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Investigation of soil carbon sequestration processes in a temperate deciduous forest using soil respiration experiments

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Considering the carbon cycles of terrestrial ecosystems, soils represent a major long-term carbon storage pool. However, the storage capacity depends on several impact parameters based on biotic factors (e.g. vegetation activity, microbial activity, nutrient availability, interactions between vegetation and microbial activity) and abiotic driving factors (e.g. soil moisture, soil temperature, soil composition). Especially, increases in vegetation and microbial activity can lead to raised soil carbon release detectable as higher soil respiration rates.

Within the frame of the ICOS project, several soil respiration experiments are under consideration at the temperate deciduous forest site “Hohes Holz” (Central Germany). These experiments started in May 2014. Soil respiration data acquisition was carried out using 8 automatic continuous chambers (LI-COR) and 60 different plots for bi-weekly survey chamber measurements in order to clarify the controlling factors for soil CO_2 emissions such as litter availability, above- and belowground vegetation, and activation of microbial activity with temperature, soil moisture and root occurrence. Hence, several treatments (trenched, non-trenched, litter supply) were investigated on different plots within the research area.

The data analysis of the 20-month observation period reveals preliminary results of the study. Obviously, significant differences between the trenched and the non-trenched plots concerning the CO_2 emissions occurred. Increased soil carbon releases are supposed to be associated to the activation of microbial mineralization of soil organic matter by root inputs. Furthermore, depending on the amount of litter supply, different levels of activation were observed. The data of the continuous chamber measurements with a temporal resolution of one hour sampling interval can be used to show the dependence on above described biogeochemical processes due to abiotic controlling factors. Especially, soil moisture as a driving factor influences soil respiration in a complex manner. In the dry summer 2015 decreased respiration rates compared to 2014 occurred due to lower microbial activity caused by low soil moisture.

Moreover, the chamber measurements depict also a spatial variability in soil respiration patterns within the forest site. This can be related to vegetation distribution, but also to soil moisture variations or to soil composition changes. More investigations are needed here. Supplementary information based on data of a soil moisture/temperature sensor network, ancillary analysis of trees and understorey vegetation, litter and coarse woody debris decomposition analysis, and soil samples analysis will be included into the comprehensive interpretation.