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Evaluating Downscaling Methods

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Climate downscaling is necessary for a large number of applied problems and the evaluation of the methods used deserves careful consideration. While it is easy to develop a method that matches many statistics of current climate, evaluating the fidelity of the climate change representation must go beyond matching simple statistics. Here we present the evaluation of multiple downscaling methods for their representation of historical variability, their future climate change signal, and the internal process representation. The methods tested (BCSD, LOCA, En-GARD, ICAR, and WRF) range from simple statistical rescaling approaches to sophisticated regional climate models.

We show that some methods do not represent the fine patterns of variability observed, while others do not represent changes in climate that are expected based on theory and high-resolution atmospheric model simulations. These mis-matches can be attributed to the processes represented (or missing) from the downscaling methods. We focus first on precipitation patterns and variability associated with the El Nino Southern Oscillation in current climate and show that downscaling methods can not add back broad patterns missing from the global climate models, but also that some methods are unable to represent observed correlation structures finer than is resolved by the global model. Next we look at the changes in extreme precipitation in different methods. In this case, some of the simpler statistical methods better match our intuition of expected future increases in extremes, while other, more theoretically satisfying approaches, do not. This work highlights the need for a holistic evaluation of downscaling methods for historical fidelity (beyond common grid-point statistics) and to evaluate the future climate changes predicted carefully.