COMPARING SEA-SURFACE TOPOGRAPHY MODES OF VARIABILITY FROM ALTIMETRY AND GLOBAL MODELS

DRAKKAR Modelling Program

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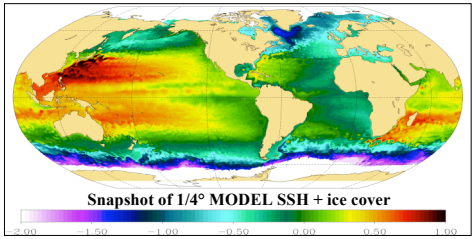
DRAKKAR

The international DRAKKAR program is building a hierarchy of ocean/sea-ice/passive tracer models to simulate and study the dynamical processes involved in the oceanic variability and scale interactions. This ensemble includes 1/2° and 1/4° configurations of the Global Ocean, 1/4° and (soon) 1/12° models of the Atlantic Ocean (30°S-80°N), all forced over the period 1950's-present by various reanalysed and observed atmospheric fields through bulk formulae. Reanalyses since 1950 will be conducted at Mercator with the ¼° global model.



GLOBAL MODEL SETUPS

- NEMO code (OPA9 ocean + LIM sea-ice)
- Partial steps+BBL, TKE mixed layer (waves+Langmuir cells)
- Advection: enstr./energy conserv. (momentum). FCT (tracers)
- Isopycnal laplacian tracer mixing.

2° MODEL
Laplacian momentum Mixing, GM90

1/4° MODEL
Biharmonic momentum Mixing
+ CFC/^{14}C tracers

1958-2004 FORCING (Brodeau, Barnier et al)

- CORE **bulk formulae**. Dai & Trenberth monthly runoffs.
- 6-hourly **ERA40** (T,q,wind) + **CORE** LW/SW radiative fluxes
- **No SST restoring.** But **SSS restoring** (τ=36 days on 1st level)

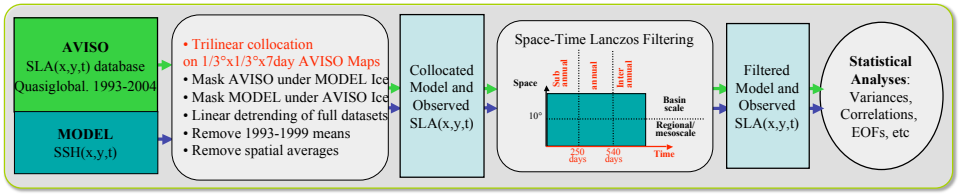
SAME FORCING FOR THE 2° AND THE 1/4° SIMULATIONS

ABSTRACT

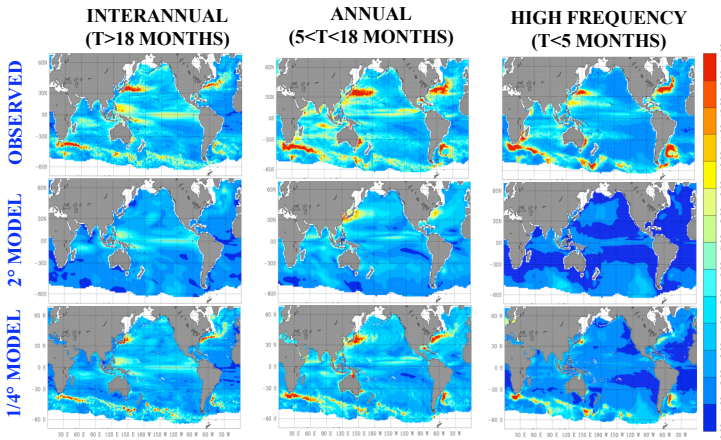
The quasi-global sea-level anomaly AVISO altimetric database (weekly SLA, 1993-present) is compared with its **collocated counterparts** simulated by the models in various wavenumber-frequency bands. This assessment concerns the structure&intensity of the leading modes of variability at global and basin scale, the part of the observed SLA variance simulated by the model (and their mutual correlation), and local investigations of the simulated and observed variabilities in selected regions. **We discuss realism of the variability simulated by the 2° and the 1/4° global models with the same forcing**, and the sensitivity to resolution is commented. More generally, this validation procedure is applied to all DRAKKAR simulations to guide physical investigations, characterize the structure of model biases, and assess the impact of numerical and physical choices.

