2021 HFIP Real-Time Demo Project:
HAFSv0.2A Regional Coupled Real-Time Experiment

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HAFS Coordination Meeting, May 26, 2021

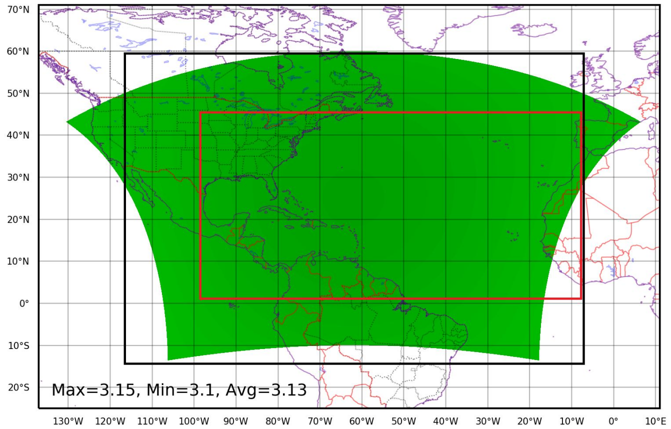
HAFSv0.2A Real-Time Demo Project Objectives

- The HAFSv0.2A regional and ocean-coupled real-time experiment is based on the 2020 HAFSv0.1A HFIP real-time demo project with
  - 3-km regional Extended Schmidt Gnomonic (ESG) grid covering a larger domain and with more uniformed grid spacing
  - Improved CMEPS-based HYCOM ocean coupling
  - Upgraded HAFS physics suite optimized for hurricane forecasting
  - Latest infrastructure and dynamics advancements of the HAFS application
- The HAFSv0.2A real-time experiment will also serve as a baseline/control experiment for other HAFS-based real-time parallel experiments, and it will be diagnosed, assessed, and compared with other real-time experiments as well as the operational hurricane model forecasts

The HAFSv0.2A Baseline Configuration

(H2AB: Based on the 2020 HAFS.v0.1A/S/J experiments)

- The FV3ATM component
  - Use the feature/hafsv0.2_baseline branch with its subcomponents synced with their latest authoritative branches (as of 01/20/2021)
  - 3-km regional ESG grid with the L91 (10 hPa top) vertical levels
  - GFSv16 netcdf files for IC; 3-hrly GFSv16 grib2 files for LBC
  - dt_atmos=90s; k_split=4; n_split=5; radiation time step: 1800s
  - Lateral boundary condition blending (nrows_blend=10)
  - Use the HAFS_V0_gfdlmp_nonsst physics suite
    - GFDL microphysic; RRTMG radiation; Scale-aware SAS convection; Noah LSM; GFS surface layer with HWRF exchange coefficients; GFS EDMF PBL with HWRF modification; Turn on orographic GWD but keep convective GWD off; Turning off the NSST component
- The HYCOM component
  - CMEPS based ocean coupling with the bilinear regridding method
  - 1/12-degree NATL domain (1-45.78N, 261.8-352.5E) with L41
  - Ocean IC from RTOFSv2 and persistent oceanic LBC
  - Atmospheric forcing from GFSv16 grib2 files for non-overlap area



