

Development toward NCEP's fully-coupled global forecast and data assimilation system: A coupled wave - ocean system

EMC

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GFDL

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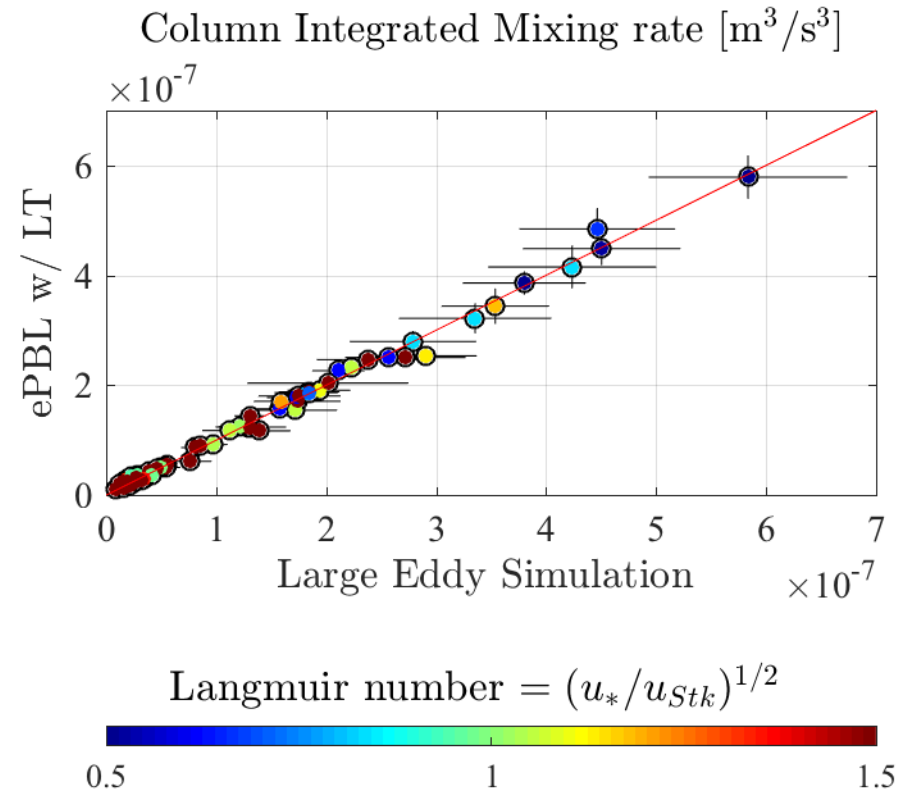
Motivation

- To add both WW3 and MOM6 to the coupled modeling infrastructure to study the impact of wave – ocean – atmosphere mixing on the sub seasonal to seasonal time scale
- To test and improve parametrizations of wave – ocean mixing schemes
- To develop capability in the WW3 model to cross over an ice free North Pole
- Transition the system to EMC as part of its next generation seasonal forecasting system

Outline

- ePBL with Langmuir mixing (wave – ocean mixing) in MOM6
- Wave propagation across the North Pole
- NUOPC Infrastructure for WW3 and MOM6

Langmuir Turbulence in the energetic Planetary Boundary Layer (ePBL)

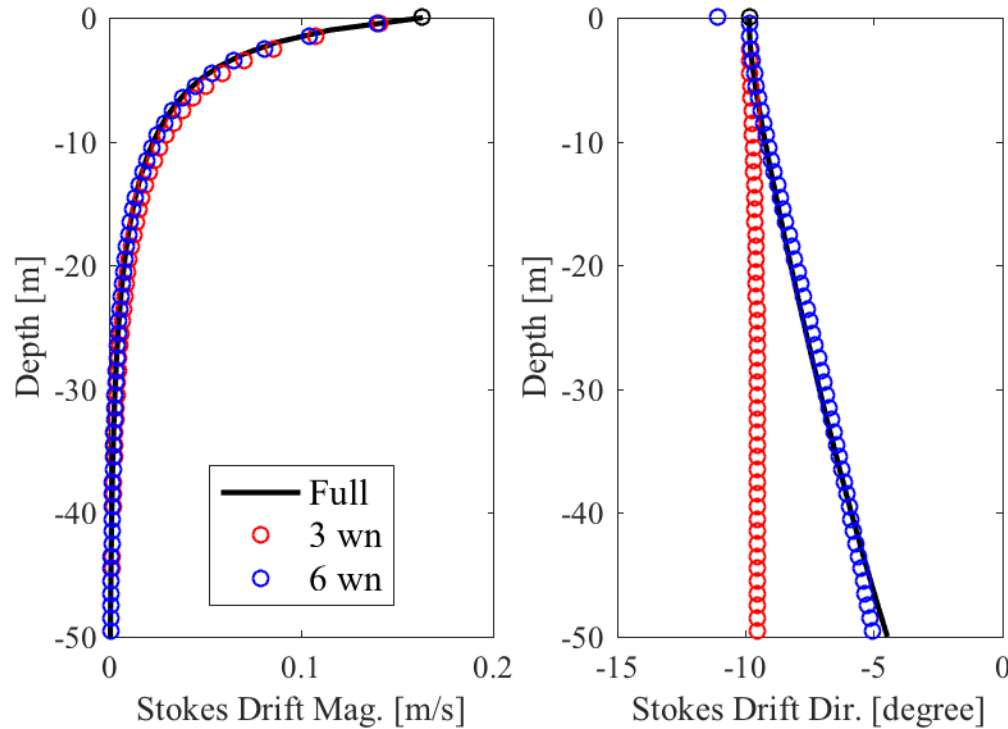


- Large Eddy Simulations show enhanced mixing due to Langmuir Turbulence
- The enhancement to the mixing correlates with the Langmuir number
- ePBL is successfully modified to capture this enhancement

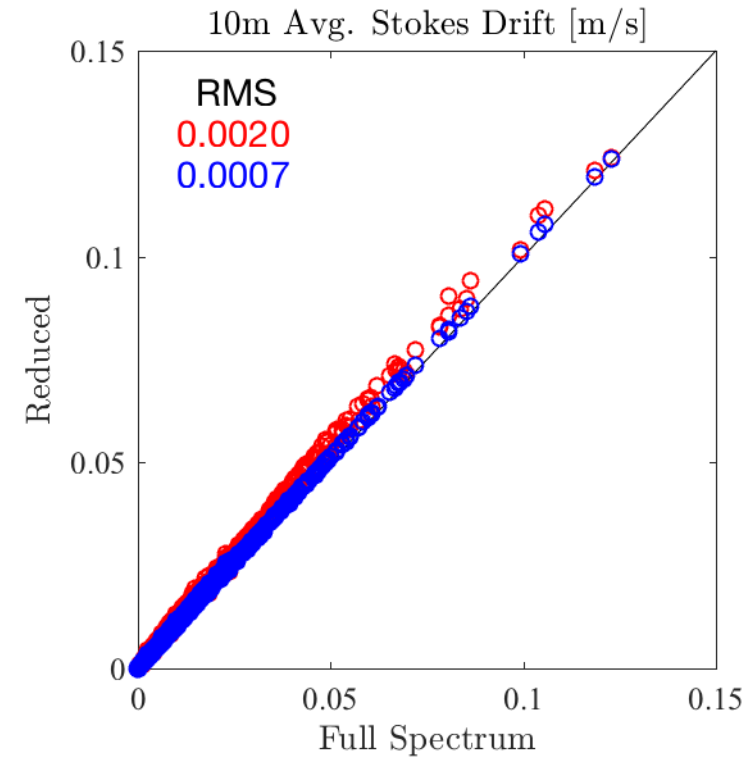
Economical Passing of Stokes Drift for Coupled Models

- The Stokes drift profile is found by integrating the wave spectrum (25 freq x 24 dirs)
- The full spectrum cannot be economically passed from the wave to the ocean model

