Performance of FV3-GFS and a vision for a long-range hurricane prediction system

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GOES-16



C1152 (9-km) FV3-GFS 144-hour prediction

- Why is the "Euro" the best NWP model (especially for hurricane tracks)?
- Dissecting & learning the strength/weakness from the best NWP models
- R/D for the long-range predictions

(Image by Xi.Chen@GFDL)

Kinetic Energy Spectra are the "fingerprints" of the model's dynamics (determined mostly by "total diffusion")



- FV3 at C1152 (9km, roughly the same as IFS) resolves the "-5/3" meso-beta (20-200 km) spectrum
- The "Euro" IFS has very little energy in the meso-scale; but follows "-3" spectrum (synoptic scale) well
- The GFS has the least amount of energy in the meso-scale (3 orders of magnitude smaller than FV3 and the theoretical value)

Total diffusion = implicit + explicit diffusion



(higher ACC r more accurate hurricane tracks)

Statistics for 2-year period: 2015 & 2016 C768L63 (13-km) for all basins

(FV3 with old scheme)



Intensity skill is as good as HWRF



Wind –SLP correlation

- Blue dots: operational GFS
- Red dots: fvGFS with Zhao-Carr
- Black dots: obs (best track)

GFS tends to have too deep SLP (with lower wind speed)

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(Source: Jan-Huey Chen@GFDL)

Comparisons of track errors with operational global models

Harvey



FV3 is the best for Harvey

IFS is THE BEST for Irma

Irma

5 day Total Precipitation in Inches

(from Thursday 8am through Tuesday 8am)



Planning for the future:

Hurricane Irma: 3-km fvGFS vs. Radar

Observed radar image (Brian McNoldy)

Nested FV3 forecast from 0906 (Andrew.Hazelton@GFDL)



Seasonal hurricane Prediction with GFDL HiRAM



"The remarkable predictability of the inter-annual variability of Atlantic hurricane activity during the past decade" (Chen and Lin 2011, GRL)"

model-observed correlation > 0.94

Periods	HY	NH
2000-2010	0.94	0.96
1990-2014	0.72	0.76

The non-hydrostatic (NH) HiRAM provided some improvements over the hydrostatic (HY) HiRAM (Chen & Lin 2011)

Impact of MJO on Gulf of Mexico tropical cyclones





A vision for long-range hurricane predictions



- A global model with resolution high enough to resolve hurricanes (2-way nest within a stretched global grid) and efficient enough for operation
- 0-30 days (MJO time-scale) ensemble predictions with a cost-effective blend of time-lag and physically based perturbations

Forecast Reflectivity Structure vs. NEXRAD Observations

fvGFS Initialized 18 UTC August 24, 2017 21-hour Forecast Radar Reflectivity (Left) and Observed Ground-Based NEXRAD Radar (Right) at 15 UTC (10 AM CDT) August 25, 2017



(Source: Andrew Hazelton)

7 Day Track Error



7% reduced 6-7 day track errors for GfsFv³ compared to current operational GFS

ECMWF significantly better in 6-7 day lead times (9% GfsFV³; 16% GFS)

Variable Resolution: Stretched Grid

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10 15 20 25 30 35 40 45 50 55 60 65 70 75

4 km CONUS stretch 2015–2016 hindcasts Mean Precipitation

Hurricane Harvey Init 20170825 00Z 21 Hour forecast

Zhou et al, in prep for BAMS