The sediment is breathing, but how much?

Geerts Luna[1], Burdorf Laurine[2] and Meysman Filip[2,3]

[1] Department of Biology, Universiteit Antwerpen, Campus Drie Eiken, Universiteitsplein 1, 2610 Wilrijk, België
E-mail: luna.geerts@student.uantwerpen.be
[2] Universiteit Antwerpen: Onderzoeksgroep Ecosysteembeheer (UA-ECOBE), Universiteitsplein 1, 2610 Wilrijk, Belgium
[3] Technische Universiteit Delft (TUDelft), Postbus 5, 2600 AA Delft, Netherlands

Marine sediments exert an important control in marine ecosystems: the exchange of nutrients and trace elements between sediments and the overlying water can have dramatic effects on coastal and lake ecosystems (e.g. oxygen depletion, eutrophication). A fundamental parameter to characterize the activity of marine sediments is the amount of oxygen it consumes. Oxygen regulates many biogeochemical cycles and their processes, one example is it's role as the ultimate electron acceptor which in turn affects carbon burial rates in the carbon cycle. By measuring oxygen consumption, we can get a glimpse into biogeochemical processes that occur, as well as the status of the sediment. Since it is a necessity for all higher life forms, it also proves to be an excellent tracer for biological activity. Despite it's importance, the quantification of oxygen consumption rates is as of yet not well established.

In this project we aim to advance the quantification methods commonly used in sediment geochemistry by offering an open, user-friendly R environment, package and web-based, grounded on two established methods (Fick's diffusion law, PROFILE) and one newly implemented method in pore water analysis (Savitzky-Golay).

To test the quantification methods, we built a model which can generate artificial vertical oxygen profiles, with known oxygen fluxes to the overlying water. For now we are only considering DOU (diffusive oxygen uptake rates) which is a subset of the TOU (total oxygen uptake). TOU and DOU should be equal however in the absence of macrofauna. This way we could identify which technique is most accurate, contains the least biases and which are most vulnerable to noise and under-sampling.

Furthermore, we generated and quantified oxygen consumption of 48 oxygen profiles, and found that Fick's diffusion law is most vulnerable to under sampling whilst PROFILE overestimates high oxygen fluxes, Savitzky-Golay outperforms both Fick's diffusion law and PROFILE in all cases thus far.

Whilst further testing is needed for conclusive results. We are eager to finalize and publicize the open-source R-script and model on https://github.com/ for everyone to use.

Keywords: Oxygen; DOU; Modeling; Quantification; TOU; PROFILE