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Technical report on input data and characteristics of the Mediterranean Reconstruction/Reanalysis

WP Coordinator:
Nadia Pinardi
INGV, Bologna

Authors
Claudia Fratianni, Nadia Pinardi

I Introduction

The Mediterranean Reconstruction/Reanalysis (hereafter RR) has been produced by INGV by combining a Mediterranean general circulation ocean model, forced by atmospheric surface fluxes, with quality controlled ocean observations, using a 3DVar assimilation scheme developed by INGV.
The RR products have been extended forward in time once a year with respect to the first release in 2012 in order to respond to the increasing demand of historical reconstruction needed as a reference for a better understanding of the ocean dynamics and its spatial/temporal variability.

II Overview of the Reconstruction/Reanalysis system

The Mediterranean RR system relies on three main components:

1. **A quality controlled observational data set**: the data set is composed of historical in-situ temperature and salinity profiles and Sea Level Anomaly along track from altimetry.
2. **An ocean general circulation model (OGCM)**: it is an hydrodynamic, baroclinic model with free surface identified in the Nucleous for European Modelling of the Ocean (NEMO);
3. **A data assimilation scheme**: a 3D variational data assimilation scheme, called OceanVar, was used to assimilate temperature, salinity profiles and satellite Sea Level Anomaly (SLA) along track data;

II.1 Description of the ocean circulation model

The OGCM used to produce the RR is NEMO version 3.2 and Nemo version 3.4, respectively for the period 1955-2012 and 2013-2014. The two codes were used with the same physical settings and the validation task performed on the entire time series didn't show any change in the quality of the products due the updating.

The model solves the primitive equations in spherical coordinated and has 1/16° horizontal resolution (ca. 6-7 km) and 72 unevenly spaced vertical layers as implemented by *Oddo et al., 2009*. It uses vertical partial cells to fit the bottom depth shape and it is located in the Mediterranean Basin, extending into the Atlantic in a box approximately 5 x 15 degrees in longitude and latitude in order to better resolve the exchanges with the Atlantic Ocean at the Strait of Gibraltar. (Figure 1)

The model is nested in the Atlantic within monthly mean climatological fields computed from ten years of daily output of the 1/4° x 1/4° degrees PSY3 global model provided by MERCATOR (*Drevillon et al., 2008*).

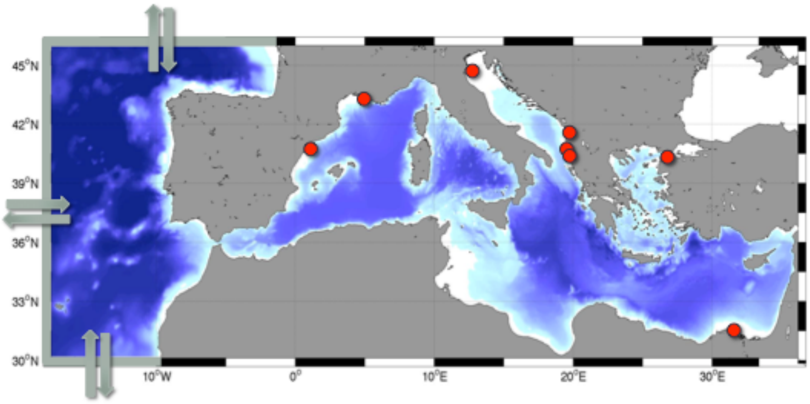

Figure 1 Model domain with rivers position and nested area in Atlantic box.

The model is forced by momentum, water and heat fluxes interactively computed by bulk formulae adapted to the Mediterranean case, using AMIP data (*Cherchi and Navarra, 2007*). AMIP data are available from 1900 and were created through a set of experiments performed with the ECHAM4 atmospheric AGCM on a T126 grid (1.125° of horizontal resolution) forced by HadISST and have a 12 hours temporal resolution. Heat flux is corrected proportionally to the difference between the model and observed SST (*Pinardi et al., 2003*), with a relaxation coefficient equal to -60 Wm^{-2} K^{-1}, corresponding to about 2.5 day scale over a depth of 3m. The observed SST dataset consist of monthly SST provided by Met Office Hadley Centre (HadISST) on regular grid of 1° x 1° starting from 1870 (*Rayner et al., 2003*) and this choice is consistent with using AMIP atmospheric forcing, which is also forced by HadISST.

