



Effects of Arctic warming on mid-latitude weather and climate

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Climate warming has been amplified in the Arctic as seen as a faster increase of air temperature and a strong melting of sea ice and terrestrial snow. These changes in the Arctic have affected mid-latitude weather and climate, but challenges remain in understanding the mechanisms of the Arctic forcing and its strength relative to other forcings on mid-latitude weather and climate. Among the mechanisms of the Arctic forcing, the following ones have received a lot of attention: reduction of the meridional temperature gradient, changes in the latitude, strength, and meandering of the Polar front jet stream, changes in storm tracks and blocking, and generation of planetary wave trains by anomalous surface heating. According to present knowledge, the Arctic effects on mid-latitudes depend on the region, season, and the large-scale state of the atmosphere. Hence, a certain thermal forcing originating from the Arctic may generate different responses in mid-latitude atmosphere, which makes the Arctic effects intermittent and difficult to predict. Different mechanisms generated by the Arctic warming may also oppose each other. For example, due to the Arctic amplification of climate warming, cold-air outbreaks originating from the Arctic have become less cold. In some regions, however, this effect may be dominated by a more frequent occurrence of cold-air outbreaks, resulting in colder winters, which, in the case of East Asia, has in several studies been attributed to sea ice loss in the Barents and Kara seas. Distinguishing between forced responses and natural variability is also a challenge.