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Estimated fine root biomass distribution maps as a tool for regionalization of CO2 efflux in forests

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Measurements of soil respiration with portable Infrared-gas analyzers produce data of high variability and poor spatial correlation. The present study aims on the one hand to clarify the influence of sampling designs on the accuracy of spatial interpolations, on the other hand to investigate the role of stand structural parameters, especially the types of forest species, their age, root distribution and allocation. The huge small-scale heterogeneity of soil respiration, caused by the intense variability of soil moisture, root biomass, thickness of litter layer, humic horizon and stand structure accounts for the low reliability of most kriging approaches. Therefore we implemented root biomass distribution maps to improve regionalisation results with regression kriging.

Two separate measurement campaigns (MC) were carried out in an investigation site of 4.6 ha that is located in an old growth forest in the core zone of the Hainich NP in Central Germany (50°14' N, 10°00' E). The CO2 efflux was determined biweekly using sets of up to 79 closed chambers that have been arranged in a spatially nested design (first MC) and completely random (second MC). This allowed for the evaluation of scale dependency of the CO2 efflux. CO2 concentration in the chambers was determined by a PP EGM 4 infrared gas analyzer (PPM Systems, Hitchin, UK) in all cases. During the second measurement campaign, we additionally mapped all individual trees within the investigation area. For more than 3000 individual trees location, species, and diameter at breast height (dbh) were determined. Based on species and an empirical model (Ammer & Wagner 2002) their fine root distribution was estimated. The latter was used to create root distribution maps to deliver root biomass as input parameter for a regionalization approach. We evaluated the quality of these fine root distribution maps with a separate dataset.

The results underline the great within-site heterogeneity of soil respiration. The higher density of collars in the small scale level of the nested approach changed significantly the amount of the calculated annual efflux (Jordan et al., 2009). The validation result was satisfactory and proves that potential fine root biomass can be estimated by extension of the Ammer & Wagner approach. Furthermore, only ash (Fraxinus excelsior) showed a significant correlation between estimated fine root biomass and soil respiration especially in springtime whereas in general. This was neither the case for the general data set nor for other tree species. Our attempt to improve the regionalization of soil respiration using estimated root distribution maps proved to be difficult in mixed stands. However, it worked well for single tree species and might be a good tool for modeling soil respiration in homogeneous forests.

References:

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