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The impacts of long-term, high intensity N addition on the chemical composition of soil organic matter in a boreal forest

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The intense use of fertilisers for agricultural and forest management purposes as well as atmospheric nitrogen (N) deposition has changed ecosystem stoichiometry in some parts of the planet, drawing great attention to the long-term impacts of N additions on carbon (C) sequestration. Soil organic matters (SOMs) are the major sink of C in terrestrial ecosystems and hence it is essential to understand the impacts of N addition on SOM not only quantitatively but also qualitatively. In temperate and boreal forests, chronic N addition generally suppresses SOM decomposition and increases C accumulation. The potential mechanisms for this have long been discussed and yet to be unearthed.

Here, we examined the impacts of long-term N addition on the chemical composition of SOMs in boreal forests situated in northern Sweden under two vegetation types (Norway spruce or Scots pine) and a range of N addition regimes where N addition rates varied between 3 and 70 kg N ha^{-1} $year^{-1}$, duration between 12 and 32 years and total added amount between 50 and 2000 kg N ha^{-1}. Soil samples were collected from the organic layer (litter and humus layers) and analysed for the chemical composition of SOMs using two metrics: pyrolysis gas chromatography–mass spectrometry (GC/MS) and solid-state ^{13}C nuclear magnetic resonance spectroscopy (^{13}C-NMR).

We found that the chemical composition of SOMs shifted with soil C:N ratios regardless of vegetation types, or duration and rates of N addition. Preliminary results suggest that the observed shift in chemical composition in SOMs may have been attributed to altered decomposition of lignin and carbohydrate-derived compounds. This was in line with previous research conducted in the same study sites that demonstrated added-N enhanced non-enzymatic brown-rot lignin oxidation relative to enzymatic white-lot lignin mineralisation. Here, the comprehensive examination of SOM chemical composition demonstrates altered molecular characteristics of SOMs with soil C:N conditions. This may help us to elucidate the mechanisms by which N addition alters the balance of decomposition and accumulation of SOMs.