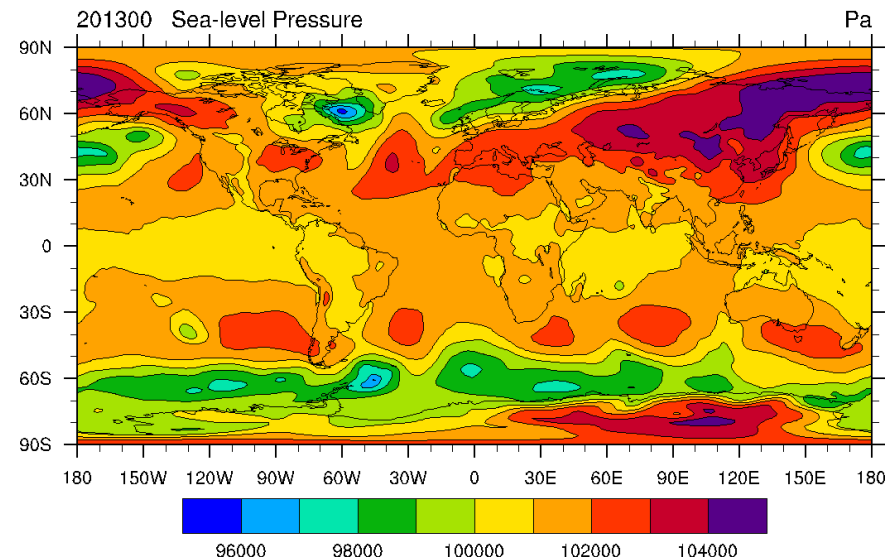
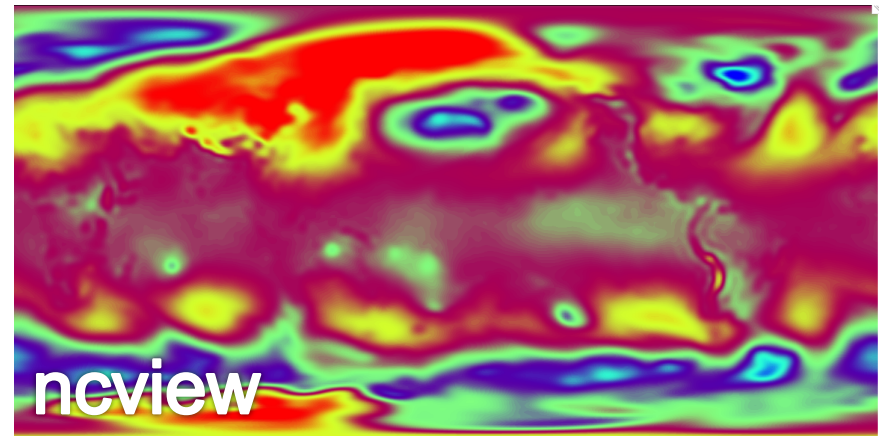
Plot: `plotfmt_nc.ncl`



CONTOUR FROM 96000 TO 104500 BY 500

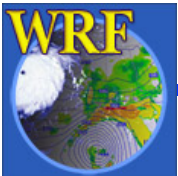
201300 PMSL

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

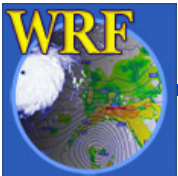
```
ncra -v OLR wrfout* -o OLR.nc
```

- **ncks (nc kitchen sink)**

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

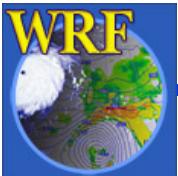
Specifically handy to split files

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



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 = "" ;

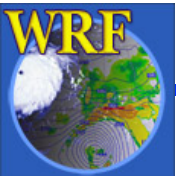
.....

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

-->1

◀◀

◀

⏏

▶

▶▶

Edit

?

Delay:

