Simulations and Analyses of Global NEMO Models

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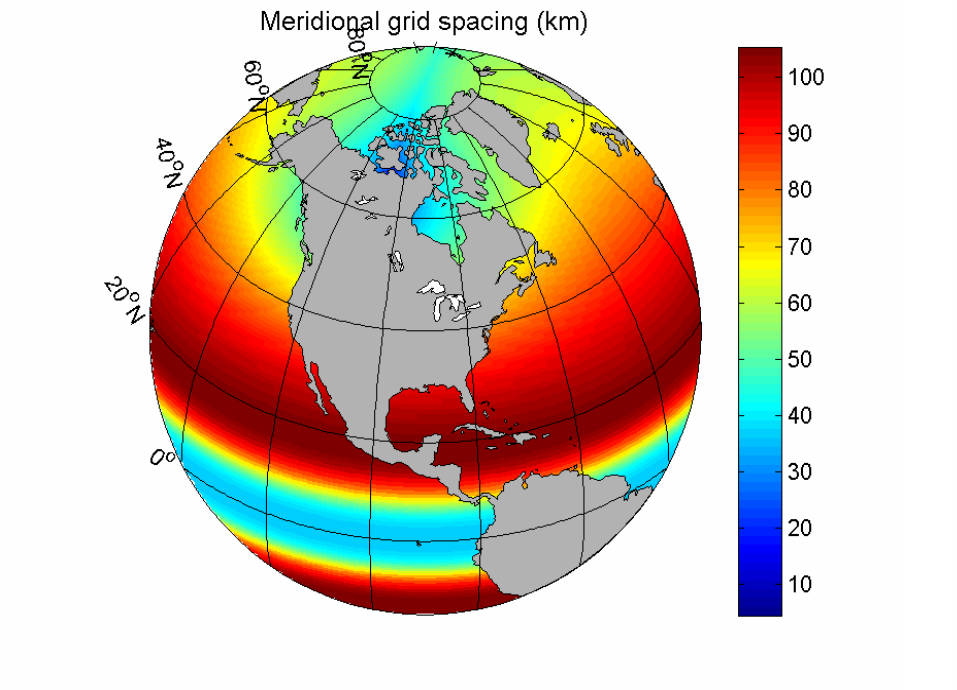
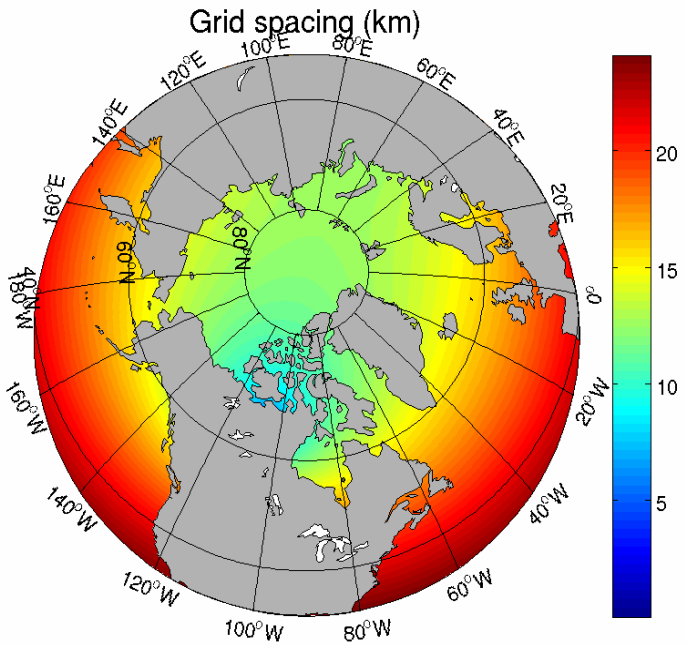
Two Global Ocean Models

Horizontal: Global tri-polar grids; finest resolution in CAA

ORCA1: nominal 1° in lat/long; ~23 km grid spacing in CAA

ORCA025: nominal 1/4° in lat/long; ~6 km grid spacing in CAA





ORCA1 **ORCA025**

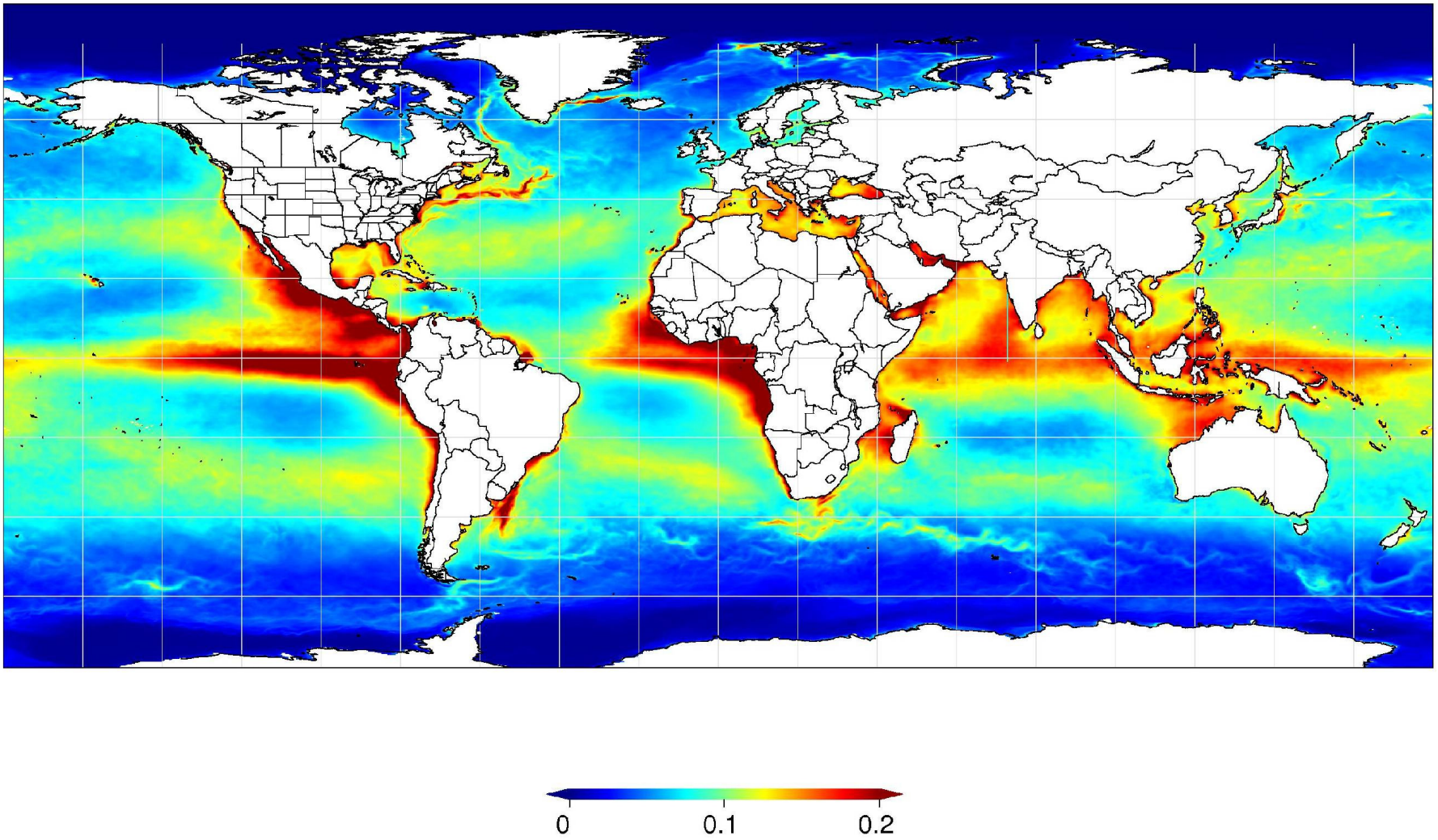
Vertical grids :

50 levels (1 m thick & surface);46 levels (6 m thick & surface)

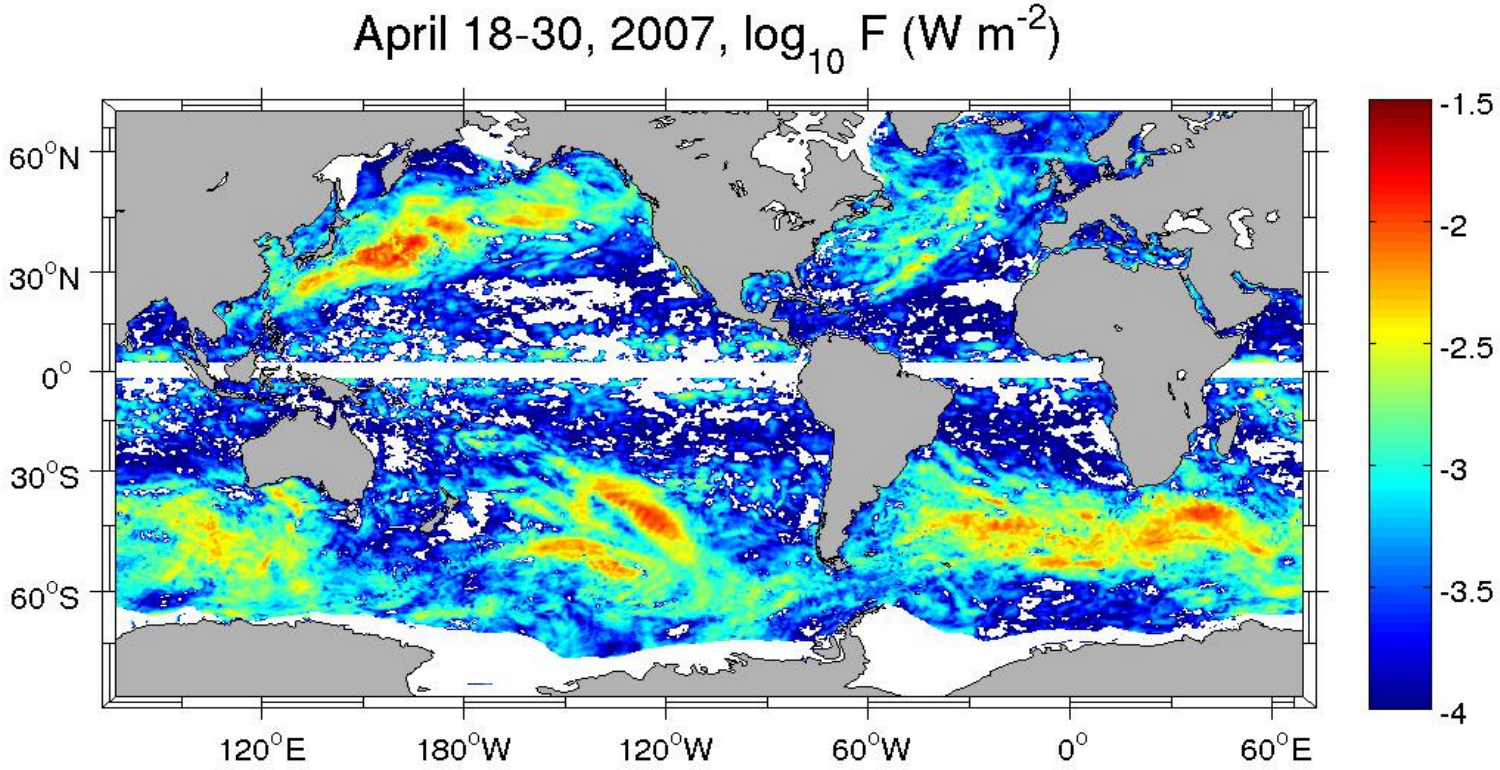
1/4° Global Model Simulations

- 6-year spin-up simulation using daily climatology forcing OMIP, initialized with January T-S climatology
- 10-day forecasting tests (CMC vs. ECMWF forcing)
- 1-year simulation using 3-hourly CMC forcing, initialized with Mercator-Ocean analysis of April 18, 2007

