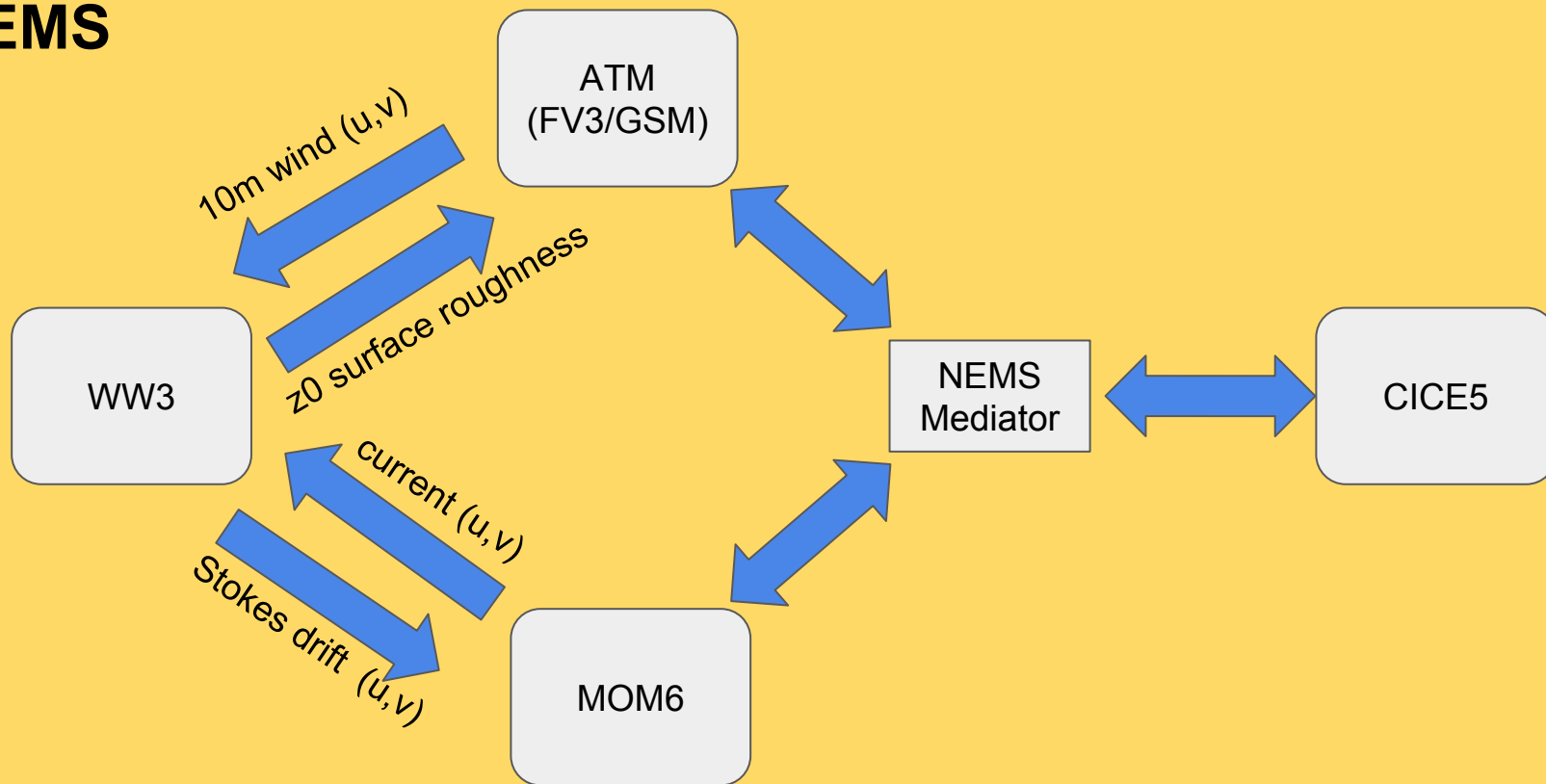


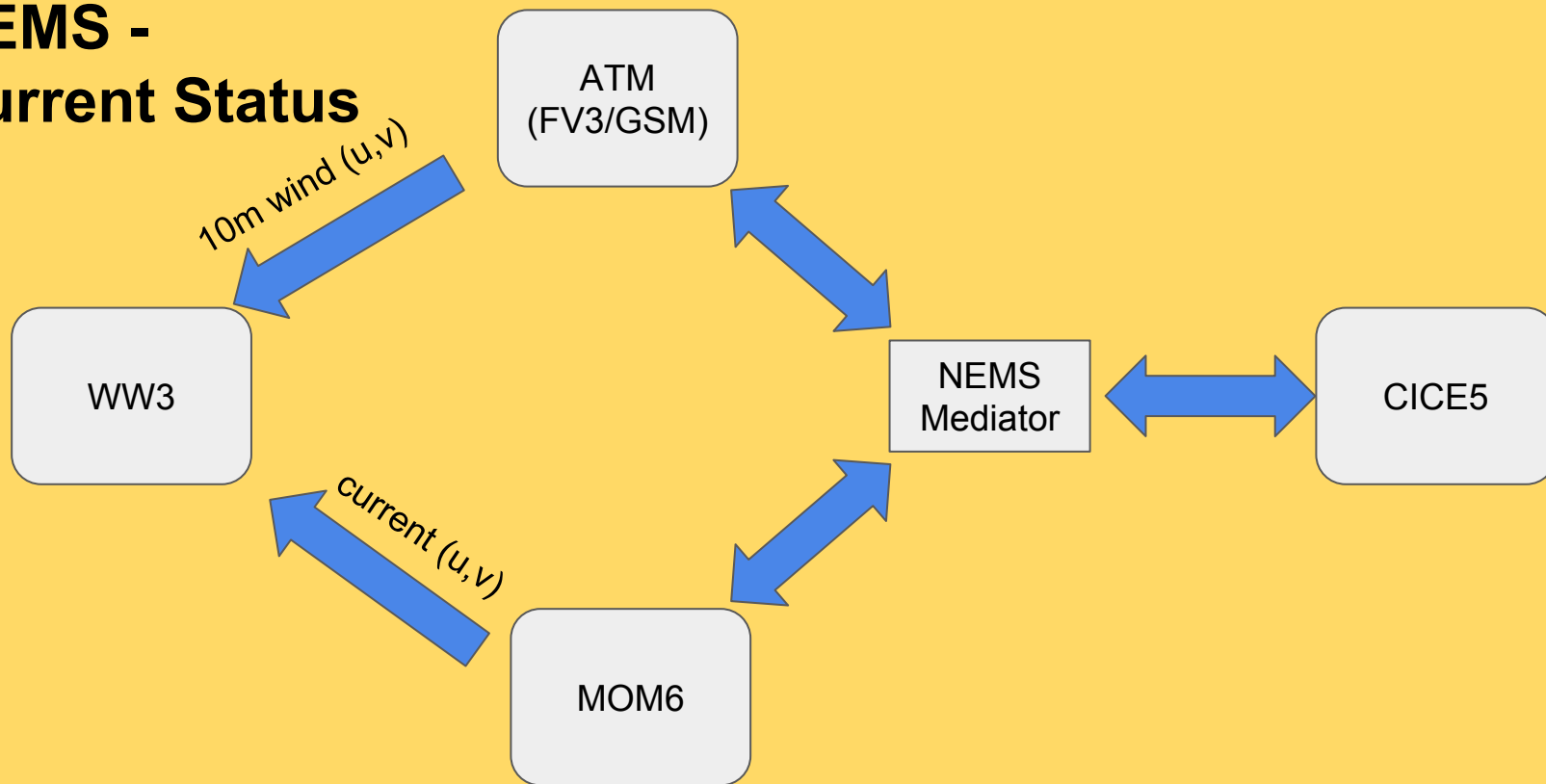
Wave Coupling at NCEP

February 21, 2018

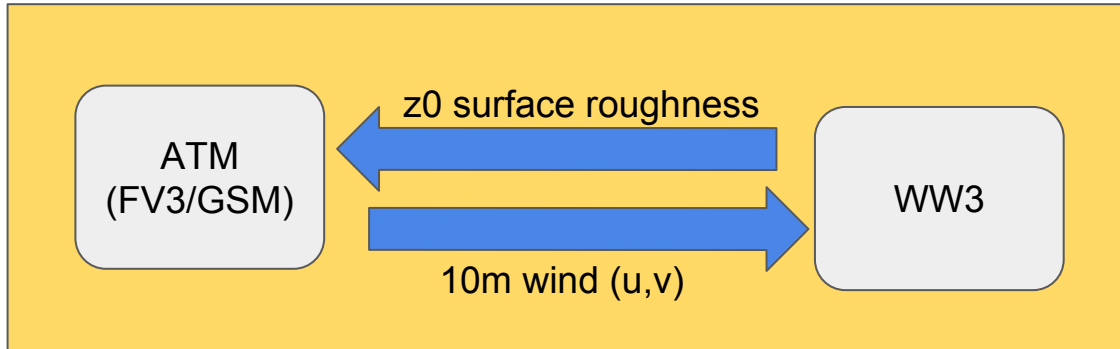
NEMS



NEMS - Current Status



