Global-Nested HAFS 2019
Real-time Demo Results

Andy Hazelton\textsuperscript{1,2} and Zhan Zhang\textsuperscript{3,4}

\textsuperscript{1}UM CIMAS, \textsuperscript{2}NOAA AOML, 
\textsuperscript{3}NOAA EMC, \textsuperscript{4}IMSG
Acknowledgements

- Collaborators: Gus Alaka, Avichal Mehra, Bin Liu, Jili Dong, Weiguo Wang, Frank Marks, Xuejin Zhang, Sundararaman Gopalakrishnan, Morris Bender, Tim Marchok, Henry Winterbottom (and others)

- Thanks to HFIP and Jet management for the HPC reservation

- Thanks to JetHelp (specifiedly Wei Yu and Shawn Needham) for technical help
Global-Nested HAFS Configuration

- Global-nested domain
- Tile 6 centered over the Atlantic
- Will be adjusted in the future for multiple basins
- Forecasts run out to 168h
## Global-Nested HAFS Physics Description

<table>
<thead>
<tr>
<th>Parameter</th>
<th>HAFS-globalnest (Nested Domain)</th>
<th>HAFS-globalnest (Global Domain)</th>
<th>GFSv15.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convective Scheme</td>
<td>None</td>
<td>Scale-aware SAS</td>
<td>Scale-aware SAS</td>
</tr>
<tr>
<td>Microphysics</td>
<td>GFDL</td>
<td>GFDL</td>
<td>GFDL</td>
</tr>
<tr>
<td>PBL</td>
<td>EDMF with modified K for Hurricane Conditions (as in HWRF)</td>
<td>EDMF with modified K for Hurricane Conditions (as in HWRF)</td>
<td>EDMF</td>
</tr>
<tr>
<td>Surface</td>
<td>GFDL (modified drag as in HWRF)</td>
<td>GFDL (modified drag as in HWRF)</td>
<td>GFS</td>
</tr>
<tr>
<td>Advection Scheme</td>
<td>hord_mt = 6 (more diffusive)</td>
<td>hord_mt = 5 (less diffusive)</td>
<td>hord_mt = 5 (less diffusive)</td>
</tr>
<tr>
<td></td>
<td>hord_tr = 8</td>
<td>hord_tr = 8</td>
<td>hord_tr = 8</td>
</tr>
<tr>
<td>3-d Ocean Coupling</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Global-nested HAFS had the best track forecasts at D4-5

HAFS in general did very well compared to other GFS-based guidance

Biggest difference was cross-track error
Global-Nested HAFS Intensity Statistics

➢ HAFS has a low bias at initialization due to GFS init
➢ Catches up within about 6-12 hr
➢ Slightly worse than HWRF/HMON at days 1-2, but better 4-5
➢ Bias is low (offsetting high and low?)
Global-Nested HAFS Wind Radii Statistics

- HAFS had a high bias in R34 consistently through the season
- Doesn’t seem to be from GFS init - shows up after spinup
- R50 and R64 are more consistent with other guidance
- Physical and/or dynamical reasons for the structure issue will be explored
- Global-nested HAFS was run out to 7 days
- Chance to see nest impact at longer range
- Track was better through 132h, degraded D7 (tough cases looked at later!)
- Very large negative bias in GFS increasing with time
- Shows value of high-resolution nest for structure/intensity
Hurricane Dorian Results

➢ Early tracks were generally too far west (like most models)
➢ HAFS mostly showed the turn/stall in the Bahamas, before Florida
➢ After a few early cases, intensification was generally predicted (rate a bit off)
➢ Slight high bias after peak (ocean coupling?)
Structure Compared With Observations

➢ Two forecasts initialized 6 hours apart
➢ Near the time of center relocation
➢ Very different wind structures
➢ Second one correctly predicted the small wind core that developed
➢ Track/intensity very different
Structure Compared With Observations

➢ The run that correctly got the core development was much stronger and further NE
➢ Chicken/egg question: was earlier development a cause or result of track difference?
➢ Good case for ensembles
Dorian Structure/Environment Evolution

➢ One of the biggest obstacles for Dorian initially was low mid-level RH
➢ This animation shows the precip symmetrized and expanded as environmental RH increased
Humberto was a case with some differences between two HAFS versions:

- Mostly from 1-2 cycles where HAFS-SAR turned back NW too quickly.
More amplified storm track in HAFS-SAR than HAFS-globalnest

Leads to a slightly more pronounced interaction with the trough?

Feedback between the TC and large-scale (more testing needed)?
Summary

➢ HAFS-globalnest 2019 takeaways:
   ○ Skillful track forecasts at all leads, especially 3-5 day (compared to other GFS-based guidance)
   ○ Intensity evolution catches up well after spin-up (~12h)
   ○ HAFS shows the ability to capture some aspects of small-scale TC structure
   ○ 3-km nest demonstrates value for improving TC intensity and structure

➢ Lessons Learned For Further Improvement:
   ○ Data assimilation (both large-scale and vortex scale) important for initial structure/vmax
   ○ Full 3-dimensional ocean coupling will potentially help with high bias in some cases
   ○ Less diffusive dynamics and improved PBL physics might help with the R34 bias as well as rapid intensification prediction