NCEP's WRF POST PROCESSOR (WPP)

Hui-Ya Chuang

Presented by Matthew Pyle

Outline

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

Introduction

- The WRF post package (WPP) can post process model output from both the NMM and ARW cores.
- WPP can be used as a common post processor so that forecasts from different models can be compared and verified fairly.

WPP – I/O

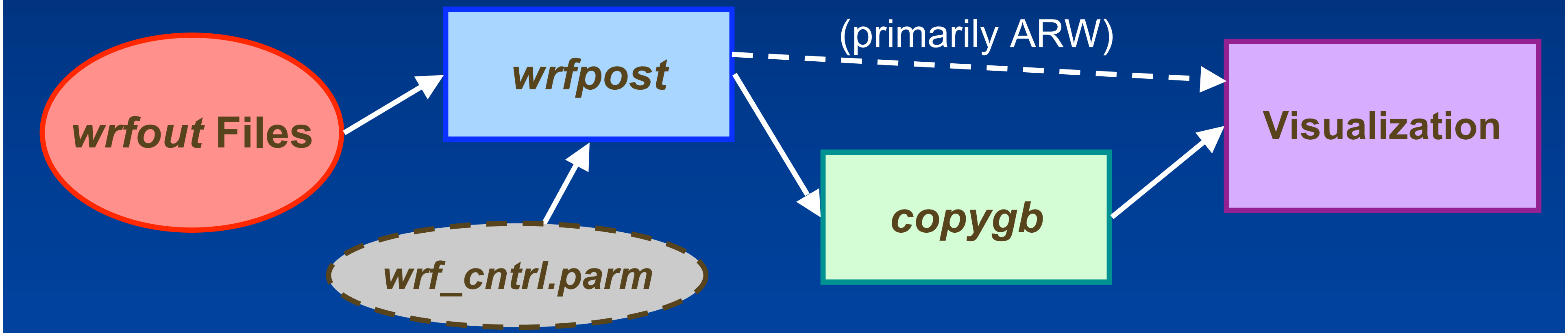
- The WRF post reads in model output in either binary or netCDF format using the WRF I/O API.

- Users are encouraged to use netCDF formatted model output for simplicity. NCEP uses binary output for speed.

- Output is on NCEP standard or user-defined grids in NWS & WMO standard GRIB format, which can be read by GEMPAK and GrADS (and other visualization software).

Components of the WPP

The WPP has two components: wrfpost and copygb.



Functions and features of *wrfpost*

- Performs **vertical** interpolations onto pressure and other levels
- Computes diagnostic fields
- Destaggers wind onto mass points (ARW)
- An MPI-parallel code

Functions of *copygb*

- Performs **horizontal** interpolation and de-staggering (for NMM core) onto a defined output grid
  - Note that most graphics packages cannot 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 can be found 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

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) for instructions.

Model fields ingested by *wrfpost*

- A list of fields (listed by WRF Registry file variable names) that are read in by *wrfpost* for both the NMM and ARW can be found in your user guide.

- All of these fields should be in the model output so that *wrfpost* can compute and output each field properly.

- These fields can be added as needed through modification of the WRF Registry file.

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_v2.2.2.tar.gz

- After *gunzip* and *untar*, should see a directory wrfpostprocV2/

  ```
  tar –zxvf wrfpostproc_v2.2.2.tar.gz
  ```

- *cd* to wrfpostprocV2/ directory

wrfpostprocV2 Directory

- The following directories, configuration file, and master makefiles for the two supported platforms (IBM, linux) exist in wrfpostprocV2/:
  - **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

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*

wrfpost input files

- *wrfpost* needs three input files to run:
  - *itag*:
    - model output file name
    - format of model output (netcdf or binary)
    - forecast verifying time in WRF format
    - model name (NMM or NCAR)
      - Created within run_wrfpost* scripts
  - *wrf_cntrl.parm*:
    - Control file specifying fields to be output
      - Linked automatically by *run_wrfpost** scripts
  - *eta_micro_lookup.dat*:
    - Look-up table containing MP coefficients used by Ferrier scheme
      - Linked automatically by *run_wrfpost** scripts

wrfpost control file: *wrf_cntrl.parm*

specifying grid number

```
KGTYPE******I5*******:(00255)********START OF THIS OUTPUT
IMDLTY       *I5*       :(00089)
DATSET       *A6*       :(WRFPRS)
(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
```

