<u>PROJECT SUMMARY</u>: *New approaches to address scaling issues for lateral flow of water in a layered snowpack*

PROJECT OVERVIEW

The goals of this proposed study are to better understand the lateral flow of water within a snowpack. I seek new knowledge on the formation and scales at which capillary and/or permeability barriers occur in snow, and the applicability of laboratory scale parameters as input for modeling. Better understanding of these processes and methods will improve knowledge of key hydrologic controls and dynamics of snow dominated systems. The objectives of my Postdoctoral Fellowship are to: 1) determine the variability in grain size and density between adjacent snowpack layers required to produce significant lateral flow at the hillslope scale, 2) determine the driving physical (topographic, land cover, *etc*.) and climatic conditions required to produce these barriers, 3) produce a two-dimensional numerical model capable of simulating layered porous media with temporally varying properties, and 4) determine how suitable laboratory scale investigations of snow properties are for applications at the hillslope scale. This research will occur at multiple sites across elevational gradients (Boulder Creek CZO and Niwot Ridge LTER) using state of the science Global Positioning Systems and Ground Penetrating Radar methods for non-destructive measurements of liquid water content in snow, dye tracer experiments for larger scale flow path development investigations, laboratory experiments for isolation of the effect of slope, and inverse modeling for upscaling previously developed laboratory scale parameters. The proposed mentors for this fellowship are Dr. Noah Molotch and Dr. Mark Williams at the proposed host Institute of Arctic and Alpine Research at the University of Colorado in Boulder as well as Dr. Stefan Finsterle in the Energy Geosciences Division at the second proposed host institute, Lawrence Berkeley National Laboratory.

INTELLECTUAL MERIT

Communities and ecosystems worldwide rely upon water resources from snow to produce valuable streamflow, groundwater recharge, and soil moisture storage. The dynamic processes that occur during snowmelt create a complex environment where the lateral flow of water has been shown to be hydrologically significant, though difficult to model. To model this process accurately, representation of snowpack properties at appropriate scales are necessary. Properties of snow will vary based on slope, aspect, and vegetative cover forming complex three-dimensional matrices of ice, air, water vapor, impurities such as dust or other constituents, and liquid water (during melt or rain events) that vary over time. The hydraulic properties of snowpack layers induce lateral flow downslope within a snowpack in the form of capillary and/or permeability barriers at layer interfaces as shown in primarily small scale (cm to m) investigations. The physical process of water flowing through the snowpack is an area of research that is still being developed and the need for more research has been highlighted in recent years, particularly the issue of scale (upscaling to tens of meters) that will be targeted in this research using new state of the science approaches.

BROADER IMPACTS

This project has strong potential to create new understanding, developing new approaches, and producing new data analysis tools useful far beyond the scope of the research proposed. These include fundamental insights into the hydrological processes that occur during spring snowmelt in multiple environments as well as the upscaling of laboratory developed parameters for modeling purposes in complex terrain. Approaches and tools developed utilizing new sensor technologies, modeling approaches, and data analysis will be of great utility across the scientific community. Data generated from this research will be made widely available through the hydrologic database CUAHSI HIS. Engaging with and mentoring undergraduate and graduate students in numerous research opportunities with this project in addition to participating with the Postdoctoral Association of Colorado will further grow my abilities in a leadership role in the scientific community. The two institutes selected for this fellowship will provide a unique opportunity for me to communicate with a world class network of scientists for future collaborative research. Additionally, opportunities to co-instruct a hydrology course at the University of Colorado will further my training as a future candidate for a tenure track position at a research focused university.