The role of dust on snow and other aeolian inputs in soil formation and biogeochemical cycling in barren, alpine catchments

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Project Summary

There is an urgency to improve our understanding of how biogeochemical cycling and surface water quality in high-elevation catchments are responding to climatic changes. The combination of increasing temperatures and dust emissions, melting glaciers, and surprisingly high amounts of microbial activity in recently deglaciated soils, suggest aeolian inputs of carbon and nutrients to barren alpine catchments may have an important and, thus far, unexplored role in nitrification and soil formation. To gain a better process-level understanding of how alpine ecosystems will respond to changes in climate, atmospheric deposition, and energy, this project seeks to investigate the initial phases of weathering and biogeochemical cycling in barren, high-elevation soils. An overarching hypothesis that defines this project is that *dust and other atmospheric inputs are important pathways to soil formation and biogeochemical processes, such as nitrification, in barren, alpine catchments***.**

Intellectual Merit: While there is a general consensus that climate change and atmospheric deposition to mountain catchments influence many ecosystem functions, much still remains to be learned about the fundamental biogeochemical processes occurring in barren soils. By building on long-term hydrological and biogeochemical data at the well-studied Green Lake 4 (GL4) catchment in the Colorado Front Range and recent breakthroughs in snowmelt and hydrochemical modeling [Molotch et al. 2008], the research team can lead a fairly ambitious integration of modeling with a process-level understanding of biogeochemical cycling acquired from new field and laboratory studies proposed here. New insights gained from investigating aeolian wet and dry deposition, microbial community composition, rates of microbial processes, and stream and soil water quality, and from conducting coupled snowmelt-biogeochemical modeling will improve the capability to forecast changes in the biogeochemical cycling and hydrology of high-elevation watersheds with a changing climate. Given the global relevance of this research, a subset of activities will be conducted at other CZO sites in the US as well as at international alpine sites. The proposed research will use novel spectroscopic techniques, stable isotope and cation analyses, and bioavailability experiments combined with soil chemistry and mineralogy to evaluate the provenance and chemical quality of aeolian deposition. Given unprecedented rates of glacier melting worldwide, the improved representation of biogeochemical processes is relevant for C- and P- limited mountain catchments on a global scale.

Broader Impact: The inclusion of US CZO sites and international alpine sites in the characterization of dust on snow and other aeolian inputs will expand the relevance of this topic and facilitate an international dialogue on the processes explored in this research. Skyline High School students participating in the St. Vrain Math, Engineering, and Science Achievement (MESA) Program, which seeks to improve achievement by Latino students, will develop their own summer research projects, mentored by the PIs and graduate student and supported with stipends through this project. To stimulate enrichment of MESA high school science teachers, NSF Research Experience for Teachers supplements will be sought. Once a year 8-10 MESA high school students will take a field trip to CU during the INSTAAR Open House, an annual event that showcases INSTAAR research. Results of this project will be disseminated as peer-reviewed publications and via the NWT LTER data management program at http://culter.colorado.edu/NWT/.