# NCEP's UNIFIED POST PROCESSOR (UPP)

Hui-Ya Chuang
(Hui-Ya.Chuang@noaa.gov)

*Presented by Matthew Pyle*
*(Matthew.Pyle@noaa.gov)*

# Outline

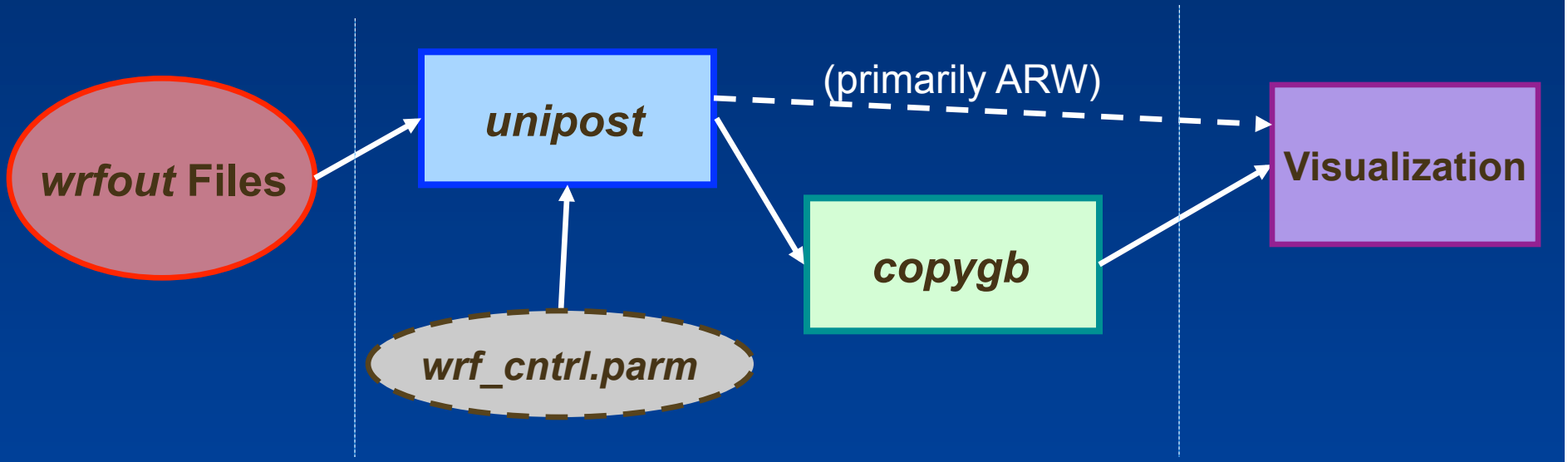
- Overview
- Components and Functions
- Sample fields generated
- Installation
- Running *unipost*
  - Controlling output generation
- Running *copygb*
  - Specifying target grid
- Visualization

# 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:
  UPPV1.0.tar.gz
- Unpack the downloaded file:
  *tar –zxvf* UPPV1.0*.tar.gz*
- *cd* to newly created UPPV1.0/ directory

# UPPV1.0 directory “important” contents

- **scripts/**: sample scripts for running UPP and generating graphics
- **parm/**: contains the control file used 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

# Compile source codes (cont.)

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

  *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:

- *itag*: specifies details of WRF model output to process

```
wrfout_d01_2010-06-27_00:00:00  ← WRF history filename
netcdf                          ← WRF output format (netcdf/binary)
2010-06-27_00:00:00             ← validation time
NMM                             ← model name (NMM/NCAR)
```

- *wrf_cntrl.parm*: control file specifying fields/levels to output
- *eta_micro_lookup.dat*: binary look-up table for Ferrier MP

* In the sample run_unipost* scripts, these files are generated on the fly or are automatically linked.

# *unipost* 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" (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.

# 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 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=( 4.0)
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.

