Geophysical Research Abstracts
Vol. 20, EGU2018-6985, 2018
EGU General Assembly 2018

The impact of the Arctic sea ice loss and variation on lower latitudes

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Arctic sea ice loss during the recent decades of global warming could have contributed to Arctic amplification and colder winters over Eurasia. However, recent reviews suggest that the impact of sea ice changes in the Arctic vary regionally and seasonally, and the results from individual modelling studies differ widely, which led to a debate on the role of sea ice in the polar amplification and Eurasian cooling trend. Here we show that the impact of the recent sea ice decline is rather limited to the high-latitude lower troposphere, through coordinated experiments with six atmospheric general circulation models (AGCMs) forced by observed and climatological daily sea ice concentration and sea surface temperature (SST). The Arctic amplification is strongly coupled with sea ice loss over the Arctic lower troposphere throughout winter, while the warming aloft is mostly associated with remote SST changes. Sea ice changes do not significantly lead to colder winters over Eurasia. The observed temperature trends and corresponding circulation trends are reproduced in a small number of ensemble members but not by the multi-model ensemble mean, suggesting that atmospheric internal dynamics could have played a major role in the observed trends.

Further, we show that Arctic sea ice variations are important for the interannual two meter air temperature (T2m) variations in northern Europe but have limited impact on all other mid and high latitude land regions. In particular, sea ice variations do not contribute to the observed opposite variations in the Arctic and mid-latitudes. The spread across ensemble members is large and many ensemble members are required to reproduce the observed T2m variations over northern Europe in our models.

The amplitude of T2m anomalies in the coldest observed winters over northern Europe is not reproduced by our multi-model ensemble means, but the sea ice conditions in these respective winters lead to an enhanced likelihood for occurrence of colder than normal winters and extremely cold winters. However, the main reason for the observed extreme cold winters seems to be related to internal atmospheric dynamics.

The coldest simulated northern European winters between 1982 and 2014 reproduce the large scale T2m and atmospheric circulation anomaly patterns in the observed coldest winters, indicating that the models are well able to reproduce the processes, which cause these cold anomalies.

The results are robust across all six models used in this study.