Evaluation of an ensemble of global ocean circulation estimates using satellite altimetry

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Summary

We compare an ensemble of ocean circulation hindcasts with the Finite Element Sea-ice Ocean Model (FESOM) to the estimates of dynamic topography from Aviso and CSIRO, operational ocean reanalysis by ECMWF (ORAS4) and to the Argo based product from JAMSTEC. The ensemble members used for the hindcasts differ by the initial integration states and by the model grids, where refinement was done in various key regions for the large scale ocean circulation, such as equatorial belt, Denmark Strait, and the mean background resolution.

- ✔ The model results compare to the data within the spread of different datasets
- ✔ ENSO mode explains the major part of comparison between data and model
- ✔ The models under the same forcing differ primarily in the deep water formation regions (mixing schemes + preconditioning)
- ✔ What is a good metric?

Model Setup

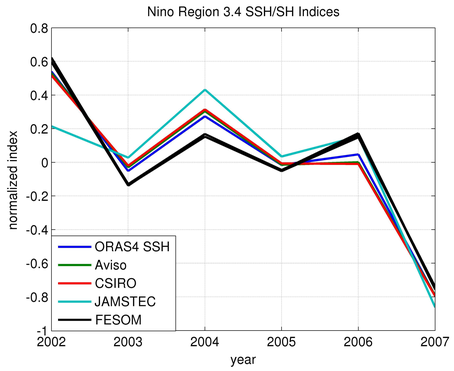
Large and Yeager (2004) CORE2 forcing is used. The model experiments are summarized in the table below:

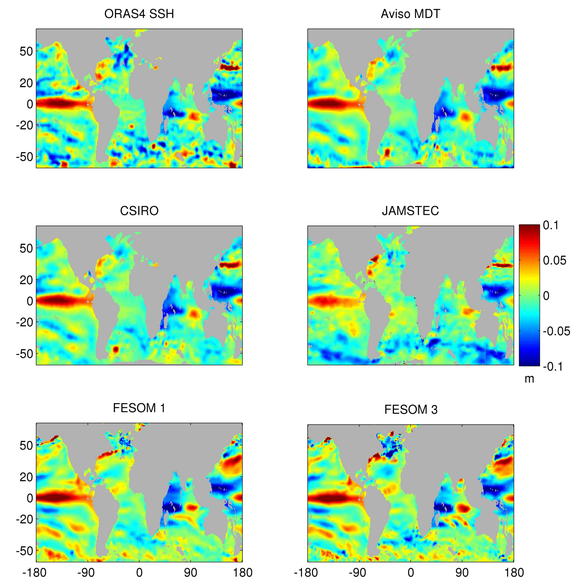
experiment name	resolution	mixing scheme	spinup
FESOM 1	Basic 1.3° (from 150 to 20 km)	PP	60 years
FESOM 2	Basic 1.3° (from 150 to 20 km)	PP	120 years
FESOM 3	Basic 1.° (from 100 to 10 km)	KPP	60 years
FESOM 4	Basic 1.° (from 100 to 10 km)	KPP	120 years

PP Pacanowski and Philander
KPP K-Profile Parameterization

Data

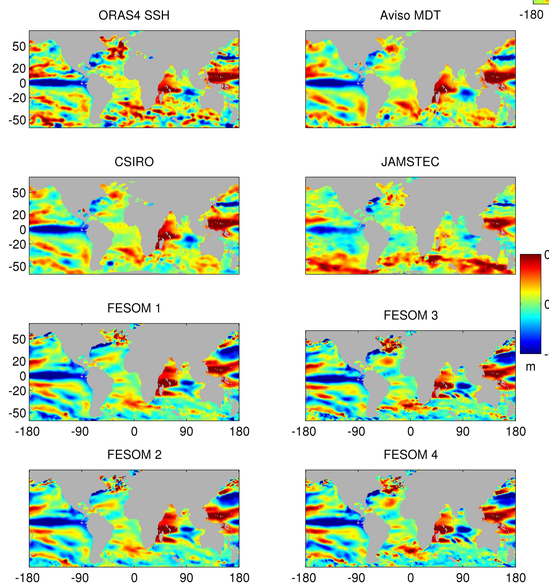
- ✔ Aviso annual mean dynamic topography
- ✔ CSIRO annual mean dynamic topography
- ✔ JAMSTEC Argo based steric height product (relative to 2000m)
- ✔ ORAS4 operational ocean reanalysis by ECMWF (sea surface height is used)



