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The Impact of Arctic Sea Ice on the Interannual Variations of Summer Ural Blocking

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The influence of Arctic sea ice concentration (SIC) on the interannual variations of the frequency of summertime Ural blocking (UB) during the period of 1980–2013 is investigated using observational and reanalysis datasets and version 5.0 of the Community Atmospheric Model. The results reveal that the variations in the UB frequency display a statistically significant association with a persistent spring-summer SIC pattern in the Barents Sea. Related to high UB frequencies, heavy SICs exert a dynamic influence by increasing the meridional temperature gradient (MTG) in the lower troposphere and cause stronger (weaker) zonal winds in high-latitude (mid-latitude) areas through the thermal wind balance. This zonal wind pattern establishes the background conditions for the blocking activity and thus helps to initiate summertime UB events. Moreover, persistent heavy SICs tend to enhance the low-level atmospheric baroclinicity to the south and decreases in mid-latitude areas, inducing weakened synoptic-scale transient eddy activity (STEA) that stretches from Eastern Europe to the Ural Mountains. This reduced STEA is accompanied by a locally intensified eddy-vorticity forcing that may exert a downstream influence on the onset of UB events. In terms of thermodynamic processes, heavy SICs-induced water vapor content anomalies are expected to cause deficits in precipitation over the East European Plateau in late spring and subsequently desiccate the underlying soil. Both of these effects are expected to increase surface heat fluxes and thickness of the lower-middle troposphere, thus favoring anomalous anti-cyclonic circulation over the Ural Mountains. On the other hand, the opposite dynamic and thermodynamic effects are expected to result from light SICs with respect to low UB frequencies. Therefore, these two effects identified in this study each contribute to an increased probability of more frequent (rare) UB events in summer as the spring-summer sea ice within the regions surrounding the Barents Sea expands (disappears).