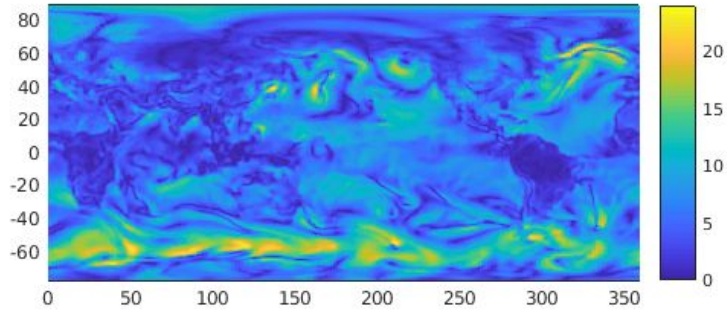
Global Weather



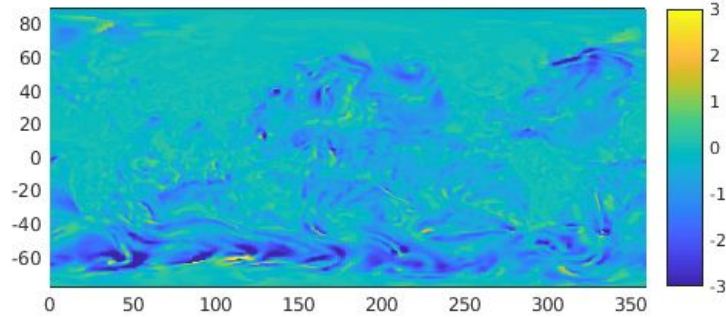
- Currently we have 1-way and 2-way coupling with GSM and 1-way coupling with FV3
- We have preliminary results for comparing 1-way and 2-way coupling and plan to have a more complete evaluation with FV3 2-way coupling this summer.

Example of 2 way Coupling Effects

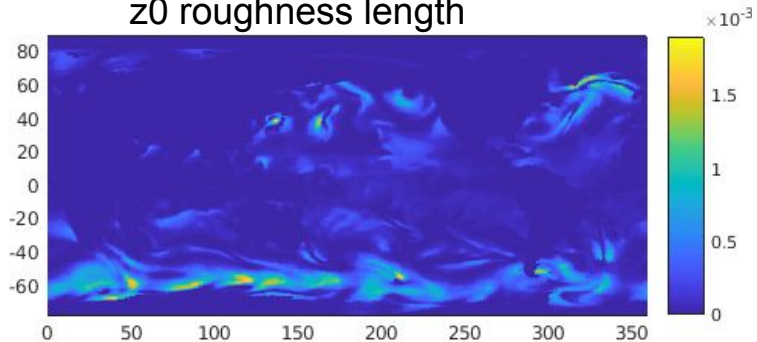
10 m wind speed [m/s]



