

Post Processing

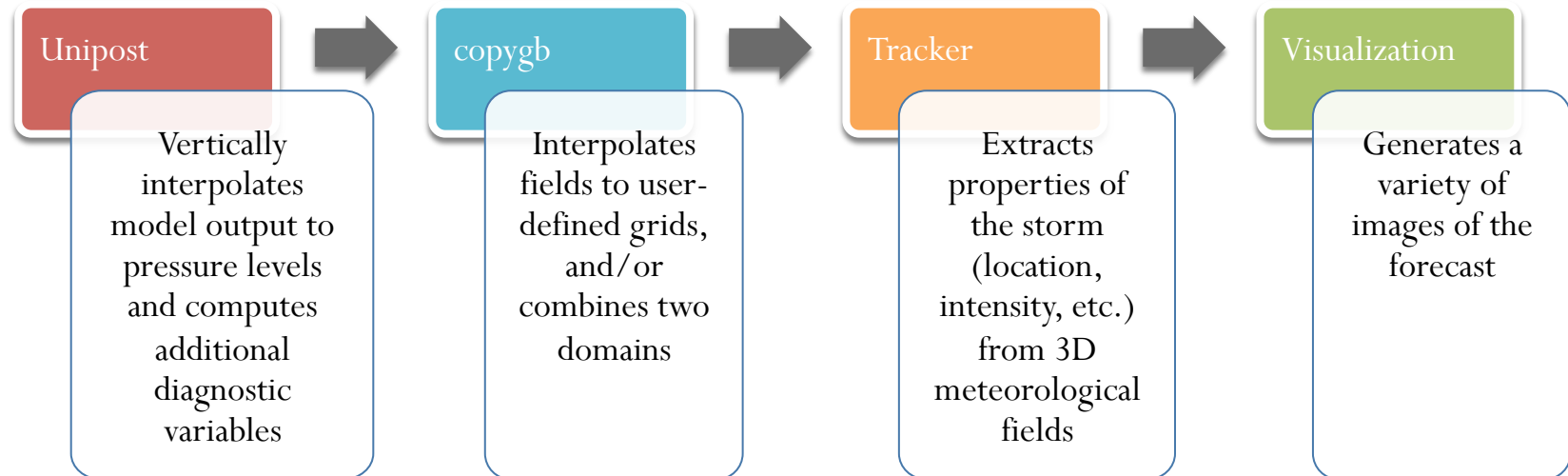
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Slides adapted from an HWRF Tutorial Presentation
by Tim Brown



Developmental Testbed Center

Overview

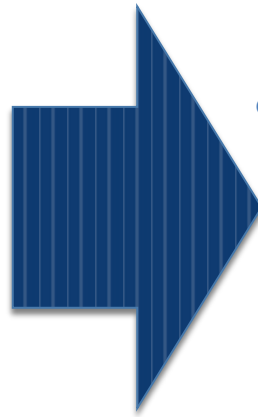


Unified Post Processor (UPP)

- Unipost
 - De-staggers HWRF parent and nest domain output
 - Computes diagnostic variables
 - Output in grib1 (HWRF scripts convert to grib2)
 - MPI parallel code that can take advantage of large numbers of processors
- copygb
 - Interpolates the output from native WRF grids (E-grid) to NWS standard levels and grids (lat/lon)
 - Combines nest data onto parent domain
 - Produces GRIB files that can be ingested by most plotting programs (NCL, GrADS etc.)

Unipost Input

- Unipost reads WRF output files (netcdf for HWRF) using WRF I/O package
- WRF provides all the unipost required fields by default
 - Be cautious when editing the WRF registry
 - Required unipost input fields are outlined in the respective WRF Users' Guide (NMM or ARW)



Unipost Output

- UPP has 100s of potential output fields
 - Complete list of output fields can be found in the ARW or NMM Users' Guides
- Typical examples:
 - T, Z, Q, U/V, cloud water, ice, rain, and snow on isobaric levels
 - T, Q, U/V at shelter level
 - SLP
 - Precipitation-related fields
 - Synthetic satellite and radar reflectivity
 - Radiative fluxes
 - Cloud-related fields
 - Aviation products

Synthetic Satellite Products

- Satellite fields are generated by using the Community Radiative Transfer Model (CRTM) forward model to transform model-predicted cloud, moisture, and surface fields
- Allows for direct comparison of model output to satellite observations
- HWRF currently generates synthetic satellite products from a variety of satellites and channels

