NCEP's WRF POST PROCESSOR (WPP)

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Outline

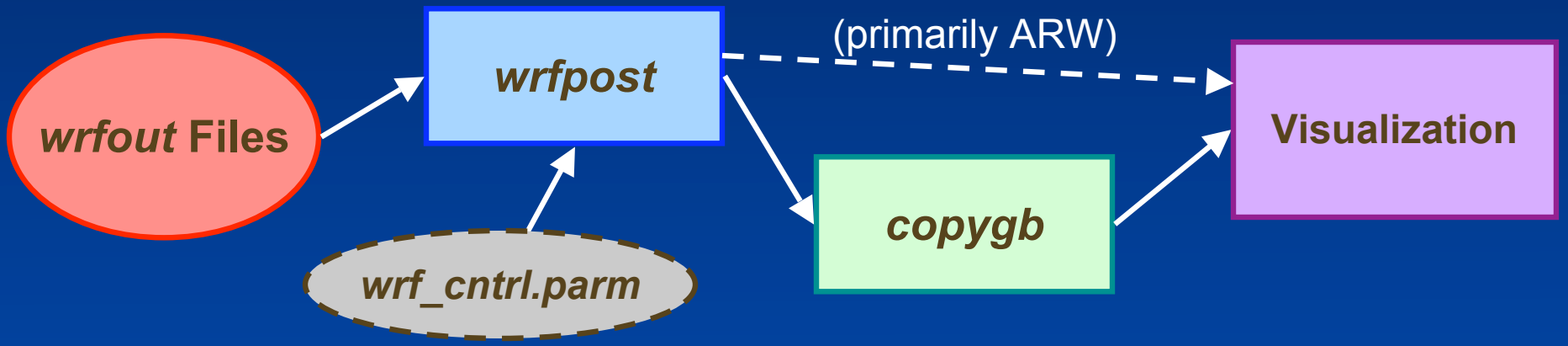
- Overview
- Components and Functions
- Sample fields generated
- Installation
- Running *wrfpost*
  - Controlling output generation
- Running *copygb*
  - Specifying target grid
- Visualization

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

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

- 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

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:

  w*rfpostproc_v3.0.1.tar.gz*

- Unpack the downloaded file:

  tar –zxvf wrfpostproc_v3.0.1.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 with on your computer by executing the configure file:

  ./configure

- At the prompt, specify:

  1) platform: “1” for LINUX (pg compiler); “2” for LINUX (ifort compiler); “3” for AIX/IBM.
  2) path to a netCDF installation
  3) path to a compiled WRF model source directory

- 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.,

GRIB packing precision

```
(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…
```

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

Product description – wrfpost code keys on these character strings.

