

NCEP's UNIFIED POST PROCESSOR (UPP)

Presented by Kate Smith¹
smithkr@ucar.edu

Slide Credit: Hui-Ya Chuang² & *Matthew Pyle*²

¹ NCAR

² NCEP



Outline

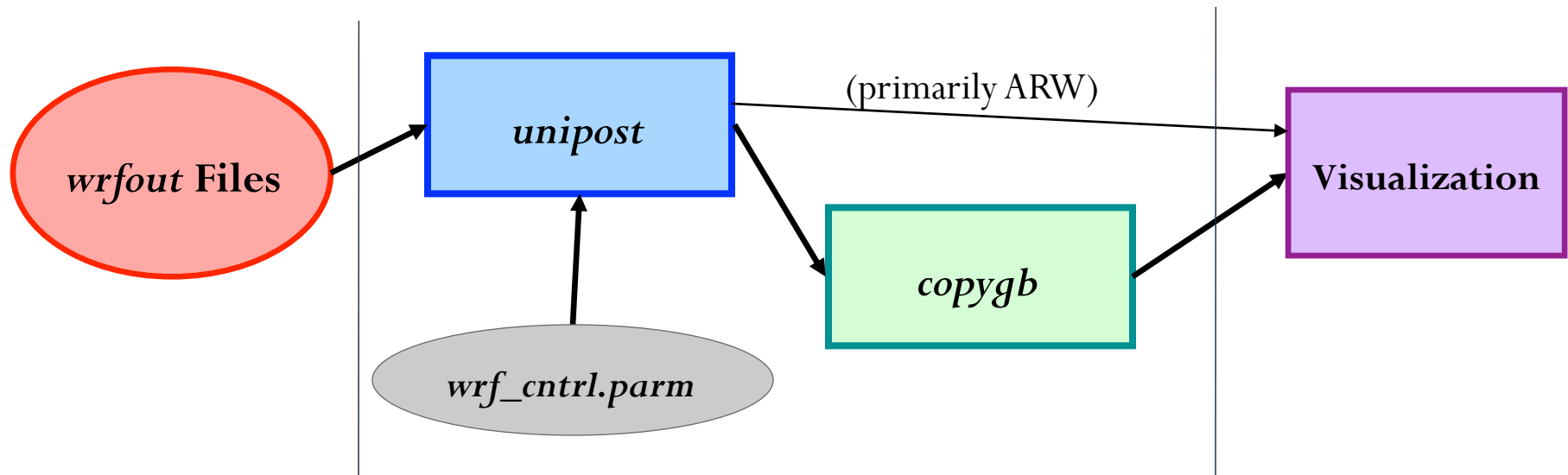
- Overview
- Components and Functions
- Sample fields generated
- Installation
- Running *unipost*
 - Controlling output generation
- Running *copygb*
 - Specifying target grid
- Visualization

The critical big picture overview

- Processes model output from both the NMM and the ARW dynamical cores.
- The Unified Post Processor (UPP) generates output in GRIB.
- The UPP enables product generation on any output grid.

Components of the UPP

The UPP has two components: **unipost** and **copygb**.



Functions and features of *unipost*

- 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 destaggering (NMM only) and horizontal interpolation to a defined output 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 will provide all fields that the unipost needs to ingest.
- The users' guide 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

Fields generated by the UPP

➤ Sample fields generated by UPP (cont.):

- 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

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

UPPV2.1 directory “important” contents

- **scripts/**: sample scripts for running UPP and generating graphics
- **parm/**: contains the files used to request output fields when running the unipost
- **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

- * This build relies on the existence of a built WRF source directory
- * UPPV2.1 depends on WRFV3.5

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 three input files to run*

In the sample run_unipost* scripts, [these files](#) are automatically generated or linked:

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

- [wrf_cntrl.parm](#): control file specifying fields/levels to output in GRIB1
- [eta_micro_lookup.dat](#): binary look-up table for Ferrier MP

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**

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 *wrf_cntrl.parm* file has entries for every possible output field.
 - The users' guide "Fields produced by *unipost*" table more fully explain 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.

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.

