Evaluating Extreme Temperatures and Associated Mechanisms in NARCCAP Hindcast Experiments

Several metrics are developed and employed to evaluate daily surface temperature probability distribution functions (PDFs) focusing on extremes and associated mechanisms in a suite of regional climate model (RCM) hindcast experiments over North America. All RCMs are provided as a part of the North American Regional Climate Change Assessment Program (NARCCAP) and are evaluated against two high-resolution reanalysis products. In many cases, temperature bias at the tails and the median of the PDF are of the same sign, indicating a shift in the PDF relative to reference data independent of PDF shape. In some cases, especially over higher latitudes in the winter, RCMs have higher variance than reanalysis while temperature skewness generally shows strong agreement. Summertime daily temperature skewness varies considerably amongst models and reference data, especially at lower latitudes, indicating relatively large uncertainty in the simulation of temperature extremes here. A novel approach, using k-means cluster analysis, is used to group model and reference data PDFs by PDF shape and structure allowing for a holistic approach to identifying regions of model-reference data disagreement and providing a regional basis for investigating mechanisms associated with this disagreement. The identified biases in PDF structure, and their relation to temperature extremes, provide a basis for identifying and analyzing associated mechanisms including biases in synoptic-scale atmospheric circulation and surface energy budget processes. The metrics successfully used in this work can be applied to model evaluation of extremes in surface temperature and other key variables in RCMs on other domains.