Are melting alpine glaciers a source of legacy priority contaminants to downstream environments? A high-frequency analysis of water chemistry in the Canadian Rockies.

Kasia Staniszewska¹, Colin Cooke¹², and Alberto Reyes¹

¹Dept. Earth and Atmospheric Sciences, University of Alberta, Edmonton, Canada (katarzyn@ualberta.ca)
²Alberta Environment and Parks, Government of Alberta, Edmonton, Canada

Glaciers are retreating across the Canadian Cordillera. As this ice melts trace elements and other contaminants, accumulated from millennia of atmospheric deposition, are subject to release with uncertain consequences for downstream water quality. It is therefore imperative to constrain the rate and magnitude of contaminant input to river systems from glacierized watersheds. Meltwater chemistry was monitored and modelled at a high temporal frequency using a combination of grab-sampling and sondes for physical, chemical, and hydrological parameters at the outlet of proglacial Sunwapta Lake, Athabasca Glacier, Canada. Principal component analysis revealed that chemical parameters could be split into two groups with distinct seasonal trends. Group A encompasses solutes and endogenic bedrock weathering associated elements. Group B includes particulate, and exogenic dust-associated elements. Group A element concentrations were highest during low flow conditions and were correlated positively with conductivity. Group B element concentrations were highest during high flow conditions and had a moderate positive correlation with turbidity. Concentrations of potentially hazardous trace elements remained below Canadian Environmental Quality Guidelines throughout the hydrological season (THg < 2.7 ng/L; TPb < 1.7 µg/L; TAs < 0.34 µg/L; TCr < 1.9 µg/L). Trace element fluxes (kg/year) and yields (kg/year/watershed area) were modelled at a high temporal-resolution by pairing grab sampling results with corresponding strongly correlated high-frequency physical parameters: conductivity or turbidity. Annual fluxes and yields were comparable or lower than fluxes and yields from other glacial meltwater streams globally. Annual fluxes and yields were THg: 95 kg/yr and 3.2 g/yr/km²; TPb: 34 kg/yr and 1.2 kg/yr/km²; TCr 39.5 kg/yr and 1.4 kg/yr/km²; TAs: 7.3 kg/yr and 0.25 kg/yr/km². Numerous studies have suggested that glaciers are a significant source of high concentrations, fluxes, and yields of contaminants, including: pesticides; PAHs; PCBs; and toxic trace elements. In contrast, we found low concentrations, fluxes, and yields of trace elements in meltwater from the rapidly retreating Athabasca Glacier. Grab-sampling complemented by high-frequency monitoring of physical and chemical water parameters allowed a high-resolution view of water chemistry variation in meltwater from the Athabasca Glacier.

How to cite: Staniszewska, K., Cooke, C., and Reyes, A.: Are melting alpine glaciers a source of legacy priority contaminants to downstream environments? A high-frequency analysis of water