GRIB packing precision

switch to specify which levels of field to output with "1" = yes, "0" = no

abbreviated name used in post source code for each field

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 2nd column of the table and look for it in *wrf_cntrl.parm.*
    - the control file supplied in the tar file lists all available fields
  - Make sure that the switch is turned on to “1” for desired level(s).

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 mb, then 75 to 1000 mb every 25 mb
  - 7 flight levels above MSL: 914, 1524, 1829, 2134, 2743, 3658, and 6000 m.
  - 6 PBL layers (values averaged over 30 mb deep layers)
  - 2 AGL levels: 1000 m and 4000 m for radar reflectivity.
- Except for AGL and isobaric levels, vertical levels are counted from the ground surface up in *wrf_cntrl.parm*.

Example: Outputting fields

- To output temperature at 75 and 125 mb:

```
(TEMP ON PRESS SFCS  ) SCAL=( 4.0)
L=(00000 00010 10000 00000 00000 00000 00000 00000…
```

- To output 30 mb PBL mean U from 30 to 60 mb and then from 90 to 120 mb AGL:

```
(U WIND IN BNDRY LYR ) SCAL=( 5.0)
L=(01010 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 –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* – Option 1

1. Interpolate to a pre-defined NCEP standard grid

   – For example, to interpolate onto NCEP grid 212:

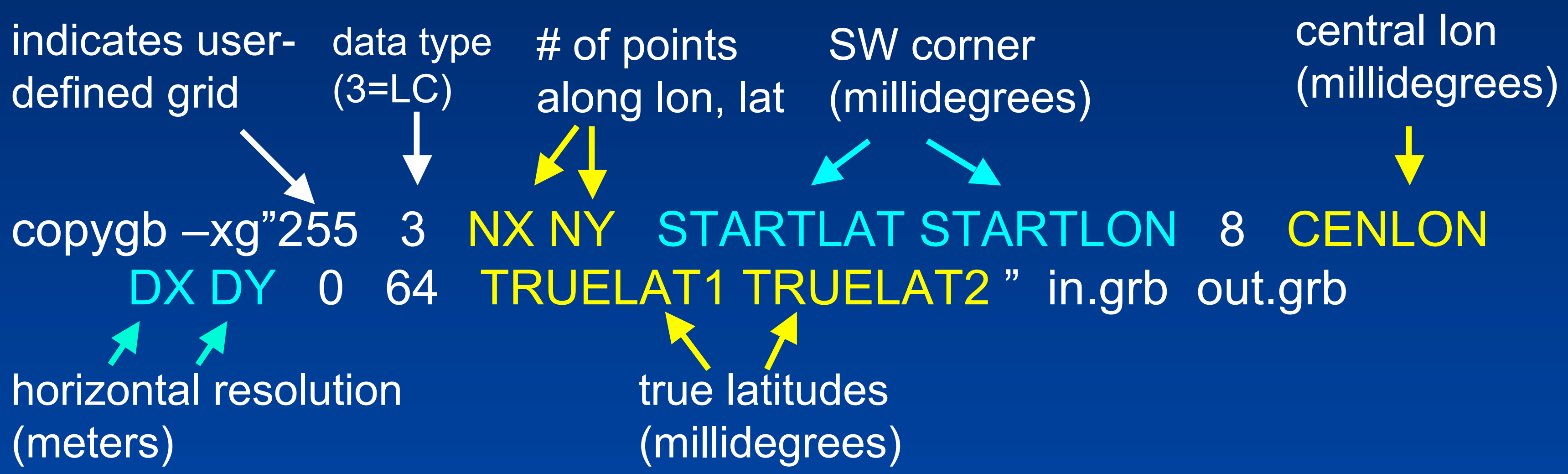
   ```
   copygb –xg212 in.grb out.grb
   ```

Descriptions of NCEP grids are available online:

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

Run *copygb* – Option 2

