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Interactive comment on "Drivers of diffusive lake CH_4 emissions on daily to multi-year time scales" *by* Joachim Jansen et al.

Anonymous Referee #1

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L 33 : Statement "A significant portion of sediment-produced CH4 reaches the atmosphere by turbulence-driven diffusion-limited gas exchange" is misleading and term "significant" is conveniently vague. The synthesis of CH4 fluxes from inland waters given by Bastviken et al (2011) and cited by the authors provides a total diffusive flux of CH4 of 9.9 TgCH4/yr that is much smaller than the total flux of 103.3 TgCH4/yr. I suggest that authors be more specific and introduce quantitatively the importance of diffusive CH4 fluxes from inland waters.

L36: Chambers also "traditionally" capture CH4 ebullition fluxes in addition to diffusive fluxes.

L44: DelSontro et al. (2018) estimated global (and not regional as stated) CH4 emissions based on a statistical (and not "process-based" as stated) approach.

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L 52: the formulation of equation (1) was given by Liss and Slater (1974) well before Wanninkhof (1992).

I have the impression that methane oxidation is the main process “that dissociate[s] production from emission rates”, it’s odd this is not mentioned in section L69-83.

L141-143: Can you please elaborate this section ? It’s unclear how the effect of artificial enhancement of turbulence was discarded, and how the citation of the Ribas-Ribas et al. paper is relevant in this context, since this technical paper describes an apparatus to measure fluxes with chambers.

L164: It’s strange that only one standard was used to calibrate the GC-FID (a multipoint calibration curve is recommended, Wilson et al. 2018), and the value of standard is so low compared to the sample values, as pCH4 in the headspace was » 2 ppm, as shown in Figure 2. Authors should provide an accuracy and precision of the CH4 measurements and propagate this into an error analysis of the CH4 fluxes, as well as for the computed k600 values.

L168: Could be useful to explain here how zmix was estimated from the temperature profiles.

L206 : This equation assumes that Caq remains unchanged during the 24h chamber deployment which seems unrealistic. Please clarify what does Caq correspond to. Was Caq measured each time Ch was measured ?

L207: specify if T is the average during the 24h chamber deployment.

In Eq[3] explain how dx/dt was computed. Linear regression over all points ? Difference between end and start ? Difference between each of the samples ?

The use of a single value for scalar c1 is surprising because the accumulation of CH4 in the chamber should depend on the flux intensity itself, so I would expect this value not to be constant.

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In equations 2 and 3, the same symbol (T) is used for water temperature and air temperature, when separate symbols should be used for distinct variables.

L 241: It's odd that both a symbol and an abbreviation are used for turbulent kinetic energy

L307: Please explain how the residence time of a CH4 molecule in the lake was estimated.

In Figure 6 the relation between storage time and water T seems significant for I Harrjon and M Harrsjon.

L637-639: why would damping of turbulence by near-surface stratification affect particularly your lakes but not those reported by Cole & Caraco (1998) and Wanninkhof and Crusius (2003) ?

An alternative explanation could be fetch limitation (Wanninkhof 1992) in the very small sampled ponds, and this effect could be more marked at high wind speeds than at low wind speeds.

Figure 9: abbreviations given in the plot should be defined in the figure legend.

In Figure 9, the binned data value at highest wind correspond to a wind speed that is higher than highest wind speeds of individual Kch measurements. How is this possible ? The binned value should be below the highest individual wind speeds measurements.

668-670. While I agree with the idea that CH4 is formed in the sediment, as this seems the most likely process in this type of environments, I do not see why the Arrhenius relation proves this. All biological processes follow Arrhenius-type relations, so the occurrence of this relation only shows that CH4 might be biologically produced, but does not allow to pin-point it as sedimentary. Please rephrase. Since it's not explained in the text how the residence time was computed it is not clear how this proves or disproves a sedimentary CH4 production.

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L671: Why do high CH4 in the stream suggest this is of “terrestrial” origin? CH4 is also produced in-stream in sediments. Do you mean that CH4 comes from soils then to streams ? or that the stream CH4 production is fueled by terrestrial organic matter ? This statement is very vague and confusing, please clarify.

L677-679: or alternatively from dilution with water with low CH4 from surface runoff and rain ?

L723: methane oxidation is also an important removal process that should contribute to imbalances between production and emission.

730-740: Wave breaking and bubbles also explain why the relation between the gas transfer velocity and wind speed is non-linear in the ocean (e.g. Wanninkhof 1992), while here you report a linear relation between gas transfer velocity and wind speed.

763 : Is thermocline tilting expected to occur in small ponds ?

797-811: Methane oxidation affects CH4 concentrations, so it’s very obscure why methane oxidation should affect the alpha term. This is a scaling between gas transfer velocity that is measured and modelled, and gas transfer velocity depends on physical processes (mainly turbulence) that have nothing to do with CH4 concentration, and how it’s affected by oxidation.

Refs

Liss P. S. & P. G. Slater (1974) Flux of gases across the air-sea interface, Nature, DOI: 10.1038/247181a0

Wilson et al. (2018) An intercomparison of oceanic methane and nitrous oxide measurements, Biogeosciences, 15, 5891-5907

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