

A New Optical Oxygen Sensor for Monitoring Spatio-Temporal Oxygen Dynamics at Highly Reactive Aquatic Interfaces

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We explored:

Spatio-temporal dynamics of **Dissolved Oxygen (DO)** in a highly reactive aquatic zone

Background

Despite continuous technical advancements in optical oxygen sensing, the lack of suitable technology for specific environmental monitoring applications *in situ* poses a main challenge towards an improved process understanding.

This is particularly relevant for highly reactive environments, e.g. aquatic interfaces such as streambeds, where dissolved oxygen (DO) dynamics and interlinked biogeochemical processes exhibit a high degree of temporal and spatial variability.

We developed:

miniDOS – a miniaturized Distributed Oxygen Sensor for DO profiling *in situ*

Technology

➤ further developed from Vieweg et. al (2013)

Motor and control unit

- Motorized side-firing Polymer Optical Fiber (POF), \varnothing 2 mm
- Controlled via microcontroller (in preparation)

Tubular oxygen probe

- Clear acrylic tube dipcoated with oxygen sensitive dye (PtTFPP-polystyrene matrix)
- Outer/Inner diameter: 5/3 mm

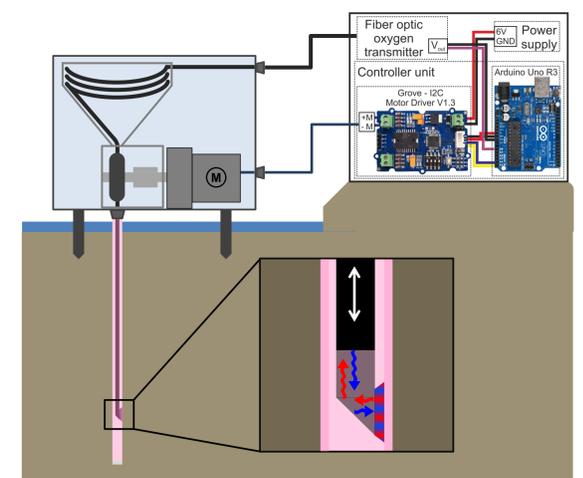


Fig. 3: Conceptual design of the miniDOS with tubular oxygen probe, motor and control unit (not to scale).



Fig. 2: Prototype of the miniDOS prior to installation *in situ*. Left panel: control unit (not shown here: power supply, fiber optic oxygen transmitter, controller unit). Right panels: side-firing POF in tubular oxygen probe.

Key features

- + Quasi-continuous vertical oxygen profiles with sub-cm resolution
- + Automated measurements
- + Fast, reliable, minimally invasive
- + No oxygen consumption
- + Minimal flow disturbance
- + Suitable for long term installation *in situ*

We found:

Distinct spatio-temporal DO distribution patterns with **sharp, persistent gradients**

Field application

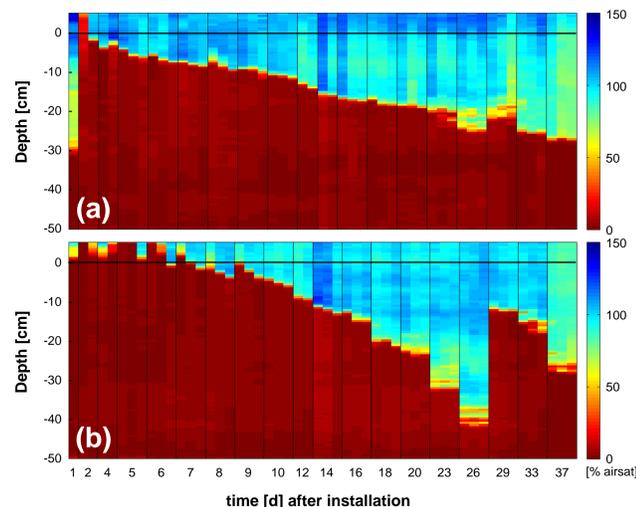


Fig. 5: Vertical oxygen distribution during cessation of surface flow (transition from saturated to unsaturated conditions) in the streambed of the Fuirosos stream (a) up- and (b) downstream of a pool-cascade sequence.

Fuirosos stream, Spain

- Seasonally *intermittent*
→ flow cessation in Summer
- Repeated DO measurements in the streambed during flow cessation (June-July 2015)
- 2 locations within 80 m reach:
(a) up- and (b) downstream of pool-cascade sequence

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Reference:

Vieweg, M., Trauth, N., Fleckenstein, J. H., Schmidt, C. (2013): Robust Optode-Based Method for Measuring in Situ Oxygen Profiles in Gravelly Streambeds. Environmental Science & Technology. doi:10.1021/es401040w

Acknowledgement:

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 607150 (FP7-PEOPLE-2013-ITN – INTERFACES - Ecohydrological interfaces as critical hotspots for transformations of ecosystem exchange fluxes and biogeochemical cycling).