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Atmospheric radioisotopes in cryoconite from the Flade Isblink ice cap, NE Greenland

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Under climatic warming and increased melting, glaciers and ice caps are becoming secondary sources of contaminants deposited decades ago. Cryoconite, an organic-rich material found on the surface of many glaciers, is particularly efficient at accumulating airborne contaminants due to biogeochemical exchanges with the organic matter within cryoconite. Atmospherically derived radioactive isotopes, commonly referred to as fallout radionuclides, have now been found to accumulate in cryoconite globally. However, data from the polar regions, especially ice sheets and ice caps, is scarce. This study helps to address this regional gap in understanding fallout radionuclide accumulation in glacial settings. We present the first radioactivity dataset from cryoconite on a Greenlandic ice cap and assess the role of cryoconite in the distribution of radioactive species in the High Arctic. Forty-six cryoconite samples were collected from the Flade Isblink ice cap (NE Greenland) in August 2022. These samples were analysed via alpha and gamma spectrometry for atmospheric radionuclides, including ^{137}Cs, ^{241}Am, ^{210}Pb$_{exc.}$, ^{207}Bi, ^{7}Be, and several plutonium isotopes. The results of this study confirm cryoconite's exceptional ability to accumulate fallout radionuclides, even in remote and relatively pristine regions such as Northern Greenland. The activities of radionuclides in cryoconite from Flade Isblink are among the highest reported across the High Arctic and the highest ever reported from Greenland. Flade Isblink's radioactivity source is compatible with the stratospheric reservoir established during atmospheric nuclear tests and with weapon-grade fissile fuel, likely originating from Novaya Zemlya. Our findings emphasise the necessity for continued research efforts on the release of legacy contaminants from glaciers, particularly given accelerated global warming and consequent glacier retreat.