Toward Improved Understanding of Extreme Snow Melt Runoff Events Under Past, Present, and Future Climate

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ABSTRACT

The ablation of snow cover is an important contributor to crucial hydrologic variables such as streamflow, soil moisture, and groundwater supplies. In regions with discontinuous snow cover the number and magnitude of ablation events vary greatly from one season to another. Even in stream basins that are characterized by a single large melt event each season, estimates of the size and time of occurrence of peak flows changes dramatically from one year to the next. Seasonal variations in the frequency and magnitude of large ablation events are important as they can lead to severe environmental and societal consequences. These consequences may manifest themselves as snowmelt-induced floods, lack of streamflow in snowmelt fed rivers, and transport of pollutants or excess nutrients in rapid snowmelt events, to name a just few. Little research has been conducted on understanding the connection between the frequency and magnitude of ablation events and the role of global-scale atmospheric and oceanic forcings in their variation. Moreover, the pathways that link global-scale forcings to basin-scale snow hydrology are poorly understood as is the manifestation of snow-induced streamflow variability in future climate scenarios.

Using a combination of observational data and a suite of model-generated products, we propose to examine the climatology of significant snow ablation events across the United States east of the Rocky Mountains. Our analysis will include an examination of the influence of global-scale forcings (major atmospheric and oceanic teleconnections) on the frequency and magnitude of ablation events in several major drainage basins characterized by diverse snow cover climatologies, geographic locations and sizes. In addition, we will address the pathways by which global-scale anomalies influence individual basins using air mass and synoptic type analyses, and by modeling the surface energy fluxes associated with the diverse weather patterns associated with ablation. Finally, using Climate Model Intercomparison Project 5 model output, we will evaluate the ability of current general circulation models to accurately reproduce the observed ablation event climatology and to examine future climate scenarios for evidence of changes in the frequency and/or magnitude of ablation events for several major drainage basins across the eastern two thirds of the United States. These analyses will lead to the generation of several new and unique data sets for snow hydrology research including a comprehensive snow cover ablation data set, daily snow cover/atmosphere grids for North America, synoptic type analyses for the eastern United States, and model estimates of surface energy fluxes associated with major ablation episodes.