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  )
L=(11111 00000 00000 00                                    00000 00000…)
```

- Output U-wind com AGL:

```
(U WIND AT FD HEIGHT) S
L=(22200 00000 00000 00                                    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

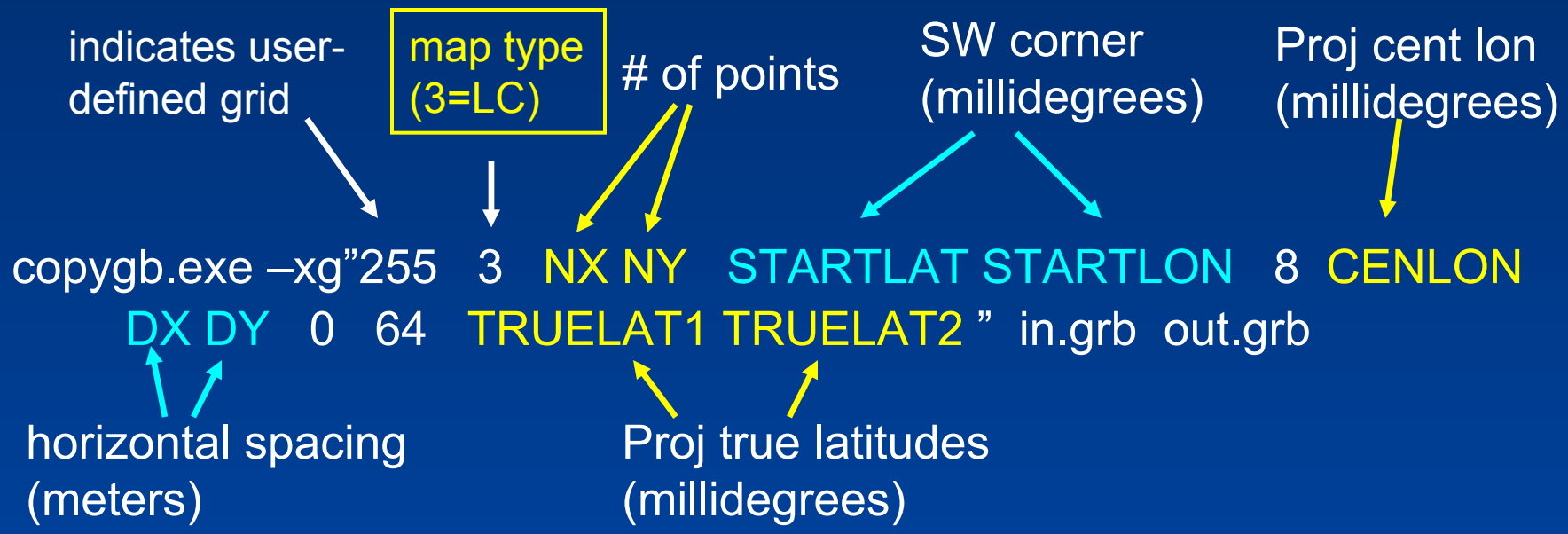
- Read in grid navigation file created by *unipost* (NMM only, simple, restrictive)
  - Running *unipost* on WRF-NMM output produces two ASCII files containing grid navigation information which is similar in domain and grid spacing to the model integration domain.
    - *copygb_gridnav.txt* for a Lambert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

