

NCEP's WRF POST PROCESSOR (WPP)

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Outline

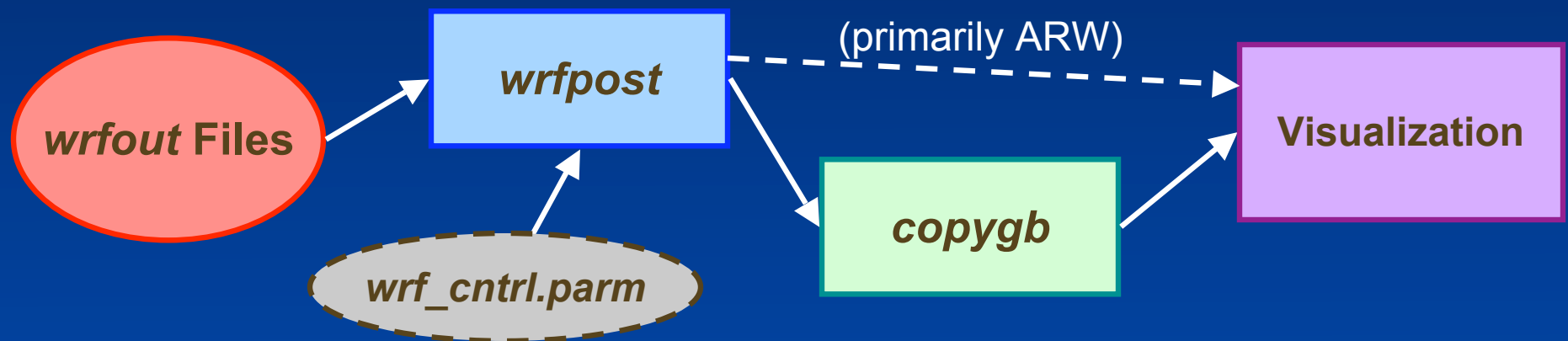
- Overview
- Components and Functions
- Sample fields generated
- Installation
- Running *wrfpost*
 - Controlling output generation
- Running *copygb*
 - Specifying target grid
- Visualization

The critical big picture overview

- Processes model output from both the NMM and the ARW dynamical cores.
- The WRF post processor (WPP) generates output in GRIB.
- The WPP enables product generation on any output grid.

Components of the WPP

The WPP has two components: wrfpost and copygb.



Functions and features of *wrfpost*

- Performs vertical interpolation onto isobaric and other non-model surfaces
- Computes diagnostic fields
- Destaggers wind onto mass points (ARW)
- An MPI-parallel code

Functions of *copygb*

- Performs horizontal interpolation and de-staggering (NMM core) onto a defined output grid
 - Many visualization packages cannot properly handle staggered grids, so *copygb* is an important step for processing NMM core output (optional for ARW).
- Useful for both cores in creating an output grid not fixed by the model integration domain.

Ingesting WRF model output

- wrfpost reads in WRF model output in either binary or netCDF format using the WRF I/O package.
- Users are encouraged to use netCDF formatted model output for simplicity. NCEP uses binary output for speed.

Ingesting WRF model output

- The model fields read in by *wrfpost* for both dynamical cores can be found in your user guide (listed by WRF Registry file variable names) .
- These fields are automatically provided by the default WRF model Registry files.

Fields generated by the WPP

- The WPP currently outputs 288 fields.
 - Complete list in the Post Processing Utilities Chapter of the user guide
- Sample fields generated by WPP:
 - 1) T, Z, humidity, wind, cloud water, cloud ice, rain, and snow on isobaric levels
 - 2) Shelter level T, humidity, and wind fields
 - 3) SLP (two kinds)
 - 4) Precipitation-related fields

Fields generated by the WPP

- Sample fields generated by WPP (cont.):
 - 5) PBL-related fields
 - 6) Diagnostic fields
 - 7) Radiative fluxes
 - 8) Surface fluxes
 - 9) Cloud related fields
 - 10) Aviation products