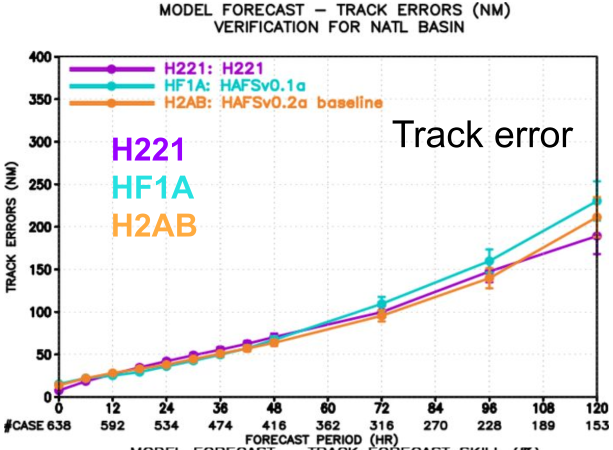
FV3ATM model domain

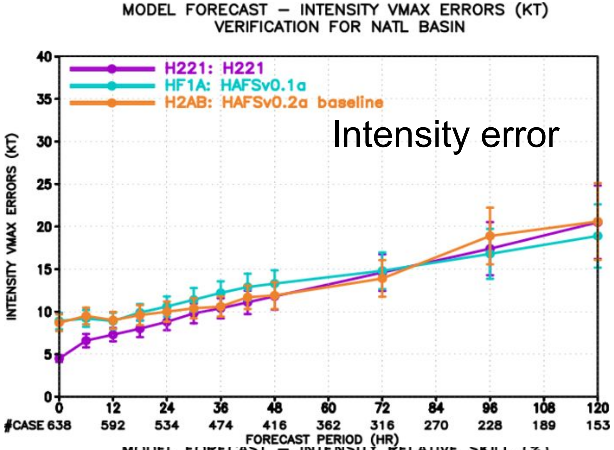
FV3ATM output domain

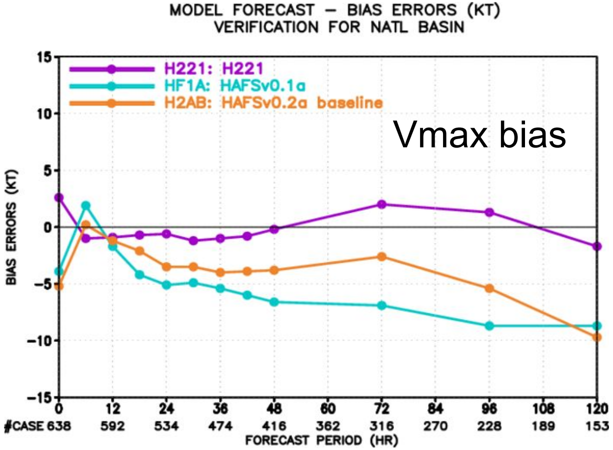
HYCOM ocean domain

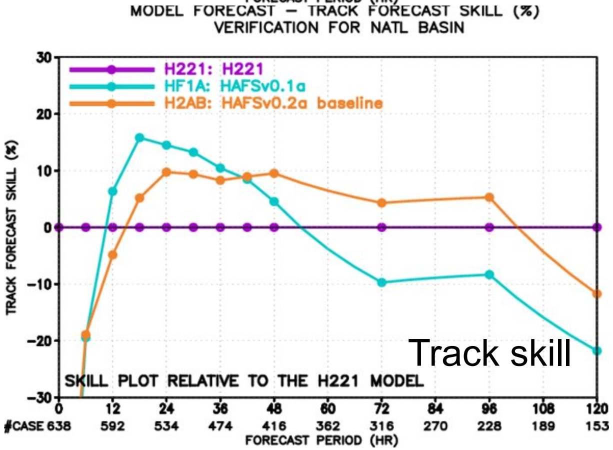
HAFSv0.2A Baseline Experiment Performance

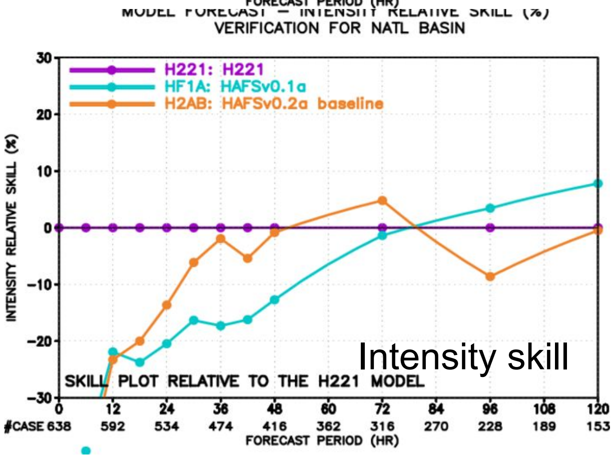
(For NATL storms of 2020 03-28L; 2019 05-12L)











