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Arctic Ocean climate simulations by the FE model and directions of further progress.

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The modified version of the coupled ice-ocean finite-element general circulation model of the Arctic Ocean (FEMAO) is presented. The model will be used for the estimation of the role of the tides in the formation of the Arctic Ocean climate in the frame of the EU DAMOCLES project, the European input to the International Polar Year. This model is based on the INM RAS finite-element model, already intensively tested during the AOMIP (Arctic Ocean Model Intercomparison Project).

The ocean model is free surface, z-coordinate one, with rotated spherical grid. Dynamical part of the ocean model involves parameterizations of the barotropic coastal jets (similar to the “Neptune effect” by Holloway, 1992, with approximations by Kazantsev, et. al., 1998 and Polyakov, 2001) and scalar eddy transport (by Gent and McWilliams, 1990, with the skew-flux formulation by Griffies). Ice model based on the Los Alamos Sea ice model physics of ridging and EVP rheology. Thermodynamics of multy-category ice and snow is similar to Sempter, 1976, although there are some improvements concerning physical parameterizations.

The main peculiarity of the model is the method of numerical solution – the Gelerkin (Finite Element) spatial approximation, applied both for ocean and sea ice components. Some general details of the model numerical implementation for the uniform structured grid are presented.

The results of the 1948-2002 hindcast of Arctic Ocean sea ice and water north of 65N are demonstrated: sea ice characteristics, the Beaufort Gyre freshwater content and their interannual variability. These results confirm the good quality of the model and inspire to develop in further.

The preliminary results of the numerical experiments with the explicit quantitative estimation of the role of tides in the formation of the climate system of the Arctic Ocean (water and sea ice) are also presented. The tidal forcing is specified as the incident M2 wave, similar to the approach by Kowalik and Proshutinsky, 1994. The problems of the model development for the wider model area, with the necessity to take into account both the tidal potential and incident tidal wave are discussed.

Some aspects of the current model development such as unstructured grids implementation, bottom topography approximation by analog of “partial cells” or “shaved cells”, free-surface formulation in “z”, “sigma” and “z-star” vertical coordinate systems, are also under discussion.