

## ***Interactive comment on “Factors governing the pH in a heterotrophic, turbid, tidal estuary” by A. F. Hofmann et al.***

### **Anonymous Referee #2**

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The authors present a method to quantify the relative importance of biogeochemical processes, CO<sub>2</sub> air-water exchange, and transport on the pH of an ecosystem and its application in the Scheldt estuary. Model results show that nitrification is the main process governing the pH profile of this estuary, while CO<sub>2</sub> degassing and advective-dispersive transport 'buffer' the effect of nitrification.

This work allows to unravel the mechanisms controlling pH and is not limited solely to try to reproduce the patterns of the variables.

### **SPECIFIC COMMENTS**

P198 L6: Based on Fig. 5, the CO<sub>2</sub> degassing has more important impact on pH than nitrification. Based on Fig. 4, the advective-dispersive transport in the upper estuary

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consumes H<sup>+</sup> while in the lower estuary (>35km) advective-dispersive transport produces H<sup>+</sup>. Hence, statement 'Nitrification is identified as the main process governing the pH profile of this estuary, while CO<sub>2</sub> degassing and advective-dispersive transport 'buffer' the effect of nitrification' is an over-simplification of the model results and conclusions of the paper.

P201 L11: annual average freshwater flow?

P202: Validation of the present model is given in Hofmann et al. (2008b). However, was the model validated in relation to oxic mineralization and primary production measurements? As discussed in this paper, their model underestimates the CO<sub>2</sub> export to the atmosphere and the role of heterotrophy in controlling the CO<sub>2</sub> dynamics compared to previous estimations. Could this be to fact that mineralization or primary production in the estuary are not correctly represented in the model? What would be impact of this on the pH dynamics of the present work? Would this affect the relative contribution of the different processes on pH dynamics, since the relative contribution of heterotrophy and CO<sub>2</sub> degassing from the model is different to the one of previous studies? Finally, do you have an idea of the impact of the parameter value of remineralisation on the relative importance of biogeochemical processes on the pH simulation?

P207 L7: URL for FEMME does not seem to work ('Pagina niet gevonden')

P208 L7: No at lot of details are given about forcing in Hofmann et al. 2008b. What is the temporal variability of the forcing (monthly?)? There is no information about temperature.

P 211 L 10-12: Please comment and provide an explanation for the fact that at the upstream boundary advective- dispersive transport accounts for 44% of proton consumption while at river kilometres 48 and 67 it delivers about 50% of the protons.

P211 L15: Please remove Table 6 that gives the same results (in%) as Table 5, and Table 6 is not commented in the paper.

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P212 L 1-8 : A note of caution is needed is here, because depending on the section of the estuary advective-dispersive can have a positive or a negative effect on pH (Table 5, Fig.4). When averaged in the whole estuary these effects cancel each other, and in Fig. 5 give the impression that this a minor contributor to pH dynamics, when in fact it is one of the most dynamic processes controlling pH.

Fig 4-6-7: The legends of the symbols in the Figures are too small and barely readable.

Figure 6 is difficult to interpret without the relative contribution in % of the different processes.

P212 L 17-19 : Please clarify which boundary conditions or which changes in freshwater flow induce the changes of oxic mineralization reported between 2003 and 2004?

P213 L 11: The authors mention a 'distinct pattern of the influence of advective-dispersive transport' however this pattern is not apparent anywhere as in Fig. 6.

P 214 L10-11: Besides Régnier et al. (1997) the impact of nitrification and oxic mineralization on carbonate chemistry has been discussed by Frankignoulle et al. (1996), Abril et al. (2000) and Vanderborght et al. (2002).

## References

Abril G., H. Etcheber, A. V. Borges & M. Frankignoulle (2000) Excess atmospheric carbon dioxide transported by rivers into the Scheldt Estuary, *Comptes Rendus de l'Académie des Sciences - Series IIA - Earth and Planetary Science*, Paris , 330(11): 761-768, doi:10.1016/S1251-8050(00)00231-7

Frankignoulle M., I. Bourge & R. Wollast(1996) Atmospheric CO<sub>2</sub> fluxes in a highly polluted estuary (The Scheldt), *Limnology and Oceanography*,41(2): 365-369.

Vanderborght, J. P., Wollast, R., Loijens, M., and Regnier, P. (2002) Application of a transport-reaction model to the estimation of biogas fluxes in the Scheldt estuary, *Biogeochemistry*, 59, 207-237

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