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Links of Atmospheric Blocking to Temperature Extremes over Ukraine

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Atmospheric blocking is a phenomenon in which a large, quasi-stationary anticyclone develops in the mid-latitudes and persists for several days or longer, blocking the ambient westerly winds and weather systems. Extremes on both ends of the temperature distribution are especially closely connected to atmospheric blocking (Brunner et al. 2017).

In this study the link between atmospheric blocking and Ukrainian cold and warm spells is investigated during winter and summertime in the period of 1991-2019 in order to provide better insight into the shifting role of blocking for extremes. Extreme temperatures are termed cold or warm spells if temperature stays outside the 10th to 90th percentile range at least six consecutive days. The detection of temperature extremes is based on daily minimum and maximum temperatures obtained for 12 meteorological stations that evenly cover territory of Ukraine. In the database obtained only the high-impact extreme temperature episodes are selected to be investigated in the further study.

The atmospheric blocking is detected on the basis of the daily 500 hPa geopotential height fields from the NCEP/NCAR reanalysis and potential temperature fields on the dynamical tropopause (PV = 2 PVU) obtained from ERA-Interim. In order to objectively diagnose atmospheric blocking two standard detection techniques are used. The first method utilizing the reversal of mid-latitude 500hPa geopotential height gradients was elaborated by Tibaldi and Molteni (1990) and detailed in Trigo et al. (2004), and the other one using reversal of potential temperature gradients was developed in Pelly and Hoskins (2003). These blocking detection algorithms identify fairly well the breaking of upper-level Rossby waves on 500 hPa height and on the dynamic tropopause, associated with onset of mid-latitude atmospheric blocking.

Up to 80% of winter cold and summer hot temperatures in Ukraine are associated with a collocated blocking. Large positive anomalies of 500 hPa geopotential height play a key role in maintaining prolonged extreme temperature spells and atmospheric blocking, though spell and blocking periods are much shorter than periods of positive anomalies. Spatio-temporal distribution of both indices are uneven, which meant that the wave-breaking process is not steady either at the 500 hPa surface or on the dynamical tropopause. Thus, during each episode the prolonged existence of ridges are maintained due not only to breaking of Rossby waves, but other mechanisms It should be mentioned that atmospheric blocking is more frequently revealed with

the Tibaldi-Molteni indices than the Pelly-Hoskins ones, meaning that breaking of Rossby waves occurs more frequently at the 500 hPa geopotential height than on the tropopause.