Development of an in situ measurement protocol for volumetric oxygen consumption rates in permeable sediments

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Objectives

- Compare the results of the novel optode-spot exetainer method with flow-through reactors.
- Measure volumetric oxygen consumption rates during winter and summer.
- Visualize oxygen profiles and consumption rates along a sandy beach transect.

Introduction

Sandy sediments cover up to 70% of continental shelf areas. Sandy beaches, characterized by high permeability, allow for increased seawater advection, transporting solutes and particles from the water column into the sediment. Sand microbial communities serve as natural bio-catalytic filters, using oxygen from advected seawater to remineralize organic matter. Sediment incubated flow-through reactors allow for quantification of such rates by reducing complex transport processes into a measurable one-dimensional concentration gradient. It is, however, a low throughput method. Thus a novel in situ measurement protocol for volumetric oxygen consumption rates was developed and compared with flow-through reactor derived rates. The novel optode exetainer method was then used to measure winter and summer rate profiles.

Introduction

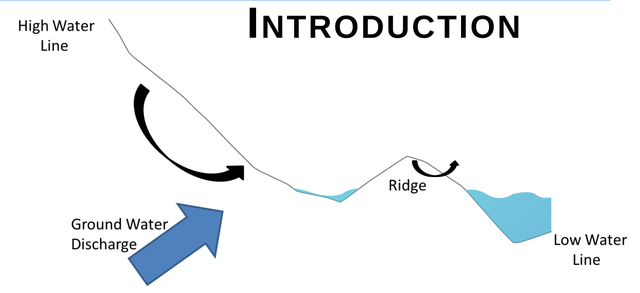


Figure 1A: Low tide body circulation

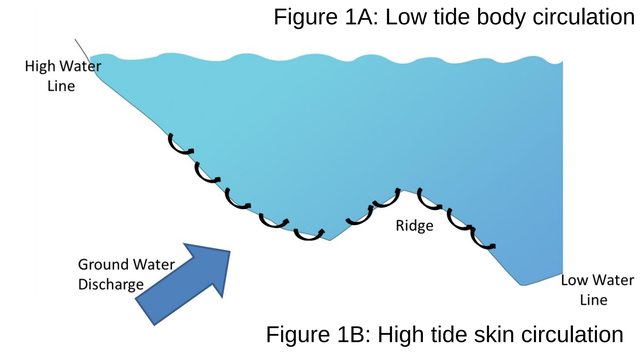


Figure 1B: High tide skin circulation

Results

Seasonal oxygen consumption rates

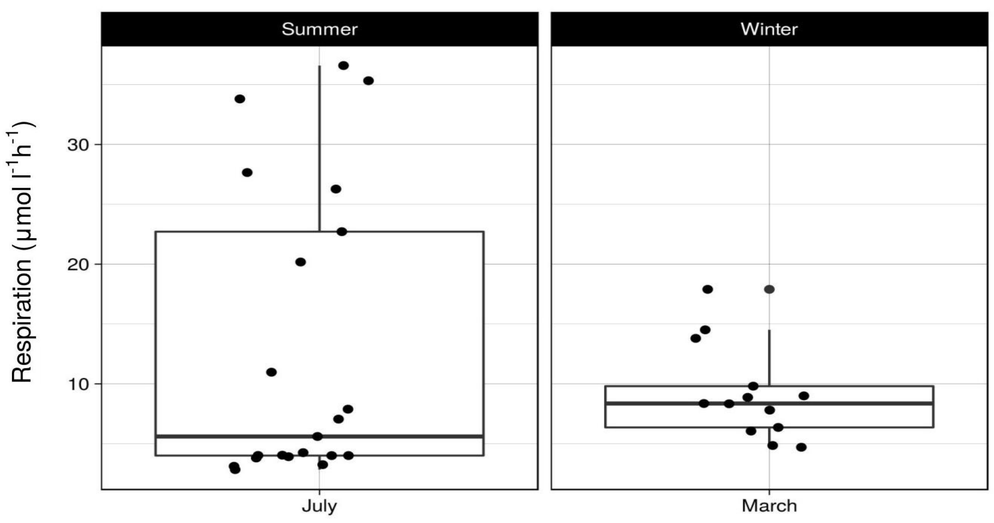


Figure 2A: Shows winter and summer rates. Winter rates are slightly higher. Larger variability in summer rates, (Objective 2).

