NCEP's UNIFIED POST PROCESSOR (UPP)

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Outline

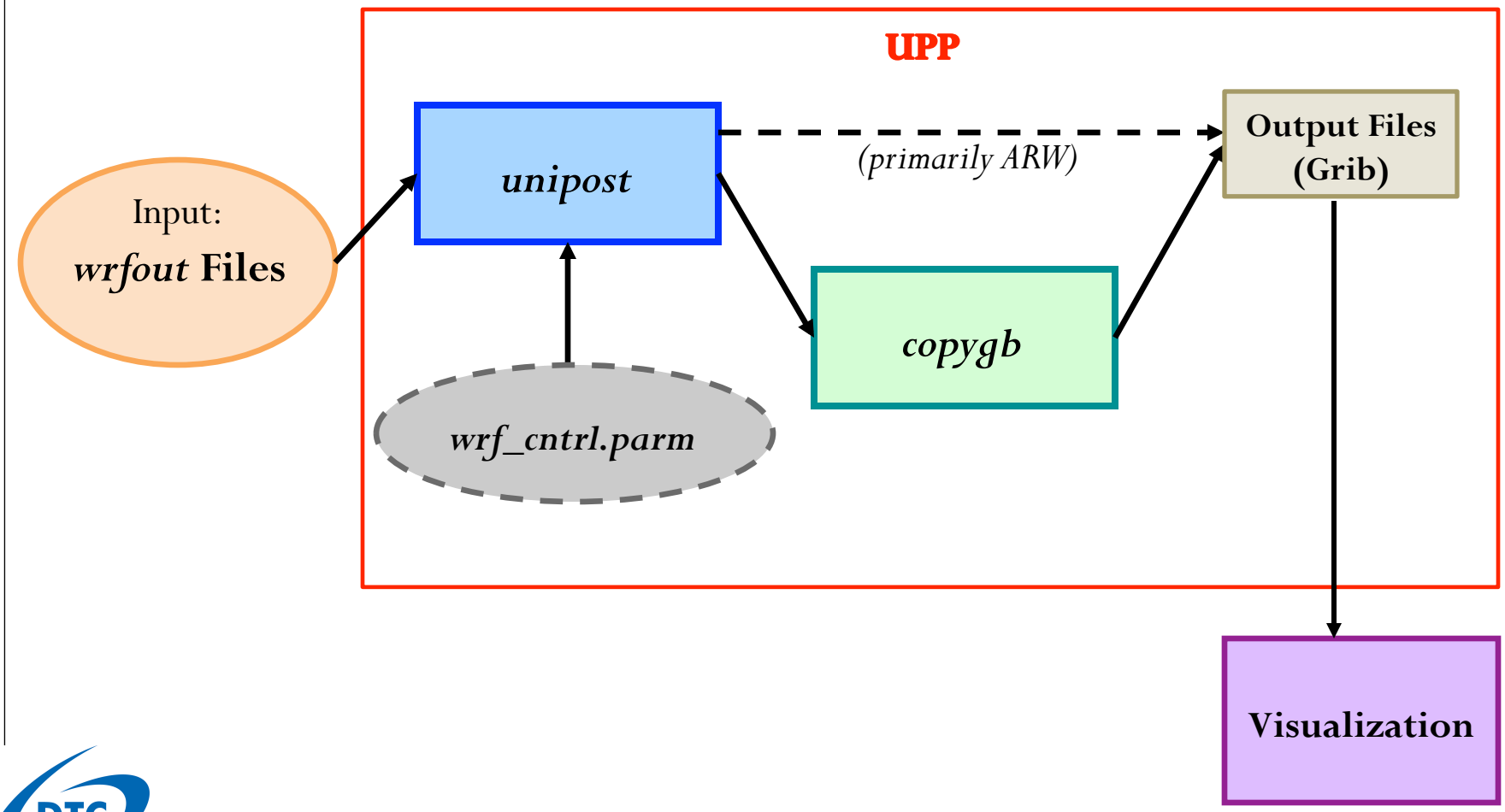
- Overview
- Components and Functions
- Sample fields generated
- Installing UPP
- Running *unipost*
  - Controlling output generation
- Running *copygb*
  - Specifying target grid
- Visualization

