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On oceanic forcing of Arctic climate change

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Recent dramatic climate change in the Arctic is most manifested by the reduction of multiyear sea ice pack. It has been commonly associated with anomalies of surface air temperature and atmospheric circulation, which in turn have been linked to the Arctic Oscillation (AO). A typical assessment of such hypotheses is the assumption of the dominant role of external atmospheric forcing and the neglect of effects of processes internal to the Arctic Ocean. Especially the oceanic thermodynamic control of sea ice through the under-ice ablation and lateral melt along marginal ice zones tends to be overlooked. However, those ice-ocean interactions may act to de-correlate AO forcing, which helps to explain some of the timing issues between AO/atmospheric forcing and recent sea ice variability.

To address the above concerns we analyze results from a coupled ice-ocean model of the pan-Arctic region forced with realistic atmospheric data for 1979-2003. We find that the recent decrease of sea ice cover is in large part due to oceanic forcing. Some of the critical oceanic effects contributing to the reduction of sea ice and climate change include: the northward heat flux of warm summer Pacific Water into the Chukchi/Beaufort seas and Atlantic Water into the Nansen Basin and the thermodynamic interaction at the ice-ocean interface, in particular upward heat fluxes due to increased advection of heat into the central Arctic Ocean during the 1990s and 2000s. The decreasing ice cover, through positive ice-albedo feedback, may lead to further warming of the upper ocean and subsequent reductions of sea ice. The lack of or under-representation of such ocean-ice-atmosphere feedbacks in global climate models might be one of the primary reasons for large errors in those models representation of past, present and future climate of polar regions.