UNIFIED MODELING AT GFDL

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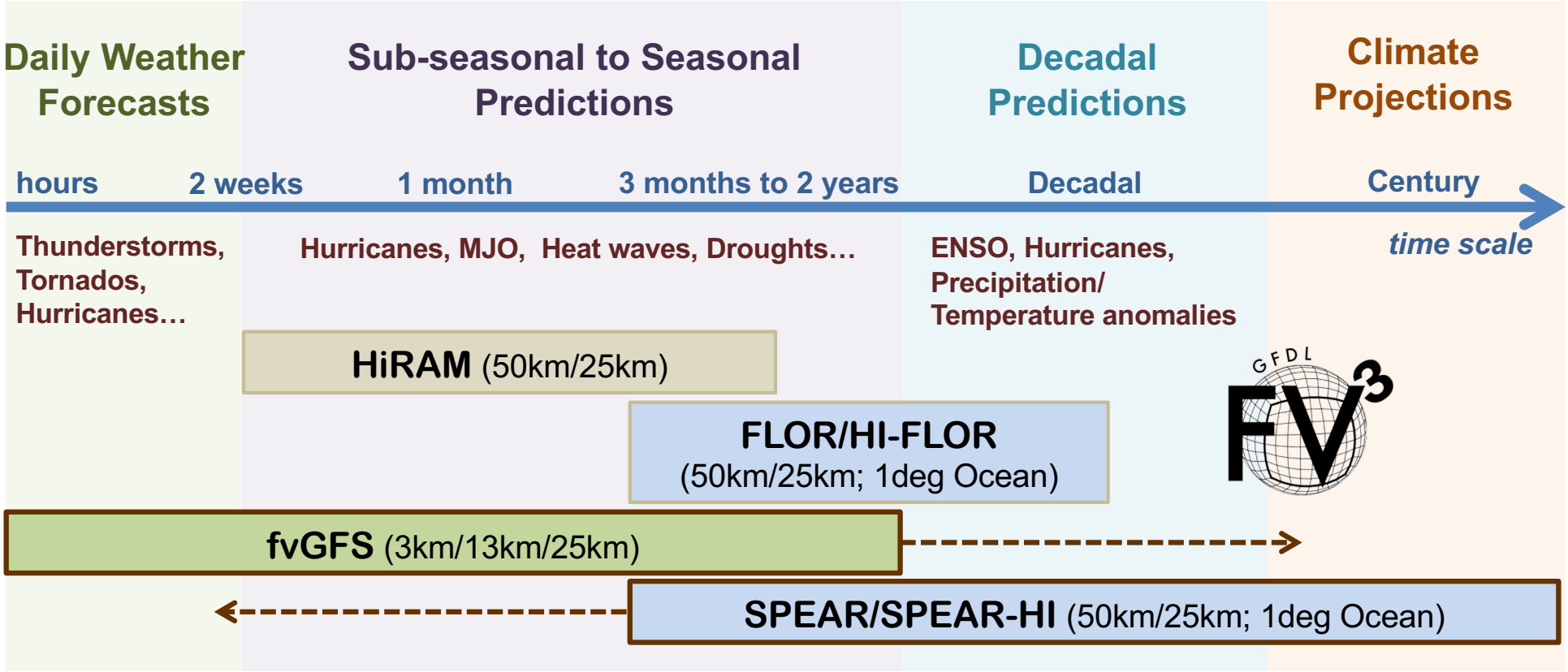
with contributions by Jan-Huey Chen,
Morris Bender, and Andy Hazelton

for S-J Lin and the GFDL FV3 Team

GFDL Prediction Modeling System



From Weather Forecasts to S2S Prediction

GFDL fvGFS

The finite-volume Global Forecast System

A prototype for the Unified Forecast System

Nonhydrostatic FV3 dynamical core coupled to a heavily-modified GFS Physics suite and NOAH land model

