Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 5627-5634, 2008
www.atmos-chem-phys.net/8/5627/2008/

The interpretation of spikes and trends in concentration of nitrate in polar ice cores, based on evidence from snow and atmospheric measurements

E. W. Wolff, A. E. Jones, S. J.-B. Bauguitte, and R. A. Salmon
British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK

Abstract. Nitrate is frequently measured in ice cores, but its interpretation remains immature. Using daily snow surface concentrations of nitrate at Halley (Antarctica) for 2004–2005, we show that sharp spikes (>factor 2) in nitrate concentration can occur from day to day. Some of these spikes will be preserved in ice cores. Many of them are associated with sharp increases in the concentration of sea salt in the snow. There is also a close association between the concentrations of aerosol nitrate and sea salt aerosol. This evidence is consistent with many of the spikes in deposited nitrate being due to the conversion or trapping of gas-phase nitrate, i.e. to enhanced deposition rather than enhanced atmospheric concentrations of NO_y. Previously, sharp spikes in nitrate concentration (with concentration increases of up to a factor 4 seen in probably just one snowfall) have been assigned to sharp production events such as solar proton events (SPEs). We find that it is unlikely that SPEs can produce spikes of the kind seen. Taken together with our evidence that such spikes can be produced depositionally, we find that it is not possible to track past SPEs without carrying out a new multi-site and multi-analyte programme. Seasonal and interannual trends in nitrate concentration in cores from any single site cannot be interpreted in terms of production changes until the recycling of nitrate from central Antarctica to coastal Antarctica is better quantified. It might be possible to assess the interannual input of NO_y to the Antarctic lower troposphere by using a network of cores to estimate variability in the total annual deposition across the continent (which we estimate to be $9 \pm 2 \times 10^7$ kg/a – as NO_3^-), but it will first have to be established that the outflow across the coast can be ignored.

Final Revised Paper (PDF, 344 KB) Discussion Paper (ACPD)

Citation: Wolff, E. W., Jones, A. E., Bauguitte, S. J.-B., and Salmon, R. A.: The interpretation of spikes and trends in concentration of nitrate in polar ice cores, based on evidence from snow and atmospheric measurements, Atmos. Chem. Phys., 8, 5627-5634, 2008. Bibtex EndNote Reference Manager