NCEP's WRF POST PROCESSOR (WPP)

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Outline

- Overview
- Components and Functions
- Sample fields generated
- Running *wrfpost*
  - Controlling output generation
- Running *copygb*
  - Specifying target grid
  - Combining parent and nest domains
- Visualization

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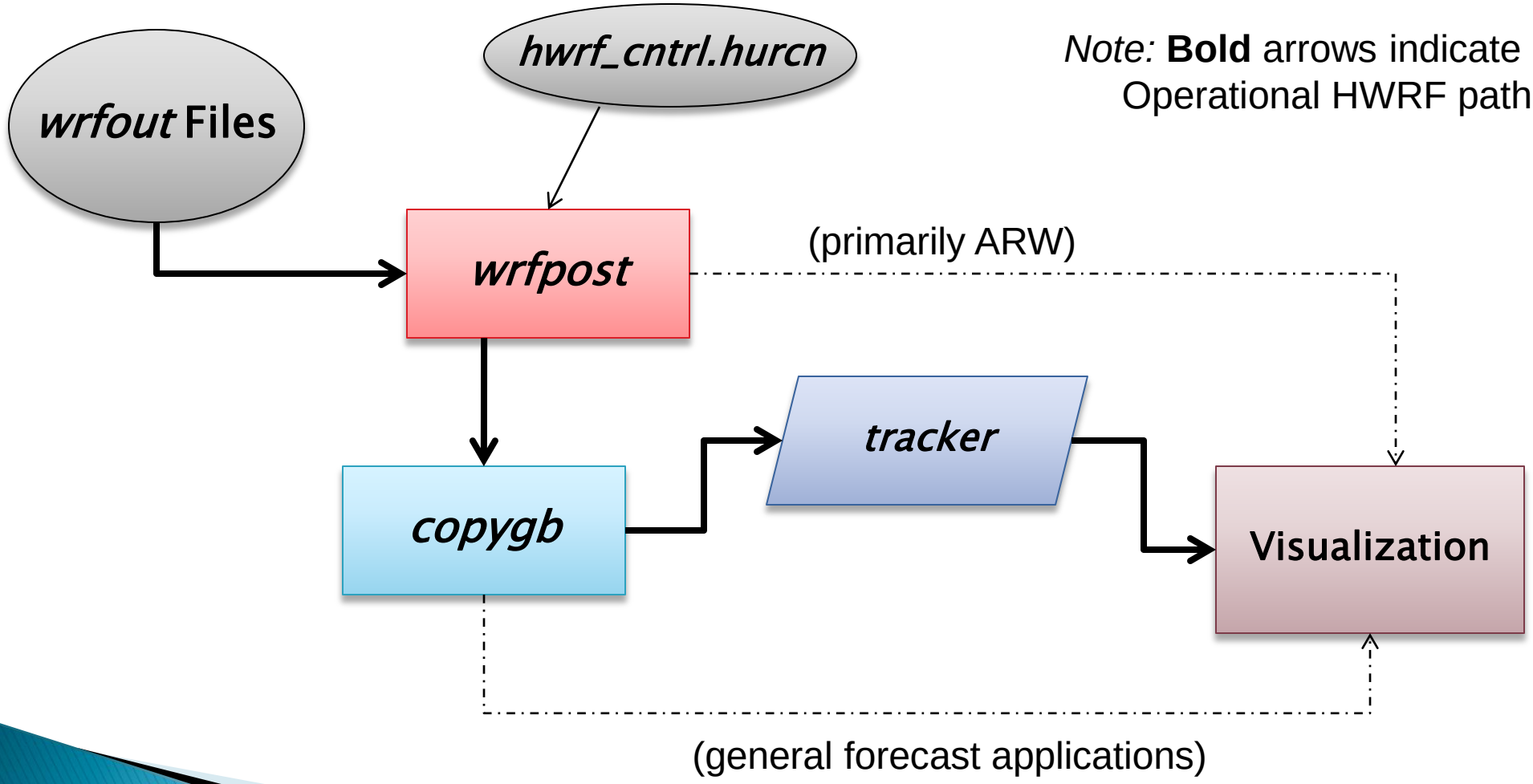
The critical big picture overview

