Ice core evidence of depleted nitrate at Dome A, Antarctica

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Nitrate (NO_3^-) in polar ice cores is expected to contain information about past atmospheric concentration of NO_x [1,2]. However, post-depositional processing compromises a quantitative interpretation of the ice core record [3,4]. Dome A has the highest elevation in East Antarctica. The snow accumulation rate of 23.2 kg m^{-2} a^{-1} at Dome A [5] is among the lowest in Antarctica. In order to determine the degree of post-depositional processing of snow NO_3^- and the extent of NO_3^- preservation in snow below the air-snow exchange zone at Dome A, measurements of concentration and stable isotopic composition of NO_3^- in a shallow Dome A ice core covering the last 2840 years are reported.

The average NO_3^- concentration of 11.8 μg kg^{-1} at Dome A is the lowest among those reported for Antarctic ice cores covering several hundred years or longer. Isotopic composition of NO_3^- indicates that NO_3^- in the Dome A core has experienced strong post-depositional processing most likely driven by photolytic chemistry, which results in the extremely low NO_3^- concentration. NO_3^- cycling, including photolytic loss, re-oxidation and re-deposition, occurs all the time until it is buried in depth where photolytic process is negligible due to lack of UV light. NO_3^- remaining at depth far below the surface is likely produced locally via the oxidative reaction with O_3 and OH/H_2O. In the Dome A core, significant NO_3^- displacement is observed in layers containing volcanic sulphate; the degree of displacement is largely influenced by the volcanic signal magnitude, i.e., large volcanic signals lead to significant displacement, while small signals result in negligible displacement.

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