10 m wind speed (1-way minus 2-way) [m/s]



z_0 roughness length



HWRF: Three-way Atmosphere-Wave-Ocean Coupling

Atmosphere → Ocean

- Atmospheric surface forcings

Ocean → Atmosphere

- Sea surface temperature
- Sea surface currents

Atmosphere → Waves

- Lowest model level wind and height
- Stability Richardson number

Waves → Atmosphere

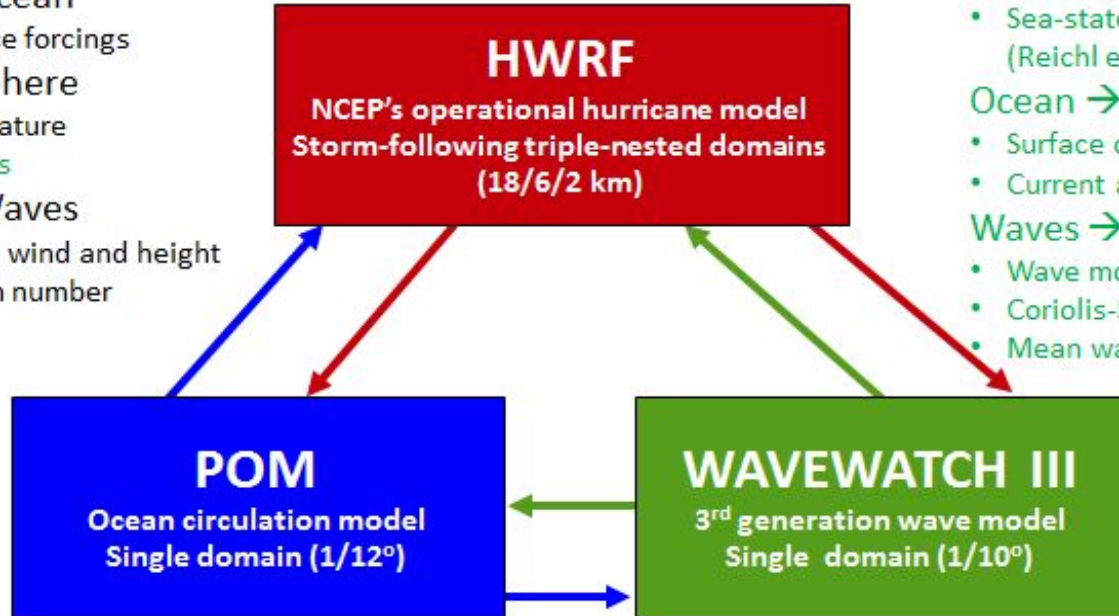
- Sea-state -dependent drag coefficient (Reichl et al 2014)

Ocean → Waves

- Surface current
- Current at depth

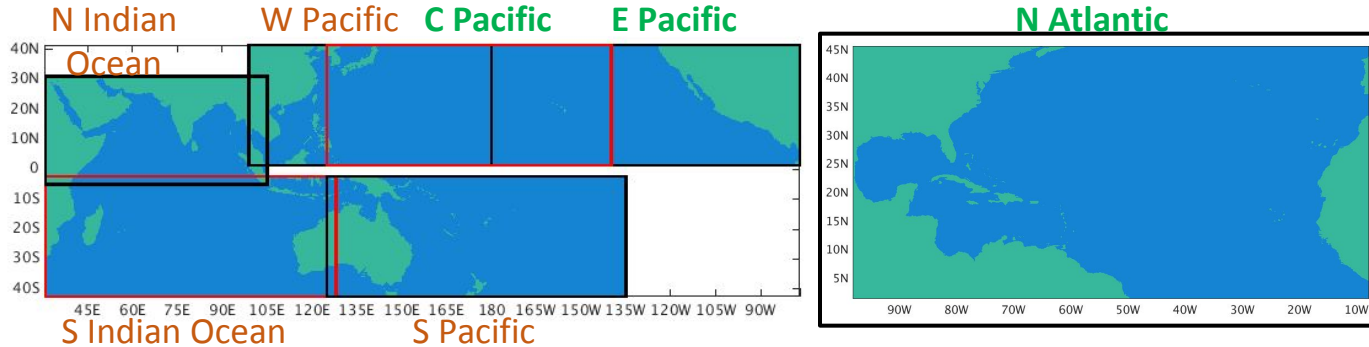
Waves → Ocean

- Wave modified wind stress (Fan et al 2010)
- Coriolis-Stokes drift forcing
- Mean wave length (for current field)



