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Assessment of DRAKKAR global simulations against altimetry and hydrography

Thierry Penduff, Mélanie Juza, Bernard Barnier

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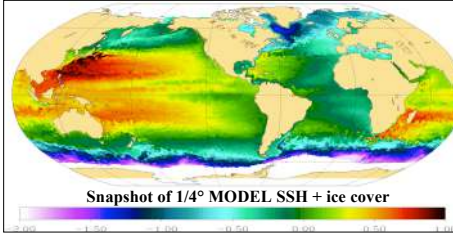
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ABSTRACT In order to guide physical investigations, characterize the structure of model biases, and assess the impact of numerical and physical choices, DRAKKAR simulations are evaluated against altimetric sea-level anomalies (AVISO: 1993-present, see Poster by Penduff et al), and temperature/salinity profiles (ENACT/ENSEMBLES: 1956-present). Model outputs are first sub-sampled like actual observations to build altimetric and hydrographic "synthetic observations". Real and synthetic observations and more integral quantities (mixed layer depth cycle, heat/salt contents, etc.) are then compared over various regions, periods, and timescales. **This study presents the methods and a validation of DRAKKAR simulations with respect to hydrography**



1/4° GLOBAL MODEL SETUP

- NEMO code (OPA9 ocean + LIM sea-ice + CFC/¹⁴C tracers)
- Partial steps+BBL, TKE mixed layer (waves+Langmuir cells)
- Advection: enstr./energy conserv. (momentum), FCT (tracers)
- Isopycnal laplacian tracer mix. Biharmonic momentum mix.

1958-2004 FORCING (see Brodeau, Barnier et al)

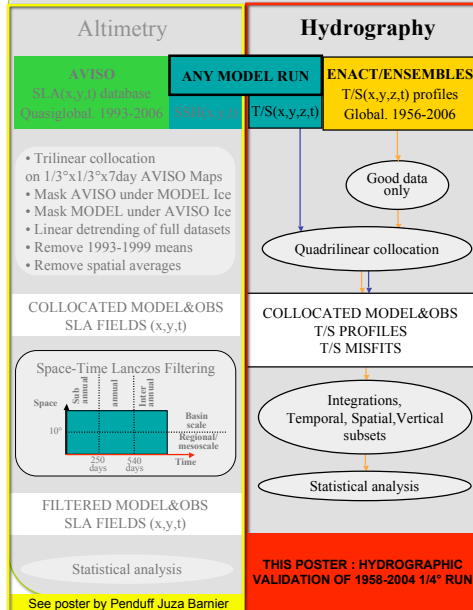
- CORE bulk formulae. Dai & Trenberth monthly runoff.
- 6-hourly ERA40 (T,q,wind) + CORE LW/SW radiative fluxes
- No SST restoring. But SSS restoring ($\tau=36$ days on 1st level)

DATA PROCESSING

Validation procedure of DRAKKAR runs against altimetry and hydrography :

- Collocation of model fields (SSH(x,y,t) and T,S(x,y,z,t) on the observation space from various simulations. We build simulated counterparts of :
 - weekly 1/3°x1/3° SLA maps (1993-2004)
 - instantaneous T,S profiles (1956-2004). Flagged hydrographic observations are rejected.
- Computation of derived quantities from collocated observed/simulated databases
- Quantitative assessment of model skill in space and time

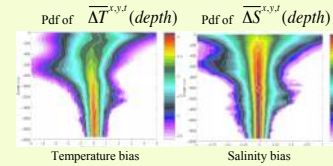
PROCESSING



GLOBAL MODEL T / S BIASES

• VERTICAL STRUCTURE

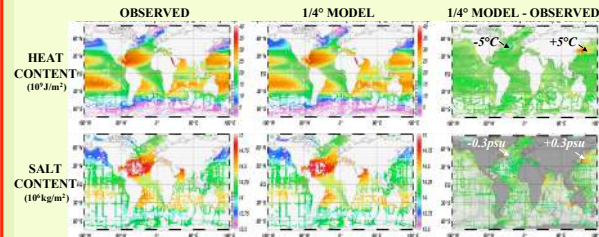
PDF of T,S biases from collocated profiles. Global scale, 1958-2001.



Median T bias : +0.5°C at 150m, -0.2°C in 250-1000m, -0.05°C below 1500m
Median S bias : -0.05 above 1000m, ~ 0 below

• HORIZONTAL STRUCTURE

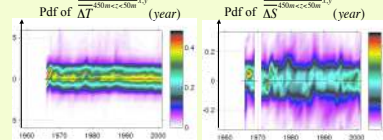
Color dots show local collocated estimates of model & observed heat and salt content within the layer 50-450m. Period 1980-2004.



Upper T/S biases over the observed ocean 1980-2004 remains below ~ +/- 2°C and +/- 0.1 p.s.u. Biases: displaced NAC & Kuroshio.

• TEMPORAL STRUCTURE

PDF of T,S biases from collocated profiles. Global scale, 50-450m



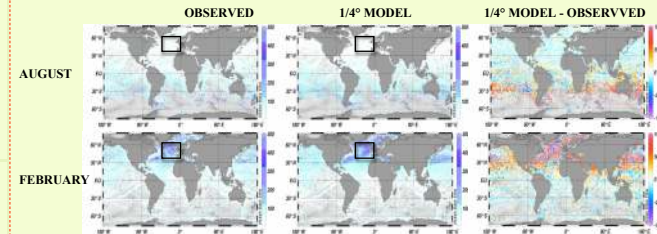
White lines: yearly medians of misfits (global domain, 450-50m layer)
=> T bias decreases from +0.2°C to 0.
=> S bias oscillates around 0

The simulated 3D thermohaline structure remains stable and globally close to observed T/S profiles during 43 years, despite a global +0.5°C/ -0.05p.s.u bias in upper layers

MIXED LAYER

• MLD(m) AT GLOBAL SCALE

Color dots show all collocated estimates of model & observed Mixed Layer Depth(m). Period 1980-2004. Criterion: $|\Delta T|=0.2^\circ\text{C}$, as Montegut et al (2004)



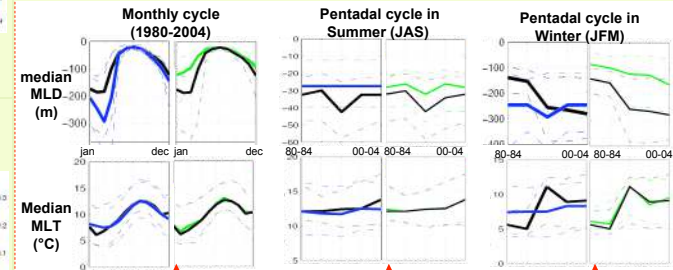
Difference maps show the realism of MLD distribution & magnitude. Apparent deep bias in winter (see below, N.E. Atlantic)

• MLD(m) AND MLT(°C) OBSERVABILITY & REALISM

Example in the Northeast Atlantic

Full 1/4° model
1/4° model colloc. with Obs.
Observations

Blue and black lines ==> observability of MLD and MLT in the region
Green and black lines ==> realism of the simulated MLD and MLT in the region



Annual cycle of MLD well captured by hydrographic array and well simulated (except in JFM). Better observability and simulation for MLT.

Pentadal cycle of summer MLD and MLT correctly captured by hydrographic array. Better observability and simulation for MLT.

Pentadal cycle of winter MLD and MLT captured after 1990 by hydrographic array. Realistic MLT, too deep MLD.

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