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The non-Gaussianity and spatial asymmetry of temperature extremes relative to the jet: the role of horizontal advection

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Global warming is expected raise the number of warm spells and lower the number of cold spells, by simply shifting of the near-surface temperature probability distribution to warmer temperatures. However, changes in the shape of distribution strongly affect how the occurrence of temperature extremes will change. Hence, understanding the processes shaping the spatial and statistical distribution of temperature variations and extremes in the present climate is central to understanding how temperature extremes might vary in the future.

Using meteorological reanalyses data we show that the distribution of near-surface temperature variability is non-Gaussian, and consistent with this, extreme warm anomalies occur preferentially poleward of the location of extreme cold anomalies. The non-Guassianity evident in reanalysis data is also found in a set of dry General Circulation Model runs in which the jet is forced at different latitudes, and the location of extremes is influenced by the location of the jet stream. Using a simple model of Lagrangian temperature advection, we investigate the role of synoptic dynamics in causing this non Gaussianity.

The meridional shifting between cold and warm extremes, and the related non-Gaussianity are traced back to the synoptic evolution leading up to cold and warm extreme events. We find that the meridional movement of synotpic systems, as well as nonlinear temperature advection are both of crucial importance for the warm/cold asymmetry in the latitudinal distribution of the temperature extremes. The possible implications for future changes in extremes will be briefly discussed.