

Interactive comment on “CO₂ partial pressure and CO₂ emissions from the lower Red River (Vietnam)” by Thi Phuong Quynh Le et al.

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General Comments:
The manuscript entitled “CO₂ partial pressure and CO₂ emissions from the lower Red River (Vietnam)” by Le et al provides new and important data on CO₂ in the Lower Red River. The results are a good contribution for the understanding of the role of Asian rivers for the global carbon evasion from freshwater ecosystems. However, there are many technical problems that need to be address to increase the quality of the paper. I agree with the other reviewers that the estimate of the CO₂ evasion is the main problem in the paper and must be reworked. The figures and tables are clear and well designed. However, I suggested some changes in the number of figures and tables. In summary, the authors should review the flux calculation (see specific comments

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below); consider k_{600} calculations based on turbulence generated by water flow and; reorganize Results and Discussion sections. Specific comments and suggestions are below. We thank you very much for the helpful comments and suggestions.

Specific comments: 66 – This sentence suggests that there is a “limited knowledge” about carbon flux. Does it mean that there are published information about carbon flux in the Red River, or not? Yes, there are some published information about carbon fluxes for a peri-urban area in the Red River Delta (Trinh et al., 2012) and (Nguyen et al., 2018). We revised the sentence and add the references: “However, there is a lack of data concerning CO₂ outgassing and carbon budget of the lower Red River (Trinh et al., 2012, Nguyen et al., 2018).”

79 – In the figure 1, the Ba Lat station does not seem to be located about 50 km from the sea. Please clarify. We apologize for the error. The Ba Lat site is 13 km from the sea. The information was corrected in the text page 3.

Some references in the introduction are missing (e.g. lines 48, 56) References were added in the revised manuscript

86 – I suggest removing the sentence “see below for the detail river discharge in 2014” and insert the correct reference - figure, table etc. The sentence was removed, the word “table 1” was replaced

109 – The sentence “All solutions used for. . .” is unnecessary. This sentence was deleted

151 – What is the “regulator”? You mean pump or a flux regulator? Please, clarify. It was changed into “a flow regulator”.

162 – By convention k_{600} is the gas transfer velocity normalized to a Schmidt number of 600. And k is the gas transfer velocity. “ Sc ” should not be the “Schmidt number, normalized to Schmidt number of 600”. “ Sc ” should be the Schmidt number of a given gas (CO₂ in this case) at a given temperature. Please, clarify the calculation and check

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if the calculation is correct. We revised the paper by recalculating the k_{600} proposed by (Raymond et al., 2012). Thus, S_c was removed from the new calculation. K_{600} was calculated as presented in the section “2.5 CO₂ fluxes determination”, page 5-6: “In this study, k_{600} was calculated using the equation from Raymond et al. (2012) based on stream velocity (V , in m s^{-1}), slope (S , unitless), depth (D , in meters) and discharge (Q , in $\text{m}^3 \text{s}^{-1}$), as follow: $k_{600} = 4725 \pm 445 \times (V \times S) 0.86 \pm 0.016 \times Q - 0.14 \pm 0.012 \times D 0.66 \pm 0.029$ Eq. (2)

166 – I wonder why the authors did not considered the temperature variation measured by HOBO sensor to calculate “ a ”? Were temperature records not made at the same time? In addition, conductivity is much higher in Ba Lat station suggesting differences in salinity among stations. If “ a ” is a constant (line 167), the salinity variation seems not to be considered in the calculation. We calculated the $f\text{CO}_2$ at 5 sites of the Red River with different α values : $\alpha = 3.941 \times 10^{-2} \text{ mol.L}^{-1}.\text{atm}^{-1}$ at 24 °C for dry season and $\alpha = 3.138 \times 10^{-2} \text{ mol.L}^{-1}.\text{atm}^{-1}$ at 27 °C for rainy season. The average flux of CO₂ outgassing was $525.7 \text{ mmol.m}^{-2}.\text{d}^{-1}$. Then, this value was very close with the one calculated from the constant $\alpha = 3.4 \times 10^{-2} \text{ mol.L}^{-1}.\text{atm}^{-1}$ we used for both rainy and dry seasons of the Red River in this study, which resulted in the $f\text{CO}_2$ average of the whole Red River $530 \text{ mmol.m}^{-2}.\text{d}^{-1}$. An explanation was added in page 6 “ K_{CO_2} is the solubility coefficient of CO₂ for given temperature and salinity (Weiss, 1974) ($\text{mol L}^{-1} \text{ atm}^{-1}$). In this case, $K_{\text{CO}_2} = 0.034 \text{ mol L}^{-1} \text{ atm}^{-1}$. In this study, salinity variations were low, except for the Ba Lat station. Temperature did not change a lot. We checked the influence of different K_{CO_2} values in the dry ($\alpha = 3.941 \times 10^{-2} \text{ mol L}^{-1} \text{ atm}^{-1}$ at 24 °C) and the wet season ($\alpha = 3.138 \times 10^{-2} \text{ mol L}^{-1} \text{ atm}^{-1}$ at 27 °C) at the 5 sites and compared with the constant K_{CO_2} value of $0.034 \text{ mol L}^{-1} \text{ atm}^{-1}$. “

