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Interannual variability (1979-2013) of the North-Western Mediterranean deep water mass formation: past observation reanalysis and coupled ocean-atmosphere high-resolution modelling

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The North-Western Mediterranean Sea is known as one of the only place in the world where open-sea deep convection occurs (often up to more than 2000m) with the formation of the Western Mediterranean Deep Water (WMDW). This phenomena is mostly driven by local preconditioning of the water column and strong buoyancy losses during Winter. At the event scale, the WMDW formation is characterized by different phases (preconditioning, strong mixing, restratification and spreading), intense air-sea interaction and strong meso-scale activity but, on a longer time scale, it also shows a large interannual variability and may be strongly affected by climate change with impact on the regional biogeochemistry. Therefore observing, simulating and understanding the long-term temporal variability of the North-Western Mediterranean deep water formation is still today a very challenging task.
We try here to tackle those issues thanks to (1) a thorough reanalysis of past in-situ observations (CTD, Argo, surface and deep moorings, gliders) and (2) an ERA-Interim driven simulation using a recently-developed fully coupled Regional Climate System Model (CNRM-RCSM4, Sevault et al. 2014). The multi-decadal simulation (1979-2013) is designed to be temporally and spatially homogeneous with a realistic chronology, a high resolution representation of both the regional ocean and atmosphere, specific initial conditions, a long-term spin-up and a full ocean-atmosphere coupling without constraint at the air-sea interface.
The observation reanalysis allows to reconstruct interannual time series of deep water formation indicators (ocean surface variables, mixed layer depth, surface of the convective area, dense water volumes and characteristics of the deep water). Using the observation-based indicators and the model outputs, the 34 Winters of the period 1979-2013 are analysed in terms of weather regimes, related Winter air-sea fluxes, ocean preconditioning, mixed layer depth, surface of the convective area, deep water formation rate and long-term evolution of the deep water hydrology.