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# Dynamics and drivers of extreme seasons in the Arctic region

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Single extreme weather events such as heavy storms or heat waves can have a major impact on Arctic surface temperatures, melting rates and sea-ice extent. If weather conditions in the Arctic become anomalous on the time scale of an entire season, this could affect the Arctic energy budget and sea ice coverage even more.

From a meteorological perspective, in a certain region an extreme season can be defined as a season when a specific meteorological parameter, such as surface temperature, reaches extremely high or low seasonal-mean values in this region. The dynamical processes leading to such anomalous seasons in the Arctic region as well as their possible change in a warmer climate have not yet been analysed in detail. Furthermore, it is yet unknown if climate models are able to correctly represent the processes leading to extreme seasons, which is an important aspect for the validation and potential further improvement of such models.

Here we focus on a detailed analysis of Arctic extreme seasons and their underlying atmospheric dynamics in the ERA5 reanalysis data set. Specifically, extreme seasons are determined based on departures from a transient climatology of four parameters (surface temperature, sea-ice extent, surface energy balance and net surface freshwater flux) in distinct regions of the Arctic with different climatological sea-ice extents. Using EOF analysis, the overall most extreme seasons, which occur as significantly anomalous for several parameters, are selected to perform extended case studies. Highly anomalous seasons occur on a broad range of spatial scales as well as for areas nearly covering the whole Arctic Ocean. The formation of small and large extreme seasons may vary significantly, including local processes as well as large-scale atmospheric features.

The winter of 1984/1985 shows one of the largest positive departure of surface temperature from the background warming trend together with a significant sea-ice reduction in the region of the High Arctic and the Greenland Sea. An analysis of the synoptic situation for this winter shows a slightly positive cyclone frequency anomaly over the Greenland Sea combined with a more pronounced negative cyclone frequency anomaly over the Kara-Barents Sea, favouring the advection of warm mid-latitude air masses towards the pole.