Assessing melt effects on aerosol tracers in a firn core with non-target screening

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Natural archives, for example, high-alpine glacier ice cores, allow the reconstruction of past trends in the composition and concentration of atmospheric aerosols. Unfortunately, these archives are heavily affected by climate change, and the chemical impurities are prone to relocation, thereby limiting the chemical signal interpretation. So far, mainly the signal preservation of inorganic ions was studied. The majority of the organic aerosol tracers have not been investigated, let alone their behaviour in firn/ice influenced by melting. Our goal is to narrow this knowledge gap and provide a more comprehensive understanding of organic aerosol tracer preservation in firn and ice.

Here, we present data from a firn core collected on the Corbassière glacier (Grand Combin, Swiss Alps) in 2020. The firn core was dated by annual layer counting using stable oxygen isotope ratio ($\delta^{18}O$). We analysed organic tracers with a hybrid target/non-target screening approach optimised for determining oxidation products of volatile organic compounds. As these tracers are usually present at low concentrations, we performed solid-phase extraction as a pre-concentration step. The samples were analysed with high-performance liquid chromatography coupled with high-resolution mass spectrometry, using Electrospray Ionisation and Orbitrap technology. This approach allowed the identification of a wide range of compounds at low concentrations through the comparison of their MS/MS spectra with spectral libraries (e.g., mzCloud) and reference standards.

To reduce data complexity, we conducted hierarchical cluster analysis, enabling the identification of profiles that share similar sources (e.g., biogenic, or anthropogenic) and/or are affected by similar processes (e.g., melting). Our results indicate that one cluster shows a periodicity, i.e., is mostly preserved. Whereas, the other clusters display varying degrees of meltwater influence. Overall, this investigation provides a unique and comprehensive assessment, for the first time, of the impact of melting on the preservation of organic aerosol tracers within a firn matrix. This knowledge is crucial for understanding and interpreting ice core records in the context of global warming.