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=( 3.0)
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=( 3.0)
L=(10000 00000 00000 00000 00000 00000 00000 00000 00000 00000…)
```

Examples

- Do not output cloud top height:

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

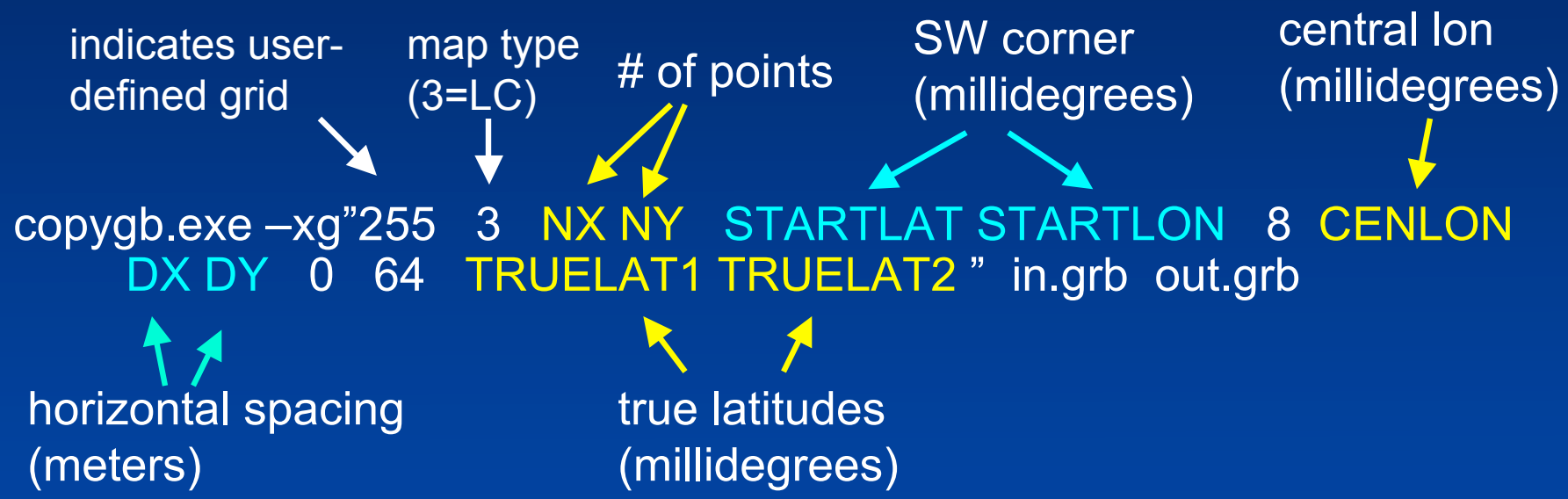
- Read in grid navigation file created by *wrfpost* (NMM only, simple, restrictive)
  - Running *wrfpost* on WRF-NMM output produces two ASCII files containing grid navigation information which is similar in domain and grid spacing to the model integration domain.
    - *copygb_gridnav.txt* for a Lambert 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 3

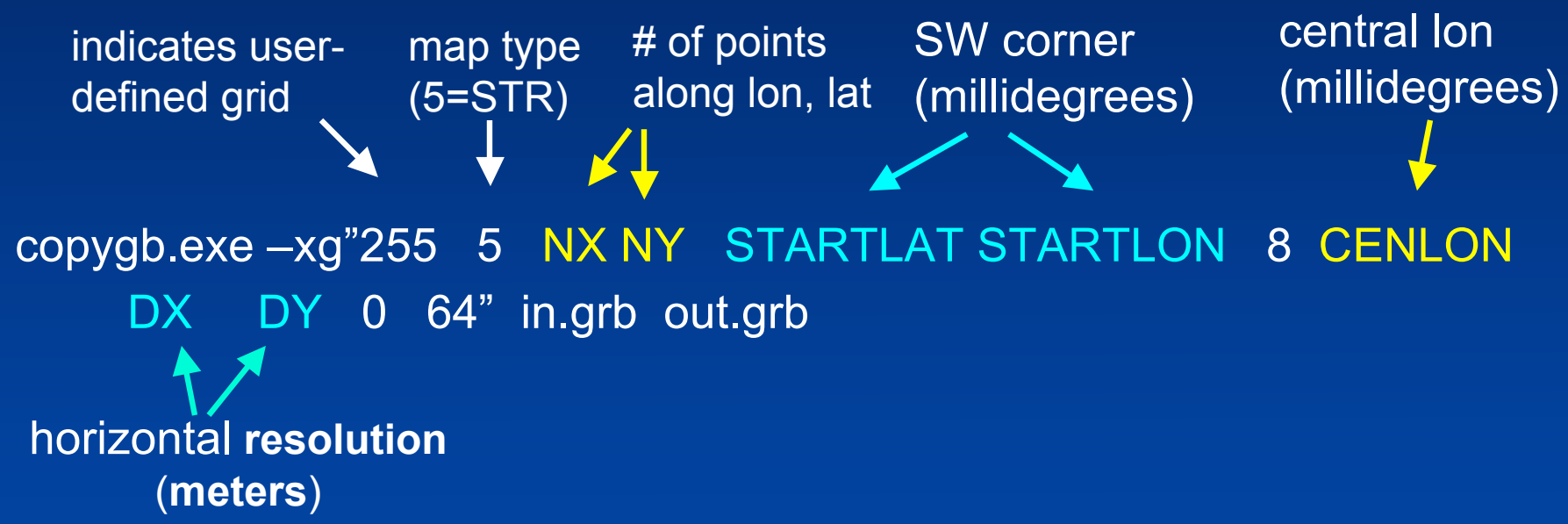
- Create a user-defined grid by specifying a full set of grid parameters. To interpolate onto a Lambert conformal grid:




