

The global ocean reanalysis effort of MyOcean: description and early results

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Introduction

We present here the global ocean reanalysis effort carried out within the project MyOcean, a project granted by the European Commission within the GMES Program (7th Framework Program), whose main goal is to set up an integrated capacity for ocean monitoring and forecasting in Europe.

The production of **global ocean reanalyses** spanning the altimetric era (1993-present) is part of the global Monitoring and Forecasting Centre. Several partners (namely Mercator Océan, CLS, CMCC, ESSC and LEGI-CNRS) have several global ocean state estimations at eddy-permitting resolution covering the period 1993-present. Within MyOcean the production of reanalyses is coordinated with several Work Packages like Thematic Assembly Centres (which provide the useful observations for reanalyses), or with the Cal/Val working group (which defines appropriate ways to assess and measure the quality of MyOcean products). This set of global ocean reanalyses will be shortly freely available through MyOcean web portal www.myocean.eu.

Here we summarize the methodology and validation framework used to produce global ocean reanalyses at eddy-permitting resolution. We show also some early validation results for the period from 1993 to present.

Reanalyses features

MyOcean global ocean reanalysis product consist of 5 data sets. 4 of those data sets are produced with the eddy-permitting resolution ($1/4^\circ$) DRAKKAR ORCA025 model configuration based on the NEMO ocean/sea-ice GCM. The atmospheric forcing driving the model simulations is derived from the latest ERA-INTERIM atmospheric reanalysis of ECMWF.

- **The MJM95 data set (produced by LEGI-CNRS) is the control simulation with no data assimilation.**
- **The GLORYS data set (produced by Mercator Océan),**
- **The C-GLORS data set (produced by CMCC),**
- **The UR025.1 data set (produced by U-Reading) ,**

are all reanalysis data sets that assimilated various types of observations (SLA, SST and in situ hydrographic observations) in the dynamical model using different advanced data assimilation schemes (respectively, SEEK filter + Bias correction, 3D-VAR, and S(T) an OI with isothermal analysis of salinity). Those reanalysis products consist of monthly averages of temperature, salinity, horizontal velocity, sea ice concentration, thickness and drift.

- **The ARMOR3D data set (produced by CLS) is an estimation of the ocean state based on observations only (SST, SLA and in situ profiles).**

Further information on each reanalysis data set can be found on posters:

- XY688 EGU2011-3428 (**ARMOR3D**)
- XY624 EGU2011-3516 (**GLORYS**)
- XY356 EGU2011-6708 (**C-GLORS**)
- AS2.2:EGU2011-10892 and OS1.3:EGU2011-10990: **ERA-INTERIM forcing corrections for ocean reanalyses**

Validation protocol

A common validation protocol for reanalyses has been defined and relies on previous initiatives like MERSEA-GOADE metrics, CLIVAR/GSOP diagnostics, plus new metrics defined in the framework of MyOcean quality control for operational forecasting systems. Briefly, the validation protocol is organized according to 6 types of diagnostics:

- CLASS1: computations are done on the model native grid. Those include regional tendency maps.
- CLASS2: comparison of reanalysis products moorings, tide gauges and indexes (e.g. Nino boxes) comparisons
- CLASS3: Mean and variability of integrated quantities like transports (volume, heat, freshwater), sea ice extent, global/regional averages of various parameters (SST, SLA, sea ice concentration, ...)
- CLASS4 : collocation of observation with model
- DATA ASSIMILATION DIAGNOSTICS: innovation statistics.
- EOFs analysis

Part of these diagnostics have been implemented and help to assess and check the skill of the 5 reanalyses data sets.

This should also help to identify the robust results among the reanalyses.

The document presenting the validation protocol strategy in MyOcean global ocean reanalyses is available upon request.

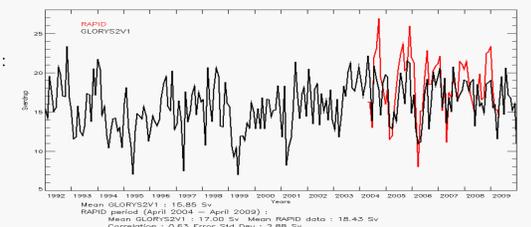
MyOcean reanalyses results

We present here results for each reanalysis data set.