- Processes model output from both the NMM and the ARW dynamic cores
- The WRF Post Processor (WPP) generates output in GRIB
- The WPP enables product generation on any output grid

Components of Post-Processing



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Functions of *wrfpost*

- Performs vertical interpolation onto isobaric and other non-model surfaces
- Computes diagnostic fields
- De-staggers wind onto mass points (ARW)

Functions of *copygb*

- Performs de-staggering (NMM core) and horizontal interpolation onto a defined output grid
  - Many visualization packages cannot properly handle staggered grids
- Useful for both cores in creating an output grid not fixed by the model integration domain
- Combines the *nest* data onto the *parent* domain

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Ingesting WRF model output

- *wrfpost* reads in WRF model output in netCDF format using the WRF I/O package
  - A single time per *wrfout* file works best with sample WPP run scripts (*frames_per_outfile=1* in WRF namelist)
- By default, the WRF model will provide all fields that *wrfpost* **requires**
  - Only a concern if you are modifying the Registry file
- **All** model fields read in by *wrfpost* for both dynamic cores can be found in the respective User Guides (listed by WRF Registry file variable names)

Fields generated by the WPP

- The WPP currently outputs **up to 288 fields**
  - Complete list in the Post Processing Utilities chapter of the ARW or NMM User Guides
- **Sample fields** generated by WPP
  - T, Z humidity, wind, cloud water, cloud ice, rain, and snow on isobaric levels
  - Shelter level T, humidity, and wind fields
  - SLP (two types)
  - Precipitation-related fields
  - PBL-related fields
  - Diagnostic fields
  - Radiative fluxes
  - Cloud-related fields
  - Aviation products

Fields required by the tracker

- Input for the tracker program
  - **Primary**
    - MSLP
    - Relative vorticity* at 10m, 850 and 700 hPa
    - Geopotential height at 850 and 700 hPa
  - **Secondary**
    - Winds (u/v) at 10m, 850 and 700 hPa
      - also used to extract intensity

*WPP outputs absolute and the tracker derives relative

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WPPV3 directory contents (subset)

- **sorc/**: source codes
- **scripts/**: sample scripts for running WPP and generating graphics for general forecast applications
- **lib/**: libraries used in the build
- **parm/**: control file used when running *wrfpost* for general forecast applications
- **exec/**: WPP executables
- **configure**: script to configure the *configure.wpp* file for the compile
- **compile**: script to compile the WPP code
- **clean**: script to clean created files and executables

hwrf_utilities directory contents (subset)

- scripts/: sample scripts for running WPP and generating graphics for HWRF-specific applications
- **lib**/: libraries used in the build
- parm/: control file used when running *wrfpost* for HWRF applications
- **exec**/: HWRF utility executables
- **configure**: script to configure the *configure.hwrf* file for the compile
- **compile**: script to compile HWRF utilities code
- **clean**: script to clean created files and executables

wrfpost input files

- *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*: generic *wrfpost* control file specifying fields to output
  - *hwrf_cntrl.hurcn*: HWRF-specific control file
- *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

- The *wrf_cntrl.parm* file has entries for every possible output field
- The *hwrf_cntrl.hurcn* file has entries required by the tracker plus some additional diagnostics
- The "Fields produced by *wrfpost*" table in the ARW or NMM User guides may help understand the character string abbreviations used in the control file

wrfpost control file: *wrf_cntrl.parm*

- Users specify which fields and which level(s) of fields to output by modifying control file

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.

