Geophysical Research Abstracts
Vol. 19, EGU2017-3660, 2017
EGU General Assembly 2017

Evidence for substantial forestry canopy processing of nitrogen deposition using isotopic tracer experiments in low deposition conditions

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Temperate forest ecosystems are significant sinks for nitrogen deposition (N_{dep}) yielding benefits such as protection of waterbodies from eutrophication and enhanced sequestration of atmospheric CO_2. Previous studies have shown evidence of biological nitrification and N_{dep} processing and retention in forest canopies. However, this was reported only at sites with high environmental or experimentally enhanced rates of N_{dep} ($\sim$18 kg N ha^{-1} y^{-1}) and has not yet been demonstrated in low N_{dep} environments. We have used bulk field hydrochemical measurements and labelled isotopic experiments to assess canopy processing in a lower N_{dep} environment ($\sim$7 kg N ha^{-1} year^{-1}) at a Sitka spruce plantation in Perthshire, Scotland, representing the dominant tree species (24%) in woodlands in Great Britain. Analysis of 4.5 years of measured N fluxes in rainfall (RF) and fogwater onto the canopy and throughfall (TF) and stemflow (SF) below the canopy suggests strong transformation and uptake of N_{dep} in the forest canopy. Annual canopy N_{dep} uptake was $\sim$4.7 kg N ha^{-1} year^{-1}, representing 60-76% of annual N_{dep}. To validate these plot-scale results and track N uptake within the forest canopy in different seasons, double ^{15}N-labelled NH_4NO_3 (98%) solution was sprayed in summer and winter onto the canopy of three trees at the measurement site. RF, TF and SF samples have been collected and analysed for $^{15}NH_4$ and $^{15}NO_3$. Comparing the amount of labelled N recovered under the sample trees with the measured δ^{15}N signal is expected to provide further evidence of the role of forest canopies in actively processing and retaining atmospheric N deposition.