```
copygb –xg"255  3  185  129  12190      -133459       8   -95000
    40635 40635  0  64  25000      25000"       in.grb  out.grb
```

Run *copygb* – Option 3

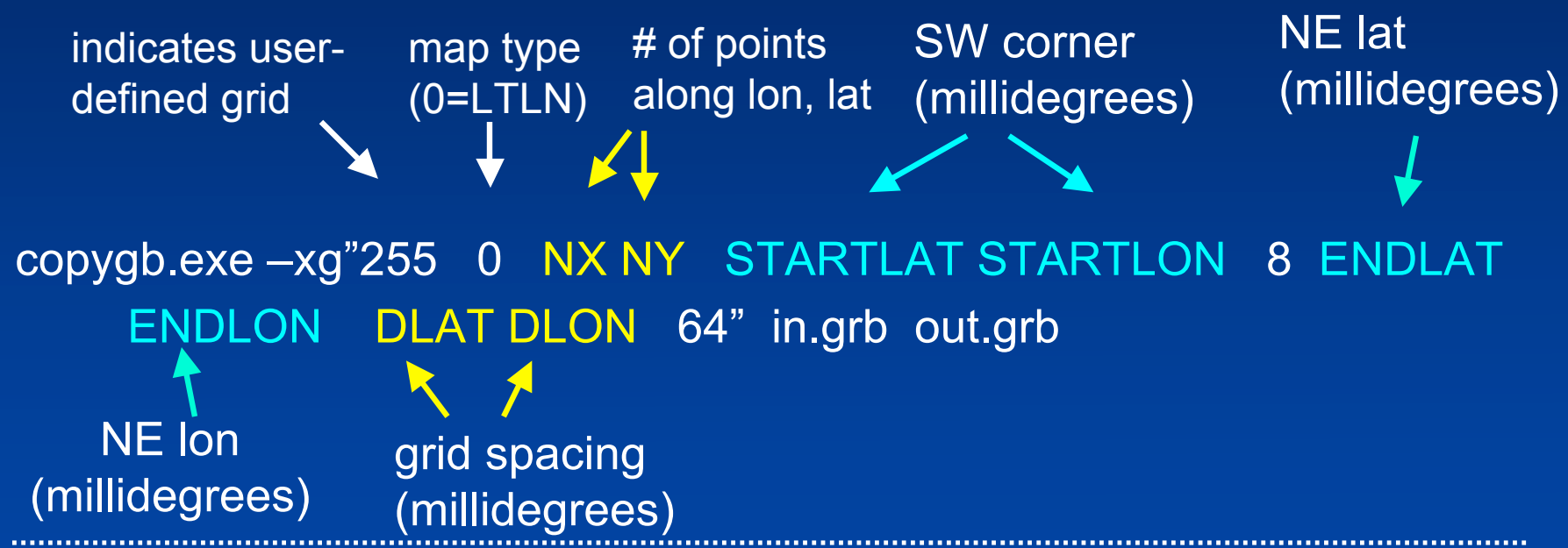
- Create a user-defined grid by specifying a full set of grid parameters. To interpolate onto a Polar stereographic grid:



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

Run *copygb* – Option 3

- Create a user-defined grid by specifying a full set of grid parameters. To interpolate onto a regular Latlon grid:

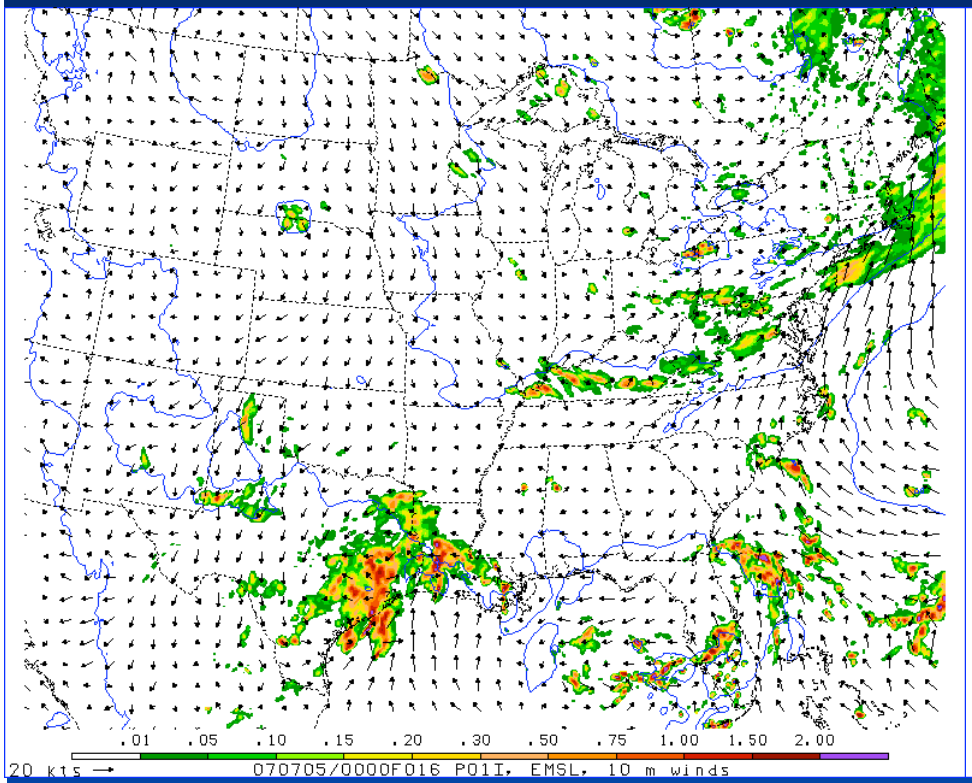


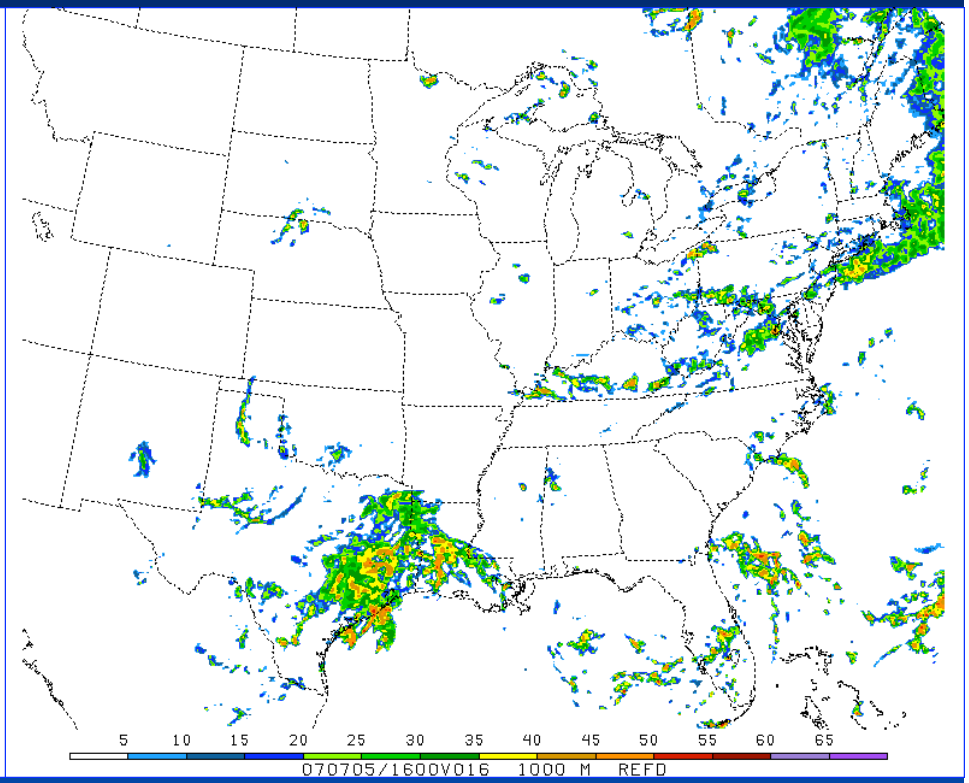