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

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 the parameter control file***

Examples

- Output T every 50 hPa from 50hPa 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)

- Output instantaneous surface sensible heat flux:

```
(INST SFC SENHEAT FX ) SCAL=( 4.0)
L=(10000 00000 00000 00000 00000 00000 00000 00000 00000 00000…)
```

- Do not output cloud top height:

```
(CLOUD TOP HEIGHT    ) SCAL=( 4.0)
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…)
```

Run *wrfpost*

- The generic command to run *wrfpost* to vertically interpolate and compute diagnostic fields is:

wrfpost.exe < itag

- Runs one forecast time and outputs a single GRIB file

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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* include:
  - Pre-defined NCEP standard grid number
  - Defined grid definition
    - Operational HWRF grid definition
    - User-defined grid definition
  - Grid navigation file created by *wrfpost*

Run *copygb* – Option 1

- Interpolate to a pre-defined NCEP standard grid (restrictive but simple)
  - For example, to interpolate onto NCEP grid 212:

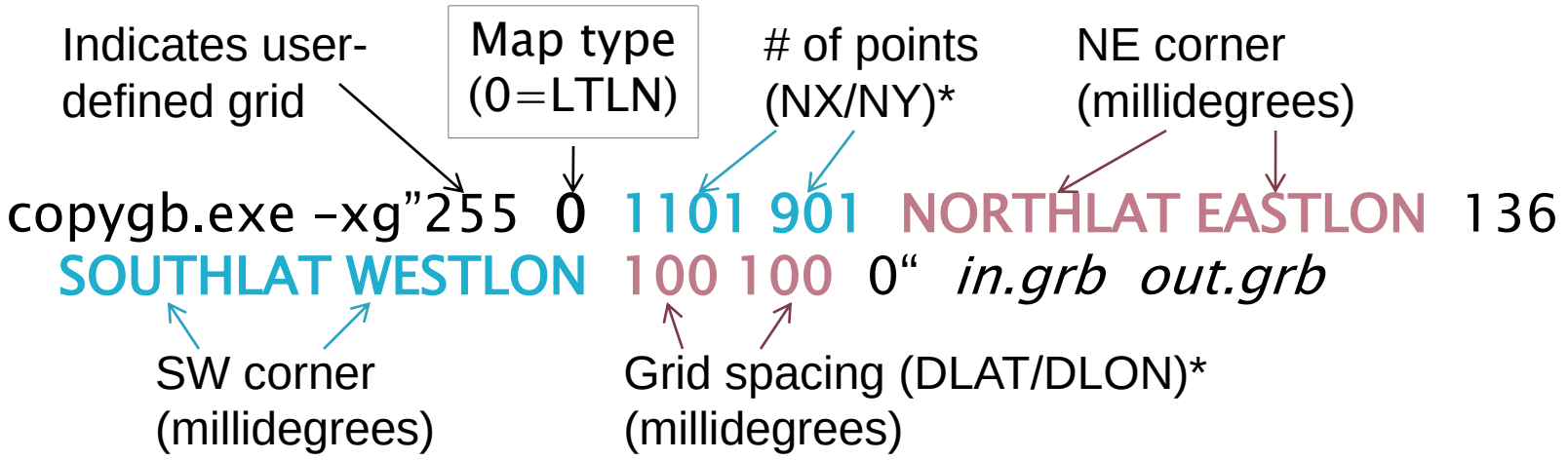
copygb.exe -xg212 *in.grb out.grb*

- Description of NCEP grids are available online:

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

Run *copygb* – Option 2a

- Create an Operational HWRF Latitude-Longitude grid by specifying a full set of grid parameters (complicated, somewhat flexible)

