Impact of sea ice on the Northern Hemisphere atmospheric circulation

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The diabatic heating associated with the variations of sea ice in the Arctic has the potential to affect the large-scale atmospheric circulation, including its impacts on the populated areas of middle latitudes. Global climate model experiments as well as observational data analyses spanning the past several decades suggest that such impacts may be occurring in the autumn and winter. After a brief review of these studies, we will extend the observational analysis to include nearly 100 additional years prior to the late 1970s, when satellite passive microwave data and most observational analyses began. While there is strong interannual variability, the data show that there has indeed been a weakening of the upper-level westerly winds, with implied increases of meridional flow and atmospheric blocking since the late 1970s, consistent with the recent loss of sea ice in the Arctic. However, the upper-level westerlies strengthened from the 1940s through the late 1970s. If sea ice is indeed a driver of the atmospheric circulation, there must have been an increase of sea ice coverage from the 1940s through the 1970s. We present a synthesis of sea ice data extending back to the early 20th Century, showing that three subperiods of the regime of 20th-Century Arctic sea ice coverage can be distinguished: a decrease from the 1910s through the 1940s, an increase from the 1940s through the 1970s, and a decrease thereafter. While filtered time series of sea ice and the intensity of the atmospheric westerlies are correlated, the interannual-to-decadal variability obscures the statistical significance of the associations over the longer timeframe. We conclude that the recent regime shift of sea ice may have been sufficient to trigger atmospheric impacts, but a longer subperiod of diminished ice cover is required in order to establish the robustness of associations of sea ice with the jet stream over middle latitudes, particularly characteristics such as the seasonality and regionality of the associations.

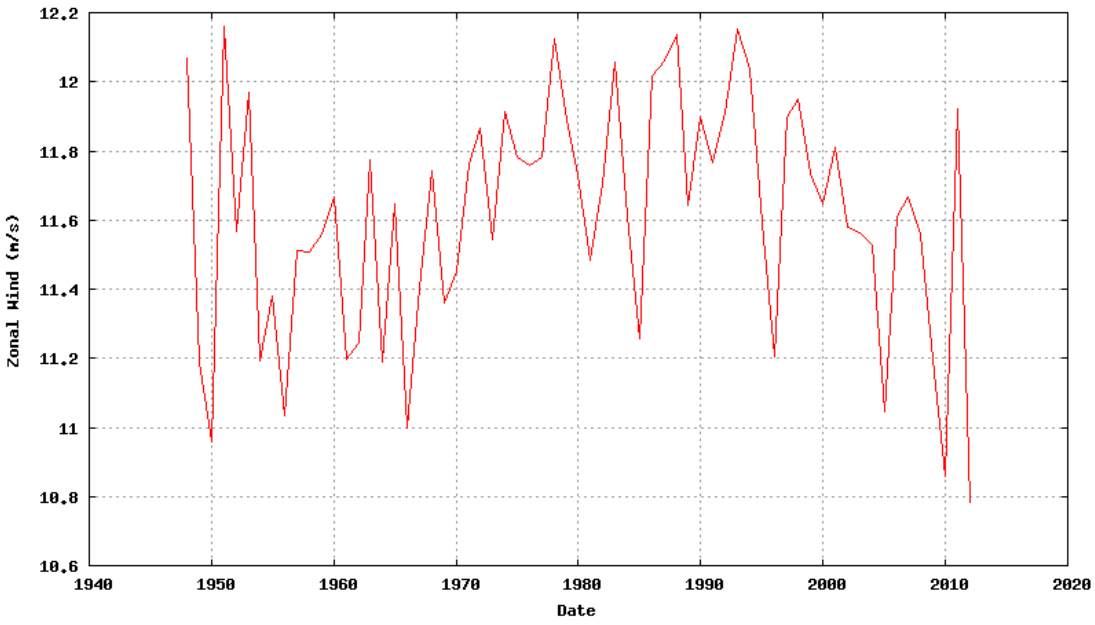

Figure 1. Annual values of October-December zonal windspeed (m s^{-1}) at 500 hPa in the Northern Hemisphere between 30° and 80ºN.