**Response to RC1**

Below, we respond to the comments made by referee #1. Referee #1's comments are numbered and displayed in black. The author's comments are highlighted in blue. Citations and modifications of the manuscript are *italicized* and quoted.

1. Lessmann et al. presented a very interesting study that reveals the importance of CH4 emissions due to reservoir flushing. To the best of my knowledge, this is one of the first studies that estimate CH4 emissions due to reservoir flushing. Their results indicated that this CH4 emission pathway could be an important missing piece for the reservoir CH4 cycle. Besides, Lessmann et al. also answered several questions that I had in my mind before reading the work, including 1) how this CH4 emission pathway compares with other pathways in this reservoir; 2) how this CH4 emission pathway interacts with other CH4 emission pathways; 3) how important this CH4 emission pathway might be for other reservoirs in the globe. In addition, the work also provides reasonable operation advice to reduce CH4 emissions from this pathway. Although the estimates still have many gaps and the conclusion may not be applied to other reservoirs of different environments, as a pioneer study it will help encourage more following studies to bridge these gaps and address the transferability issue. Overall, I think that it is well-written and all results are clearly explained. I recommend its publication in this journal.

Thank you for taking time to review our work and your positive assessment. We appreciate the helpful comments you provided regarding our manuscript. Please find our response to each comment in detail below.

2. Some comments for the authors to consider. 1) The manuscript does not provide the information of reservoir age. Previous studies showed that the transition of carbon dynamics with reservoir aging is significant (Maavara et al., 2020). It is thus valuable that the authors can put their estimates and discussion in this context and warn the audience that the importance of this pathway can change significantly in time. Maavara, T., Chen, Q., Van Meter, K., Brown, L. E., Zhang, J., Ni, J., & Zarfl, C. (2020). River dam impacts on biogeochemical cycling. Nature Reviews Earth & Environment, 1(2), 103-116.

Thank you for pointing out this study. Maavara et al. discuss that greenhouse gas (GHG) emissions are initially high in young reservoirs due to flooding and decomposition of terrestrial biomass, are decreasing in middle-aged reservoirs with decreasing flooded biomass, and are increasing again in old reservoirs with sediment accumulation (2020). Because reservoir flushing affects the sediment budget, the accumulation of sediment with reservoir age does not necessarily follow the typical processes as outlined in the suggested paper. Thus, the relevance of $CH_4$ release due to flushing concerning reservoir age might be very complicated and is beyond the scope of our study. Nevertheless, we have included the information about the reservoir's age in section 2.1:

*"Since the dam was completed in 1926, the reservoir has been completely emptied on three occasions in 1935, 1952, and 1997."*

3. 2) The method to estimate diffusive CH4 flux from sediment to the water column is only accurate when there aren't any large CH4 production or oxidation in the surface sediment layers. But Figure 3d shows that the gradient of CH4 concentration changes between 0 and 2.5 cm depth, implying that CH4 oxidation occurred during April 2019 sampling and CH4 production occurred

during both June and September 2020 sampling. Do the authors have a sense of the related estimate uncertainty?

We calculated the instantaneous diffusive sediment flux of $CH_4$, by multiplying the actual gradient of the $CH_4$ pore water concentration by the molecular diffusivity of $CH_4$ in water. This does not require a steady-state assumption. Production and oxidation of $CH_4$ may alter the gradient over time, but not our estimate of the instantaneous diffusive sediment flux.

One difficulty comes from the limitation of the experimental technique. We estimate the gradient in the $CH_4$ concentration by linear regression within the uppermost sediment layers (in our case: 0.25–2.25 cm). Hence, the estimated diffusive flux is calculated from the average gradient within these sediment layers, which is not the true local gradient across the sediment-water interface. If substantial oxidation occurs above our uppermost sample, the sediment flux into the water is smaller than our estimate. However, this does not affect our estimate of the minimum production required to generate the estimated fluxes.

Another problem is that if the $CH_4$ pore water concentrations change non-linearly within the uppermost sediment layers, it would imply that the diffusive fluxes vary within these sediment layers. In that case, our estimate is always lower than the maximum sediment flux in these sediment layers.

4. 3) Is the y-axis of Figure 2b really sediment depth? I suspect it is still water depth, consistent with Figure 2a. Anyway, I cannot tell that DO in September 2020 were oversaturated near the water surface and above 2 mg throughout the entire water column from the figure, as described in Line 180.

We apologize for this mistake. The y-axis in Figure 2b should be labeled *"Height above ground (m)"*, consistent with Figure 2a. We changed it accordingly.