Poster #157

Observing and Modeling Snow Processes Across Spatial and Temporal Scales in a Rocky Mountain Headwater Catchment

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In high elevation catchments of the western United States, snowmelt supports downstream populations, provides ecosystem services, and drives critical zone water, nutrient, and metal fluxes and transformations. Changing climatic conditions are challenging our current conceptualization of processes that govern snow accumulation and melt over seasonal and decadal timeframes, with studies performed as part of Berkeley Lab's Watershed Function Scientific Focus Area addressing these challenges through observational and modeling studies conducted in the East River watershed in Central Colorado. Recent work has found that snow formulations in physically-based land surface models perform poorly in the Rocky Mountains; a finding which may be attributed to complex terrain and vegetation heterogeneity that is not captured at larger scales. Here, we combine modeling with airborne and ground observations of snow at high resolution to characterize its role in controlling critical zone processes. We validate the land surface model in ParFlow-CLM using locations with co-located meteorological and snow observations to understand the parameters driving precipitation partitioning, sublimation, and snowmelt. Hourly simulations are run for nearly a decade to evaluate model performance with variable precipitation conditions at high temporal resolution and to explore the effects of altered precipitation patterns with climate change. To fully understand snowmelt across spatial scales in complex terrain, the land surface model is applied to the ca. 300-km2 East River watershed over elevations ranging from 2700-3900m and life zones from montane to alpine. Model outputs are interpreted using LiDAR overflights of the ground surface (0.5m lateral resolution) and maximum snow depth (3m lateral resolution) to characterize high resolution topography and snow loading. Remote observations of snow are complemented by extensive ground sampling to improve estimations of snow density and quantify uncertainty. The combination of point-scale observations and model evaluation with high resolution modeling and airborne data collection provides new insight into snow processes from the plot to watershed scale. This combined approach uses modeling to bridge the gap between the spatial and temporal limitations of observations. In turn, observations contribute confidence that physical processes important to snow accumulation and melt are captured in the model, which offers a test bed for understanding snow-driven processes across the critical zone, from bedrock through the canopy.