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ARCTIC IMPACTS ON MID-LATITUDE WEATHER AND CLIMATE: THE RESEARCH CHALLENGE

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The extent to which Arctic changes influence broader hemispheric weather represents a major scientific challenge. Despite a recent acceleration of research as well as public interest, the topic remains controversial with considerable skepticism in the scientific community. There is considerable interest, however, in understanding how persistent Arctic changes might contribute to improvements in mid-latitude seasonal forecasting. Major obstacles to a convincing demonstration of a role of the Arctic in mid-latitude weather and climate are (1) the short duration of the Arctic's "new regime" of amplified warming and largely seasonal sea ice, (2) the small signal-to-noise ratio inherent in the climate of middle and high latitudes, (3) the absence of consistency in the metrics used to describe midlatitude variability, particularly with respect to extreme departures from normal, and (4) the lack of agreement on the dynamical mechanisms that would explain the Arctic-midlatitude linkage. Nevertheless, there are indications that signals of an Arctic's role are emerging on a regional basis. This review will highlight the value of a regional rather than a hemispheric approach to Arctic-midlatitude linkages.

There is little debate about the reality of the recent Arctic amplification of the warming of near-surface air temperatures. While there is some debate about the relative importance of various drivers of Arctic amplification, there is also convincing evidence that the near-surface warming is sufficient to alter the upper-air geopotential and hence the winds in the Arctic. It is the impact of this change on middle latitudes that is difficult to establish, especially because there henispherically averaged variables such as upper-air zonal wind show little correlation with Arctic changes. However, hemispheric averages obscure two regional signals that have recently been established with increasing consistency among various studies. The first is the impact of anomalies in the Barents/Kara Sea region on the wintertime climate of Asia. Theoretical arguments, modeling experiments and observational data analyses point to a robust association between an increase of low-level atmospheric heating over the Barents-Kara Seas, a downstream wavetrain, and increased intrusions of cold air over eastern Asia during the winter. The second is the increase in blocking in the Greenland region in recent winters. While manifested in negative values of the North Atlantic (and Arctic) Oscillation indices, the increased meridionality stands out statistically in the long-term record of atmospheric circulation. In some cases, extreme blocking in the Greenland region has been associated with extreme cold-season weather events over eastern North America. However, the connection to wintertime weather over Europe is even more tenuous because other factors contribute to the variability in this area, especially over central and eastern Europe.