WPP download and compile

Downloading the WPP source code

- The WPP source code can be obtained from:
<http://www.dtcenter.org/wrf-nmm/users/downloads>
- The latest version available is:
WPPV3.1.tar.gz
- Unpack the downloaded file:
tar -zxvf WPPV3.1.tar.gz
- *cd* to newly created WPPV3/ directory

WPPV3 directory contents

- **sorc/**: source codes
- **scripts/**: sample scripts for running WPP and generating graphics
- **lib/**: libraries used in the build
- **parm/**: control file used when running the wrfpost
- **configure**: sets up makefiles based on user-specified computing platform and paths to software
- **makefile**: master makefile to compile lib/ and sorc/

Compile source codes

- Prepare master makefile to build WPP on your computer by executing the configure file:
./configure
- Follow screen prompts to enter information about target computing platform, and possibly netCDF installation location.
- Compile all libraries and source code by executing the master makefile in the top directory:

make >& compile_wpp.log &

Compile source codes (cont.)

- If compilation is successful, these three executables will be present in exec/ :

copygb.exe

ndate.exe

wrfpost.exe

Running wrfpost and copygb

wrfpost needs three input files to run:

- *itag*: specifies details of WRF model output to process

wrfout_d01_2005-04-27_00:00:00 ← *WRF history filename*

netcdf ← *WRF output format (netcdf/binary)*

2005-04-27_00:00:00 ← *validation time*

NMM ← *model name (NMM/NCAR)*

- *wrf_cntrl.parm*: control file specifying fields to output
- *eta_micro_lookup.dat*: binary look-up table for Ferrier MP

* In the sample run_wrfpost* scripts, these files are generated on the fly or are automatically linked.

wrfpost control file: wrf_cntrl.parm

- Users specify which fields or which level(s) of fields to output by modifying control file, e.g.,

```
(PRESS ON MDL SFCS ) SCAL=(6.0)
L=(11000 00000 00000 00000 00000 00000 00000...
```

(HEIGHT ON MDL SFCS) SCAL=(6.0)

```
L=(11000 00000 00000 00000 00000 00000 00000...
```

GRIB packing
precision**

*Each column represents a single model/isobaric level:
"1" = output, "0" = no output*

Product description – wrfpost code
keys on these character strings.

** larger values → more
precision, but larger GRIB files.

wrfpost control file: *wrf_cntrl.parm*

- The included *wrf_cntrl.parm* file has entries for every possible output field.
- The “Fields produced by *wrfpost*” table in the user’s guide may help understand the character string abbreviations used in the control file.

Outputting fields on different vertical coordinates

- *wrfpost* outputs on several vertical coordinates:
 - Native model levels
 - 47 isobaric levels
 - 7 flight levels above MSL: 914, 1524, 1829, 2134, 2743, 3658, and 6000 m
 - 6 PBL layers: each averaged over 30 hPa AGL layer
 - 2 AGL levels: 1000 & 4000 m (radar reflectivity).
- Except for AGL and isobaric levels, vertical levels are counted from the ground surface up in *wrf_cntrl.parm*.

Examples

- Output T every 50 hPa from 50 hPa to 1000 hPa:

```
(TEMP ON PRESS SFCS ) SCAL=( 4.0)  
L=(00000 01001 01010 10101 01010 10101 01010 10101 01010 10000...)
```

From left to right, the isobaric levels increase 2, 5, 7, 10, 20, 30, 50, 70, then 75-1000 hPa every 25 hPa.

