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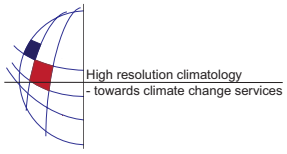


# Simulation of Annual Snowfall over Colorado using a High Resolution Mesoscale Model and some Impacts of Climate Change using the Pseudo Climate Simulation Method

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Snowpack is the most important water resource in the Western United States, and widely regarded as the most vulnerable. It is thus critical to provide water managers the most accurate estimate of how that resource will evolve as the climate changes, including its societal impact.

The headwaters region of Colorado that includes, among others, the Colorado, Platte, Rio Grande and Arkansas Rivers, is one of the key source regions for water in the Southwest as ∼85% of the streamflow for the Colorado River comes from snowmelt in this region. This region is a particularly difficult area for global climate models to properly handle, with inconsistent snowpack trends in this region from different models despite consistent predictions of temperature increases in this region from all climate models from both the 3rd and 4th IPCC reports (2001, 2007). Observations over the past 50 years in the upper Colorado River basin also reflect the same increasing temperature trend but show no identifiable trends in snowpack (Edwards and Redmond, 2005, Colorado and California Water Users Conference publication). A recent analysis of the 2007 IPCC 4th Assessment global models by Hoerling and Eischeid (2006,Southwest Hydrology) indicates that the combination of increased temperature and weak to no trends in snowfall will produce unprecedented drought conditions over the next 50 years in the Southwest due to a strong increase in evapotranspiration associated with the increased temperature.

While the above predictions based on global models indicate dire consequences for the Southwest, it should also be noted that the AR4 indicates that global models typically perform poorly in mountainous regions due to the poor depiction of terrain as well as significant uncertainty in detailed hydrometeorological processes (i.e. cloud/precipitation microphysics, embedded convection and cloud-scale circulations, snowpack and snow ablation, and runoff generation in complex terrain) that currently limit model simulation skill. Colorado's headwaters region is dominated by high altitude snow melt, so climate assessments in this region using global models are particularly uncertain. However, simple increases in model resolution without clearer understanding and representation of hydroclimatic processes controlling water resources will not be sufficient for improving model performance. It is therefore critical to examine climate impacts in this region using detailed coupled atmosphere-hydrology models in order to more realistically simulate precipitation, sublimation, and runoff processes, as well as their impact on managed water systems.

This paper will present results of annual snowfall, snow/rain fraction, and snowpack over Colorado based on high resolution simulations of the Weather Research and Forecast (WRF) model running at 2 km horizontal resolution using the North American Regional Reanalysis (NARR) as initial and lateral boundary conditions. Four retrospective years will be shown. Results from four Pseudo Climate simulations (Hara et al. 2008) using the four retrospective runs as the baseline will also be presented. These simulations will be forced by the mean monthly climate signal difference between current (1995 – 2004) and 2045-2055 mean conditions. The NCAR CCSM3 A1B AR4 climate runs with 6 hourly output will be used for the current and future climate model forcings.