Sea Ice Cover Sensitivity analysis in Global Climate Model

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Climate model includes AGCM, ocean model and sea ice evolution model. The purpose of the work is analysis of seasonal and annual evolution of sea ice, long-term variability of a model ice cover, and also its sensitivity to some physical and model characteristics.

Results of 100 years simulations of Arctic basin sea ice evolution are analyzed. The significant (about 0.5 м) interannual fluctuations of an ice cover exist. The spectral analysis of results demonstrates 5-7 years period climate and 3-10 days synoptical ice cover fluctuations. The auto correlation function with the excluded annual and seasonal components shows data dependence with 3 days time lag.

A number of numerical experiments according to influence of some physical and model parameters on results are carried out.

The ice - atmosphere sensible heat flux 10% reduction leads to growth of mean sea ice thickness within the limits of 0.05 m – 0.1 m. However in separate spatial points there is a decreasing of thickness up to 0.5 m. The maximum increase of ice thickness is observed in the end of spring and summer seasons. It is connected with the maximal difference of air - ice temperatures in the warm period.

The analysis of average ice thickness seasonal change at decreasing on 0.05 of clear sea ice albedo shows reduction of ice thickness in a range from 0.2 m up to 0.6 m, and the maximum of change is during the summer season of intensive melting. The spatial distribution of ice thickness changes (Fig. 1) shows, that on the large part of Arctic ocean there was a reduction of ice thickness down to 1 m. However, there is also area of some increase of the ice layer basically in a range up to 0.2 m. It is located in the Beaufort sea.

The 0.05 decreasing of sea ice snow albedo leads to reduction of average thickness of ice approximately on 0.2 m, and this value slightly depends on a season. The changes in separate points are not so great (Fig. 2), as in the previous case, because the surface albedo change in polar areas is essential in summer period, and at this time snow on the significant areas of an ice cover has melted and does not influence on solar radiation absorption. There is a stable area of ice cover thickness increase as in previous case. Probably, it is connected with the atmospheric circulation, clouds and precipitation changes.

In the following experiment the ocean – ice thermal interaction influence on the ice cover is estimated. It is carried out by increase of a heat flux from ocean to the bottom surface of sea ice on 2 W/sq. m in comparison with base variant. Analysis demonstrates, that there was a reduction of average ice thickness in a range from 0.2 m up to 0.35 m (Fig. 3). There are small seasonal changes of this values.

The numerical experiments results have shown, that an ice cover and its seasonal evolution rather strongly depend on varied parameters. The spatial and seasonal structure of changes has rather complex non-uniform character, there are great areas of opposite changes. It is connected with nonlinear behavior of feedback and interactions in model system including an atmosphere, sea ice and ocean.

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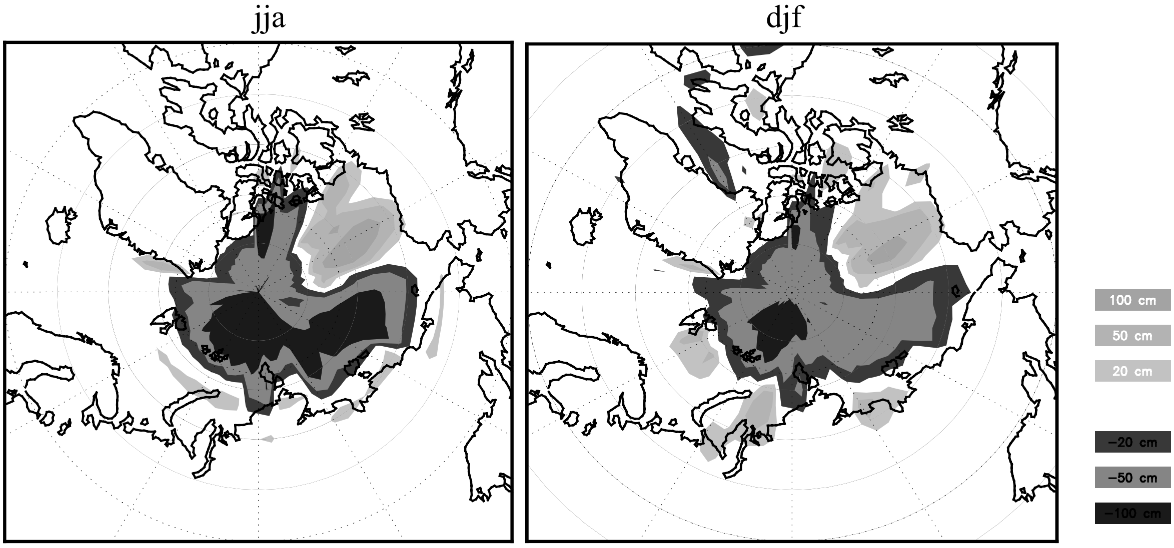

Fig. 1. Sea ice thickness changes: ice albedo decreasing experiment.

