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Sea-Ice Variability in the Barents Sea Brings Arctic Warm and Continental Cold
- Clues to Coldness in Japanese Winter -

Overview
Jun Inoue and his colleagues at the Research Institute of Global Change found that winter cyclones originating in the Barents Sea tend to take more northerly paths under recent reduced sea-ice extent, compared to those in heavy ice years in the past. The findings were obtained from atmospheric reanalysis data from 1979 to 2011.

According to their study, the northward shift in cyclone paths brings anomalous warm air over the Arctic Ocean; while over Siberia, a cold air mass is apt to move in from the north. This phenomenon may help explain recent cold events in Japan despite ongoing global warming, and suggests a close correlation between the warm Arctic conditions and climate variability at the downstream mid-latitudes.

The study will appear in the March 2012 edition of the Journal of Climate, issued by the American Meteorological Society.

Title: The role of Barents Sea ice on the wintertime cyclone track and emergence of a warm-Arctic cold-Siberian anomaly.
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Results
Researchers found that under the reduced sea-ice extent in the Barents Sea in winter, cyclone tracks tend to shift northward, from the Siberian coast toward the Arctic Ocean (Fig.1). The resultant distribution of atmospheric sea-level pressure facilitates warm advection over the Arctic Ocean; whereas over Siberia and the Norwegian coast, it creates conditions inducing cold anomalies (Fig. 2a). The cold air mass formed over Siberia reaches the downstream East Asia including Japan within a few days, effecting a colder winter in Japan. Such warm Arctic and cold continental conditions are referred to as a warm-Arctic cold-Siberian (WACS) anomaly, and the WACS anomaly could be a procurer of severe weather in the downstream region.
As in the winter of 2005/2006, which brought heavy snowfall to Japan, the

sea-ice extent in the Barents Sea has been significantly low during the winter of 2011/2012. This suggests that a reduced sea-ice situation may induce the emergence of the WACS anomaly, which could bring colder winter temperatures to Japan (Fig. 2b, Fig.3 and Fig. 4).

Background

The coldness of Japanese winters is generally explained by the combined effects of climate variations, including El Niño/La Niña- Southern Oscillations at low-latitudes, and the positive/negative phase of the Arctic Oscillation (AO) at high-latitudes. Occurrences such as the 2011/2012 winter (Fig. 2b) that brought sever coldness over the continental region, however, cannot be simply explained by such a coupled effect, and thus are often difficult to predict. Meanwhile, in larger spatial scales, warm Arctic and cold Siberia conditions are often observed in pairs, and a linkage to global warming has been receiving increasing attention.

In this study, researchers focused on the wintertime cyclonic activity in the Barents Sea, where the Arctic warming is the most evident, and investigated changes in cyclone tracks in response to the sea-ice variability, as well as their effects on the Arctic warming and Siberian cold.

Future studies

Generally, the large-scale response to sea-ice variability, such as operational long-term weather forecasts in Japan, has been discussed using general circulation models that use long-term mean sea-ice distribution values. Heavy- or light- ice situations in individual years are not reflected in calculations, making predictions largely dependent on mid- to low-latitude data. Incorporating the sea-ice variability and its effects in individual years would, therefore, enhance the reliability of the predictions.
As the Arctic sea-ice retreat is still robust, it is vital to utilize these prediction models to investigate remote responses of atmospheric and oceanic circulation systems to the changes in sea-ice cover.

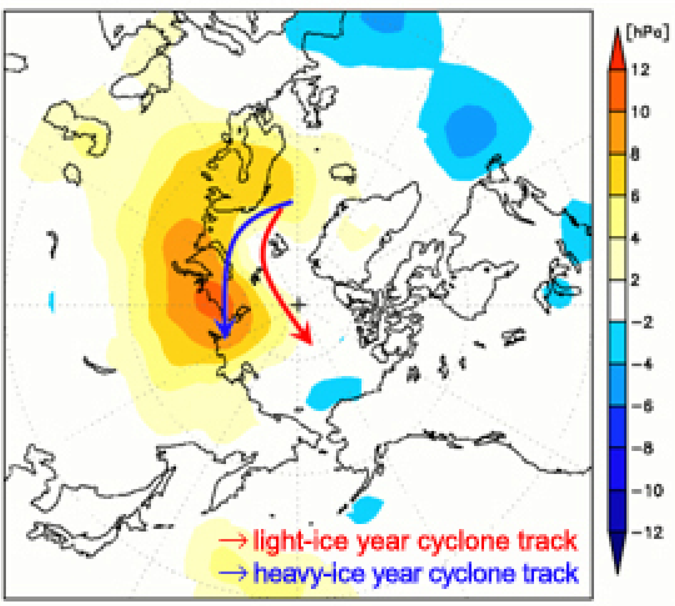

Figure 1. Sea-level pressure (hPa) anomaly and typical cyclone paths (Red arrow: light-ice year, Blue arrow: heavy-ice year). In the light-ice year, the cyclone path shifted northward and the Siberian High expanded up to the Arctic coast.