- GFS EDMF PBL → **YSU PBL**

  Courtesy Hailey Shin, UCAR/GFDL

- **Fully-Inlined GFDL six-category MP**

  L. Zhou et al. (2019, BAMS)

- Specified SST → **Mixed-layer ocean**

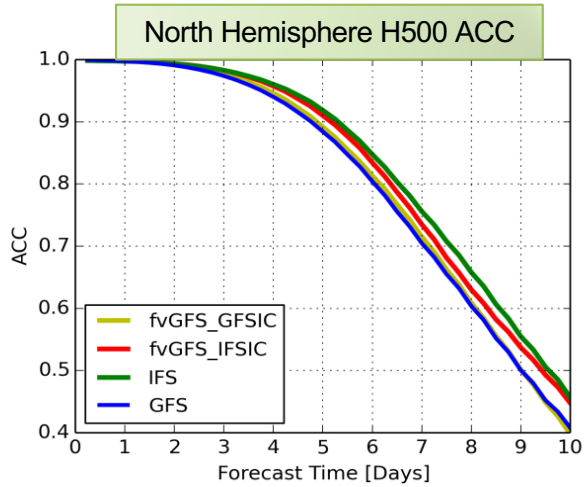
  Courtesy Baoqiang Xiang, UCAR/GFDL

- **Scale-Aware SAS shallow/deep convection**

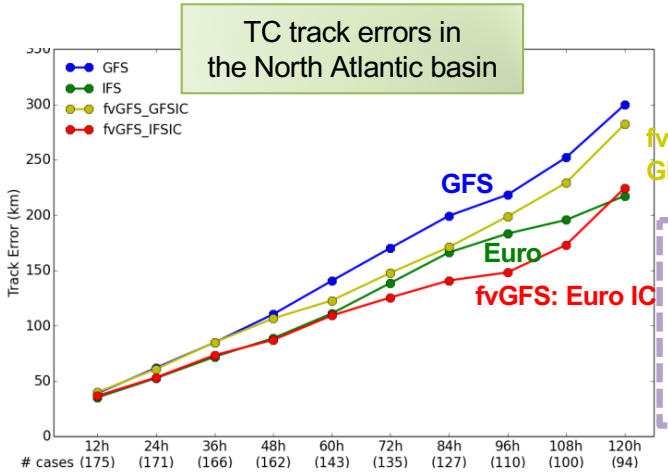
  J-I Han et al, (2017, MWR)

- **Initialization from GFS or ECMWF analyses**

  J-H Chen et al, 2018; Proc. 33rd Tropical Conf.



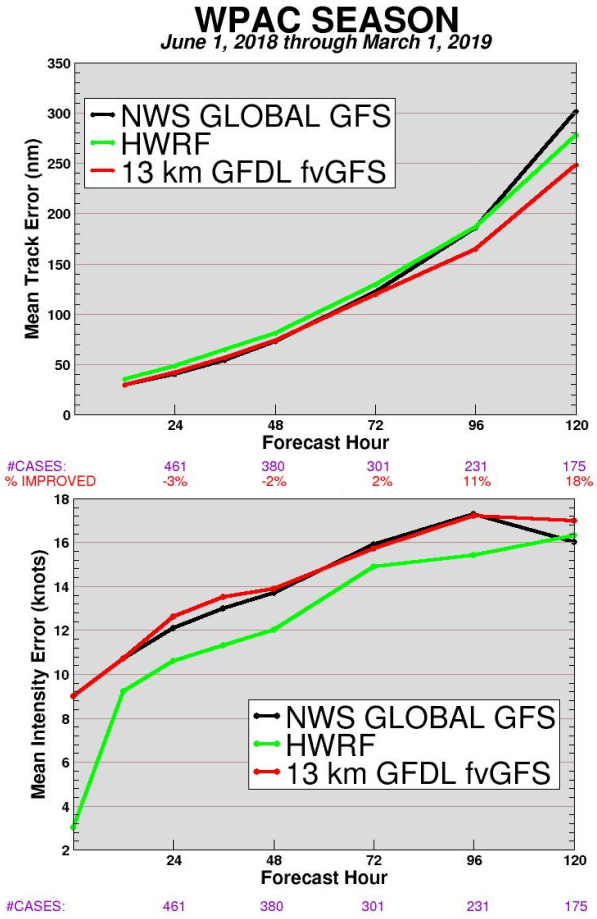
13-km fvGFS (v2018)
Chen et al. 2019 GRL