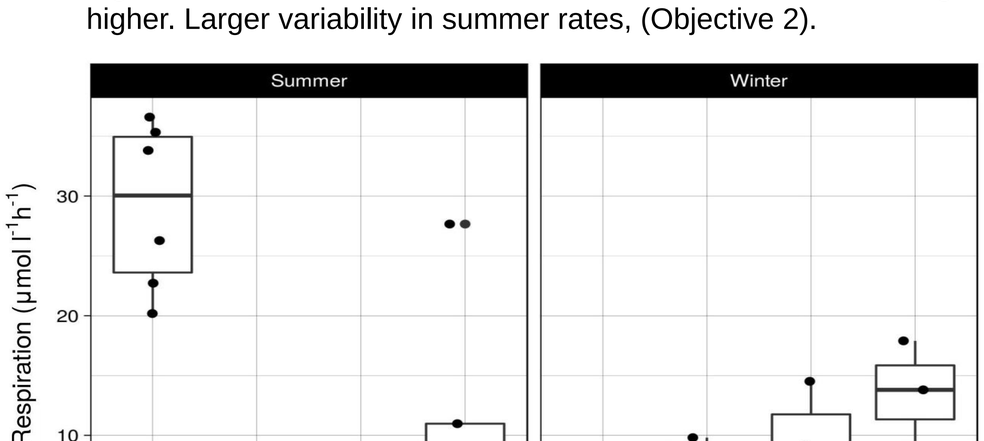
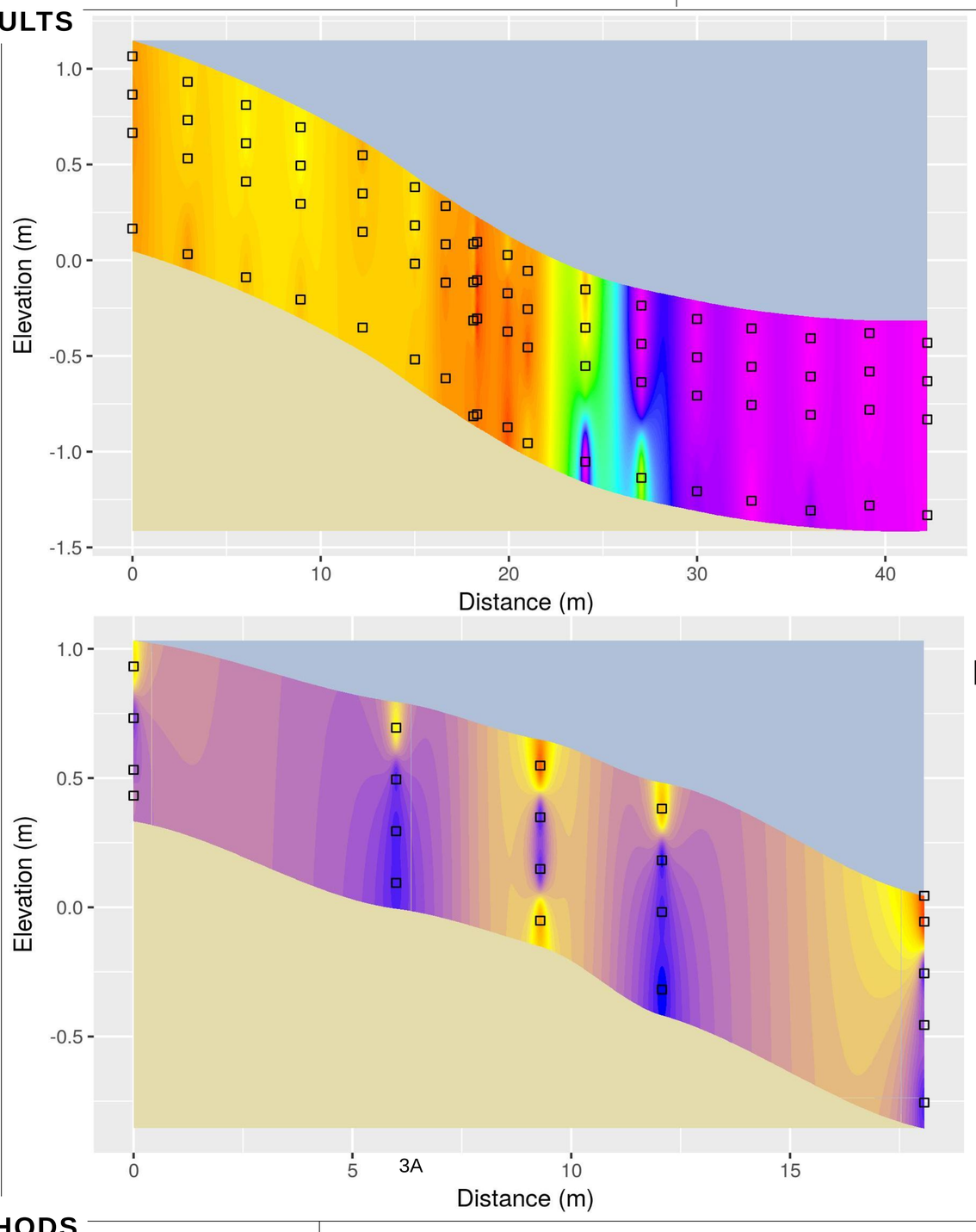


Figure 2B: Depth fractionated rates. Highest rates in summer surface sediment. Winter rates tend to increase with depth.