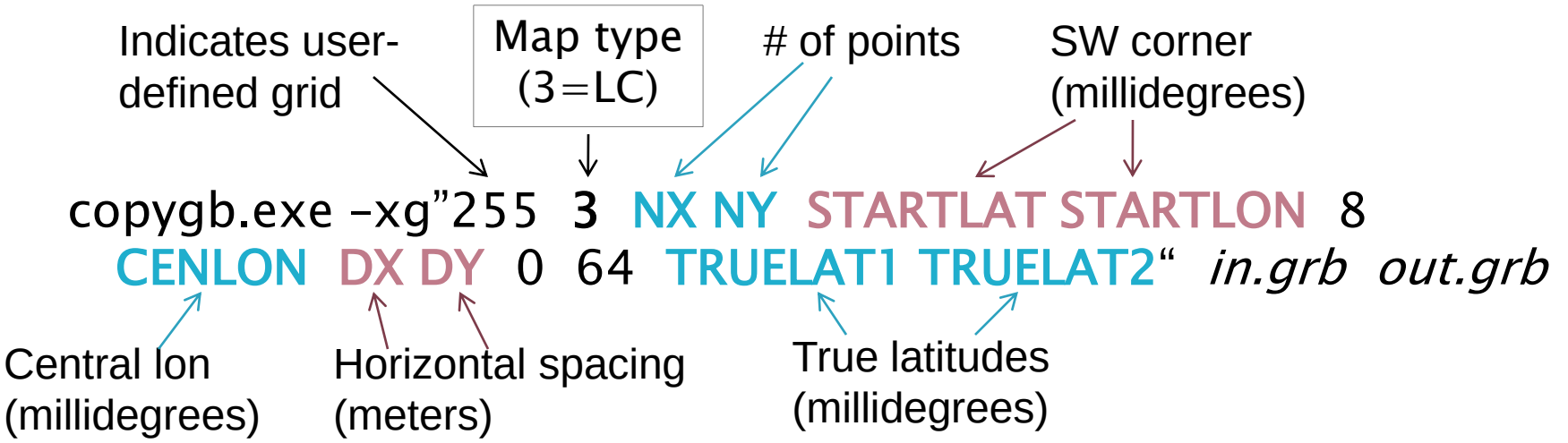


- NX/NY and DLAT/DLON are hard-coded for the Operational HWRF configuration
- Corners defined based on position of observed storm at model initialization time (from NHC Storm Message (TC Vitals))

copygb.exe –xg"255 0 1101 901 66700 334800 136 -23300 224800 100 100 0" in.grb out.grb

Run *copygb* – Option 2b

- Create a user-defined Lambert Conformal grid by specifying a full set of grid parameters (complicated, flexible)



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

Run *copygb* – Option 2b

- Create a user-defined Polar Stereographic grid by specifying a full set of grid parameters (complicated, flexible)

Map type (5=STR)

