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Interactive comment on "Low methane (CH_4) emissions downstream of a monomictic subtropical hydroelectric reservoir (Nam Theun 2, Lao PDR)" *by* C. Deshmukh et al.

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The authors want to thank the reviewer for his careful reading of the manuscript and for his positive comments.

RC: The sampling program was designed such that downstream emissions could be partitioned among different features of the system including turbine discharge, aeration pools, and river channels. While it is informative to understand the spatial distribution of downstream emissions, this approach does introduce some complications to the analysis. Specifically, to estimate emissions from the downstream flowing waters the authors needed to make assumptions regarding the air-water gas exchange rate. While this is

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Interactive Discussion
Discussion Paper

not a major problem, it does cause the reader to wonder about the accuracy of these estimates, particularly for the section immediately downstream of the turbines where the water was too turbulent to allow for chamber deployments. I suggest the authors also estimate downstream emissions by assuming that all CH_4 in excess of atmospheric equilibrium that leaves the reservoir is emitted to the atmosphere. downstream emissions = [$CH_{4,obs}$ – $CH_{4,eq}$]Q where CH_4 is the dissolved CH_4 concentration that was measured ($CH_{4,obs}$) and at atmospheric equilibrium ($CH_{4,eq}$), Q is the rate of water withdrawal from the reservoir. This would provide an upper bound to the downstream emission estimate (i.e. assumes no CH_4 oxidation in downstream waters). ANSWER: In the downstream channel, oxidation occurs and it is significant (specific oxidation rate of 1 d^{-1}, now given in the section 3.4). In addition, the CH_4 concentration never decreased below 0.11 μmol L^{-1} which is 40 times higher than the concentration at equilibrium. Therefore, the proposed method would lead to a significant overestimation of downstream emissions. The same equation was used for degassing (equation now given in the section 2.4.2) but we used the difference in concentration between upstream and downstream of the “degassing structure”. For the assumption about the gas transfer velocity, see the detailed answer to the second comment by Damien Maher.

RC: The authors conclude “The hydrodynamics but also the water residence time significantly impact downstream emissions and must be taken into account for future estimation of total emissions from hydroelectric reservoirs at the global scale”. While this is no doubt true, I would like to see a deeper discussion of how we might go about doing this. I very much like the related discussion on page 11333 (lines 1-15) which suggest that the mixing status of a reservoir is an indicator of potential downstream CH_4 emissions. Are there other readily accessible data that can be used in emission inventory guidelines to better estimate downstream emissions? Certainly, downstream emissions scale with discharge, as discussed in page 11331, lines 4-9. Should we recommend that downstream emissions be estimated as a function of reservoir discharge? What about details of the intake structure? I wonder if the discussion of this

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topic in section 4.3 can be expanded upon. For example, some dams can only withdraw from the hypolimnion, while others can withdraw from multiple depths, including the epilimnion. It seems withdrawal depth is another important factor determining the magnitude of downstream emissions. Overall, I think this paper would be more impactful if it not only said we should estimate downstream emissions in global inventories, but also provided a framework for how we should go about it.

ANSWER: all the parameters that might significantly influence downstream emissions are spread in the last two sections of the discussion as pointed by the reviewer.

As it would be more impactful to group all them in one place, the following paragraph was added at the end of the conclusion : " On the basis of these results, different from those previously published, we recommend that estimates at the global scale of emissions below dams take into account the mixing status of reservoirs, the water residence time and depth of the water intake and its impact on the oxygenation of the water column immediately upstream of the turbines."

Specific comments

RC: Page 11316, line 23: . . .were first reported. . .

ANSWER: changed

RC: Page 11316, line 25: akward to start a sentence with a list of references. Suggest rephrasing.

ANSWER: The sentence was rephrased as follow: "When all emission pathways from tropical or temperate hydroelectric reservoirs (disregarding the drawdown emissions) are taken into account, downstream emissions could contribute 50 to 90% of total CH_4 emissions (Abril et al., 2005;Kemenes et al., 2007;Maeck et al., 2013)."

RC: Fig. 1: There is a lot going on in this monitoring program. I suggest making this figure as large and clear as possible. Please increase the size of the inset. Consider using colors. I suggest eliminating the icons used to symbolize the dams, intake struc-

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12, C9525–C9528, 2016

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tures, etc. They are relatively large and overlap with the sampling locations. RC: Page 11319, line 26: RES3 and RES7 not included in Fig.1

ANSWER: The map (Figure 1) was modified as suggested by the reviewer and the stations were added

RC: Page 11324, line 15: below the dam?

ANSWER: Replaced by “further downstream”

RC: Line 17: Fig 3 cited before Fig 2?

ANSWER: Figure 2 was initially not cited. Now cited in the section 3.1.

RC: Line 20-21: data from NTH4 and NTH5 not shown?

ANSWER: Data from NTH5 are not shown. Data from NTH4 are visible on Fig 3a and 3b as now noted in the text (section 3.2.1 & 3.2.2).

RC: Page 11331, line 2: . . .between X and 1.5. . .

ANSWER: Corrected: . . .range between 0.2 and 1.5. . .

Section 4.3: very interesting discussion.

RC: Figs 3 and 4, panel b: y-axis label, “Diffusive emissions (mmol CH4 m-1 d-1)”

ANSWER: Changed by “CH4 Diffusion mmol m-1 d-1”

RC: Fig. 5. Probably not necessary.

ANSWER: Kept since it is needed for the estimation of the oxidation at the water intake.

Interactive comment on Biogeosciences Discuss., 12, 11313, 2015.

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