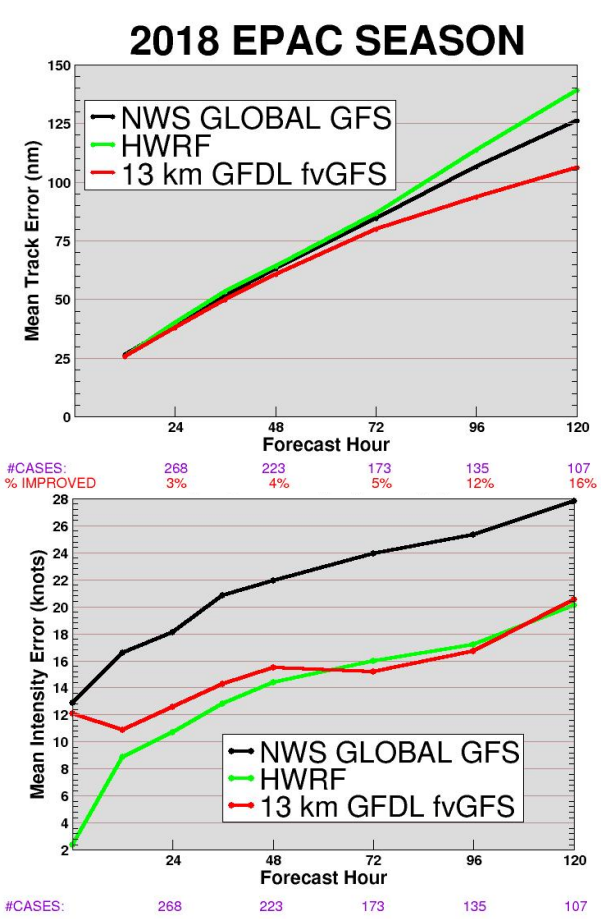


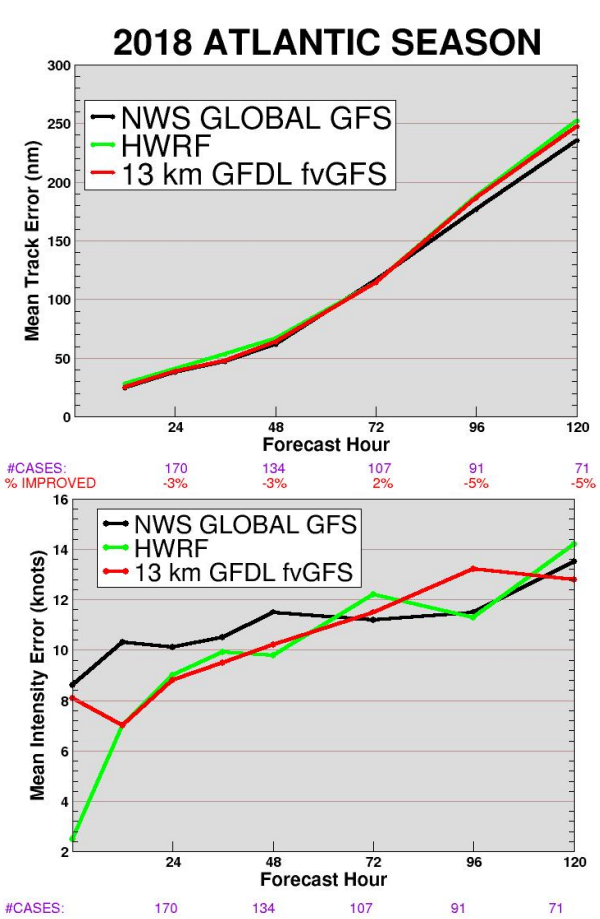
For the super-active 2017 hurricane season:

