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Spatial variations in snowpack chemistry and isotopic composition of nitrate along a nitrogen deposition gradient in West Greenland

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The relative roles of anthropogenic nitrogen (N) deposition and climate change in causing ecological change in remote Arctic ecosystems, especially lakes, have been the subject of debate over the last decade. Some palaeoecological studies have cited isotopic signals ($\delta(^{15}N)$) preserved in lake sediments as evidence linking N deposition with ecological change, but a key limitation has been the lack of co-located data on both deposition input fluxes and isotopic composition of deposited nitrate (NO_3^-). In Arctic lakes, including those in West Greenland, previous palaeolimnological studies have indicated a spatial variation in $\delta(^{15}N)$ trends in lake sediments but data are lacking for deposition chemistry, input fluxes and stable isotope composition of NO_3^-.

In the present study, snowpack chemistry, stable isotopes in NO_3^- and net deposition fluxes for the largest ice-free region in Greenland were investigated to determine whether there are spatial gradients from the ice sheet margin to the coast linked to a gradient in precipitation. Late-season snowpack was sampled in March 2011 in three regions (ice sheet margin in the east, the central area near Kelly Ville and the coastal zone to the west). We found major differences in nitrate concentrations (lower at the coast) and deposition (higher at the coast due to higher precipitation).

The $\delta(^{15}N)$ of snowpack NO_3^- shows a significant decrease from inland regions (-5.7 ‰ at Kelly Ville) to the coast (-11.3 ‰). We attribute the spatial patterns of $\delta(^{15}N)$ to post-depositional processing rather than differing sources because of

1. spatial relationships with precipitation and sublimation,
2. within-catchment isotopic differences between terrestrial snowpack and lake-ice snowpack, and
3. similarities between fresh snow (rather than accumulated snowpack) at Kelly Ville and the coast.

Hence the $\delta(^{15}N)$ of coastal snowpack is most representative of snowfall in West Greenland, but after deposition the effects of photolysis, volatilisation and sublimation lead to ^{15}N enrichment of the remaining snowpack with the greatest effect in inland areas of low precipitation and high sublimation losses.