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Complementary impacts of the North Atlantic Oscillation and oceanic heat anomalies in the Nordic seas on the wintertime climate variability in middle latitudes

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There is a growing evidence that Arctic sea ice anomalies influence mid-latitude weather and climate through coupled changes in the polar jet stream, planetary waves and storm tracks. In particular, the wintertime atmospheric conditions over Eurasia are sensitive to disturbances of sea ice cover in the Barents Sea. Our previous studies, based on a lagged regression analysis between oceanic observations and atmospheric (NCEP/NCAR) reanalysis data in the period 1982–2006, indicate that more than 70 % of the interannual variance of the total wintertime sea ice area in the Nordic (Greenland-Iceland-Norwegian and Barents) seas region can be explained by Atlantic water temperature (AWT) anomalies at the entrance to the Barents Sea in the preceding summer. When brought to the surface, oceanic heat anomalies influence not only the sea ice cover in the Nordic seas but also the local atmospheric conditions up to the tropopause level. The sea ice and atmospheric anomalies persist in winter because of a feedback between oceanically-driven wind anomalies and wind-driven AWT anomalies. A question is whether remote effects of sea ice anomalies in the Nordic seas are modulated by interannual variability in oceanic forcing. Here we show, using the same oceanic and atmospheric datasets as in the previous studies, that the summertime AWT anomalies are indeed significant precursors of a large-scale wintertime atmospheric variability. In particular, positive AWT anomalies precede predominantly westerly wind anomalies in high latitudes and easterly wind anomalies in middle latitudes. The mid-latitude wind anomalies, while being generally equivalent barotropic in the upper troposphere, have a strong low-level baroclinic contribution over Eurasia. The near-surface easterly wind anomalies in this area are locally deflected southward, maintaining cold spots near orography. As at the same time a strong warm anomaly is forced over the Barents and Greenland Seas, the lower-tropospheric temperature anomalies exhibit a ‘warm Arctic-cold Eurasia’ pattern. The ‘warm Arctic-cold Eurasia’ pattern coexists with a hot spot in an anomalous equivalent-barotropic anticyclone that develops over the Gulf of Alaska. An Eulerian analysis of synoptic variability indicates that these teleconnections are related to reorganization of storm tracks. The AWT anomalies explain as much as 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. Interestingly, the AWT-related wintertime atmospheric anomalies are uncorrelated with the concurrent anomalies associated with the North Atlantic Oscillation. This increases a potential for seasonal prediction based on summer AWT anomalies.