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Enhanced Wintertime Temperature Variability Over North America due to the Rocky Mountains

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Although climate is often characterized by mean temperature, surface temperature variability is of immense societal and ecological importance. However, we still do not have a good understanding of what controls the regional pattern of temperature variability in today's climate, limiting our ability to make predictions of how this will change in the future. For instance, North America experiences substantially more temperature variability on daily and synoptic time-scales (days to weeks) during winter than Eurasia. Here, we provide an explanation for why this is the case, based on the control of temperature variability by horizontal advection across mean temperature gradients. Using a combination of theory, idealized modeling work and simulations with a comprehensive climate model, we show that the presence of large-scale orography enhances downstream temperature gradients (particularly meridional gradients), in turn enhancing downstream temperature variability, and reduces upstream temperature gradients, reducing upstream temperature variability. Hence the presence of the Rockies on the western edge of the North American continent results in large temperature gradients over North America and, consequently, large temperature variability there. By contrast, the Tibetan Plateau and the Himalayas are located on the eastern edge of the Eurasian continent, and so damp temperature variability over most of Eurasia.