Sample Profile from Global Simulation



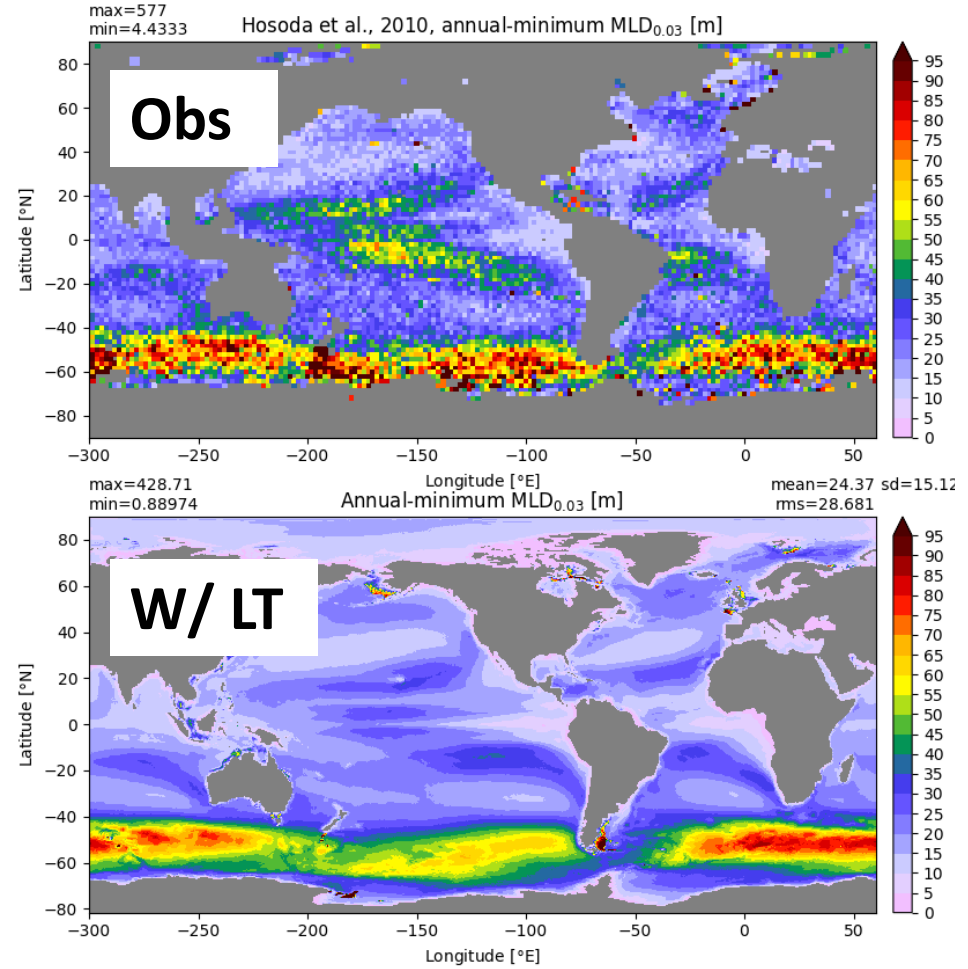
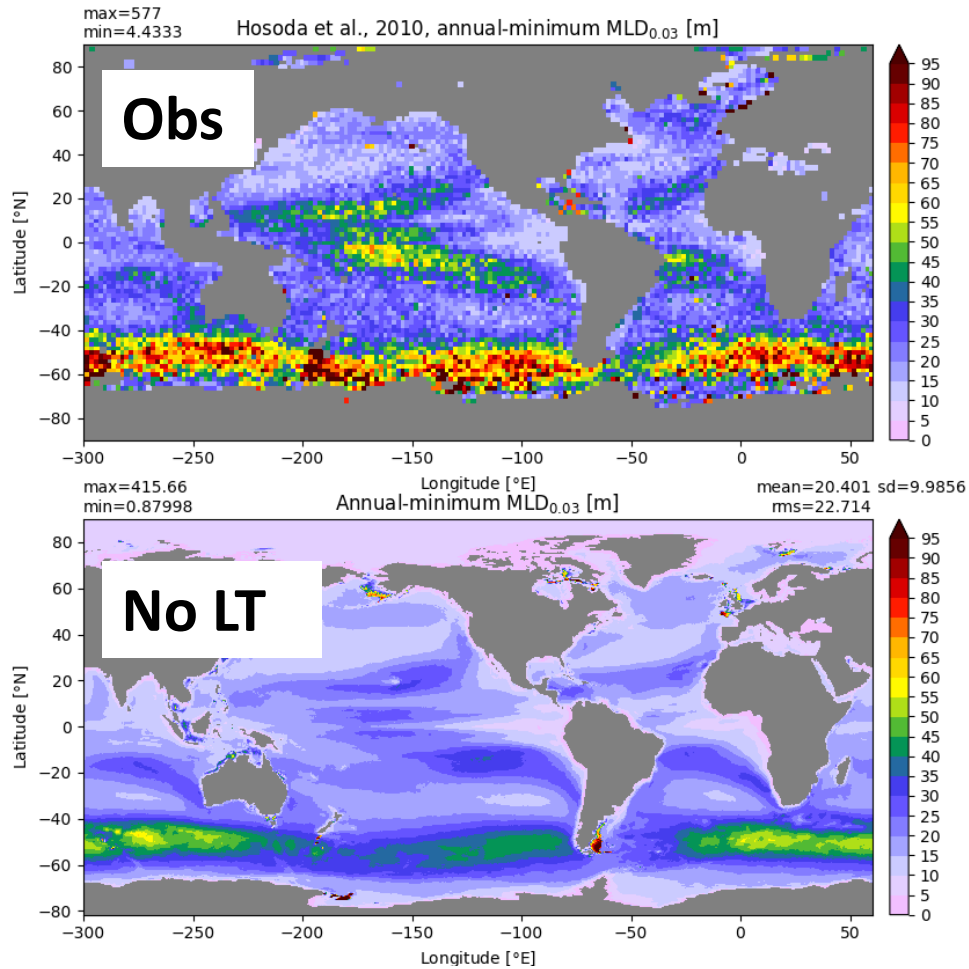
Global summary w/ RMS [m/s]



- Reducing from full spectrum to 3 freq (x2 dir) still allows accurate Stokes profiles
 - Decreases information from 600 to 6 parameters per location.

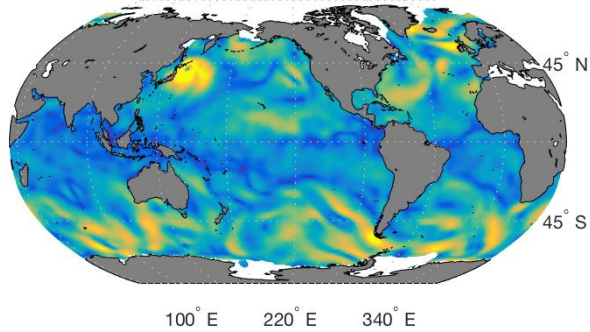
Impact of Langmuir Mixing in Global Climate Simulations

- Employ ePBL w/ Langmuir from parameterized Stokes drift in prototype GFDL CM4 mode.
- Reduction in Summer Mixed Layer Depth biases relative to observation in Southern Ocean