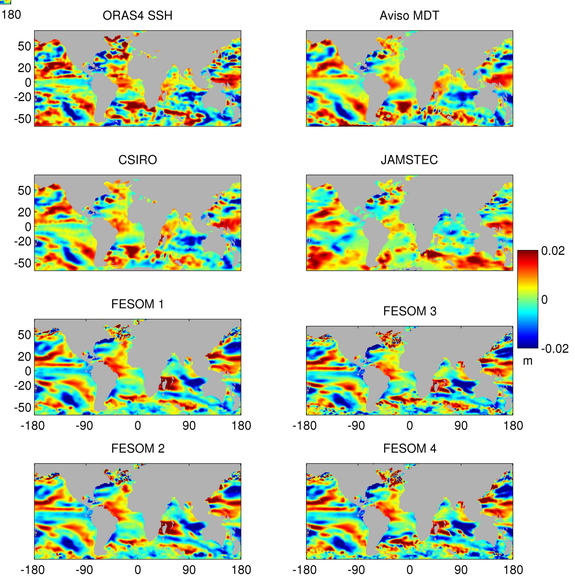


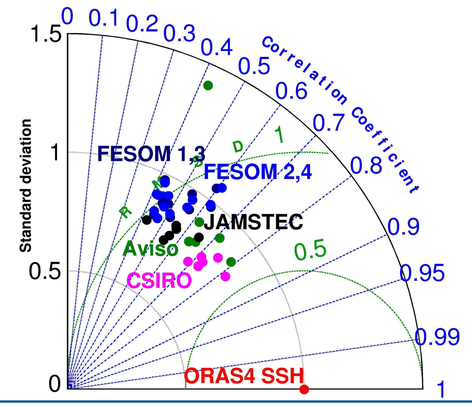
The Indexes computed from the height fields as averages over El Nino 3.4 region are shown in the left figure. The modes of variability in both, data and model, are in a good agreement. JAMSTEC deviates from the spread the most in 2002 and 2003.

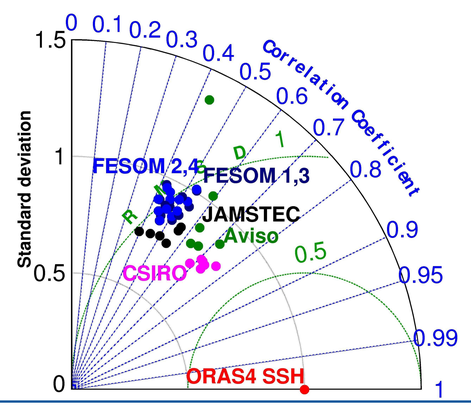
The corresponding patterns are shown in the right plot. JAMSTEC tends to underestimate the signal in the Indian ocean. The major differences between data and model are seen in the Southern Ocean.



Differences between years 2007 and 2002 (left) and corresponding differences with ENSO like index removed (right) show that the ENSO mode explains the largest variance to the fields (note the color scale in the left and right plots). The agreement between data and model remains even with the ENSO like mode removed. The difference between model runs is seen primarily in the deep water formation regions.







Taylor diagrams for the full (left) and with the ENSO mode removed (right) signals show that the agreement between model and data is as large as the difference between different datasets. The diagrams are computed with ORAS4 chosen as reference.

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