Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2017-340-RC2, 2017

Interactive comment on "Continuous measurement of air-water gas exchange by underwater eddy covariance" *by* Peter Berg and Michael L. Pace

Anonymous Referee #2

Received and published: 23 September 2017

The manuscript by Peter Berg and Michael Pace investigates air-water gas exchange at three shallow river sites. The authors focus on the determination of oxygen and temperature exchange by using the eddy covariance technique on a floating platform to assess gas exchange coefficients. The major findings show that oxygen dynamics (on an hourly scale) are largely independent of current velocities and biological activity; instead oxygen dynamics are driven by heat exchange, i.e. changing oxygen saturations. Furthermore, the authors point out the importance of high resolution temperature measurements to correct for the oxygen sensor specific temperature sensitivity.

The manuscript is well written / structured and of interest for a broader readership as the results have important implications for the growing community that uses the aquatic eddy covariance technique. The approach to determine gas exchange coefficients using the temperature+oxygen eddy covariance technique is also a methodological advance. However, the manuscript is lacking some important details and it would benefit from a more in-depth analysis of the interesting and promising dataset. The heat-exchange driven oxygen fluxes are only masking the more interesting biogeochemical processes and are overemphasized. In the current version, the discussion about the temperature bias raises more questions than it actually resolves. See below for a detailed argumentation.

Argumentation

1. One of the key findings and also a major part of the discussion is that heat exchange is driving most of the oxygen dynamics in shallow-water rivers. This is reasonable on timescales of hours, however, the physical process is only masking the biogeochemical processes which are still occurring and which are of importance. Based on the dataset it should be easily possible to distinguish between the biologically induced oxygen fluxes and the heat exchange induced oxygen fluxes. On the long run, the heat exchange induced fluxes should also average out implying a limited role for net exchange fluxes. When the authors follow my recommendation they could subtract the heat exchange induced oxygen flux from the total flux. I am convinced that this procedure will reveal good correlations with parameters like flow velocity and biological activity.

2. The effect of temperature fluctuations on the oxygen measurement is convincing but in the current version of the manuscript it raises several question that need to be addressed:

Resolution: The authors are discussing the response time of the temperature sensor, which is indeed in the range of the oxygen sensor. However, the sensor tip is much thicker (8mm, line 154) which implies that the spatial resolution is limiting the minimum

eddy size, i.e. frequency, that can be resolved.
Sampling Rate / Correction Procedure: The “real” sampling rate of the oxygen sensor and temperature sensor differ as the response times are slightly different and there is also a distance between the two sensors. How did the authors ensure that the temperature measured is similar to the one at the oxygen sensor tip? Did the authors also apply a time shift correction?
Range of Error: The example depicted in Figure 6 indicates that in the case of systems with large heat exchange, basically all measurements without temperature-correction are wrong. Therefore, this kind of correction needs a careful assessment. It would be interesting to see the temperature correction applied in Figure 2 for the hourly oxygen fluxes.

Figure / table / line specific comments
Figure 5: It is of interest to present the missing correlation between the gas exchange coefficient and flow velocity, however this should be contrasted by an existing correlation. An example could be the comparison of the temperature gradient versus the gas exchange coefficient. This correlation would strengthen the argumentation.
Table 1: Most of the oxygen flux is driven by heat exchange, which shows most of its variation on a daily basis. The presented oxygen fluxes are averaged in time intervals of 1 hour – 12 hours and are, therefore, strongly biased. As a result the variability within the oxygen fluxes is arbitrary as it only depends on the cut-off time.
Line 103: many studies
Line 135: It is not very convincing that a floating platform is stable when fixed as described. Actually, I would expect movements that are in the range of the eddies that carry the oxygen signal.
Line 185 and 196: How accurate was the positioning / how big was the sensor tilt? It is not clear if the correction for the sensor tilt was performed or not.
Line 210: It should be stated in which range the time shift is. Considering the very constant flow velocity and the known response times it should be possible to calculate

it. The time shift should not be bigger than the time it needs to travel from the ADV measuring volume to the sensor tip + response time!?
Line 219: Equation 3 is not adequately described, what does the second term imply, how is it measured, what is the range relative to the eddy covariance flux.
Line 239: To my knowledge “lumped” is not a statistical method.

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