Vortex Tracker Required Fields

- Primary
 - MSLP
 - Relative vorticity* at 10m, 850 and 700 hPa
 - Geopotential height at 850 and 700 hPa
- Secondary
 - Winds (u/v) at 10m, 850, 700, and 500 hPa (required for intensity estimate, too)

*UPP provides absolute vorticity, which is converted to relative vorticity within the tracker

Running Unipost and Copygb

Code Structure

arch/	build scripts
bin/	executables location after building
include/	mod files used for building
lib/	libraries used for building
parm/	control file used to specify which variables to output
scripts/	sample scripts for running UPP (not used for HWRF)
src/	source codes
clean	} build scripts
compile	
configure	

Required unipost.exe Input

WRF Output and 3 other files

HWRF native output: wrfout_d01, wrfout_d02 or wrfout_d03

itag – Specifics on model output

- Model output file name
- Format of model output
- Fcst validation time
- Model name

hwrf_eta_micro_lookup.dat – binary look-up table for Ferrier microphysics

Control file – specifies output fields/levels

- wrf_cntrl.parm
- hwrf_cntrl.nosat
- hwrf_cntrl.sat

**HWRF
scripts
generate/
gather these**

USAGE:

unipost.exe < itag

Unipost Control File: hwrf_cntrl.nonsat

Contents specify the fields/levels for which UPP provides output

```
(HEIGHT OF PRESS SFCS) SCAL=( 6.0)
L=(11111 11111 11111 11111 11111 11111 11111 11111 11111
11111 11111 10000 00000 00000)
(TEMP ON PRESS SFCS ) SCAL=( 4.0)
L=(11111 11111 11111 11111 11111 11111 11111 11111 11111
11111 11111 10000 00000 00000)
(SPEC HUM ON P SFCS ) SCAL=( 5.0)
```

Product
Description

GRIB packing
precision

Columns represent a single
model/isobaric level

1 = output

0 = no output

Available Control Files

- HWRF provides all the control files required by unipost.exe
- The UPP source code (sorc/UPP/parm) provides the wrf_cntrl.parm
- The HWRF parm/ configuration directory contains hwrf_cntrl.nosat and hwrf_cntrl.sat{BASIN} files used for HWRF-specific output fields
 - hwrf_cntrl.nosat includes tracker-related variables
 - hwrf_cntrl.sat{BASIN} includes basin-specific satellite fields where {BASIN} is a single letter basin identifier

Vertical Coordinates of Output

- Output can be interpolated to several vertical coordinates
 - Native model level
 - 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 and 4000 m (radar reflectivity)

Vertical levels (except for AGL and isobaric levels) are counted from the ground surface up in the parameter control file

Copygb Execution: Generic

- Several options for defining horizontal interpolation onto new grid
 - Pre-defined NCEP standard grids
 - Grid navigation from unipost
 - User-defined grids:
 - Lambert Conformal grid
 - Polar Stereographic grid
 - Lat-long grid

USAGE:

copygb.exe -xg"\$grid" in.grb out.grb

Copygb for Pre-defined NCEP Grids

- An example for NCEP grid 212

copygb.exe -xg212 in.grb out.grb

- Description of NCEP grids is available online at
<http://www.nco.ncep.noaa.gov/pmb/docs/on388/tableb.html>

Copygb for Unipost Grids

- Unipost creates two ASCII files containing grid navigation information similar to the domain and grid spacing of the model integration domain
 - `copygb_gridnav.txt`: Lambert Conformal grid (NMM only)
 - `copygb_hwrf.txt`: regular lat/lon grid (ARW or NMM)
- Example:

```
read nav < 'copygb_hwrf.txt'  
copygb.exe -xg"$nav" in.grb out.grb
```

Copygb for Lambert Conformal Grids

flag for user-defined grid map type (3=LC) number of points SW corner (millidegrees)

copygb.exe -xg"255 3 NX NY STARTLAT STARTLON 8
 CENLON DX DY 0 64 TRUELAT1 TRUELAT2" in.grb
 out.grb

Projection center longitude (millidegrees) horizontal spacing (m) projection true latitude (millidegrees)

Example:

copygb.exe -xg"255 3 185 129 12190 -133459 8
 -9500 40635 40635 0 64 25000 25000" in.grb
 out.grb

Copygb for Polar Stereographic Grids

flag for user-defined grid map type (5=STR) number of points SW corner (millidegrees)

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

Projection center longitude (millidegrees) horizontal spacing (m) Center flag (0=NH ; 1=SH)

Example:

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

Copygb for User-defined Lat-Ion Grids

flag for user-defined grid map type (5=STR) number of points SW corner (millidegrees)

