Geophysical Research Abstracts
Vol. 15, EGU2013-6377, 2013
EGU General Assembly 2013

Comparing Hydrologic Sensitivities to Climate Change in the headwaters of the Colorado River basin

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Over the last few decades, many sources of uncertainty have been identified in climate change studies: different emissions scenarios, different general circulation model (GCM) structures and parameters, distinct GCM initial conditions, several downscaling methods, multiple hydrological model structures and multiple hydrological model parameters. Although the hydrological community has recognized the relevance and practical utility of applying this "cascade of uncertainty" paradigm, this approach does not help to advance process understanding or predictive capabilities. Additionally, recent studies have demonstrated that the choice of hydrologic model structure is a critical issue for the assessment of climate change impacts, but we still have limited understanding of why different models have different sensitivities to climate change.

In this study, we assess the climate sensitivity of three different hydrologic/land surface models (PRMS, VIC and Noah-MP) over a small set of case study basins located in the headwaters of the Colorado River, USA. Our goal is to evaluate how hydrologic sensitivities vary across models in terms of 1) the main water balance components, and 2) seasonal changes in individual states and fluxes. Despite the partitioning of precipitation into ET and runoff is clearly model-dependent, all models predict an increase in ET and decrease in SWE and runoff for a future climate scenario. Noah-MP is the most sensitive model in water balance budget components, and all models reflect very similar seasonal changes in basin-averaged snowpack. Some individual fluxes are more sensitive to changes in climate than others (e.g. baseflow), and ongoing research is currently focused on parameter perturbation experiments to improve understanding of the relative role of parameters and model structures in determining the conclusions of climate impact assessments.