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Biogeosciences Discussions

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 thank Damien Maher for his comprehensive and positive review of the manuscript.

RC : A few equations on how various fluxes were calculated would be welcomed – while I am familiar with the floating dome calculations other readers of BG might not be, also some equations on the "degassing" calculations (I am assuming these are a simple mass balance?) would also be good. Also a little bit more on the analysis precision and accuracy would be appreciated (other than just the 5% reproducibility).

ANSWER : Equation for the calculation of diffusive flux from surface concentrations and equation for degassing were added in the sections 2.41 and 2.4.2, respectively. In the section 2.3.4, the text was modified as follows: "The detection limit is 0.3 ppmv in the headspace and the accuracy is around 4% allowing the determination of nanomolar concentrations in water samples, depending of the volume of the vials and headspace. Duplicate injection of samples showed reproducibility better than 5%."

RC : My main issue is with the use of a single "averaged" k600 value for the downstream section of the study area, I feel this simplistic approach is not appropriate as the k600 is likely much higher in the immediate downstream area (and also concentrations are likely to be much higher here) therefore there would be an underestimation of the fluxes. Indeed 10 cm/h seems much too low for an area that would have extremely high turbulence, as noted by the authors in the comment on not being able to do floating chamber measurements due to "safety reasons because of strong water currents". Is there any other way of estimating this? Considering the flow is so highly regulated perhaps a similar method can be employed as used for the "degassing" calculations, essentially a CH4 mass balance between an upstream and downstream point. At least some dissussion about the implications of using the single value for gas transfer velocity should be included.

ANSWER: The zone of high turbulence that leads the Nam Theun Power Company to forbid navigation are located immediately downstream of the dam, downstream of the power house and downstream of the aeration weir where there are "artificial waterfall" where degassing occur. Otherwise, the water current velocity in the artificial channel never exceeds 1 m/s and averaged 0.5 m/s. Therefore "safety reasons because of strong water currents" will be rephrased to better describe the sampling conditions. These dangerous areas correspond to the "immediate downstream areas" where degassing was calculated and therefore no k600 was considered and emissions are determined by "mass balance" (see section 2.4.2).

For the other sections where degassing does not occur, a simple mass balance be-

tween the upstream and downstream points would lead to an overestimation of the emissions since a fraction of the CH4 would be oxidized (data not show but the specific oxidation rate obtained in the articicial channel is now given in the section 3.4). Modelling is needed in order to take into account both oxidation and diffusion.

As said in the MS and in Guerin et al (2015), the chamber deployment performed in rivers in the watershed gave an average k600 of 10 cm/h. This is very similar to the average k600 value obtained using the formulation k600-wind speed relationships from Guerin et al (2007) obtained downstream of the Petit Saut Reservoir and in small estuaries of the same size with similar water currents like the Scheldt (Borges et al., 2004). We therefore kept 10 cm h-1 as a conservative estimate of the k600 in the artificial channel downstream of the NT2R. k600 was kept constant over the whole period of monitoring since the average of the results obtained by the formulations of Borges et al (2004) and Guerin et al (2007) was 10.06 $\pm$ 1.48 cm h-1 according to the limited variation of the monthly average wind speed (1.8 $\pm$ 0.46 m s-1).

The section 2.4.1 was modified according to the comments above. We believe that our hypothesis is reliable and its consequences in the methane balance are minor. According to the results presented in table 2, even if we underestimated or overestimated the k600 by 50%, still diffusion would not contribute more than 4% to the total CH4 emissions from the Nam Theun 2 reservoir.

Minor Comments

RC: P 11324 L8-10 Comparisons like this belong in discussion P11324 L25 – P11325 L2 Discussion P11325 L9-12 Discussion

ANSWER: The discussion deals with the spatial and temporal variability and the significance of downstream emissions in absolute values (in Mg(CH4) month-1, for instance) and almost no data that could be compared with other studies (like concentrations or diffusive fluxes) are included. Therefore we kept comparison of our dataset with other studies in the result section.

RC : P11325 L13-16 How was the 10km length defined? Is this based on any modelling or just best guess? Some explanation on how this value was calculated should be included

ANSWER : As mentionned line 6-7 (same page) and L20-25 of the previous page, this is based on the measurements at the NTH3 station located immediately downstream of the dam and on the measurements at the NTH4 station located 10 km downstream of the dam. At NTH4, CH4 concentrations and calculated fluxes were always very similar to pristine rivers in the watershed. The text was slightly modified as follow : "Downstream the station NTH4 located 10 kilometres downstream of the dam, the CH4 emission was similar to what found in pristine river of the watershed and it was 2 orders of magnitude lower than the emissions observed downstream of 10-20 years-old reservoirs (Guérin et al., 2006;Kemenes et al., 2007). Considering that the CH4 emissions from the Nam Theun River below the dam can be attributed to the reservoir over a maximum length of 10 km and a constant width of 30 m, annual emissions below the Nakai Dam decreased from 20 to 1 Mg-CH4 month-1 between 2009 and 2012, respectively (Figure 3c)."

RC : P11326 L24-25 Maybe a narrow range considering the max of âĹij 1000 uM but this is still 3 orders of magnitude difference. Perhaps look for different terminology than “narrow range”

ANSWER : The sentence was rewritten as follow : " Whatever the years, in the CD season, surface CH4 concentrations was lower than 14.5 μmol L-1 along the 30 km long watercourse.”

RC: P11328 L5 – 10 Discussion

ANSWER: as mentioned before, these comparisons of our dataset with other studies are kept in the result section.

RC : P11329 L20-23 Give details on how this depth integrated value was calculated in

the methods (including equations)

ANSWER : The following text was added in the section 2.3.3 "The kinetics parameters of aerobic methane oxidation obtained from the experiment were combined to the in situ CH4 concentration profiles in order to calculate the integrated aerobic methane oxidation in the oxic water column. As the aerobic methane oxidation rates we obtained were potential, CH4-ox were corrected for two limiting factors, the oxygen availability and the light inhibition as described in Guerin and Abril (2007). The final equation to compute in situ oxidation rates (CH4-ox, mmol.m-2.d-1) is:

CH4-ox = CCH4 x SCH4-ox x CO2/ (CO2 + Km (O2)) x d x I(z)

with CCH4, the CH4 concentration; SCH4-ox, the specific CH4-ox; CO2, the oxygen concentration; Km(O2), the Km of O2 for CH4 oxidation, d, depth of the water layer and I(z), the inhibition of methanotrophic activity by light as defined by Dumestre et al. (1999) at the Petit Saut Reservoir. Finally, the CH4 oxidation rates were integrated in the oxic water column, from the water surface to the limit of penetration of oxygen."

The sentence pointed out by the reviewer was removed since all explanation is now given in the above-mentioned section.

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