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Quantifying the relevance of local blockings for temperature extremes on sub-daily to daily time scales

S. Pfahl
ETH Zurich, Institute for Atmospheric and Climate Science, Zurich, Switzerland (stephan.pfahl@env.ethz.ch)

Atmospheric blockings can influence near-surface temperature, on the one hand by inducing circulation anomalies, on the other hand since they are associated with clear-sky conditions, which can lead to anomalies in the surface radiation budget. The latter is due to subsiding motions and the deflection of low pressure systems. In this study, it is quantified how relevant these effects are locally (at the location of the blocking) for the occurrence of sub-daily and daily temperature extremes, based on ERA-Interim reanalysis data in the Northern Hemisphere for the period 1989-2009.
Blockings are identified from the reanalysis dataset as negative anomalies of the vertically integrated potential vorticity (PV) between 150 hPa and 500 hPa with a lifetime longer than 5 days. The threshold for the identification of the PV anomalies is varied between -1.3 PVU and -0.7 PVU in order to distinguish between strong and weaker blocking systems. Temperature extremes are identified at each grid point if the six-hourly maximum (minimum) temperature exceeds (falls below) its local 99% (1%) percentile. For investigating extremes on longer time scales, the temperature time series are smoothed with a 1- or 3-day running mean before identifying the extremes. Finally, a blocking is assumed to be locally related to a temperature extreme if both occur simultaneously at the same grid point. The percentage of temperature extremes coinciding with a blocking is then quantified at every grid point.
The percentage of hot temperature extremes associated with a strong blocking reaches maxima of more than 50% over southern Greenland and Quebec and around 30% over Northern Europe and Asia, exceeding the climatological blocking frequency by about a factor of 5. The spatial patterns of this percentage are similar if the smoothed time series are used, but the maxima are increased up to 70%. If also weaker blockings are considered, in the order of 80% of the six-hourly hot extremes coincide with such systems in large regions in northern Eurasia and North America. On the contrary, cold temperature extremes are generally associated with a reduced (rather than increased) local blocking frequency.
The strong linkage of hot temperature extremes and blockings found here is relevant for investigating changes of such extremes with global warming. It indicates that not only the rising average temperature, but also variations in blocking dynamics may be crucial for local changes of hot extreme events in mid to high latitudes. General circulation models, in order to realistically reproduce the extreme events and their potential changes, have to be able to also simulate atmospheric blockings in a realistic manner.