1-Year Simulation with 3-hourly forcing: Standard deviation of diurnal SST variations



Simulation with 3-hourly forcing:
Wind energy input to oceanic near inertial motions



- **Initial estimates based for April 18-30, 2007**
- **High energy flux associated with synoptic storms**
- **Further analyses to reveal seasonal cycle**
- **Comparison to be made with semi-analytic solution**

1° Global Model Simulations

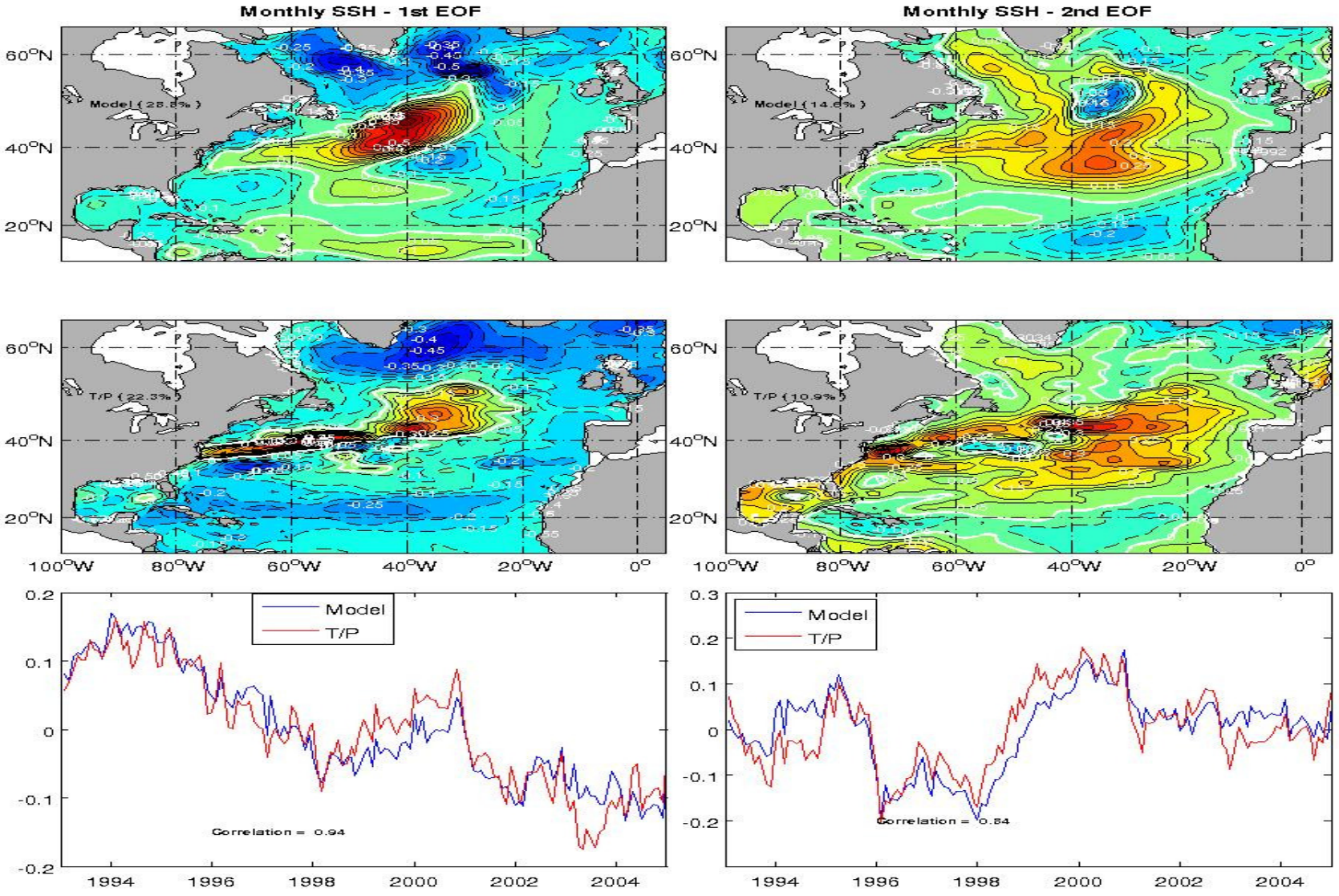
- Spin-up simulations with OMIP climatology and CORE “normal-year” forcing
- 49-year (1958-2006) “Control” simulation using CORE forcing
- Sensitivity experiments:

  HEAT: wind stress set to climatology

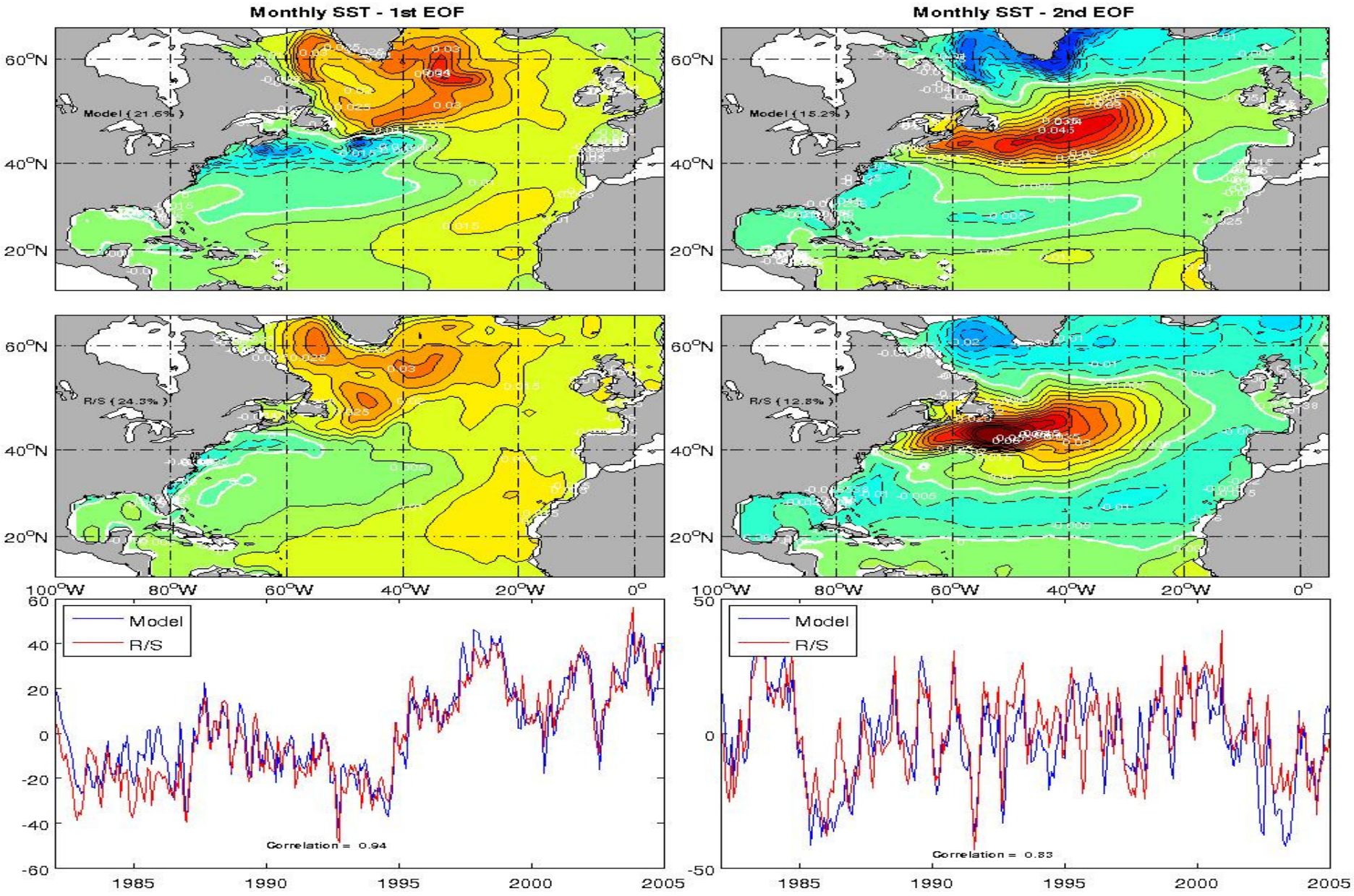
  WIND: buoyancy flux set to climatology

  MJO: wind stress = climatology + MJO

Model Validation: Sea Levels (1993-2004)

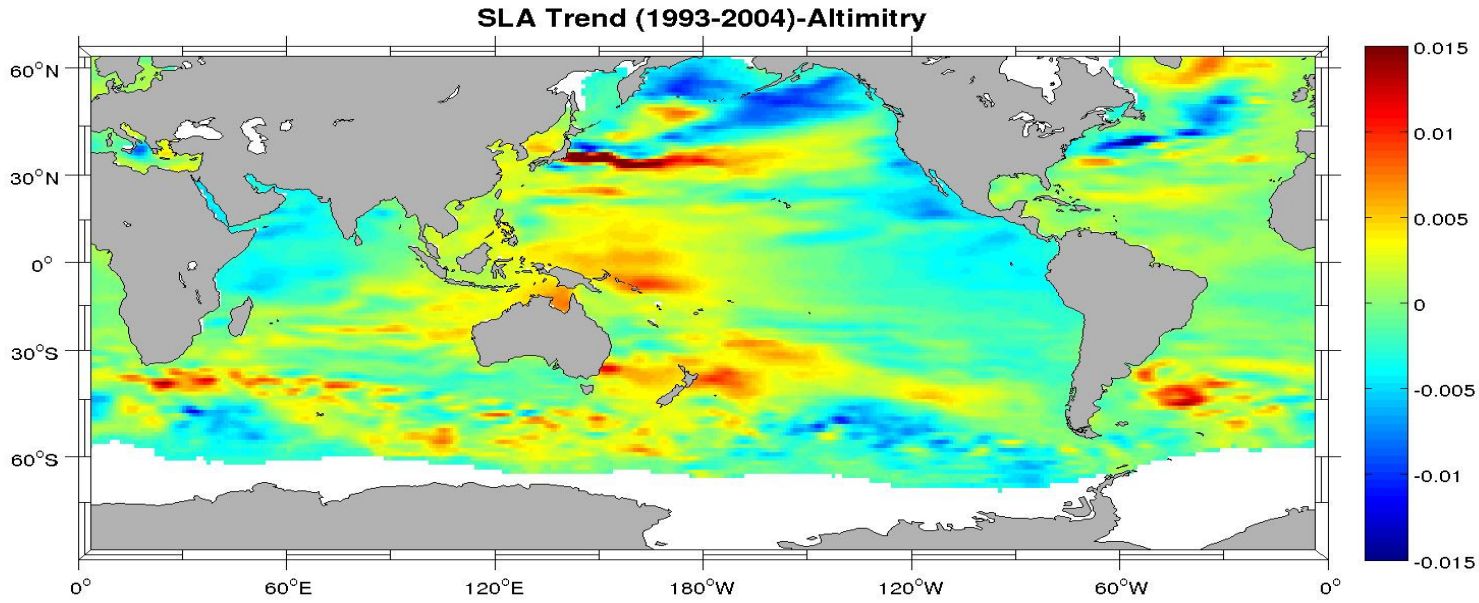


Model Validation: SST(1982-2004)