Opts

3gauss

Inv P

Inv C

Mag X1

Linear

Axes

Range

blowup

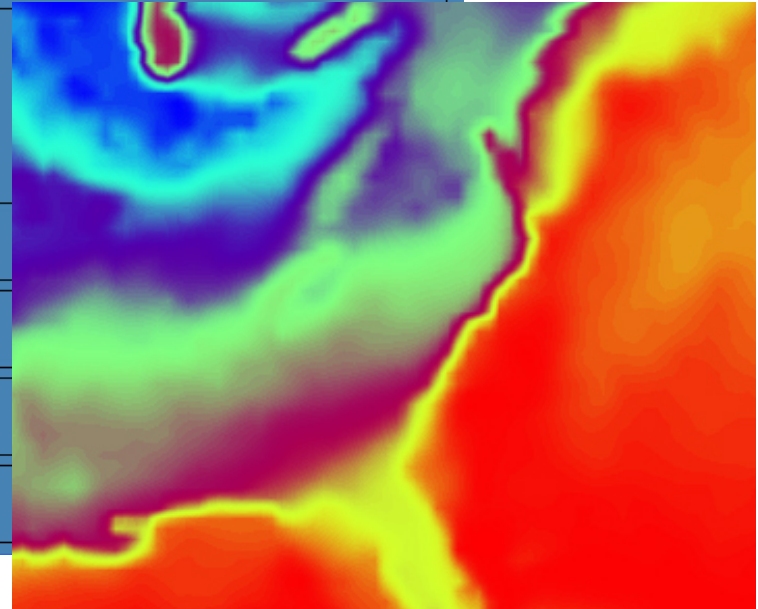
Print

(18) 1d vars

(48) 2d vars

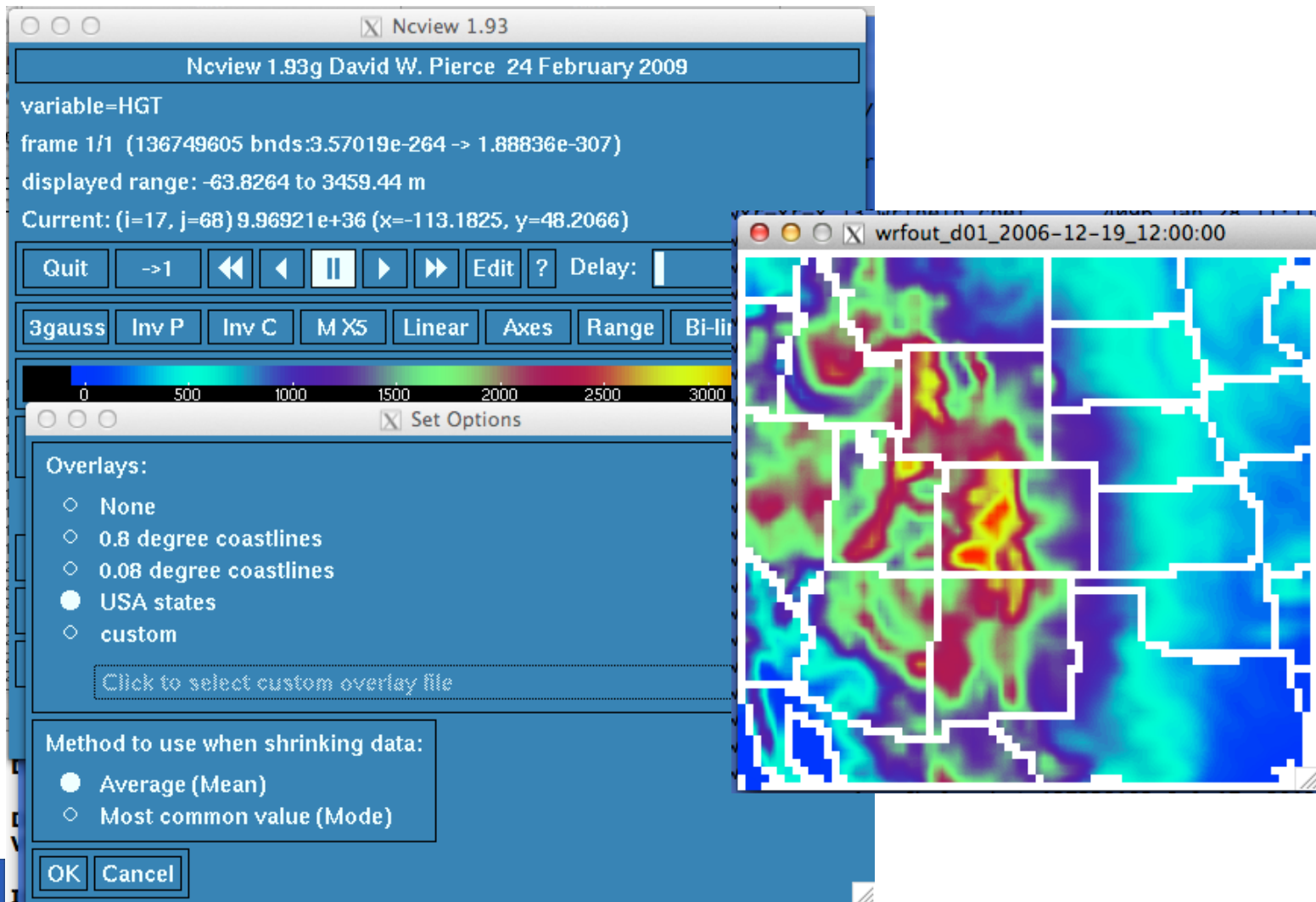
