

CANOPY INFLUENCE ON TRACE METAL DYNAMICS OF SNOWFALL, SNOWPACK, AND SNOWMELT

Yannick Agnan, J. Crews, C. Hedge, C. Pearson, J. Hoberg, D. Obrist

Desert Research Institute, Division of Atmospheric Sciences/Division of Hydrologic Sciences, Reno, Nevada, United States

yannick.agnan@biogeochemie.fr; daniel.obrist@dri.edu

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Introduction: In snow-covered regions, the terrestrial dynamics of chemicals from atmospheric deposition is largely influenced by snowfall and subsequent snowmelt that leads to strong pulses of chemical inputs in streams during the onset of melt (Williams and Melack, 1991). The snowmelt pulses of trace metals, potentially harmful elements to the ecosystems, can account for 70-80% of the total annual trace metal loads (Johannessen and Henriksen, 1978). Vegetation influences both snowfall interception and dynamic of trace metal deposition through metal recycling, particularly for Co, Cd, Pb, and Zn (Heinrichs and Meyer, 1980). Vegetation can act as either a source (by throughfall) or a sink (leaf interception) for trace metal, altering deposition pattern between under canopies and in open areas (Gandois et al., 2010, 2014). The objective of this study was to characterize the dynamics of various metals with different environmental behaviors (e.g., Al, As, Cd, Mn, Pb, V, and Zn) in the atmosphere–snow–snowmelt continuum during an entire winter season and assess the differences in cycling between canopy and canopy-free locations.

Methods: The study area was located in the Sagehen Creek basin in the Sierra Nevada (California, USA) at 2,000 m ASL. We collected wet deposition, snowpack, and snowmelt samples at adjacent duplicate sites throughout the snow season, two sites were located directly under *Pinus contorta* canopy, while two sites were located in an adjacent open meadow. We used four heated precipitation samplers (MDN 00-125 and TM 00-127, N-CON Systems Company, Inc., Crawford, GA, USA) that were placed at the four locations and served to collect precipitation during major snowfall events. Snowpack samples were collected each month at 10 cm depth increments through the snow profile using an acid-cleaned stainless steel cutter (RIP 1 cutter 1000 cc) and stored in Nasco Whirl-Pak® plastic bags. We developed novel snowmelt lysimeters made of 1 m² Teflon sheets connected to collector tubes and vacuum bottles, and allowed for collection of meltwater below the snowpack prior to soil infiltration. We further collected creek water on a monthly basis, before and after the snowmelt, using acid-cleaned glass bottles. All the collected samples were conducted in duplicates, and solutions were filtered (45 µm) and acidified (0.2% HNO₃) in the lab and analyzed by ICP-MS (Agilent 7700X, Agilent Technologies, Santa Clara, CA, USA) for trace metal concentrations.

Results: The volume of precipitation collected under canopy was on average 20% lower than those collected in open area, reflecting a strong effect of canopies on observed precipitation volumes. Snow depth between canopies and open locations showed much larger differences, with a peak snowpack depth of 90 cm in the meadows versus 30 cm under canopies. This resulted in a decrease of snow water equivalent (SWE; the amount of water stored in snowpack) under canopies by an average decrease of more than 70%. Using the novel lysimeter device, we were able to collect snowmelt water from the end of January to the end of season, showing that snowpack water can be collected below the snowpack using trace metal procedures. Snowmelt volumes collected were highly variable between open areas and under canopies, probably due to microclimate and topographic conditions. Trace metal analysis are currently in progress to assess correlations of trace metal concentrations with snowmelt volumes, SWE, and snowfall volumes. This will allow us to estimate a wintertime balance of inputs and losses of trace metals in Sierra Nevada mountain snowpack, which are a major factor of the annual hydrologic cycle in these systems.

Conclusion: Our initial results in assessing canopy influence on snowfall, snowpack, and snowmelt dynamics and associated trace metal cycles showed large differences in terms of volume of precipitation and snowpack accumulation between canopies and adjacent open meadows. Novel trace metal grade snowpack lysimeters proved instrumental for the collection of snowmelt water for trace metal characterization under snowpack prior to infiltration into soils. The resulting trace metal budgets and dynamics at these locations are currently under development and will allow a comprehensive view of snow-related trace metal inputs, storage, and melt losses at this mountain location.

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