

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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Dear Dr J. Crawford

Thank you very much for your comments. We revised the ms in taking into account all your comments and suggestions. Below we try to reply and explain our revision following to your questions and comments. Best regards, On behalf of co-authors Thi Phuong Quynh LE

J. Crawford jtcrawford@usgs.gov Received and published: 8 January 2018

This paper documents the chemical conditions and concentrations of dissolved carbon dioxide in the Red River system of Vietnam. The data contribute to the "database" of concentration values for the globe, with one goal of further constraining the CO₂ source

C1

strength of inland waters. Therefore, the data are valuable on their own, especially given that they fill in geographic gaps for SE Asia. The main criticism of this paper is the use of a wind-driven gas exchange model. While criticism of gas exchange models are prevalent within the community of researchers, this example is especially problematic as it relies on unlikely drivers of turbulence (and thus gas exchange) in riverine systems. There is some evidence that gas exchange is enhanced by some wind patterns in very large rivers, however, gas exchange in rivers is not considered to be a major driver. Rather, it is turbulence generated by water flow that drives gas exchange rates in these systems. Therefore, the CO₂ emission estimates are not only biased, as recognized by the authors, but are likely to be highly inaccurate due to the model selected. It is hard to believe the results without some other line of confirmation. In addition to the criticism of the estimates of gas exchange, I did not find the discussion points to be well supported by the data especially given the limited time and geographic scope of the measurements. There is simply not enough evidence to support any of the inferred drivers of CO₂ variability in this river system. Thank you for the comments. We revised the manuscript in taking into account all comments from reviewers.

Specific Comments: 48: what references support plate tectonics as major drivers of carbon fluxes in this system? We added the information in page 3 "The Delta is located in a very flat and low land, with an elevation ranging from 0.4 to 12 m above sea level (Nguyen Ngoc Sinh et al., 1995). Previous studies showed the difference of lithology in the three upstream tributaries: Paleozoic sedimentary rocks (55.5

53: are changes in sediments the hypothesized drivers of changing carbon fluxes in this study? Yes. The information concerning changing of suspended solids of the Red River was added in page 12, in the section "Influence of dams on pCO₂ and CO₂ emission". Noted that the Hoa Binh site is situated downstream a series of reservoirs, which have been constructed in both Chinese and Vietnamese parts including two large dams Hoa Binh (in 1989) and Son La (in 2010). The Vu Quang site is located in the downstream of a series of reservoirs, including two important Thac Ba (in 1970) and

C2

Tuyen Quang (in 2010). Previous studies emphasized that these dams have impacted water and sediment discharges downstream (Ha and Vu 2012; Ngo et al. 2014; Lu et al. 2015) with significant sediment deposition being observed in the reservoirs (Dang et al. 2010; Vinh et al. 2014; Lu et al. 2015).

184: if exchange is less related to wind, then what is the justification for using this model in the present study? Thank you for the suggestion. But we now revise the ms by recalculating k600 proposed by Raymond et al 2012 K600 was calculated as presented in the section "2.5 CO₂ fluxes determination" , page 5-6: "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: $k600 = 4725 \pm 445 \times (V \times S) 0.86 \pm 0.016 \times Q - 0.14 \pm 0.012 \times D 0.66 \pm 0.029$ Eq. (2)

214: such low temperature variability leads to skepticism of this environmental parameter being a significant driver of CO₂ variability. In addition, the broad conclusion here is that water chemistry seems to be quite stable over time. Thank you for the suggestion. The test by ANOVA and t-test results showed that no clear day-night variation but clear seasonal (dry-wet) variation of temperature was found at 5 sites. Other variables including pCO₂, organic matters . . . showed seasonal variation. So, we revised the section of temporal variation of pCO₂ and CO₂ flux in page 9 -10

273: a lack of CO₂ diel variability, but a finding of diel exchange variability, is a direct function of the model. This diel variability in fluxes then, is simply due to changes in wind which I do not believe are likely drivers of gas exchange in most river systems. Again, we recalculated the k600 by Raymond et al (2012), that lead to the change in CO₂ flux. We re-write the discussion.

276: this section reads more like discussion than results We removed this section in the revised ms.

346: in contrast, this opening paragraph of the discussion most likely belongs in the

C3

results section of the manuscript Thank you for the suggestion. In the revised ms, this paragraph is in the section Results/ 3.4. Relations between pCO₂ and water chemistry variables in page 8 -9.

359: what part of the study design allows for a significant investigation on the role of dams and gas exchange? We added the paragraph for describing the 5 sites observed in page 3 "Five stations were studied along the lower Red River (Vietnam): Yen Bai station (at the outlet of the Thao River); Hoa Binh station (after Son La and Hoa Binh reservoirs, at the outlet of the Da River); Vu Quang (at the outlet of the Lo River); Hanoi and Ba Lat stations (in the main course of the Red River downstream). The three stations Yen Bai, Vu Quang and Hoa Binh are representative for water quality of the three main tributaries (Thao, Da and Lo) of the upstream Red River, whereas the Hanoi station is representative for the main course Red River after confluence of three main tributaries. Only the Ba Lat station, which is located at the Red River mouth (about 13 km from the sea) is influenced by seawater intrusion (Fig 1). A more detailed description of the river characteristics of the Thao, Da, Lo and the main branch of the Red River can be found in (Le et al., 2007)"

401: paragraph is too speculative The paragraph was revised in page 13 (line 451)

449: but the temperature variation was very small. How much could this have possibly contributed to the variation in CO₂ exchange? Thank you for the suggestion. As we mention above, we recalculate the k600 and fCO₂. So the results now were represented and synthesized. The discussion concerning day-night variations was rewritten. pCO₂ differences between night and day were really low, most probably because of low temperature difference and low photosynthetic activity due to the turbidity of the Red River. The conclusion was also revised.

Please also note the supplement to this comment:

<https://www.biogeosciences-discuss.net/bg-2017-505/bg-2017-505-AC1-supplement.pdf>

C4

C5

Supplementary Material

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

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C6

Figure SMI: Daily variation of river discharge at the outlet of the Thao (Yen Bai), Da