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

Alejandro N. Flores[1]*, William J. Rudisill[1], Allison Vincent[2,1], Caroline Nash[3,1]

[1]Boise State University, Boise, ID;
[2]Idaho Department of Water Resources, Boise, ID;
[3]CK Blueshift, LLC, Boise, ID

Contact: (lejoflores@boisestate.edu)

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

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Project Abstract: Although the rate, spatial distribution, and magnitude of water delivery to Earth's critical zone presents a first order control on all subsurface biogeochemical processes, it is incredibly difficult to measure in the world's mountainous regions. Because the presence, longevity, and extent of seasonal snowpacks are a complex function of surface hydrometeorological conditions, it stands to reason that the ability to understand and model subsurface biogeochemical processes is directly related to the quality with which those forcings, particularly precipitation, are known. Commonly used mountain precipitation data can broadly be divided into three types: 1) applied interpolation techniques used to map sparse gauge observations across terrain, 2) statistical downscaling approaches to map coarse resolution atmospheric reanalyses to watershed-scales, or 3) dynamical downscaling, where physically based coupled land-atmosphere models are forced by atmospheric reanalyses as boundary conditions. The last decade has demonstrated that dynamical downscaling techniques are powerful tools for estimating both mountain precipitation inputs, and the related problem of modeling mountain snow accumulation. Evaluating output is a long-standing challenge, and one that is exacerbated in mountain regions where observations are sparse. Gridded datasets derived from surface observations can disagree substantially in mountain watersheds because of choices related to geostatistical methodologies. Moreover, there is often mutual dependence on these products and observations such that they are not entirely independent. Here we evaluate 34 years of Weather Research and Forecasting (WRF) model, version 3.8.1 precipitation output throughout a 700 km^2 mountain watershed (how high) in Colorado, using a combination of precipitation gauge observations, streamflow records, and a limited number of snow-lidar surveys (2018-2019). We also compare precipitation fields to gridded products. Basin-mean precipitation is also compared against precipitation-from-streamflow Bayesian inference method. This work builds upon prior research by incorporating lidar-derived snow water equivalent

estimates into the precipitation estimating framework. The developed forcing data is now available on the Environmental Systems Science Data Infrastructure for a Virtual Ecosystem (ESS-DIVE) data-sharing platform [Rudisill et al., 2022].

References

Rudisill W; Vincent A; Nash C; Flores A (2022): Dynamically Downscaled (WRF) 1km, Hourly Meteorological Conditions 1987-2020. East/Taylor Watersheds. Science Area 1: Standard Award: Model-Data Fusion to Examine Multiscale Dynamical Controls on Snow Cover and Critical Zone Moisture Inputs, ESS-DIVE repository. Dataset. doi:10.15485/1845448