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Heat and salt redistribution within the Mediterranean basin in the Med-CORDEX model ensemble

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Characterizing and understanding the basic functioning of the Mediterranean Sea in terms of heat and salt redistribution within the basin is a crucial issue to predict its evolution. Here we quantify and analyze the heat and salt transfers using a simple box model consisting of 4 layers in the vertical for each of the two (western and eastern) sub-basins. Namely, we box-average 14 regional simulations of the MedCORDEX ensemble plus a regional and a global reanalysis, computing for each of them the heat and salt exchanges between layers. First, we analyze in detail the heat and salt redistribution at different time scales from the outputs of a single simulation (NEMOMED8). We show that in the western basin the transfer between the surface (0-150m) and intermediate (150-600 m) layers is upwards for both heat and salt, while in the eastern basin both transfers are downwards. A feature common to both sub-basins is that the transports are smaller in summer than in winter due to the enhanced stratification, which dampen the mixing between layers. From the comparison of the 16 simulations we observe that the spread between models is much larger than the ensemble average for the salt transfer and for the heat transfer between the surface and intermediate layers. At lower layers there is a set of models showing a good agreement between them, while others are not correlated with any other. The mechanisms behind the ensemble spread are not straightforward. First, to have a coarse resolution prevents the model to correctly represent the heat and salt redistribution in the basin. Second, those models with a very different initial stratification also show a very different redistribution, especially at intermediate and deep layers. Finally, the assimilation of data seems to perturb the heat and salt redistribution. Besides this, the differences among regional models that share similar spatial resolution and initial conditions are induced by more subtle mechanisms which depend on the variable and process analyzed. In order to reduce the uncertainties in the Mediterranean regional climate projections further modelling studies and better observational datasets are needed to constrain the main sources of discrepancies among models. In the absence of those, an ensemble modelling approach as the one followed in the MedCORDEX initiative seems to be the best solution to propagate model uncertainties into the future climate projections.