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Mediterranean circulation response to enhanced resolution and tide

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The Mediterranean Thermohaline circulation (MTHC) is sustained by the atmospheric forcing and controlled by the exchange of water with the neighboring Atlantic ocean through the Gibraltar Strait (SoG). The counter-flowing fluxes of Atlantic and Mediterranean waters are subject to tide-induced vigorous mixing within the Strait, where tidal forcing also affects the hydraulic control of volume fluxes, both processes determining heat, salt, and mass fluxes into the Mediterranean. A correct prescription of the lateral boundary condition at the Gibraltar inlet can therefore only be achieved by explicitly including the Gibraltar Strait in the numerical domain at a spatial resolution sufficient to account for both the fast barotropic tidal signal propagating eastward from the Atlantic Ocean and the baroclinic mixing processes occurring within the strait. The aim of this work is to evaluate the separate and joint long-term effects of increased resolution in the strait, SoG dynamics, and tides on the simulated MTHC by comparing results from multi-year hindcast numerical simulations. The model used is a regional Mediterranean version of the Massachusetts Institute of Technology general circulation model. A non-uniform curvilinear orthogonal grid with a resolution of 1/16°x1/16° in its regular portion inside the Mediterranean Sea and a refinement in the SoG reaching a maximum horizontal resolution of about 1/200° x 1/200° has been used. 72 unevenly spaced z-levels have been prescribed in the vertical, with resolution ranging from 1 m to 200 m. The surface atmospheric forcing has been provided by the dynamical downscaling of the ECMWF-ERA40 air-sea fluxes reanalysis via a regional model.
Results from two multi-year simulations differing only for the inclusion/omission of the four dominant constituents of the semi-diurnal and diurnal internal and lateral tidal forcing have been compared analyzing in details the differences in the MTHC with particular attention on the deep convection areas.
A further simulation with the same model at the uniform resolution of 1/12° has been used to evaluate separately the effects of resolution.