Elucidation of nitrate dynamics in a temperate region watershed with heavy snowfall using triple oxygen isotopes as tracers

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Atmospherically deposited nitrogen to the terrestrial environment due to human activity has been increased over the last decades. It is important to elucidate the response of ecosystems towards nitrogen deposition. In this study, a triple oxygen isotope approach was used as a tracer for environmental fate of atmospheric NO_3^- in a temperate forest with heavy snow for the years 2015 and 2016. The $\Delta^{17}O$ values of NO_3^- for precipitation and throughfall ranged from 22 to 32‰ and reflect the seasonal variation between summer (minimum) and winter (maximum), this is attributed to the changes in atmospheric formation pathways of NO_3^- over seasons. Based on $\Delta^{17}O$ values of NO_3^- in litter layer and mineral soil at 25, 55, and 90 cm depths respectively, calculated fraction of $NO_{3\ atm}^-$ (f_{atm}) shows that nitrification mainly occurs in the litter layer in the summer. In the winter, on the other hand, relatively high $\Delta^{17}O$ values of NO_3^- in litter layer were observed, indicating that nitrification does not occur in the litter layer due to the existence of snowmelt water. Although different f_{atm} for litter layer were observed over the seasons, f_{atm} of stream water were constant (approximately 10%) in both winter and summer. In addition, gross nitrification rates (GNR) based on f_{atm} for stream water and total NO_3^- input for this study site in summer were lower than those in winter, suggesting higher nitrification activity in winter due to higher loads of NO_3^- and NH_4^+ inputs in the latter season. So far, nitrogen and oxygen isotopic values for biologically produced NO_3^- showed no significant correlation, indicating no detectable trend of assimilation by plants and/or denitrification.

Keywords: stable isotopes, fraction of atmospheric nitrate, gross nitrification rate, biologically produced nitrate