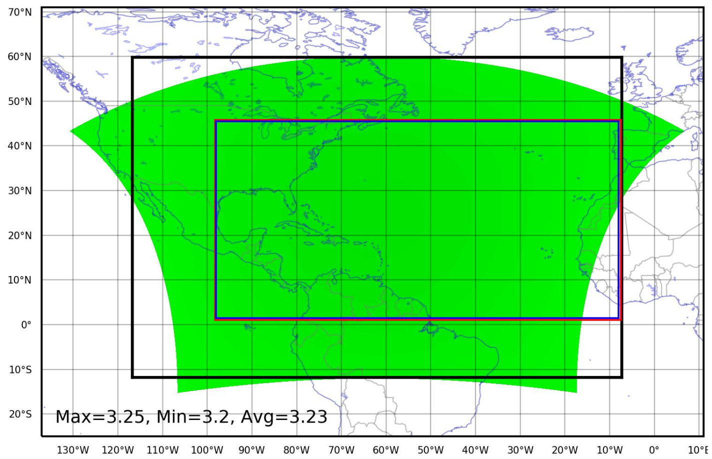
Comparing to HF1A, the overall improvements in H2AB are mainly due to:

- Turning on the scale-aware SAS convection scheme
- Using GFSv16 and RTOFSv2 input data

The HAFSv0.2A Phase 2 Combined Configuration

(H2PC: Based on HAFSv0.2A baseline configuration)

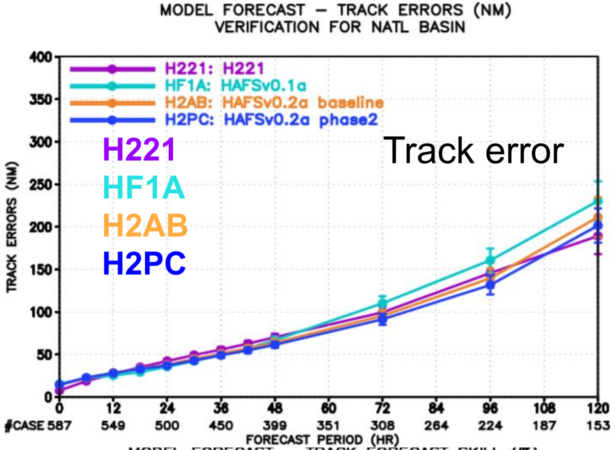
- The FV3ATM component
  - Use the HAFS feature/hafs_ensda_202104 branch with its subcomponents being synced as of 04/16/2021
  - 3-km ESG C3099 grid with L91 (10 hPa top) vertical levels
  - GFSv16 netcdf files for IC; 3-hrly GFSv16 grib2 files for LBC
  - dt_atmos=90s; k_split=3; n_split=5; radiation time step: 900s
  - LBC blending with nrows_blend=10
  - Turn off the two thickness parameters in the GFDL tracker
  - Use the HAFS_v0_gfdlmp_tedmf_nonsst physics suite
    - GFDL microphysic; RRTMG radiation; Scale-aware SAS convection; Noah LSM; GFS surface layer with HWRF exchange coefficients; GFSv16 scale-aware TKE-EDMF PBL scheme; Turn on orographic GWD but keep convective GWD off; Turning off the NSST component
- The HYCOM component
  - CMEPS based ocean coupling with the bilinear regridding method
  - 1/12-degree NATL domain (1-45.78N, 261.8-352.5E) with L41
  - Ocean IC from RTOFSv2 and persistent oceanic LBC
  - Atmospheric forcing from GFSv16 grib2 files for non-overlap area

