

# NCEP's UNIFIED POST PROCESSOR (UPP)

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# Outline

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

# The critical big picture overview

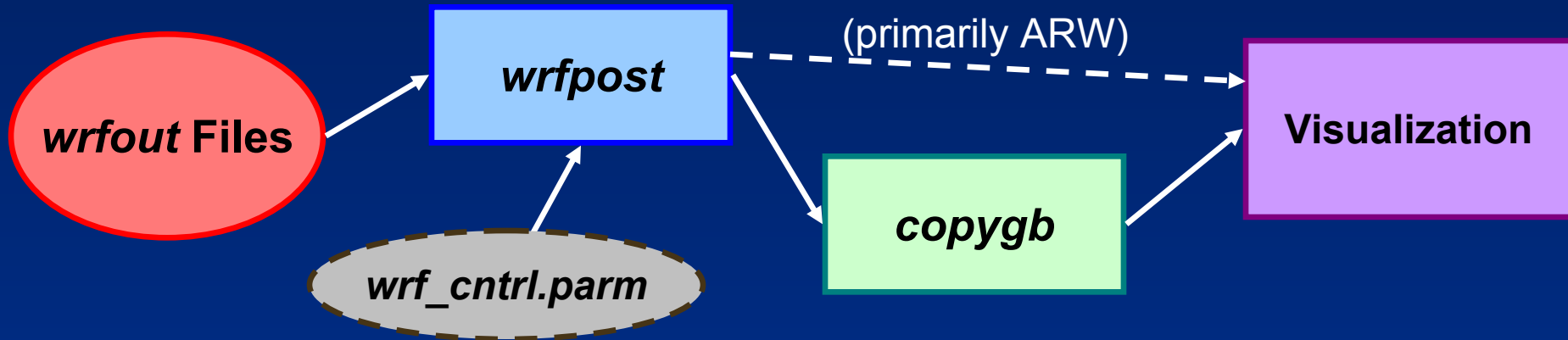
- The WRF post package (WPP) generates output in GRIB.
- Processes model output from both the NMM and the ARW dynamical cores.
- The WPP enables product generation on any output grid.

# WPP – I/O

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

# Components of the WPP

The WPP has two components: wrfpost and copygb.



# Functions and features of *wrfpost*

- Performs vertical interpolations 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
  - Most graphics 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 specified model integration domain.

# 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.):
  - 1) PBL-related fields
  - 2) Diagnostic fields
  - 3) Radiative fluxes
  - 4) Surface fluxes
  - 5) Cloud related fields
  - 6) Aviation products

# Computation of fields

- Documentation for how most fields are computed can be found in ETA post documentation online:

*<http://www.emc.ncep.noaa.gov/mmb/papers/chuang/1/OF438.html>*

- Be aware of differences between WRF and ETA postprocessing that are evident in this documentation. These include the vertical coordinate and how various model constants are ingested.

# Computation of fields

- A field not included in the online documentation is simulated radar reflectivity.
- Different algorithms are used depending on the microphysics (MP) option used in the model run:
  - Ferrier MP scheme: consistent with assumptions made in Ferrier MP scheme [details in Ferrier, 1994: *J. Atmos. Sci*, **51**, 249-280].
  - Other MP schemes: adopted from RIP4. More information can be found online:  
<http://www.mmm.ucar.edu/wrf/users/docs/ripug.htm>
  - If users want to use the RIP4 algorithm on Ferrier MP based runs to get a fair reflectivity comparison, e-mail Hui-Ya ([Hui-ya.Chuang@noaa.gov](mailto:Hui-ya.Chuang@noaa.gov)) for instructions.

# Model fields ingested by *wrfpost*

- 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 will be provided by the default Registry files.

WPP download and compile

# Download 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:  
*wrfpostproc\_v3.0.tar.gz*
- Unpack the downloaded file:  
*tar uzxvf wrfpostproc\_v3.0.tar.gz*
- *cd* to newly created WPPV3/ directory

# wrfpostprocV3 Directory

- The following directories and files exist in WPPV3/:
  - **sorc/**: Source codes
  - **scripts/**: Sample scripts for running WPP and generating graphics
  - **lib/**: libraries used in the build
  - **parm/**: control files used when running the wrfpost.
  - **configure**: Sets up makefiles based on user-specified computing platform and paths to software used for I/O.
  - **makefile**: master makefile to compile all of the lib and sorc.

