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Wintertime response of mid-latitude atmospheric circulation to heat anomalies in the Barents Sea in recent decades

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Prospects for seasonal prediction of climate variability depend on the strength of feedbacks between different components of the climate system. Sources for seasonal predictability of surface atmospheric anomalies in middle latitudes have been previously sought in teleconnections to the tropical phenomenon of El-Niño-Southern Oscillation and among various extratropical drivers including sea surface temperature anomalies, Arctic sea ice cover extremes, continental snow variability and tropospheric-stratospheric interactions. However, impacts of extratropical subsurface ocean variability on atmospheric teleconnections are poorly known. Here we use a lagged regression analysis between an index of the observed summertime Atlantic water temperature (AWT) anomalies at the entrance to the Barents Sea in the period 1982-2005 and the corresponding year-round data from the National Centers for Environmental Prediction/National Center for Atmospheric Research (NCEP/NCAR) reanalysis to show that subsurface oceanic heat anomalies heading the Arctic Ocean are significant precursors of wintertime atmospheric anomalies over mid-latitude Eurasia and North Pacific. In particular, warm AWT anomalies precede an Arctic warming accompanied by a cooling over Eurasia. The summertime oceanic anomalies explain about 40% of the variance in the surface air temperature averaged over entire Eurasia from 35˚ to 45˚N and 50% of the variance in surface winds over the Far East Asia in the following winter. We find that the remote tropospheric response arises from modification of planetary waves and interaction of mean winds with synoptic eddies leading to a reorganization of the mid-latitude storm tracks. The AWT anomalies explain about 60% of the variance in the upper-tropospheric storm track activity averaged over the Pacific and Eurasia from 35˚ to 55˚N and in the lower-tropospheric poleward transient eddy heat flux over western Eurasia. Finally, we show that the tropospheric response to the oceanic forcing may involve interactions with the stratospheric polar vortex and appear in quadrature with the concurrent anomalies associated with the North Atlantic Oscillation.