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# Investigating nitrate sources and export in an alpine catchment using Orbitrap-based stable isotope techniques

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Alpine ecosystems are sensitive to subtle perturbations in reactive nitrogen (Nr) availability, with high rates of nitrogen deposition in these environments linked to species composition changes, biodiversity losses, acidification, and additional changes in soil chemistry. Atmospheric deposition of nitrate ($NO_3^-$) and ammonium ($NH_4^+$) is the sole mechanism by which anthropogenic N is transported to remote alpine watersheds, with winter deposition accumulated in the snowpack acting as a reservoir of Nr that is subsequently supplied to surface waters upon snowmelt. Stable isotope techniques have been used previously to investigate the relative contributions of $NO_3^-$ deposition and soil nitrification to elevated surface water $NO_3^-$ concentrations in alpine catchments. In this study, $NO_3^-$ stable isotopic data ($\delta^{15}N$, $\delta^{18}O$, $\Delta^{17}O$) will be used to investigate the sources of $NO_3^-$ in alpine lakes and lower elevation streams in the Sangre de Cristo Mountains of New Mexico (USA), the southernmost subrange of the Rocky Mountains (North America). While $\delta^{15}N$ and $\delta^{18}O$ data provide insight to the partitioning of anthropogenic nitrate sources (e.g., agricultural emissions, fossil fuel combustion), $\Delta^{17}O$ offers unique insight to the post-depositional processing of $NO_3^-$. This isotopic signature allows for exclusive differentiation between microbial $NO_3^-$ production and atmospheric deposition. Atmospheric $NO_3^-$ forms through the oxidation of nitrogen oxides ($NO_x$) by ozone ($O_3$) and has a positive $\Delta^{17}O$ value (20-35‰) that contrasts sharply with the signature of $NO_3^-$ formed via nitrification ($\Delta^{17}O$ = 0‰). Notably, the $\Delta^{17}O$ of atmospheric $NO_3^-$ remains unaltered following deposition and subsequent environmental processing. To advance this research, we are developing a novel Orbitrap-based isotopic technique coupled with ion chromatography (IC), which stands to improve the throughput and accessibility of $NO_3^-$ multi-isotopic tracer studies. This approach, alongside $NO_3^-$ and $NH_4^+$ concentrations and isotopic data will be used to infer the sources and processes regulating $NO_3^-$ export within this previously uncharacterized watershed. By presenting isotopic data from both conventional GC-IRMS and IC-Orbitrap-MS, we demonstrate the potential of Orbitrap-based stable isotope measurements for environmental applications.