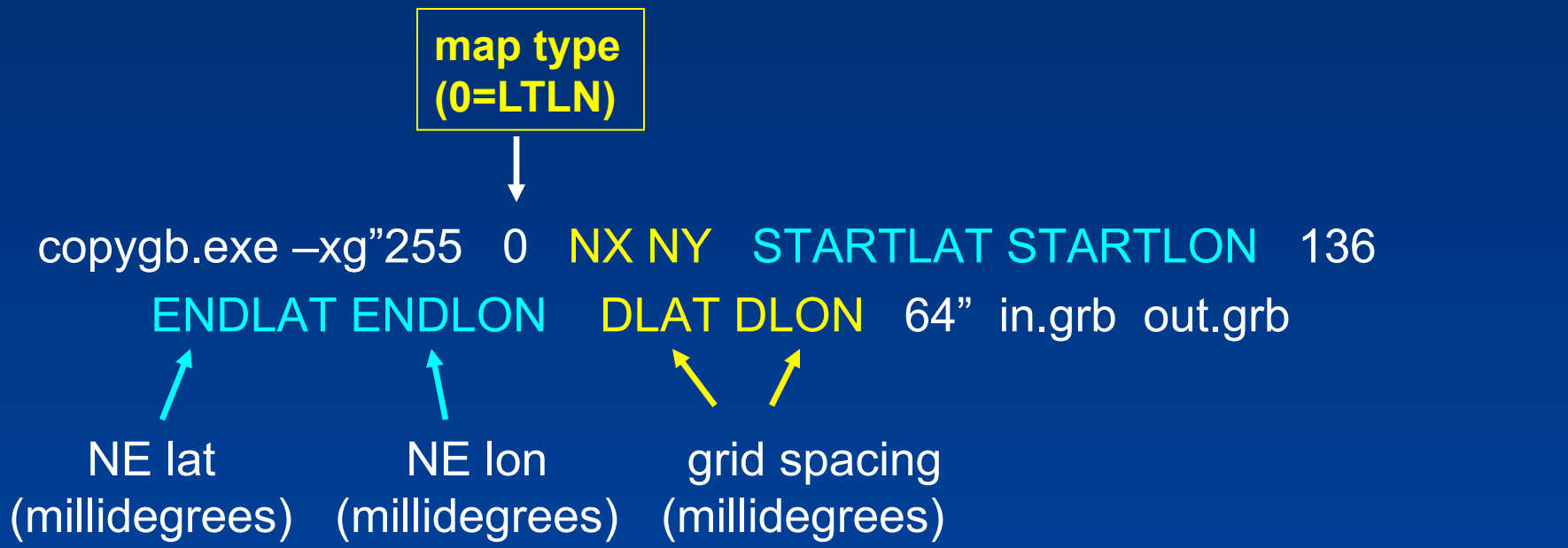
copygb.exe –xg"255 5 NX NY STARTLAT STARTLON 8 CENLON
DX DY 0 64" in.grb out.grb

**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).



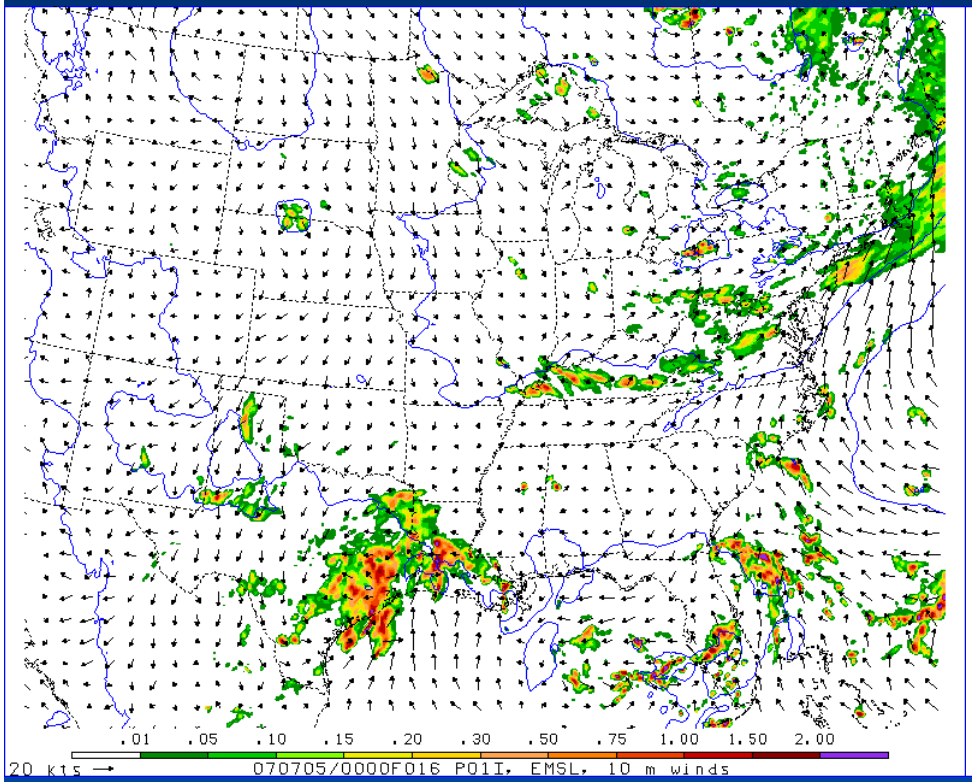

```
copygb –xg"255 0 401 401 10000 -130000 136
       50000 -90000 100 100 64" in.grb out.grb
```

