Recent increases in the abundances of dicarboxylic acids and fatty acids in Antarctic ice core

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A 120 m long ice core (ca. 350 years), collected from Antarctica (site H15, 69°4'S, 40°46'E, elevation 1057 m), was analysed for dicarboxylic acids, oxocarboxylic acids and fatty acids. Aliquots of ice melt samples (150 ml) were concentrated and reacted with 14% BF_3 in n-butanol to derive butyl esters and dibutoxy acetals. The derivatives were analysed by a capillary gas chromatography (GC) and GC/mass spectrometry. Homologous series of diacids (C_2-C_{12}, concentration range: 0.15-10.2 ng/g-ice, ave. 1.5 ng/g-ice) and oxoacids (ωC_2-ωC_9, pyruvic, 0.015-1.6 ng/g-ice, 0.20 ng/g-ice) were detected together with fatty acids (C_{14}-C_{20}, 0.012-8.6 ng/g-ice, 1.1 ng/g-ice). Molecular distributions of diacids were characterized by the predominance of oxalic acid (C_2) whereas those of oxoacids were by glyoxylic acid (ωC_2). Azelaic acid (C_9) and 9-oxononanoic acid (ωC_9), which are specific photo-oxidation products of unsaturated fatty acids (e.g., oleic acid) derived from surface ocean, were also detected as major species.

We found that concentrations of diacids and related compounds started to increase after 1850 and the trend was enhanced after 1970. Interestingly, relative abundances of azelaic acid (C_9%) in total diacids increased from 5% in 1750s to 35% 1990s. We also found that concentration ratios of C_9 to unsaturated fatty acids largely increased after 1970s probably due to the enhanced UV radiation as a result of depletion of stratospheric ozone. Increased concentrations of C_9 and ωC_9 after 1850s may be associated with a retreat of sea ice due to a warming in the Antarctic Ocean. The Antarctic ice core recorded climatic changes in the Anthropocene.