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# Comment on bg-2021-151

Dirk de Beer (Referee)

Referee comment on "Technical note: Novel triple $O_2$ sensor aquatic eddy covariance instrument with improved time shift correction reveals central role of microphytobenthos for carbon cycling in coral reef sands" by Alireza Merikhi et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-151-RC1, 2021

This is an interesting and well written method paper. Although a method paper, some observations are thought-provoking. The ecological aspects may deserve a dedicated paper rather than 'hiding' the data in a technical note.

Important is if the more complex method is better, and worth the extra costs and effort. In the end the results with 3 sensors are similar those from the 2 sensor design, so would the conclusion be that 1 is enough? Line 164 states that the differences were not statistically significant. The advantages of the 3 sensor system is at the moment not well explained. This is my main issue with this manuscript.

The introduction is complete, but the focus could be a bit shifted. It should start with the method rather then the carbonate sands in reefs, as the method is more generally applicable than in reef sands. The strength of the eddy covariance method is that it can measure exchange fluxes with all benthic ecosystems, with few exceptions, and from those fluxes infer metabolic activities. As the paper describes an improved method, the current issues should be better introduced. At the moment designs with 1 and 2 sensors are used. The reasoning for using a 3th sensor should be better explained. My understanding is that the variations in flow direction make it difficult to link the local flow direction and speed to the local oxygen concentration, as the flow and concentrations are measured a few cm apart. The corrections are now made by continuously time-shifting the oxygen signal by the measured flow speed and direction, and thus synchronize both. This is apparently not perfect. Exactly how 3 sensors can improve things should be described in detail, best with sketches.

The habitat in which the tests are done seems not the most challenging, as the flow direction is rather constant. Not much wave action occurs at 10 m depth.

The method deserves better explanation. Fig. 1 is good in the sense that is complete, but

one needs a microscope. Crucial parts need to be magnified: the yellow cylinder and red triangle in 1b (in my high quality printout an amorphous colored little blob), the yellow ring in 1c is invisible, 1d can be omitted as it has no information. Is the pink stuff in 1a an error or something real?

A mathematical proof is needed for the crucial assumption that the average of the 3 sensors is the concentration in the geometric center of the sensors. This is crucial for the paper and should be provided. From Fig 8 one can see that a lot of detailed post processing is needed to get to the average!

Comparing Fig 2 and 4, there seems to be no relation between ecosystem activity and hydraulics. There seems a relation between the integral of the irradiance (photons/day) and both productivity at day and the respiration at night. Would be good to do some calculations on this. Would be indeed logical and understandable if the metabolic activity, including respiration at night, is controlled by the light input.

The cited numbers in L 211 and 212 are 1000x off. Actually Koopmans measured similar (to this study) metabolic rates in an equally illuminated, also oligotrophic, ecosystem. That the two ecosystems, although totally different (seagrass canopies versus reef MBP), are similarly productive at the same light level seems meaningful. Both benthic photosynthesis and respiration are controlled by light input.

The oxygen exchange rates measured in this study are well in the reported ranges. These ranges are very wide. L 195 states 'matching or exceeding', but rates are truly about average, sometimes below, sometime above average (see Fig 6).

It is interesting that small eddies can transport oxygen in a different direction as big eddies. These go thus in different directions. Can a physical interpretation be given for this phenomenon, and an indication of their sizes? The big eddies persist for several hours, is that correctly understood? This phenomenon, if true, requires a larger discussion, as it may have a large impact on the interpretation of such data.

Some minor points:

The ecosystem is net autotrophic, and since no organic deposits are build up, the produced organics must be exported. Any suggestions how?

‘elevation’ in legend Fig. 8 must be defined and explained.