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Towards a realistic climate modelling of the Mediterranean Sea over the last 50 years: method and result overview

Samuel Somot (1), Florence Sevault (1), Jonathan Beuvier (2), Marine Herrmann (3), Benoit Meyssignac (3), Roland Aznar (4), Gabriel Jordà (5), Simon Josey (6), and Michel Déqué (1)

(1) Meteo-France, CNRM, TOULOUSE, France (samuel.somot@meteo.fr, 00 33 (0)56107 9610), (2) MERCATOR, Toulouse, France, (3) CNRS/LEGOS, Toulouse, France , (4) Puertos de l'Estado, Madrid, Spain, (5) IMEDEA, Majorca, Spain, (6) NOCS, Southampton, U.K.

The Mediterranean Sea is known to show high interannual variability in terms of air-sea fluxes, surface circulation and deep water formation. It also experiences decadal variability as proved by the Eastern Mediterranean Transient event (EMT) in the 90s and the recent Western Mediterranean Transition (WMT) in the 2000s. The existence of long-term trends in the deep layers has also been reported. Therefore, simulating and understanding the evolution of the Mediterranean Sea over the last decades is considered as quite a challenging task for the ocean and climate modelling community.

To tackle this issue, we set up a high-resolution, physically and temporally consistent dataset for the forcing of long-term Mediterranean Sea simulations. This dataset called ARPERA covers the period 1958-2008 at a 50 km horizontal resolution. It is based on a dynamical downscaling of ECMWF atmospheric products (reanalysis and analysis) using the ARPEGE Regional Climate Model and the spectral nudging technique: model spatial scales larger than 250 km are forced to follow the reanalysis whereas the small scales (250 - 50 km) are free to develop. This dynamical technique is often called a "poor-man regional reanalysis". We first analyse the sea wind field and air-sea fluxes of ARPERA, showing a good agreement with independent dataset and an added-value compared to state-of-the-art reanalysis (Herrmann and Somot, 2008; Aznar et al., 2010; Josey et al. 2010). Secondly, we used the ARPERA dataset to force daily a regional ocean model (NEMOMED8, 10 km, SST relaxation, no SSS relaxation) over the 1960-2008 period starting from initial conditions representative of the beginning of the 60s. In addition to the interannual air-sea fluxes, we applied interannual variability for the river runoff fluxes, the Black Sea freshwater inputs and the near-Atlantic characteristics. After a validation of the long-term stability and interannual variability of this hindcast simulation (surface circulation, sea level, SST, SSS, heat content, salt content, deep water formation, Gibraltar transports), we show that it is able to reproduce the EMT in the 90s (Beuvier et al., 2010) and the WMT in Winter 2004-05 (Herrmann et al., 2010).
Next steps towards a more realistic representation of the long-term variability of the Mediterranean Sea are:
- an increase of the horizontal resolution of the forcing (10 km)
- a better description of the near-Atlantic influence (in particular for the sea level variability)
- rivers and Black Sea data for the recent years
- the use of a coupled atmosphere-land-river-ocean regional climate model instead of a forced ocean regional model
- the implementation of in-situ and satellite data-assimilation
- the use of an improved version of the regional ocean model