(13) 3d vars

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



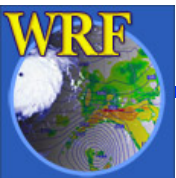
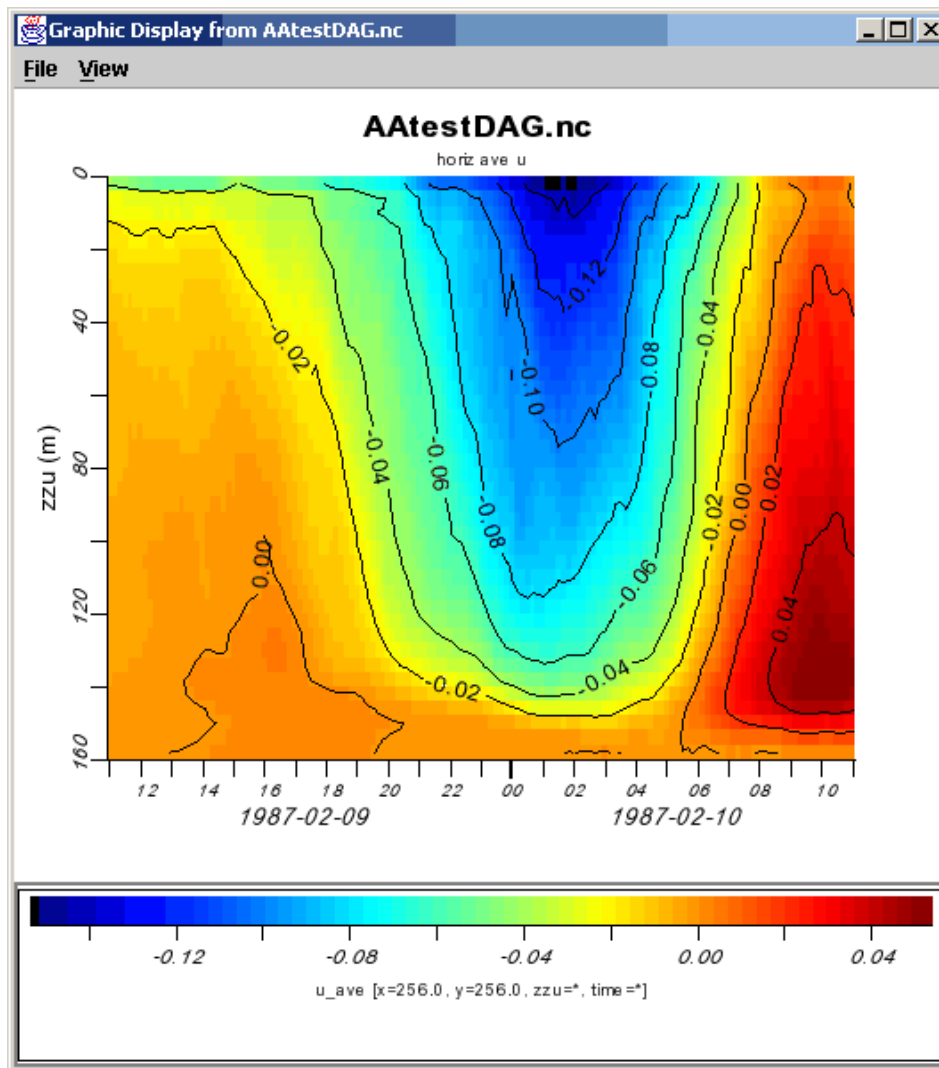
ncview