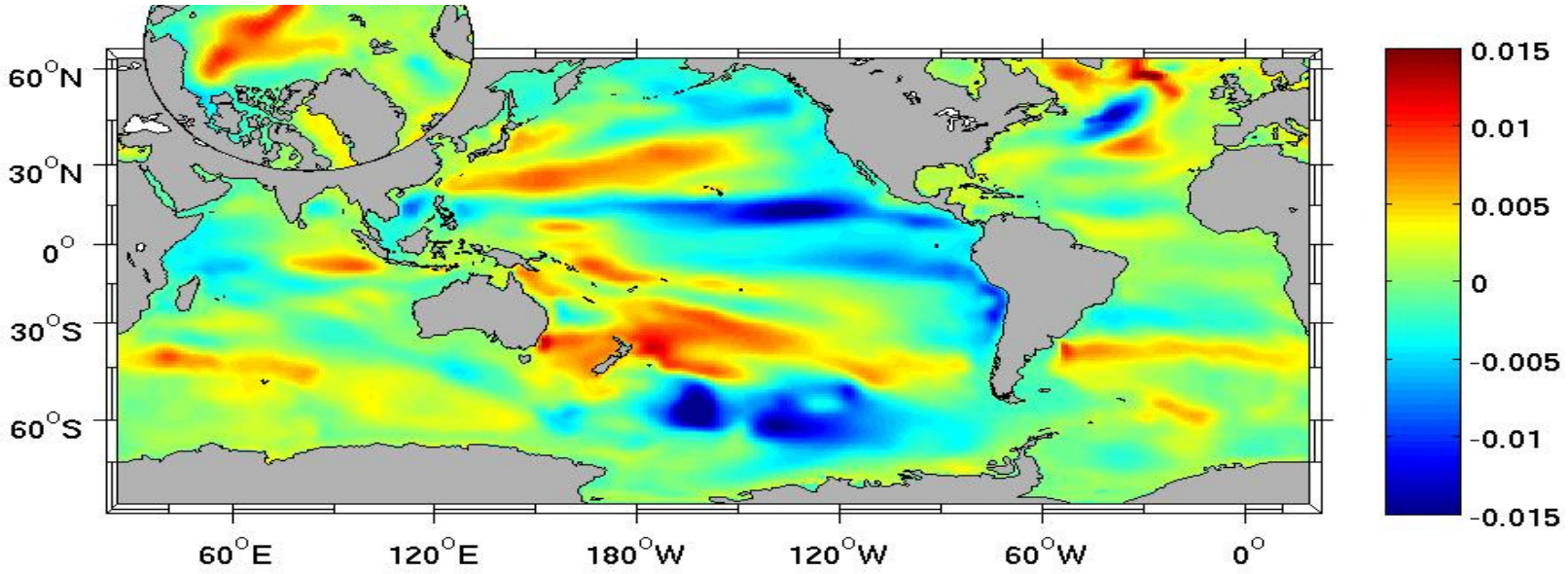


Sea-Level Trend 1993-2004 (m/yr)

