Geophysical Research Abstracts
Vol. 20, EGU2018-15702-1, 2018
EGU General Assembly 2018

Higher belowground C allocation under eCO_2 did not improve N nutrition in beech trees but decreased soil C

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A major limitation for plant growth under elevated concentrations of CO_2 (eCO_2) is the ability of plants to increase nitrogen (N) uptake. To improve N nutrition, plants may increase their investment of photosynthetically fixed carbon (C) into N acquiring strategies, such as fine root growth, root exudation, or C allocation to mycorrhizal fungi. Because these strategies stimulate microbial activity and therefore the decomposition of soil organic matter, uncertainties on net effects of eCO_2 on future C storage remain.

To improve the understanding and quantification of the involved plant-soil C-N-interactions, we conducted an elevated CO_2 mesocosm experiment using stable isotope labeling. For four months of the vegetation period in 2016, 64 saplings of *Fagus sylvatica* L. were grown in a natural beech forest topsoil and were exposed to near ambient (390 ppm) or elevated (560 ppm) CO_2 concentrations at two levels of continuous $^{13}CO_2$ enrichment ($\delta^{13}C$ +50 or +150 permil). During the experiment, aboveground and belowground C fluxes were monitored separately with a high temporal resolution.

Under eCO_2, we found enhanced GPP rates, while plant biomass only increased marginally. However, $\delta^{13}C$ enrichments of fine roots, microbial biomass (PLFAs), and bulk soil indicated enhanced belowground C allocation of newly assimilated C under eCO_2 in these beech trees, suggesting higher plant investments into nutrient acquisition. Still, this did not fulfill the plants' N nutrition, but was rather associated with significantly lower bulk soil N concentrations, lower plant-available N, as well as lower fine root N concentrations under eCO_2. During the experiment, we observed increased soil respiration rates and at the end of the experiment, soil C concentrations were decreased under eCO_2. These findings emphasize possible negative effects of increased belowground C allocation on soil C storage under eCO_2, if N is a limiting factor.