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Modelling the interannual variability (1979-2012) of the Mediterranean open-sea deep convection using a coupled regional climate system model

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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 simulating and understanding the temporal variability of the North-Western Mediterranean open-sea deep convection is considered as quite a challenging task for the ocean and climate modelling community. Achieving such a goal requires to work with high resolution models for the ocean and the atmosphere interacting freely and to run long-term and temporally homogeneous simulations with a realistic chronology.

In agreement with this statement, we developed at Meteo-France / CNRM a Mediterranean Regional Climate System Model (RCSM) that includes high-resolution representation of the regional atmosphere, land surface, rivers and ocean. The various components are respectively ALADIN (50 km), ISBA (50 km), TRIP (50 km) and NEMO-MED8 (10 km). All the components are interactively coupled daily and a simulation over the period 1979-2012 has been performed using the atmosphere ERA-Interim reanalysis and the ocean NEMOVAR1° reanalysis as 3D lateral-boundary conditions. Spectral nudging technique is applied in the atmosphere.

We first evaluate the ability of this model to simulate some of the observed WMDW formation events (air-sea flux, timing, water mass characteristics, deep water formation rate) thanks to the large observational efforts recently carried out to better document this phenomena (programmes HyMeX, MERMEX, MOOSE). We then analyze the interannual variability of this open-sea deep convection comparing the relative role of the water column preconditioning and of the winter buoyancy loss.