The coupling processes in **black** are active in operational HWRF with WW3 one-way coupled. The coupling processes in **green** are additional coupling processes for the 3-way coupled configuration.

2017 Hurricane Wave Domains



Green: Operational
Brown: Operational (in future)

- Multiple separate domains
- Runs within HWRF System (4 cycles a day; each cycle 6 hours hindcast+120 hours forecast)
- Winds from 6km/18km HWRF and GFS (outside of HWRF domains) interpolate/sub-sample to the 1/10° wave grid
- Domain resolution 1/10°
- Initial and Boundary conditions from the Global Wave Model (multit_1)

2017 HFIP Real-time Parallel Experiment for North Atlantic Storms

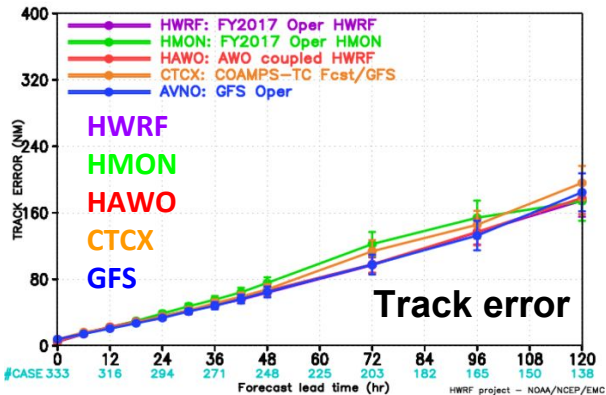
- HWRF - 2017 Operational HWRF
- HAWO - Three- way coupled Atmosphere-Wave-Ocean

Note: HAWO storms were run on Jet without the self-cycled EnKF hybrid DA system for TDR and priority storms.

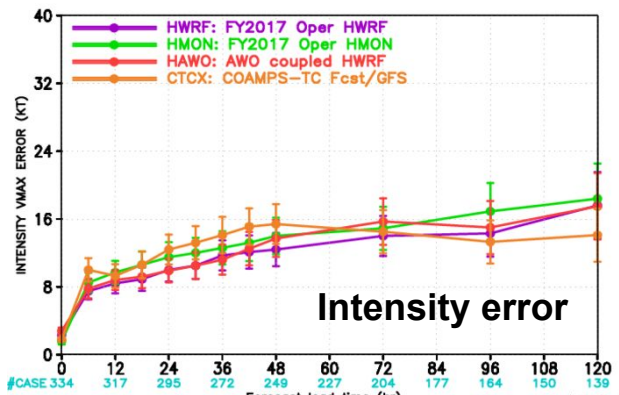
HAWO Performance for 2017 North Atlantic Storms