See the Poster by Penduff, Juza, Barnier concerning validation against hydrography

PROCESSING



GLOBAL Std(SLA) BY FREQUENCY RANGE (cm)



1993-2004 simulated SLA: standard deviations by frequency range:

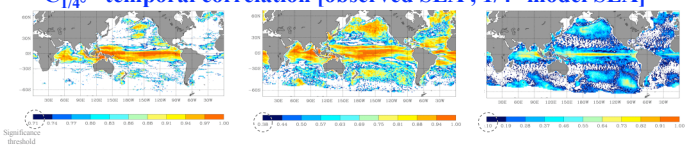
✓ Mid-latitude mesoscale activity (thus main fronts) well located at 1/4°: Confluence, Agulhas, ACC, etc

✓ std(SLA) weaker than observed at 1/4°. Weak penetration of Kuroshio and NAC (partly locked to the MAR)

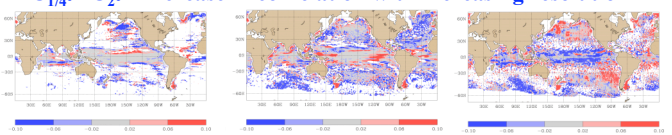
✓ Global increase of std(SLA) from 2° to 1/4° (all timescales), even interannual

✓ No increase in equatorial variability with resolution (only slight at high frequency).

$C_{1/4°}$= temporal correlation [observed SLA , 1/4° model SLA]



$C_{1/4°} - C_{2°}$ = increase in correlation with increasing resolution



1993-2004 simulated SLA: Impact of resolution on local SLA correlation with obs:

✓ Interannual
- **low-lat:** realistic both at 1/4° & 2°
- **elsewhere:** no clear improvement

✓ Annual
- **low-lat:** slight improvement
- **coastal zones:** clear improvement

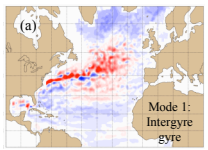
✓ High frequency
- **better:** coastal zones, midlatitudes, north high latitudes, eastern basins.
- **worse:** ACC, 10°N/S bands

MODES OF INTERANNUAL VARIABILITY

The ability of the 2° and 1/4° model to reproduce the observed interannual variability is compared in various regions as follows:
-Compute the first 4 EOFs of observed interannual SLA variability in key regions (1st observed N.Atl. mode shown in **Fig a**, associated PC is green in **Fig b**)
-Project the 2° and 1/4° simulated SLA fields on these 4 observed modes (time series of these projections shown for the 1st mode in **Fig b** for the two runs)
-Compare the variances of these projections with the variances of each observed mode (shown in **Fig d**)
-Compare the correlations between these projections and the observed PC of each observed mode (shown in **Fig d**)

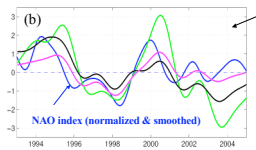
NORTH ATLANTIC

1st EOF of observed SLA (interannual only): 20%



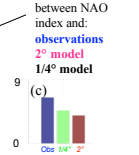
The 1st EOF of observed SLA at interannual scales corresponds to Marshall et al (2001)'s intergyre gyre, which reflects the NAO impact.

1st PC of observed SLA (interannual)
2° run projected on 1st observed mode
1/4° run projected on 1st observed mode



The 1st observed PC (green) exhibits abrupt transitions (e.g. 1995, 1999). The projections of both simulated SLA on this mode reproduce the main features of this observed variability.

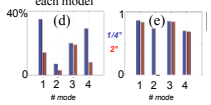
Lags (months) between NAO index and:
observations
2° model
1/4° model



This observed mode lags the NAO index by 6.5 months. The simulated lag is more realistic at 1/4° than at 2°

% of observed nth EOF variance simulated by each model

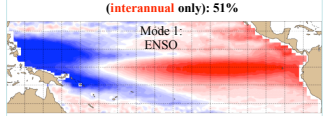
Obs/model SLA correlation for the 4 leading modes

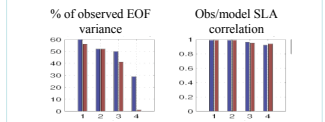


The 1/4° run represents better than the 2° run the first 4 observed modes of North Atlantic interannual variability (more explained variance, better correlation).

EQUATORIAL PAFICIC

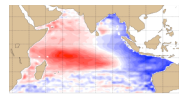
1st EOF of observed SLA (interannual only): 51%

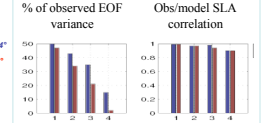




INDIAN OCEAN

1st EOF of observed SLA (interannual only): 39%





The 1/4° model represents the leading modes of observed interannual variability better than the 2° model :

- simulated counterparts of observed modes are stronger at 1/4°

- higher correlation between timeseries of observed modes and their model projection

- true in most regions investigated (Global, Atlantic, Gulf Stream, Indian, equatorial Pacific., etc.)

- More realistic lag with NAO in the North Atlantic

Other regions are currently under investigation

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