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

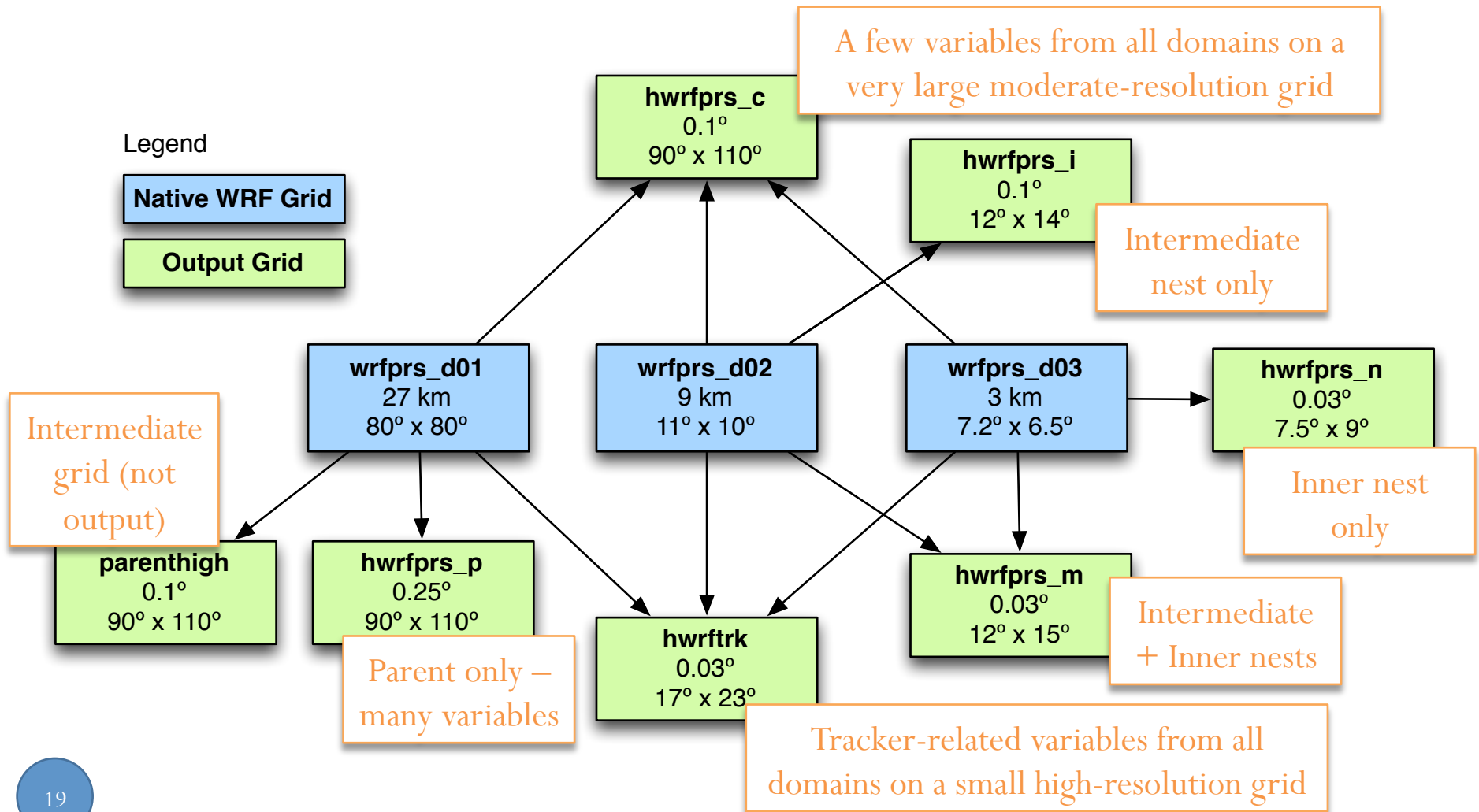
NE latitude & longitude (millidegrees) grid spacing (millidegrees)

The diagram illustrates the command line for the copygb.exe utility. It features a command line with various arguments color-coded to match descriptive labels. Arrows point from the labels to the corresponding arguments: a blue arrow from 'flag for user-defined grid' to '255'; a black arrow from 'map type (5=STR)' to '0'; orange arrows from 'number of points' to 'NX' and 'NY'; green arrows from 'SW corner (millidegrees)' to 'STARTLAT' and 'STARTLON'; blue arrows from 'NE latitude & longitude (millidegrees)' to 'ENDLAT' and 'ENDLON'; and red arrows from 'grid spacing (millidegrees)' to 'DLAT' and 'DLON'.