Track, intensity, and size errors

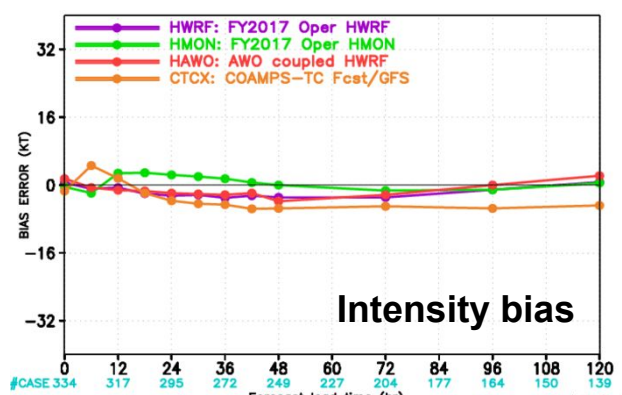
HWRP FORECAST – TRACK ERROR (NM) STATISTICS
VERIFICATION FOR NATL BASIN



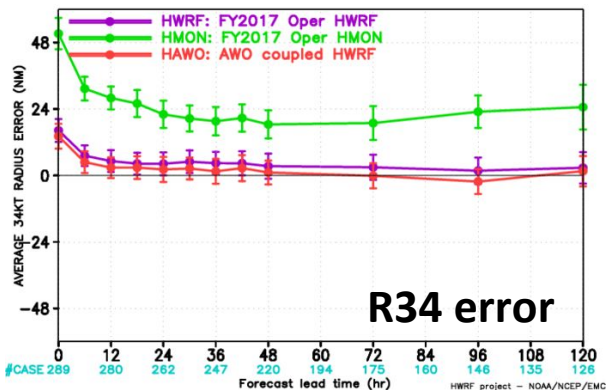
HWRP FORECAST – INTENSITY VMAX ERROR (KT) STATISTICS
VERIFICATION FOR NATL BASIN



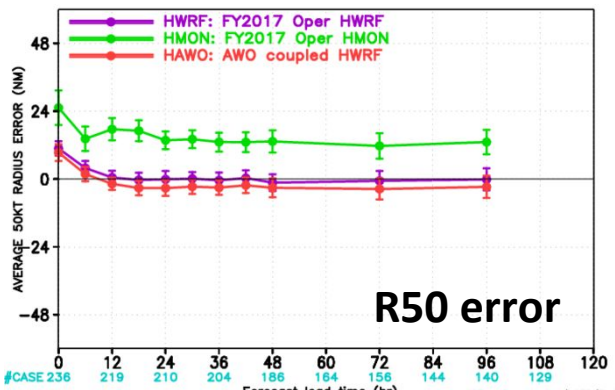
HWRP FORECAST – BIAS ERROR (KT) STATISTICS
VERIFICATION FOR NATL BASIN



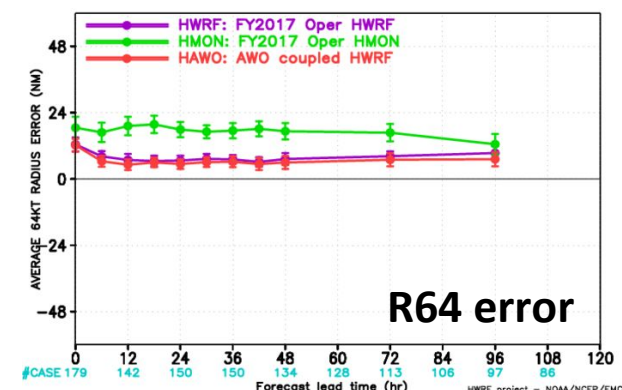
HWRP FORECAST – AVERAGE 34KT RADIUS ERROR (NM) STATISTICS
VERIFICATION FOR NATL BASIN



HWRP FORECAST – AVERAGE 50KT RADIUS ERROR (NM) STATISTICS
VERIFICATION FOR NATL BASIN



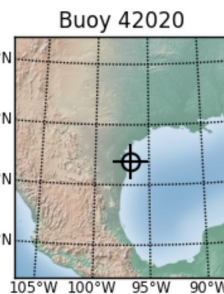
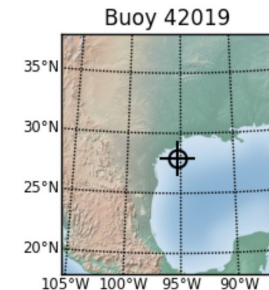
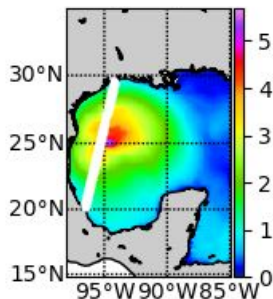
HWRP FORECAST – AVERAGE 64KT RADIUS ERROR (NM) STATISTICS
VERIFICATION FOR NATL BASIN