```
copygb –xg"255  0  401  401  10000      -130000       8    50000
       -90000     100    100     64"    in.grb  out.grb
```

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

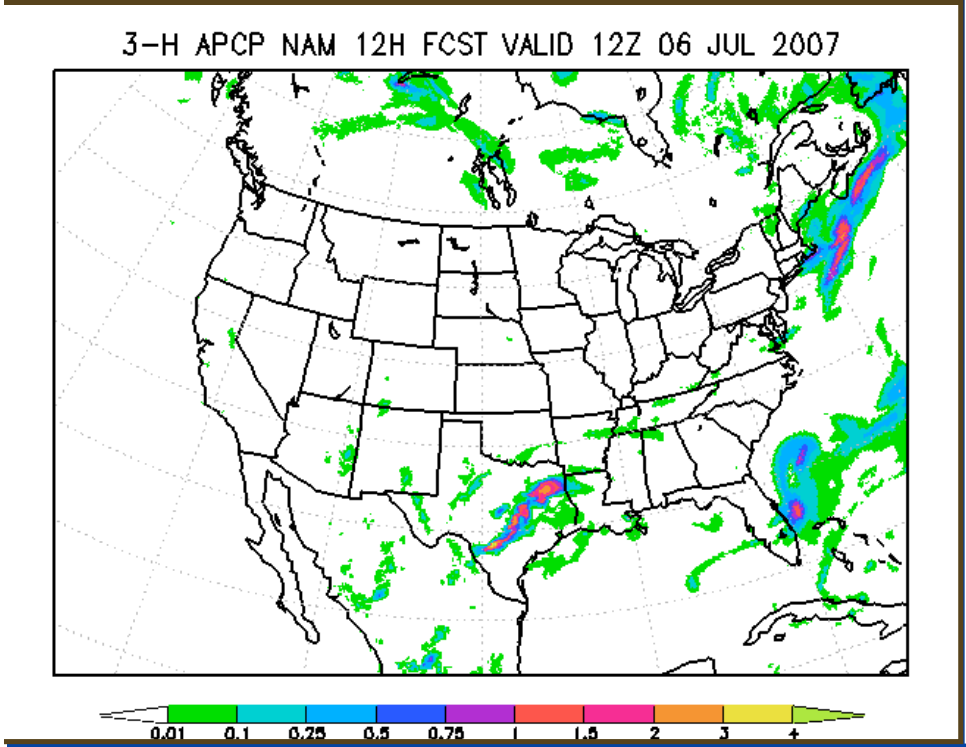
- GrADS also has utilities to read GRIB files on any non-staggered grids and generate GrADS “control” files. The utilities grib2ctl and gribmap are available via: http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html