- Output instantaneous surface sensible heat flux:

```
(INST SFC SENHEAT FX ) SCAL=( 4.0)  
L=(10000 00000 00000 00000 00000 00000 00000 00000 00000 00000...)
```

Examples

- Do not output cloud top height:

```
(CLOUD TOP HEIGHT      ) SCAL=( 4.0)  
L=(00000 00000 00000 00000 00000 00000 00000 00000 00000 00000...)
```

- Output the U-wind component at the 5 lowest model levels:

```
(U WIND ON MDL SFCS    ) SCAL=( 4.0)  
L=(11111 00000 00000 00000 00000 00000 00000 00000 00000 00000...)
```

copygb target grid definition

- The generic command to run *copygb* and horizontally interpolate onto a new grid is:

copygb.exe -xg"\${grid}" in.grb out.grb

- Three options on how to specify the target \$grid:
 1. Pre-defined NCEP standard grid number
 2. Grid navigation file created by *wrfpost* (NMM only)
 3. User-defined grid definition

Run *copygb* – Option 1

- Interpolate to a pre-defined NCEP standard grid (restrictive but simple)
 - For example, to interpolate onto NCEP grid 212:
`copygb.exe -xg212 in.grb out.grb`

Descriptions of NCEP grids are available online:

<http://www.nco.ncep.noaa.gov/pmb/docs/on388/tableb.html>

Run *copygb* – Option 2

- Read in grid navigation file created by *wrfpost* (NMM only, simple, restrictive)
 - Running *wrfpost* on WRF-NMM output produces two ASCII files containing grid navigation information which is similar in domain and grid spacing to the model integration domain.
 - *copygb_gridnav.txt* for a Lambert Conformal grid
 - *copygb_hwrf.txt* for a regular Lat-Lon grid

For example:

```
read nav < 'copygb_gridnav.txt'  
copygb.exe -xg"${nav}" in.grb out.grb
```

Run *copygb* – Option 3a

- Create a user-defined Lambert Conformal grid by specifying a full set of grid parameters (complicated but flexible).

indicates user-defined grid **map type (3=LC)** # of points SW corner (millidegrees) Proj cent lon (millidegrees)

copygb.exe -xg"255 3 NX NY STARTLAT STARTLON 8 CENLON

DX DY 0 64 TRUELAT1 TRUELAT2 " in.grb out.grb

horizontal spacing (meters) Proj true latitudes (millidegrees)

copygb -xg"255 3 185 129 12190 -133459 8 -95000

40635 40635 0 64 25000 25000 " in.grb out.grb

Run *copygb* – Option 3b

- Create a user-defined Polar Stereographic grid by specifying a full set of grid parameters (complicated but flexible).

map type
(5=STR)



```
copygb.exe -xg"255 5 NX NY STARTLAT STARTLON 8 CENLON  
DX DY 0 64" in.grb out.grb
```



Center flag (0=NH ; 1=SH)

```
copygb -xg"255 5 580 548 10000 -128000 8 -105000  
15000 15000 0 64" in.grb out.grb
```

Run *copygb* – Option 3c

- Create a user-defined Latitude-Longitude grid by specifying a full set of grid parameters (complicated but flexible).

map type
(0=LTLN)

NE lat
(millidegrees)

copygb.exe -xg"255 0 **NX NY** **STARTLAT STARTLON** 8 **ENDLAT**
ENDLON **DLAT DLON** 64" in.grb out.grb

NE lon
(millidegrees)