Water balance is computed as Evaporation minus Precipitation and Runoff. The evaporation is derived from the latent heat flux while the precipitation and the runoff are provided by monthly mean dataset. Precipitation is taken from Climate Prediction Centre Merged Analysis of Precipitation (CMAP) data (*Xie and Arkin, 1997*). Runoff is provided by monthly mean datasets: the Global Runoff Data Centre dataset (*Fekete et al., 1999*) for the Po, Ebro, Nile and Rhone rivers; the dataset from Raicich (*Raicich, 1996*) for the Vjosë and Seman rivers; the UNEP-MAP dataset (Implications of Climate Change for the Albanian Coast, Mediterranean Action Plan, MAP Technical Reports Series No.98., 1996) for the Buna/Bojana river (Figure 1).The Dardanelles Starit is closed but considered as net volume input (*Kourafalou and Barbopoulos ,2003*) through a river-like parametrization.

II.2 Description of the ocean data assimilation scheme

The data assimilation system is the three-dimensional multivariate variational scheme called OceanVar, developed by *Dobricic and Pinardi (2008)* that allows to correct model fields intermittently. The background error covariance matrix is subdivided into vertical and horizontal components: the vertical covariance matrix components are represented by 20 seasonally and regionally varying multivariate vertical EOFs, considering the covariance of surface elevation and vertical temperature and salinity profiles, estimated from the temporal variability of parameters in an historical model simulation (*Dobricic et al., 2005*). The Mean Dynamic Topography used for SLA data assimilation has been computed by *Dobricic et al., 2005*. In order to handle historical observations, which are normally given with regularly and finely sampling, a localization technique was implemented to decrease the correlation length scales in the background error covariance matrix.

The assimilation cycle is daily and both in-situ and satellite data are jointly assimilated to correct the initial condition once a day.

II.3 Description of the quality controlled observational data set

The assimilated data consists of satellite SLA data and in-situ temperature and salinity profiles from different sensors (see Table 1).

The SLA dataset is the so called Reprocessed sea level data set, released in delayed mode, homogenized with respect to a reference mission, which is currently Jason2, and using the same model and corrections for each satellite. This product is computed with an optimal and centred computation time window for the orbit corrections (6 week before and after the date).

The in situ temperature and salinity profiles considered for the RR production belong to different instrumental data type: CTDs, XBTs, MBTs, bottles, ARGO floats. In situ data sets have been collected from European Marine databases and have been archived in a specific format to be assimilated. They were downloaded from different sources: 1) SeaDataNet archives; 2) MEDAR-MEDATLAS dataset covering the period 1985-1999 (*Maillard et al. 2005*) and 3) CMEMS In situ TAC. Considering the time lag between the sampling and the insertion of the data inside different data collection centres, the insitu dataset used in the production is a combination of reprocessed data and near-real time observations in the recent period.

The SST dataset are not assimilated but they are used to correct the surface heat flux by a relaxation of the numerical model surface layer temperature towards the observed SST. The observed SST dataset consist of monthly SST provided by Met Office Hadley Centre (HadISST) on regular grid of 1° x 1° starting from 1870 (*Rayner et al., 2003*).

Table 1 summarizes the atmospheric forcing and observational data assimilated in the RR system .

ATMOSPHERIC FORCING	AMIP
SLA	CMEMS data set SEALEVEL_MED_SLA_L3_REP_OBSERVATIONS_008_020 SEALEVEL_MED_SLA_L3_NRT_OBSERVATIONS_008_019
ARGO	CMEMS dataset INSITU_MED_NRT_OBSERVATIONS_013_035 INSITU_GLO_NRT_OBSERVATIONS_013_030
XBT	MEDATLAS, CMEMS dataset
CTD	CMEMS dataset in-situ SeaDataNet product (FREE access temperature Salinity Observations) in-situ SeaDataNet product (RESTRICTED access temperature Salinity Observations) MEDAR MEDATLAS (historical data)
SST	Met Office Hadley Centre SST dataset (HadSST1)

Table 1: Atmospheric forcing and observational data used in the RR. CMEMS- Copernicus Marine Environment Monitoring Service.

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