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In-situ analysis of free tropospheric aerosol and small ice crystal residuals using a high resolution aerosol mass spectrometer (HR-ToF-AMS) at Jungfraujoch during CLACE 5.

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During CLACE 5 (Cloud and Aerosol Characterization Experiment), a high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) was operated at the High Alpine Research Station Jungfraujoch (Switzerland, 3500 m a.s.l.) to measure size resolved chemical composition of particles in the size range between 40 nm and 1.0 μm.

This instrument sampled aerosol particles through three different inlet systems: an interstitial aerosol inlet (cut-off 2.5 μm), a heated total aerosol inlet, and an Ice-CVI, which is a counterflow virtual impactor designed to sample only small ice crystals.

As an improvement to previous experiments (CLACE 3 and CLACE 4), where a similar setup was used, the HR-ToF-AMS allows to distinguish between hydrocarbon-like organic aerosol (HOA) and oxygenated organic aerosol (OOA) since the different ionic composition implies different exact molecular weights. For example, the ion found at the integer m/z = 43 can (amongst others) contain $C_3H_7^+$ (exact m/z = 43.0548) and $C_2H_3O^+$ (exact m/z = 43.0184). $C_2H_3O^+$ is a fragment of an oxygen-containing organic molecule and can thereby be used as a marker for OOA, while $C_3H_7^+$ can be a fragment as well of a larger hydrocarbon molecule as of a larger oxygen-containing molecule. A high contribution of oxygenated aerosol was found in

the free tropospheric background aerosol, confirming the assumption that photochemical aging converts primary organic aerosol emissions into oxygenated aerosol.

The ice residual measurements confirmed the finding that was obtained in the previous CLACE campaigns: Ice nuclei (IN) are preferably composed of refractory material as mineral dust or black carbon that can not be detected by the HR-ToF-AMS. Additional black carbon measurements and a mass balance based on SMPS volume size distributions indicate that black carbon alone can not account for all the refractory material and that therefore most likely mineral dust is the major component of free tropospheric ice nuclei.