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

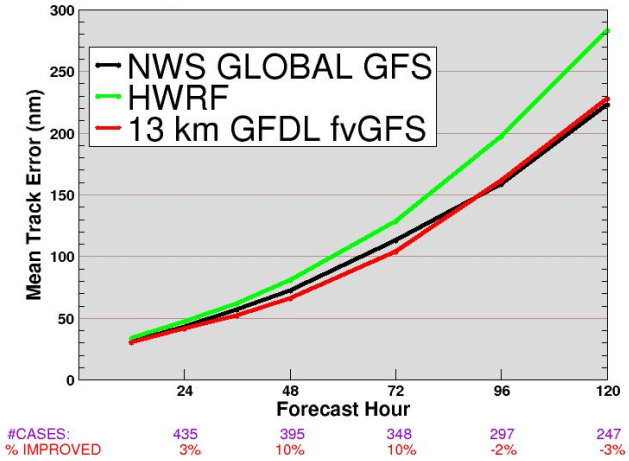
fvGFS: Track + Intensity Errors

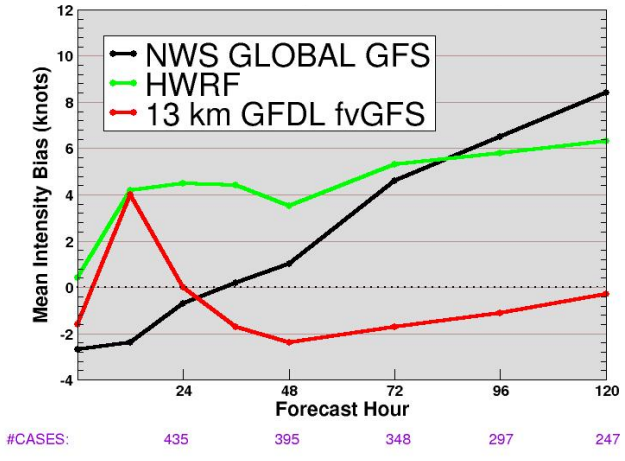


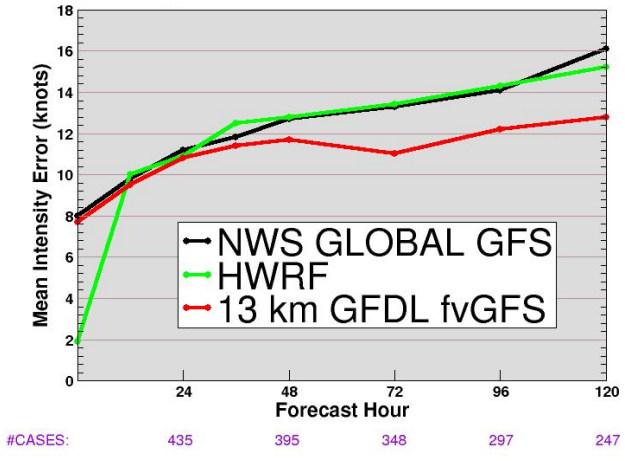




fvGFS: Southern Hemisphere TCs



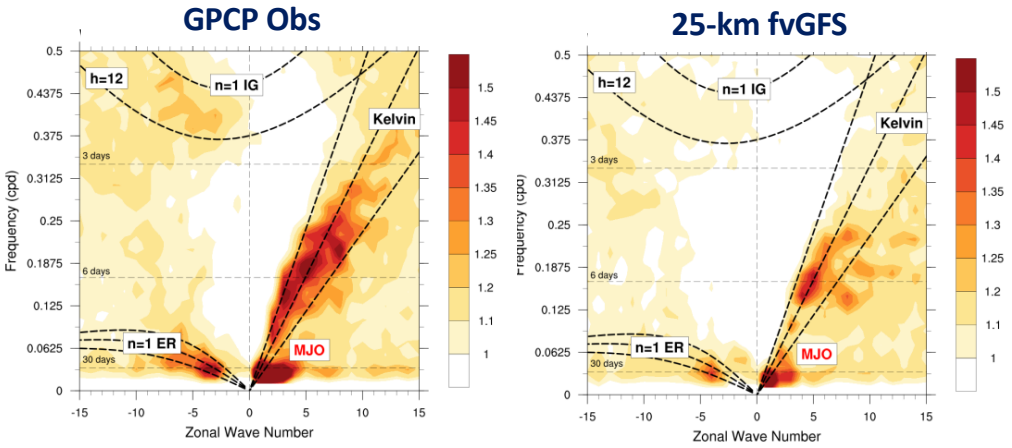




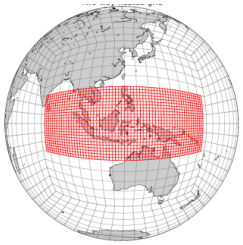
1 Sep 2018–20 Mar 2019 Southern Hemisphere

GFDL fvGFS for S2S & MJO Prediction

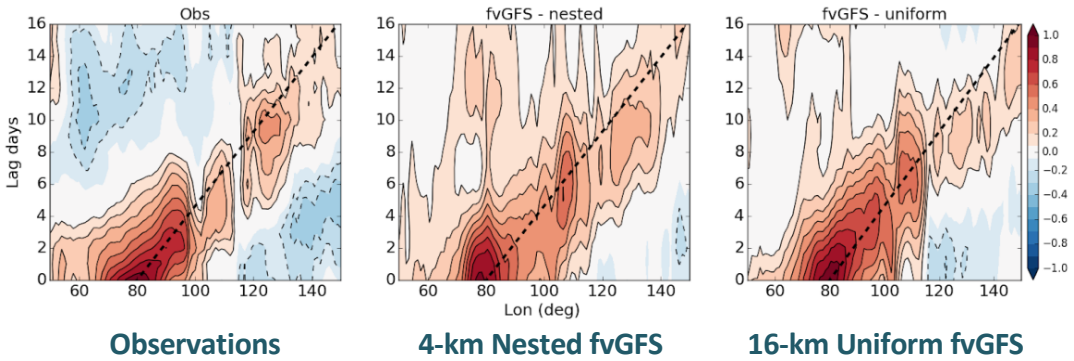
- 25-km S2S prediction model
  - Courtesy Jan-Huey Chen & Yongqiang Sun
- Preliminary 10-year climatology run: Good MJO and CCEW variability
  - Further improvement through better air-sea interactions