Obs

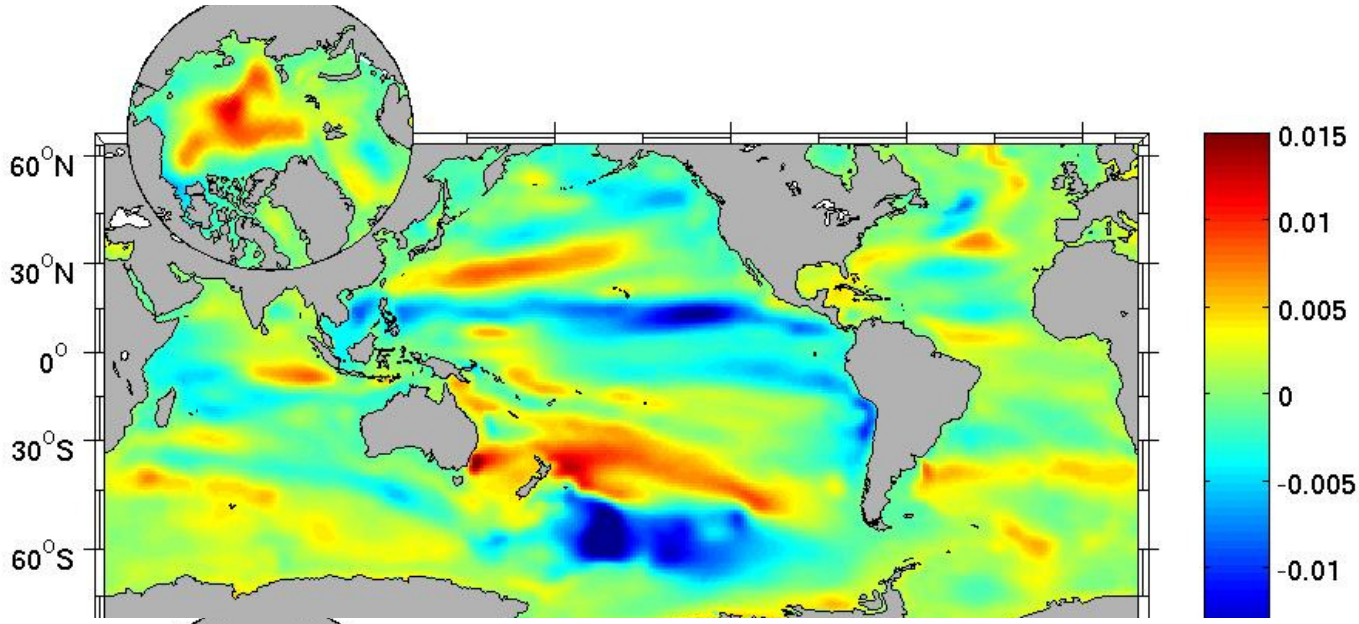


Model

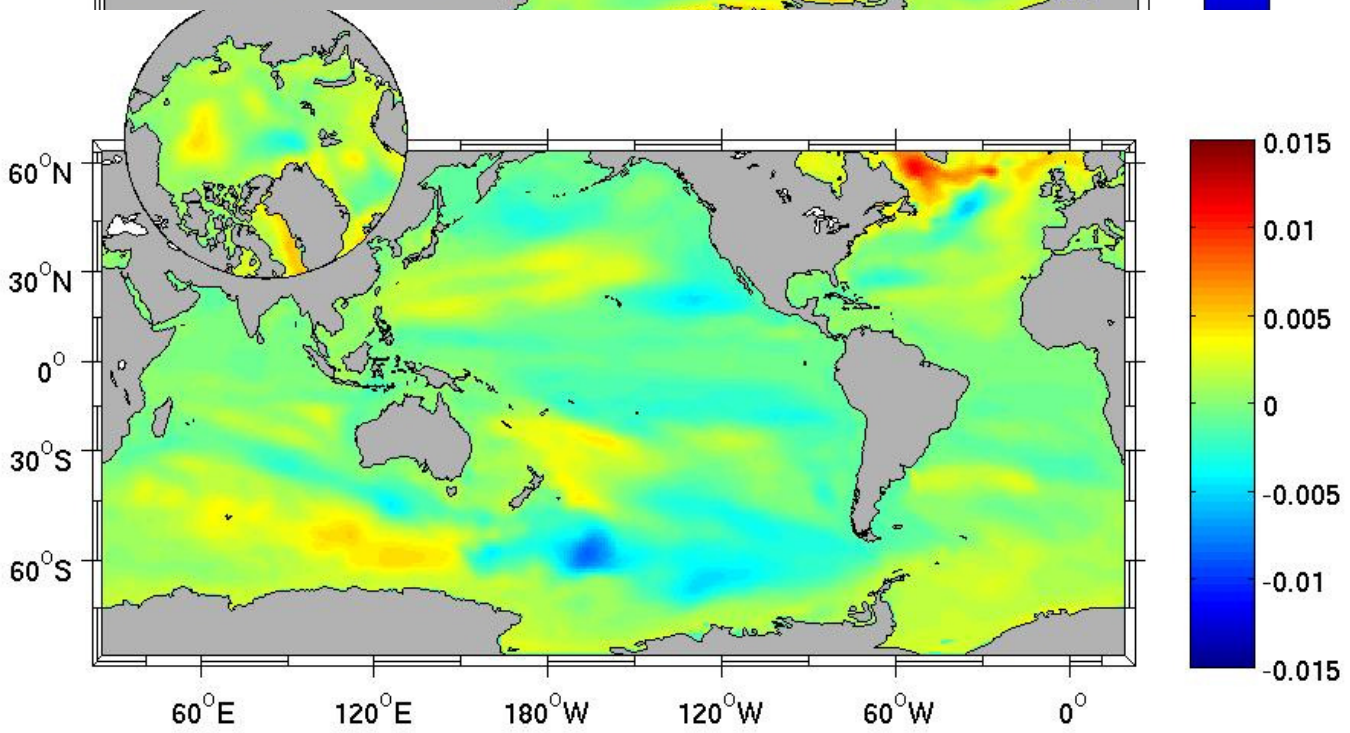


Forcing sensitivity

Wind

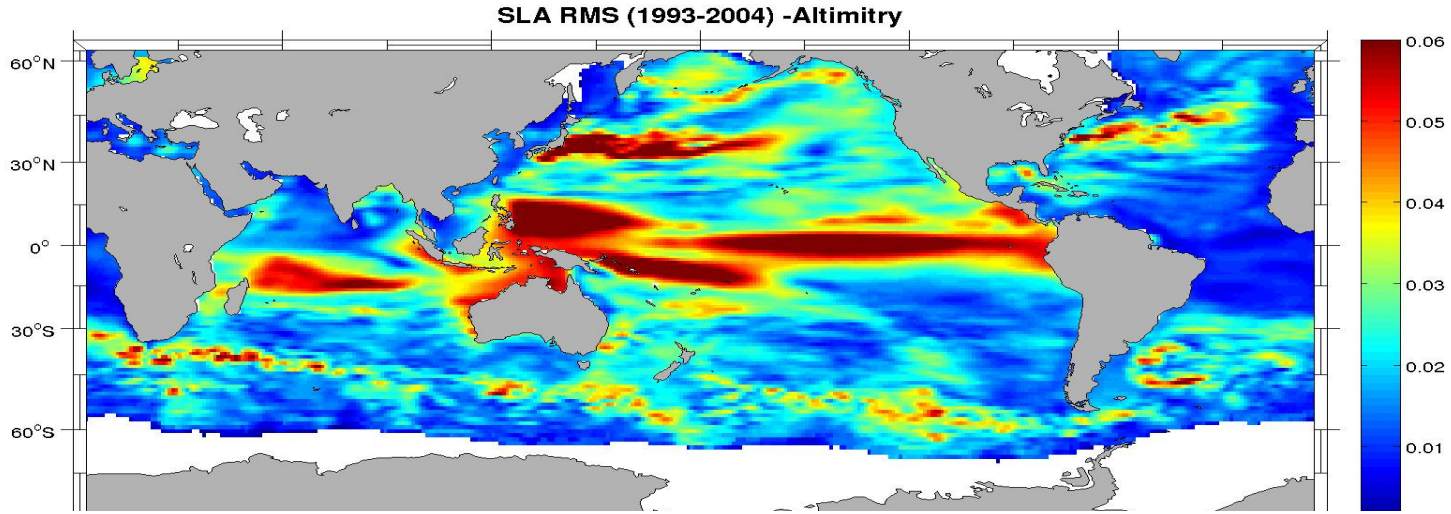


Heat

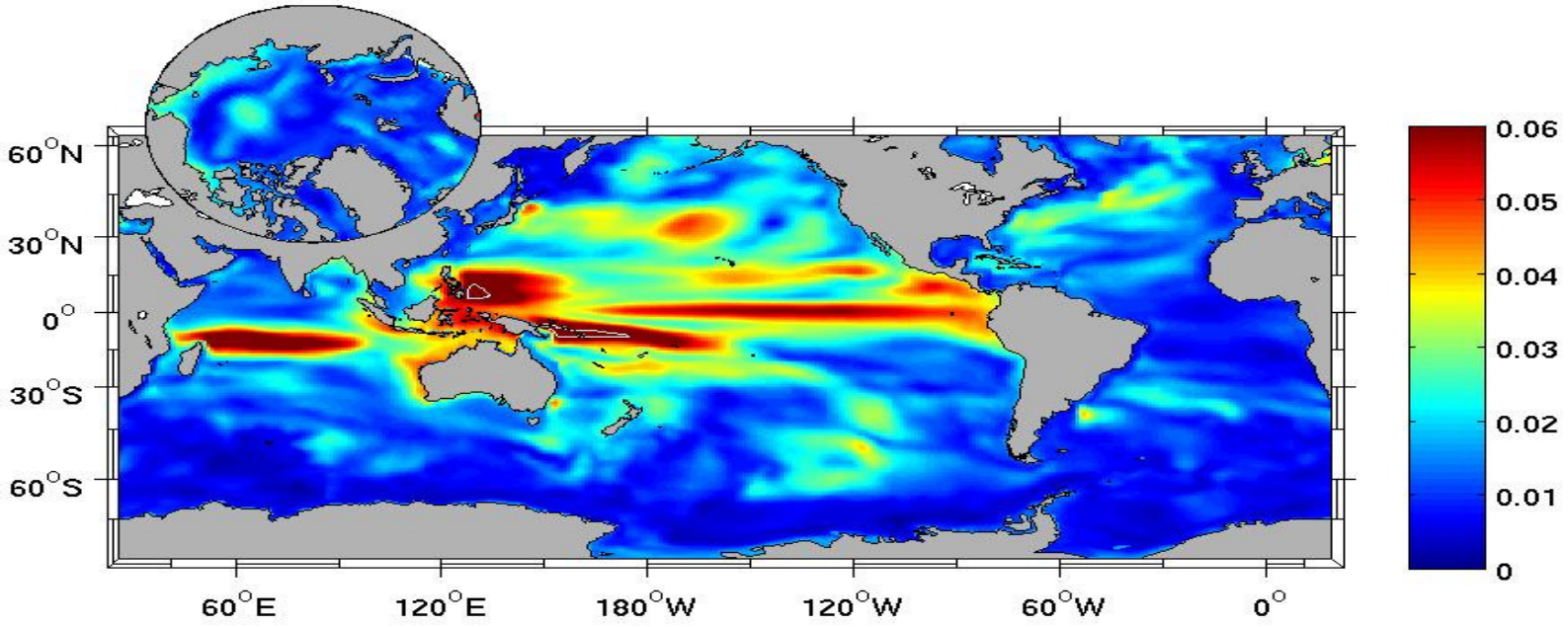


Inter-Annual Sea-Level RMS 1993-2004 (m)

