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Sensitivity studies of the Arctic-North Atlantic ice-ocean coupled model to the mixed layer parameterization

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As a result of convective instability in the ocean the formation of mixed layer occur, where the vertical distribution of the main thermodynamic characteristics is close to uniform. The thickness of the mixed layer varies in space and time, making a few tens of meters during the spring-summer heat and capturing the entire active layer up to several hundred meters in the autumn-winter cooling ice-free seas. Mixed layer exchanges momentum, mass, heat and salt with deep ocean via interfacial stresses, entrainment and diffusion. Estimates of mixed layer depth are important to a wide range of ocean research, such as upper-ocean productivity, exchange with the atmosphere, and long-term climate change. In ocean-ice numerical models the proper reproduction of the upper mixed layer state is especially important, since it is closely related to processes of ice formation.

Numerical model results can be very sensitive to the mixed layer parameterization. The intensification of mixing in the upper layer in the model experiments may lead to the disappearance of fresh water in the Beaufort Sea, reducing the thickness of the Atlantic water layer, changing Arctic ocean circulation, etc.

On the other hand, the restriction of the ocean upper layer mixing in the numerical models leads to reducing of heat loss in the Atlantic layer and excessive heat accumulation it in the Arctic waters.

In this paper we investigate the sensitivity of a regional Arctic model to the parameterizations of convective processes in the ocean. We investigated how the different mixing schemes affect the simulated ocean ventilation, water mass properties, and sea ice distributions.

The investigation was based on the coupled regional ice-ocean model of the ICMMG SB RAS. Two parameterizations of mixed layer were chosen: standard procedure used in the ICMMG model, based on the Richardson criteria and nonlocal K profile parameterization (KPP).

We compare numerical fields of temperature and salinity, current velocity, thickness of the ice obtained for two numerical experiments. We analyze the thermohaline structure of the Arctic Ocean, in particular freshwater content in the Beaufort Gyre and compare numerical results with observational data. The main focus is on the analysis of the upper 500-m layer state.

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