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

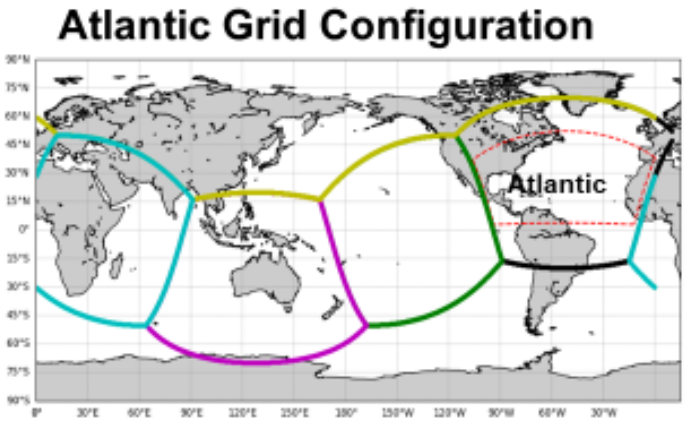


MJO Precipitation Lag-Regression Plot

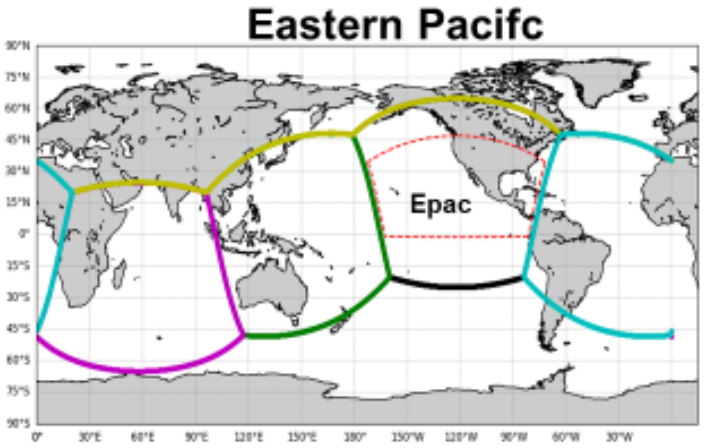


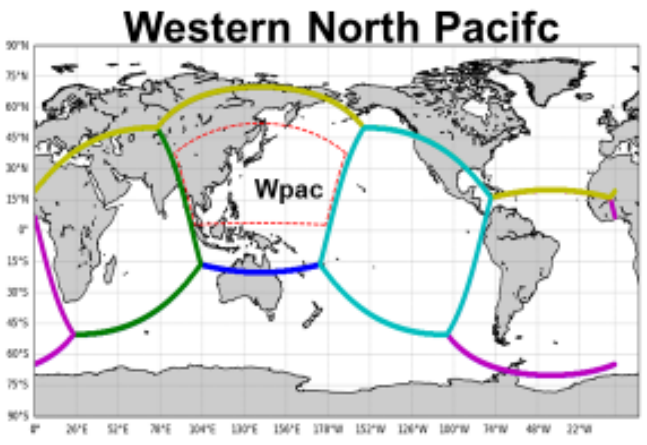
hfvGFS 2019: Triple Alliance

- 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)

