Arctic sea ice transformations: present situation and future scenarios

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ABSTRACT
The sea ice cover, which presently is perennial in the Arctic Ocean and at least seasonal in its marginal seas, is an important component of the global climate system. A consensus in the climate modelling community is that global warming should be amplified in the Arctic due to feedback processes within the atmosphere–ocean–ice climate system. The amplified warming suggests a drastic reduction of the sea ice cover. First changes will be mostly pronounced in the marginal seas of the Eurasian sector. That should increase offshore activities and marine transportation over the Northern Sea Route, inducing on the other side such changes in the navigation conditions as increased storminess and unpredicted moving of ice floes and making offshore activities more dangerous.
The most consistent, quantitative means to monitor the Arctic sea ice cover is from satellite-borne passive microwave sensors. In the presented study merged "inter-calibrated" SMMR-SSM/I time series have been produced and analysed, establishing the trend of the Arctic sea ice cover of about 3% per decade. The reductions have been mostly pronounced in the European sector in winter and the Siberian-Alaskan sector in the summer, with the record of low arctic ice minima in 2002 - 2005. The pronounced summer reductions imply changes in the character of the ice cover – i.e., reduced amount of perennial, multi-year (MY) ice. The negative trend in MY ice area analysis is often cited as evidence of a substantial change in the ice cover. However, capabilities and limitations of passive microwave algorithms to estimate of the relative coverage of FY and MY ice have not been quantitatively established. The uncertainties are greatest in the marginal seas. In this study the QuikSCAT scatterometer data was used as a complimentary source of information that assisted in separating first year and multi year ice, improving algorithm of multi year ice retrieval and describing multi year ice movement in the periods when passive microwave retrievals cannot provide a stable picture. NORSEX calculations and QuikSCAT-based retrievals were validated using available SAR images, ice charts and in situ ice type observations.
A set of model predictions is used to quantify changes in the ice cover through the twenty-first century, with greater reductions expected in summer than winter. In summer, a predominantly sea-ice-free Arctic is predicted for the end of this century.

Keywords: Arctic environment, sea ice, perennial ice, sea ice reduction, passive microwave satellite data, scatterometer data