Example for HWRF output domain:

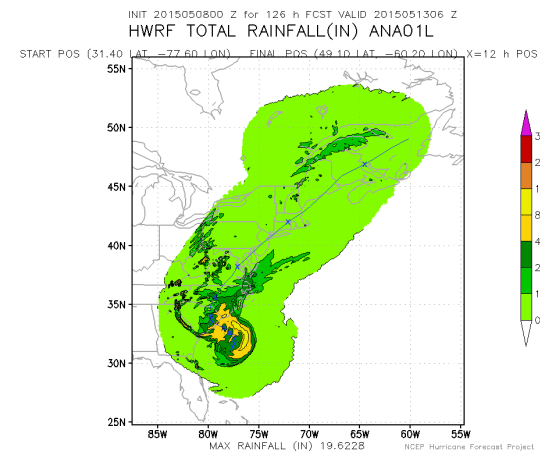
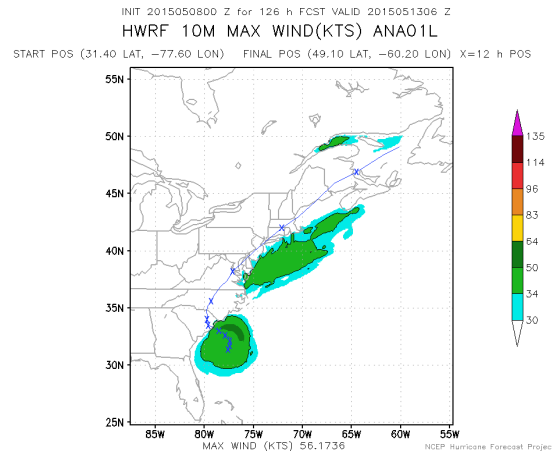
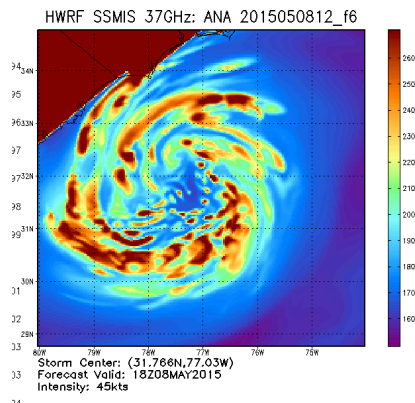
copygb.exe -xg"255 5 551 451 70000 229700 136
-20000 339700 200 200 64" in.grb out.grb

HWRF's Use of *copygb*



Standard HWRF Forecast Products

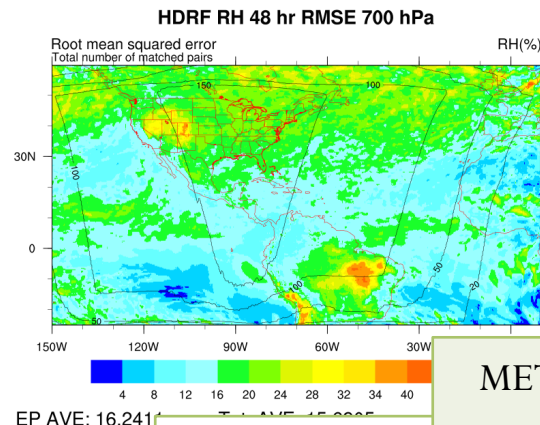
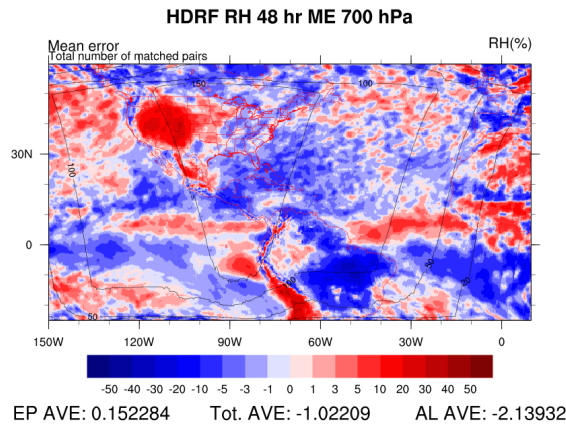
- ATCF text files from GFDL Vortex Tracker
- Grib2 files of standard and synthetic satellite fields on combined and single grids, at various resolutions
- Swath rain and wind products



Model Evaluation Tools (MET)

MET and MET-TC are comprehensive verification tools supported at the DTC

MET Series Analysis tool can be used to generate large-scale statistics over a large region



MET-TC is used to generate statistics from the ATCF output files

Get MET
here...

<http://www.dtcenter.org/met/users/>