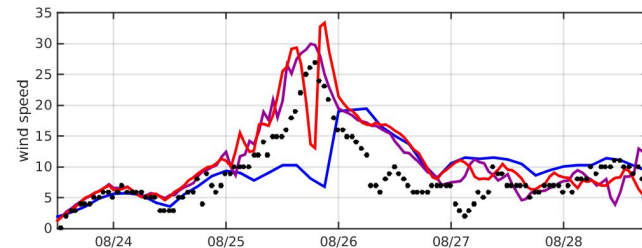
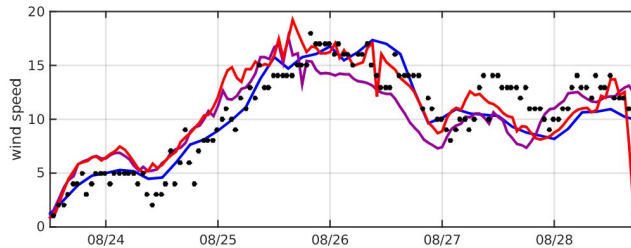
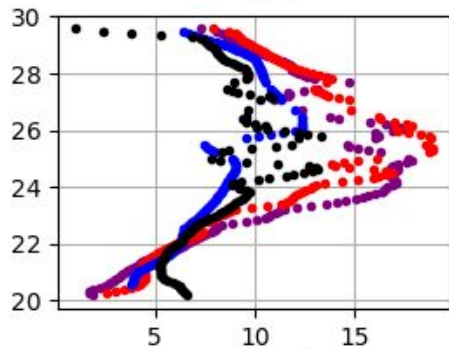
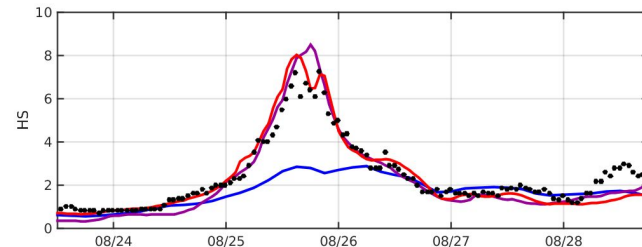
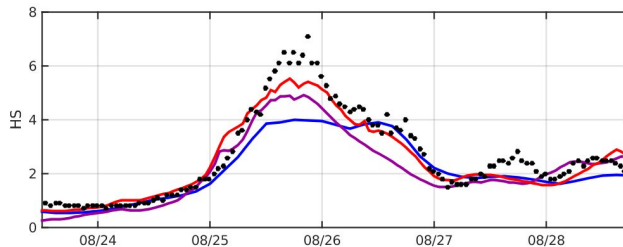
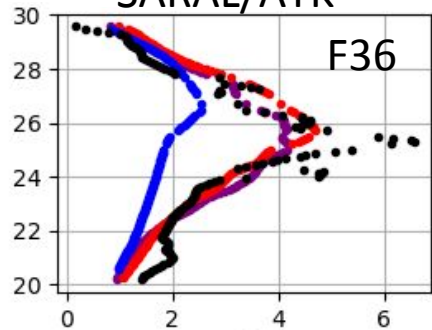
HAWO Wave Forecasts for Hurricane Harvey (09L)

Comparison to satellite and buoy observations

- HWRF
- HAWO
- Multi_1
- SARAL/ATK



Forecast
cycle:
2017082312
Z



Current and Future Work

- Coupling between MOM6-WW3 (in collaboration with GFDL)
 - Adding output variables to ESMF cap
- Evaluating two-way coupled (FV3-WW3) forecast skill
- Unifying GFS and Multi-1
 - Adding capability to interpolate from regular input grid to irregular computational grids
 - Adding export grid in ESMF cap
- Unifying GEFS and GWES
- Possible hurricane wave updates for 2018:
 - Evaluating 3-way coupled feedback
 - Initial condition from multi_1 for the first cycle of each storm