UPP Overview

- NCEP Developed & Supported Operationally
  - NCAR Supports community code for WRF Post Processing
- Processes model output from both the NMM and the ARW dynamical cores.
- Generates output in GRIB format.
- Enables product generation on any output grid.
- Produces requested diagnostics and fields, but does not plot or visualize data.

Components of the UPP

UPP has two components: 1) unipost 2) copygb



Unipost: Functions & Features

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

Copygb: Functions & Features

- Performs **horizontal** interpolation to a defined output grid
- Destaggers NMM grid
  - NOTE: many visualization packages cannot properly handle staggered grids
- Creates an output grid different than the model integration domain.

Ingesting WRF model output

- The unipost ingests WRF model output in netCDF or binary format using the WRF I/O package.

  - Users are encouraged to use netCDF-formatted model output for simplicity.
  - Binary I/O is quicker for large file sizes. DTC is working to improve binary support using MPI-IO.
  - One time per output file is best w/ sample UPP run scripts (frames_per_outfile=1 in WRF model namelist).

Ingesting WRF model output

- By default the WRF model should provide all fields that the unipost needs to ingest.
- The Users' Guide Table 1 & 2 lists the fields read in by the unipost for both dynamical cores (by WRF Registry file variable names)
- Not a concern unless modifying the Registry.

Fields generated by the UPP

- **The UPP currently outputs hundreds of possible fields.**
  - Complete list in the Post Processing Utilities Chapter of the user guide

- **Sample fields generated by UPP:**

1) T, Z, humidity, wind, cloud water, cloud ice, rain, and snow on isobaric levels
2) SLP + shelter level T, humidity, and wind fields
3) Precipitation-related fields
4) PBL-related fields
5) Diagnostic products
6) Radiative/Surface fluxes
7) Cloud related fields
8) Aviation products
9) Satellite look-alike products

UPP download and compile

UPP Dependencies & Required Libraries

- UPP build relies on the existence of a built WRF source directory
  - Next release of WRF (Spring 2014) will contain an option to compile only necessary WRF i/o libraries required by UPP
- UPPV2.1 depends on WRFV3.5 or later releases.
- Libraries required: netCDF, JasPer, PNG, Zlib, wrf io libs

Downloading the UPP source code

- The UPP source code can be obtained from:
  http://www.dtcenter.org/wrf-nmm/users/downloads
  - The latest version available is: UPPV2.1.tar.gz
- Unpack the downloaded file:
  tar –zxvf UPPV2.1.*tar.gz*
- *cd* to newly created UPPV2.1/ directory
  - Important Directories:
    - scripts/: sample scripts for running UPP and generating graphics
    - parm/: contains the files used to request output fields when running the unipost (i.e. wrf_cntrl.parm)
    - clean, configure, compile: scripts used in the build process

Compile source codes

- The build mechanism* follows the WRF model build paradigm:

  ./configure : respond to screen prompts about target computing platform

- *./compile >& compile_upp.log*

Compile source codes (cont.)

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

  copygb.exe
  ndate.exe
  unipost.exe

- Currently have build options established for IBM (AIX) and Linux (PGI/Intel/Gnu compilers)

- The arch/configure.defaults file has compilation options for various platforms, and is where new computers or compilers might be added.