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](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

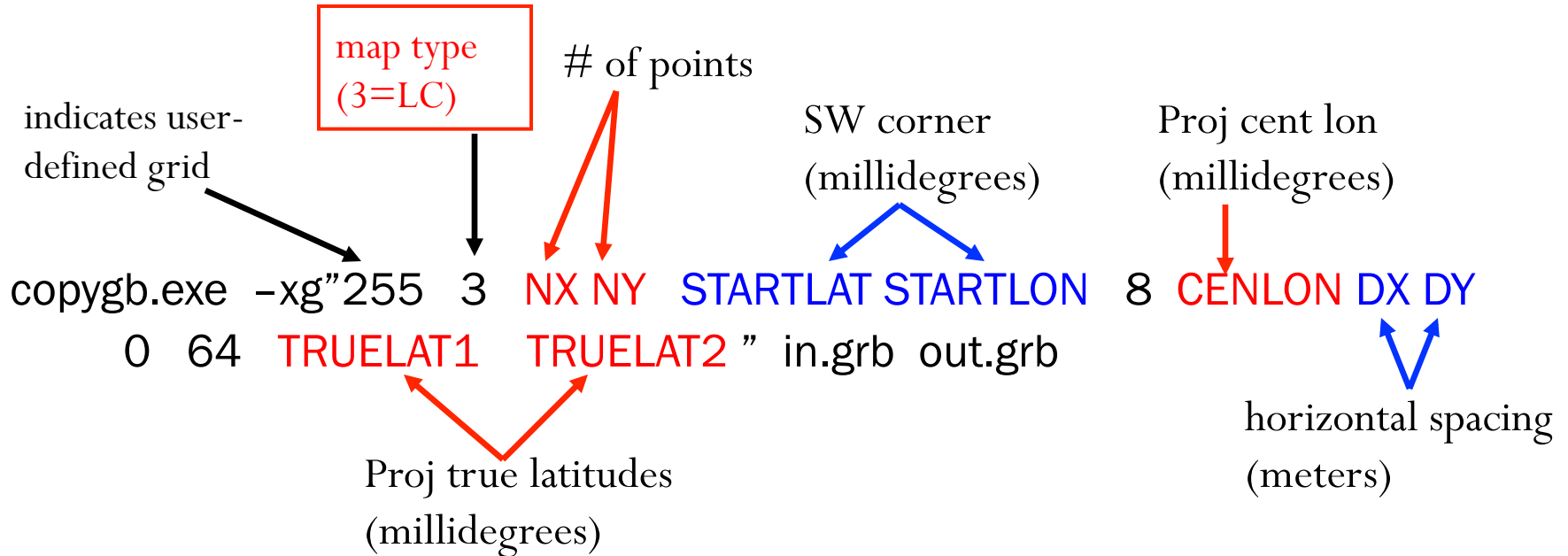
For example:

```
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).

map type
(0=LTLN)

copygb.exe -xg"255 0 NX NY STARTLAT STARTLON 136 ENDLAT ENDLON
DLAT DLON 64" in.grb out.grb

grid spacing
(millidegrees)

NE lat
(millidegrees)

NE lon
(millidegrees)

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



GRIB file visualization with GEMPAK

