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Novel organic compounds in ice cores for use in paleoclimate reconstruction

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Despite contributing up to half of atmospheric aerosol concentration, detection and understanding of organic compounds in ice cores is not as well developed as their inorganic counterparts. Two groups of organic compounds emitted from the marine and terrestrial biosphere, fatty acids and terpene secondary oxidation aerosols (SOAs), display characteristics suitable for ice core paleoclimate reconstruction: Emission rates depend on environmental conditions, compounds survive long-distance transport in the atmosphere to high latitudes, and some compounds are shown to survive in ice layers up to hundreds of years old.

A single, reproducible method of quantification for trace levels of compounds is developed, including preconcentration of samples and analysis with high resolution liquid chromatography - mass spectrometry (HPLC-MS). This method is used to test shallow ice core samples representing both dominant terrestrial and marine aerosol input locations.

We present an inventory of chemicals found in detectable amounts in locations including the Belukha glacier, Altai Mountains (Russia) and sub-Antarctic islands. A suite of SOA compounds are detected in the Belukha core, displaying large summer-time peaks in concentrations. Longer terms trends, since the 1600's, are different for different compounds. Statistical analysis indicates these concentrations are related to emission quantities, rather than subsequent transport processes. In the sub-Antarctica Bouvet Island core, oleic acid (a fatty acid component of marine diatoms) is strongly correlated with methasulfonic acid (MSA) and historical sea ice concentration in the region.