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A comparison of isotopes in ice core nitrate from Greenland and Antarctica

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The ice core record of nitrate (NO_3^-, or nitric acid, HNO_3) contains important details about past changes in our atmosphere. Previous studies have shown that the chemical processing of nitrate prior to deposition determines the δ^{18}O of nitrate, while the δ^{15}N of nitrate is predominantly determined by the sources of precursor nitrogen oxides. Thus the ice record of nitrate may contain information about changes in atmospheric oxidants and sources of nitrogen oxides over time. However, the interpretation of ice nitrate records is complicated by post-depositional effects, which can alter the isotopic composition and the concentration of nitrate preserved in ice. Quantifying these post-depositional effects is therefore an important step in the interpretation of ice core nitrate records.

We present measurements of the δ^{15}N and δ^{18}O of nitrate in ice from Summit, Greenland and South Pole, Antarctica. These cores, each spanning approximately 300 years, contain nitrate that was deposited and preserved in very different environments. Nitrate in the snow at South Pole is strongly influenced by post-depositional losses such as photolysis and evaporation. Conversely, post-depositional changes are less important at Summit, where the high accumulation rate dampens the effects of photolysis. We compare and contrast the δ^{15}N and δ^{18}O records of nitrate from both regions and explore the influences of post-depositional change on the nitrate record. For example, the δ^{18}O of nitrate in the South Pole record shows lower variability (the standard deviation of δ^{18}O is 10 per mil) than the Greenland core (the standard deviation is $\sim$14 per mil), pointing to the influence of post-depositional smoothing in Antarctic snow.

Furthermore, the δ^{15}N of nitrate in the Greenland core has an entire range of 18 per mil (from -3 to 15 per mil vs. N2), while the δ^{15}N of nitrate in the South Pole core exhibits a strong trend in the upper 20 meters of core, increasing from -4 per mil at the surface to 80 per mil at 20 meters depth. Such a strong trend in δ^{15}N is also indicative of post-depositional losses of nitrate. [For details on the Greenland core, see also Hastings et al., this meeting.]