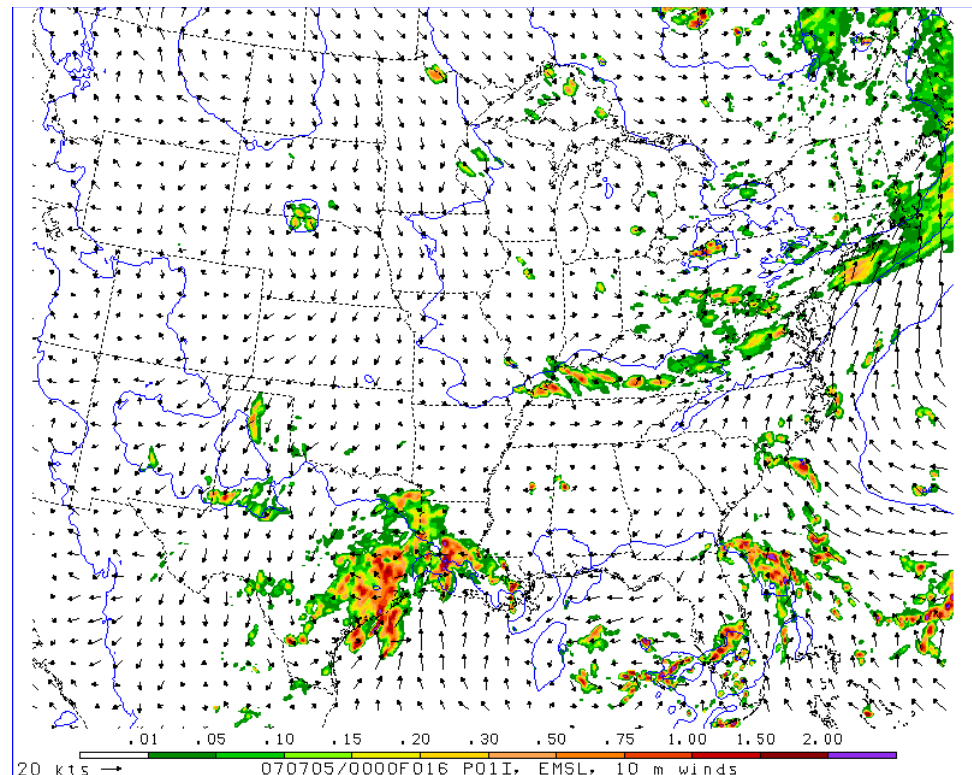
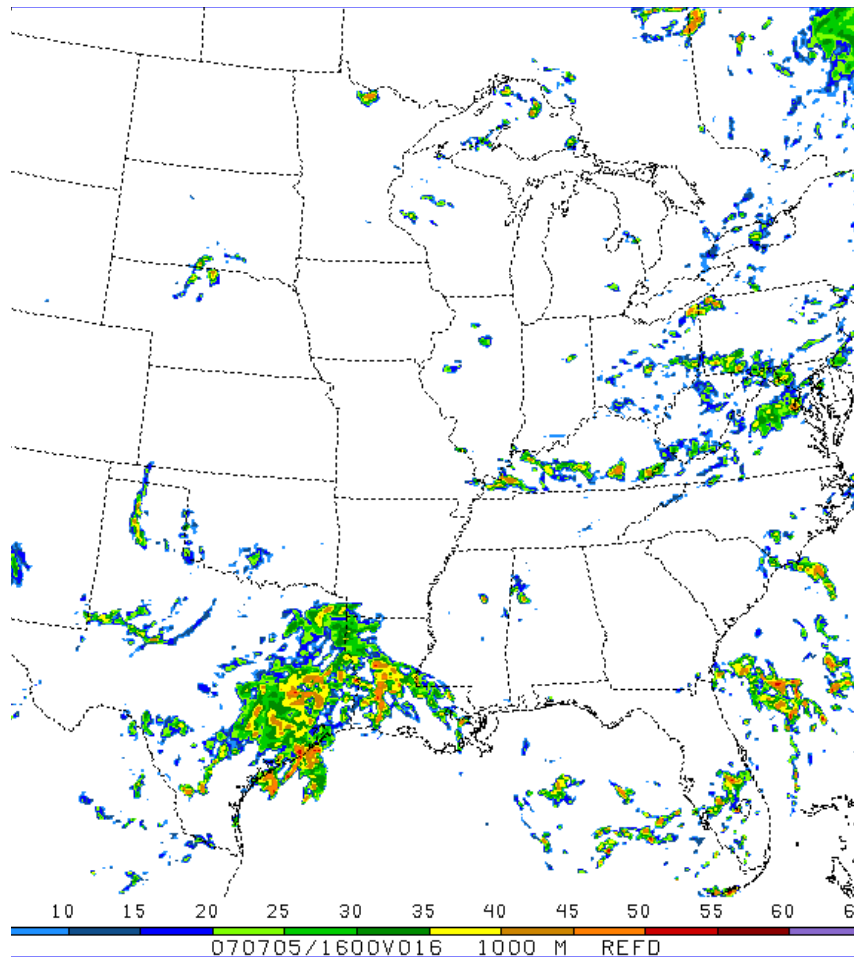
- The GEMPAK utility “nagrib” reads GRIB files from any non-staggered grid and generates GEMPAK-binary files that are readable by GEMPAK plotting programs
- GEMPAK can plot horizontal maps, vertical cross-sections, meteograms, and sounding profiles.
- Package download and user guide are available online:

<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:

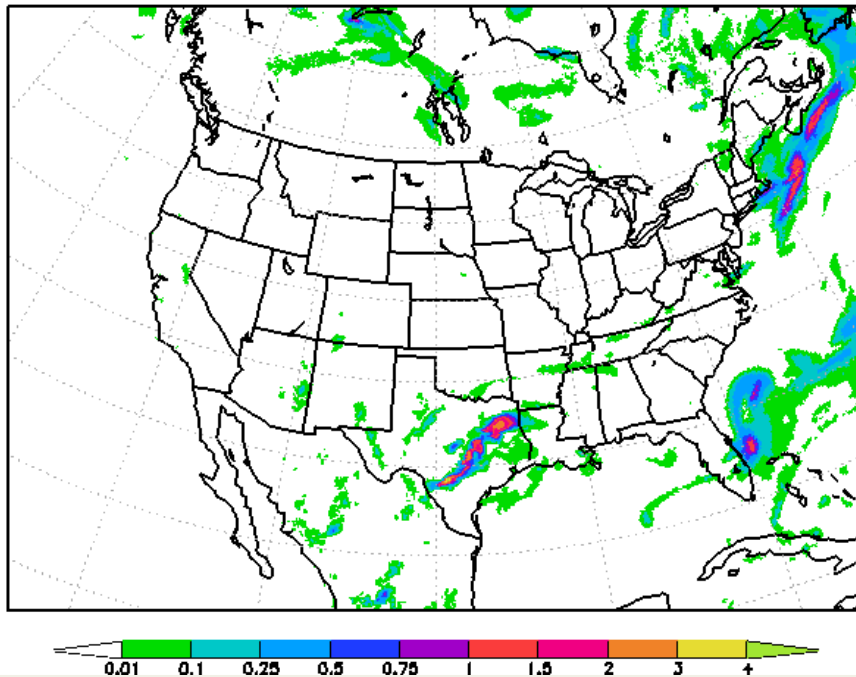
