Distribution and controls on the accumulation of fallout radionuclides in cryoconite across the global cryosphere

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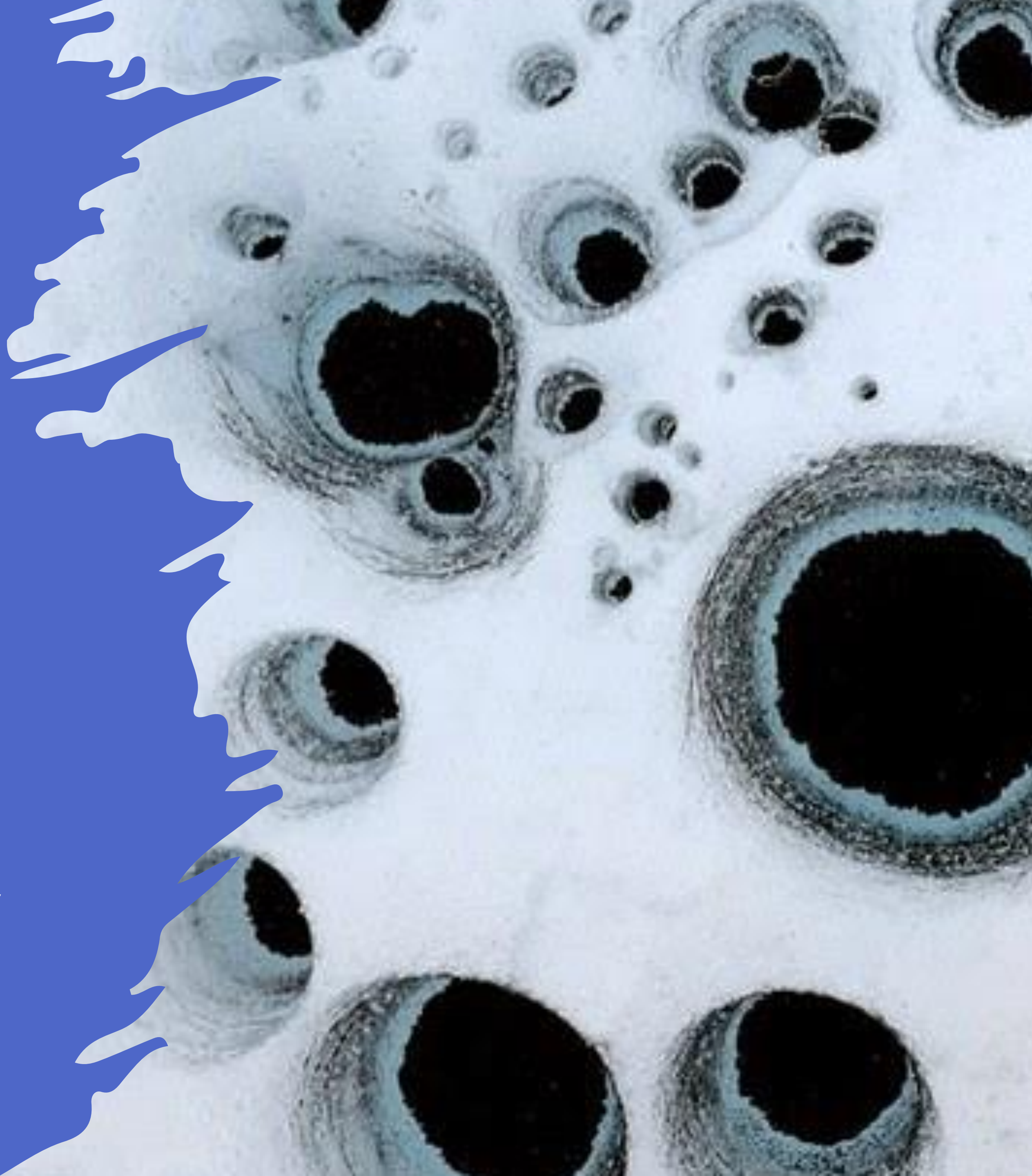