Obs

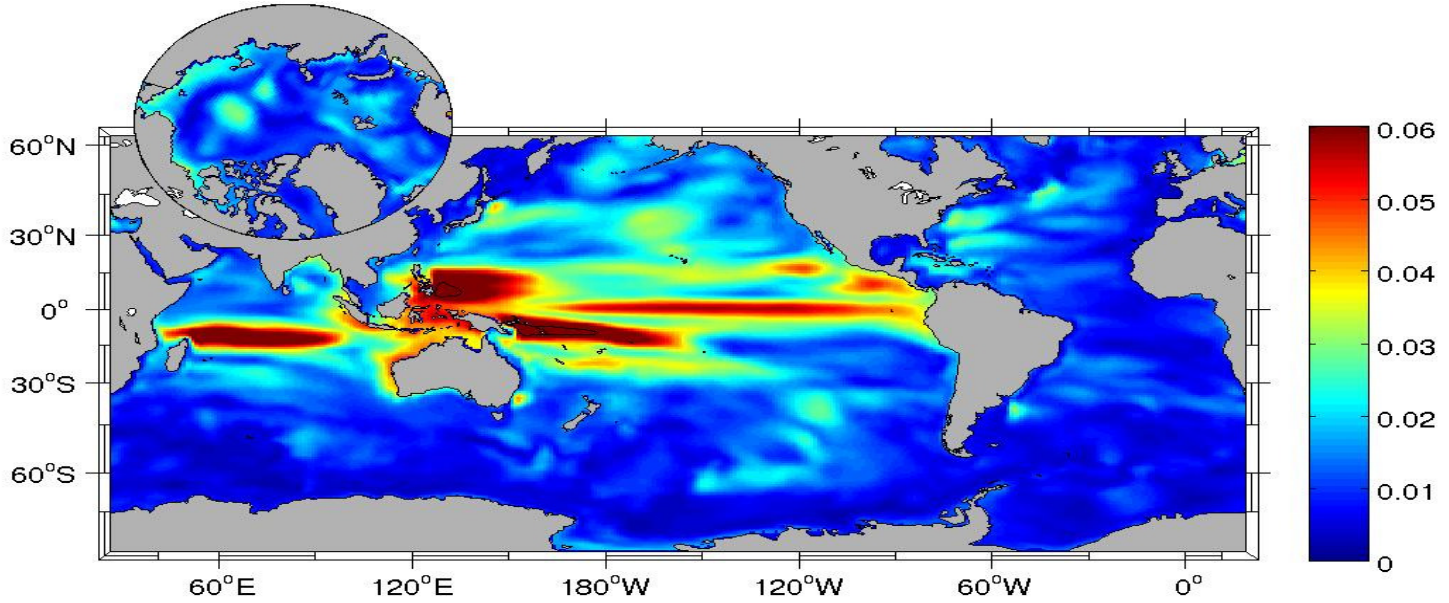


Model

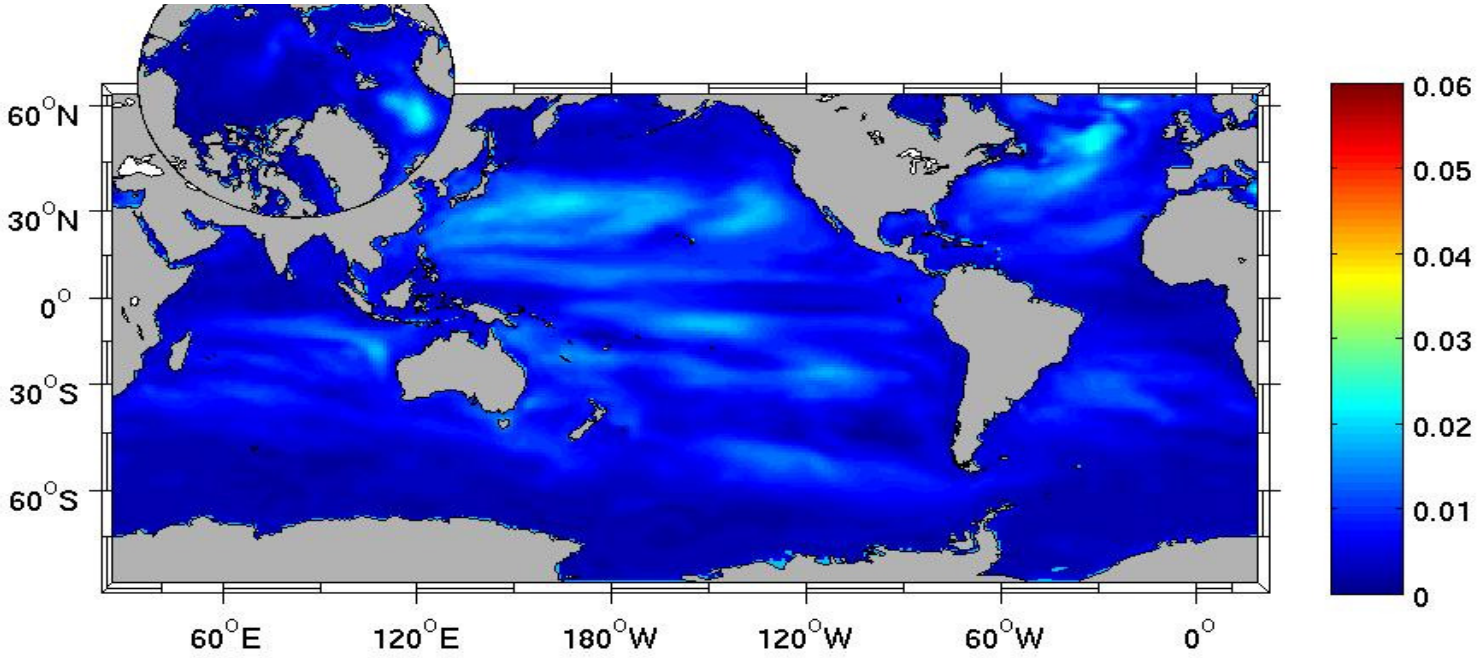


Forcing sensitivity

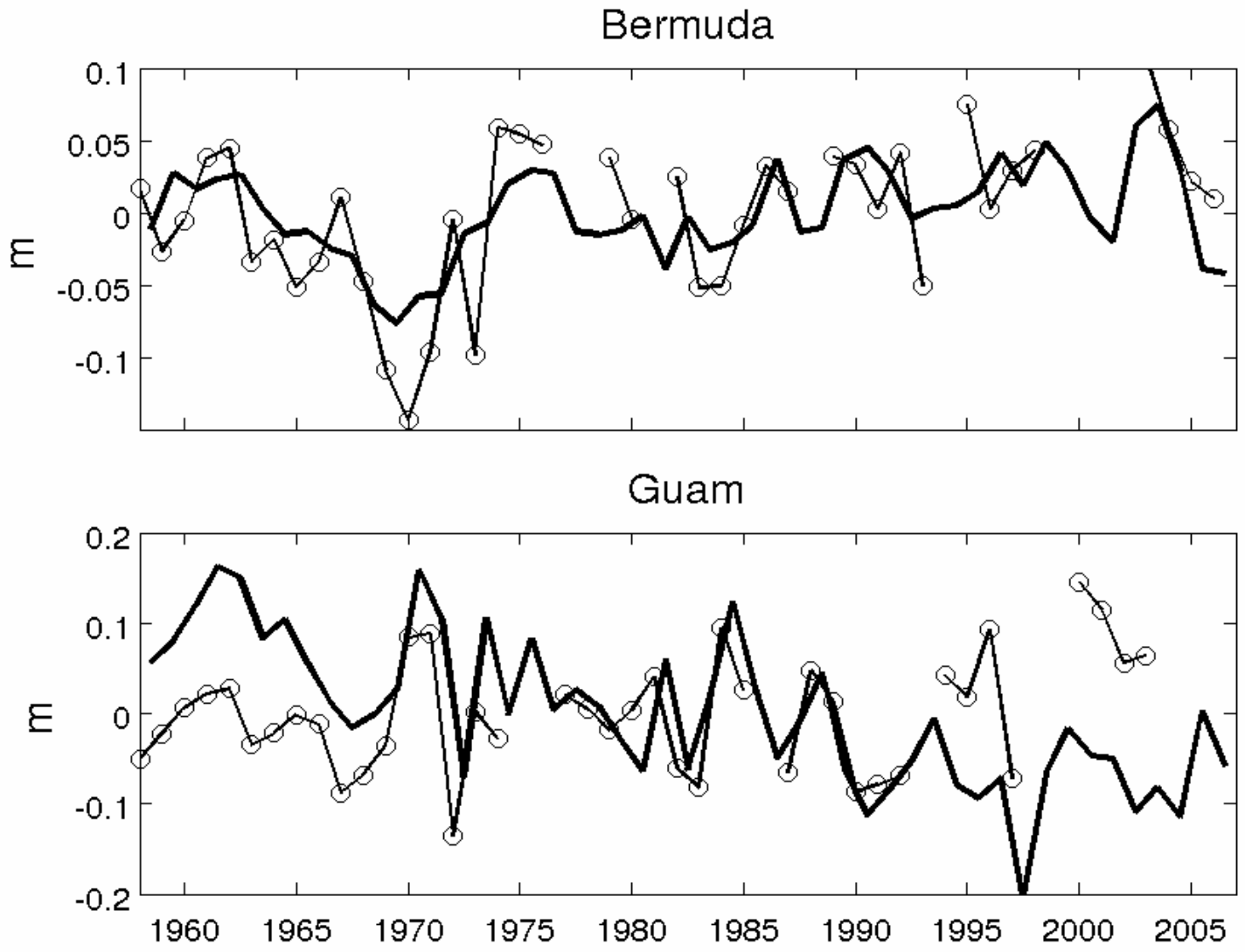
Wind



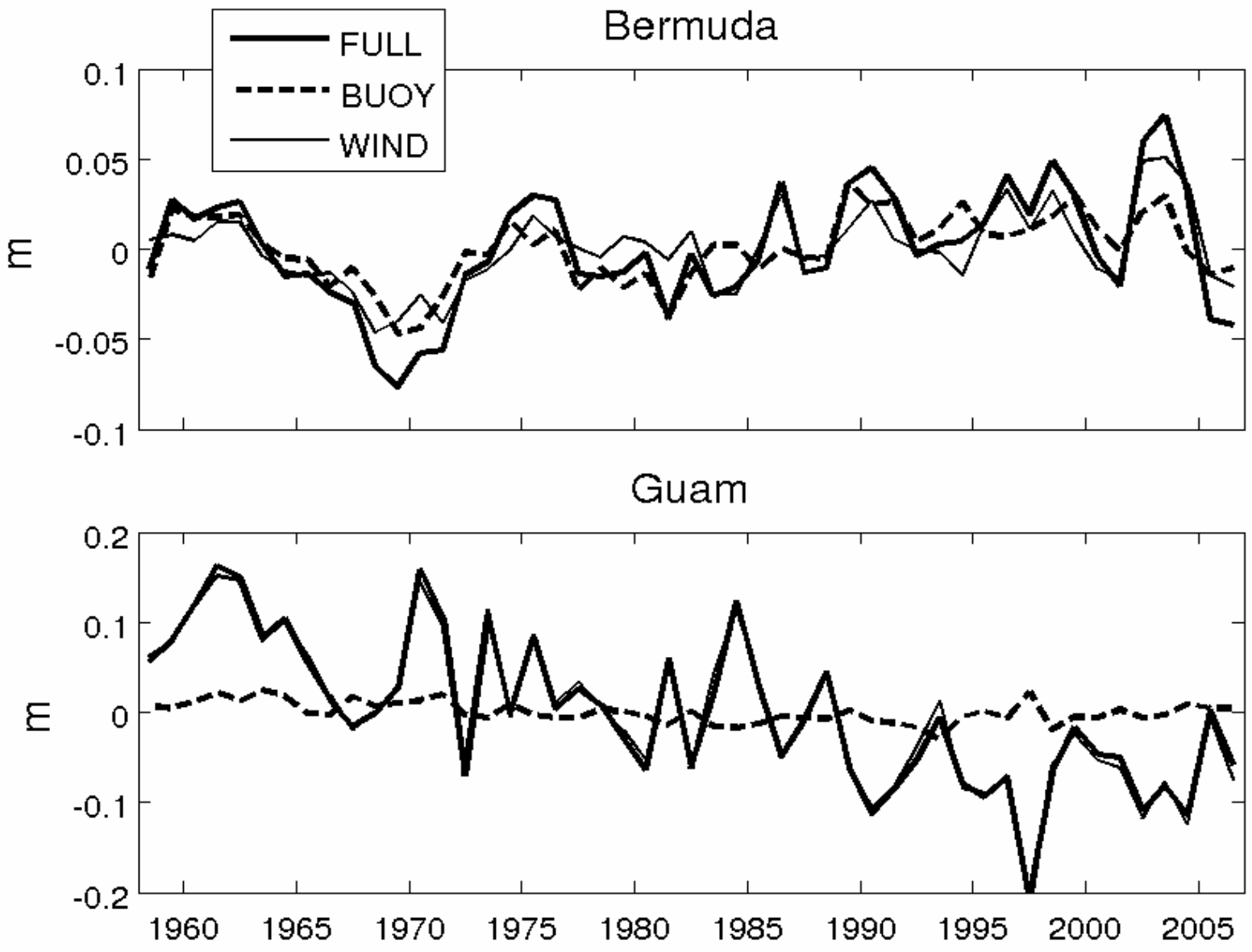
Heat



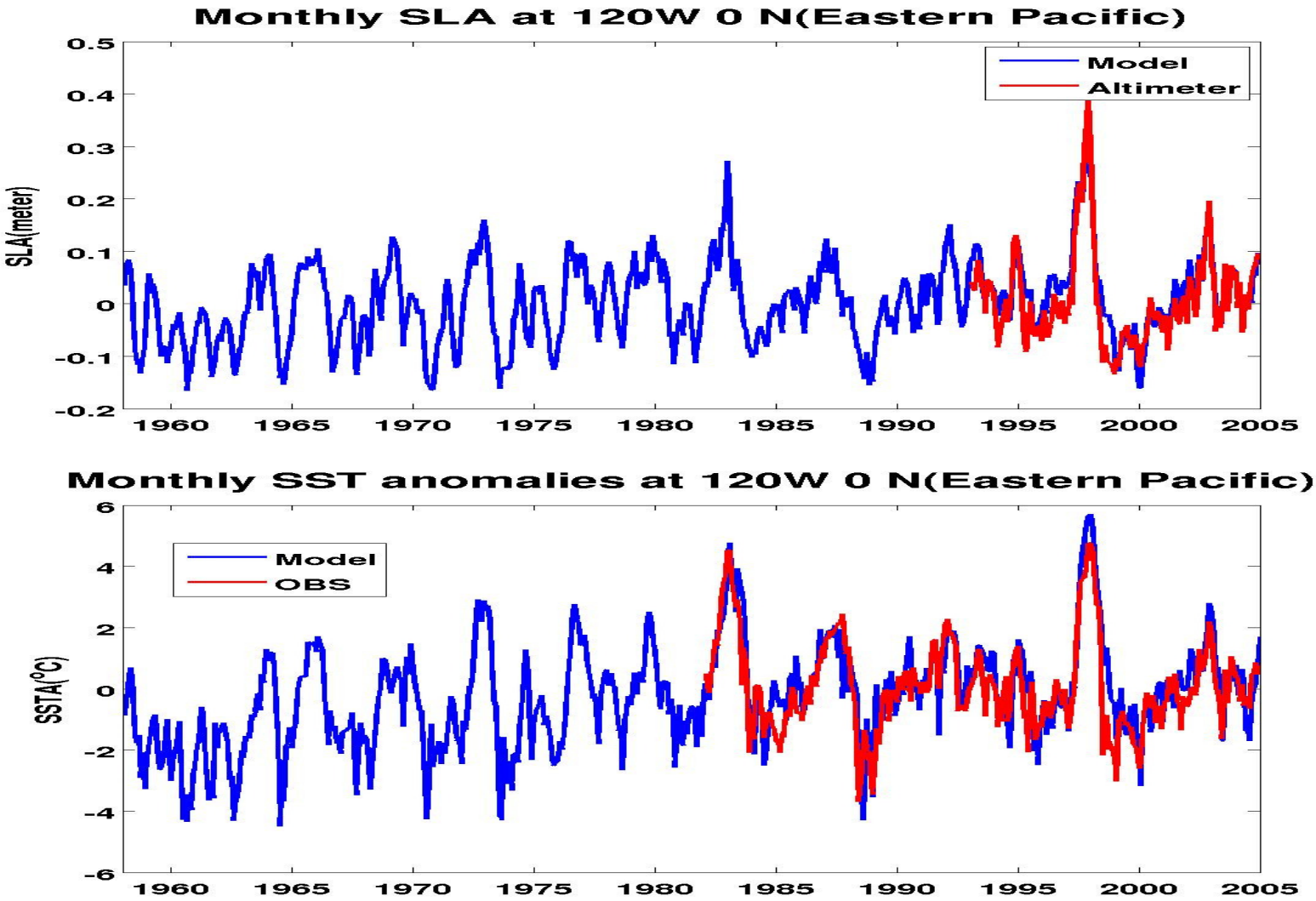
Mid-Latitude Variability



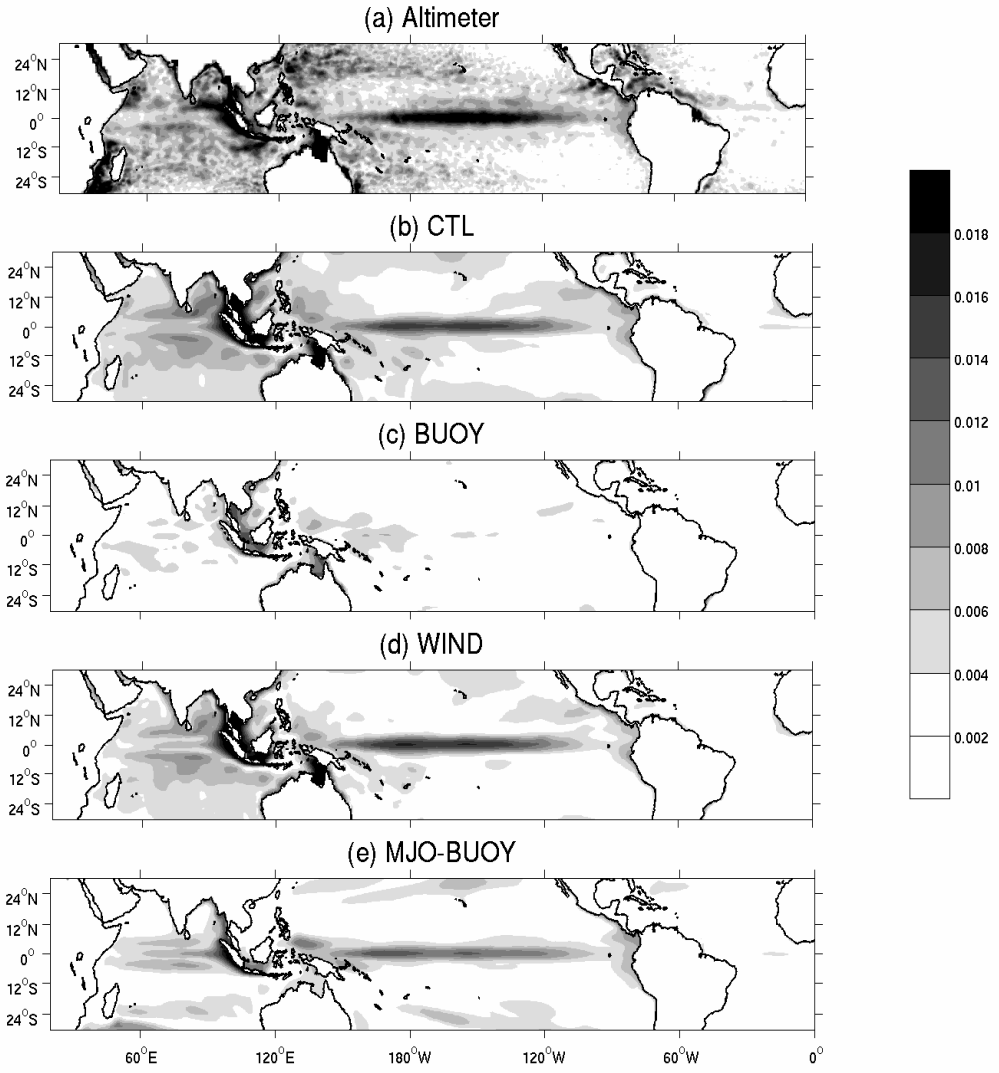
Forcing sensitivity



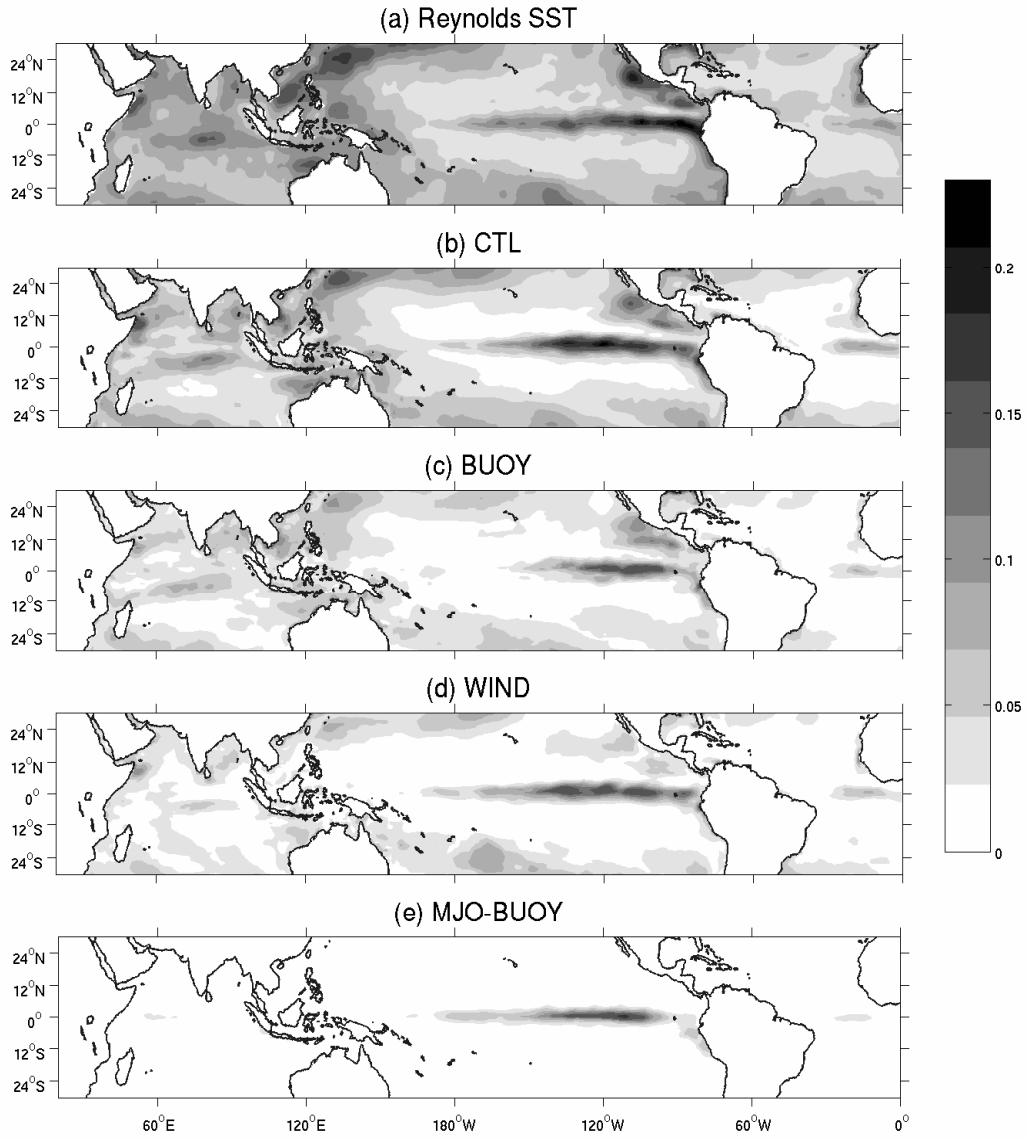
Tropical Pacific Variability



