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Optimum sampling setup for chamber-based measurements of soil respiration

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Soil respiration is known to be highly variable in space and time. The temporal variabilty is quite easy to capture by simply using an appropriate frequency of automated measurements. The spatial variability, however, is more cumbersome in case representative average fluxes are required. Within this study we propose a method based on the concept of temporally persistent spatial structures to measure most accurate average fluxes with a minimum sampling effort.
We simultaneously measured soil heterotrophic respiration, soil water content and soil temperature at 48 to 76 locations within a 13- by 14-m bare soil plot for 15 measurement dates. The plot was located in an agricultural field. A standard LICOR chamber setup covering a surface area of 0.032 m2 was applied.
A geostatistical data analyses indicated a mean range of spatial auto-correlation of 2.7 m. We detected rather high coefficients of variation of heterotrophic respiration between 0.13 and 0.80, with an average of 0.33. The number of observations required to estimate average respiration fluxes at a 5% error level ranged between 5 and 123. The analysis of the temporal persistence revealed that a subset of 17 sampling locations is sufficient to estimate average respiration fluxes at a tolerable root mean square error of 0.15 g C m-2 d-1. Using only eight selected locations resulted in a respective error of 0.24 g C m-2 d-1.