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

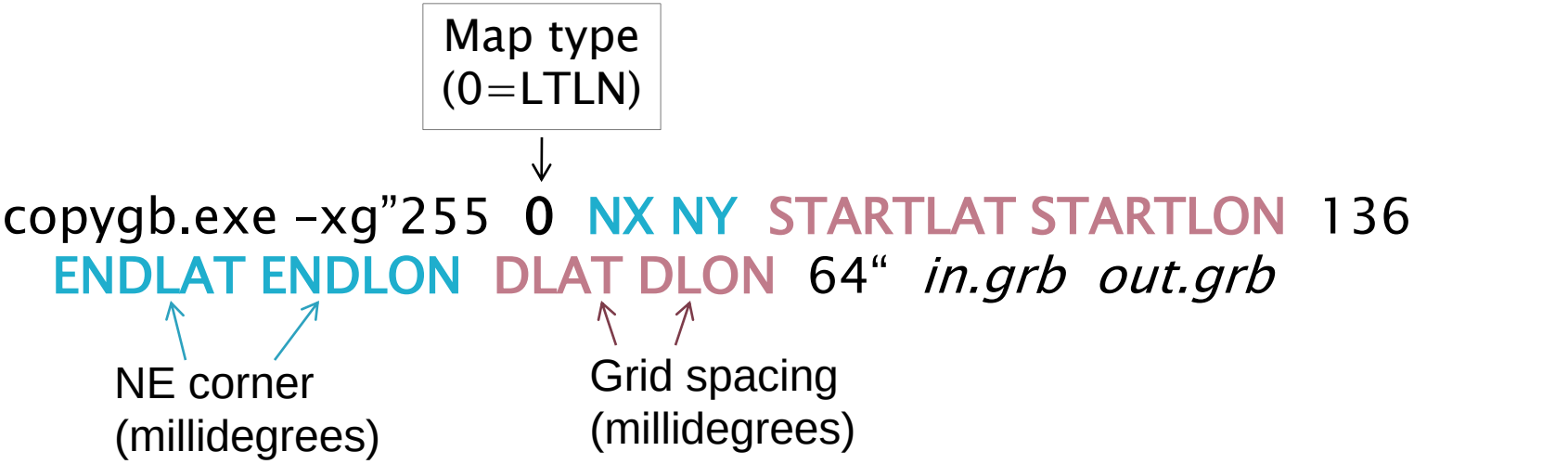
Center flag 0=NH; 1=SH

---

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

Run *copygb* – Option 2b

- Create a user-defined Latitude-Longitude grid by specifying a full set of grid parameters (complicated, flexible)



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

Run *copygb* – Option 3

- Read in grid **navigation file** created by *wrfpost* (simple, restrictive)
  - Running *wrfpost* produces up to 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 (NMM only)
    - *copygb_hwrf.txt* for a regular Lat-Lon grid (ARW and NMM)
  - For example:

read nav < 'copygb_hwrf.txt'

copygb.exe -xg "*$nav*" in.grb out.grb

Note: This file is **not** used in operations

Combine input files with *copygb*

- Put *nest* data onto the *parent* domain and generates a new GRIB file with the combined data

copygb.exe -g"*$grid***" -xM** *parent_in.grb nest_in.grb*

**** In the sample HWRF run_wrfpost script, these files are automatically linked and generated on the fly.***

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GRIB file visualization with GrADS

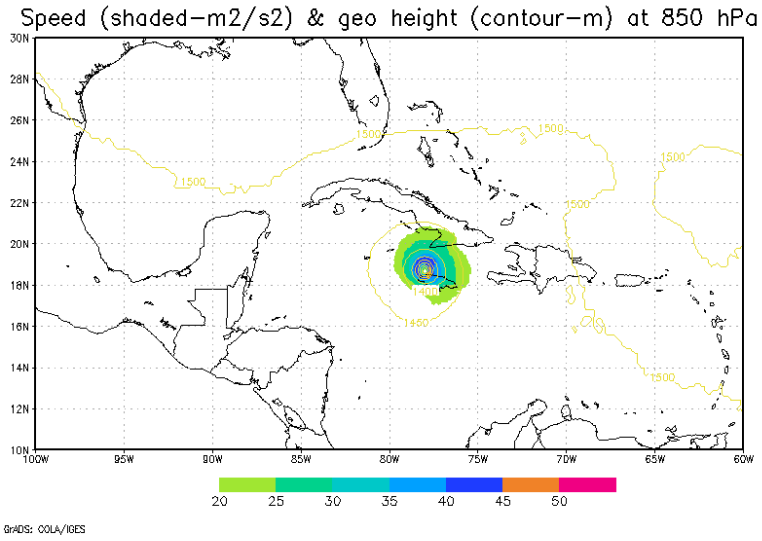
- GrADS has utilities to read GRIB files on any non-staggered grids and generate GrADS "control" files. The utilities *grib2ctl* and *gribmap* are available via: http://www.cpc.ncep.noaa.gov/products/wesley/grib2ctl.html