MJO-related Sea Levels

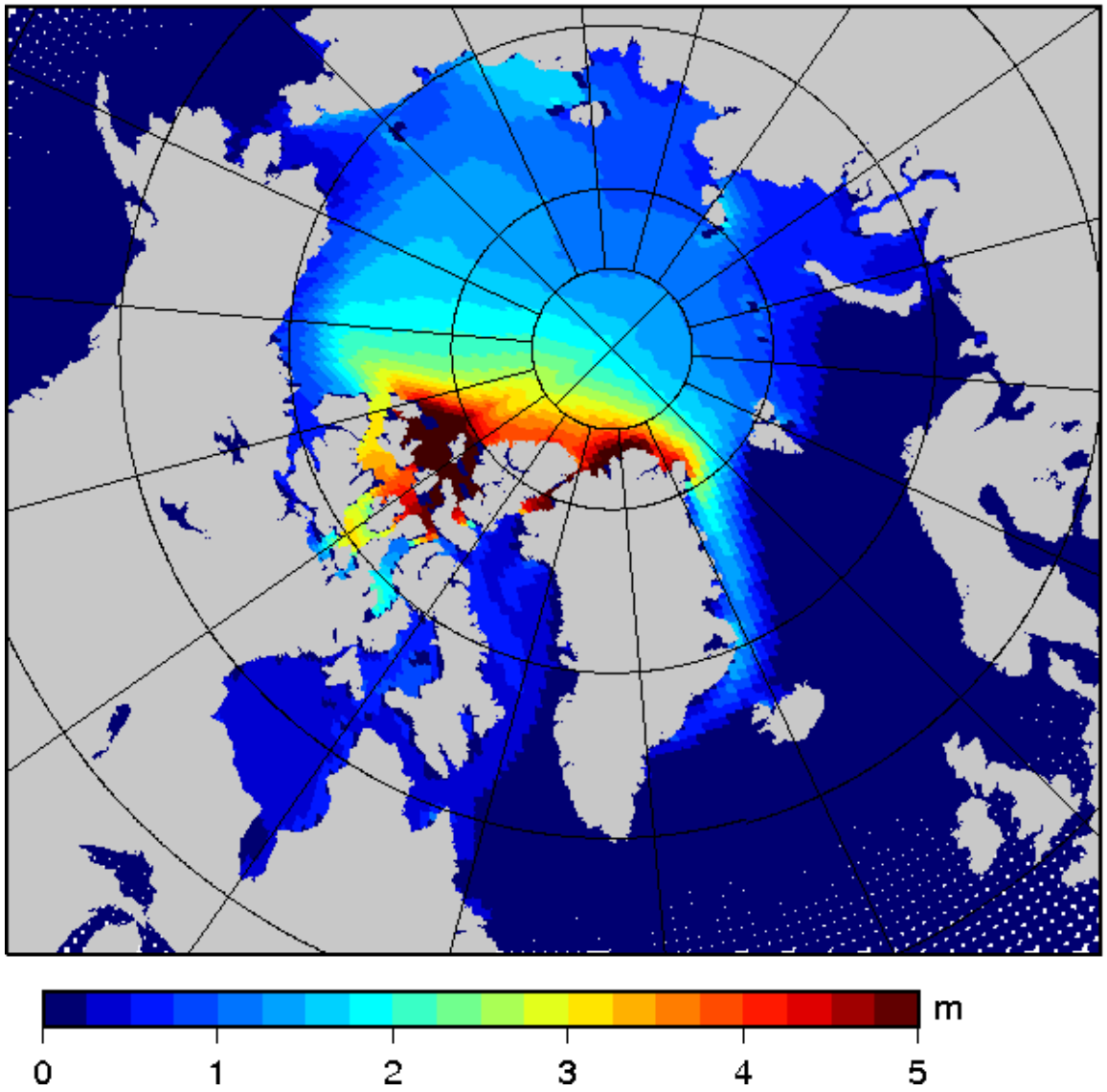


MJO-related SST

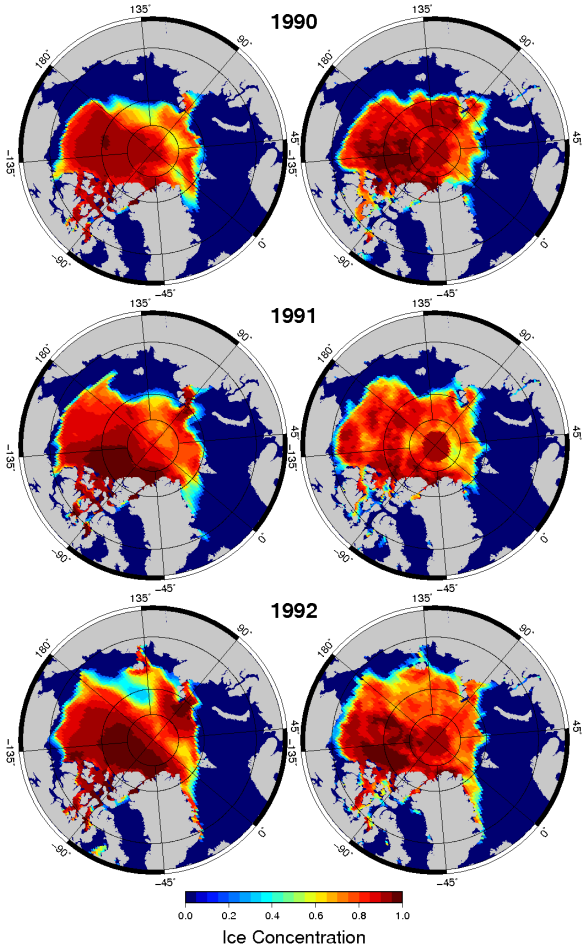


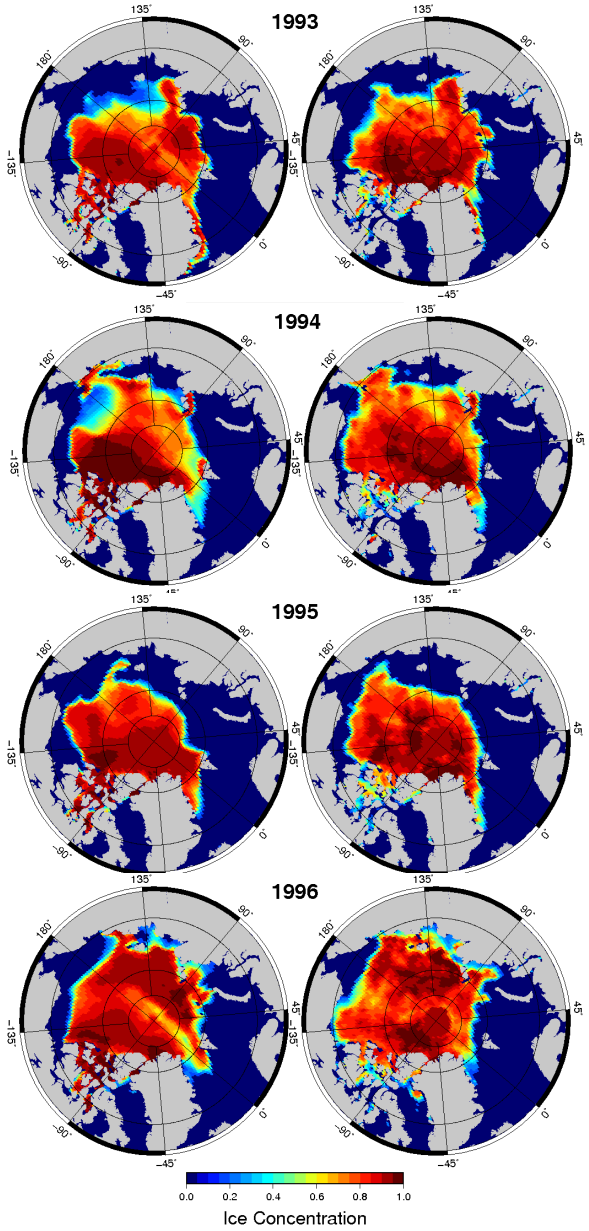
1º Model: Annual Mean Ice Volume

(thickness x concentration) for 1979-2006



September Ice Concentration 1990-1996 Arctic

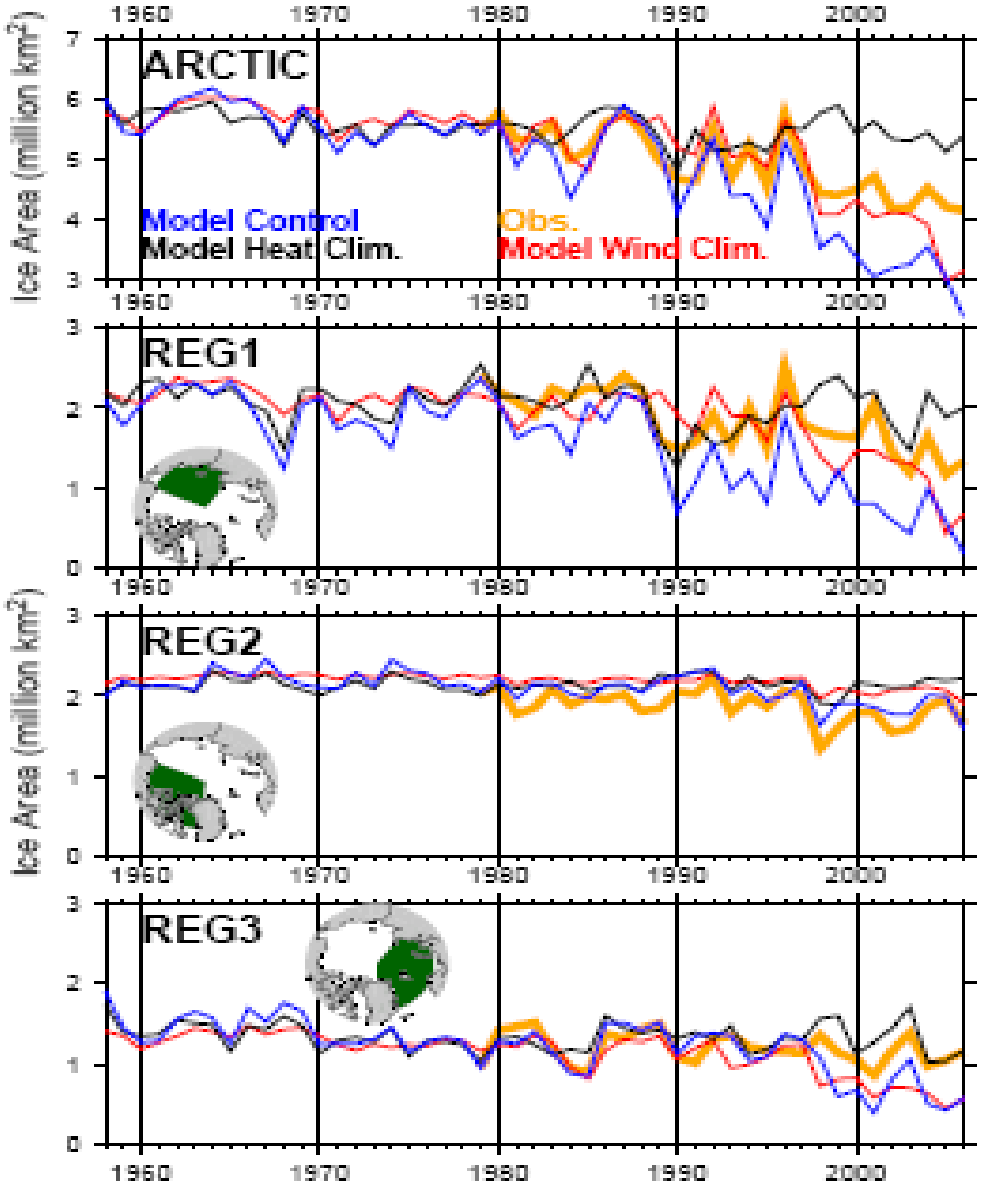




Control run (left)

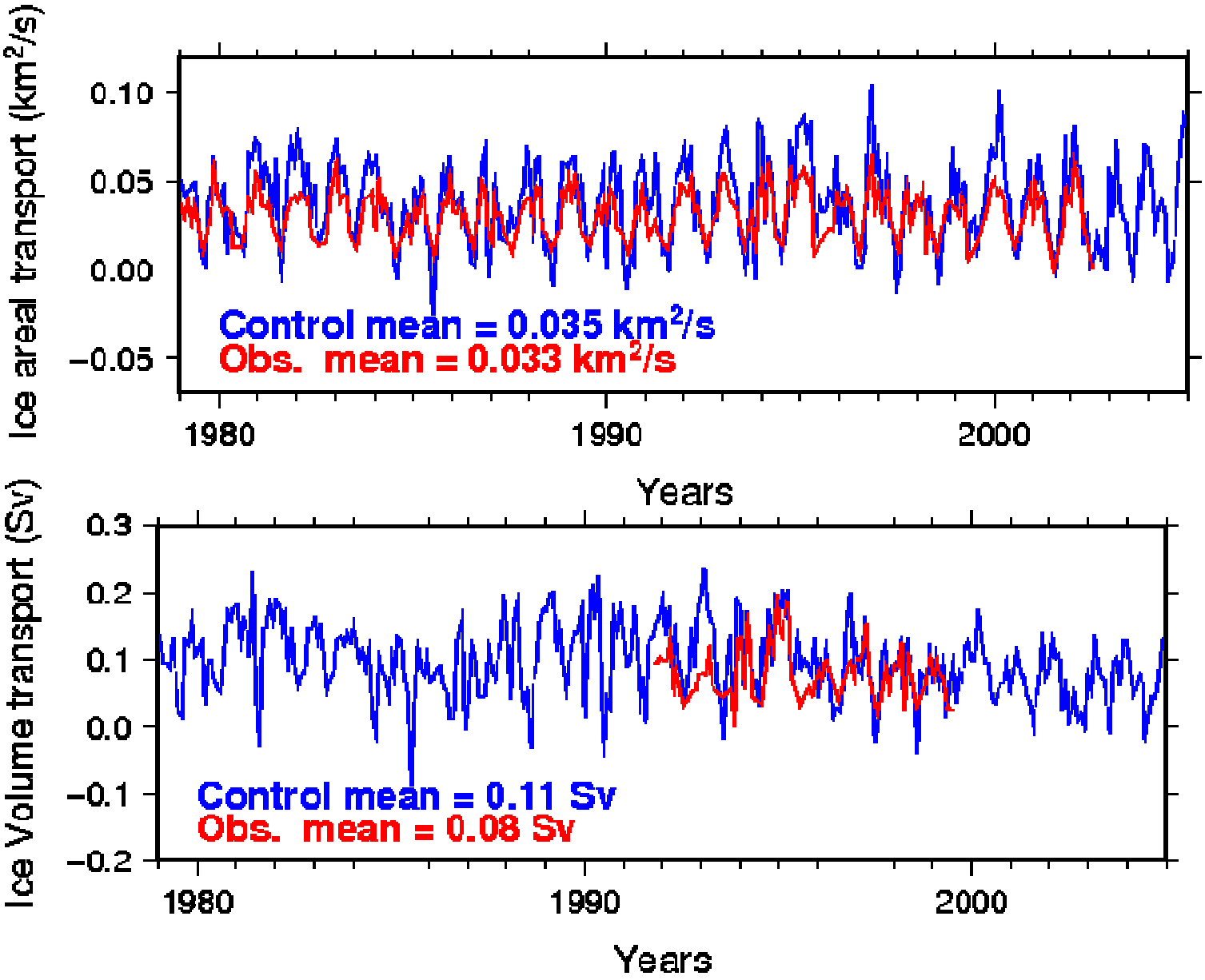
Obs. (right)

Arctic Ocean: September Ice Area



