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Quantification of the Physical Process Leading to Extreme Day-to-Day Temperature Changes

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Extreme temperature changes from one day to another, either associated with warming or cooling, can have a significant impact on health, environment, and society. Previous studies have quantified that such day-to-day temperature (DTDT) variations and extremes are typically more pronounced in mid-and high latitudes compared to tropical zones. However, the underlying physical processes and the relationship between extreme events and large-scale atmospheric circulation remain poorly understood. Here, such processes are investigated for different locations around the globe based on Observation, ERA5 reanalysis data, and Lagrangian backward trajectory calculations. In the extratropics, extreme DTDT changes are generally associated with changes in air mass transport, in particular shifts from warm to cold air advection or vice versa, linked to regionally specific synoptic-scale circulation anomalies (ridge or through patterns). Lagrangian temperature changes in the advected air masses are due to adiabatic warming, which is dominant in the local winter season, and diabatic warming, most importantly in summer. In contrast, for extreme DTDT changes in the tropics, local processes are more important than changes in advection. For instance, the strongest DTDT decreases over central South America in December-February are linked to a transition from mostly cloud-free to cloudy conditions, indicating an important role of radiative heating. The mechanistic insights into extreme DTDT changes obtained in this study can be helpful for improving the prediction of such events and anticipating future changes in their occurrence frequency and intensity.