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Comment on bg-2021-151

Conrad Pilditch (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-RC2, 2021

Overall this is a very interesting paper and one I enjoyed reading very much. It tests whether adding additional O_2 sensors to an eddy-covariance instrument improves aliasing in data due to the separation of velocity and O_2 sampling locations. Given the increasing use of eddy covariance measurements to estimate benthic primary production/respiration at scale technological improvements are timely and welcome. I am very supportive of this paper however there are a number of elements that if considered in revision could improve the focus and clarity of the manuscript.

My main comment addresses the multiple elements to this paper. It seems to bounce around between a confirmation of the fact that shallow water permeable carbonate sands are hot spots of benthic primary production and organic matter processing and testing whether additional O_2 sensors improves the precision of flux measurement. Given the paper is submitted as a technical note it could be improved (and shortened) by focusing on the increase in performance of adding additional sensors. The sections of the paper discussing the high production/respiration rates of carbonate sands confirms previous studies (see Fig 6) and in my opinion distracts from the method which is generalizable to many systems. If using eddy-covariance techniques I would want to know exactly what gains could be made by adding sensors as the additionally increases costs and/or may reduce the ability to spatial replicate units. These trade-offs are import – is it more important to increase the precision at one location or potentially increase the number of locations at which flux measurements are made to assess spatial variability? So the questions I would like answered explicitly are what improvements are made my adding sensors in terms of precision and do these improvements vary with hydrodynamic setting (eg. uniform steady flow vs more wave dominated flows), do these improvements really matter in system with high natural variability in fluxes and what other conditions/settings need testing to confirm the value of sensor additions. Revising the manuscript (mainly editing the Introduction/Discussion) with this comment in mind I think would result in a much more assessable paper with a tighter focus. In short make the technical note more about the method than the system in which it was tested.

Specific Comments

- Ln 160 Please provide more detail on what data was used in t-test comparing the 3OS and 2OS. The DF indicates 7 data points – were these the average of the 15 min blocks across the four sample dates? I am assuming that both the 3OEC and 2OES systems were synched so perhaps a better test may have been a paired t-test where you ask whether the difference between the data is <> than 0.
- Line 165 Two sentence paragraph that does not make sense on its own
- Fig 3 – Add the p values for the regression statistics and clarify what data is being average for each of the visible data points. If the data represents averages of 15 min intervals then surely there is a variation in mean current velocity between intervals that should be plotted as an error term? I would also like to see what if any difference results from the generated PI curves from the 2OEC and 3OEC systems – are the fits better (r^2) are the fitted parameters known with greater precision and does this matter?
- Fig 5 Are there any corrections applied to data in the (a)? That is, is the variation observed between individual sensors a function of sensor performance vs data that has not been corrected for R, S, T & W.
- Line 180 The order is a little illogical – when looking at Fig 5 c&d I see a T correction was included in the 3OEC data processing – yet in the Introduction it was emphasised that the advantage of using 3 sensors was to avoid needing to do this. It is not until the Discussion that this is discrepancy is explained. I would suggest that Fig 8 & text goes into the Results to explain/justify this correction. Alternatively improve the legend to Fig 5 and point to the Discussion for explanation.
- As mentioned above the Discussion might be better focused on the comparisons between sensor configurations. To aid this the authors could consider adding a summary table that summarises the increased in precision and compares this the natural variability and provide some 'cost-benefit' analysis for investigators. Are there conditions where a 1 or 2 sensor system may give similar results to a 3 sensor system and where should researchers favour a 3 sensor system?