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An Integrated High-Resolution Multi-Member Modeling Approach to Understanding Climate Change Impacts on Water Supply Availability for Southern California

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Southern California is located in a semi-arid climate with finite natural supplies of water. Precipitation in the area generally occurs in the fall and winter months. Consequently, the region relies on imported water originating primarily from snowpack in northern areas of California and surrounding states including 1) the San-Joaquin River and Tulare Lake basins, 2) the Sacramento River basin, 3) Owens Valley and Mono Lake basins and 4) the Colorado River basin. This study provides an integrated approach to understanding and assessing climate change impacts on the hydrologic cycle for all water supplies to Southern California. A 10-member ensemble of coupled global climate models are dynamically downscaled forcing one regional and one hydrological model resulting in a high-resolution 4.6-km output for the region. Greenhouse gas concentrations are prescribed according to the IPCC Representative Concentration Pathway 8.5 using the present-day period of 1966-2005 and future period of 2011-2050. On the annual timescale, increases in precipitation and evaporation are projected throughout the majority of the study area with the exception of the Owens Valley and Mono Lake basins. As a result, only a minor reduction in runoff for the California Sierra Nevada and a minor increase the Colorado River basin are simulated. Although these changes in annual runoff are minimal, the interannual variability of runoff also increases across all basins indicating a higher probability of extreme wet or dry years and less normal years. Furthermore, increased temperatures result in significant reductions in snow water equivalent along with earlier shifts in snowmelt timing. Precipitation that falls is less likely to fall as snow decreasing snowpack and natural storage. On one hand, the escalating likelihood of runoff occurring earlier in the year poses a significant flood control risk to the region requiring the release of water from reservoirs to prevent flooding. On the other hand, the increased likelihood of drought necessitates additional multiyear storage solutions for Southern Californian water resources.