UNIFIED MODELING AT GFDL

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with contributions by Jan-Huey Chen, Morris Bender, and Andy Hazelton

for S-J Lin and the GFDL FV3 Team
## GFDL Prediction Modeling System

<table>
<thead>
<tr>
<th>Daily Weather Forecasts</th>
<th>Sub-seasonal to Seasonal Predictions</th>
<th>Decadal Predictions</th>
<th>Climate Projections</th>
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<tr>
<td>hours</td>
<td>2 weeks</td>
<td>1 month</td>
<td>3 months to 2 years</td>
</tr>
<tr>
<td>Thunderstorms, Tornadoes, Hurricanes...</td>
<td>Hurricanes, MJO, Heat waves, Droughts...</td>
<td>ENSO, Hurricanes, Precipitation/ Temperature anomalies</td>
<td></td>
</tr>
</tbody>
</table>

- **HiRAM (50km/25km)**
- **fvGFS (3km/13km/25km)**
- **FLOR/HI-FLOR (50km/25km; 1deg Ocean)**
- **SPEAR/SPEAR-HI (50km/25km; 1deg Ocean)**
For the super-active 2017 hurricane season:

- fvGFS outperforms GFS when using GFS IC
- fvGFS outperforms Euro when using Euro IC

TC track errors in the North Atlantic basin

13-km fvGFS (v2018) Chen et al. 2019 GRL
fvGFS: Track + Intensity Errors
fvGFS: Southern Hemisphere TCs

1 Sep 2018–20 Mar 2019 Southern Hemisphere
GFDL fvGFS for S2S & MJO Prediction

- 25-km S2S prediction model
  - Courtesy Jan-Huey Chen & Yongqiang Sun
- Preliminary 10-year climatology run: Good MJO and CCEW variability
  - Further improvement through better air-sea interactions

- Variable-resolution fvGFS
  - Courtesy Lucas Harris & Kun Gao
- Efficient two-way 4-km nest improves propagation of MJO across maritime continent
hfvGFS 2019: Triple Alliance

- EMC is running 3-km Atlantic nest
- **New for 2019:** GFDL and AOML will run nests in the Pacific basins, each twice-daily or on a priority basis

Courtesy Andy Hazelton (HRD)
hfvGFS: Pacific Basin RI events

hfvGFS intensity forecasts comparable to HWRF and COAMPS-TC
hfvGFS better predicts maximum intensity than existing models
hfGFS: Sensitivity to Microphysics

Intensity Bias

Intensity Error

2018 Atlantic Hurricane Season
cfvGFS 2019: HWT Spring Experiment

- Re-tuned GFDL MP for better reflectivity and reduced intense precipitation
- Still working on moderate → intense coverage
- Scale-aware shallow SAS (no deep) reduces over-active convection
- Re-configured YSU PBL to address undermixing, surface wet bias, and instabilities
- FV3 is virtually inviscid in the vertical

24-hour forecast
Composite Reflectivity
Init 00Z 21 May 2019
DYAMOND 40-Day Simulations

- First International inter-comparison of global cloud-resolving models

**Participants:**
- FV3 (GFDL)
- NICAM
- ICON
- UKMO-UM
- MPAS
- GEOS
- ARPEGE-NH
- ECMWF-IFS
- SAM

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