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Effect of long-term snow climate change on C and N cycling in the Great Basin Desert, USA

Michael Loik
(mloik@ucsc.edu)

Snowfall is the dominant hydrologic input for high elevations and latitudes of the arid- and semi-arid western United States. Sierra Nevada snowpack provides numerous important services for California, but is vulnerable to anthropogenic forcing of the coupled ocean-atmosphere system. Fundamental ecological models envision migrations of species to higher elevations under a warmer climate, altered water cycling patterns, changes in carbon fluxes, and impacts on nutrient cycling. How will future complex patterns of snow depth and melt timing affect ecosystem patterns and processes at seasonal and decadal scales? To address such questions, my experiments utilize large-scale, long-term roadside snow fences to manipulate snow depth and melt timing at the ecotone between the Great Basin Desert shrub and the Sierra Nevada conifer forest in eastern California, USA. Soil water, carbon, and nitrogen dynamics were compared across snow depth treatments (increased, decreased, and ambient snow depths) as well as across microhabitats (under the canopies of the two dominant shrub species and in open, intercanopy sites.) At this site, April 1 snow pack averages 1344 mm (1928-2008) with a CV of 48%. Snow was about 2-fold deeper on increased depth plots, and was about 20% reduced on decreased snow plots, compared to upwind, ambient-depth plots. Snow fences altered snow melt timing by up to 18 days in high-snowfall years, and affected short-term soil moisture pulses less in low- than medium- or high-snowfall years. Soil temperature was colder during the low-snowfall winter of 2006-2007, compared to the prior and subsequent winters when ambient snowfall was higher. Short-term turnover rates of NO3- and NH4+ were higher after winter compared to summer, but there was considerable variation across snow depth treatments and small-scale microhabitats. Wintertime fluxes of CO2 from soils were dependent on soil temperature, which was affected by snow depth. Snow depth and microhabitat (particularly under the canopies of a N-fixing shrub) interacted to affect long-term patterns of snow depth forcing on total C and NO3-. Results indicate that snow depth affects water, carbon, and nitrogen dynamics in both winter and the subsequent spring and summer, and that plant community composition will feedback on water cycling, carbon storage, and N availability over longer time scales. Interactions between species responses and ecosystem processes may help maintain resilience to snow climate change at this widespread shrub-conifer ecotone.