

Sensitivity analysis of the GLORYS bias to Initial conditions and atmospheric forcing

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Context

The Glorys1 ocean reanalysis an estimation of the ocean from 2002 to 2006

- 1/4° global ORCA configuration

- SAM2 assimilation system (3D « anomalies »).

It provides a « historical » analysis of the ocean AND a long « diagnostic » simulation for the operational analysis system:

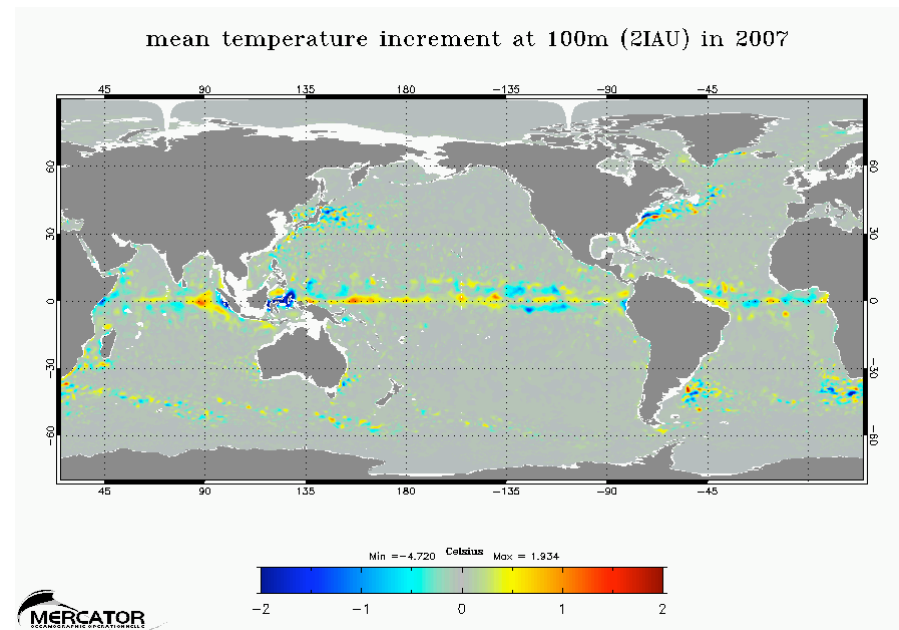
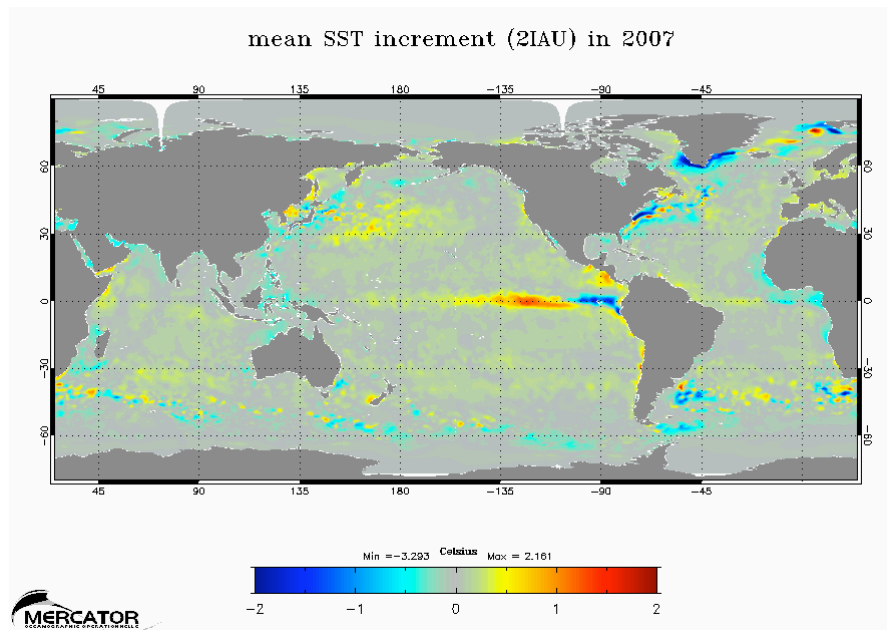
- Identification of problems only visible after several years: systematic bias, drift... difficult to track in the rapidly evolving operational system.