# Compile source codes

- To create a WPP configuration file for your computer, type:

*./configure*

- Users will be prompted to specify:
  - 1) platform: “1” for LINUX or “2” for IBM
  - 2) path to your netCDF installation
  - 3) path to your WRF model source code
- 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, three executables will exist in the exec/ dir:

*copygb.exe*

*ndate.exe*

*wrfpost.exe*

Running wrfpost and copygb

- *wrfpost* needs three input files to run:
  - *itag*: four-line file specifying details of WRF output to process

wrfout\_d01\_2005-04-27\_00:00:00 ← *file name of WRF history file*  
netcdf ← *format of WRF output (netcdf/binary)*  
2005-04-27\_00:00:00 ← *validation time*  
NMM ← *model name (NMM or NCAR)*

- *wrf\_cntrl.parm*: control file specifying fields to output
- *eta\_micro\_lookup.dat*: look-up table for Ferrier MP

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

# Outputting fields **on multiple levels**

- *wrfpost* outputs fields on several vertical coordinates:
  - **Native model levels**
  - **47 isobaric levels**: 2, 5, 7, 10, 20, 30, 50, 70 hPa, then 75 to 1000 hPa every 25 hPa
  - **7 flight levels** above MSL: 914, 1524, 1829, 2134, 2743, 3658, and 6000 m.
  - **6 PBL layers** (values averaged over 30 hPa thick layers)
  - **2 AGL levels**: 1000 m and 4000 m for radar reflectivity.

# wrfpost control file: wrf\_cntrl.parm

GRIB packing  
precision

(PRESS ON MDL SFCS ) SCAL=(6.0)

L=(11000 00000 00000 00000 00000 00000 00000 00000 00000)

(HEIGHT ON MDL SFCS ) SCAL=(6.0)

L=(11000 00000 00000 00000 00000 00000 00000 00000 00000)

Product description –  
wrfpost code keys on  
these character strings.

~~W~~w= yes, ~~V~~v= no

- Except for AGL and isobaric levels, vertical levels are counted from the ground surface up in *wrf\_cntrl.parm*.

## *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 abbreviations.

# Examples

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

```
(TEMP ON PRESS SFCS ) SCAL=( 3.0)
```

```
L=(00000 01001 01010 10101 01010 10101 01010 10101 01010 10000 00000H)
```

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

- To output instantaneous surface sensible heat flux:

```
(INST SFC SENHEAT FX ) SCAL=( 3.0)
```

```
L=(10000 00000 00000 00000 00000 00000 00000 00000 00000 00000 00000H)
```

- To turn off cloud top height:

```
(CLOUD TOP HEIGHT ) SCAL=( 3.0)
```

```
L=(00000 00000 00000 00000 00000 00000 00000 00000 00000 00000 00000H)
```

