Stable isotopic identification of nitrate sources in a tundra ecosystem, Barrow, AK

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Introduction

The effect of nitrogen dynamics on release of carbon dioxide and methane from tundra ecosystems is being studied as part of the US Department of Energy Next Generation Ecosystem Experiment – Arctic project. Sampling and analysis of surface water and soil water from the active layer of the Barrow Environmental Observatory has yielded infrequent detections of nitrate, mostly in pore water from unsaturated high-centered polygons. Nitrate has also been detected late in the summer in soil water immediately above the frost table of an ancient drained thaw lake basin (DTLB).

Discussion of Results

Nitrate from high-centered polygons had $\delta^{15}N$ ranging from -9.2 to +8.5 ‰ and $\delta^{18}O$ ranging from -8.4 to +1.4 ‰. The range in nitrate $\delta^{15}N$ largely reflects the range in $\delta^{15}N$ of snowmelt nitrate and of reduced nitrogen sources including ammonium, dissolved organic nitrogen and soil organic nitrogen. The range in $\delta^{18}O$ of nitrate is largely consistent with $\delta^{18}O$ of soil water assuming that 2/3 of the oxygen in nitrate come from soil water and 1/3 comes from atmospheric O_2. No evidence for an atmospheric ^{18}O signal is seen. Following Ansari *et al*. [1], this nitrate found in high-centered polygons is interpreted as being largely derived from microbial nitrification of reduced sources of nitrogen.

Conversely, nitrate from an ancient DTLB has an isotopic composition intermediate to snowmelt nitrate and nitrate derived from bacterial nitrification ($\delta^{15}N$ ~ +2-5 ‰ and $\delta^{18}O$ ~+31 – 33 ‰). Interestingly, this isotopic signal is quite similar to that of nitrate from massive ice wedges in the Barrow area. It is unknown whether the nitrate in the ancient DTLB is derived from active permafrost degradation or represents a mixture of atmospheric and microbial nitrate.

[1] Ansari *et al* (2012) Biogeochem. DOI 10.1007/s10533-012-9761-9.