We would like to know the « origin » of the identified bias in this reanalysis using an adjoint sensitivity study in order to improve the analysis system.

Identification of systematic biases

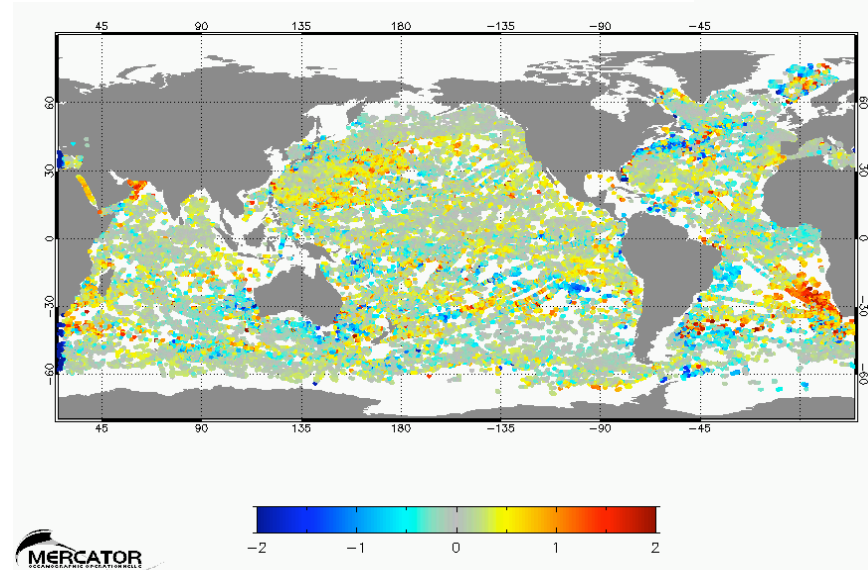
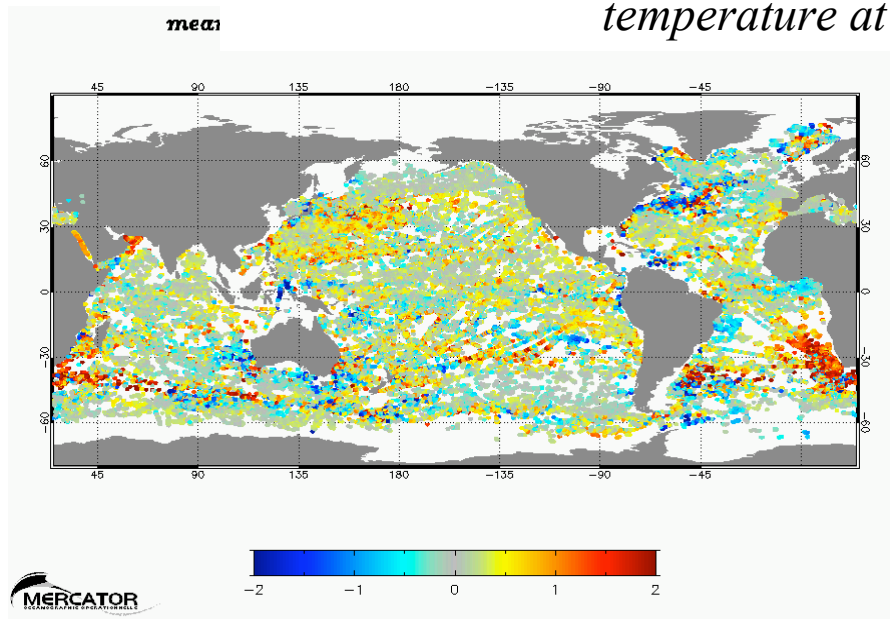
Systematic bias can be defined as persistence structures in the successive analysis increments.