# *copygb* target grid definition

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

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

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



# Run *copygb* ã Option 1

1. Interpolate to a pre-defined NCEP standard grid (restrictive but simple)

– For example, to interpolate onto NCEP grid 212:

```
copygb -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* ã Option 2

1. Create a user-defined grid by specifying the full set of kgds parameters (flexible,complex)

indicates user-defined grid      map type (3=LC)      # of points along lon, lat      SW corner (millidegrees)      central lon (millidegrees)

`copygb -xg"255 3 NX NY STARTLAT STARTLON 8 CENLON`  
`DX DY 0 64 TRUELAT1 TRUELAT2 " in.grb out.grb`

horizontal resolution (meters)      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 3

1. Read in grid navigation file created by *wrfpost* (NMM only, simple, restrictive)
  - Running *wrfpost* 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 Lambert Conformal grid
    - *copygb\_hwrf.txt* for Lat-Lon grid

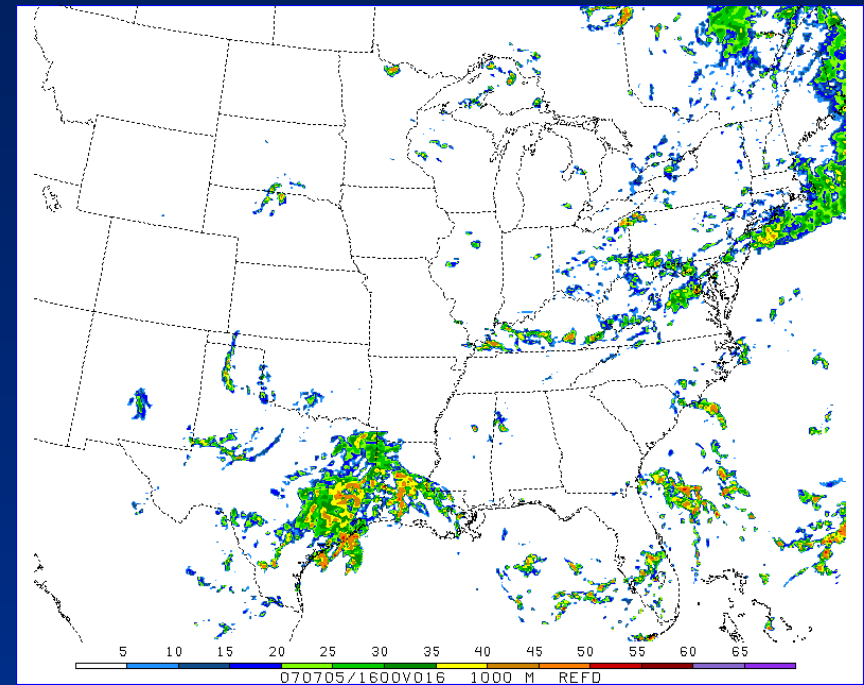
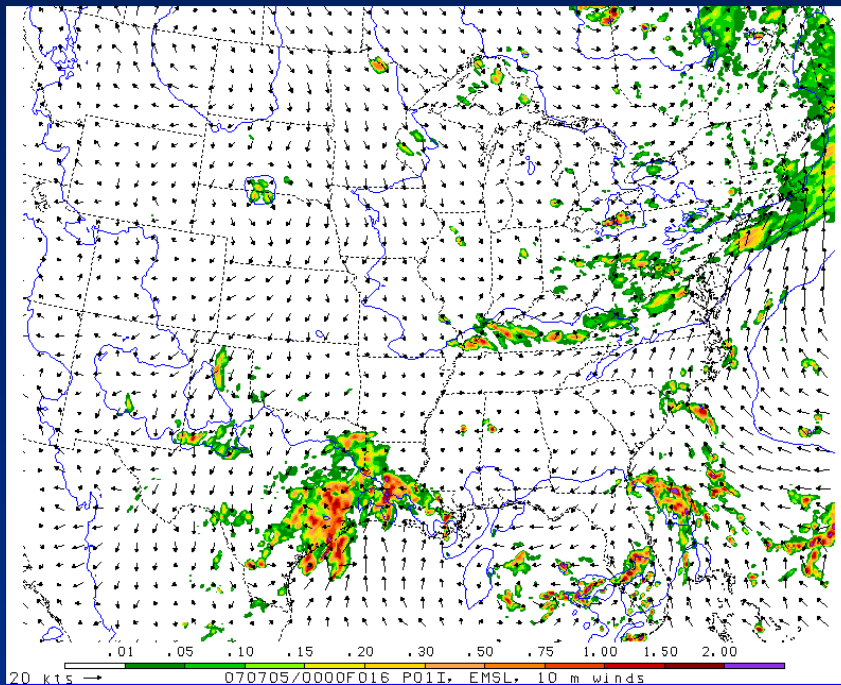
For example:

```
read nav < 'copygb_gridnav.txt'  
copygb -xg "${nav}" 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:

