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Manifestations of the Arctic warmings during last 100 years in the surface air temperature, sea ice and the Arctic Ocean

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The Arctic climate change during 20th century includes two prominent large-scale patterns that are known as the warmings in 1930-40s and 1990s. We considered manifestations of these phenomena in the Arctic Ocean, surface air temperature (SAT), sea ice extent (SIE) and interrelations between SAT and SIE using observational data sets for1900-2005. In order to evaluate regional and seasonal features of the SAT distribution during both warming periods we used the monthly-mean SAT data from 30 long-operated Arctic and sub-Arctic stations. A significant contribution to the variability of annual SAT makes the long frequency oscillation with the period of about 60 years. The largest contribution was recorded at the stations of the Greenland/Iceland region. More temperature maximums were observed in the second half of the year during the first warming period and in the first half of the year during the second warming period. SIE variability on the Northern Hemisphere has its maximum in July-September as well as the variability of the surface water temperature in mid- and high- latitude ocean regions. To estimate the variability of summer melting conditions we calculated the sums of positive SAT at 38 stations in the marine Arctic for every summer season. We found three strong summer wamings in the marine Arctic, West Greenland and adjacent Canadian Archipelago at the end of 1950s - early 1960s, end of 1970s - early 1980 and 1990s up to now. All three warming periods were followed by upper layer freshening in the North Atlantic. Correlation between variations of SIE and SAT depends on the season. Strongest correlation was observed in June even after trend removal. This is connected with anomalies of incoming radiation, atmosphere heat flux and ice extent in previous periods. Analysis of lag correlation between SIE and SAT revealed that SIE changes in spring precede SAT changes, whereas starting from

July SAT changes surpass the ice extent changes Regions with strongest correlation between SIE and SAT on the Northern Hemisphere were found. Analysis of the results from global climate models revealed some discrepancies between observed and modeled correlations. In conclusion it was discussed why the summer melts play the most important role in the sea ice volume decrease and how changes of the ice extent could influence the mean air temperature. The studies were supported by RFBR (project 06-05-64054) and INTAS (grant 03-51-4620).