In MERA11 and Glorys, systematic bias were identified., some of them are seasonal.

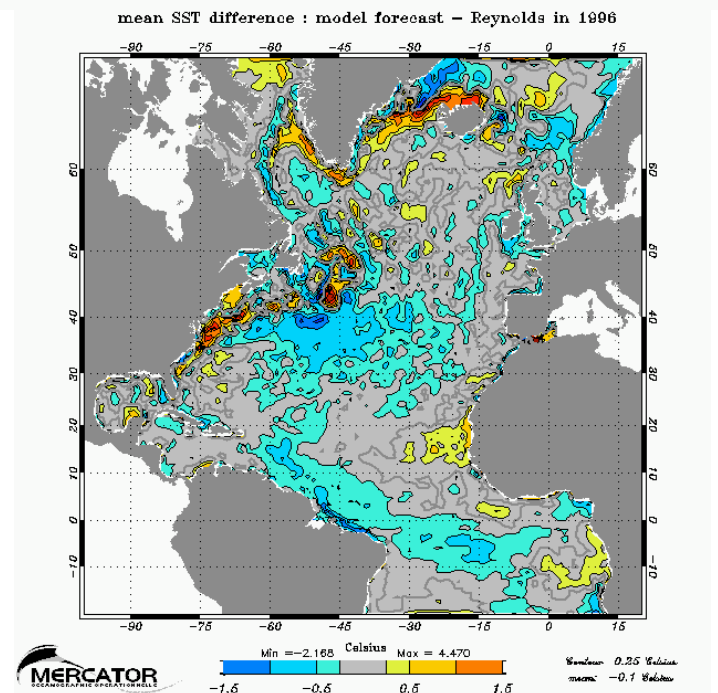
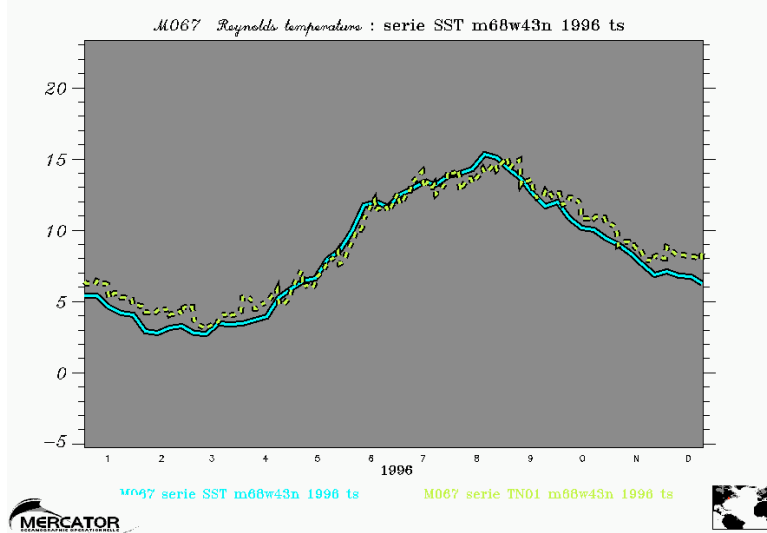


Mean SST and Temperature increments in 2007 (Glorys)

Innovations (obs - forecast) and residuals (obs - analysis) for in situ temperature at 300 m depth in 2007.



Surface temperature: comparison between the model and the Reynolds SST (E. Greiner, MERA11 reanalysis)



Correction of the forcing fields using the analysis increments

Some of those bias are attributed to atmospherical forcing errors.

Different strategies were tested in the MERA11 (Nat1 1/3°) and PSY2v2r2 (Atl 1/12°):

- Time mean temperature increments in the mixed layer depth are used to estimate a correction term to the heat flux in the regions where their impact is supposed to be dominant.

Problem: bias source identification : model dynamic and/or boundary forcing, « local » problem or remote interaction?

-> need to be known.

