Title: **Model-Data Fusion to Examine Multiscale Dynamical Controls on Snow Cover and Critical Zone Moisture Inputs**

Alejandro N. Flores[1*], William Rudisill[1], Allison Vincent[1,2]

[1]Department of Geosciences, Boise State University, Boise, ID;
[2]now at: Maps and Spatial Data Division, Idaho Department of Water Resources, Boise, ID.

Contact: (lejoflores@boisestate.edu)

Project Lead Principal Investigator (PI): Alejandro N. Flores

BER Program: Environmental System Science

Project: University Project

Project Website: N/A

Project Abstract: The timing, rate, and spatial extent of deliver of water to the critical zone in mountain regions is exerts a fundamental control on biogeochemical processes but is itself a complex process that involves interactions between the atmosphere, vegetation, topography, and subsurface. In particular, water delivery to the critical zone is fundamentally constrained by the quality (timing, magnitude, and phase) of the available precipitation data, which is often limited in high elevation mountain watersheds. We implement a 30-year long regional climate reconstruction using the Weather Research and Forecasting model, run at convection-permitting resolutions, covering the East River and Upper Colorado river basin. To validate the simulated precipitation fields, we leverage snow remote sensing, station meteorological measurements, streamflow records, and parsimonious water balance models within Bayesian data-fusion and inference methodology to create confidence intervals on annual, watershed scale precipitation. Through this effort we are able to synthesize precipitation datasets at higher spatiotemporal resolution, greater accuracy, and better characterized uncertainty than other precipitation products. To enhance constraints on the spatiotemporal variability of snow cover in the East River watershed, we simultaneously synthesized a long-term, high spatiotemporal resolution dataset of snow-covered area (SCA) through satellite data fusion. Specifically, we applied the Spatial and Temporal Adaptive Reflectance Fusion Model (STARFM) to create a 30 m, daily resolution dataset for an approximately 20 year long period, allowing us to examine patterns of seasonal snow cover. This novel application of STARFM for snow cover estimation combines low spatial and high temporal resolution data from MODIS (500-m, daily) with high spatial and low temporal resolution data from Landsat (30-m, 16 days). As an example application of this dataset, we examine percent annual snow cover in the East River for a wet, dry, and average water year. We find that predictable patterns of SCA occur over those years, with the highest percent annual snow cover occurring during the wet year and the lowest occurring during the dry year. Despite these differences, however, elevation is clearly the dominating factor in determining the spatial variability of snow cover in the landscape for all three water years. These

datasets are being made available to the Watershed Function and broader science communities to better constrain estimates of the rate of delivery of water to the critical zone through integrated hydrological modeling efforts, and to supplement gaps in observational data products. Some relevant examples of how these data are used are provided.