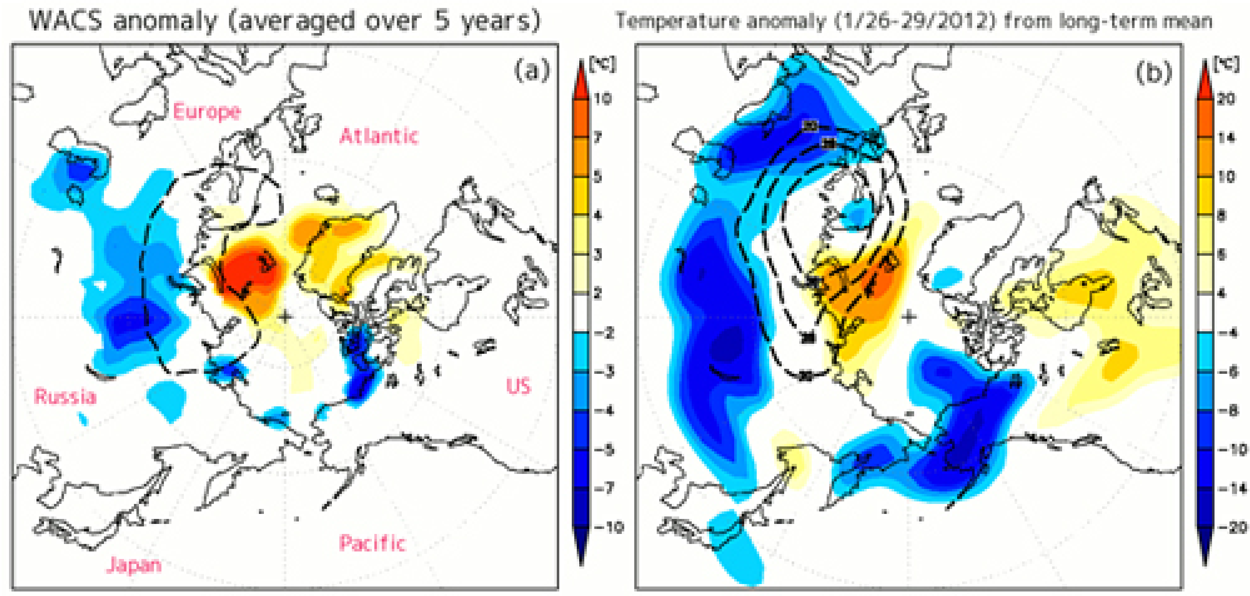

Figure 2. Surface air temperature between light- and heavy-ice years in the Barents Sea (a) WACS anomaly obtained in the study (b)Surface air temperature anomaly from long-term mean during the week from 26 to 29 January, 2012. Areas enclosed by the dashed lines indicate anomalously high pressure.