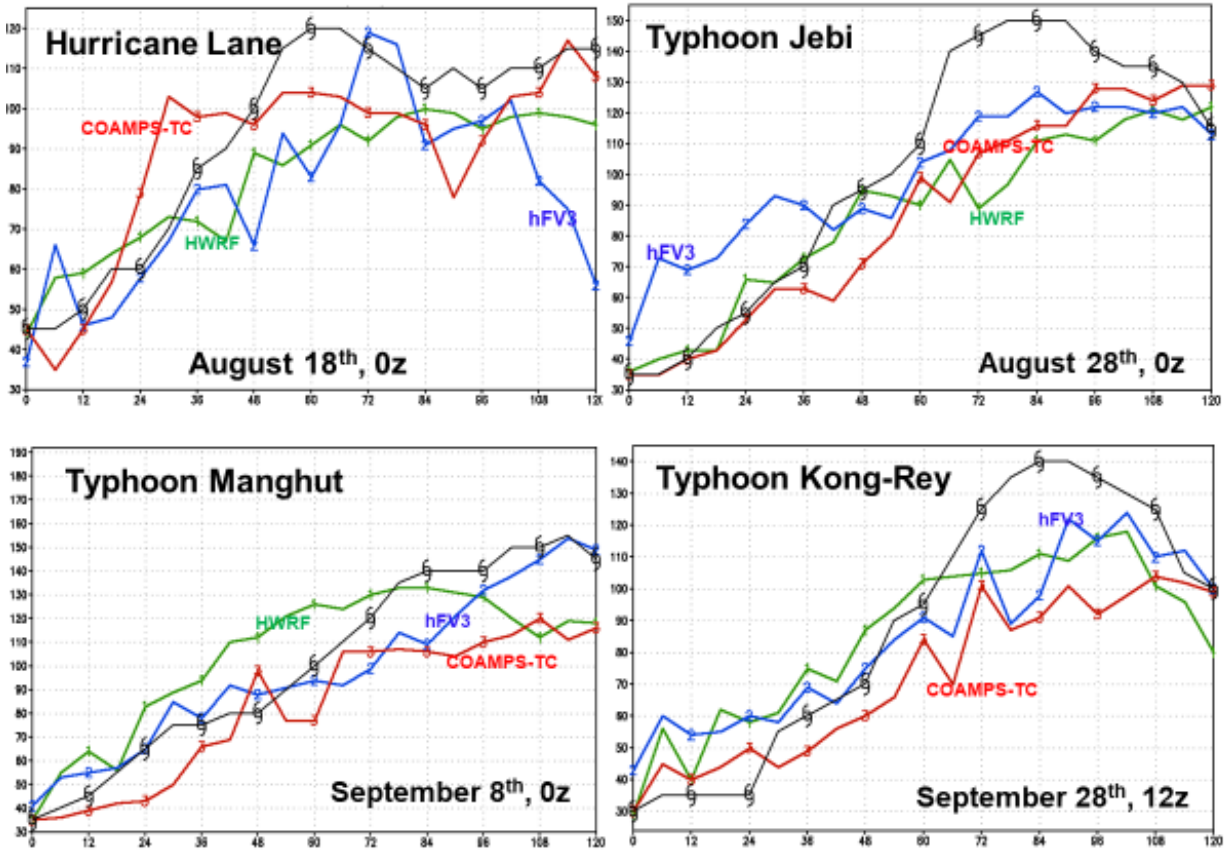




hfvGFS: Pacific Basin RI events

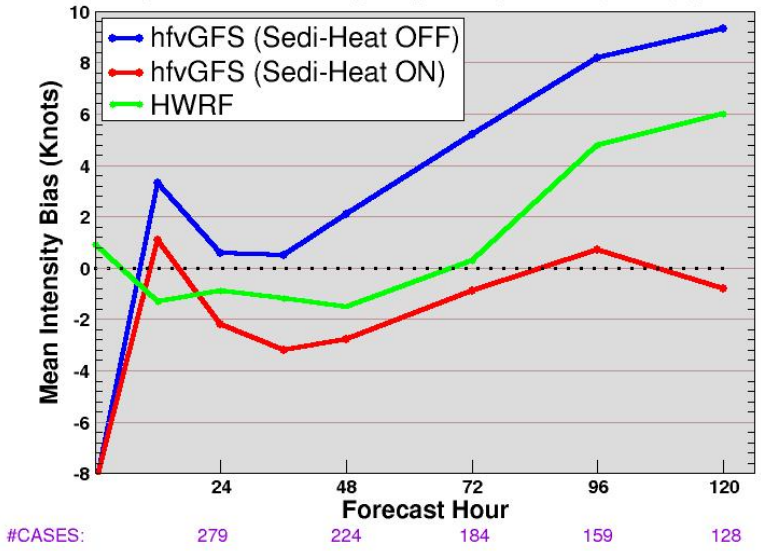
hfvGFS intensity forecasts comparable to HWRF and COAMPS-TC