- **Summer ice area change is intensifying in satellite era;**
- **Changes most significant in Pacific sector;**
- **Decline trend is mainly due to heat forcing;**
- **Wind drives non-negligible changes;**
- **Control run reproduces inter-annual changes but overestimates decline trend**

Fram Strait Ice Transport

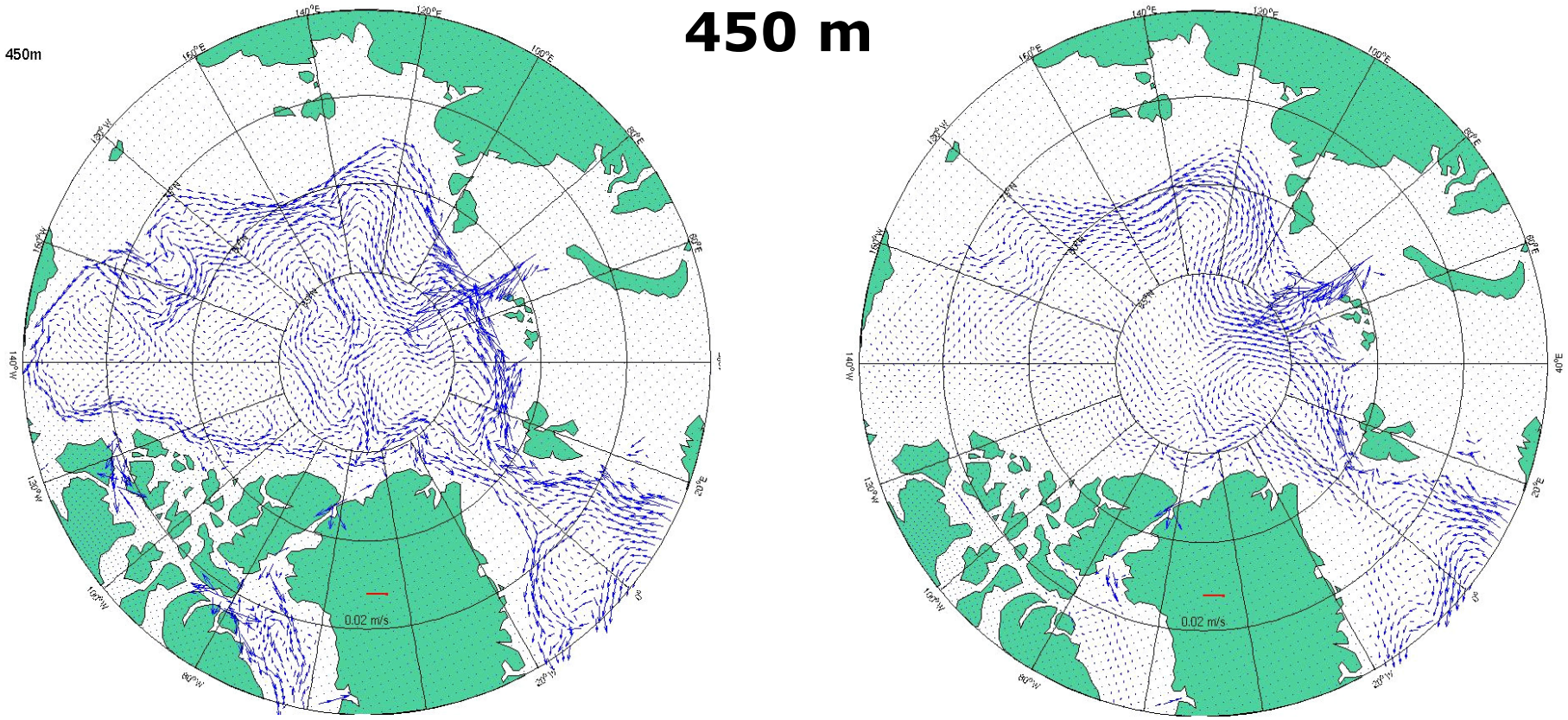


Obs from Kwok et al. (2004)

Arctic Circulation (450 m, 1º Model)

