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Soil water content and temperature induced spatial structure of heterotrophic respiration at plot and field scale

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Heterotrophic soil respiration is known to be highly variable in space and time. The spatial structure of this carbon dioxide flux strongly depends on the spatial pattern of soil water content and energy fluxes at the boundary layer between soil and atmosphere. The goal of this study was to determine the spatial variability of soil respiration, soil water content and soil temperature and their inter-relations at plot and field scale. We simultaneously measured soil CO_2 efflux, soil water content and soil temperature at 48 locations within a 14 by 14 m plot and at 65 locations within the 60 by 190 m field site. We measured an overall mean CO_2 efflux of 2.4 g C m^{-2} d^{-1} for the bare soil, associated with a coefficient of variation of 0.32. The observed data was analysed with geostatistical means including cross-semivariograms. For the plot scale we detected a mean correlation length of 2.7 m for soil respiration. Further we found a high structural semivariance of CO_2 efflux for wet soil conditions, which is attributed to the effect of limited diffusion within the soil. The correlation length of the cross-semivariance between to soil water content and soil temperature at the plot scale is 5.9 and 3.3 m, respectively. Sequential Gaussian simulations were compared to kriging concerning their ability to reproduce the spatial structure of the measured soil respiration. The stochastic simulation is seen as an appropriate approach since it better preserved the probability density function and the variogram of the original data.