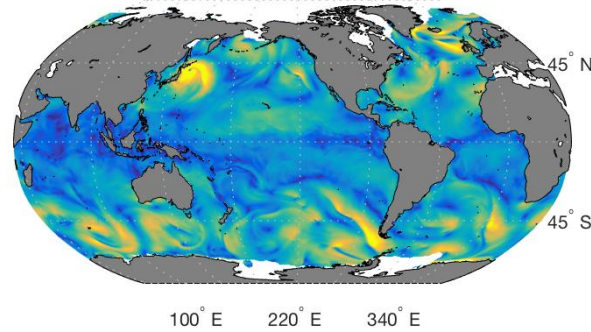


Comparing Wind Forcing Products for use in Ocean-Wave-Ice Experiments

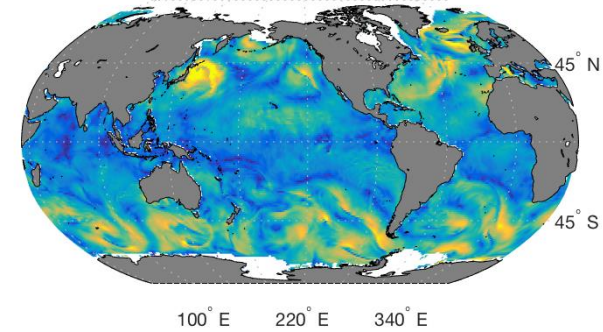
CORE Wind



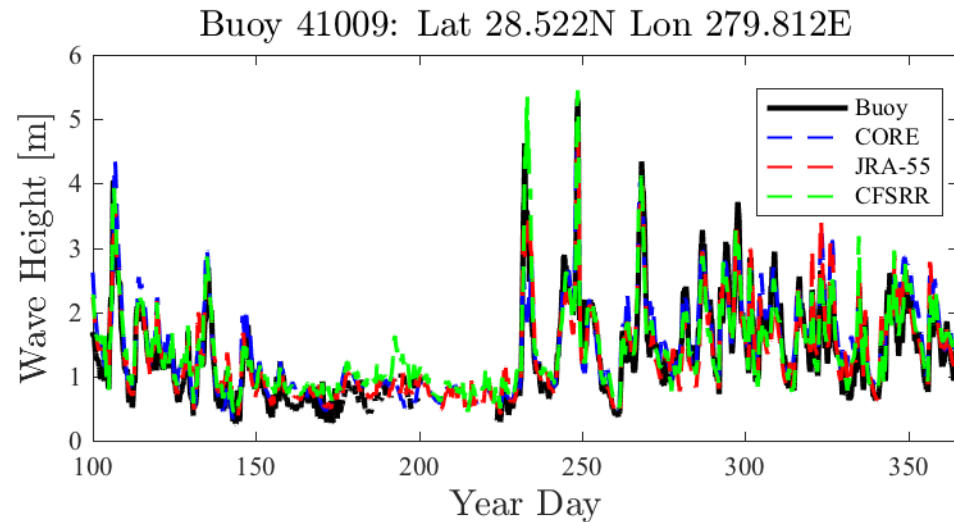
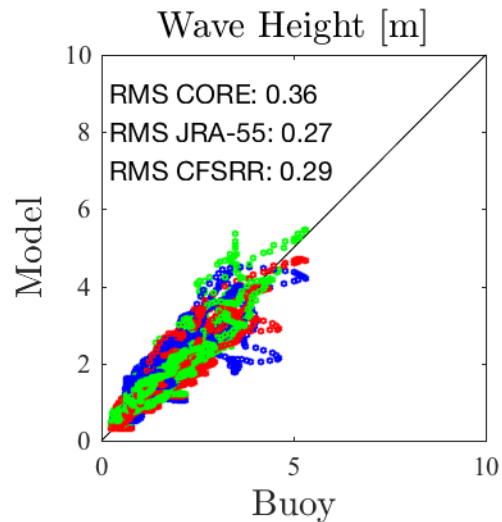
JRA-55 Wind



CFSRR Wind



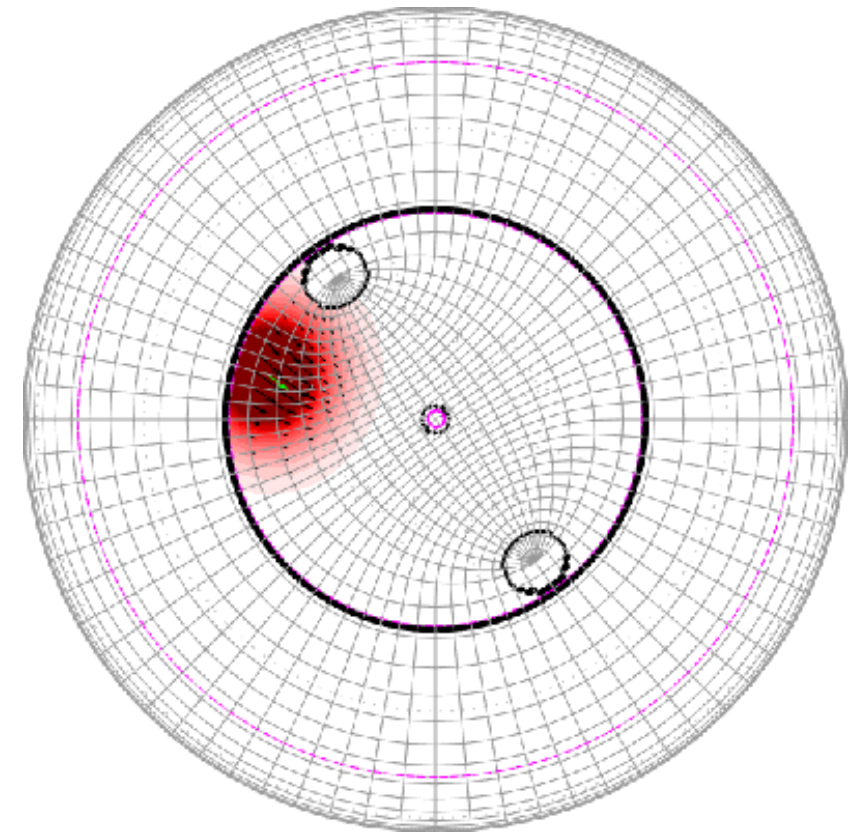
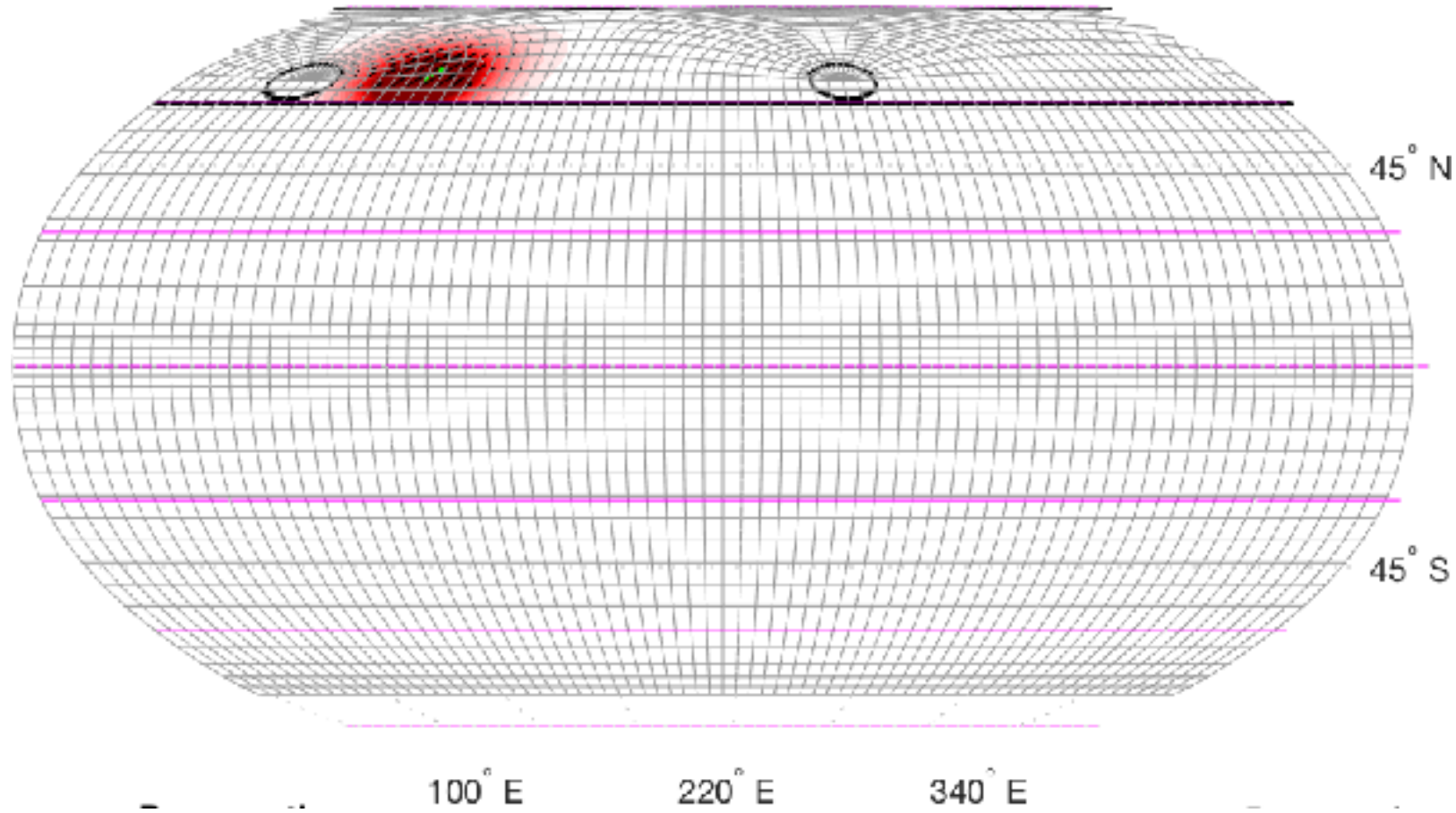
Sample buoy wave height comparison from Cape Canaveral



