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Greenland ice core organic matter indicators of local influences across the Arctic Circle Traverse

Content

Reconstructing atmospheric composition across ancient and modern scales is a central focus of ice core research, and incorporation of fluorescent organic matter (OM) characterization is improving our understanding of Earth's paleoecological history. As polar and alpine ice contain significant records of preserved carbon as OM, identifying origin and reactive nature become essential targets, not only for atmospheric reconstructions, but also to better understand ice sheet surface processes and preservation mechanisms, and to project potential impacts upon release in a warming climate. With those initiatives, we can start to perceive ice cores as both an essential record of past Earth materials as well as the key to future changes with melting and retreat. Therefore, the value of ice core measurements continues to grow with organics, microorganisms, and available nutrients driving changes at ice sheet surfaces and in adjacent marine mixing zones. We present the OM fluorescence characterizations from three basins (A, B, and C) across the Arctic Circle Traverse (ACT), Greenland, collected in 2010, encompassing OM fluctuations over short-term time and small spatial scales (dated 1973-2010 and from 20-70 km, respectively). Variability of ice core OM reflect local ecosystem changes as a function of local influences, elevation, and distance from the southeast coast. Complex, terrestrially derived OM fluorescence was a common signature across all basins, although most dominant in basin B (between A and C). More biolabile OM (freshly degraded by microbes) was reported across all basins, indicating simple, low molecular weight, and less aromatic chemical species preserved in southeast Greenland, a trend common in other Greenland ice and found ubiquitously around the world. Organic matter concentration trends were inferred from fluorescence intensities of individual OM types and related to dust concentrations and increased temperatures. We suggest that analyses of these small scale spatial records reveal indicators of marine-sourced OM, which, to-date, was difficult to isolate using other ancient and modern ice from Greenland and Antarctica that were drilled further inland. Yet, we view these results as important next steps to drive ice core research into a new realm and connect researchers across atmospheric, freshwater, and marine communities. Outspreading ice core research to routinely incorporate OM fluorescence characterization in polar and alpine studies is still in its infancy but has value to the cryosphere community and other aquatic and terrestrial fields as disintegrating icy reservoirs of OM release their contents in a warming climate.

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