Glaciers as contaminant stores

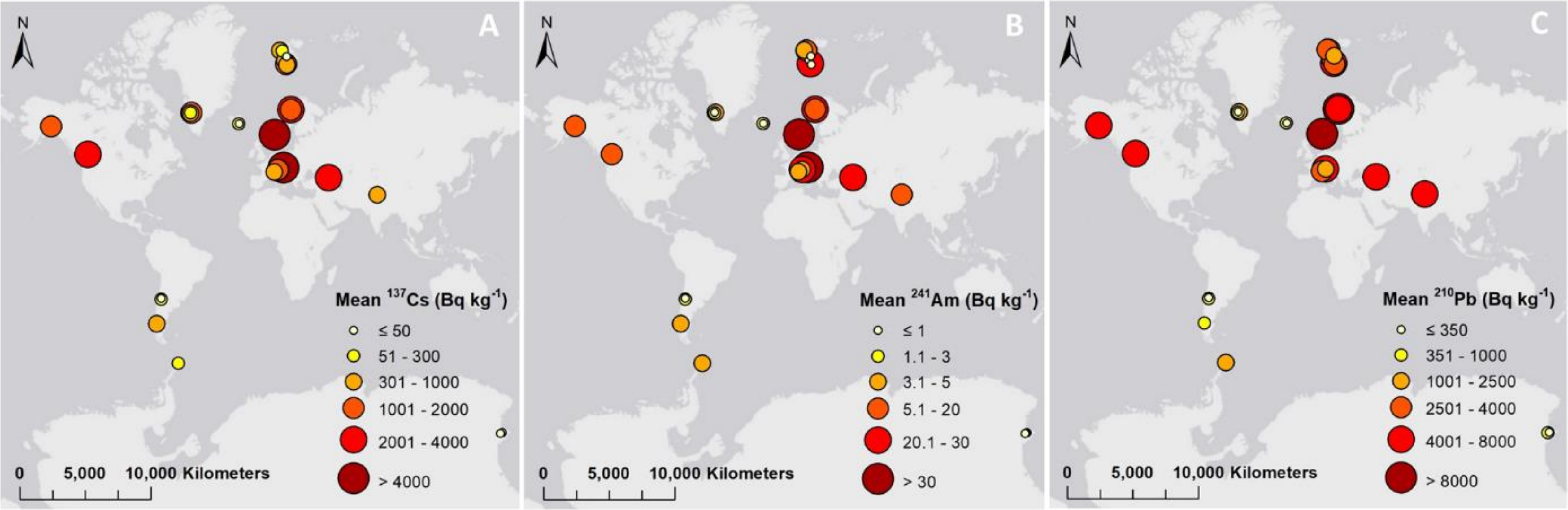
- **Glaciers are stores for materials deposited onto their surface** via atmospheric deposition, accidents, mass movements, human activity etc.
- Includes contaminants studied less commonly within the cryosphere, such as fallout radionuclides (FRNs), **products of weapons testing and nuclear accidents**.
- These **legacy contaminants pose a potential risk of secondary release** into the proglacial environment with continued melting and down-wasting.
- Cryoconite previously shown to be an efficient accumulator of C and N, and research at individual glacier sites has shown the same can be true for FRNs and other contaminant classes.

5 continents; 14 countries; 30 glaciers; 477 samples:

- Alaska (n = 17)
- Canada (n=6)
- Chile (n=30)
- Greenland (n=28)
- Iceland (n=34)
- Norway (n=17)
- Italy (n=21)
- Switzerland (n=22)
- Austria (n=149)
- Svalbard (n=102)
- Sweden (n=17)
- Georgia (n=8)
- India (n=7)
- Antarctica (n=19)

