**Exploring Climate and Bedrock Controls on Baseflow Age Distributions in a Snow- Dominated Mountainous Watershed**

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**Project Abstract**:
Groundwater contributions to streams, or baseflow, reflects the integrated effects of surface processes controlling groundwater recharge, the subsurface distribution of hydraulic conductivity, and the relative importance of groundwater circulating to different depths (different ages) for the generation of streamflow. Baseflow age reflects the time water spends in the subsurface interacting with host rock material to directly influence biogeochemical processes that control mineral weathering, including carbon and nitrogen dynamics. Identifying where and when climate affects recharge and groundwater flow paths are poorly understood in mountain basins, in part, due to a lack of observations characterizing snow distribution and subsurface hydraulic properties. We address data challenges by developing a framework for combining LiDAR Airborne Snow Observations (ASO) and novel methods for characterizing subsurface properties with a physically based hydrologic model. We demonstrate our approach in Copper Creek, CO (CC, 24 km$^2$), a snow-dominated, headwater catchment of the East River and embedded within the field testbed of the Lawrence Berkeley National Laboratory Watershed Function SFA. ASO provides confidence on the location and timing of water inputs to the basin, while high temporal observations of environmental gas tracers in stream water ($N_2$, Ar, $SF_6$ and CFC-113) indicate a minimum baseflow age of 10 years. To replicate the experimentally derived baseflow age with the hydrologic model requires an increase in bedrock permeability to partition more groundwater flow to deeper flow paths than originally simulated. Model results also indicate CC baseflow age is controlled by the ratio of recharge to hydraulic conductivity (R/K), with CC operating on a precipitation threshold defined by the historic median condition. Under historically dry conditions, recharge and water table elevations drop such that groundwater flow paths are less constrained by local topography, baseflow age becomes older and is increasingly sensitive to decreases in recharge. Looking forward, the model-experimental design is extended to the entire HUC10 East River (750 km$^2$). The increase in spatial extent will allow us to test the R/K conceptual model across landscape-scale gradients in snow accumulation, topography, vegetation and geology. ASO data will continue to constrain snowpack state, while ground and airborne geophysics are pursued to improve parameterization of lithology and geologic structure. Research stresses the need for alternative methods to characterize snow distribution and bedrock properties to link groundwater recharge and discharge zones, and quantify depth/age of groundwater flow paths and their propensity to shift toward longer timescales in a warming or drying climate.