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FEMAO (Finite Element Model of the Arctic Ocean) – state-of-the-art and prospects of development in the frame of the DAMOCLES

N. Yakovlev

Institute of Numerical Mathematics, Moscow Russia

(iakovlev@inm.ras.ru / Fax: +7(495)9381821 / Phone: +7(495)9383900)

The main contribution of the FEMAO to the EU project DAMOCLES WP 4.1 is expected to be the assessment of the impact of tidal dynamics to the long-term ice and seawater distributions. The explicit implementation of the tides in the general circulation coupled ice-ocean model will allow us to get more accurate qualitative estimates of the processes, associated with tidal dynamics. We expect to focus our attention on the role of tides both in the vertical mixing and in the additional ice ridging. The future aim is to evaluate the role of tides in the formation of the narrow coastal jets.

To solve the problems, indicated above, the modified version of the coupled ice-ocean general circulation model will be implemented. This model will be based on the INM RAS finite-element model, 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. Some general details of the model numerical implementation are presented.

The results of the 1948-2002 hindcast of Arctic Ocean sea ice and water north of 65N are demonstrated with the special focus to the representation of the Beaufort Gyre freshwater content and its interannual variability. These model experiments were carried out according to the AOMIP regulations.

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 presented. The tidal forcing is specified as the incident M2 wave, similar to the approach by Kowalik and Proshutinsky, 1994.

Some aspects of the model improvement during the DAMOCLES implementation period such as bottom topography approximation by analog of “partial cells” and “shaved cells”, free-surface formulation in “z” and “z-star” vertical coordinate systems, are also under discussion.