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Sea-ice Changes in the Sea of Okhotsk: Relationship with Storm Tracks and the North Atlantic Oscillation

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Sea-ice cover and its variability represent major atmospheric drivers. The impact of sea ice is exerted via its influence on albedo, fluxes of heat and moisture, and the radiation budget. Annual and seasonal sea-ice anomalies can be of sufficient magnitude to excite responses in the larger elements of atmospheric circulation, including the Rossby regime, which will engender responses beyond the source of local forcing. These responses may contribute to changes in storm tracks and in large-scale modes of variability, such as the North Atlantic Oscillation (NAO).
Sea ice anomalies in the Sea of Okhotsk region can have this effect. The Sea of Okhotsk is the southern-most marginal sea that exhibits an annual ice cover of sufficient size to exert an influence on the atmosphere. Previous studies have shown that the sea-ice configuration in that region can be affected by local storms; in turn, the resultant sea-ice changes can affect the downstream development of storm tracks in the Pacific and possibly provide an NAO damping effect in the Atlantic.
We investigate these effects by tracking individual storms using 6-hourly horizontal winds from the NCEP/NCAR Reanalysis data from 1978(9) to 2007 and output from the atmospheric general circulation model (AGCM) ECHAM5 forced by sea-ice anomalies in the Sea of Okhotsk. The tracking algorithm by Hodges was applied to 850-hPa and 250-hPa relative vorticity to identify and track storms. The relative vorticity field is chosen because it is less influenced by the background flow. It also focus on the smaller-spatial-scale end of the synoptic range so that many more systems are generally identified, as compared to Mean Sea Level Pressure (MSLP), which focuses on the large-scale end.
An index based on the standardized sea-ice concentration in the Sea of Okhotsk ('SOKc' – Sea of Okhotsk concentration index) was created to represent the interannual variability in that region. Monthly sea-ice concentration data was obtained from the National Snow and Ice Data Center (NSIDC). The life cycle of Northern Hemisphere storm tracks is investigated together with their relationship with the large-scale flow.
Results from the NCEP/NCAR Reanalysis data and the observations show that, sea-ice cover over the Sea of Okhotsk may affect most storm track variables, not only in the North Pacific, but also in the Atlantic. For positive SOKc, a decrease in secondary cyclogenesis, a westward shift in cyclolysis and changes in the subtropical jet are seen in the North Pacific. In the Atlantic, a negative NAO-like pattern is observed. The teleconnection results are confirmed by the AGCM ECHAM5 experiments driven with sea-ice anomalies in the Sea of Okhotsk.