Cryoconite carbon: why local geology matters

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Dark material on the surface of glaciers is reducing their reflectivity and therefore contributing to increased glacier melt. This dark material typically accumulates in regions of melt on the glacier, such as in cryoconite holes. The source of this dark material has been hypothesized to be from combustion of forest fires or fossil fuels, microbes and dust. However, few studies to date used radiocarbion of bulk and specific compounds to study the composition of cryoconite material. In this study we examined the chemical composition of cryoconite material collected from three different mountain glaciers in Alaska (Matanuska, Mendenhall, and Spencer) to determine the sources of carbon to these glaciers. Additionally, we used compound specific radiocarbon analysis of the solvent extractable lipids to further investigate the carbon source(s). While the the overall amount of carbon in the cryoconite material from these glaciers was typically low (<5%), the age of the carbon in this material varied by more than ten thousand radiocarbon years across all three glaciers. The organic carbon in cryoconite material collected on Spencer and Matanuska glaciers near Anchorage, was lower in organic carbon and yet much older than today's atmosphere. On the other hand, cryoconite carbon collected on Mendenhall glacier near Juneau, contained more organic carbon and was primarily modern carbon. If the carbon source(s) to these glaciers are the same, then these results suggest that there is a significant young carbon source to Mendenhall that is not present for Spencer and Matanuska glaciers. However, we found that the amount of solvent extractable carbon in all of these samples was low (<5% of organic carbon), which suggests that most of the carbon is mineral bound. Radiocarbon analyses of the solvent extractable lipids from these glaciers revealed young carbon, even when the bulk organic carbon was thousands of years old. Since cryoconite material is typically crustal in its composition (e.g. inorganic elemental composition) and the region near Spencer and Matanuska glaciers contains sedimentary carbon (e.g. shale), while Juneau is primarily igneous rock, we conclude that the age of the cryoconite carbon on these mountain glaciers is influenced by the local geology.