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



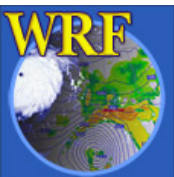
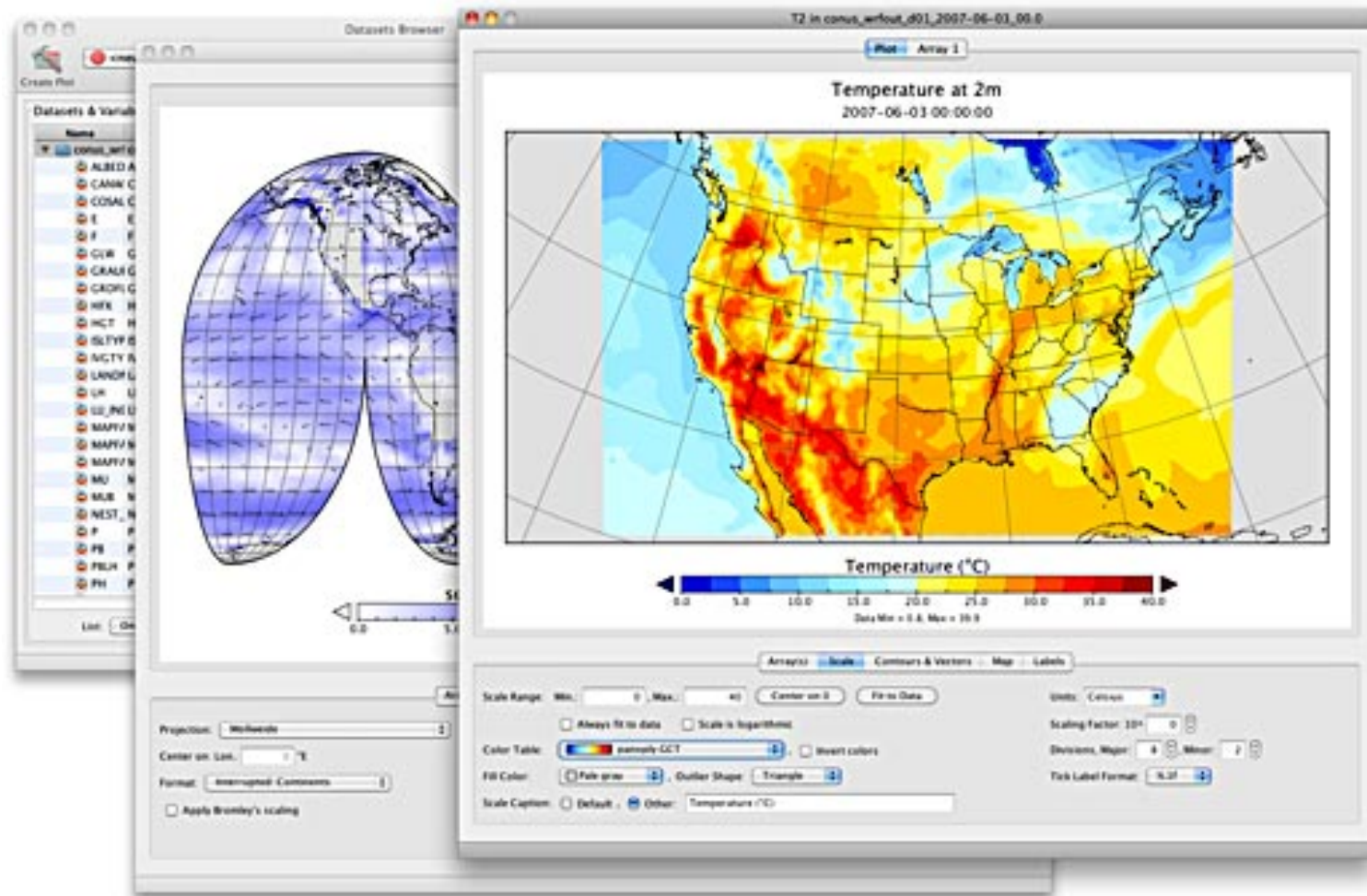
ncBrowse

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



Panoply

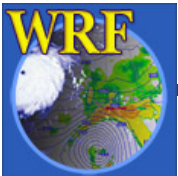
<http://www.giss.nasa.gov/tools/panoply/>



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>

- | | |
|--|---|
| <ul style="list-style-type: none">• read_wrf_nc<ul style="list-style-type: none">– Display data in a wrfout netCDF file– Specific points; min/max of fields; time series; edit data in file (NCL better)• iowrf<ul style="list-style-type: none">– Thinning of netCDF data; extracting a area; destaggering grid | <ul style="list-style-type: none">• p_interp<ul style="list-style-type: none">– Interpolate to pressure levels– Output CF compliant– Can be used as direct input to MET• v_interp<ul style="list-style-type: none">– Add vertical levels in wrf input and boundary files– For use with ndown• wrf_to_cf<ul style="list-style-type: none">– User contributed code (<i>not fully supported</i>) |
|--|---|



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

