Response to Anonymous Referee #2:

Based on comments from Referee #2 we plan to revise our manuscript as outlined below. All comments from the Referee are written with 'Italic' font. Our responses are written with 'normal' font.

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.

We thank the Referee for the positive and constructive overall evaluation.

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.

We agree that physical processes are "*masking the biogeochemical processes which are still occurring and which are of importance*", but we do not understand how "*it should be easily possible to distinguish between the biologically induced oxygen fluxes and the heat exchange induced oxygen fluxes*". We agree that this would be desirable but we cannot see a way to split the total O_2 flux that we measure into these two components. It is suggested to "*subtract the heat exchange induced oxygen flux from the total flux*". How do we quantify the heat exchange induced O_2 flux? Maybe this suggestion is rooted in misreading Fig. 3 which shows the actual heat flux, and not the heat exchange induced O_2 flux?

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:

Referee #1 echoed this point too, stating that important details on the effect of temperature fluctuations were missing, or not explained adequately. Please see our response to Referee #1 and the additional information below.

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.

The diameters of the thermistor and the active O_2 sensing foil are ~1 mm and ~5 mm, respectively, and the thermistor is positioned ~2 mm away from the edge of the foil. These dimensions should be considered in relation to the measuring volume of the Acoustic Doppler Velocimeter (ADV) which has a 14 mm diameter and is 14 mm tall. In that light, the limiting factor of what eddy sizes, or frequencies, can be resolved is associated with the ADV and not the dual O_2-temperature sensor. We can explain this point in more detail.

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?

The response times reported in Berg et al. (2016) are 0.34 s for temperature and 0.51 s for O_2. Because of that, and because of the slightly different distances from the thermistor and O_2 sensing foil to the center of the ADV's measuring volume, we applied independent time shift corrections for the heat flux and the O_2 flux. We did explain how the time shift was performed for O_2, and suggest that we add in our revised manuscript that the correction was done independently for heat.

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.

Again, Referee #1 echoed this point. Please see our response to Referee #1 and the additional information above and below. All O_2 fluxes we report, except some of those in Fig. 6, are temperature corrected. We can state this stronger in Section 2.3 where we describe our flux calculation protocol. Also, as suggested we can add non temperature corrected O_2 fluxes (as small black dots on top of red bars) in Fig. 2 to illustrate the importance of this correction.

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.

We do not understand the first suggestion here. With respect to showing the gas exchange coefficient vs. the temperature gradient (the vertical one?), unfortunately we do not have any temperature measurements down through the very top of the water column, but this would indeed be an interesting analysis to make in future studies.

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.

We disagree that our tabulated O_2 fluxes are "strongly biased" and that their variability is "arbitrary" and "only depends on the cut-off time". In Section 3.2 we stated specifically that the fluxes in Table 1 and the derived gas exchange coefficients represent periods of time with several successive 15-min time intervals that had little variation and appeared to represent a particular field condition. We don't know how to address this point any better.

Line 103: many studies.

We can fix this typo.

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.

As we state in Section 2.2, all sites were picked to have a smooth and quietly flowing water without standing riffles or waves. We regard our tests as proof-of-concept deployments and aimed carefully at keeping the field conditions as simple as possible. We didn't observe any vertical movements of the platform, or even eddies distorting the air-water interface. Although less critical for the flux calculation, we did not observe any lateral movements of the platform either due to the two-point anchoring system we used. We can expand the explanation of this in Section 2.1.

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.

It is difficult to put a number on this sensor tilt, but for the deployment featured in Figs. 2 and 3, the average rotations with horizontal to nullify the mean vertical and transverse velocity was only 1.3 degrees and did not affect the flux calculation flux. We can add this information in Section 3.1 where we present this deployment.

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!?

Due to a micro boundary layer forming on the O_2 sensing foil, the actual time shift found as described in Section 2.3 is slightly larger than suggested by the Referee. Again, for the deployment in Fig. 2, the averaged time shift equaled 1.3 s. We can add this information in Section 3.1 where we present this deployment.

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.

We agree, Eq. 3 was not adequately explained. We can correct this and also provide an average number for the magnitude of the storage relative to the eddy flux as suggest by Referee #1.

Line 239: To my knowledge "lumped" is not a statistical method.

Please note that we do not claim that. We find that the description of how to generate 8 Hz data from 64 Hz data is sufficient.