Oxygen profile

Figure 3A: Interpolated winter oxygen profile along a sandy beach transect, (Objective 3).

Respiration profile

Figure 3B: Interpolated summer oxygen consumption rates along a sandy beach transect.

Results

Respiration rates

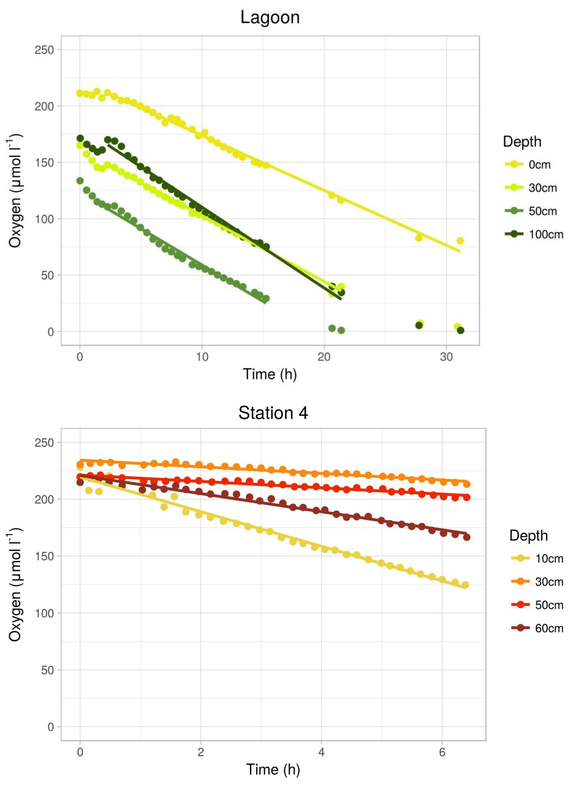


Figure 4: Example oxygen respiration rate data. Sample winter depth profile (above). Summer depth profile (below).

Methods

Method comparison

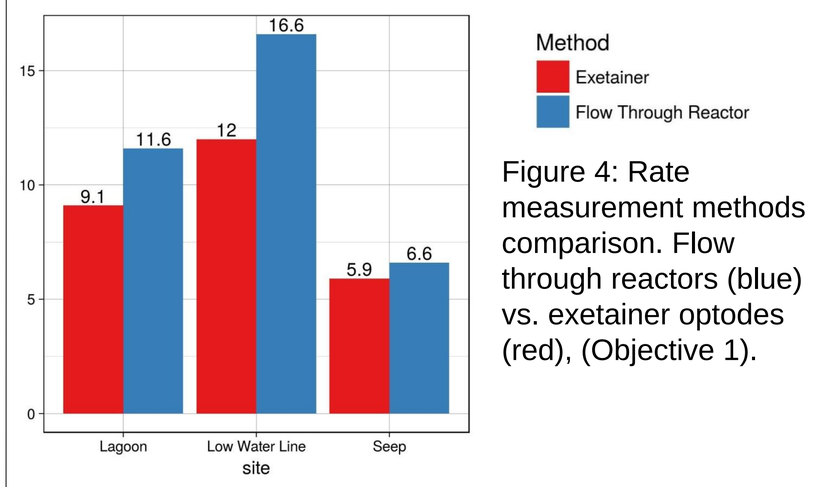
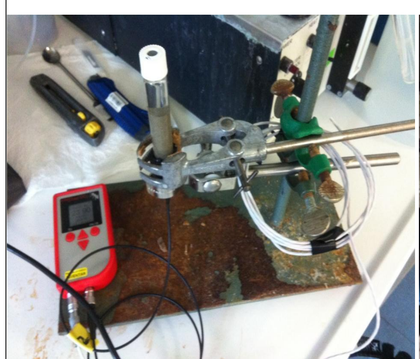


Figure 4: Rate measurement methods comparison. Flow through reactors (blue) vs. exetainer optodes (red), (Objective 1).

Exotainer optode



Flow-through reactor

Conclusions

Method comparison:

- The novel exetainer optode method allows for easier and faster measurements than previously used flow-through reactors, allowing for multiple samples with multiple depths.
- Exetainer optode derived rates are slightly lower than flow-through reactor rates.

Seasonal respiration rate profiles from a winter and summer profile:

- Average respiration rates are similar in winter and summer, but more variable in summer.
- The deepest rates were mostly constant in both seasons, but increase slightly with depth in winter.
- The highest respiration rates are in the summer surface sediment, likely resulting from increased fluxes of organic matter due to skin or body circulation patterns.

References

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