Wave propagation across North Pole

- WW3 is a phase averaged wave model propagating energy in physical and spectral (direction and frequency) space
- Directional propagation has singularity at the poles
- Tripolar grid moves poles to land
- Correction needed for grid relative direction propagation

Propagation

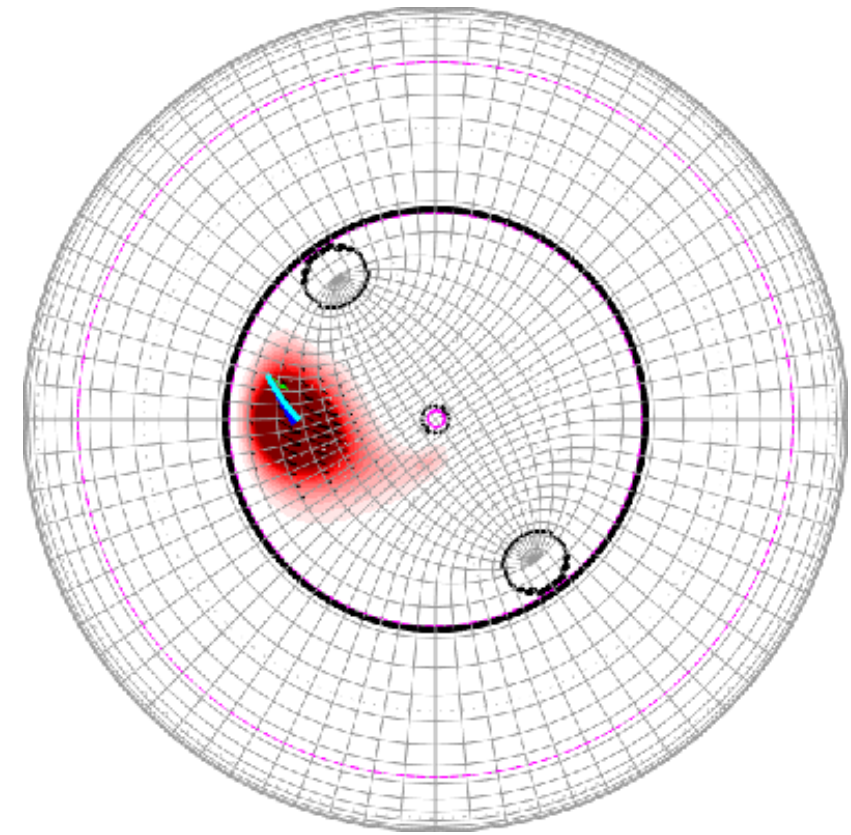
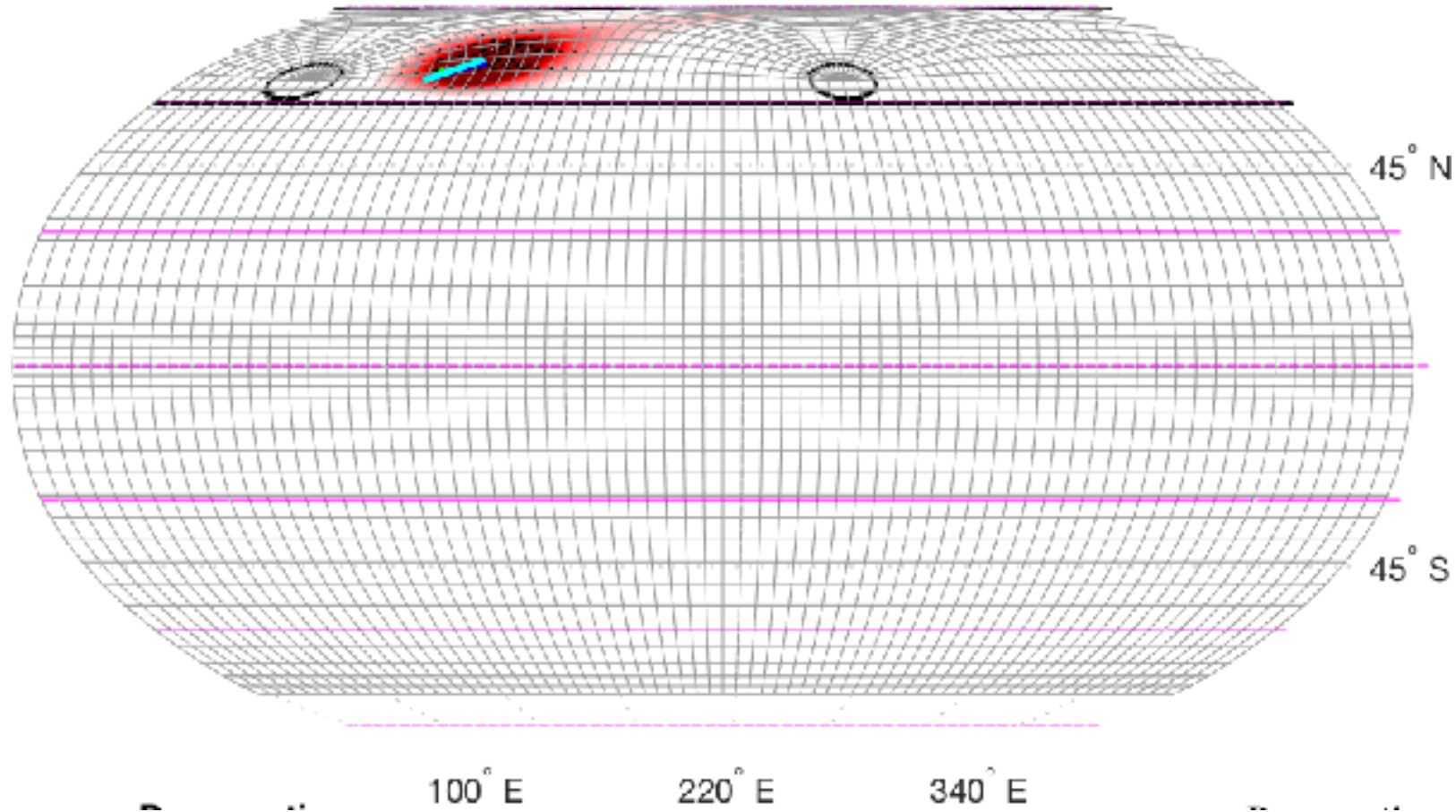