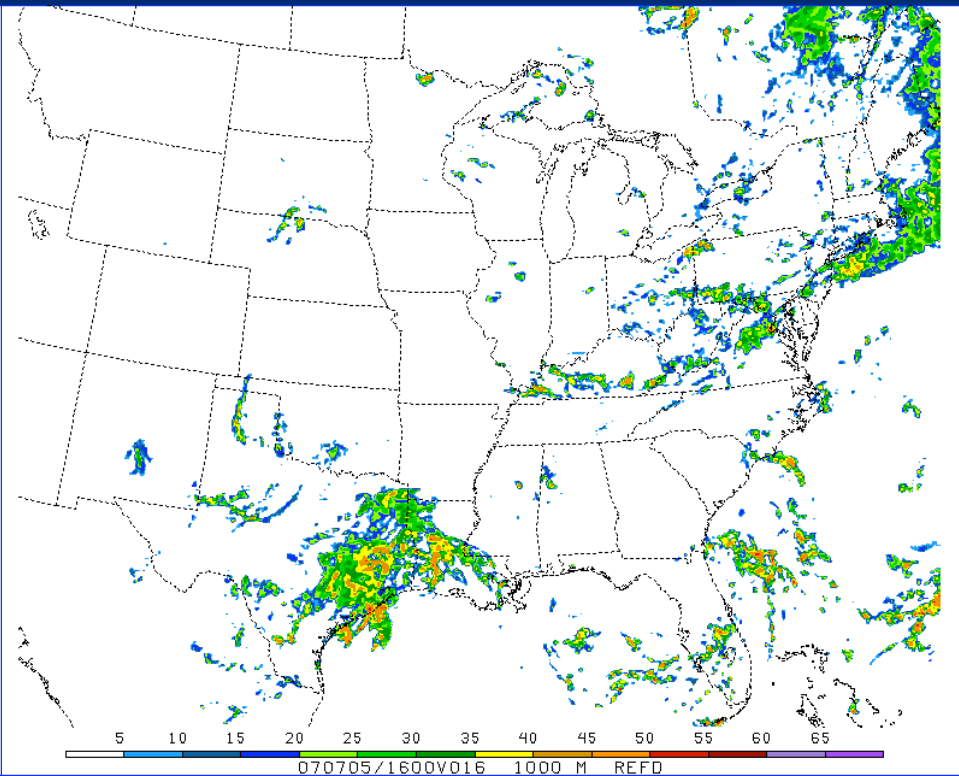
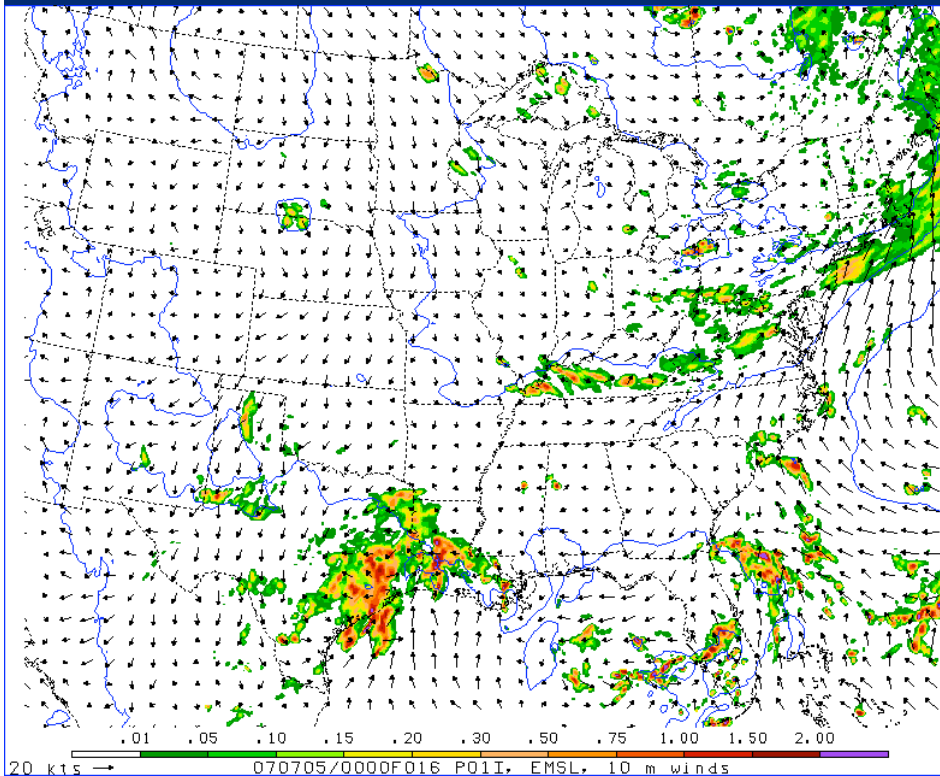
grid spacing
(millidegrees)

copygb -xg"255 0 **401 401** **10000** **-130000** 8 **50000**
-90000 **100 100** 64" in.grb out.grb

GRIB file visualization with GEMPAK

- The GEMPAK utility “nagrib” reads GRIB files from any non-staggered grid and generates GEMPAK-binary files that are readable by GEMPAK plotting programs
- GEMPAK can plot horizontal maps, vertical cross-sections, meteograms, and sounding profiles.
- Package download and user guide are available online:
<http://my.unidata.ucar.edu/content/software/gempak/index.html>
- A sample script named *run_wrfpostandgempak* is included in scripts/ that can be used to run *wrfpost*, *copygb*, and then plot various fields using GEMPAK.
- Further details on this script and using GEMPAK are available in the user’s guide.

