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Late Holocene fire activity recorded in a Greenland ice core

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The pyrolysis compounds from the thermal decomposition of cellulose during burning events are the dominant smoke tracers in continental airsheds. Important compounds from biomass burning include monosaccharide anhydrides (MAs). Levoglucosan is a MA produced by combusing cellulose at a temperatures of 300°C or greater. Ice cores contain these specific molecular markers and other pyrochemical evidence that provides much-needed information on the role of fire in regions with no existing data of past fire activity. Here, we use atmospheric and snow levoglucosan concentrations to trace fire emissions from a boreal forest fire source in the Canadian Shield through transport and deposition at Summit, Greenland (72°35'N 38°25' W, 3048 masl). Atmospheric and surface samples suggest that levoglucosan in snow can record biomass burning events up to 1000s of kilometers away. Levoglucosan does degrade by interacting with hydroxyl radicals in the atmosphere, but it is emitted in large quantities, allowing the use as a biomass burning tracer. These quantified atmospheric biomass burning emissions and associated parallel oxalate and levoglucosan peaks in snow pit samples validates levoglucosan as a proxy for past biomass burning in snow records and by extension in ice cores.
The temporal and spatial resolution of chemical markers in ice cores matches the core in which they are measured. The spatial resolution of chemical markers in ice cores depends on the core location where low-latitude ice cores primarily reflect regional climate parameters, and polar ice cores integrate hemispheric signals. We present levoglucosan flux, and hence past fire activity, measured during the late Holocene in the NEEM, Greenland (77°27' N; 51°3'W, 2454 masl) ice core. We compare the NEEM results with multiple major Northern Hemisphere climate and cultural parameters.