

Biogeosciences Discuss., author comment AC2
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Reply on RC2

Richard P. Sims et al.

Author comment on "Tidal mixing of estuarine and coastal waters in the western English Channel is a control on spatial and temporal variability in seawater CO₂" by Richard P. Sims et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-166-AC2>, 2021

Reviewer 2

MAJOR COMMENTS

This paper reports the comparison of pCO₂ measurements with two equilibration systems (both with an infra-red CO₂ detection) along a transect from Plymouth to the reference station L4. The pCO₂ data was extrapolated at larger scale using the salinity fields from a model (FVCOM), and then the air-sea CO₂ fluxes computed.

For the extrapolation the authors use a relation between ξfCO_2 (the difference of fCO₂ values of transects and fCO₂ value at L4) versus ξS (the difference of salinity values of transects and salinity value at L4). The FVCOM computes the salinity fields, that allow to compute ξfCO_2 from ξS on each grid cell of the FVCOM domain. But, in the end to compute the actual fCO₂, the ξfCO_2 needs to be added to the fCO₂ at L4. This is the major weakness of the approach because fCO₂ L4 was extrapolated linearly between the samplings at L4. These sampling are irregular, at best every 15days, in some cases with data gaps of a couple of months (mi-April to mi-June in Figure 12). This needs to be clearly stated in text, as a major limitation.

With such a rich and dense data-set there are several possibilities to extrapolate data. I suggest the authors try an alternative and check if the results are similar. Compute a relation between fCO₂ and salinity and then extrapolate (in time) between cruises the coefficients of the relation (slope and constant of the regression line) and compute directly fCO₂ from the salinity fields of FVCOM.

I like figure 12 comparing the L4 data with the Landschützer product. Even in areas where there is a very dense data coverage in SOCAT such as the English Channel (that is extremely well covered by numerous VOS lines), spatial products extrapolating data from SOCAT are not robust. This is worrying, because if spatial products are not robust in areas of extreme data coverage, things could be worst in areas of low data coverage.

It could be useful to extract from SOCAT the data "close" to L4 and add this to Figure 12. If no such data are available in SOCAT, this should be mentioned in the paper.

I found quite strange that the authors did not mention once the work of Marrec et al. (2013) that reported pCO₂ data from VOS line between Roscoff and Plymouth, so partly in the same sampling area.

We thank the reviewer for their comments and insights.

The reviewer is correct to identify we do not acknowledge the limitation of extrapolating the CO₂ measurements from L4; we have explicitly stated this in the text. Lines 307-310

The reviewer suggests sub dividing the data used to construct the salinity/CO₂ relationship to create a relationship that evolves over time. This is certainly an interesting idea but we feel the reviewer overestimates the amount of data available to us and the overreliance that would place upon single transects from different stages of the tide. This would certainly be an interesting approach to take in a follow up study with more data from sail drones/moorings with CO₂ sensors.

The Landschützer product was provided to give context to the uncertainties in the coastal CO₂ data. We do not wish to distract from the focus of this paper by diverging into a lengthy discussion about the suitability of using such data products at stations like L4. This has caught the attention of both reviewers and is obviously of interest to the community and indicates there is need for a separate study addressing this.

MINOR COMMENTS

L34: SOCAT is an abbreviation that should be defined. Corrected Line 35

L41 : "oversaturated with pCO₂" should read oversaturated in CO₂ with respect to atmospheric CO₂. (same L 360). Corrected Line 42,100,386

L46: "Most research ships have drafts that limit their ability to navigate safely in waters with shallow, irregular topography." and L48 "shallow-bottom boats". Clarified in the text Lines 47-52

Major cities worldwide were built on the shores of estuaries and rivers (London, Paris, Amsterdam, New York, etc) because estuaries have been for centuries major navigation routes. Numerous estuaries worldwide are navigated by large ships including container carriers. Admittedly there are estuaries that are very shallow, but conversely there are numerous large estuaries that can be (and have been) sampled with research vessels of standard construction with "normal" drafts. The sampling of the cited work of Bozec et al. (2012) was carried out on two research ships the "Côtes de la Manche" and the "Thalia" that are admittedly small research boats (about 25 m long), but both have a vessel draught of 3.5 m. It could useful if the authors elaborate the point they want to make with these 2 statements on "shallow topography" and "shallow-bottom boats". Should we develop alternative measuring techniques or instrumentation for shallow estuaries ? Is the extrapolation of seaward data with models of salinity the solution ?

L111: Does it make sense to report pCO₂ values at 0.01 ppm level ? pCO₂ is provided to 2decimal places in SOP5 of Dickson 2007.

L115 : "is installed permanently installed" Yes, corrected Lines 124

REFERENCES

Marrec P., T. Cariou, E. Collin, A. Durand, M. Latimier, E. Macé, P. Morin, S. Raimund 1, M. Vernet, Y. Bozec (2013) Seasonal and latitudinal variability of the CO₂ system in the western English Channel based on Voluntary Observing Ship (VOS) measurements. Marine Chemistry 155 (2013) 29-41

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Marrec et al. (2013) is a key reference that was overlooked by the authors and is now included in the text. Lines 100 and 349.