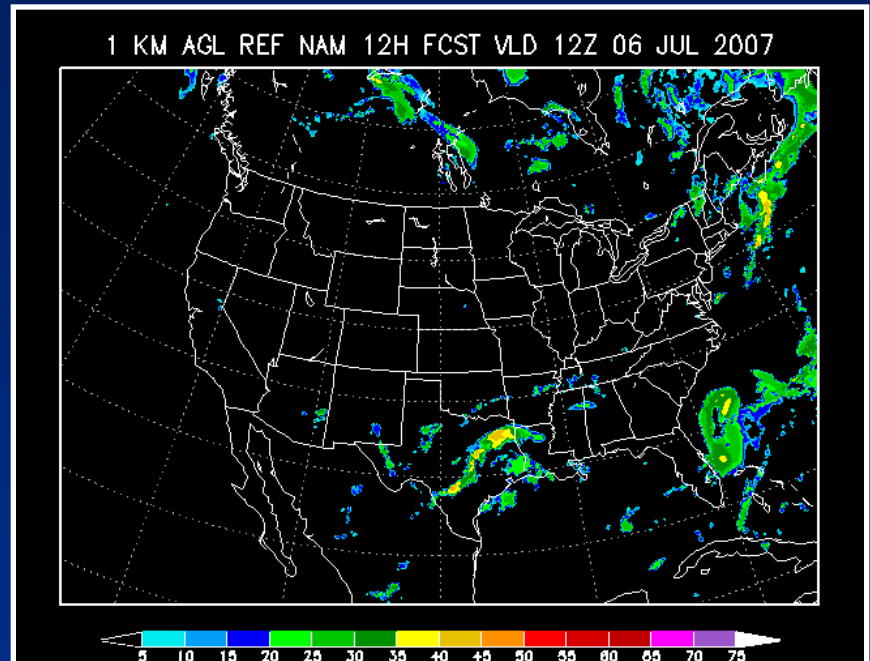
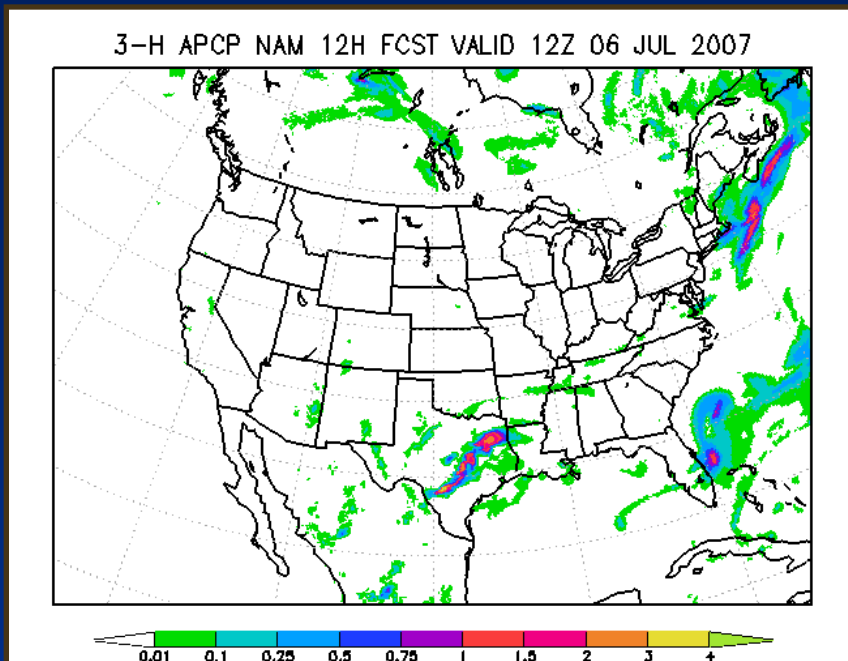
*<http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html>*

- 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



# Tips and suggestions

- To reduce the size of the GRIB file, users can modify the control file *wrf\_cntrl.parm* to output only desired fields.
- If a field in the GRIB file has non-physical values, it is likely that required fields are missing from the model output. For example, unreasonable vorticity may be due to missing grid spacing fields (dx,dy) in the model output.



# Sample *run\_wrfpost* script

```
cat > itag <<EOF          ← creating file itag in the script
wrfout_d01_2005-04-27_00:00:00 ← file name of WRF history file
netcdf                    ← format of WRF output
2005-04-27_00:00:00      ← validation time
NMM                        ← model name (NMM or NCAR)
EOF

ln -sf ${DOMAINPATH}/parm/wrf_cntrl.parm fort.14 ← linking to control file
ln -sf ${WRFPATH}/run/ETAMPNEW_DATA .           ← linking to Ferrier MP
    lookup table

${POSTEXEC}/wrfpost.exe < itag > wrfpost_${domain}.$fhr.out ← execute
    wrfpost
```

# Sample *run\_wrfpost* script (cont.)

# Execute copygb (3 options):

1. `{POSTEXEC}/copygb.exe -xg${gridno} WRFPRS_ ${domain}.${fhr}`  
`wrfprs_ ${domain}.${fhr}` ← pre-defined AWIPS grid number
2. `{POSTEXEC}/copygb.exe -xg"255 3 109 91 37748 -77613 8`  
`-71000 10379 9900 0 64 42000 42000" WRFPRS_ ${domain}.${fhr}`  
`wrfprs_ ${domain}.${fhr}` ← kgds definition
3. `{POSTEXEC}/copygb.exe -xg"${nav}" WRFPRS_ ${domain}.${fhr}`  
`wrfprs_ ${domain}.${fhr}` ← ingests grid navigation file created by *wrfpost*

# Controlling *wrfpost* output

- To output a desired field:
  - View the “Fields produced by *wrfpost*” table in the user’s guide.
  - Note the abbreviated name for any field in the 2<sup>nd</sup> column of the table and look for it in *wrf\_cntrl.parm*.
    - the control file supplied in the tar file lists all available fields  
(EMPHASIZE THIS EARLIER!)
  - Make sure that the switch is turned on to “1” for desired level(s).