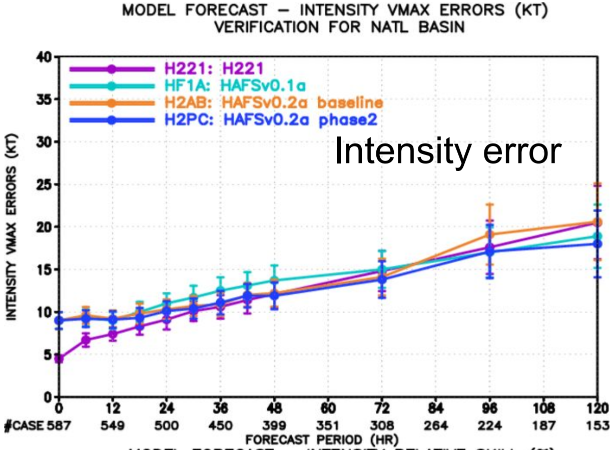


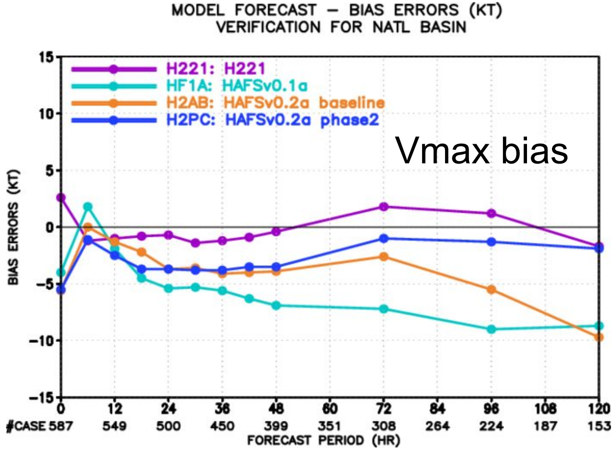
FV3ATM model domain
FV3ATM output domain
HYCOM ocean domain

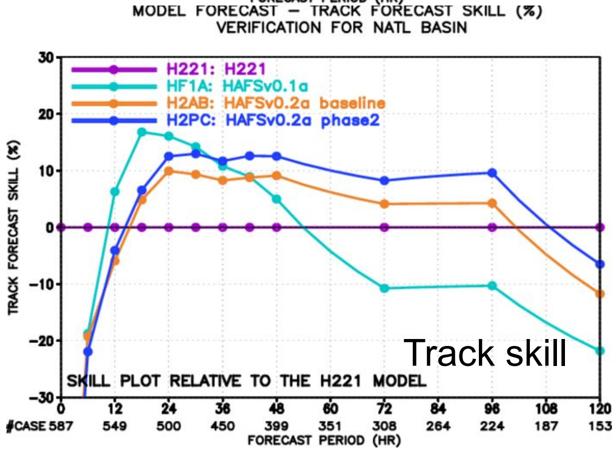
HAFSv0.2A Phase 2 Combined Experiment Performance

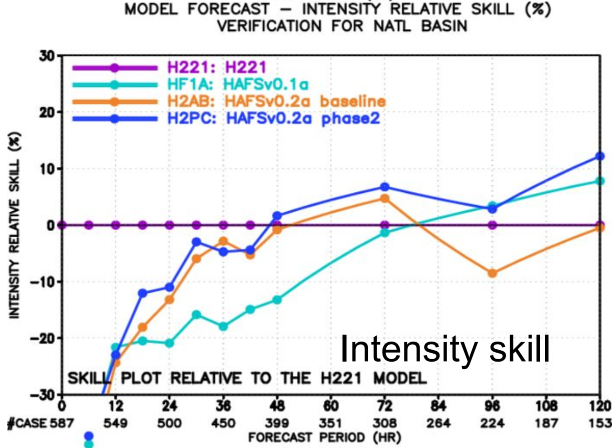
(For NATL storms of 2020 03-28L; 2019 05-12L)