Running unipost and copygb

unipost needs 3 input files to run

1) itag: text file that specifies details about WRF model output to process. Can be referred to as the namelist.

wrfout_d01_2010-06-27_00:00:00	← *WRF history filename*
netcdf	← *WRF output format (netcdf/binary)*
grib2	← *extra line only if writing GRIB2 – currently broken so don't try this yet!*
2010-06-27_00:00:00	← *validation time*
NCAR	← *model name: NMM -or- NCAR (ARW)*

2) wrf_cntrl.parm: control file specifying fields/levels to output in GRIB1

3) eta_micro_lookup.dat: binary look-up table for Ferrier MP (linked from WRF)

In the sample parm/run_unipost* scripts, these files are automatically generated (itag) or linked (wrf_cntrl.parm & eta_micro_lookup.dat).

unipost control file: *wrf_cntrl.parm (GRIB1)*

- 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**

Levels to output: Each column represents a single model/isobaric level:
"1" (or "2" - special case) = output, "0" = no output

Product description – unipost code keys on these character strings.

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

unipost control file: *wrf_cntrl.parm*

- The included parm/*wrf_cntrl.parm* file has entries for every possible output field. ** Use this as template! **

- The users' guide "Fields produced by *unipost*" (Table 3) more fully explains the character string abbreviations used in the control file.

- *Generation of GRIB2 remains a work in progress (i.e., it isn't yet working correctly), but uses an XML file to request fields instead of the wrf_cntrl.parm file*

Outputting fields on different vertical coordinates

- *unipost* outputs on several vertical coordinates:
  - Native model levels
  - 47 isobaric levels
  - 15 flight/wind energy levels: 30, 50, 80, 100, ..., 2743, 3658, 4572, 6000 m (above ground or above MSL)
  - 6 PBL layers: each averaged over a 30 hPa deep layer
  - 2 AGL radar levels: 1000 & 4000 m

- Except for AGL radar and isobaric levels, vertical levels are listed 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  01...)
      2 5  7 10 20   30 50 70 75 100   125 150
```

*** Isobaric levels increase from left to right:
2, 5, 7, 10, 20, 30, 50, 70, then every 25 hPa from 75-1000 hPa.
(Default/standard – can manually change code for different pressure levels)

Isobaric levels every 50 hPa:

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

Isobaric levels every 25 hPa:

```
L=(00000 01011 11111 11111 11111 11111 11111 11111 11111 10000 00000 00000 00000 00000)
```

Examples

- Output instantaneous surface sensible heat flux:

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

- Output U-wind component at 30, 50, and 80 m AGL:

