EGU21-2530
https://doi.org/10.5194/egusphere-egu21-2530
EGU General Assembly 2021

Variability in soil CO_2 fluxes across a range of forest types and edaphic conditions

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Forests play a key role in the global carbon (C) balance. On the one hand, a large amount of C is sequestered in soils, and on the other hand, the forest soils are also a significant source of carbon dioxide (CO_2). Soil respiration includes anaerobic and aerobic microbial respiration, and root respiration which may contribute even more that half of the total soil respiration. Assessment of the contribution of forest soils to CO_2 emissions, in addition to C sequestration, is worth special attention in the context of increasing climate change. To address this field experiments were carried out to assess the CO_2 fluxes of 10 different forest soil types with different tree species (deciduous, coniferous, and mixed) in Poland (using static chamber method). The highest CO_2 emissions were observed for a silty soil under the youngest deciduous forest (12 y.) with a daily average of 1.66 ± 0.7 g CO_2 m^{-2} d^{-1}. The lowest daily mean CO_2 flux was associated with a sandy soil in a mature stand of a predominantly coniferous forest (0.87 ± 0.3 g CO_2 m^{-2} d^{-1}). Annual averages were in the range 3.21 t C ha^{-1} to 6.06 t C ha^{-1} for a mature and young forest, respectively. The main factor causing differences in CO_2 emissions could have been the contribution of both trees and soil properties to hydrological conditions. The young forest was covered with trees with a lower root system forest and the young trees could have a lower demand for water resulting in a higher soil moisture content than in a mature forest soil. Different CO_2 fluxes could be also a result of a higher water storage capacity in silty soil in the young forest than that of a sandy soil under mature stand. In addition to water supply, the activity of soil microorganisms is also regulated by C availability which was about 30% lower in sandy soil than in silty soil. The two-yearly measurements showed seasonal variations in CO_2 fluxes depending on the soil type, age and tree species. Regardless of the characteristics of the forest being studied, the highest CO_2 emissions occurred in the summer or spring and the lowest CO_2 emissions were found in winter as a result of a strong influence of temperature on the biological processes under investigation. The observed seasonality in CO_2 emission may be attributed to changes in soil moisture during the measurement periods since soil water content regulates microbial activity and gaseous diffusion. Statistical analyses, however, imply that temperature could have a stronger control over CO_2

emissions from the soils studied than soil moisture.

Research was conducted under the project financed by Polish National Centre for Research and Development within of ERA-NET CO-FUND ERA-GAS Programme (ERA-GAS/I/GHG-MANAGE/01/2018) “GHG-Manage”.