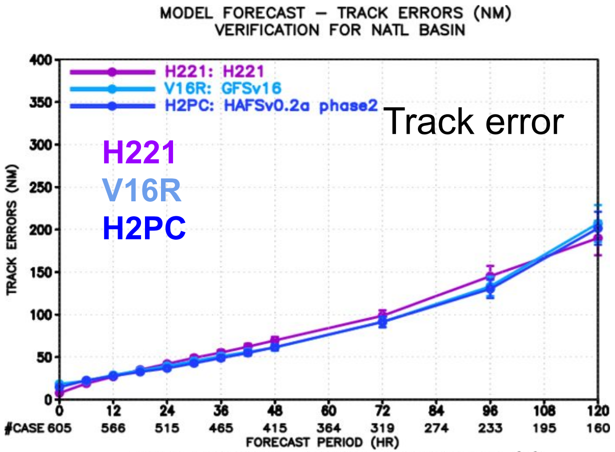


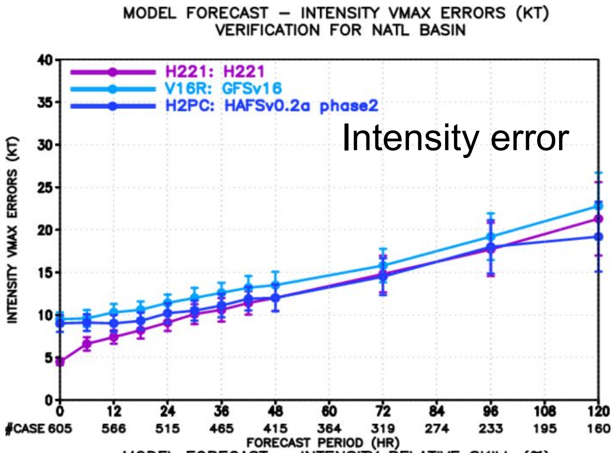


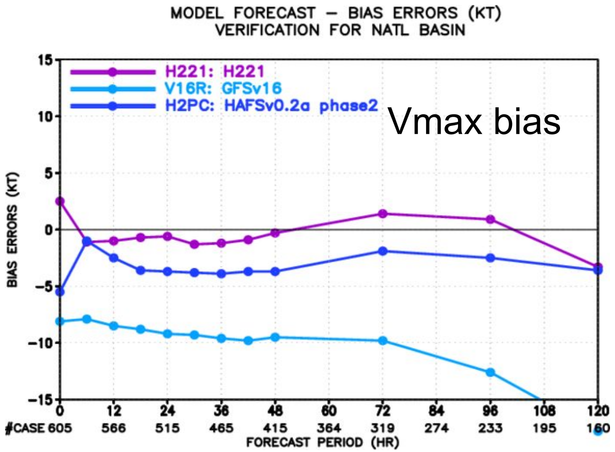
Comparing to H2AB, the H2PC improvements are mainly from:

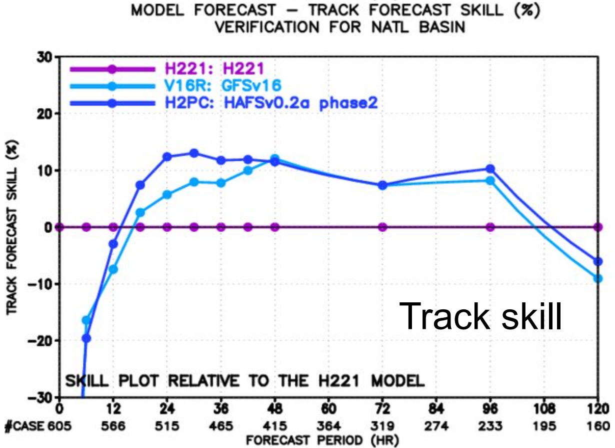
- Using GFSv16 scale-aware TKE-EDMF PBL scheme
- Reducing the radiation scheme time step