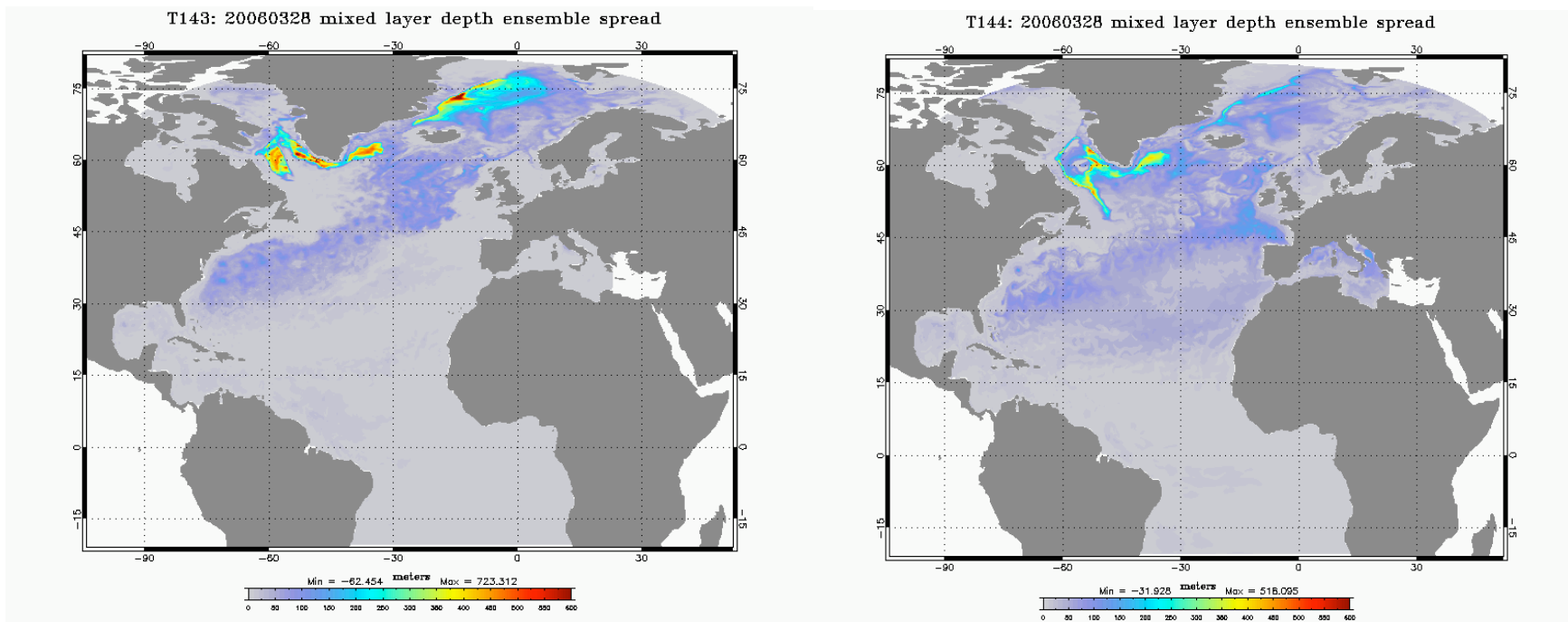
Forecast error estimate from ensemble simulations

Ensemble simulations with the $\frac{1}{4}^\circ$ North Atlantic configuration:

- ensemble of 50 simulations with perturbations of the initial conditions, 50 simulations of perturbed forcing fields (50 members of the ECMWF ensemble analysis)

-> faisability of ensemble simulations

Mixed layer depth sensitivity to initial condition (left) and forcing (right) perturbations: standard deviation after 30 days of model integration ($\frac{1}{4}^\circ$ North Atlantic).



Variational sensitivity analysis

Identification of bias error sources:

- initial conditions (which region/variables) or forcing fields?
- local « origin » of the bias or remote sources.
- > build a strategy to correct the SAM2 analysis system.

Application to the Glorys $\frac{1}{4}^\circ$ reanalysis.