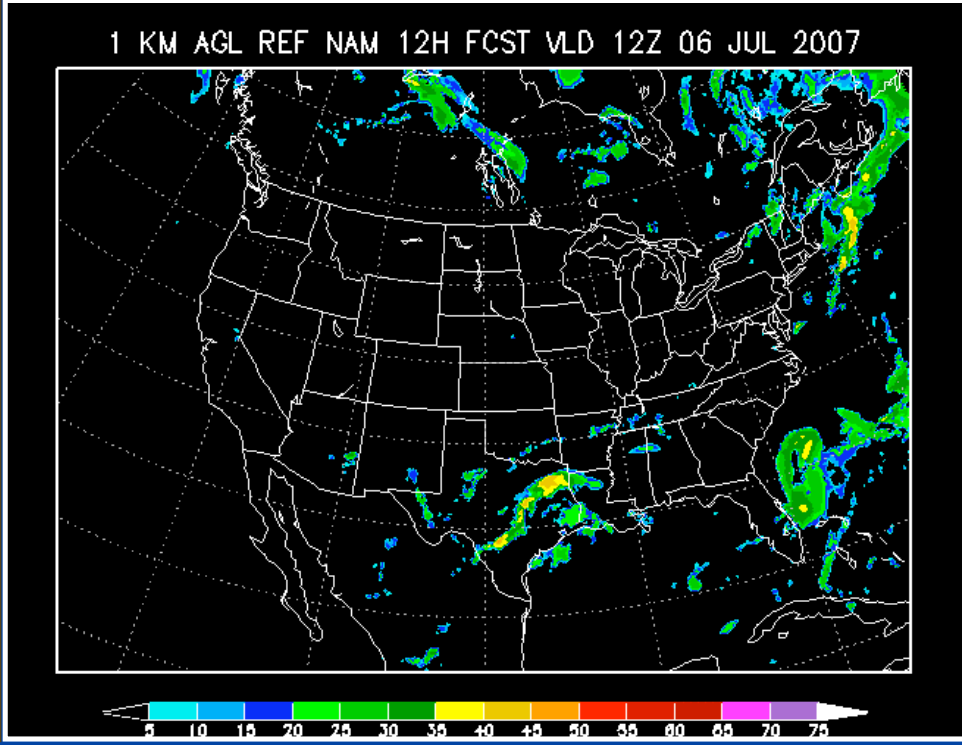
- Package download and user guide for GrADS are available online:

  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



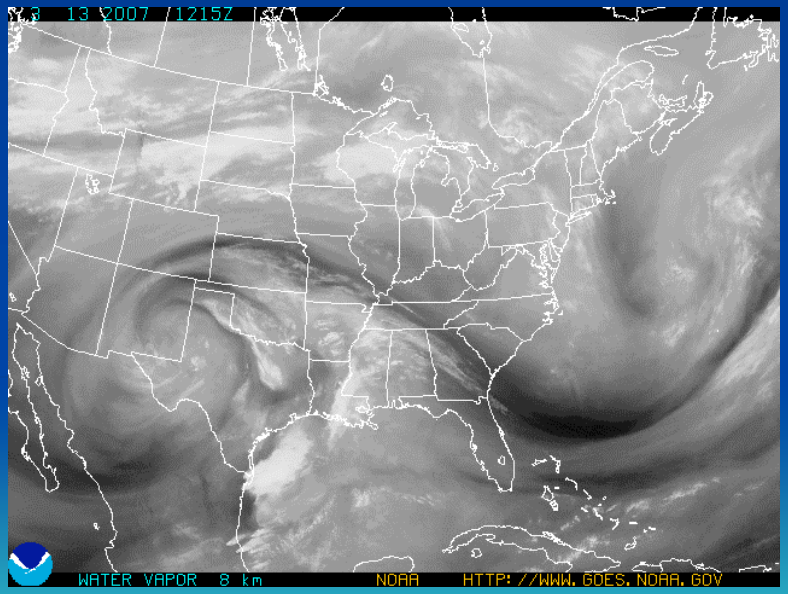


Future plan

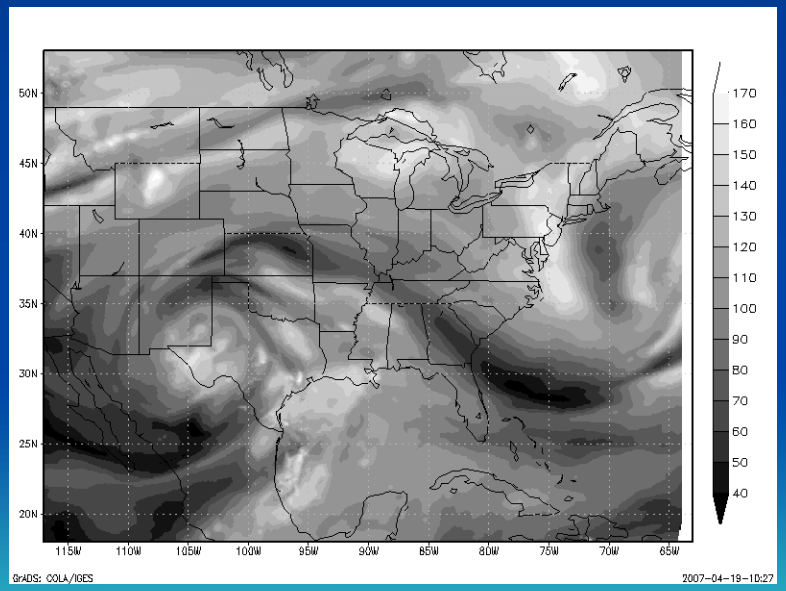
- The planned upgrade for WPP:

  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