HWRF testing at the DTC: quantification of environmental biases and impact of cumulus parameterizations on storm structure and intensity

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Topic 1: Analysis of HWRF Large Scale

- NCEP, with HFIP/ESRL/HRD/DTC, is planning to implement a basin-scale HWRF at ~ 2015. Lots of development going on.
- DTC conducted analysis of the large scale fields from the baseline cold-started basin-scale HWRF to document systematic errors.
- Results shown here are recent and further interpretation needed.
- Would like your input in determining what is relevant investigating further, and what has strongest tie to TC behavior.

489 retrospective cold-start HWRF runs for 2011 conducted by EMC were compared against GFS analysis (interpolated to HWRF grid).
Surface temperature – June 24h

HWRF has trouble representing inland ice, which creates warm bias over frozen areas (only in June)

HWRF too warm over frozen ocean/lakes

HWRF too cold over dry continental areas
2-m specific humidity – Aug 72h

HWRF has wet biases at 2-m over dry areas

GFS does not have this bias

Bias already present at 24-h forecast remains in time
925/700 hPa temp – Aug 72h

HWRF has low level cold biases not present in GFS

Over Brazil, low level cold bias translates onto warm bias at 700 hPa.
Could radiation or moist physics be placing heat at incorrect level?

Lack of stratocumulus over CA & Peru? In GFS too
HWRF has warm biases at high latitudes in N Hem at 250 hPa, which change to cold bias at 200 hPa.

Similar bias present in GFS.

Bias grows with forecast lead time.
300 hPa spec humidity – Aug 72h

HWRF is dry at upper levels on the equator
600 hPa zonal wind – Sep 72 h

African jet too strong in HWRF

In GFS jet displaced to south
1000 hPa winds – Sep 72 h

Large northerly bias in western Gulf of Mexico – onshore flow too weak

Substantial positive wind speed bias near Amazon River outlet – trade easterlies too weak?

Bias not present in GFS
850-hPa zonal wind – June 00h

Initial wind fields have noise near high topography.
Topic 2: Cu parameterization testing
follow-up from the 2011 HFIP Regional Team meeting and subsequent telecons

- Increase HWRF’s ability to use alternate physics
- Evaluate sensitivity of HWRF to cumulus parameterization

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<th>Acronym</th>
<th>Scheme</th>
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<td>HPHY</td>
<td>HWRF SAS (no shallow convection)</td>
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<td>HNSA</td>
<td>SAS implemented by YSU (with shallow convection)</td>
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Runs used HWRF 2012 pre-implementation code as of Feb 2012 (27/9/3 km)
Track and Intensity Errors Atlantic Basin

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Statistical Significance

95%

Green = HPHY better
Red = HPHY worse
HWRF Mini-Ensemble (HPMN)

Track Errors Atlantic

- HPHY performs best for track.
- HPMN suffers from high Tiedtke errors.

Intensity Errors Atlantic

- HPMN outperforms HPHY at all lead times – not tested for SS.
No definite relationship, except good correlation between track error and forecast lead time.

- Weak relationship between structure and intensity error.
- In general, larger storms too intense, smaller storms too weak.

Similar for other schemes.
Case study for Katia 2011090300
Large scale precipitation 72 h forec

All schemes overdo precip
Fluxes at 24h (W/m²): SENS (top), LAT (bottom)

Large variability in spatial distribution depending on cumulus schemes
Last comments

- Need to do further work to interpret large scale biases
- Large scale evaluation should be repeated with cycled-DA basinscale HWRF to see if environment is improved
- Possible that some of these bias are also present in op HWRF
- Follow up work we will consider conducting
  - Investigation of interpolation of fields from GFS to HWRF
  - Look at representation of inland ice
  - Consider alternate Land Surface Model
- Large sensitivity to cumulus deserves continued exploration
- DTC will continue to facilitate access to the code and avenue for developers to contribute code – feedback appreciated!