170 – Please, check the units of each element of the equation. The flux was calculated in $\mu\text{mol m}^{-2} \text{ s}^{-1}$ but the k , a and $p\text{CO}_2$ air is cm h^{-1} , $\text{mol L}^{-1} \text{ atm}^{-1}$ and ppm, respectively. Please reorganize the section 2.4.1 for clarification. Thank you for the comments. The flux is now calculated from different variables taking into account dif-

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ferent units. We added the explanation for converting the final unit of flux calculation in mmol m⁻² d⁻¹ in the section 2.4 CO₂ fluxes determination in page 5

183 – If k₆₀₀ values are closely related to flow velocity and channel gradient, why author used k₆₀₀ values calculated from wind speed? The authors should present a convincing explanation or review the calculation and values. Thank you for the comment. We now calculate the k₆₀₀ by the formula proposed by Raymond et al (2012) which is based on river flow velocity, river discharge, depth, slope in pages 5 and 6: “k₆₀₀, was gas transfer velocity of CO₂ or piston velocity (cm h⁻¹). Some studies indicate that k₆₀₀ values are closely related to flow velocity and channel gradient for rivers (Alin et al., 2011). In this study, k₆₀₀ was calculated using the equation from Raymond et al. (2012) based on stream velocity (V, in m s⁻¹), slope (S, unitless), depth (D, in meters) and discharge (Q, in m³ s⁻¹), as follow: $k_{600} = 4725 \pm 445 \times (V \times S)^{0.86} \pm 0.016 \times Q - 0.14 \pm 0.012 \times D^{0.66} \pm 0.029$ Eq. (2)”

220 – The same results are presented in Table 2 and Figure 2. Please, remove the table or the figure. Figure 2 was removed as suggested.

223 – I suggest add Alkalinity values in the table or figure 2. Alkalinity values are presented in the table 2, in the column named “TAlk”.

257 – Change “monsoon” to “wet”. It was changed

263-269 – Abril et al., 2015 discuss overestimation of pCO₂ using total alkalinity in acidic, organic-rich freshwaters. However, if this water condition is not the case of Red River, the find of Abril is not an explanation for the opposite (lower calculate values when compared with the measured values). These values should be similar or, please, provide a clear and convincing explanation. Thank you for the suggestion. We removed the sentence from the revised manuscript.

276 – Discussion inside the Results section. Results and Discussion are mixed in several parts of these sections. I suggest re-write and reorganize these sections. Thank

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you for the suggestion. We re-wrote and reorganized the Results and Discussion sections

Table 1 – Please double check the station location. I plot the station locations and there are some inconsistencies (e.g. Ba Lat is located in the ocean and not in the Red River). There was a mistake for the location of the Ba Lat site. This was corrected in table 1 and in the text. Other sites were also checked.

Table 2 and Figure 2 – Why the values after +/- in table 2 and the error bar in Figure 2 are different? What does they mean? We checked the table 2. The figure 2 was removed in the revised manuscript.

Figure 6 – What the gray and dark circles mean. Dry and wet season? Insert these information in the figure caption.

The figure 4 demonstrates the Relationship between environmental variables and pCO₂ at the five sites of the lower Red River in the wet (Sept) and the dry season (Nov) 2014. The figure and caption were revised.

Please also note the supplement to this comment:

<https://www.biogeosciences-discuss.net/bg-2017-505/bg-2017-505-AC4-supplement.pdf>

Interactive comment on Biogeosciences Discuss., <https://doi.org/10.5194/bg-2017-505>, 2017.

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Supplementary Material

**CO₂ partial pressure and CO₂ emission along the lower
Red River (Vietnam)**

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Figure SMI: Daily variation of river discharge at the outlet of the Thao (Yen Bai), Da (Hoa Binh), Lo (Vu Quang) rivers and in the main branch of the Red River at Hanoi and Ba Lat stations in 2014.

Fig. 1.

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