

Earth Syst. Dynam. Discuss., referee comment RC2
<https://doi.org/10.5194/esd-2021-30-RC2>, 2021
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Comment on esd-2021-30

Anonymous Referee #2

Referee comment on "Accounting for surface waves improves gas flux estimation at high wind speed in a large lake" by Pascal Perolo et al., Earth Syst. Dynam. Discuss., <https://doi.org/10.5194/esd-2021-30-RC2>, 2021

The authors analyze the enhancement of gas exchange velocities by surface waves in large lakes and explore the performance of a broad range of empirical and mechanistic models to predict this dependence based on wind speed and fetch length. As the authors point out correctly, the effect of surface waves on gas exchange is neglected in most studies, and observations are largely lacking – particularly in lakes. By analyzing CO₂ flux measurements obtained during different seasons in Lake Geneva, the authors demonstrate, that waves have a potentially significant influence on gas exchange velocity and gas fluxes in large lakes, although sufficiently large waves occur during rare events only.

The manuscript addresses an important research gap and makes an original contribution to advancing the prediction of gas exchange in numerical models. It is well written and organized. The largest shortcoming of the study is certainly the lack of wave observations (wave height was derived from wind speed using a model adopted from marine systems). Apparently there are only very few wave measurements from lakes available. I suggest that the authors emphasize this issue in their discussion and mention the need for direct wave observations in lakes in future studies. As listed below, I have a few additional comments, which can be addressed in minor revisions of the manuscript.

Detailed comments:

- L. 31: "...these approaches suffer from limited time and space integration..."
I don't think that this applies to EC measurements.
- L. 52: "with order larger than unity"

consider rewording

- L. 135: I suggest being more clear here: the wind observations of Simon showed that the JONSWAP parameterization did not hold for wind speed > 5 m/s
- L. 144-47: I cannot really follow the argumentation using the standard deviation. Maybe this needs to be explained in a better way. Besides leakage of the chamber in a wavy environment, there can also be flux enhancement by artificial (chamber-generated) turbulence.
- L. 173: there is a square missing in the equation for surface shear stress
- L. 334 (and elsewhere): I'm not sure if the cumulative k is a very illustrative quantity (as the numbers are kind of meaningless). Did you consider analyzing the cumulative mean values of k instead? (cumulative sum normalized by number of observations)
- L. 171: missing word
- L. 173 (and elsewhere): when discussing the frequency of occurrence of waves exceeding a certain height and corresponding enhancement of k and fluxes, it is important to keep in mind that these estimated are site-specific (within the lake). I suggest that the authors briefly discuss to what extent the observations made at the platform are representative for the entire lake. Given the distribution of wind directions and lake geometry – are there sites where wave can be expected to make large/smaller contributions?
- L. 407 ff.: how well do the monthly mean $p\text{CO}_2$ values represent the conditions during high wind speed (high waves)? As pointed out later, $p\text{CO}_2$ could be expected to be much higher (entrainment) or much lower (depletion of CO_2 in the surface layer due to strong outgassing) during these events. Do the authors have observations from such events?
- I suggest to add the observed fluxes to Table 3 to allow others to use or to reproduce the results presented here.
- L. 442: "estimate an average fetch value depending on the wind direction and the geometry of the lake"
But the dependence of k on fetch is non-linear ($\text{fetch}^{1/3}$). Should the spatial averaging take this into account?