<http://grads.iges.org/grads/gadoc/>

- 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.

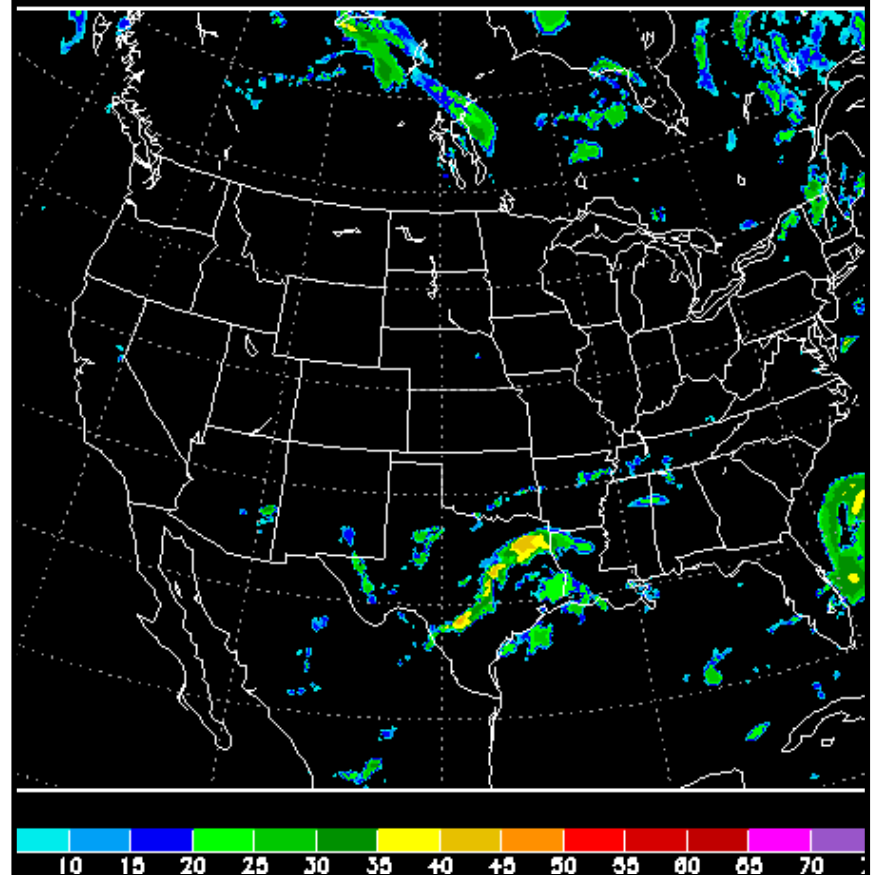
Forecast plotted with GrADS:

Precipitation and derived Radar reflectivity

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



M AGL REF NAM 12H FCST VLD 12Z 06 JUL 20



Future plans

- Fix problem(s) in the generation of GRIB2 output.
- Continue adding new products to the released UPP code as they are developed, and expand code portability.

Questions???