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Dynamic and thermodynamic drivers of Arctic lower tropospheric warm extremes

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Recent decades have revealed dramatic changes in the high Arctic (> 80°N) related to natural variability and anthropogenic climate change. In particular, episodes of extremely warm temperatures in the lower troposphere and their role for sea ice melting have gained considerable attention. While it has been recognized that injections of warm and humid air masses contribute to wintertime warm anomalies, summertime warm anomalies have also been linked to blocking anticyclones within the high Arctic. Yet, the relative importance of the various thermodynamic and atmospheric dynamical processes that can contribute to the formation of extreme warm anomalies in the high Arctic is poorly understood.

In this work, we present a systematic analysis of the processes leading to the formation of winter- and summertime lower tropospheric warm extremes in the high Arctic by means of kinematic backward trajectories based on the ERA-Interim reanalysis. The trajectories enable us to quantify the relative contributions of poleward transport from (potentially) warmer regions, adiabatic warming due to subsidence, and diabatic heating associated with surface sensible heat fluxes and latent heat release. Furthermore, we relate these processes to atmospheric dynamical flow features such as atmospheric blocking and extratropical cyclones.

Our analyses reveal that subsidence in blocking anticyclones over the Barents and Kara Seas and diabatic warming by surface sensible heat fluxes are the dominant mechanisms leading to wintertime warm extremes (contributing about 40% each), whereas the transport from southerly latitudes – predominantly accomplished by the injection of warm and humid air masses associated with an intensified and westward displaced storm track in the Nordic Seas - is of secondary importance (20%). Summertime warm anomalies, in contrast, are essentially the result of subsidence in blocking anticyclones (70%) that are located within the high Arctic. Thus, our findings point towards a rich, seasonally varying spectrum of dynamical and thermodynamic processes contributing to Arctic warm extremes that result from a complex interplay between transport induced by dynamical weather systems and diabatic processes. Furthermore, they emphasize the importance of processes within the Arctic for the formation of warm extremes.

Papritz, L., 2019: Arctic lower tropospheric warm and cold extremes: horizontal and vertical transport, diabatic processes, and linkage to synoptic circulation features, *J. Climate*, doi: 10.1175/JCLI-D-19-0638.1