Geophysical Research Abstracts
Vol. 12, EGU2010-6036, 2010
EGU General Assembly 2010

Carbon dioxide emissions of soils under pure and mixed stands of beech and spruce, affected by decomposing foliage litter mixtures

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Soil respiration is the largest terrestrial source of CO_2 to the atmosphere. In forests, roughly half of the soil respiration is autotrophic (mainly root respiration) while the remainder is heterotrophic, originating from decomposition of soil organic matter. Decomposition is an important process for cycling of nutrients in forest ecosystems. Hence, tree species induced changes may have a great impact on atmospheric CO_2 concentrations. Since studies on the combined effects of beech-spruce mixtures are very rare, we firstly measured CO_2 emission rates in three adjacent stands of pure spruce (*Picea abies*), mixed spruce-beech and pure beech (*Fagus sylvatica*) on three base-rich sites (Flysch) and three base-poor sites (Molasse; yielding a total of 18 stands) during two summer periods using the closed chamber method. CO_2 emissions were higher on the well aerated sandy soils on Molasse than on the clayey soils on Flysch, characterized by frequent water logging. Mean CO_2 effluxes increased from spruce (41) over the mixed (55) to the beech (59) stands on Molasse, while tree species effects were lower on Flysch (30-35, mixed $>$ beech = spruce; all data in mg CO_2-C m^{-2} h^{-1}). Secondly, we studied decomposition after fourfold litter manipulations at the 6 mixed species stands: the O_i- and O_e horizons were removed and replaced by additions of beech -, spruce - and mixed litter of the adjacent pure stands of known chemical quality and one zero addition (blank) in open rings (20 cm inner diameter), which were covered with meshes to exclude fresh litter fall. Mass loss within two years amounted to 61-68% on Flysch and 36-44% on Molasse, indicating non-additive mixed species effects (mixed litter showed highest mass loss). However, base cation release showed a linear response, increasing from the spruce - over the mixed - to the beech litter. The differences in N release (immobilization) resulted in a characteristic converging trend in C/N ratios for all litter compositions on both bedrocks during decomposition. In the summers 2006 and 2007 we measured CO_2 efflux from these manipulated areas (a closed chamber fits exactly over such a ring) as field indicator of the microbial activity. Net fluxes (subtracting the so-called blank values) are considered an indicator of litter induced changes only and increased on both bedrocks from the spruce - over the mixed - to the beech litter. According to these measurements, decomposing litter contributed between 22-32% (Flysch) and 11-28% (Molasse) to total soil respiration, strengthening its role within the global carbon cycle.