Greenland ice core records of biomass burning aerosol and BVOCs over the past 60 years

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It is vital to fully understand climate feedback mechanism within climate system in order to improve prediction of future climate by simulation model. However, biogeochemical feedback is not fully understood. Both the biomass burning aerosol and Biogenic volatile organic compounds (BVOCs) are thought to have a potential as chemistry feedback in response to climate change. Biomass burning aerosol is emitted from burning of forests and savanna for colonization and agriculture, burning of agricultural waste, and substances burned for fuel. BVOCs such as isoprene and monoterpenes are important precursors of secondary organic aerosol (SOA) come from terrestrial vegetation and marine plankton. However, substantial role of those aerosols in climate system is still uncertain. In order to better understand roles of biomass burning aerosol and BVOC in climate system, it is needed to explore link between climate and those emissions on various time scale. In this study, we reconstruct variability of biomass burning activity and emission of BVOC over the past 60 years based on novel approach, organic molecule tracers analyses in Southeastern Greenland-Dome (SE-Dome) ice core, which provides high-time resolution reconstruction of past environment. Organic molecular tracers such as biomass burning and biogenic SOA tracers are detected in SE-Dome ice core. Levoglucosan, which is produced by pyrolysis of cellulose and hemicellulose and thus is a tracer of biomass burning, showed sporadic peaks in the years of 1961, 1964, 1994, 1998 with the largest peak in 1964. In contrast, dehydroabietic acid, a specific tracer of the pyrolysis of conifer resin showed high peak at 1959, 2003 and showed a gradual increasing trend from 2009. The concentrations of isoprene SOA tracers (2-methylglyceric acid, 2-methylthreitol and 2-methylerythritol) are also dominant in SE-Dome ice core samples. Erythritol, is an analog of 2-methyl erythritol, a tracer species for isoprene SOA showed positive correlation with sugar compounds (arabitol, fructose, glucose) and with Dehydroabietic acid from the ice core with 95% confidence level. These results suggest that erythritol comes from continental sources. Monoterpene SOA traces are not found in SE-Dome ice core. Air mass backward trajectory showed that North America is the main source region of aerosols, indicating aerosols in SE-Dome region are transported mainly from North America. This study showed that general biomass burning tracers such as levoglucosan have been sporadically transported over the southeast Greenland and levoglucosan data matches with eastern USA fire history. In contrast, the ice core record of dehydroabietic acid indicated that fires of boreal conifer forest have occurred in North America during the last decades and transported to southeastern part of Greenland. The causes of historical variability of SOA tracers are complex and depend on atmospheric circulation, changes in vegetation cover and other factors such as temperature, tropospheric oxidative capacity.

Keywords: Isoprene SOA tracer, Biomass burning, levoglucosan, BVOC

