The Performance of Vertical Mixing Parameterizations in Replicating the Mixed Layer Depth and Surface Wind Mixing

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Mixing at the ocean surface is key for atmosphere-ocean interactions and the distribution of heat, energy, and gases in the upper ocean. Winds are the primary force for surface mixing. To properly simulate upper ocean dynamics and the flux of these quantities within the upper ocean, models must reproduce mixing in the upper ocean. To evaluate the performance of the Regional Ocean Modeling System (ROMS) in replicating the surface mixing, the results of four different vertical mixing parameterizations were compared against observations, using the surface mixed layer depth, the temperature fields, and observed diffusivities for comparisons. The vertical mixing parameterizations investigated were *Mellor-Yamada* 2.5 level turbulent closure (MY), *Large-McWilliams-Doney* Kpp (LMD), *Nakanishi-Niino* (NN), and the Generic Length Scale (GLS) schemes. This was done for one temperate site in deep water in the Eastern Pacific and three shallow water sites in the Baltic Sea. The model reproduced the surface mixed layer depth reasonably well for all sites; however, the temperature fields were reproduced well for the deep site, but not for the shallow Baltic Sea sites. In the Baltic Sea, the models overmixed the water column after a few days. Vertical temperature diffusivities were higher than those observed and did not show the temporal fluctuations present in the observations. The best performance was by NN and MY; however, MY became unstable in two of the shallow simulations with high winds. The performance of GLS was nearly as good as NN and MY, but it is computationally slower. LMD had the poorest performance as it generated temperature diffusivities that were too high and induced too much mixing. Further observational comparisons are needed to evaluate the effects of different stratification and wind conditions and the limitations on the vertical mixing parameterizations.

Keywords: wind mixing, surface mixed layer, ROMS