hfvGFS better predicts maximum intensity than existing models

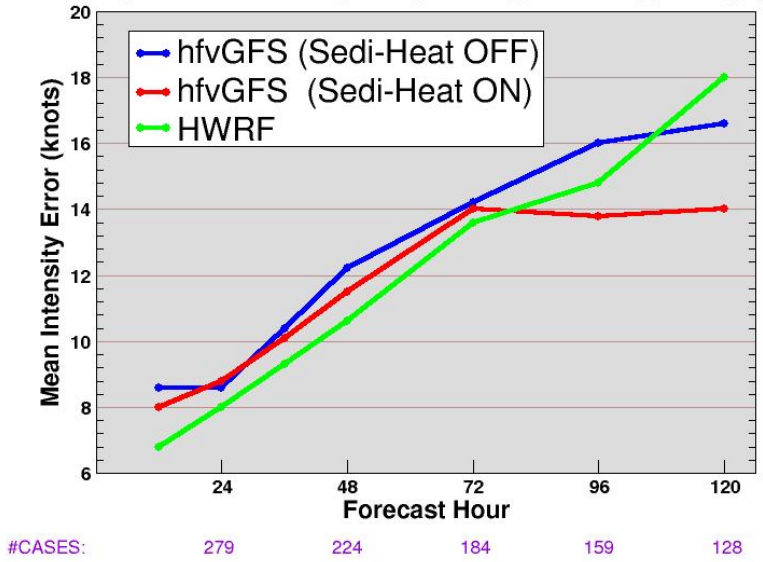


hfvGFS: Sensitivity to Microphysics

Intensity Bias



Intensity Error

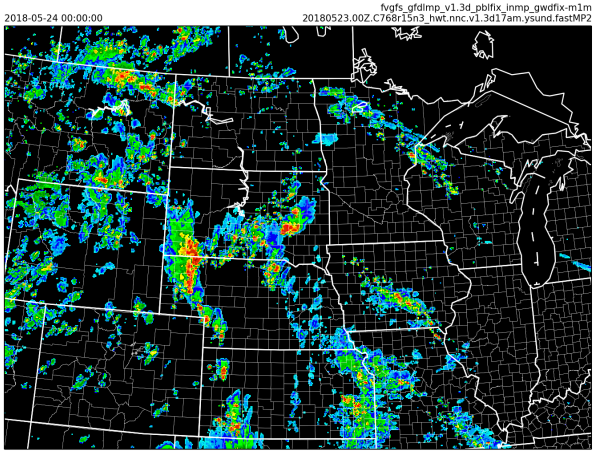


2018 Atlantic Hurricane Season

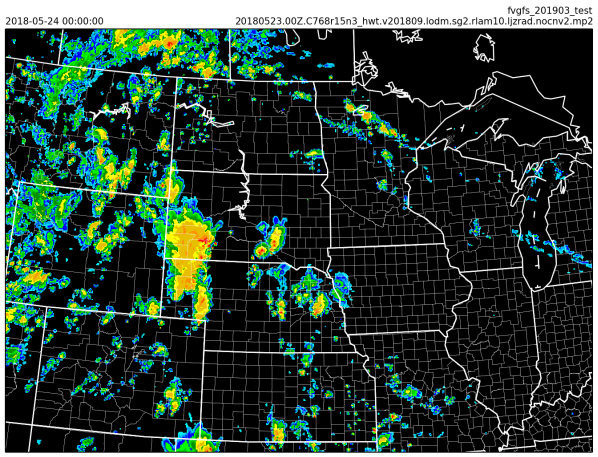
cfvGFS 2019: HWT Spring Experiment

