EGU24-14428, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-14428
EGU General Assembly 2024

Stream Length and Diatom Communities Control Si Dynamics in Glacial Meltwater Streams of the McMurdo Dry Valleys, Antarctica

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In the polar deserts of Antarctica, meltwater from glaciers flows in streams for only about two months during the summer. As the water flows downstream and interacts with the sediment in the stream channel, weathering reactions increase the concentrations of dissolved constituents in the stream water, especially silica. In the McMurdo Dry Valleys, the glacial meltwater streams that flow during the austral summer are important biogeochemical links between the alpine and terminal glaciers and the lakes in the valley floors. As part of the McMurdo Dry Valleys Long-Term Ecological Research (MCMLTER) project, 17 first and second order streams are monitored for flow and water quality, and diatom community composition in the perennial microbial mats on the streambed. This study found that in streams that are about 1 km long and have abundant microbial mats, the diatoms can take up enough silica to reduce the concentrations of dissolved silica to very low values (>/= 1 mg/L). In comparison, in longer streams Si concentrations are greater (2 mg/L and greater) due to the input of Si from weathering in the hyporheic zone. A previous study has found that diatom community composition in two short streams is significantly related to total flow during the austral summer, leading to a hypothesis that decreases in Si concentrations with increasing flow may favor smaller diatoms with less silicified frustules. We analyzed the 25-yr discharge and silica record for 10 streams using the Weighted Regressions on Time, Discharge, and Season (WRTDS) model to estimate mean 5-day silica concentrations for December through January. These analyses revealed that the shortest stream with the strongest relationship between flow and diatom community composition consistently exhibited minimum Si concentrations of ~ 0.5 mg/L at peak flow. In contrast, Si concentrations were higher and more stable throughout the summer for long streams that exhibit little variation in diatom community composition. These results suggest that Si uptake by diatoms can control both in-stream Si concentrations and diatom community composition. Understanding the relationship between the diatoms in the mat communities and environmental change is useful for interpreting the record of the stream diatoms preserved in lake sediments and for considering future scenarios for the Dry Valleys.