• Mercator Océan: GLORYS2V1

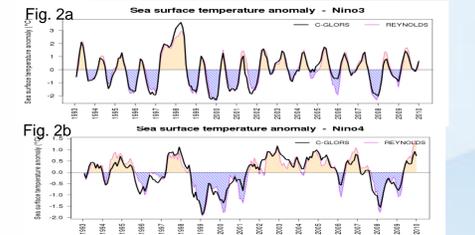
GLORYS2V1 Atlantic meridional overturning circulation (AMOC) at 26.5°N is compared to RAPID estimate (Fig. 1). The reanalysis exhibits a slightly weaker magnitude of $\sim 1.5\text{Sv}$ over the 2004-2009 RAPID period. However, a significant correlation (0.63) is found between the GLORYS2V1 and RAPID data. No significant long term or unrealistic trend is found in GLORYS2V1. The 2000's years shows however somehow higher values than the 90's.

Fig. 1:



• CMCC: C-GLORS

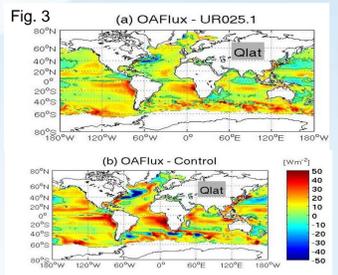
SST anomaly for Nino3 and Nino4 boxes is compared against NOAA Reynolds 1/4 degree SST analyses. Figures show a very good agreement between the observed dataset and the reanalysis, although C-GLORS reanalysis is not relaxed to SST data and does not yet assimilate space-borne SST observations.



• University of Reading: UR025.1

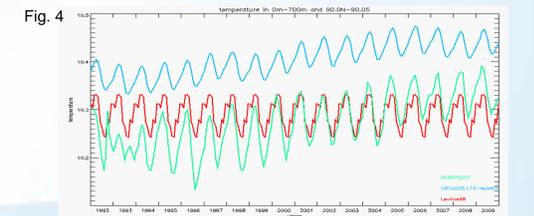
Fig. 3 shows mean changes in latent heat flux (Qlat) between the OAFux product and (a) UR025.1 and (b) the model unconstrained by data (Control). The reanalysis is closer to OAFux, indicating a substantial reduction of the mean cooling in the model upon data assimilation. The OAFux product (Yu et al., 2008) synthesizes atmospheric state variables and SST from satellite observations and NWP analyses, but not from in situ measurements, so Fig. 4 represents a somewhat independent test of the quality of UR025.1.

Reference: Yu et al. (2008): OAFux Project Technical Report (OA-2008-01), Woods Hole Oceanographic Institution, 64pp.



• LEGI-CNRS: MJM95

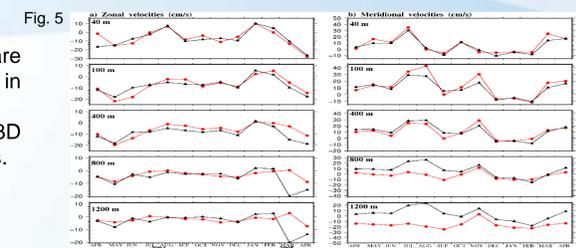
Although MJM95 reference simulation does not assimilate observation, it is close to the real ocean in many aspects. For example, Figure 4 shows that the global ocean heat content increase in the upper 700m diagnosed in GLORYS2V1 reanalysis is well simulated in MJM95. The shift between GLORYS2V1 and MJM95 is attributed to a vertically more stratified ocean in the reanalysis than in the reference simulation.



• CLS: ARMOR3D

Monthly averaged zonal and meridional components of the Surcouf3D current fields are interpolated to the date and position of the current meters from RAPID-MOCHA array in the Atlantic Western Boundary Current off the Bahamas (near 76.5°W , 26.5°N).

Figure 5 shows the comparisons between the monthly averaged currents from Surcouf3D and the ones from RAPID-MOCHA array from April 2004 to April 2005 at different depths. Good consistency is found for both zonal and meridional components at all depths.



Conclusions and perspectives

In the framework of MyOcean project, several global ocean eddy permitting reanalyses have been produced in a coordinated way. These reanalyses share the same horizontal grid ($1/4^\circ$), same atmospheric forcing (ERA-INTERIM) but differ by the data assimilation method and kind of assimilated data. This unique reanalysis data set ensemble is being assessed and validated using a common protocol and will be freely available at www.myocean.eu in June 2011.

A second version of these reanalyses is already planned. The coherency between the various reanalyses configuration will be improved with the use of common observation data sets and ERA-INTERIM atmospheric forcing fields including updated corrections.