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Impact of vertical resolution in an eddy-permitting Ocean Global Circulation Model forced with ERA-Interim

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In this study, we assess the benefits of increasing the vertical resolution in an eddy-permitting 1/4° Ocean Global Circulation Model. We have carried out twin experiments with the DRAKKAR ORCA025 configuration, based on the NEMO code, with 75 and 46 levels. The 75 levels grid has a fine resolution (1 meter) in the upper 10 meters of the ocean and nearly 200 meters in the deep ocean. The 46 levels grid has 6 meters resolution at the surface and 250 meters in the deep ocean. To take full advantage of the fine vertical resolution at the surface, we have used the high-frequency (3-hourly) ERA-interim forcing, with an analytical diurnal cycle for solar radiations. The models have been run from 1989 to 2009 and we compare the results of the simulations to observations provided by ENACT-ENSEMBLES and NOAA OI SST analysis over the 10-year period 2000-2009.

Model outputs are collocated (space and time) with the observations of the ENACT-ENSEMBLES database. Model/observation comparisons show that the coarser vertical resolution has positive heat content biases in the upper 300 meters in the Indian, south Atlantic and eastern Pacific oceans. Those warm biases are partly corrected when the finer vertical resolution is used. The four major upwelling regions of eastern basins are also found to be very sensitive to the change in vertical resolution. The fine vertical resolution reduces the surface temperature bias (compared to NOAA OI SST) by 0.3 to 0.5°C. In those areas, the models exhibit a subsurface warm bias which is reduced by almost 1°C with increased vertical levels. We also noticed small differences in the deep flows, among those a reduction of the high salinity bias often found in the subpolar gyre of the North Atlantic in forced DRAKKAR model simulations, the reasons of which are yet to be identified. Finally, in terms of large scale circulation, both models have a very similar behavior. Considering the importance of the large upwelling systems in the ocean general circulation, we recommend the use of the 75 levels for coupled physical/biological simulations. However, the relevance of the 46 level model for sensitivity studies of the meridional overturning circulation is not questionned by our results.