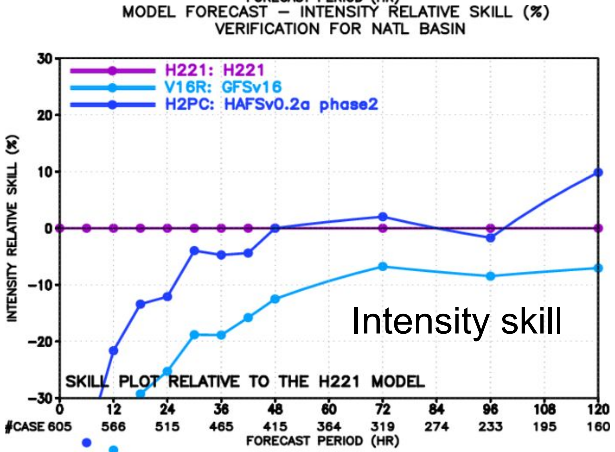
HAFSv0.2A Phase 2 Combined Experiment Performance
(For NATL storms of 2020 03-28L; 2019 05-12L)







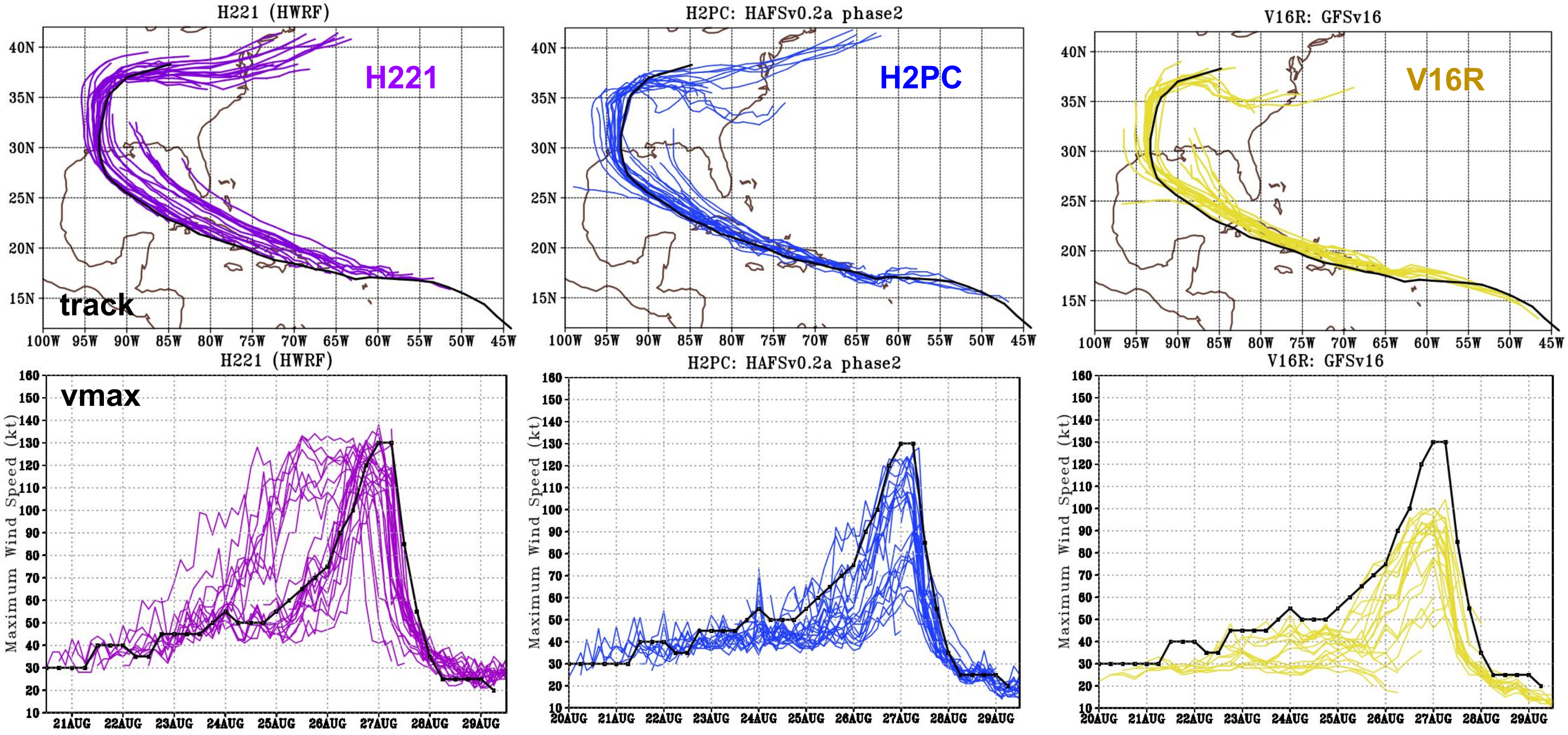




Comparing to V16R (its parent model), H2PC produced similar track forecast performance, while