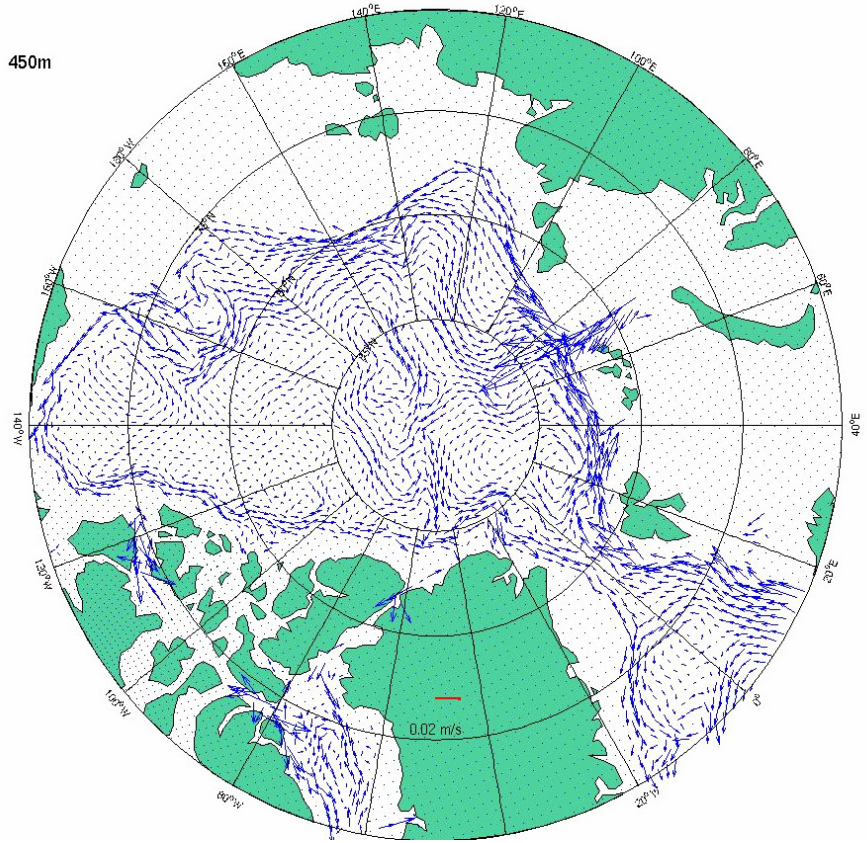
Neptune

No Neptune

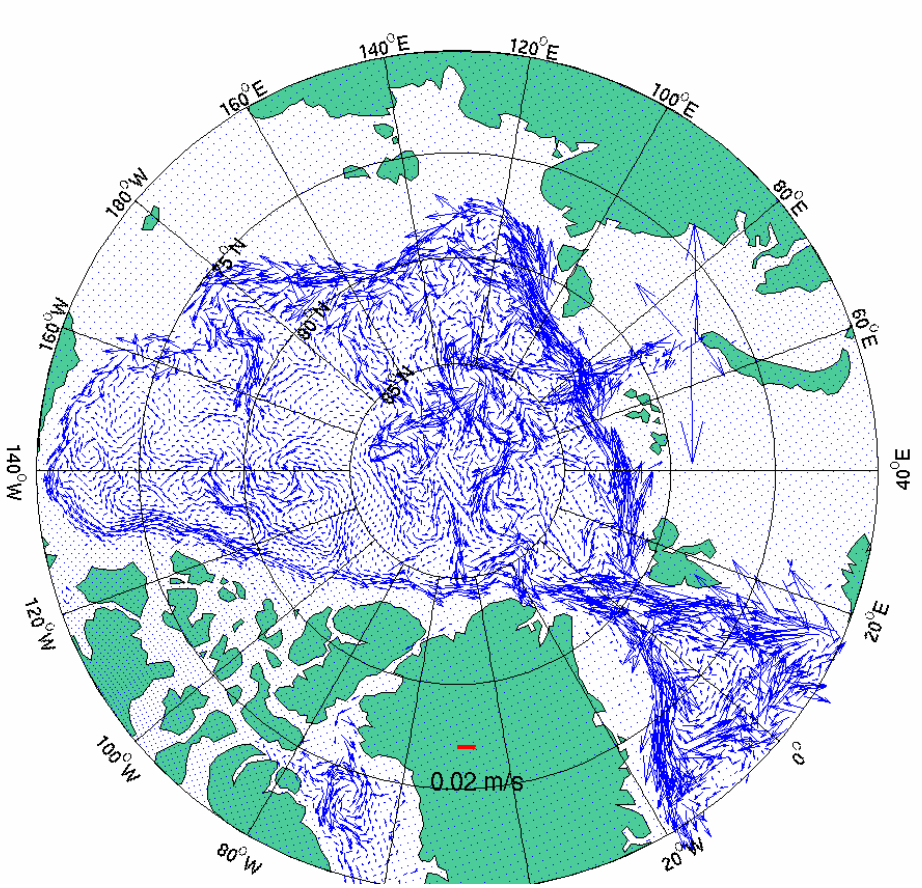


Arctic Circulation (450 m)

1°Neptune



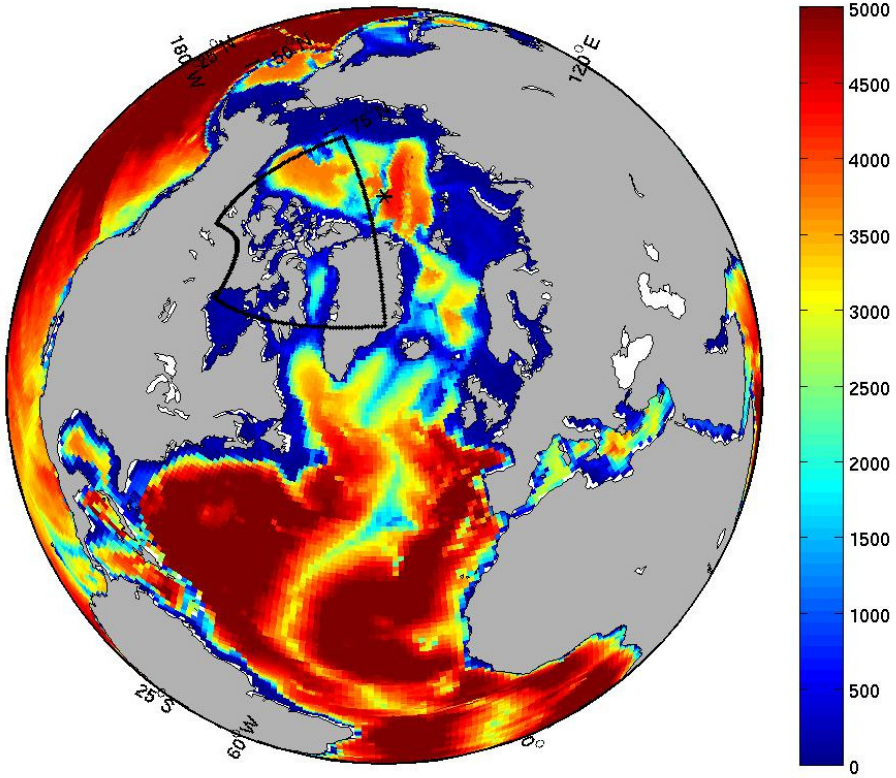
1/4° model



Nesting Approach to Improve Arctic Solutions

- Solutions depend on model resolution: in circulation, and most severely in T-S fields
- ARGRIF in NEMO enables 2-way nesting

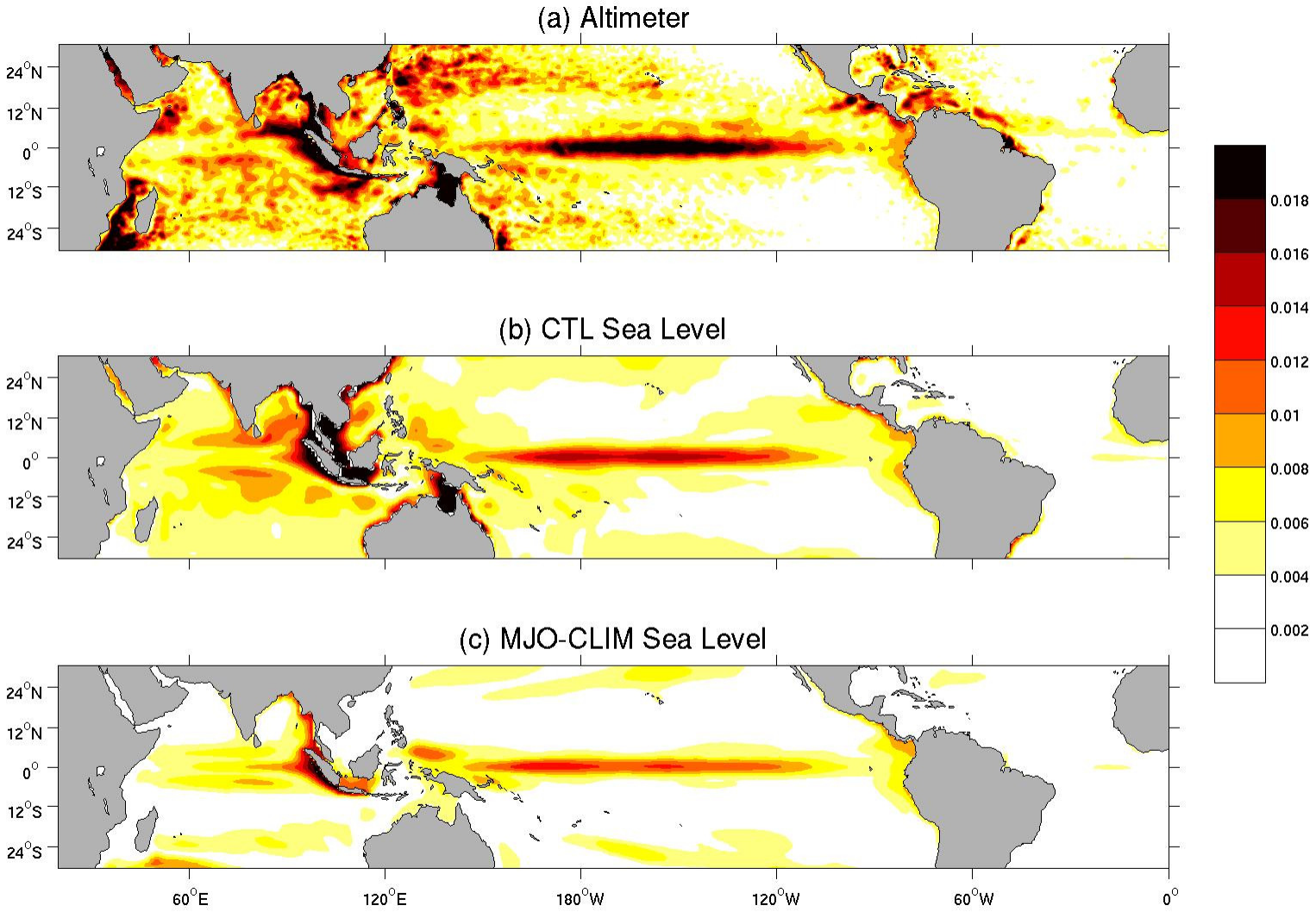
Example: nesting CAA in ORCA configuration



Summary

- **NEMO applications for ocean and sea-ice modelling are coordinated in Canada (thanks to CONCEPTS, GOAPP, etc)**
- **Global models able to reproduce observed ocean variations at various spatial/temporal scales (e.g., diurnal, intra-seasonal, inter-annual, decadal)**
- **Model sensitivity studies reveal dependence of ocean responses to atmospheric forcing, and to accuracy of forcing!**
- **Model solutions depend on resolutions; Nesting using AGRIF will be beneficial**
- **NEMO & coupled NEMO-GEM have great potential for operational and research applications**

MJO-related Sea Levels



MJO-related SST