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Development of spatial cumulative distribution functions to compare extremes in climate model output

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We address the question of how to compare extremes among climate models and with observations through the development of spatial cumulative distribution functions (SCDFs). We consider a spatial (or spatio-temporal) stochastic process, called Z, indexed potentially by space, altitude, and time. A field of climate data are a realization of Z, and are denoted by z. We define the SCDF as a random function using an indicator variable, I, such that I=1 at some location within the domain of Z where the climate data, z, are greater than or equal to the stochastic process Z, that is I{Z<=z}=1. The SCDF is a random function defined as the integral of the indicator variable, I, over a region within the domain of Z. The SCDF is a random function of both actual and potential observations, rather than an empirical distribution function. As such, we are predicting the SCDF rather then estimating parameters of distribution function. The value of SCDF is the capability to build into the spatial stochastic process, Z, scientific understanding of spatial dependence which enables direct evaluation of systematic versus random variations in spatial fields. We can learn with this tool, therefore, whether differences in spatial variability among climate model data and observations arise from similar spatial dependence structure, and we can diagnose inherent spatial scales of non-stationarity within the climate data rather than arbitrarily choosing regions of presumed climate stationarity. Many quantities can be derived from the SCDF such as regional means, variances, and quantiles. We will discuss this approach within the context of daily maximum and minimum temperature.