Arctic environment variability in a context of global climate change

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Changes apparent in the arctic climate system in recent years require evaluation in a century-scale perspective in order to assess the Arctic's response to increasing anthropogenic greenhouse-gas forcing. Coupled atmosphere-ice-ocean climate models predict that greenhouse global warming in the Arctic should be greater than the global mean. The reasons are found in complex interactions or feedback processes within the atmosphere-ocean-ice climate system. The warming predicted for Arctic is ~3-4 °C during the next 50 years, with a substantial decrease of the sea ice cover and changes in the ocean. There is also some observational evidence of remarkable recent changes in the Arctic, from pronounced winter and spring warming in Siberia and northern North America since the 1970s, to apparent melting of the sea ice cover, marked changes in arctic oceanography and in the Greenland Ice Sheet elevation.

Here, a new set of century and multidecadal-scale observational data of surface air temperature (SAT) and sea ice is used in combination with ECHAM4 and HadCM3 coupled atmosphere–ice–ocean global model simulations in order to better determine and understand arctic climate variability. We show that two pronounced twentieth-century warming events, both amplified in the Arctic, were linked to sea-ice variability. SAT observations and model simulations indicate that the nature of the arctic warming in the last two decades is distinct from the early twentieth-century warm period. It is suggested strongly that the earlier warming was natural internal climate-system variability, whereas the recent SAT changes are a response to anthropogenic forcing. The area of arctic sea ice is furthermore observed to have decreased ~$8*10^5$ km^2 (7.4%) in the past quarter century, with record-low summer ice coverage in September 2002. 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.