Geophysical Research Abstracts,
Vol. 11, EGU2009-6051, 2009
EGU General Assembly 2009

Potential impacts of future fine-scale climate change on United States hydrology

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The 4th IPCC report concludes that climate change is now unequivocal and projected increases in evaporation and atmospheric water content could intensify the hydrological cycle. However, the coarse spatial resolution and biases in global climate model simulations limit their usefulness in climate impact assessment. In order to improve on these limitations, we used high-resolution regional climate model (RegCM3) simulations, covering the contiguous United States, and a quantile-based bias correction technique to drive a hydrological model, the Variable Infiltration Capacity (VIC) model, at 1/8th degree spatial and daily temporal resolution. The simulations covered 1961-1990 in the historical period and 2071-2100 in the future (A2) period. Bias correction was applied to the monthly times-series of RegCM3 simulated precipitation, minimum temperature and maximum temperature, and correction from individual months was subsequently translated to the daily time-series. For comparison, the VIC model was also driven by observations for the historical period. Our results showed that bias correction not only substantially improved the VIC model results for the reference period, but it also affected the response of key hydrological variables to projected future anthropogenic increases in greenhouse forcing. For instance, bias correction reversed the sign of summer and autumn baseflow change over the southeastern U.S. Likewise, spring and summer runoff decrease over the higher elevations was considerably more moderate in the bias corrected simulation than that in the un-bias corrected simulation. Further, we found that changes in the daily distribution of extremes were critical in determining the sign of hydrological change. For instance, increases in summer runoff over regions with negative changes in mean precipitation were due to increases in the frequency of extreme precipitation events. These results have important implications for the assessment of future hydrologic changes, as well as for the general effort of developing approaches for quantitative impacts assessment.