```
(U WIND AT FD HEIGHT) SCAL=( 4.0)
L=(22200 00000 00000 00000 00000 00000 00000 00000 00000 00000…)
```

For the flight/wind energy level fields:
- "2" requests AGL.
- "1" requests above mean sea level.

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 *unipost* (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 *unipost* (NMM only, simple, restrictive)

  - Running *unipost* 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

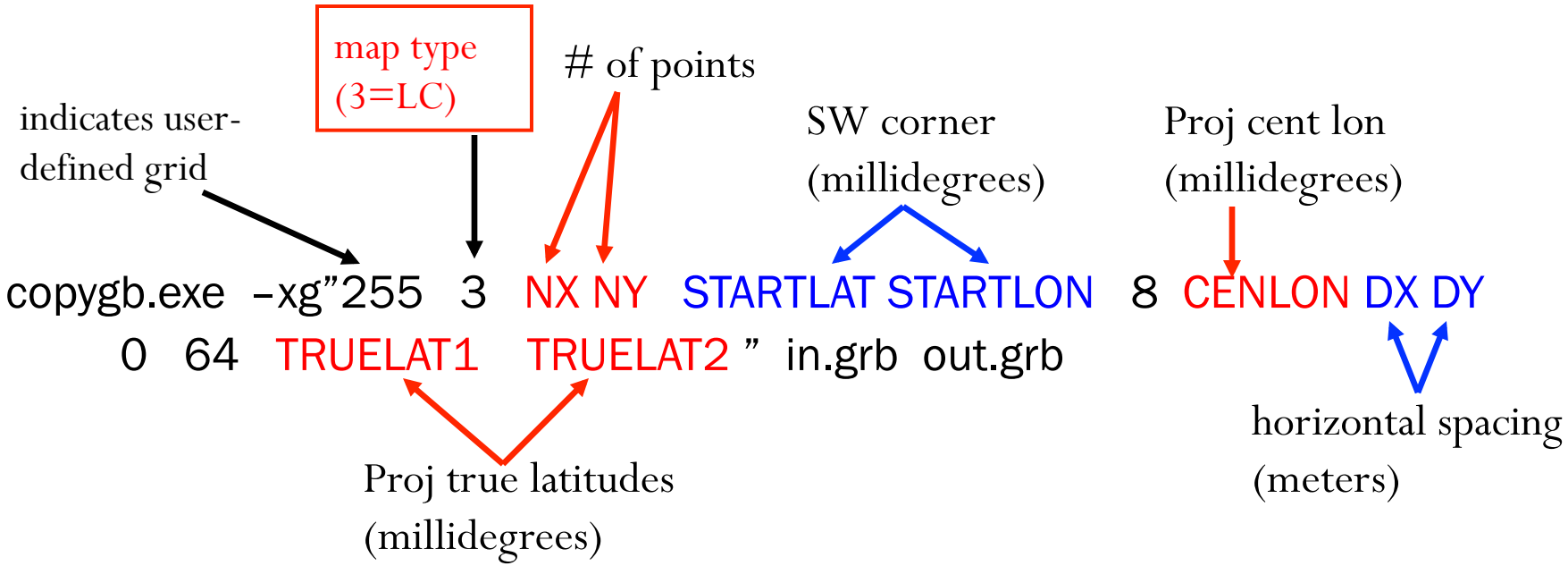
  For example:

  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).



