# The CMCC Eddy-Permitting Global Ocean Reanalysis (1991-2010)

**Andrea Storto**
*Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), Bologna, Italy*

**Simona Masina**
*Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), Bologna, Italy and Istituto Nazionale di Geofisica e Vulcanologia (INGV), Bologna, Italy*

**Srdjan Dobricic**
*Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), Bologna, Italy*

**Ida Russo**
*Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC), Bologna, Italy*

In the framework of the European Commission-funded project MyOcean, the Centro Euro-Mediterraneo per i Cambiamenti Climatici (CMCC) has developed a one-quarter degree horizontal resolution reanalysis system for the altrimetric era (1993-2009), called hereafter C-GLORS (CMCC-GLobal Ocean Reanalysis System).

The system has produced a 20-year reanalysis dataset (1991-2010) by assimilating all hydrographic data from the U.K. MetOffice EN3 dataset with XBT fall rates corrected, sea-surface temperature observations optimally interpolated by NOAA from AVHRR and AMSR-E measurements, and all altimetric data from 1993 onwards calibrated and distributed by AVISO, which also provided a mean dynamic topography obtained by combining altimetric, gravimetric and in-situ data. The initialization technique consists in a cold start from a non-assimilative experiment in January 1989, the latter being in turn initialized from the ocean at rest in 1979 and forced by ERA-Interim surface fluxes for the period 1979-1988.

The Ocean General Circulation Model (OGCM) used in the forecast step is NEMO 3.2 coupled with the Louvain-la-Neuve sea-ice model (LIM2) and forced by the ECMWF ERA-Interim atmospheric reanalysis. Precipitation fluxes were corrected through inter-calibration with the Passive Microwave Water Cycle (PMWC) dataset derived from microwave SSM/I data to reduce the fresh bias in the Intertropical Convergence Zone. Surface radiative fluxes were also corrected through comparison with the GEWEX Surface Radiation Budget dataset. The sea-ice concentration within the OGCM is also nudged to daily observed estimates from NOAA for consistency with the SST observations, with a relaxation coefficient equal to 15 days.

The C-GLORS assimilation component consists of a weekly 3D-Var analysis that corrects the three-dimensional fields of temperature and salinity. Background covariance modeling is separated into horizontal correlations, modeled through an application of a first-order recursive filter, with inhomogeneous, and season-dependent background-error horizontal correlation length-scales, and background covariances obtained by inhomogeneous and season-dependent bivariate EOFs of temperature and salinity. Both vertical covariances and horizontal correlations were obtained from a set of climatological anomalies from global ocean hindcasts; the use of non-uniform correlation length-scales was a major improvement in the assimilation system, and it is proved to better covariate in space the analysis increments, especially in mesoscale areas. A vertical localization operator was used to reduce spurious vertical correlations between model levels above and below the mixing layer. All the observations are subjected to background-quality check and observation type-dependent spatial thinning prior to the assimilation ingestion.

In this work, we discuss and present the main features of C-GLORS (both the OGCM and the 3D-Var components) and recall the motivations and results behind the most recent improvements of the reanalysis system. We then give an insight on the performances of the reanalysis system in terms of uncertainty estimates, extended validation against dependent and independent observations with respect to non-assimilative experiments and computational performances. Finally, the interannual variability of many Global Ocean key parameters (heat and freshwater budget, sea-level, volume transports) as depicted by C-GLORS is presented and discussed.

Corresponding Author:
Name: Andrea Storto
Organization: Centro Euro-Mediterraneo per I Cambiamenti Climatici
Address: viale Aldo Moro, 44, I-40127 Bologna, Italy
Email: andrea.storto@cmcc.it