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# An in situ method for real-time monitoring of soil gas diffusivity

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Soil aeration is an important factor for the biogeochemistry of soils. Generally, gas exchange between soil and atmosphere is assumed to be governed by molecular diffusion and by this way fluxes can be calculated using by Fick's Law. The soil gas diffusion coefficient DS represents the proportional factor between the gas flux and the gas concentration gradient in the soil and reflects the ability of the soil to "transport passively" gas through the soil. One common way to determine DS is taking core samples in the field and measuring DS in the lab. Unfortunately this method is destructive and laborious and it can only reflect a small fraction of the whole soil. As a consequence, uncertainty about the resulting effective diffusivity on the profile scale, i.e. the real aeration status remains.

We developed a method to measure and monitor DS in situ. The set-up consists of a custom made gas sampling device, the continuous injection of an inert tracer gas and inverse gas transport modelling in the soil. The gas sampling device has seven sampling depths (from 0 to -43 cm of depth) and can be easily installed into vertical holes drilled by an auger, which allows for fast installation of the system. Helium (He) as inert tracer gas was injected continuously at the lower end of the device. The resulting steady state distribution of He was used to deduce the DS depth distribution of the soil. For Finite Element Modeling of the gas-sampling-device/soil system the program COMSOL was used.

We tested our new method both in the lab and in a field study and compared the results with a reference lab method using soil cores. DS profiles obtained by our in-situ method were consistent with DS profiles determined based on soil core analyses. Soil gas profiles could be measured with a temporal resolution of 30 minutes. During the field study, there was an important rain event and we could monitor the decrease in soil gas diffusivity in the top soil due to water infiltration. The effect of soil water infiltration deeper into the soil on soil gas diffusivity could be observed during the following hours.

Our new DS determination device can be quickly and easily installed and allows for monitoring continuously soil gas transport over a long time. It allows following modifications of soil gas diffusivity due to rain events. In addition it enables the analysis of non-diffusive soil gas transport processes.