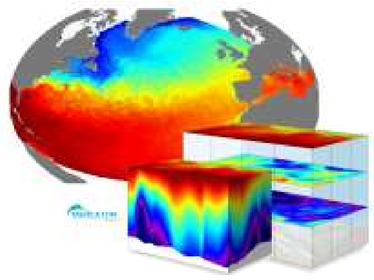
The Global 1/12° Mercator Ocean forecasting system: scientific design and first results



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The new ocean forecasting system

An integrated ocean forecasting and data assimilation system has been and is continuing to be developed by Mercator Ocean. It consists of a **global ocean and sea ice high resolution (1/12°) model** (NEMO OGCM) coupled to the data assimilation scheme named SAM2v1 (based on the SEEK filter). Assimilation of both in situ and remotely sensed data (SLA, SST) provides the initial conditions required for numerical ocean prediction.
An interannual simulation forced by ECMWF atmospheric forcing without data assimilation enables to calculate statistics of prognostic variables (background error covariances) into the **data assimilation scheme**.
This poster summarizes various considerations taken into the design of this ocean forecasting system, and describes its main characteristics. A special focus is given on the interannual simulation and the **first hindcast experiment.**

Data assimilation scheme

The SAM2 data assimilation scheme is based on the SEEK filter.
Analysis grid: Global 1/3°ORCA-type grid (sub-sampling of the 1/12°model grid)
Innovation: Calculated from the First Guess at Appropriate Time (FGAT) approximation.
Control vector: Barotropic height, T, S, U and V
State vector :T, S, U and V
Background error covariance: Ensemble of 3D anomalies, see Figures 3 and 4.
Adaptive error variance: consistency with innovation vector (a posteriori diagnostic)
Localization: Using the now-common localisation technique by the introduction of a negative-squared-exponential function.
Initialization: Incremental Analysis Update (IAU) method to apply the correction.
Assimilated data: On track altimetry measurements of sea level anomalies (SLA) from DDUACS AVISO, in situ temperature and salinity profiles from CORIOLIS and ½° RTG-SST products from NCEP.

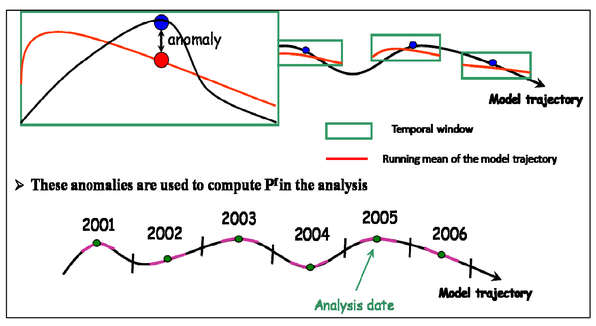


Figure 3: Schematic representation of the anomalies calculation along a model trajectory (these anomalies are used to build the model forecast covariance).

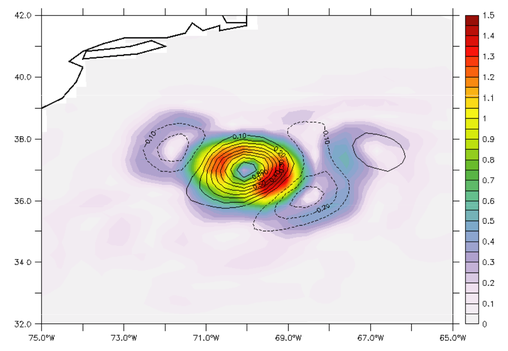


Figure 4: Representer function for the velocity field in cm/s relative to a + 1 cm SLA located at 37°N,70°W. The contour interval is 0.1 cm/s.

Global ocean and sea ice high resolution model (1/12°) model

The eddy resolving Mercator-ocean model is based on the OGCM NEMO 1.09 (Madec 2008) coupled to the sea ice model LIM2.
Model grid: Global 1/12°ORCA-type grid (4322x3059 points)
50 vertical levels from 1 m at the surface to 450 m at the bottom
Bathymetry: ETOPO2_V2
Initialisation: Levitus 2005
Parameterizations:
- Filtered free surface
- Partial step.
- Energy and enstrophy conserving scheme
- Isopycnal diffusion for tracers; Biharmonic for momentum
- Restoring zone at Gibraltar, Bab El Mandeb
- Monthly climatological Runoffs (Dai&Trenberth data)
- TKE scheme

Atmospheric forcing:
- Bulk CLIO Formulation
- Daily mean operational analyses from ECMWF
- Precipitations corrected between 30°S-30°N with GP CP data.

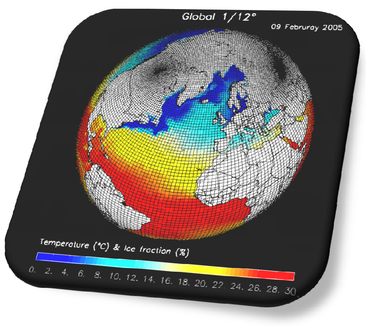


Figure 1 : Global tripolar ORCA grid. 3 day mean SST simulated with ORCA12.

