ASSESSMENT OF DRAKKAR GLOBAL SIMULATIONS AGAINST ALTIMETRY AND HYDROGRAPHY

Thierry PENDUFF
Mélanie JUZA
Bernard BARNIER

Grenoble, France

DRAKKAR Modelling Program

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

Snapshot of 1/4° MODEL SSH + ice cover
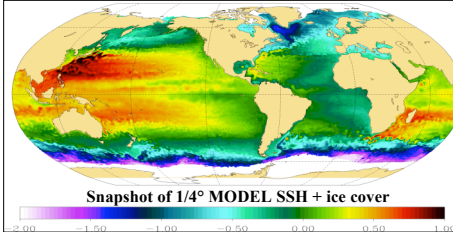
1/4° GLOBAL MODEL SETUP
- NEMO code (OPA9 ocean + LIM sea-ice + CFC/^{14}C tracers)
- Partial steps+BBL, TKE mixed layer (waves+Langmuir cells)
- Advection: enstr./energy conserv. (momentum). FCT (tracers)
- Isopycnal laplacian tracer mix. Biharmonic momentum mix.

1958-2004 FORCING (see Brodeau, Barnier et al)
- CORE **bulk formulae**. Dai & Trenberth monthly runoffs.
- 6-hourly **ERA40** (T,q,wind) + **CORE** LW/SW radiative fluxes
- **No SST restoring.** But **SSS restoring** (τ=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 :
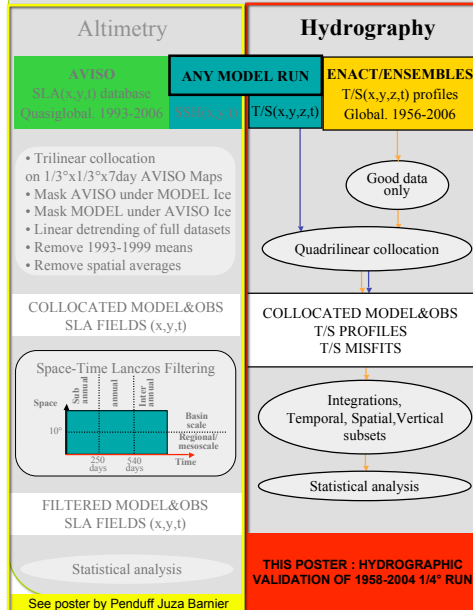
-weekly 1/3°x1/3° SLA maps (1993-2004)

- instantaneous T,S profiles (1956-2004). Flagged hydrographic observations are rejected.

- **Computation of derived quantities from collocated observed/simulated databases**

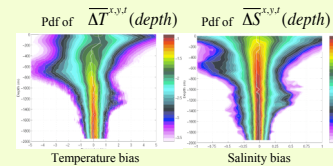- **Quantitative assessment of model skill in space and time**

PROCESSING

See poster by Penduff Juza Barnier

GLOBAL MODEL T / S BIASES

• VERTICAL STRUCTURE

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

Pdf of $\overline{\Delta T}^{x,y,t}(depth)$ Pdf of $\overline{\Delta S}^{x,y,t}(depth)$

Temperature bias   Salinity bias

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.

OBSERVED   1/4° MODEL   1/4° MODEL - OBSERVED

HEAT CONTENT (10[9]J/m^{2})

SALT CONTENT (10[6]kg/m^{2})
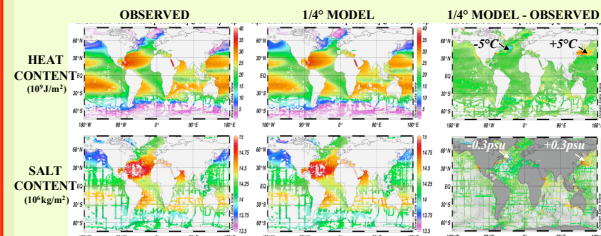
Upper T/S biases over the observed ocean 1980-2004 remains below ~ +/- 2°C and +/- 0.1 p.s.u. Biases: displaced NAC & Kuroshio.

• TEMPORAL STRUCTURE

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

Pdf of $\overline{\Delta T}^{450m<z<50m}(year)$ Pdf of $\overline{\Delta S}^{450m<z<50m}(year)$
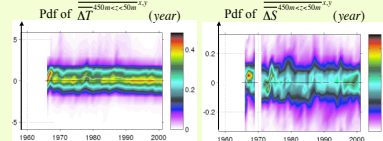
White lines: yearly medians of misfits (global domain, 450-50m layer)
⇒ T bias decreases from +0.2°C to 0.
⇒ S bias oscillates around 0

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: |ΔT|=0.2°C, as Montegut et al (2004)

OBSERVED   1/4° MODEL   1/4° MODEL - OBSERVVED

AUGUST

FEBRUARY
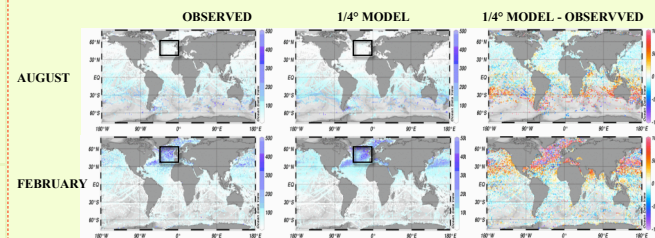
Difference maps show the realism of MLD distribution & magnitude. Apparent deep bias in winter (see below, N.E. Atlantic)
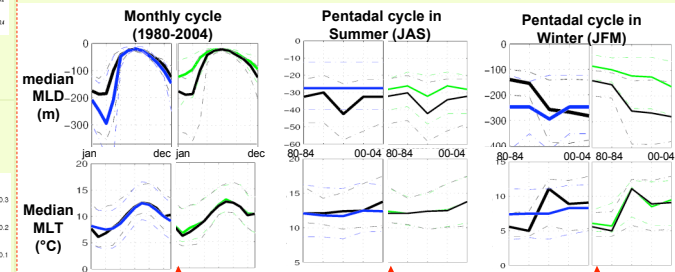
• MLD(m) AND MLT(°C) OBSERVABILITY & REALISM

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

Monthly cycle (1980-2004)   Pentadal cycle in Summer (JAS)   Pentadal cycle in Winter (JFM)

median MLD (m)

Median MLT (°C)

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.

REFERENCES

Brodeau, L., B. Barnier, A.M. Treguier, and T. Penduff, 2006: « Comparing sea surface atmospheric variables from ERA40 and CORE with a focus on global net heat flux. » Newsletter of the WCRP Working Group on Surface Fluxes, in press

Barnier, B., G. Madec, T. Penduff, J.-M. Molines, A.-M. Treguier, J. Le Sommer, A. Beckmann, A. Biastoch, C. Böning, J. Dengg, C. Derval, E. Durand, S. Gulev, E. Remy, C. Talandier, S. Theetten, M. Maltrud, J. McClean, B. De Cuevas, 2006: "Impact of partial steps and momentum advection schemes in a global circulation model at eddy permitting resolution", Ocean Dynamics, in press.

Montegut, C.D., G. Madec, A. Fischer, A. Lazar and D. Iudicone (2004), Mixed layer depth over the Global Ocean: an examination of profile data and a profile-based climatology. Journal of Geophysical Research 109(C12), C12003, DOI: 10.1029/2004JC002378