with much better skills for intensity and bias

Track and Intensity Composites

(For 2020 Hurricane Laura13L)

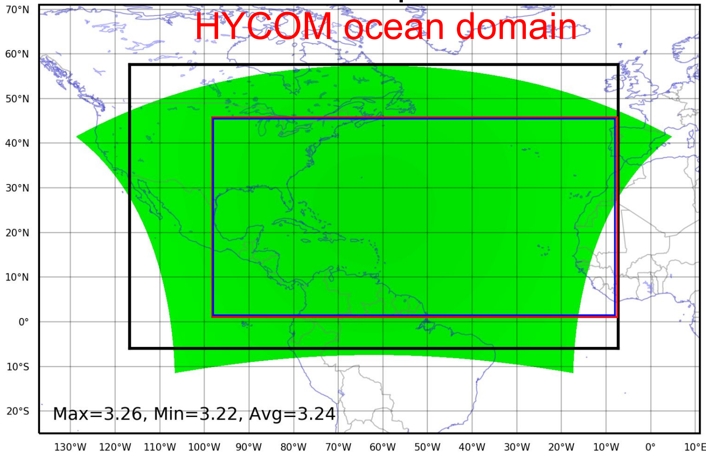


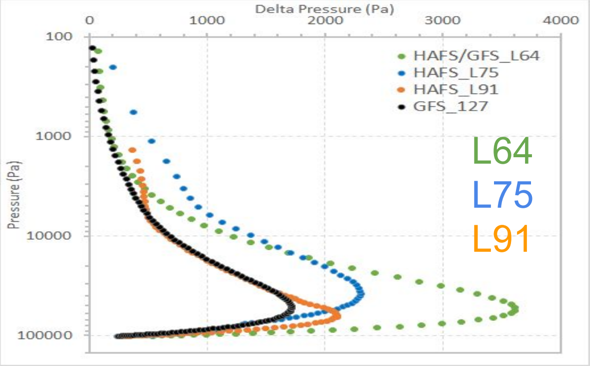
The HAFSv0.2A Phase 3 Configuration

(Based on HAFSv0.2A phase 2 configuration)