t=0

Direction of propagation

Direction of propagation without correction

Propagation

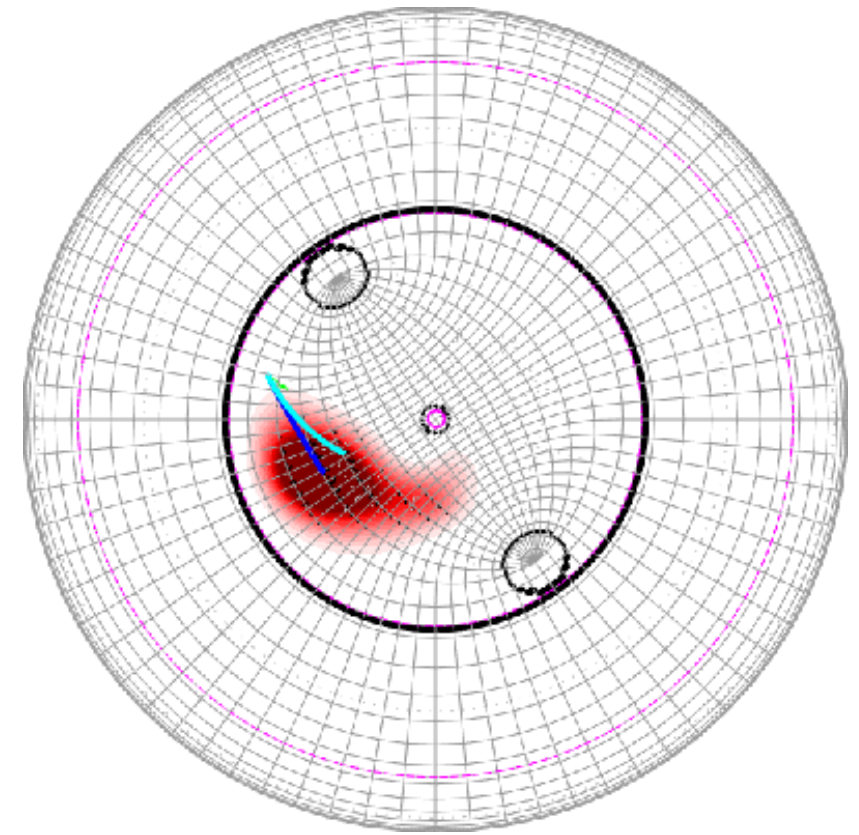
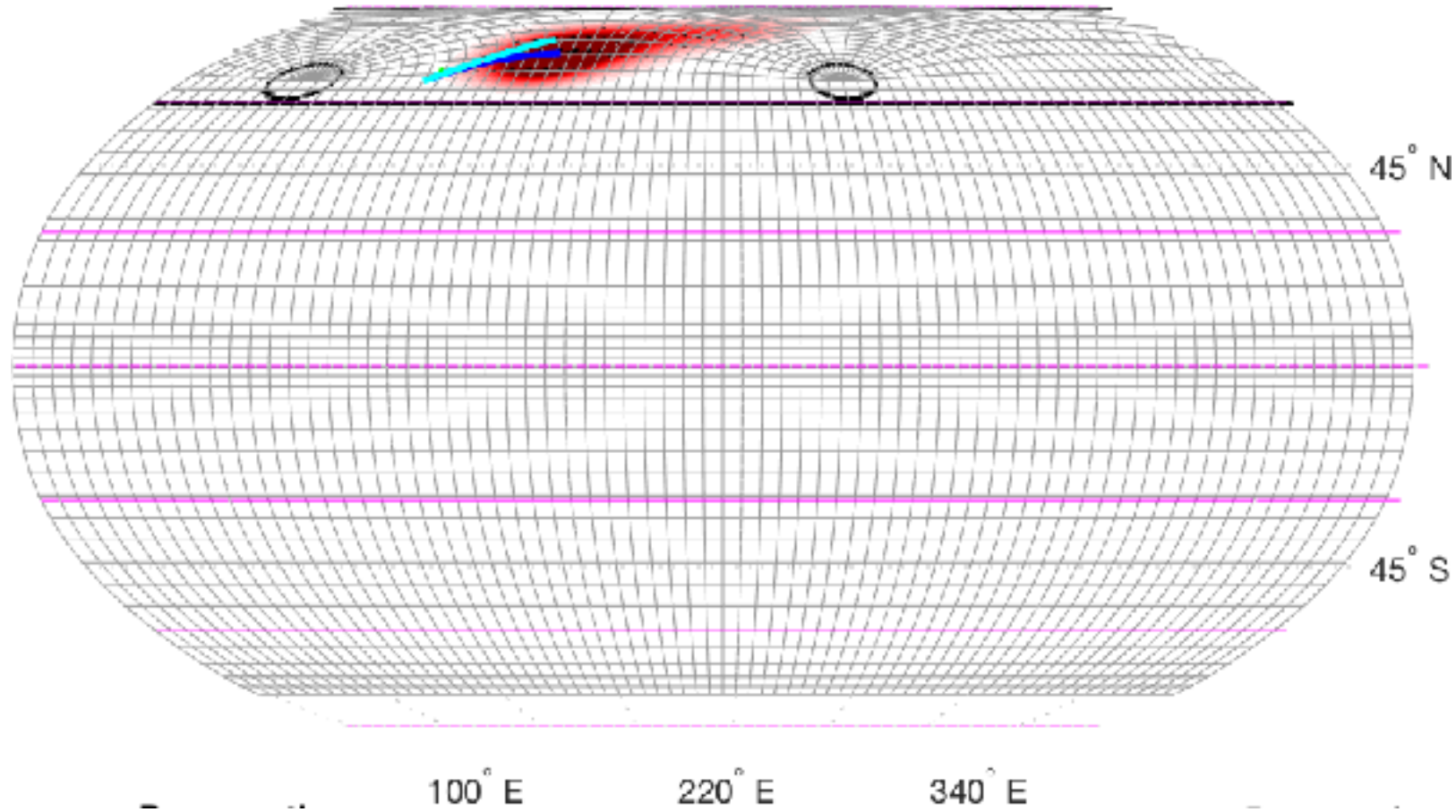


