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Measuring vertical oxygen profiles in the hyporheic zone using planar optodes

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On of the key parameters, controlling biogeochemical reactions in the hyporheic zone (HZ) is the distribution of oxygen. A reliable measurement of the vertical oxygen distribution is an important tool to understand the dynamic fluctuations of the aerobic zone within the HZ. With repeated measurements of continuous profiles, mixing of surface water and groundwater as well as the consumption of oxygen can be evaluated.

We present a novel approach for the in situ measurements of vertical oxygen distribution in the riverbed using a planar optode. The luminescence based optode measurement enables a non invasive measurement without consumption of oxygen, no creation of preferential flow paths and only minimal disturbance of the flow field. Possible atmospheric contamination by pumping pore water into a vessel can be avoided and the readings are independent of flow velocity.

A self manufactured planar optode is wrapped around an acrylic tube and installed in the riverbed. The measurement is performed by vertically moving a profiler-piston inside the acrylic tube. The piston holds a robust polymer optical fibre which emits a modulated light signal through the acrylic glass to the optode-foil and transmits the induced luminescence signal back to a commercially available trace oxygen meter. Temperature compensation is accomplished using a depth-oriented temperature probe nearby and processing the raw data within a Matlab script. Robust and unbiased oxygen profiles are obtained by averaging multiple consecutive measurements. To ensure a constant velocity of the profiler for replicating the exact measuring depths, an electric motor device is used.

First results at our test site show a variable oxygen profile down to 40 cm depth which is strongly influenced by stream level and upwelling groundwater conditions. The measured oxygen profiles will serve as input parameter for a 3D solute transport and chemical reaction subsurface model of the HZ.