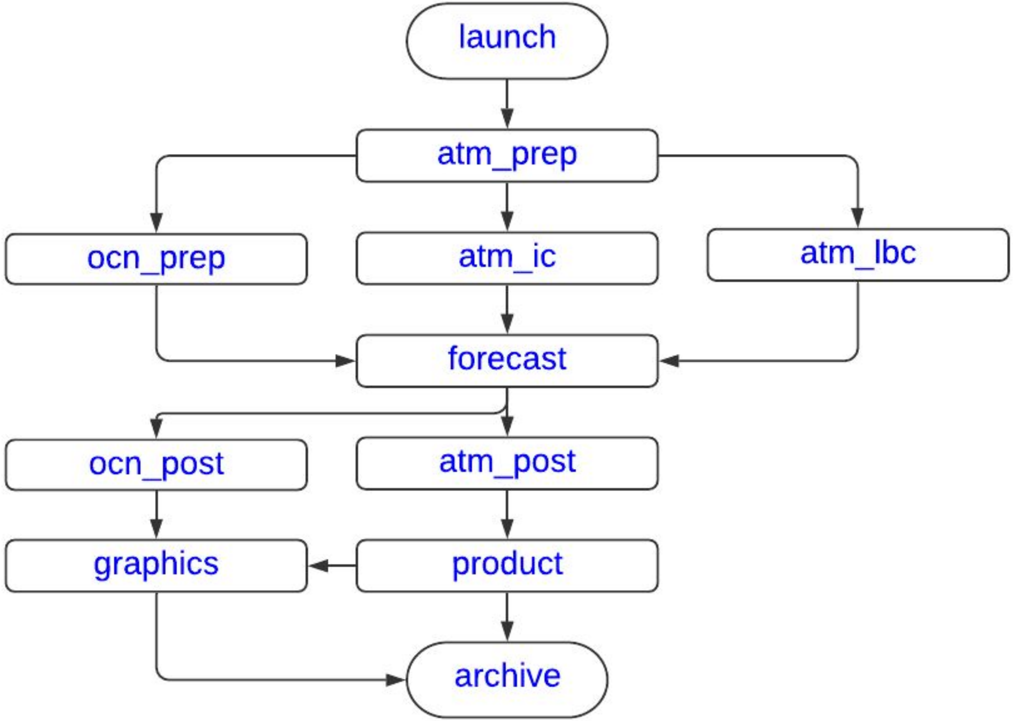
- The FV3ATM component
  - Use the HAFS feature/hafsv0.2_phase3 branch with its subcomponents being synced as of 05/12/2021
  - Regional ESG C3089 grid (~3-km) with L91 (10 hPa top) levels
  - GFSv16 netcdf files for IC; 3-hrly GFSv16 grib2 files for LBC
  - dt_atmos=90s; k_split=3; n_split=5; radiation time step: 1800s
  - LBC blending with nrows_blend=10
  - Turn off the two thickness parameters in the GFDL tracker
  - Use the HAFS_v0_gfdlmp_tedmf_nonsst physics suite
    - GFDL microphysic; RRTMG radiation; Scale-aware SAS convection; Noah LSM; GFS surface layer with HWRF exchange coefficients; Modified GFSv16 scale-aware TKE-EDMF PBL scheme (with rlmx/elmx of 100 vs 300); Turn on orographic GWD but keep convective GWD off; Turning off the NSST component
- The HYCOM component
  - CMEPS based ocean coupling with updated exchange variables
  - 1/12-degree NATL domain (1-45.78N, 261.8-352.5E) with L41
  - Ocean IC from RTOFSv2 and persistent oceanic LBC
  - Atmospheric forcing from GFSv16 grib2 files for non-overlap area

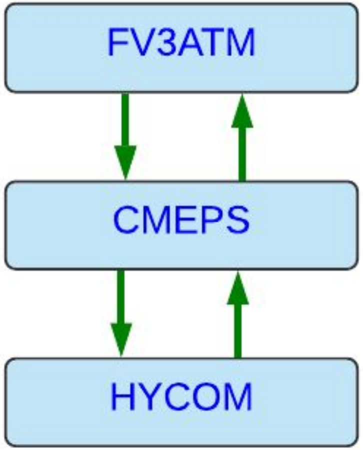
FV3ATM model domain
FV3ATM output domain
HYCOM ocean domain





HAFSv0.2A Experiment Workflow with Ocean Coupling





From ATM to OCN: air-sea momentum, sensible and latent heat fluxes; net shortwave and longwave radiation fluxes; surface pressure; precipitation
From OCN to ATM: sea surface temperature

The HAFSv0.2A Experiment Computation Cost

<table>
<tr><th>Epoch Offset (+HH:MM)</th><th>workflow task</th><th>workflow task</th><th>workflow task</th><th>workflow task</th><th>Total cores consumed</th></tr>
<tr><td>+04:10</td><td>launch (1 node)</td><td></td><td></td><td></td><td>24 cores (1 node)</td></tr>
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<tr><td>+10:02</td><td></td><td>288 cores (12 nodes)</td></tr>
<tr><td>+10:08</td><td></td><td></td><td></td><td>96 cores (4 nodes)</td></tr>
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Thanks!