Geophysical Research Abstracts,
Vol. 11, EGU2009-971-1, 2009
EGU General Assembly 2009

Post-depositional processing of nitrate recorded in the Vostok ice core does not care about ice ages

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The concentration of nitrate in ice cores has long been suspected to harbour information about the oxidative capacity of ancient atmospheres since nitrate stems from the degradation of nitrogen oxydes (NO_x=NO+NO_2). Nitrate concentrations are however altered by intense post-depositional loss processes at the snow surface, particularly at low accumulation sites (e.g. central Antarctica), where the longest datasets were produced. Isotopic studies can help to unravel this complex issue. We measured the comprehensive isotopic composition of selected samples of nitrate from the Vostok ice core (δ^{15}N, δ^{18}O, Δ^{17}O) and found that throughout the last 150 000 years, δ^{15}N spans a range of [89; 306]‰, δ^{18}O of [34; 66]‰, and Δ^{17}O of [23; 36]‰. The current understanding is that photochemical and physical processes are responsible for nitrate loss and thereby lead to elevated ^{15}N/^{14}N ratios in the nitrate fraction remaining in the snow. δ^{15}N consequently provides a measurement of the loss processes. The elevated isotopic enrichment observed in the deep core demonstrates that post-depositional loss processes similar in magnitude to those today occurred through the last glacial [89; 306]‰ and interglacial [155; 261]‰ periods. This implies that nitrate re-mobilization has not ceased during the last glacial as previously suggested and that the interpretation of nitrate concentration maxima during the Last Glacial Maximum needs to be revisited. In addition, dual O and N isotopic evidence provides new constraints on the respective implication of photolytical and physical loss processes.