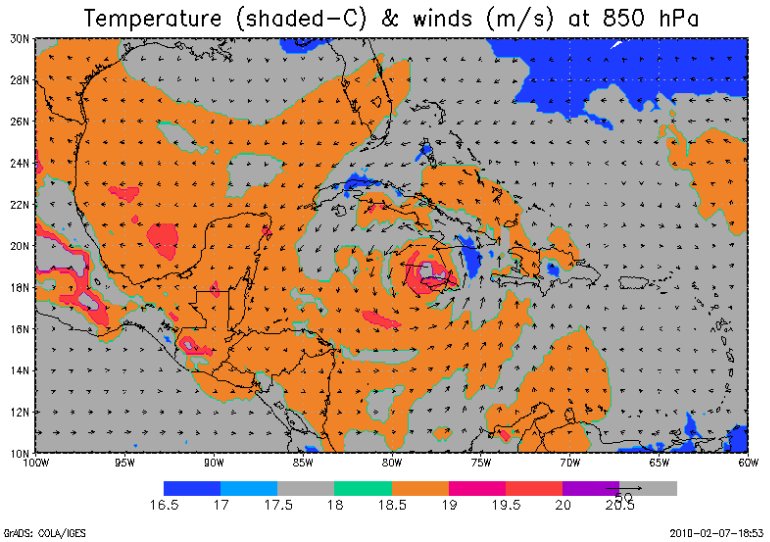
- Package download and user guide for GrADS are available online:

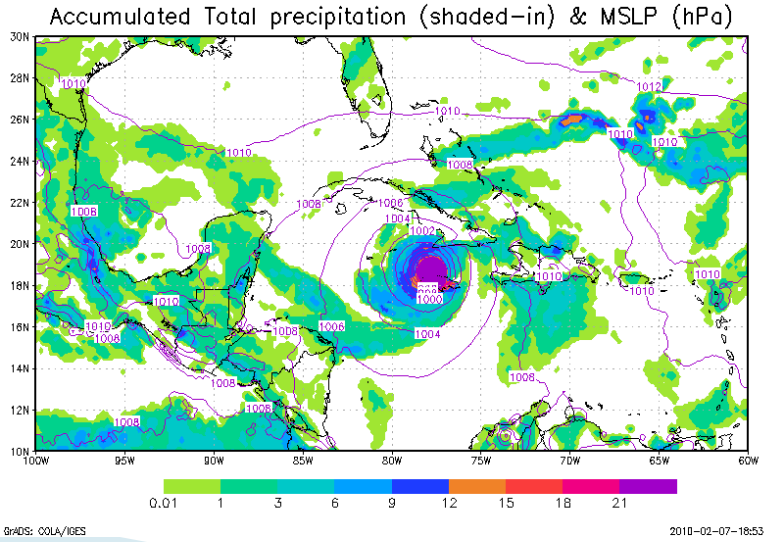
  http://grads.iges.org/grads/gadoc/

- A sample script named ***run_grads*** is included in *hwrf_utilities/scripts/* that can be used to plot various fields using GrADS

Forecast plotted with GrADs:







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
- Further details on this script and using GEMPAK are available in the user’s guide

Future Plans

- NCEP/EMC and the DTC are transitioning to use the Unified Post Processor (UPP) by late Spring 2011
  - All WPP capabilities, plus additional features
    - Process both global and regional lat/lon grids
    - New products such as simulated brightness temperature (satellite look-alike products)

Additional Resources

- WRF-NMM Users Page

http://www.dtcenter.org/wrf-nmm/users/

- WRF-NMM Users Guide

http://www.dtcenter.org/wrf-nmm/users/docs/users_guide/V3/users_guide_nmm_chap1-7.pdf

- WRF-ARW Users Page

http://www.mmm.ucar.edu/wrf/users/

- WRF-ARW Users Guide

http://www.mmm.ucar.edu/wrf/users/docs/user_guide_V3/contents.html

- Questions regarding WPP can be directed to: wrfhelp@ucar.edu

Questions?