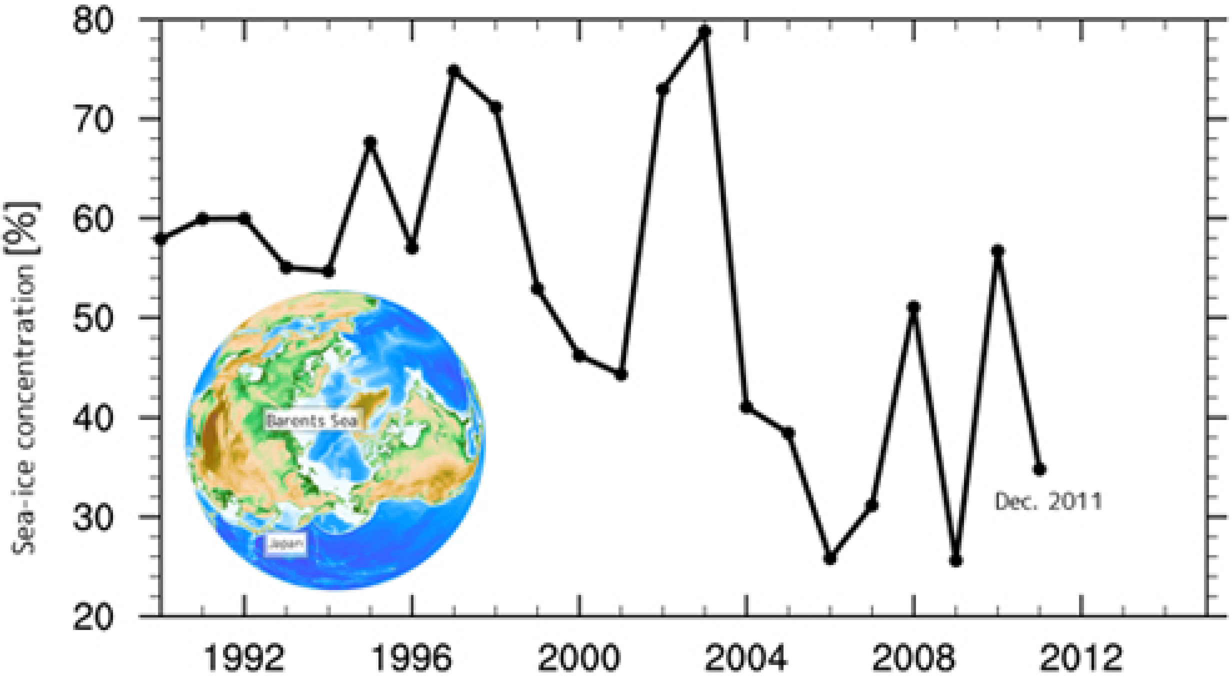

Figure 3. Change in sea-ice cover in the Barents Sea during December from 1990 to 2011.

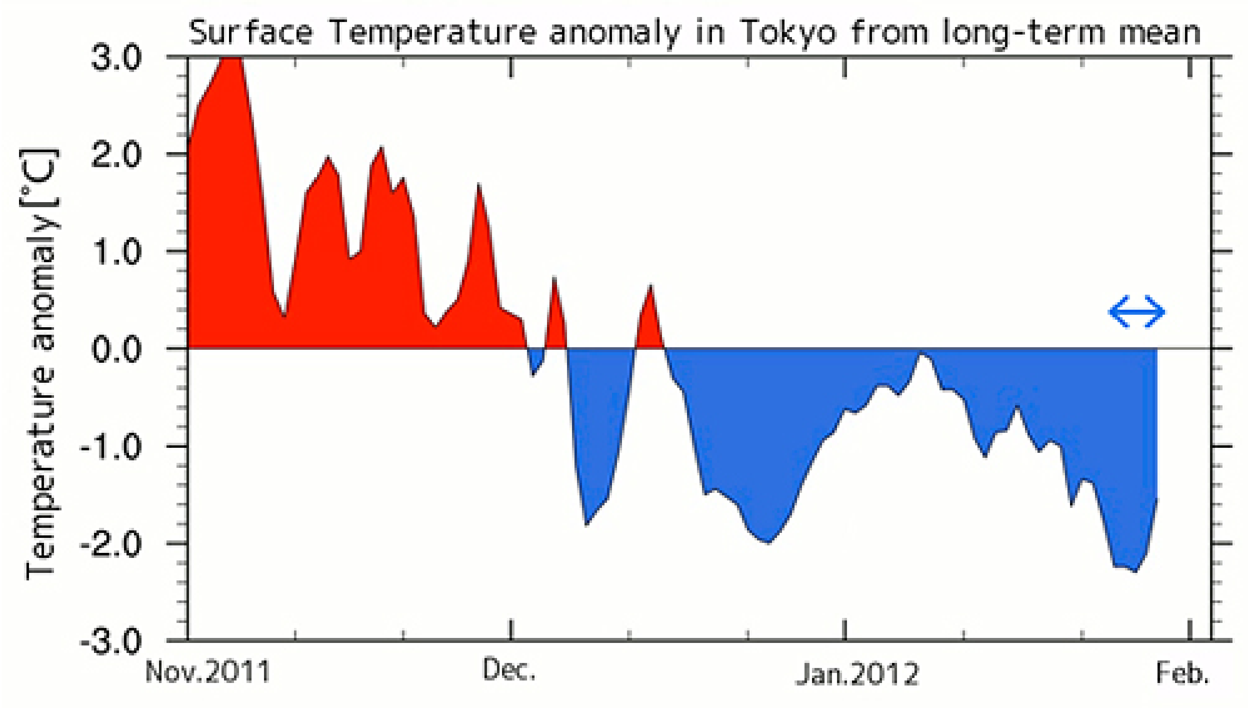

Figure 4. (a) Surface air temperature anomaly from long-term mean in Tokyo. The period indicated by the arrow corresponds with the period (between 26 to 29 January) shown in Figure 2b.

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