In Situ Hyporheic Oxygen Dynamics during Drought Revealed by Novel Optical Sensing Technology

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We explored:

Spatio-temporal dynamics of **Dissolved Oxygen (DO)** in the Hyporheic Zone (HZ) of an intermittent stream during drought

Field site

Fuirosos stream, Spain

- Seasonally *intermittent* third order stream
- Permeable streambed, impermeable bedrock

- Repeated DO measurements in the HZ during cessation of surface flow (June - July 2015)
- 2 locations within 80 m reach:
  - up- (*HZup*) and downstream (*HZdown*) of pool-cascade sequence

Fig. 1: Locations of repeated DO measurements in the HZ of the Fuirosos stream: (a) upstream and (b) downstream of pool-cascade sequence with

We developed:

miniDOS – a **m**iniaturized **D**istributed **O**xygen **S**ensor for DO profiling *in situ*

Technology

➢ further developed from Vieweg et. al (2013)

Motor and control unit

- Motorized side-firing Polymer Optical Fiber (POF), ø 2 mm

Tubular oxygen probe

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

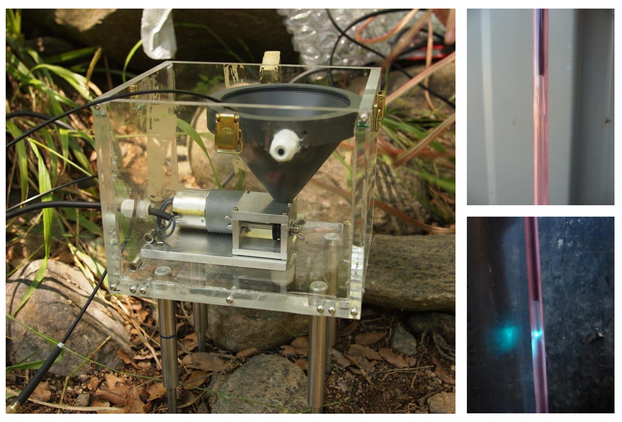

Fig. 2: Prototype of the miniDOS prior to installation *in situ*. Left panel: control unit (not shown here: power supply, fiber optic oxygen transmitter, controller unit). Right panels: side-firing POF in tubular oxygen probe.

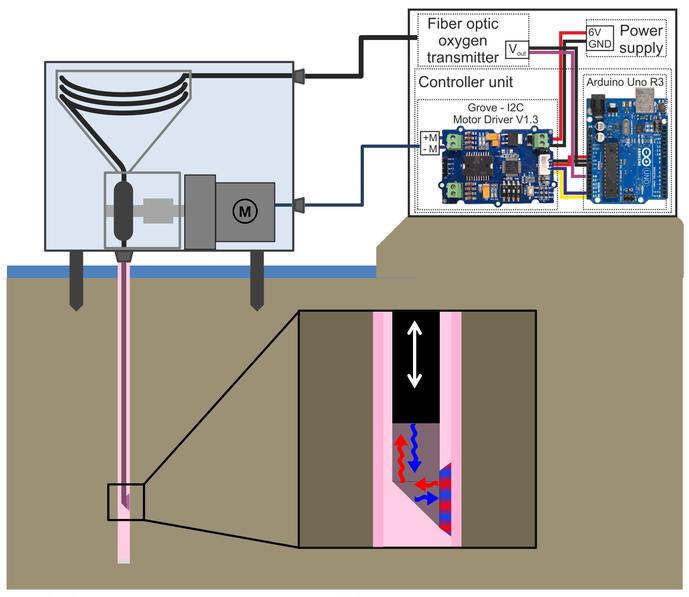

Fig. 3: Conceptual design of the miniDOS with tubular oxygen probe, motor and control unit (not to scale).

Key features

+ Quasi-continuous vertical oxygen profiles with sub-cm resolution
+ Automated stand-alone measurements
+ Fast, reliable, minimally invasive
+ Suitable for long term installation *in situ*

We found:

Sharp, persistent DO transition zone that is controlled by changing hydrological conditions

Results

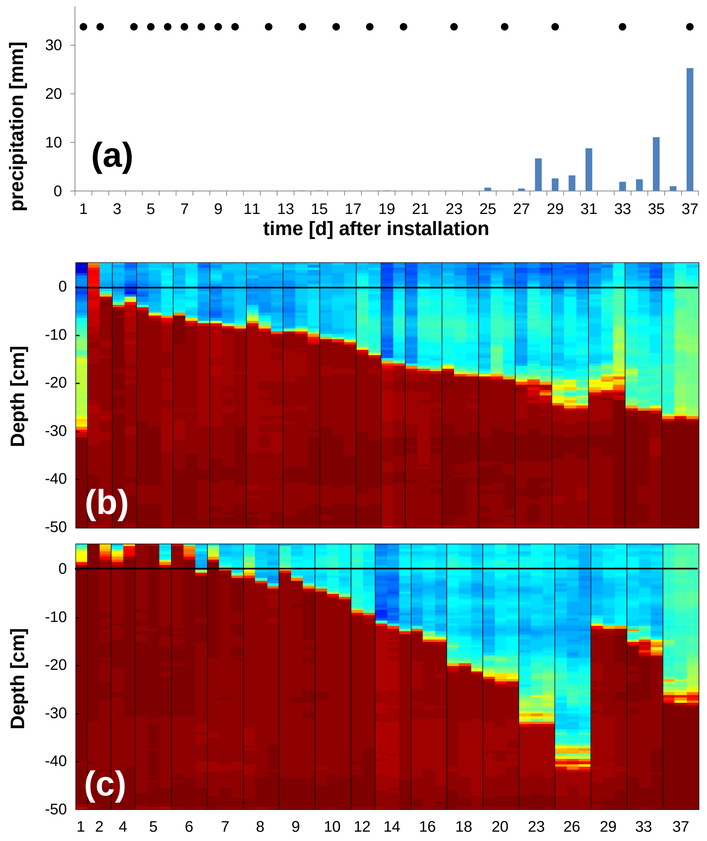

Fig. 4: (a) Schedule of repeated DO measurements (black circles) at both locations and precipitation on location (La Battloria, Spain) and vertical oxygen distribution during cessation of surface flow (transition from saturated to unsaturated conditions) in the streambed of the Fuirosos stream (b) up- and (c) downstream of a pool-cascade sequence.

- Sharp, persistent DO zonation that is controlled by changing water level
  - ➢ water level indicates oxygen zonation
- Rewetting events reduce sharpness DO transition zone
  - ➢ Indication of hot moments of biogeochemical activity upon rewetting of dry streambed

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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

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