Method

- Use of the NEMO adjoint model to compute the gradient of the cost function measuring the « bias ».
- Temporal scale < few months / climate studies (MOC, bathymetry...)
- Choice of the norm: first an energy norm will be tested.

Glorys configuration

- ORCA $\frac{1}{4}^\circ$
- NEMO 1.9 and soon NEMO 3.?
- Clio bulk formulation (CORE in the next version), ECMWF analysis
- LIM2 ice model + some modifications
- Assimilation of along track SLA (AVISO/SALTO), SST and in-situ observations (CORA02).
- MPP (11x27 on ECMWF c1a computer)
- outputs in dimg format
- feedback files = « OLA » files

Ongoing work

Glorys model configuration in NEMO3.0

- Ok
- 1 feedback files per proc
- To be done : use of Glorys restart on dimg format with a different number of procs.

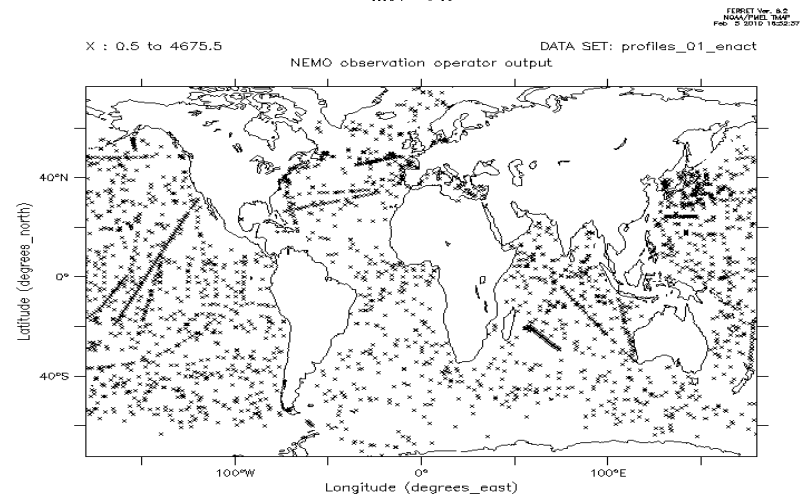
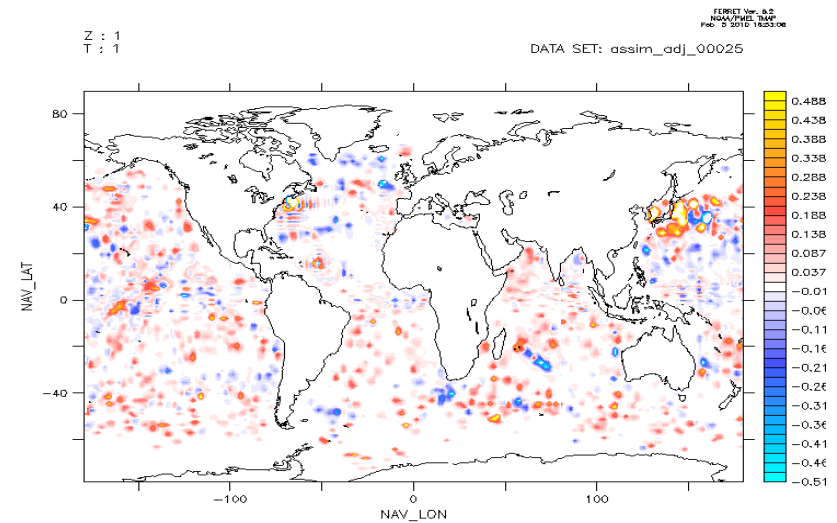
Adjoint (all calls to « B » skipped):

- Running few time step BUT problems (with observations?) close/under the antarctic ice shelves appear (ice_if/lim2, forced flx/clio...)
- Add the input fluxes in the control vector...

Open questions:

Choice of the « bias cost function »: selection of a region, variables, depth range(MLD), time range?

- ...



Temp_adj for ORCA2 (2x2 procs) after 13 days and the in situ observation point