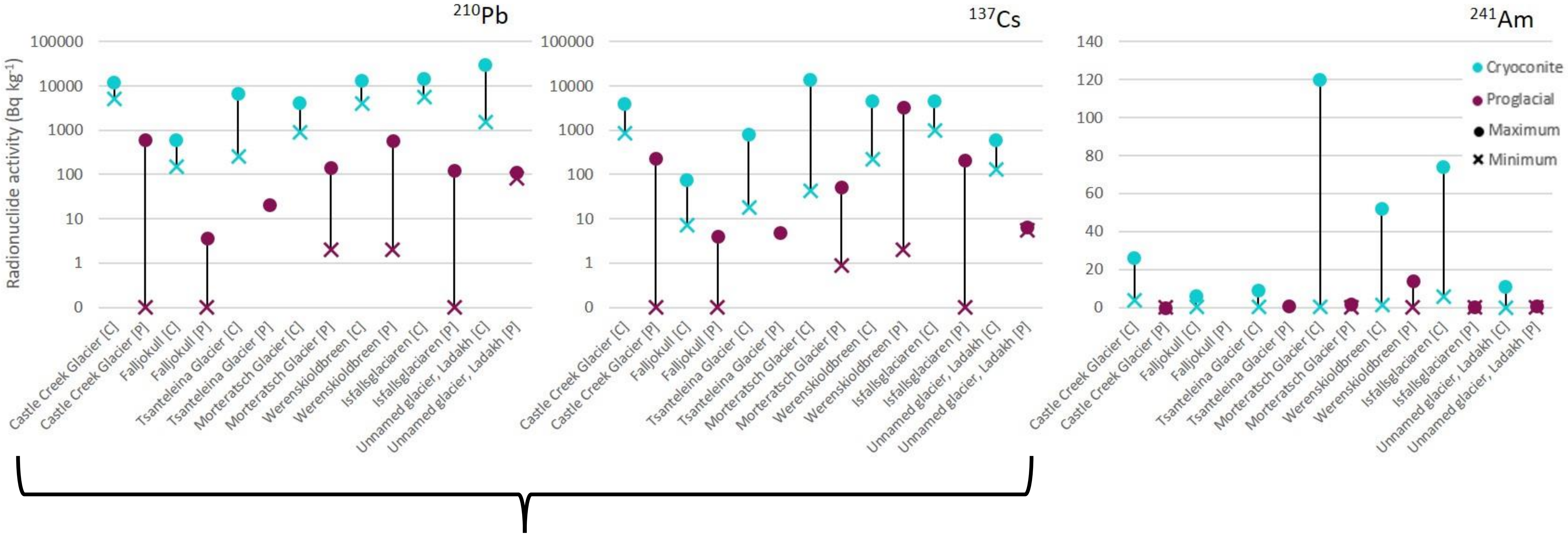
All cryoconite samples (and proglacial sediments where available) were analysed for FRN activity via gamma spectrometry

FRNs in cryoconite across the global cryosphere



- Large spatial variability (up to three orders of magnitude) in both natural and anthropogenic FRNs.
- Some ^{137}Cs activities are amongst the highest recorded outside of nuclear exclusion zones.
- ^{210}Pb in cryoconite can be one to two orders of magnitude higher than activities typically found in lichens, mosses, and non-glacial sediments.

FRNs in cryoconite vs proglacial samples



Note logarithmic scales for ^{210}Pb and ^{137}Cs

Why do FRNs accumulate in cryoconite?

	Elevation	Continentality	Chernobyl	Precipitation	Latitude	Organic content
^{137}Cs	Pearson = 0.019 P-value = 0.334	Pearson = 0.042 P-value = 0.83	Pearson = -0.266 P-value = 0.163	Pearson = 0.553 P-value = 0.002	Pearson = 0.125 P-value = 0.518	Pearson = 0.814 P-value = 0.0
^{241}Am	Pearson = 0.233 P-value = 0.223	Pearson = 0.137 P-value = 0.479	Pearson = -0.439 P-value = 0.017	Pearson = 0.502 P-value = 0.006	Not available	Not available
^{210}Pb	Pearson = 0.283 P-value = 0.145	Pearson = 0.366 P-value = 0.055	Pearson = -0.498 P-value = 0.007	Pearson = 0.247 P-value = 0.205	Pearson = 0.444 P-value = 0.018	Pearson = 0.713 P-value = 0.0

Take-home 1: Glaciers are stores for FRNs, with some exceptionally high values in cryoconite, often orders of magnitude more than found off-ice.

Take-home 2: We need to know more about overall cryoconite mass and distribution to assess what this means in terms of environmental risk.

Take-home 3: Impacts on water and environmental quality, including accumulation in flora and fauna, should be a focus of future research efforts, including stakeholder perspectives within activities.

Take-home 4: As a community we need to better understand the processes and dynamics of legacy contamination in glacier catchments (including those contaminants introduced by us!).

Thanks for listening!

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