Water Cycle Variability and Future Droughts in the Colorado River Headwater Region

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Model projections of the 21st century water budget trend over the Colorado River headwater region were assessed via a statistical comparison of model and observational data in the 20th century. Five coupled ocean-atmosphere general circulation models (GCMs) featured in the fourth IPCC assessment and the NOAA Global Historical Climate Network (GHCN) and University of East Anglia Climate Research Unit Hulme observational data sets for precipitation were utilized as the basis for verification. Means and variances of the time series of precipitation for the winter and summer seasons of both centuries were calculated, and statistical significance was determined by way of t-tests and Kolmogorov-Smirnov tests for means and goodness-of-fit, respectively, and f-tests for variances. Evaporation time series were similarly calculated only with models since evaporation observation data are not available. It was found that using the composite of the model output produced results closest to those of the observations, even though the model mean and variance of precipitation were roughly twice as large as in observations. Variance did not change significantly from the 20th to the 21st centuries except for a 10.7% increase in variance of winter evaporation. Mean precipitation decreased significantly by 10.49% in the summer season, while mean evaporation increased significantly by 11.84% in winter and decreased by 5.36% in summer. The water budget, calculated as precipitation minus evaporation (P-E), decreased by 5.13% in the winter and 22.62% in summer. These results indicate a significant overall drying trend over the Colorado River headwater region, meaning that future water runoff provided by this river will likely decrease and future droughts may have more devastating impacts on western US water resources than they do presently.