Application of Ultraviolet Laser Ablation Inductively Coupled Plasma Mass Spectrometry (UV-LA-ICPMS) to Ice cores: in situ high resolution retrieval of elemental 'dust' proxies

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In recent years Laser Ablation Inductively Coupled Plasma Mass Spectrometry has been applied to ice cores to investigate dust and aerosol variability in polar regions by retrieving elemental species at the highest resolution.

At Royal Holloway University of London, a 193nm laser-ablation system with two-volume cryo-LA-cell is coupled to an Agilent 8800-QQQ triple-quadrupole inductively-coupled-plasma mass spectrometer (LA-ICPQQQ-MS) to analyze aerosol compositions in frozen Greenland ice core samples at unprecedented sub-annual resolution, utilizing a custom-built cryo-holder (Laurin Technic, AU), able to accommodate three strips of ice (50 x 11 x 11 mm) below the freezing point.

The triple quadrupole setup, utilizing O_2 and H_2 as reaction gases, removes efficiently polyatomic isobaric interferences and allows the simultaneous measurement of several crucial isotopes (^{40}Ca, ^{56}Fe, ^{25}Mg, ^{23}Na) achieving Limits of Detection (LODs) in the lowest ppb range, as required to resolve Greenland concentrations from ice blanks. These isotopes have been traditionally utilized in paleoclimate studies as 'dust' and aridity indicators, showing an inverse relationship between temperature and concentrations. Furthermore, the triple quadrupole mass shift mode allows the measurements of other unconventional isotopes, e.g. ^{32}S, ^{33}S, ^{34}S, ^{35}Cl, ^{79}Br, utilized to detect volcanic time-marker events, sea salt contribution to the Greenland ionic budget, and sea salt extent variability, respectively.

Results of several high-resolution acquisitions across important climatic transitions of the last glaciation, such as GI-20a – GS-20 and GS-22 – GI-21, will be presented, showing an increase up to an order of magnitude for most of the elements across warm to cold transitions and vice versa, also showing that selected ions often complete this switch in a few years only. These changes are accompanied by a relative decrease in selected elemental ratios (Fe/Al, Mg/al and Ca/Al) at the onset of the Stadial phase and vice versa, suggesting that the location of the dust source might change between warm and cold phases.