Regional Hydrologic Response to Climate Change over the Conterminous United States

Achievements:

- Used a high-resolution hierarchical modeling framework to downscale 10 CMIP5 GCMs at 4km horizontal grid spacing
- High-resolution hydrological modeling skills at continental-scale are one of the most skillful reported to date
- Future projections show a shift in hydrological timing for snow driven water resources and increase in hydrological extremes across the United States

Significance and Impact: Using a hierarchical modeling framework, this research provides one of the most detailed (to date) high-resolution (4km) resolution hydrological projections over the conterminous United States for the near-term future.

Research Details:

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Overview:

Despite the fact that Global Climate Model (GCM) outputs have been used to project hydrologic impacts of climate change using off-line hydrologic models for two decades, many of these efforts have been disjointed — applications or at least calibrations have been focused on individual river basins and using a few of the available GCMs. This study improves upon earlier attempts by systematically projecting hydrologic impacts for the entire conterminous United States (US), using outputs from ten GCMs from the latest Coupled Model Intercomparison Project phase 5 (CMIP5) archive, with seamless hydrologic model calibration and validation techniques to produce a spatially and temporally consistent set of current hydrologic projections. The Variable Infiltration Capacity (VIC) model was forced with ten-member ensemble projections of precipitation and air temperature that were dynamically downscaled using a regional climate model (RegCM4) and bias-corrected to 1/24° (~ 4 km) grid resolution for the baseline (1966–2005) and future (2011–2050) periods under the Representative Concentration Pathway 8.5. Based on regional analysis, the VIC model projections indicate an increase in winter and spring total runoff due to increases in winter precipitation of up to 20% in most regions of the US. However, decreases in snow water equivalent (SWE) and snow-covered days will lead to significant decreases in summer runoff with
more pronounced shifts in the time of occurrence of annual peak runoff projected over the eastern and western US. In contrast, the central US will experience year-round increases in total runoff, mostly associated with increases in both extreme high and low runoff. The projected hydrological changes described in this study have implications for various aspects of future water resource management, including water supply, flood and drought preparation, and reservoir operation.