t=30000

Direction of propagation

Direction of propagation without correction

Propagation

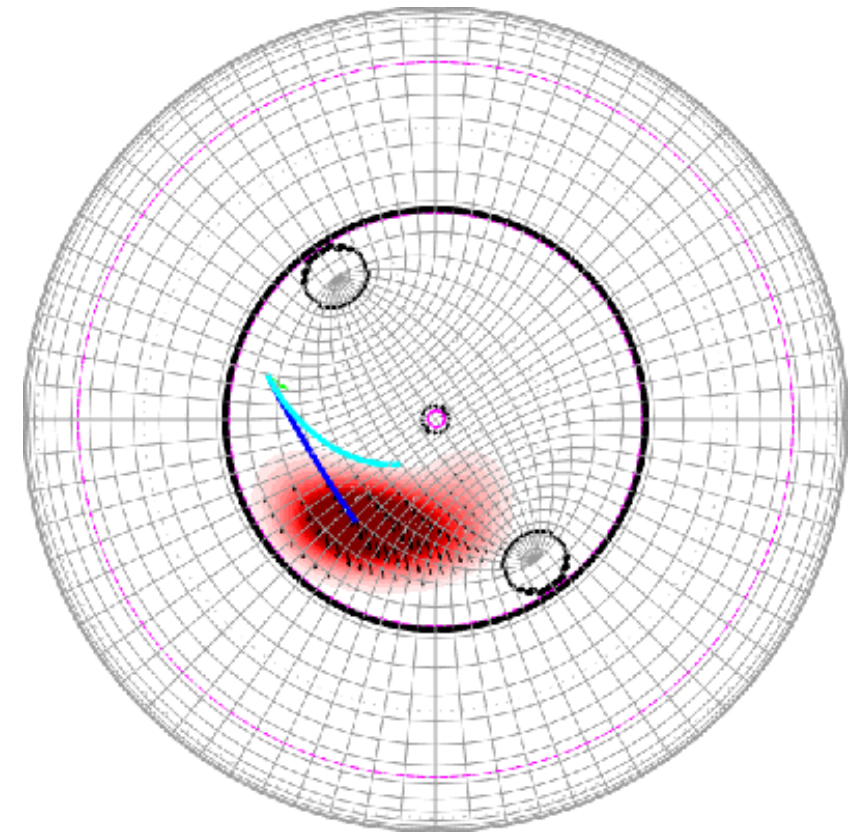
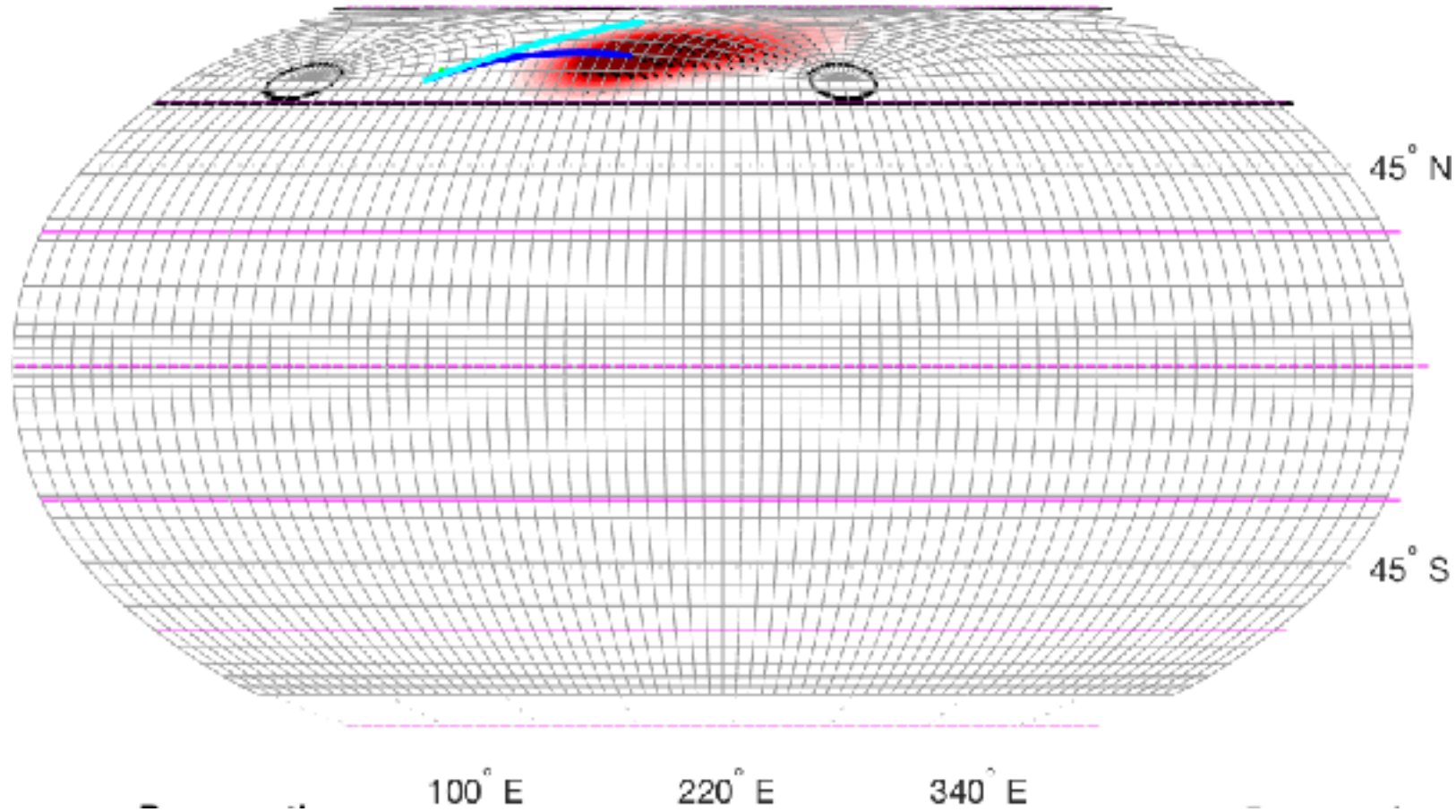


t=60000

Direction of propagation

Direction of propagation without correction

Propagation

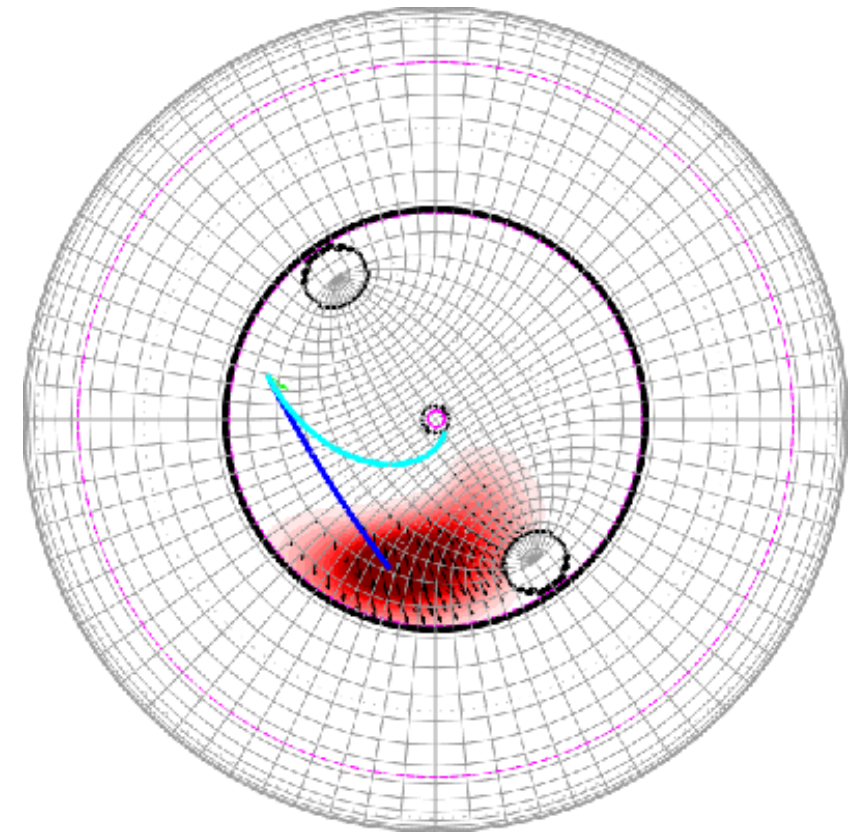
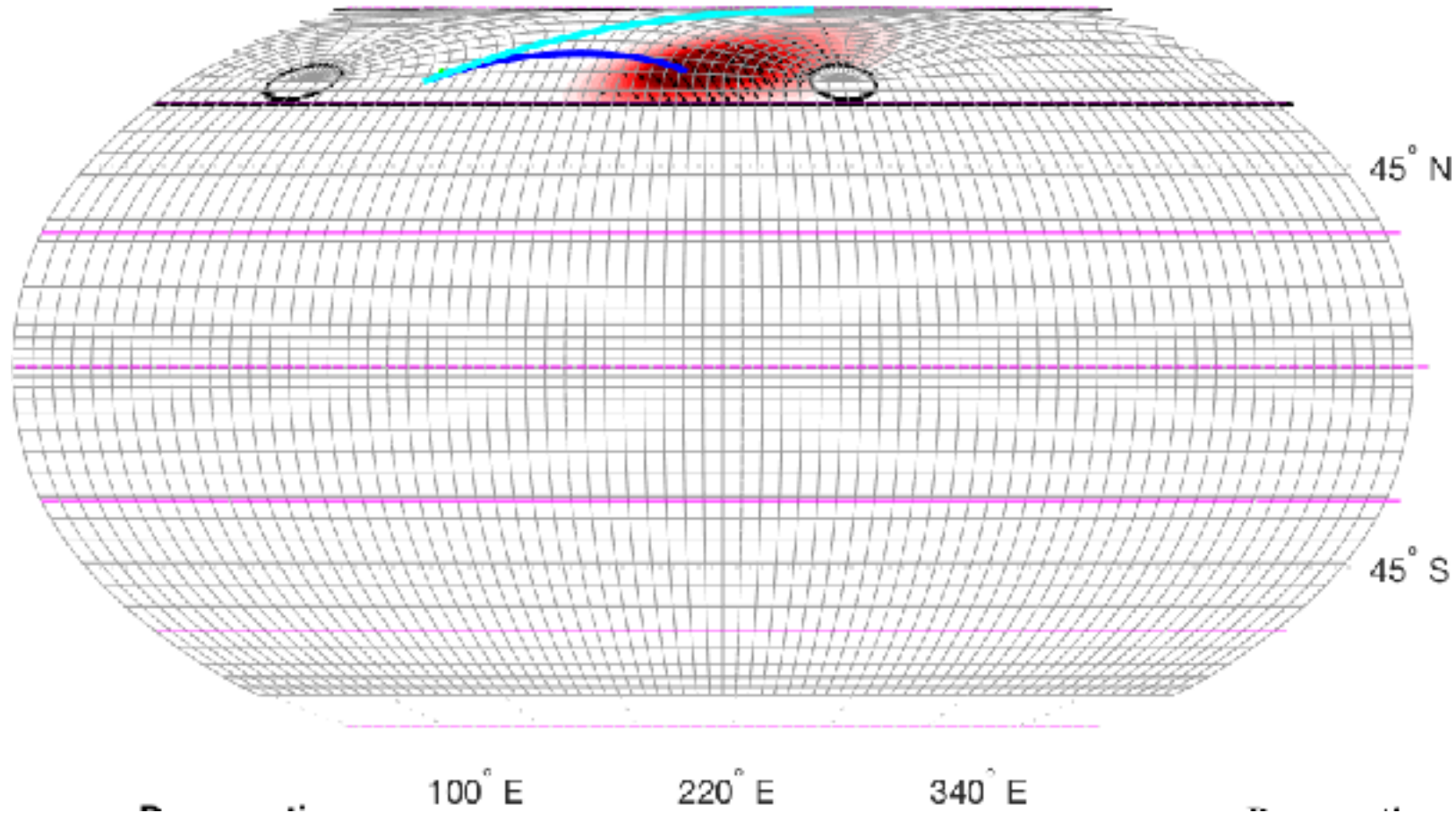


