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Model estimations of the Arctic sea ice conditions in XXI century

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Dynamic-thermodynamic sea ice model, developed in AARI is applied for estimations of recent and future sea ice conditions in the Arctic Basin. The model describes sea ice cover in terms of relative areas of level ice, ridges with fixed form, and leads. The main equations of model are stationary impulse balance equation and non-stationary mass balance equation with parameterizations of heat and dynamic processes in level ice, leads and ocean mixed layer. The parameterizations include: quasi-stationary thermodynamic model for level sea ice, Brown parameterization of atmospheric boundary layer, McPhee parameterization of the ocean mixed layer, Kenig-Langlo & Augstein parameterization of incoming longwave radiation, Monin -Obukchov parameterization for stratified atmospheric surface layer, Shine parameterization for shortwave radiation balance, parameterizations of heat processes in leads (similar Ebert and Curry), Flato and Hibler parameterization of internal ice stresses in the framework of cavitating fluid, Hakkinen and Mellor estimations of oceanic heat fluxes in the Barents, Bering and Greenland seas, and some intuitive data about ridge melting. External forcing of the model are: fixed dynamic topography of the Arctic ocean and monthly mean fields for relative humidity, total cloudiness and solid precipitation, and NCEP/NCAR or from different scenarios data about atmospheric surface pressure and surface level air temperature.
Numerical experiments with a dynamic-thermodynamic sea ice model under NCEP/NCAR Reanalysis forcing allowed to reproduce the thinning of the sea ice cover in the main part of the Arctic Basin, that had been documented by Rothrock et all (1999), as well as well-know strong decrease of sea ice area in 2007 and 2008. Follow our model estimations the main reason of the sea ice thinning and decline is the changes in atmospheric circulation. The second reason is the increase of atmospheric surface layer temperature.
Using as atmospheric forcing the results of prognostic estimations follow scenario A1B from ECHAM5/MPI-OM, HAD CM3 and CCSR/NIES/FRCGC models for period 2000 – 2100 the estimations of sea ice cover had been done. It is shown that despite the strong decrease of sea ice cover area and volume, especially with data from ECHAM5/MPI-OM and CCSR/NIES/FRCGC, numerical experiments with dynamic-thermodynamic model show that under all three scenarios multy-year ice will save in the Canadian Basin up to the end of XXI century.