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Highly-resolved Imaging in aggregated soils

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Dissolved oxygen is the primary electron acceptor in soil, and the concentration undergoes consumption reactions. Oxygen transition zones results from combined effect of soil structures, water flow, oxygen transport limitations and oxygen consuming reactions. In case of higher water saturation such oxygen transition zones will result from metabolic activity, but will in turn limit or enhance such activities. A prerequisite to precisely quantify the distribution of dissolved oxygen mass is to know the water content distribution, which is an important property affecting biogeochemical soil processes. We aim not only for detecting interfaces between fully-aerobic and oxygen-deficit regions with high spatial resolution, but even for determining the dissolved oxygen concentrations in the areas of the gradient and of oxygen depletion.

Our approach to visualize and quantify water content and oxygen transition zones in soils is applying non-destructive imaging techniques to avoid the destruction of samples, which allows observations of temporal developments. The methodology is based on a combination of recently developed imaging approaches. The first is the possibility to detect dissolved oxygen concentrations via fluorescence of specific, dissolved photoluminescent molecules that act as oxygen probes when excited with UV light. Additionally we use the sodium fluorescein for imaging water content. In both setups the fluorescence light is detected with a camera, allowing for visualization of rapid changes. X-ray radiography, light transmission, and in some cases the highly sensitive and selective neutron radiography imaging, are possible alternatives to visualize water content. We are testing our set-up to estimate water content via fluorescence intensities (as shown by Bridge et al., 2007) and it was partly possible with a modulated imaging setup to visualize oxygen distributions in glass bead packs and sands.