Landscape controls on the nitrogen biogeochemistry of high elevation ridges

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Abstract. Topographic orientation influences patterns of snow accumulation and generates distinct edaphic properties and biogeochemical processes on the leeward and windward slopes of alpine ridges. Removal of snow from windward slopes exposes these landscapes to colder wintertime soil temperatures and higher frequency of freeze-thaw events. In contrast, increased snow accumulation on leeward slopes dampens subnivean temperature fluctuations and maintains adequate conditions to sustain wintertime soil microbial activity. Our work on alpine ridges at the Fraser Experimental Forest in central Colorado Rockies indicates that nitrogen dynamics and the soil chemical environment differ between windswept and leeward alpine slopes and across the alpine-subalpine ecotone. Soil nitrate occurs at near-detection levels in subalpine forest and on leeward alpine slopes. In contrast, windward alpine soils contain significant nitrate in both the 0-5 cm (3.4 mg g-1) and 5-15 cm (4.5 mg g-1) depths. Alpine soils incubated under constant moisture and temperature showed a similar, but less dramatic topographic effect on nitrification. This suggests that sufficient substrate exists to support nitrifying bacteria on both aspects and that environmental conditions may be more critical in regulating microbial processes in the alpine. Similar to the pattern observed for nitrate, soil pH is significantly higher on windward alpine sites. We believe this demonstrates a shift in the relative importance of physical to chemical weathering across the alpine ridge. The distinct biogeochemical conditions within alpine landscapes and across the treeline ecotone may help explain patterns of N export and improve predictions regarding the impact of climate change on watershed processes and water quality.

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