

Interactive comment on “Diurnal cycle of the CO₂ system in the coastal region of the Baltic Sea” by Martti Honkanen et al.

Anonymous Referee #2

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Diurnal cycle of the CO₂ system in the coastal region of the Baltic Sea, by Honkanen et al.

General comments

The paper by Honkanen et al. presents measured pCO₂ data over a year from July 2018 to June 2019 from a marine site off the island Utö in the Baltic Sea. A variety of additional data is provided from the marine site, from two additional coastal sites and from the flux tower at the Utö island. The authors have examined the different drivers for the observed changes in pCO₂, and they address the importance of high frequency data when precise air-sea CO₂ fluxes are to be calculated. Data from coastal sites like this is highly valuable and the manuscript is very welcomed. However, the manuscript is poorly written and needs improvement both regarding English language and the

structure. In the current version, the reader needs to jump back and forth to get a grip on the story, and it is not always clear what the authors want to communicate.

Specific comments

Abstract: phrases like “monthly median diurnal pCO₂ peak-to-peak amplitude” is difficult to understand. Please change to e.g. “monthly median of diurnal . . .” throughout the manuscript

Chapter 1: The dataset are from 2018-2019, why not use a more updated reference for the global carbo cycle (e.g. the years 2009-2018: Friedlingstein et al., 2019, Earth Syst. Sci. Data, 11, 1783–1838, 2019, <https://doi.org/10.5194/essd-11-1783-2019>).

Chapter 2: Please note that Appendix A is not mentioned in the text.

Chapter 3 Materials and methods: This chapter needs improvement. It would be helpful if a map was included where the position of the Utö station, its water intake, thermistor chain position as well as the position of the ctd casts were marked. You should clarify the difference between the marine station and station, maybe it is better to use “laboratory” for the on-shore facility? LI-COR 840 measures CO₂ and H₂O, but are the gas dried prior to the detection (if so, please include information). Are you using the H₂O measurements to calculate dry xCO₂, or are you calculating pH₂O from T and S? The pCO₂ is corrected for temperature difference between water intake and equilibrator, and this should be done according to Takahashi et al. (1993). Why are you including TA in this recalculation? Please include accuracy and precision of Optode and Chlorophyll A. The value of the one month of thermistor chain data is not properly explained. Please include reference for CO₂SYS program used. There are some repetition of information that is found in Appendix, please decide where to present it. Flux of oxygen is most commonly presented as a function of (measured O₂ concentration minus saturation O₂ concentration). Why not use this here?

Technical corrections:

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P2 L25: Replace “voluntary” with “Voluntary”.

P3 L10: Please rewrite sentence and include more explanation.

P4 L26: Please rewrite this line to clearly differentiate between marine station and station. E.g. “Water from the marine station, which is situated 250 m from shore, is pumped to an onshore laboratory, where analyses are performed”.

P5 L15: Rewrite the paragraph starting on line 15. The temperature difference between inlet and equilibrator can be corrected for by using Takahashi et al. (1993). Why introducing the salinity-alkalinity relationship here?

P5 L26: Delete “between the”.

P5 L27: Rewrite the last sentence.

P6 Ch 3.4: The chapter needs improvement/restructure.

P6 L3: Capitalize the first letter of “temperature” and “depth”.

P6 L5: The depth closest to the surface was selected for what? Further, the temperature chain was deployed for only one month in 2018. Is this representative for the whole year?

P6 L8: Replace “temperature vertical profiles” with “vertical temperature profiles”.

P6 L9: I suggest moving the name Ismo Willström to the Acknowledgements.

P6 L24: Replace “1) on the the” with “1) an”.

P6 L26: Replace “2) on the” with “2) a”.

P7 L20: Please include reference for CO2SYS.

P7 L21: Explain why you use constants from Millero (2010), as Lueker et al (2000) is recommended in open sea.

P7 L26: The TA-salinity relationship is presented in Appendix C, there is no need for

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repetition, please chose where to include it.

P8 L18: Remove parenthesis. The flux of oxygen is usually presented as a function of (measured O₂ concentration minus saturation concentration of O₂).

P9 Figure 1 text: Please clarify in figure text from where the different data are from, e.g. in panel a) the T structure is based upon ctd station data, etc.

P9 L1: You write that r is used to describe the diurnal pCO₂ variability, but in Figure 8, r is used as root mean square.

P9 L8: Replace “ca month” with either “a month” or “one month”.

P10 L5: Do you mean remineralization?

P10 L11: The assumption of fresh water lenses is not introduces anywhere else, please explain more.

P12 Figure 4 text: Please replace “monthly diurnal variability” with “monthly median of diurnal variability” (as used in Chapter 5 Conclusion).

P13 L19: Rewrite the last sentence.

P14 L7: Replace “observed one during” with “observed during”.

P15 L5: Replace “is an increasing trend” with “seems to be increasing throughout the day”.

P16 L5: The correlation coefficient (R²) is called “r” in the panels of Figure 8. Please be consistent.

P16 L10: Please explain the sensitivity evaluation better.

P16 L11 and P17 L1: This sentence needs rewriting and more thorough explanation.

P18 L9: Replace “O₂” with “O₂”.

P18 L22: Remove “to the”.

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P18 L27: Replace “and smallest afternoon” with “and smallest in the afternoon”.

P20 L22: Replace “solubility constant” with “solubility”. Solubility is not a constant but rather dependent on T and S.

P21 L8: Hydrogen carbonate dissociate into carbonate AND hydrogen ion.

P21 L18: DIC does vary with temperature.

P22 L10: TA is highly dependent on salinity (and to a minor degree on temperature) and thus not a conservative variable.

P22 L19: “. . .which was based on the direct total alkalinity and salinity measurements carried out. . .”.

P22 L25: You claim that salinity has no units, why introduce PSU?

P23: I suggest merging Appendix A: Air-sea gas exchange of CO₂ and D: Gas transfer velocity, as these paragraphs discuss similar things.

P23 L9: Insert “than” between “less” and “30%”.

P23 L10: Insert “a” between “purely” and “theoretical”.

P23 L11: You used you own CO₂ flux measurements and calculated “The best quadric fit (0.31U₂. . .)”, right? Or are you referring to Wanninkhof (1992), who presented exactly the same number? Moreover, on line 12, what is the “common parameterisation”; is it Wanninkhof (1992); 0.31U₂. . ., or Wanninkhof (2014); 0.25U₂. . .?

P25 L5: Please include “(ICOS)” after “Integrated Carbon Observation System”.

P26 L15: The doi of this paper is placed in the middle of the word “methods”. I would also recommend using the updated reference: Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO₂ measurements. PICES Special Publication 3, 191 pp.

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