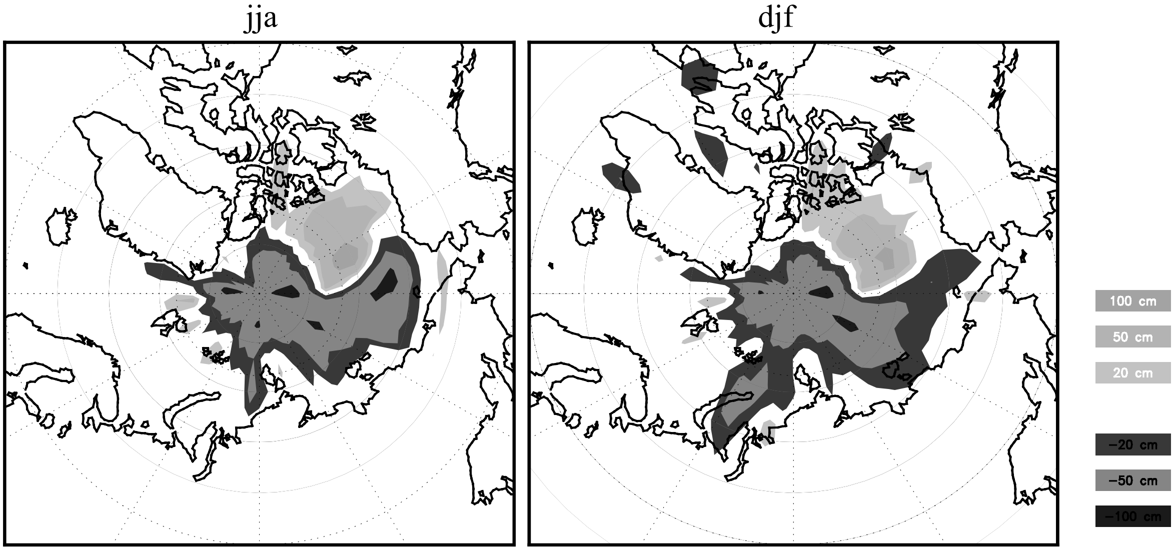

Fig. 2. Sea ice thickness changes: snow albedo decreasing experiment.

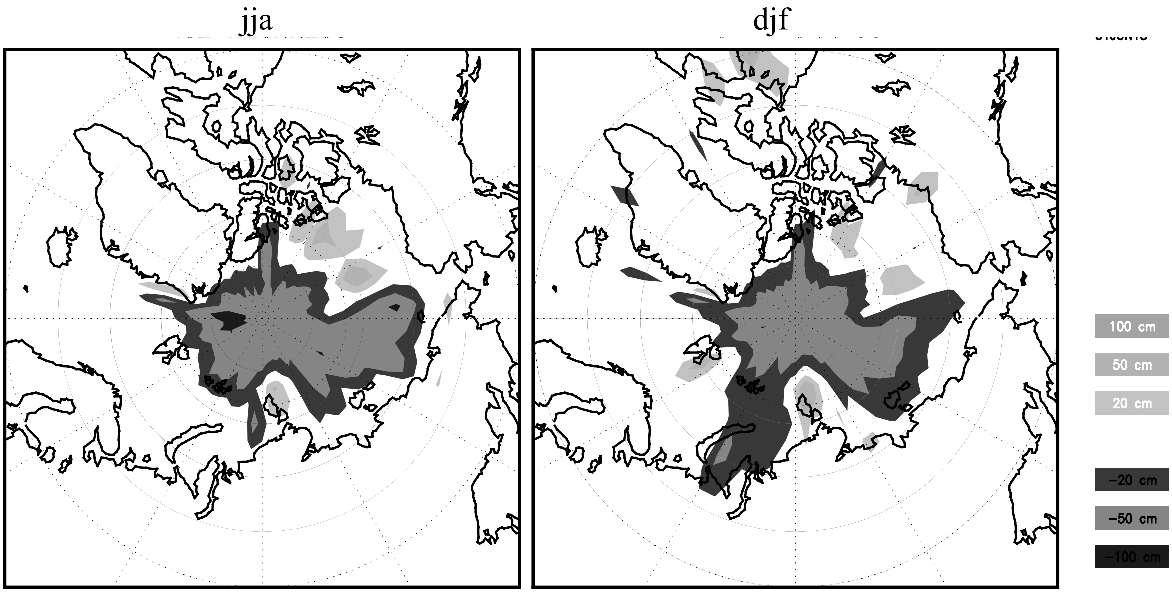

Fig. 3. Sea ice thickness changes: ocean - ice heat flux increasing experiment.