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Arctic sea ice in 1948-2002 as derived by the coupled ice-ocean model FEMAO

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Recent ice extent shrinking, which was not predicted by the climate models, manifested that there are still problems in the Earth climate system modeling. It may be due to the lack of some physical mechanisms, responsible for the destabilization of the Arctic climate system.

The coupled ice-ocean model FEMAO was applied to the simulation of the Arctic Ocean state in the period 1948-2002. Forcing and basic parameterizations were according to the AOMIP protocol. The results on the simulation of sea ice extent, area, volume, mass and drift are presented. The special attention is paid to the representation ice characteristics in the Fram Strait, where sufficient data are available.

Analysis of sea ice extent and area shows, that model simulates trends in ice extent and area well for the proper choice of periods, used to calculate these trends: 1970-1979, 1979-1990, 1990-2002. It means, that from one hand sea ice data should be treated carefully (1979 is the start of the satellite era), and from the other hand that some rapid changes in sea ice cover may be due to events of the Atlantic water injection. For the whole 1960-2002 period model estimates ice area trend as 3% per decade, which is 3 times less than satellite data estimates - this discrepancy mainly due to jumps in 1979 and 1990. The ice edge location simulated in general well, the main errors are located on the Siberian shelf and may be attributed to specified clouds and solar penetration in ocean (which assumed to be clear water).

Sea ice volume has a negative trend 5.5% per decade for the period 1970-2002. In 1996-2002 period sea ice area decreased faster, than volume - the mean sea ice thick-

ness trend is positive and about 1.7 cm per year. It means, that during this period there was redistribution of sea ice thickness - thin ice fractions melted faster, than thick ones.

The structure and absolute values of sea ice drift are consistent with the satellite and buoy data. Sea ice characteristics in the Fram Strait are also very realistic and consistent with the data by Vinje, at.al., 1998. The only problem is the discrepancy in sea ice thickness distribution during summer - model can't represent the probability maximum at thickness 2.5 m, distribution is almost uniform.

Tides are one of the physical mechanisms, responsible for stabilization or destabilization of the Arctic Ocean large-scale state. Tides are responsible both for extra open water production, and for extra heat transport from the warm Atlantic water layer. The quantitative estimates of these somewhat contradictory processes are still not accurate.

Some preliminary analysis on the role of the M2 tide on the sea ice state formation was carried out. It was shown, that ocean-ice coupling in the assumption of the "levitated" ice leads to unsatisfactory results. To evaluate the utility of the more sophisticated model formulations with the thick floating ice, the set of experiments with ice-ocean drag coefficients 10 and 100 times the standard one were carried out. It was shown that large coefficients lead to more realistic ice thickness distribution in the Fram Strait with the probability maximum at approximately 3 m. Thus the problem of the explicit implementation of tides into the climate model is the problem of the ice-ocean coupling for high frequency forcing.