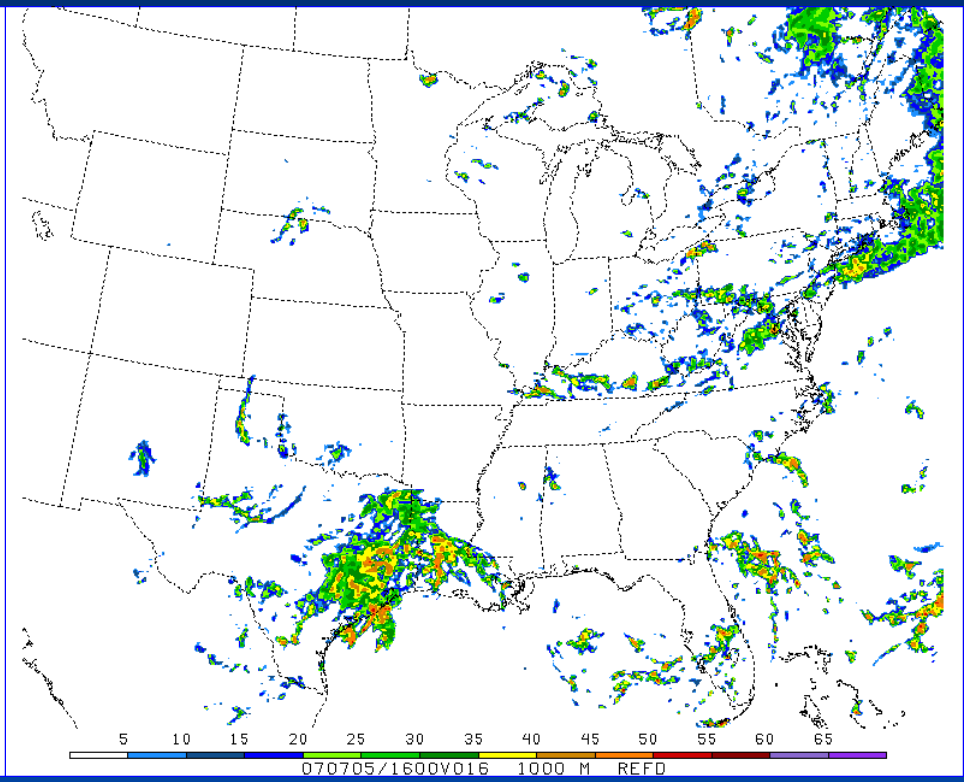
# GRIB file visualization with GEMPAK

- 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

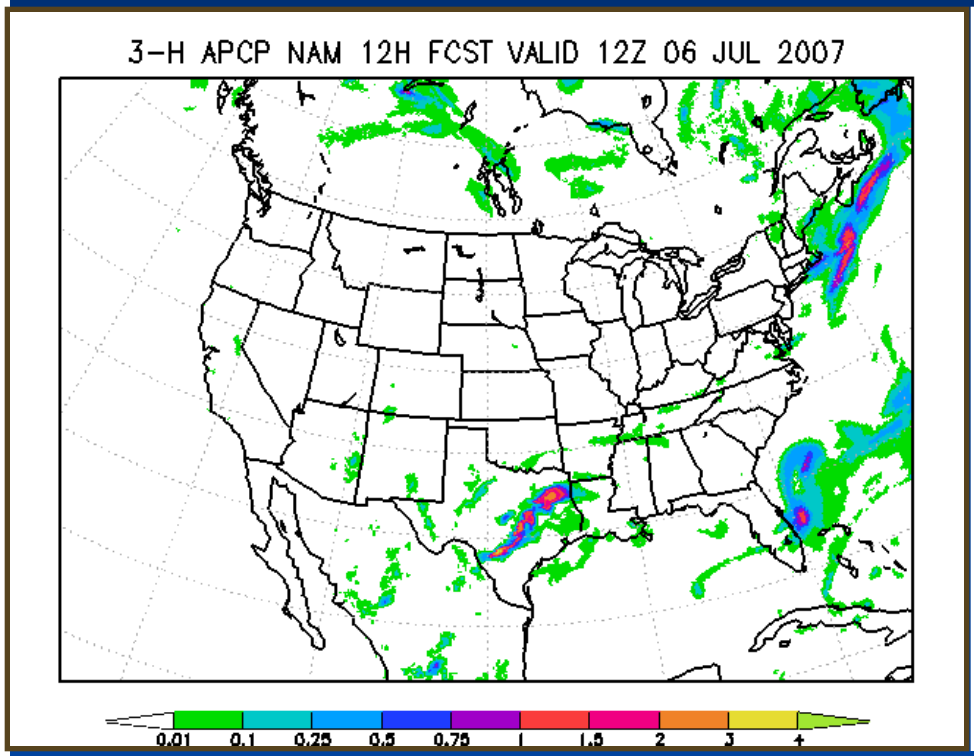
- Package download and user guide for GrADS are available online:

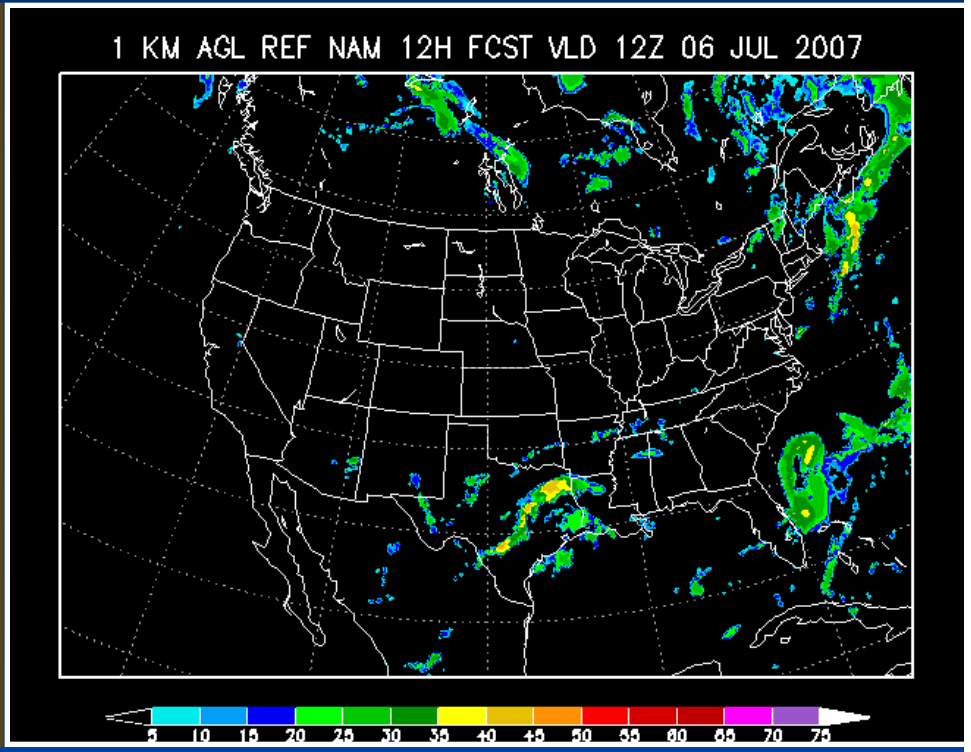
  http://grads.iges.org/grads/gadoc/

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

# Forecast plotted with GrADS:

## Precipitation and derived Radar reflectivity



# Future plans

- NCEP/EMC and the DTC are working on an updated version that will have the option to write GRIB1 or GRIB2 (currently just writes GRIB1).
- As mentioned earlier, better support for reading WRF model binary output also is in the plans.
- Both upgrades should be included in an April 2012 update release.

Questions???