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Regionalization of soil respiration in a beech forest based on modeled fine root biomass

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Typically, measurements of soil respiration with portable Infrared-gas analyzers produce data of high variability and little spatial correlation. It is especially difficult to model the spatial variability of soil respiration when soil parameters in the research area exhibit, as in our case, little or no spatial variability. The present study aims on the one hand to clarify the influence of different sampling designs on the accuracy of spatial interpolations, on the other hand to investigate the role of different stand structural parameters, especially the types of forest species, their age, root distribution and allocation.

Two separate measurement campaigns, each containing up to 79 collars were carried out on a research area of 4.6ha 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 a closed chamber method and CO2 concentration determination by a PP EGM 4 infrared gas analyzer (PPM Systems, Hitchin, UK. In order to clarify the scale dependency we determined soil CO2 efflux at the first measurement campaign from randomized locations using a double nested approach. Distribution of the collars for the second campaign for investigating the role of trees was random.

The results underlined the great within-site heterogeneity of soil respiration. Soil parameters did not explain the spatial variation in soil respiration. The higher density of collars in the small nests changed significantly the amount of the calculated annual efflux. For the second measurement campaign, we mapped more than 3000 individual trees, their types, breast-height-diameter and their exact location and we modelled their root distribution. The amount of the calculated potential fine root biomass was not correlated with the annual efflux of each collar, but ash trees show a significant correlation between their calculated fine root biomass and soil respiration especially in springtime.

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 account for the low reliability of most kriging approaches. Our attempt to improve the regionalisation of soil respiration using calculated root distribution maps for a regression kriging failed for the whole stand but worked for a single tree type (ash and beech) and was best during bud-break. Therefore, it might be promising for modelling soil respiration in homogeneous forests.