Hydrologic Assessments of Climate Change

Overview

Water management agencies such as the Bureau of Reclamation and US Army Corps of Engineers require reliable methods for incorporating climate change information into long-term water resource management planning in the United States. Because of the coarse spatial resolution and biases of climate projections output by global climate models (GCMs), assessment relies on some form of spatial downsampling and bias correction. Water agencies face decisions regarding the selection of 1) downscaling method(s), and 2) configuration of hydrological models. The overarching goal of the project is to identify strengths and weaknesses of current techniques used for generating hydrologic projections and to assess the effect of these methodological decisions on the projection.

Downscaling Methods

Hydrological applications require weather and climate inputs to exhibit certain hydrologic relevant characteristics, such as mean precipitation, wet day fraction, and extreme precipitation events. The figure below illustrates impacts of two popular statistical downscaling methods (BCSD daily and BCSD monthly). Relative to an observational dataset (Maurer et al., 2002: M02), BCSD daily produces too many rainy days (high wet-day fraction), resulting in a reduction in estimated shortwave radiation, which reduces ET and increases runoff.

Our findings show that existing downscaling methods have mixed success in representing current climate. In addition, statistical downscaling provides a climate change signal that differs from that of a regional climate model (not shown). This prompts us to seek improved downscaling methods through incorporation of more physically based relationships.

Hydrologic Models

The choice of hydrologic model can also affect predicted changes in the overall water balance. The impact of such hydrologic modeling decisions is illustrated with 4 models over three basins (above). Our results demonstrate that the choice of hydrologic model affects runoff projection outcomes, though slightly less so if hydrologic model parameters are calibrated. In addition, the calibration process can change even the sign of the climate change signal.

Popular calibration procedures constrain climate change impacts more directly for hydrologic metrics that are closely related to the objective function used in model calibration. For example, minimizing errors in streamflow reduce inter-model differences for mean change in the future, but does not constrain important hydrologic behaviors such as seasonal timing or low flow rates. The use of a single uncalibrated hydrology model is ill-advised, and there is a clear need to implement more comprehensive parameter estimation schemes.

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