Remote tropical influence on a regional Arctic warming over the Barents Sea since the late 1990s

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In the Arctic, a region over the Barents-Kara Seas exhibit the strongest warming in the wintertime surface air temperature in association with a rapid sea-ice reduction since the late 1990s. While ice-albedo feedback is often cited as an underlying cause for the Arctic warming in general, other mechanisms not requiring the sea-ice change are also proposed, an example being Rossby wave-train of circulation anomalies originated in tropics. The recent regional Arctic warming trend in winter over the Barents-Kara Seas is associated with an upper tropospheric circulation trend as well and objective of this study is to investigate the cause(s) of this regional expression of the wintertime Arctic warming trend for the period 1997-2013.

To this end, a series of ensemble A/CGCM experiments are performed: (1) AGCM experiment forced with global, time-varying, satellite-observed sea ice concentration (SIC) and SST (GOGA), (2) AGCM experiment forced with time-varying SST only in tropics and daily climatological mean SST and SIC elsewhere (TOGA), and (3) CGCM experiment with tropical SST nudged towards the observed (C-TOGA). The latter two experiments are intended to examine possible tropical influence. The radiative forcing is fixed to values for present-day climate. A/CGCM experiments consist of 20 and 10 members, respectively.

GOGA displays a pronounced Arctic warming over the Barents-Kara Seas due to a thermodynamic effect of the prescribed reduced SIC but its upper-tropospheric signature is much weaker than the observed. On the other hand, C-TOGA shows a stronger regional Arctic surface warming than GOGA, a surface cooling over the Eurasia, and wave-train circulation anomalies in the upper troposphere similar to the observation, the latter two being absent in GOGA. The warming in C-TOGA is associated with the coherent sea-ice decline in the Barents Sea among 10 ensemble members despite that the sea-ice freely evolves and the only external forcing is the tropical SST in the CGCM experiment. Interestingly, there is also a slight warming in the Arctic eastern hemisphere in TOGA with no interannualy-varying SIC and SST prescribed in high-latitudes. These results suggest that the regional Arctic warming over the Barents-Kara Seas since the late 1990s is triggered by decadal SST trend in tropics via atmospheric teleconnection and is enhanced by local interaction among atmosphere, ocean and sea ice. Pathway of atmospheric teleconnection from tropics to the wave-train of atmospheric circulation anomalies in high latitudes is currently being investigated and will be discussed.

Keywords: Arctic warming, Teleconnection, Atmosphere ocean sea-ice interaction, Coupled General Circulation Model