2. Create a user-defined grid by specifying the full set of kgds parameters



indicates user-defined grid

data 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

3. Read in grid navigation file created by *wrfpost* (NMM only)

   – 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.

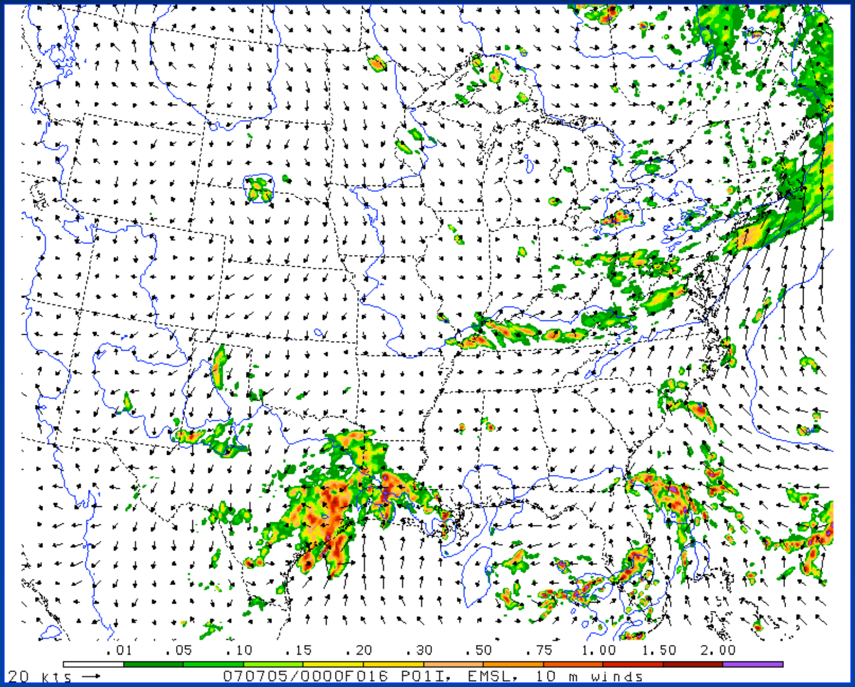
- Package download and user guide are available online:

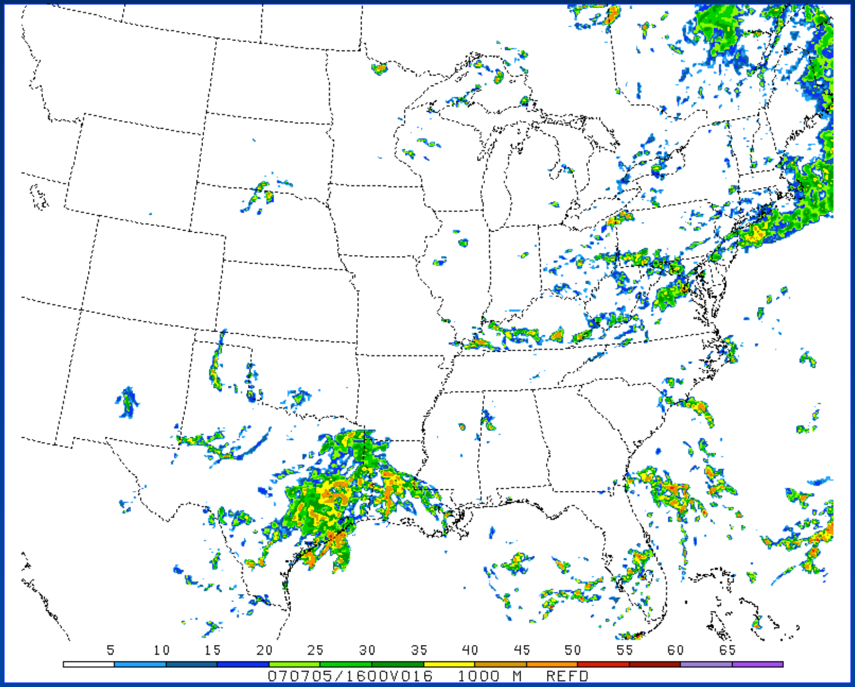
  http://my.unidata.ucar.edu/content/software/gempak/index.html

- 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:

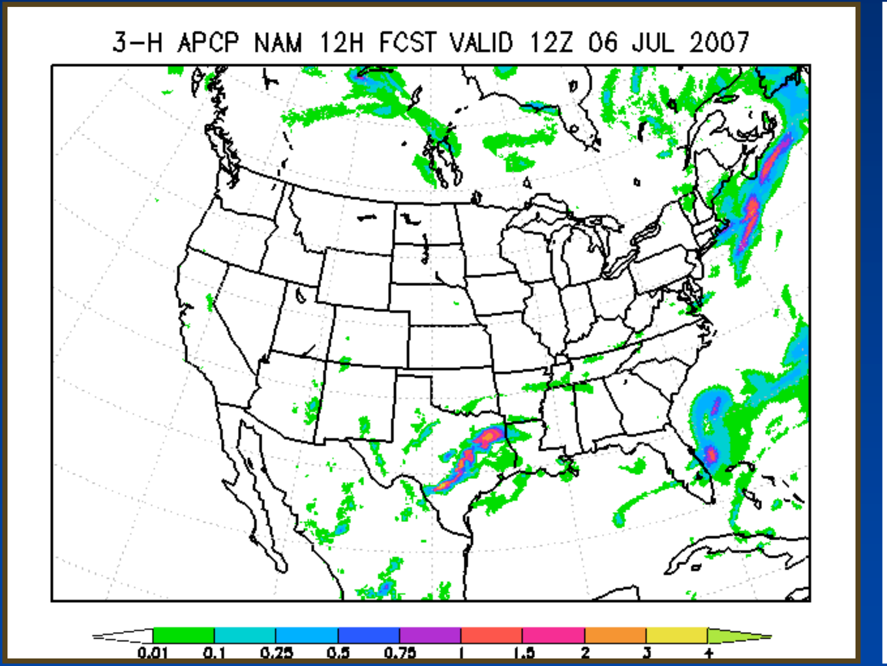
  http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html

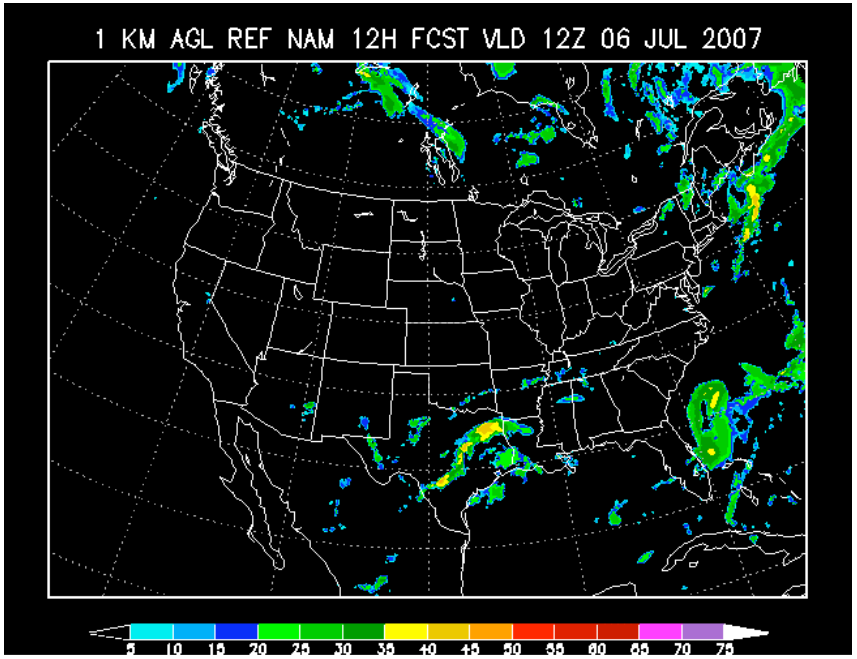
- Package download and user guide for GrADS are available online:

  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.