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Quantification of the effects of nitrogen deposition on carbon sequestration by forests at a global scale

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The severe perturbation of the nitrogen (N) cycle since the beginning of nineteenth century has caused an enhanced N deposition on forests. Due to N limitation in most forest ecosystems increased N deposition usually increases net primary production (NPP) thus stimulating carbon (C) sequestration in trees. Increased productivity may also increase C sequestration in the soil due to increased litter production and reduced decomposition of organic matter, depending on the stage of humus formation.

It is estimated that at present about 26% of the anthropgenic CO_2 emission is sequestered in terrestrial ecosystems, predominantly forest ecosystems. An important question is: which fraction of this global C sequestration is determined by enhanced N deposition and how will changes in N deposition affect global C sequestration? Quantification will depend on both the magnitude of N deposition and the CO_2-C response per kg N input. These C-to-N deposition-response ratios (Nitrogen Use Efficiency; NUE) are dependent on the occurrence of N limitation versus possible limitation by other factors, such as low temperature, limited water availability and/ or limited availability of other nutrients such as phophate (P). Responses thus differ between type of forest ecosystem, such as boreal, temperate and tropical forests. Furthermore, NUE will most likely decrease with N input and with time (no fixed C-to-N deposition ratios).

In this presentation, we shortly review approaches to quantify impacts N on CO_2-C exchange by forest ecosystems, including N retention measurements combined with stoichiometric scaling, C responses to N addition experiments (meta-analysis), empirical relations between spatial patterns of forest carbon uptake N deposition, while accounting for other environmental factors and large scale modelling. Ranges in CO_2-C per kg N input, are then presented for major world forest ecosystems making use of those approaches. Using these factors, a quantification is made of the CO_2-C sequestration induced by N deposition at world scale for the years 2000 and 2050 for two RCP scenarios (RCP2.6 and RCP8.5).