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

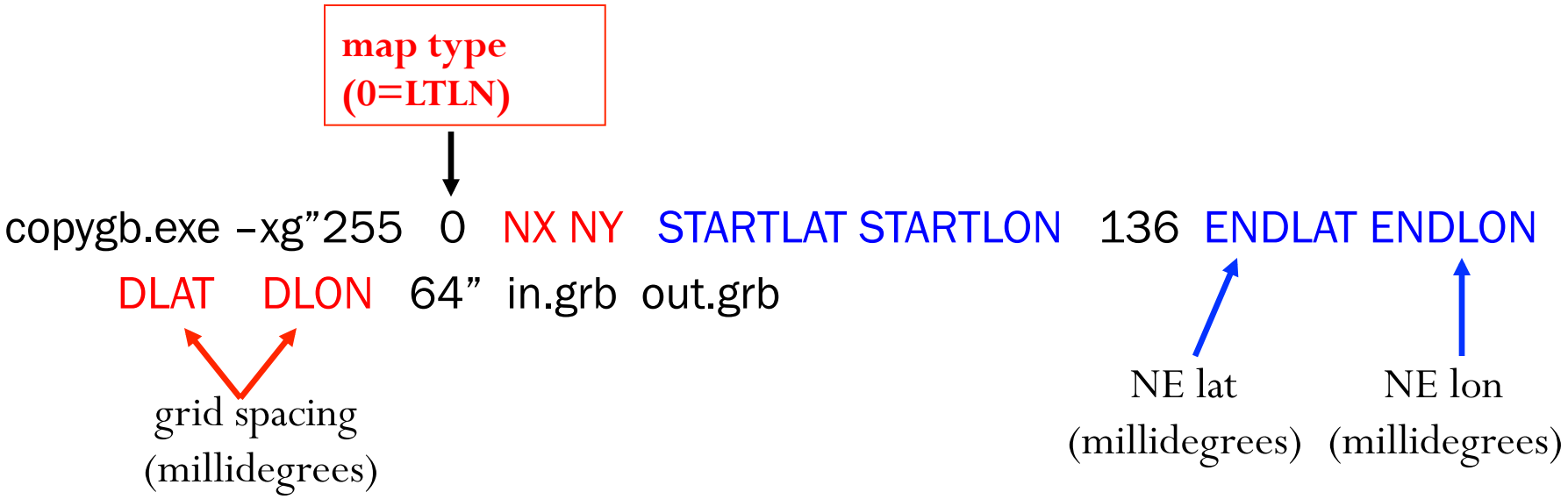
Center flag (0=NH ; 1=SH)

---

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).



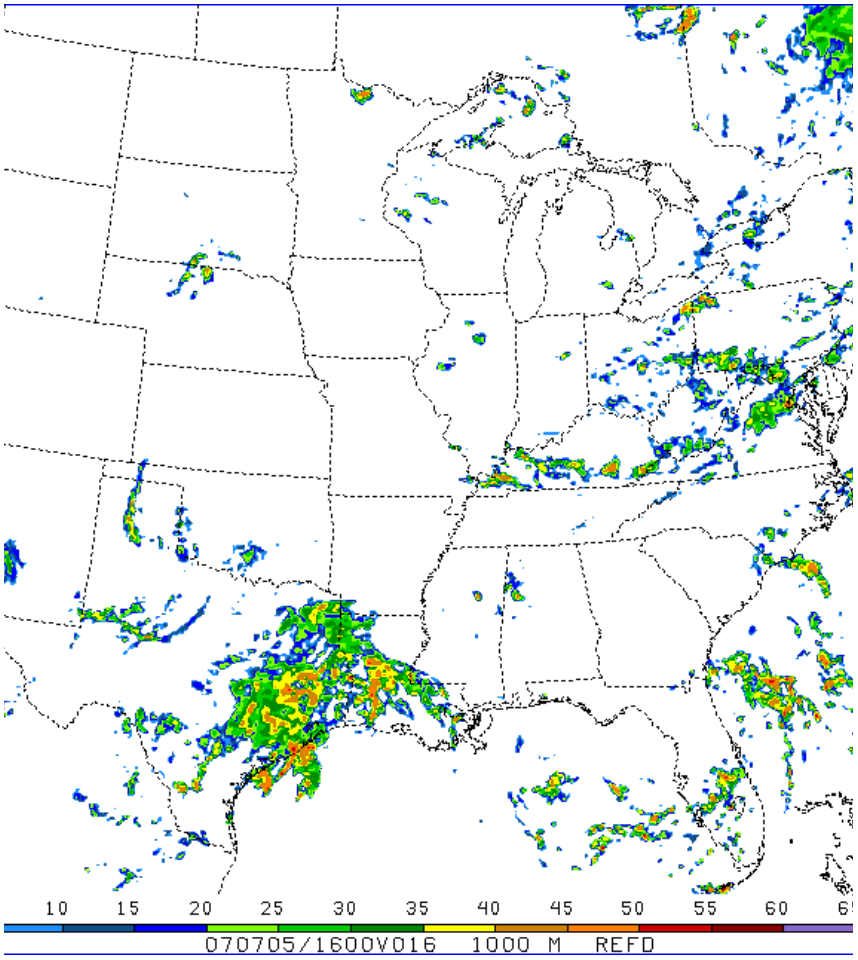
copygb –xg"255 0 401 401 10000 -130000 136 50000 -90000
100 100 64" in.grb out.grb

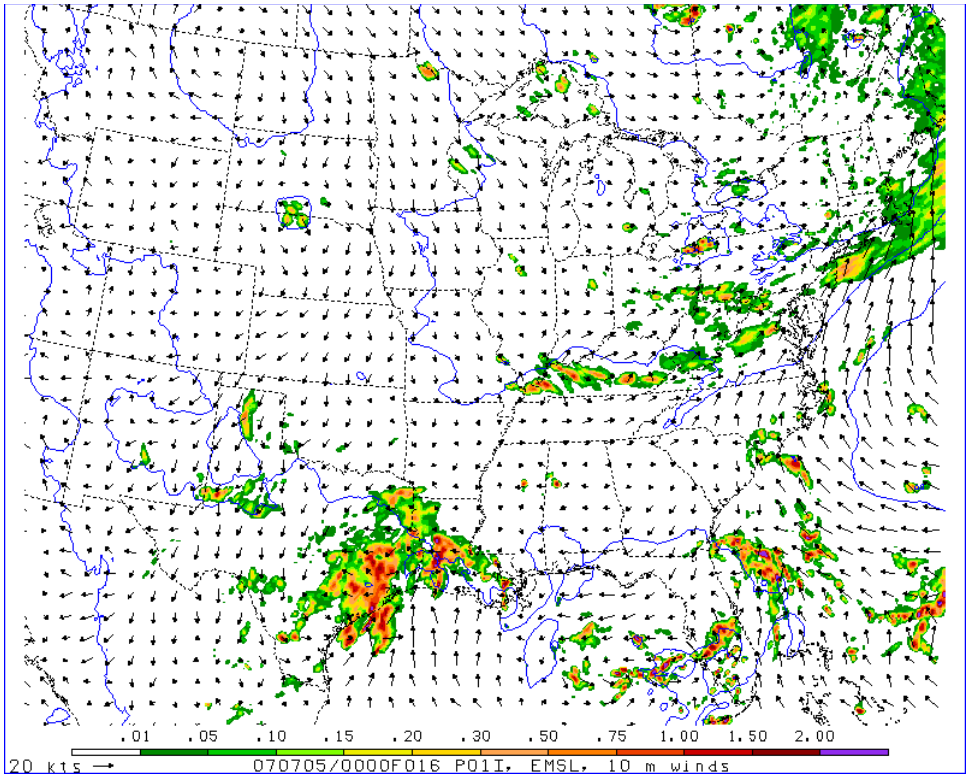
GRIB file visualization with GEMPAK

- 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://www.unidata.ucar.edu/content/software/gempak/index.html
