Evaluation of Snow Cover Depletion to Support Snowmelt Runoff Modeling for the Cache la Poudre River, Colorado

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Abstract. The Cache la Poudre River in northeastern Colorado is a vital source of water for agricultural, municipal, and industrial users. Most runoff in the basin is generated from snowmelt, but snow measurements are sparse, located at a few high elevation SNOTEL stations and snow courses. For this study we analyzed snow covered area (SCA) depletion characteristics to im-prove understanding of snowmelt runoff in the Cache la Poudre basin. Mod-erate Resolution Imaging Spectroradiometer (MODIS) 8-day snow cover products were obtained for the snowmelt season, mid-March through June, from 2000 to 2006. We analyzed snow cover depletion within spatial subsets of the basin, including sub-basins and elevation bands. Regression analyses compare the 8-day SCA images to naturalized stream flow at the USGS can-yon mouth gauge. Probability of snow cover datasets were generated from a binary reclassification of the MODIS product.
Results from regression analyses show a wide range of relationships be-tween SCA and streamflow ($0.00<R^2<0.92$), mostly due to variability in spring precipitation and the elevation of spatial subsets. For sub-basins, the strongest correlations between SCA and streamflow ($0.59< R^2<0.92$) were for the sub-basin with the highest average elevation. However, for elevation bands, the strongest correlations ($0.63< R^2<0.91$) were for the middle elevation band from 2680 to 3042 m. The poorest relationships between SCA and streamflow occurred for low and very high elevation bands. The average probability of snow during the snowmelt season within the highest elevation sub-basin and middle elevation band were 53% and 50%, respectively. The highest probability of snow, 90-100%, occurred above 3000 m on average. While the initial rise in the snowmelt hydrograph correlates well with SCA depletion at middle elevations, the onset of peak flow does not occur until a significant change in snow water equivalent (SWE) is observed at the high elevation SNOTEL sites. These relationships between snow data and runoff will be used to develop and test a new model that integrates both the ground-based and satellite-derived observations.

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