t=90000

Direction of propagation

Direction of propagation without correction

Propagation



t=120000

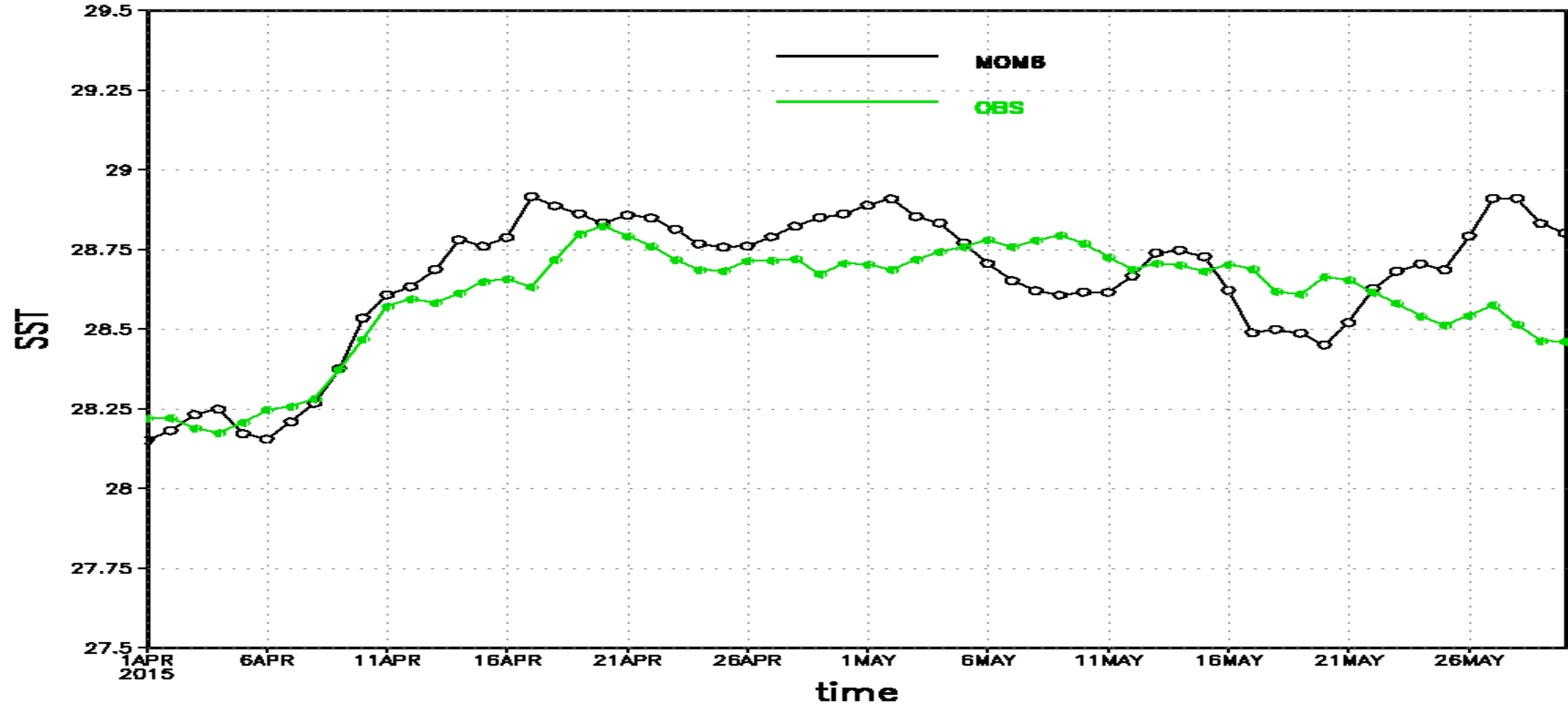
Direction of propagation

Direction of propagation without correction

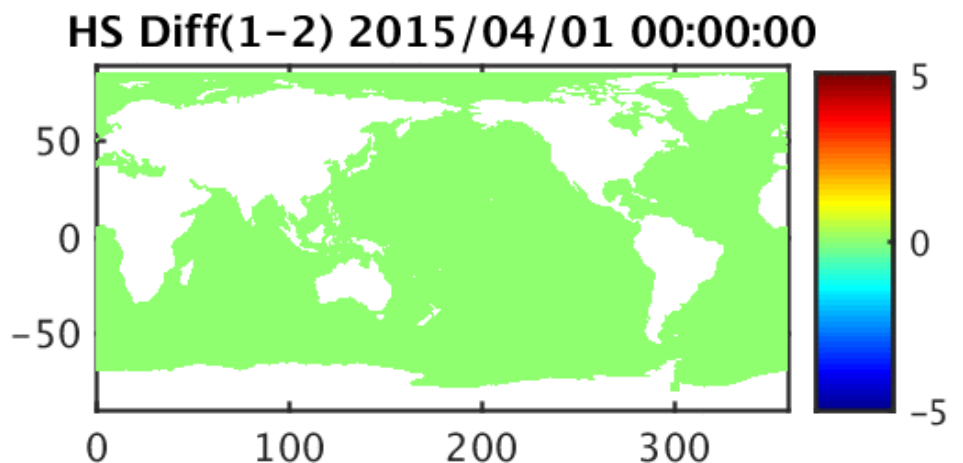
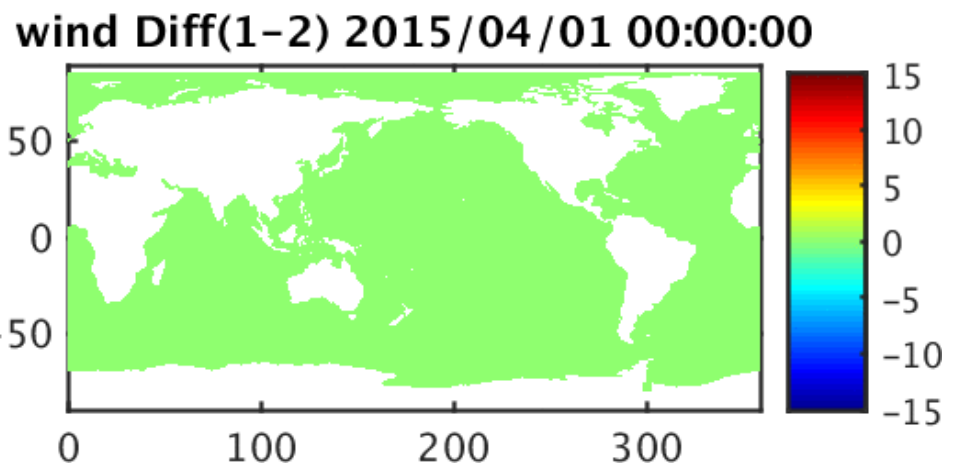
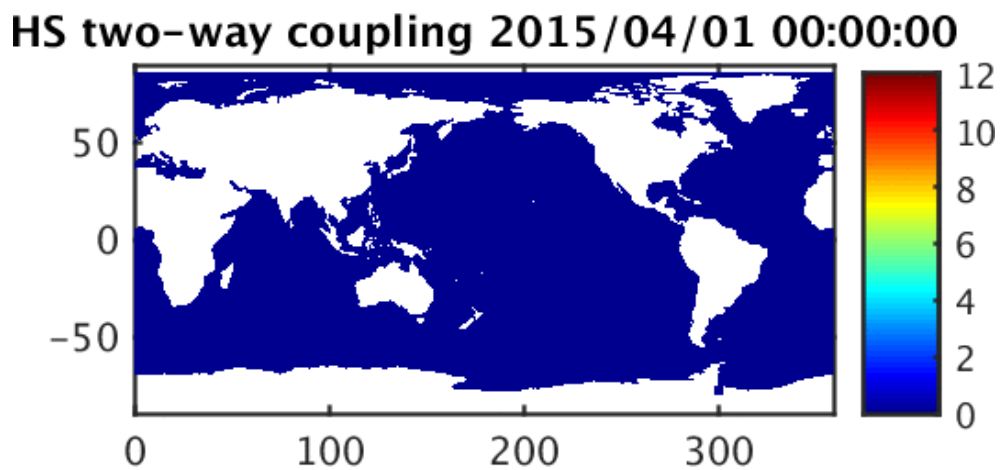
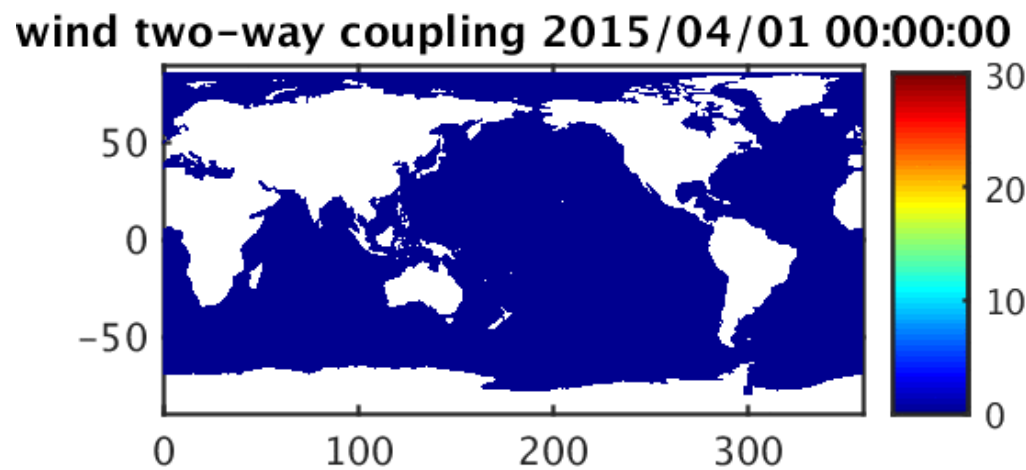
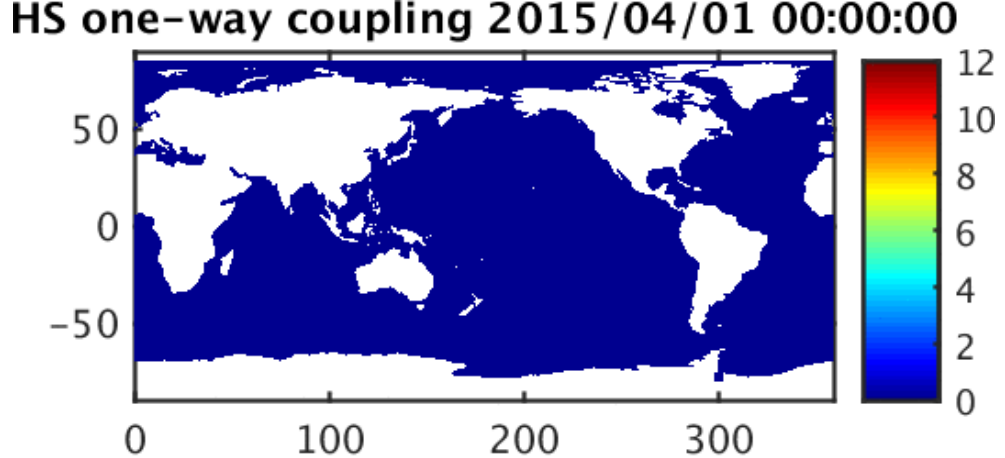
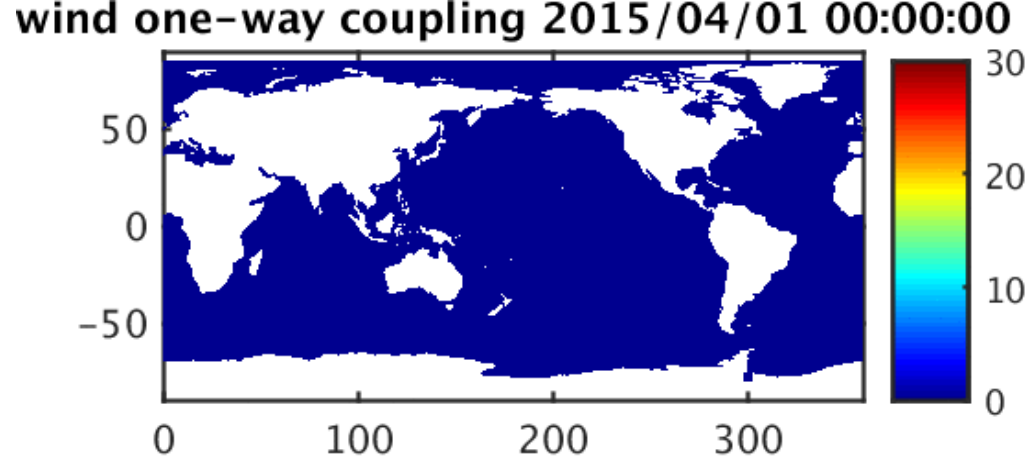
NEMS/NUOPC Infrastructure

- NCEP models use the NEMS framework to couple different earth system models
- NUOPC caps for WW3, GSM and MOM6 are ready
- NUOPC cap for FV3 under development
- Flux fields for Langmuir mixing being added

Nino34 index



WIND



Significant Wave Height

Conclusions

- Coupling framework for GSM, MOM6 and WW3 is in place
- Initial work on passing fluxes between atmosphere and ocean and between atmosphere and waves have been completed
- Upgrades completed to WW3 (propagation over the poles) and to MOM6 (Langmuir mixing processes) and have been tested in uncoupled situations
- Ready to begin benchmark runs to quantify the impact of wave – ocean mixing on sub seasonal to seasonal scales
- These components will form the framework of the next gen seasonal forecast system at NCEP