- A sample script named *run_unipostandgempak* is included in scripts/ that can be used to run *unipost*, *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

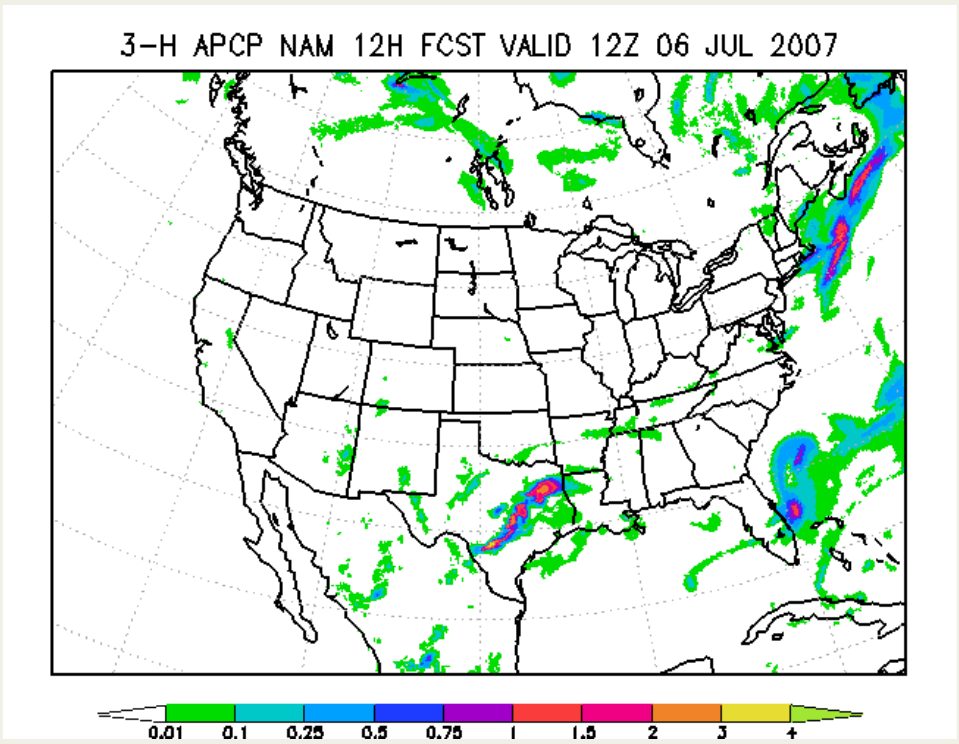
- GrADS also has utilities to read GRIB files on any non-staggered grids and generate GrADS "control" files. The utilities grib2ctl and gribmap are available via:
  http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html

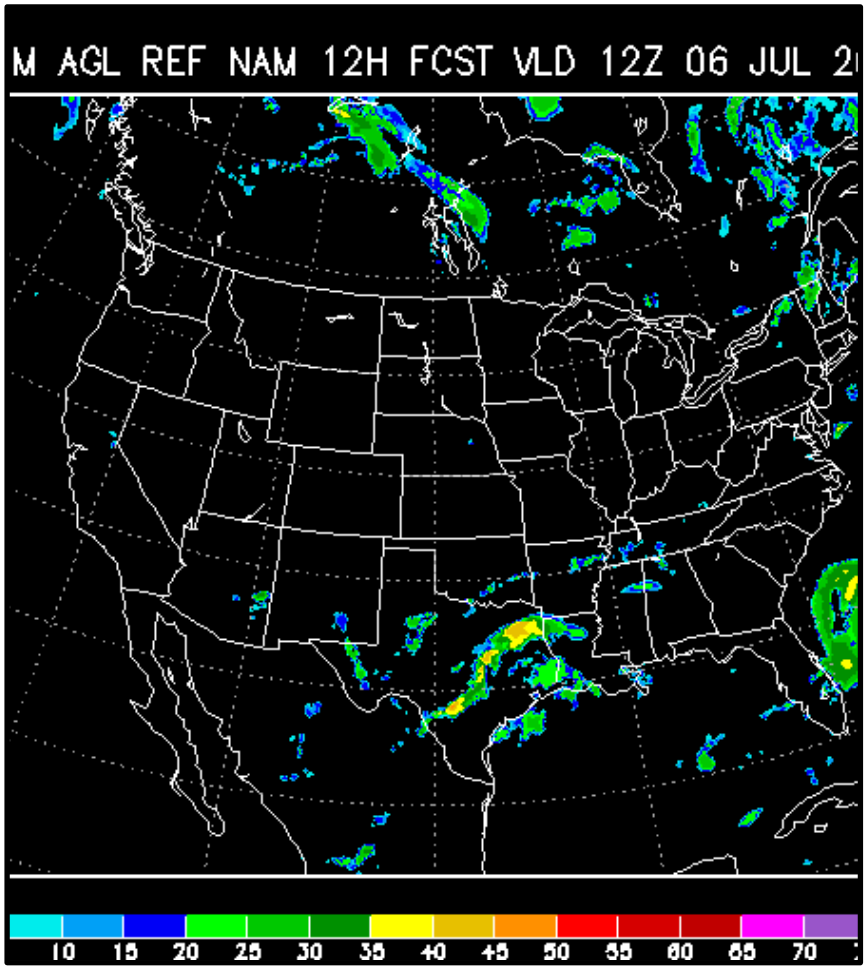
- Package download and user guide for GrADS are available online:
  http://grads.iges.org/grads/gadoc/

- A sample script named *run_unipostandgrads* is included in scripts/ that can be used to run *unipost*, *copygb*, and then plot various fields using GrADS.

Forecast plotted with GrADS:

Precipitation and derived Radar reflectivity





Future plans

- Fix problem(s) in the generation of GRIB2 output.
  - NCEP currently working on this

- Continue adding new products to the released UPP code as they are developed, and expand code portability.

UPP Users' Guide available at:

www.dtcenter.org/wrf-nmm/users/docs/user_guide/V3/users_guide_nmm_chap7.pdf

Questions???