Forecast plotted with GEMPAK : Precipitation and derived Radar reflectivity

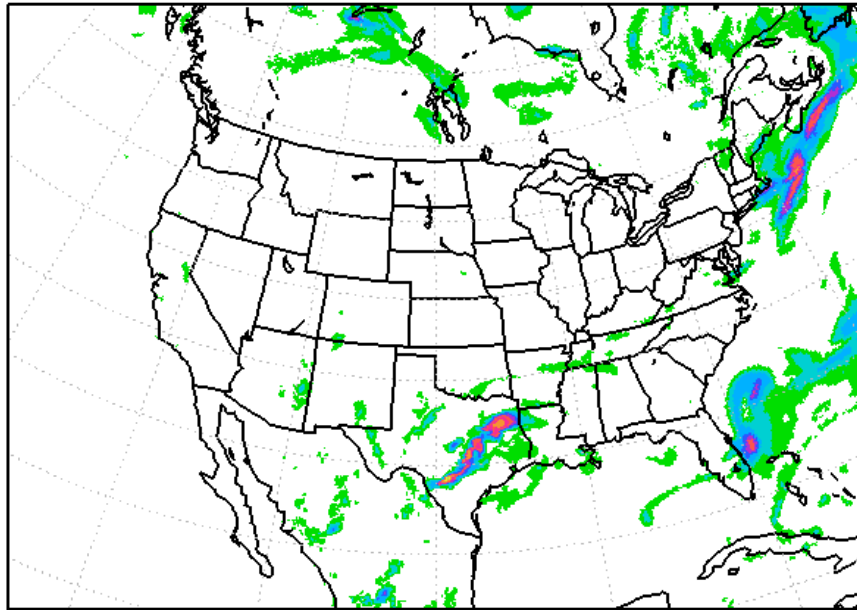


GRIB file visualization with GrADS

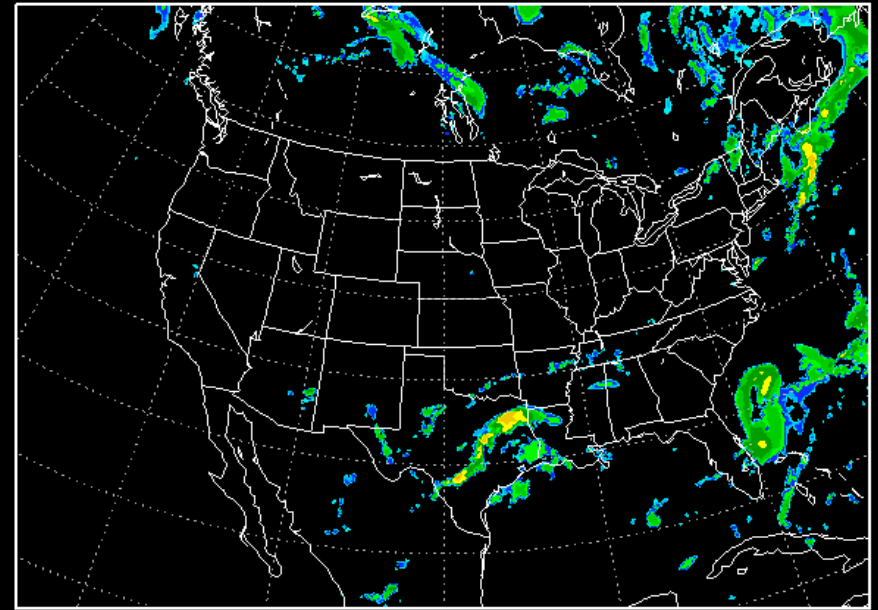
- GrADS also has utilities to read GRIB files on any non-staggered grids and generate GrADS “control” files. The utilities `grib2ctl` and `gribmap` are available via:
<http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html>
- Package download and user guide for GrADS are available online:
<http://grads.iges.org/grads/gadoc/>
- A sample script named *run_wrfpostandgrads* is included in `scripts/` that can be used to the run *wrfpost*, *copygb*, and then plot various fields using GrADS.

