Nitrogen deposition and transformation along the canopy–soil continuum of a suburban forest in Japan

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Purpose and Approach

Heavy nitrogen (N) deposition often generates high nitrate (NO_3^-) storages in soils in forested ecosystems. In order to clarify the sources and transformation pathways of this NO_3^-, we monitored NO_3^- isotope values in deposition processes along the canopy–soil continuum of a suburban forest of Tokyo, Japan. We used stable isotopes of N and oxygen (O) to trace the source and transformation dynamics of NO_3^- in two types of forest stands: a plantation of *Cryptomeria japonica* (conifer; CJ) and a natural secondary forest of *Quercus acutissima* (broadleaf, deciduous tree; QA). We measured NO_3^- and ammonium (NH_4^+) concentrations, as well as $\delta^{15}N$ and $\delta^{18}O$ values of NO_3^-, in rainfall, throughfall, stem flow, litter layer water, and soil waters. Gross mineralization and nitrification rates were also measured by the pool dilution method using ^{15}N tracers.

Results and Discussion

Seasonal variations were found in the $\delta^{15}N$ values of throughfall and stem flow NO_3^- at both CJ and QA sites, and in the $\delta^{18}O$ values of throughfall and stem flow NO_3^- at the QA site. The range in the $\delta^{18}O$ values of rain and throughfall NO_3^- was large (65–70‰) but decreased rapidly to 2–5‰ in soil waters. At the QA site, $\delta^{18}O$ values of stem flow NO_3^- decreased to 40‰ during several rain events, especially in the growing season. Atmospheric NO_3^- deposition was effectively replaced by microbially produced NO_3^- mainly in the organic (litter) horizon and surface part of the mineral soils under excess N deposition in this suburban forest. Gross rate observation showed that microbial activity, including both immobilization and nitrification in organic-rich horizons near the surface, contributed to incorporating atmospheric NO_3^- quickly into the internal microbial N cycle. Additionally, we found evidence of microbial nitrification in the canopy (tree surface) of the QA stand in summer.