- 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

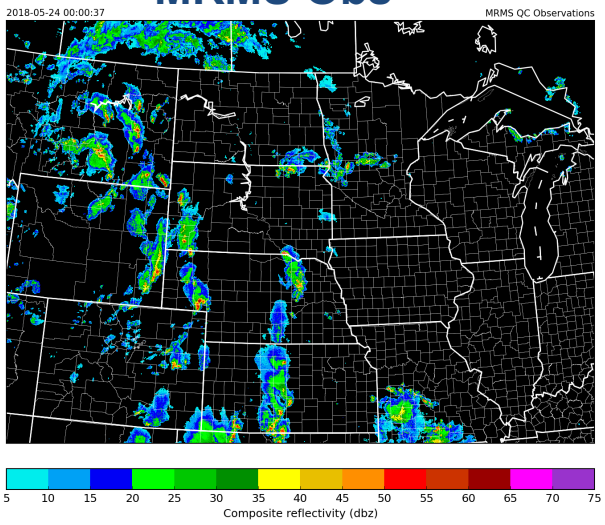
cfvGFS 2018



cfvGFS 2019



MRMS Obs

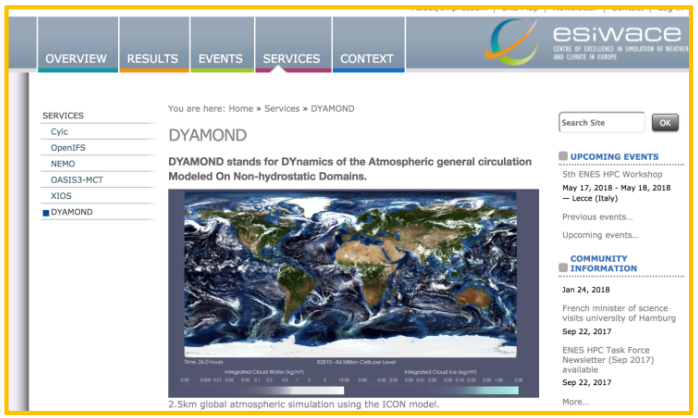


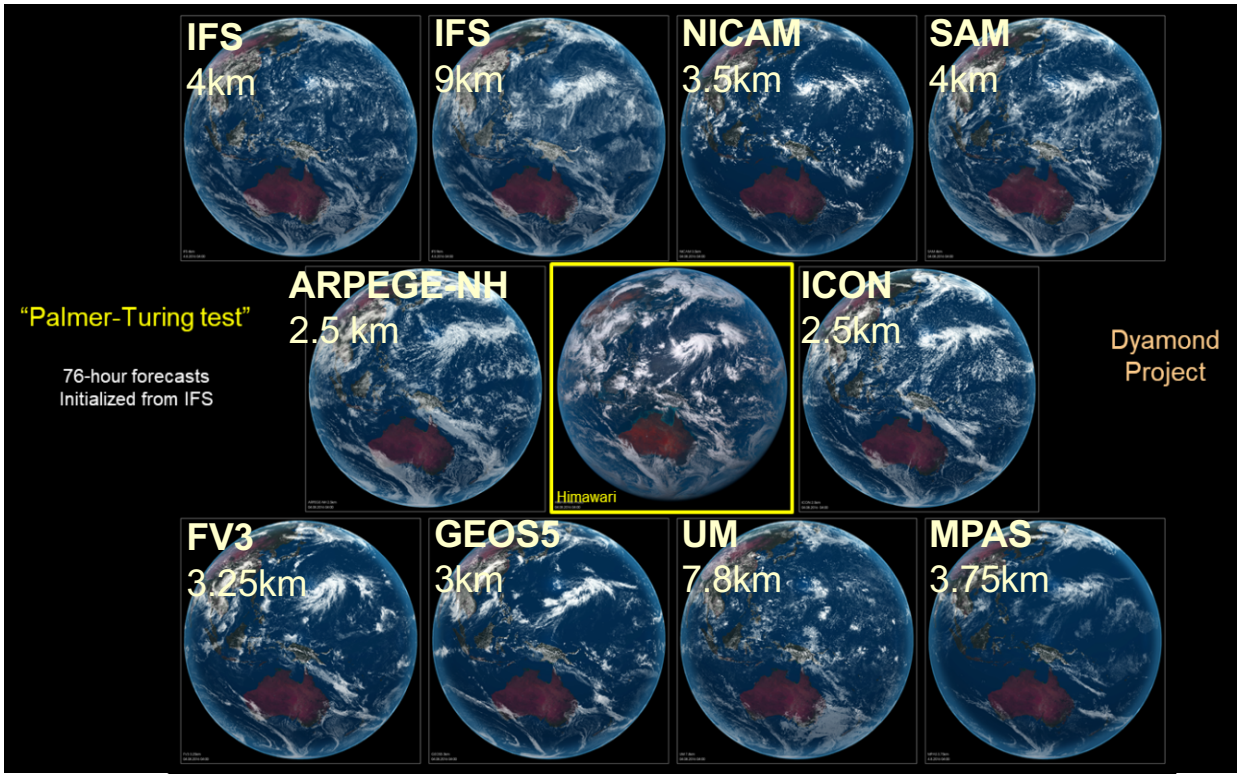
24-hour forecast Composite Reflectivity

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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