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Carbon and nitrogen stoichiometry in tree-derived dissolved organic matter at the Hainich Critical Zone Exploratory: First monitoring results

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In critical zone research, determination of the chemical composition, stoichiometry, and vertical distribution of tree-derived dissolved organic matter (tree-DOM) is a crucial prerequisite to initializing and running models of solute fluxes, such as carbon and nitrogen, from forest canopies to aquifers. Moreover, the monitoring of tree-DOM in mixed species ecosystems with a high temporal resolution across seasons helps to better quantify its sources in function of weather and canopy conditions as well as by species composition. Such information contributes to a deeper understanding of temporal patterns of biogeochemical processes in the critical zone.

As part of the Hainich Critical Zone Exploratory in Central Germany, eighteen plots distributed in European beech and maple mixed forests and Norway spruce stands were installed between November 2017 and February 2018 to monitor biweekly the chemical composition and quantify the input fluxes of dissolved organic carbon (DOC) and total dissolved nitrogen (TDN) via throughfall, stemflow and soil solution at four depths using free draining lysimeters in the forest floor, 0-4, 0-16, and 0-30 cm soil increments. Solution sampling and chemical analysis started mid-May 2018, which enabled us to capture the effects of the unusually warm and dry summer and autumn of 2018 on physical and chemical properties of stemflow, throughfall, and soil solutions.

During the monitoring season of 2018, stemflow, throughfall and soil solution water fluxes did not differ significantly between beech and maple plots but were higher than in spruce plots. Interestingly however, we measured at several sampling dates higher TDN than DOC concentrations in solutions from lysimeters of the 0-4, 0-16, and 0-30 cm soil increments, leading to tree-DOM C-to-N ratio < 1, under beech and maple canopies. Tree-DOM C-to-N ratio below 1 did not occur in the spruce lysimeters or in the forest floor lysimeters. Narrow tree-DOM C-to-N ratio in the deepest lysimeters indicate a source of soluble N below the rooting zone especially in the beech and maple plots. Nitrogen speciation of the soil solutions is underway to evaluate the potential of nitrate fluxes out of the rhizosphere. Preliminary results indicate a large contribution of NO_3-N to TDN fluxes. Acknowledging that the lysimeters do not contain tree roots, we attribute the recurrent high TDN concentrations in soil solution to microbial biomass turnover following rewetting during heavy rain events after long-lasting dry periods during the 2018 monitoring season.