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Glacier recession as a source of environmental pollutants: a case study from Isfallsglaciären, Arctic Sweden

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Glaciers can be stores for environmental pollutants that have been scrubbed from the atmosphere by snow or deposited onto the snow/ice surface, with the release of glacial meltwater potentially acting as a secondary source of contamination in proglacial environments years after the initial source was active. Fieldwork was conducted in the Isfallsglaciären catchment of the Tarfala Valley in Arctic Sweden during the summer of 2017 to investigate historical atmospheric contaminant transport through glacier systems, including FRNs (fallout radionuclides) and heavy metals. Isfallsglaciären is a small polythermal glacier which has been steadily retreating over the last century with meltwater and sediments released from the glacier collecting in two proglacial lakes (Frontsjön and Isfallssjön). The region received fallout from the Chernobyl nuclear accident, offering an important marker to test the hypothesis of contaminant concentration in the glacier system through interaction of a large snow/ice volume with low mass cryoconite and other glacial sediments. Sediment samples were collected in the supraglacial and proglacial environments and a 38 cm core extruded from Isfallssjön. The samples have been analysed for FRNs and naturally occurring radioactive elements by gamma spectrometry, and a full suite of major and minor elements by wavelength-dispersive X-Ray fluorescence, and a timeline for sediment accumulation and contamination constructed based on excess Pb-210 and Cs-137 in the lake core from 1960s weapons testing and the Chernobyl nuclear accident. The goal of this research was to determine whether inorganic atmospheric pollutants are concentrated through capture by snowfall and interaction with glacial sediments, and to investigate whether contaminants released through melting are enriched on the soil surface or in downstream fine sediments to potentially harmful levels. High levels of anthropogenic FRNs Cs-137 and Am-241 (averaging 3070 $\pm$ 940 and 26 $\pm$ 16.7 Bq kg respectively) were recorded in cryoconite deposits sampled on the ice surface as well as markedly elevated levels of natural fallout Pb-210 (averaging 9790 $\pm$ 2390 Bq kg). Comparison to surface sediments sampled off-ice implies that fallout contamination levels are enhanced by two orders of magnitude in cryoconite. These findings offer an important insight into the potential vulnerability of pristine Arctic environments to contaminant-enriched sediments released by glaciers, either in-situ or transported downstream, as they continue to retreat in response to a warming climate.