



Climate changes in the Arctic in the 20th and 21st centuries from observations and modeling and their impact on the navigation at the Northern Sea Route

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Sea ice changes along the Northern Sea Route (NSR) in the 20th century were retrieved from satellite passive microwave measurements, which are available continuously since November 1978. Future changes of the climate parameters along the NSR in the 21st century were estimated using ensemble of IPCC AR4 global climate models.

In all arctic seas, which the Northern Sea Route goes through, the negative trend in sea ice concentration has been determined over the whole period of satellite observations. During this period the decrease in the winter and spring time has been most pronounced in the Barents, Greenland and Kara seas. In the Barents sea the negative trends are statistically significant from December to July, in the Kara sea they are statistically significant from December to August. The winter months trends for the whole Barents sea ice area are about -10% per decade: -12% in January, -10% in February and -8% in March. The summer and fall sea ice decreases have been largest in the Chukchi and East Siberian seas. In the Chukchi sea the negative trend in the sea ice area is statistically significant during eight months – from May to December, being as large as -25% per decade in August, -31% per decade in September and -27% per decade in October..

Climate models project an acceleration of the Arctic sea ice retreat with periods of extensive melting spreading progressively further into spring and autumn. According to modeling data global warming is expected to be amplified in the Arctic and sub-Arctic regions in the 21st century. Change of the annual mean air temperature in the 21st century may reach +2.6 ° C comparing to the end of the 20th century. Continued greenhouse warming reduces the sea ice coverage in the AR4 model simulations, especially during summer and in all the coastal Arctic seas, although there is a considerable range among the retreats projected. Sea ice simulations were analysed for different Arctic seas and several time slices: 2010-2030, 2040-2060, 2070. Modelled sea ice distributions for the NSR indicate decreasing sea ice coverage and plausible increase in the length of the NSR navigation season throughout the 21st century. Many of the simulations show retreating ice cover along the NSR, but with the ice consistently presented at the northern tip of Severnaya Zemlya. An extended navigation season could have major implications for transportation and access to the natural resources.