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Occurrence and mechanisms of extreme winter air temperatures in the Arctic and surrounding continents

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The recent rapid warming of the Arctic atmosphere and ocean and related sea ice decline have been associated with increasing occurrence of extreme weather events in the Arctic. Applying ERA-Interim reanalysis, we identify 100 days with largest positive and negative anomalies (compared to local climatology) in 2-m air temperature (T2m) in the Northern Hemisphere in winter during 2005-2019, and address various physical mechanisms contributing to these events. The mechanisms responsible for warm extremes in the Arctic are often associated with a meandering Polar front jet stream, favouring cases of large transports of heat and moisture from mid-latitudes to the Arctic. In addition, subsidence heating often contributes to warm extremes in the Arctic, allowing them to occur also under high-pressure conditions. The coldest T2m anomalies north of 30^{o}N mostly occur in regions that are also climatologically cold, i.e., cannot be strongly affected by cold-air advection. This suggests a dominating role local surface energy budget and boundary-layer processes.

Extreme weather events often interact with anomalies in sea ice concentration. Cases of strong winds transporting warm, moist air masses to the Arctic provide both dynamic and thermodynamic forcing for large sea ice anomalies, and during winter the openings in sea ice field contribute to air temperature extremes via large heat fluxes from the ocean to atmosphere.

Coldest winter extremes in mid-latitudes are typically associated with meandering jet stream and high-pressure blockings, but show differences between Central Europe, North America and northern China. In Central Europe the coldest events are typically associated with cold-air advection from the East or Northeast, whereas during the coldest events in North American East Coast the cold air is transported from the North. In northern China, the coldest events often occur under high-pressure conditions with weak winds. Accordingly, the role of cold-air advection is much smaller than in the case of the coldest events in North America.