Forecast plotted with GrADS: Precipitation and derived Radar reflectivity

3-H APCP NAM 12H FCST VALID 12Z 06 JUL 2007

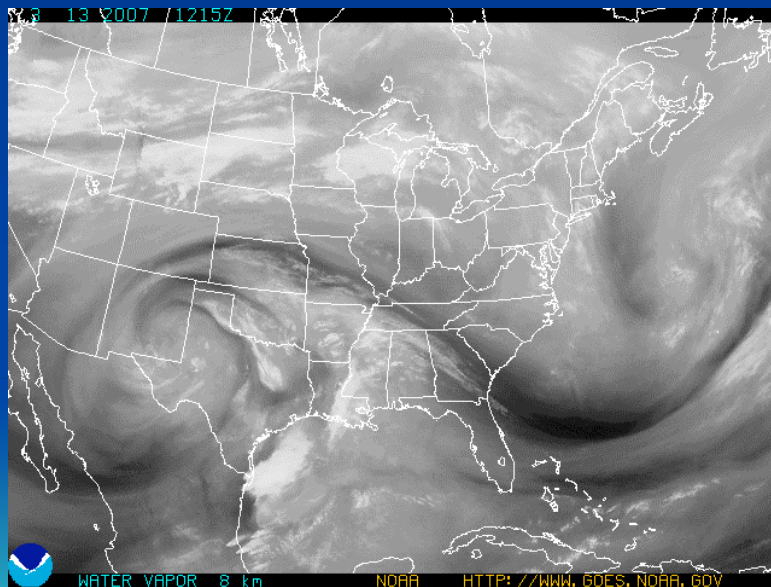


1 KM AGL REF NAM 12H FCST VLD 12Z 06 JUL 2007

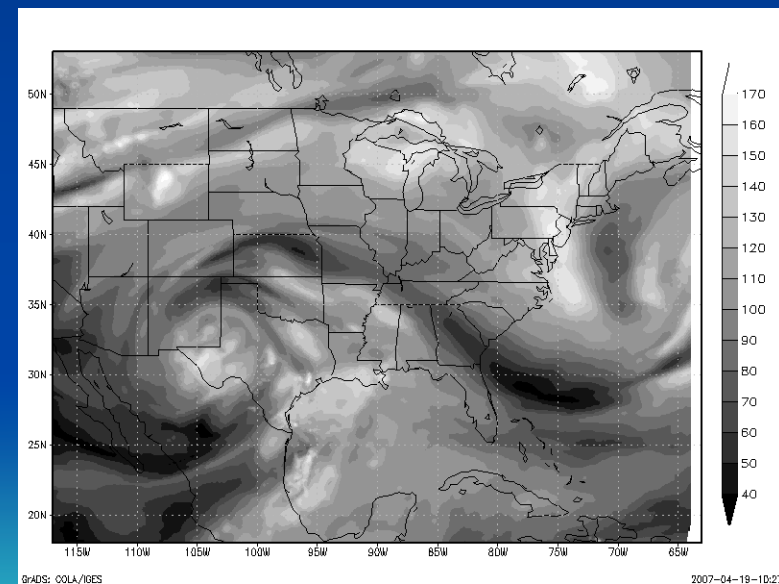


Future plans

- The planned upgrade for WPP:
 - 1) add new products including simulated brightness temperature for GOES IR and water vapor channels;
 - 2) Include options to process and output on global grids.



observed water vapor ch



simulated WRF water vapor ch