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Quantifying the generation of cold air during boreal winter and its relevance for cold weather extremes

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The presence of anomalously cold air close to the surface is a prerequisite for the occurrence of cold weather extremes, such as cold spells. However, the process of cold air generation features a substantial variability in space and time, modulated by the rate of energy loss to space by infrared radiation.

Such a variability is investigated using a Lagrangian approach, identifying trajectories that experience rapid non-adiabatic cooling over Eurasia. This approach allows to identify source regions of cold air, and the meteorological conditions that particularly favor its generation and accumulation – which often precedes the most extreme cold spells.

The unraveling of this connection allows to interpret the intra-seasonal and the inter-annual variability in the occurrence of cold extremes, and to gain a mechanistic understanding of how anthropogenic global warming will modify them.