Interannual simulation

Main results of this simulation (8 years from 1999 to 2006) can be found in **session 4, poster #41**. Nevertheless, to quantify the meso-scale representation, a diagnostic have been applied for instance along the Alaskan coast. In this area, anticyclonic eddies are formed between the Queen Charlotte Islands and the bottom of the Gulf of Alaska. Thereafter, these eddies are advected along Aleutian Islands (Figure 2).

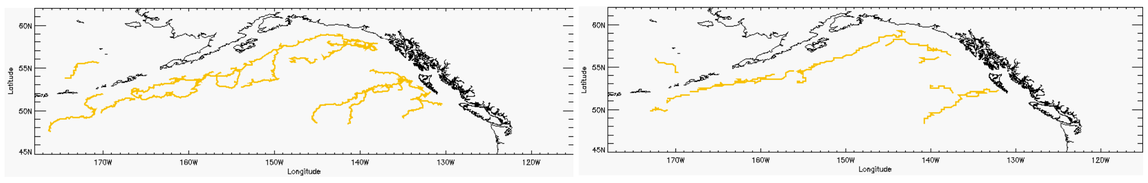


Figure 2 : Pathway of the anticyclonic eddies during 2003 to 2006 in the ORCA12 simulation (left) and in the altimetry data (right). Eddies with a lifetime larger than 6 month are presented.

The proportion of anticyclones is close to 80% both in the model and in the altimetry but only anticyclonic eddies have a lifetime larger than 6 month (Figure 2). The seasonal cycle of anticyclones formation is marked, with a maximum in summer. These results are in good agreement with *Henson and Thomas*, 2008.

First hindcast experiment

A 5-month hindcast experiment using a 7-days assimilation cycle with the Mercator Global Ocean configuration at 1/12° (ORCA12) and the SAM2v1 assimilation scheme have been performed from November 2007 to April 2008. This simulation provides the initial oceanic condition for the Mercator demonstration phase in the MERSEA context. It consists of a very short near real time experiment (one or two week on April 2008). Figure 5 and 6 show the good convergence of this assimilated simulation both in term of realistic mean oceanic structures and variability after only few month This simulation shows a significant convergence in terms of innovation (non-assimilated data) statistics, as can be seen on Figure 7.

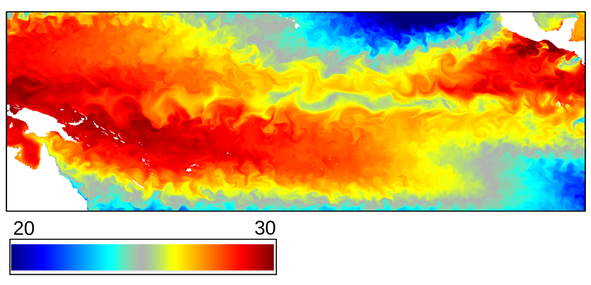


Figure 5: An example of Sea Surface Temperature (in °C) over the Tropical Pacific ocean for the 22 april 2008.

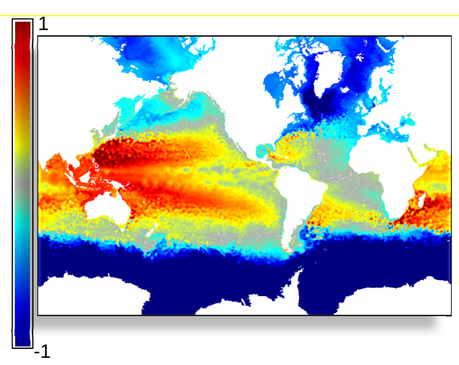
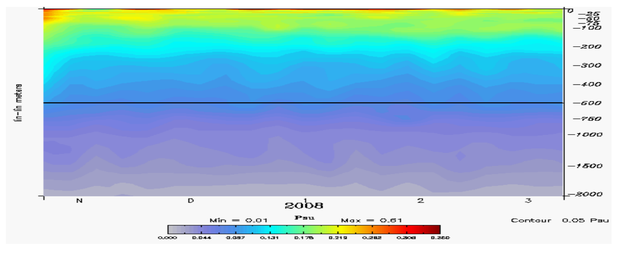


Figure 6: An example of Sea Surface Height (in meter) over the global domain for the 22 April 2008.



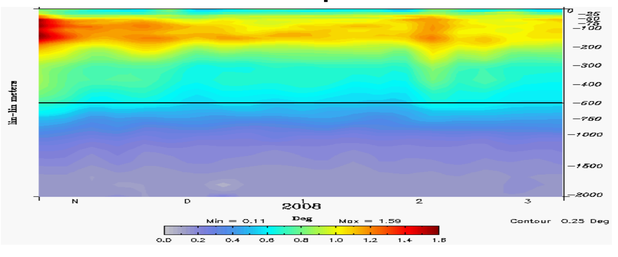


Figure 7: RMS of innovation (non yet assimilated observation minus model counterpart) Temperature (left) and Salinity (right) until 2000 meter depth during the first 5 months (from November 2007 to March 2008) for global ocean.

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