

Interactive comment on “The Potential of using Remote Sensing data to estimate Air–Sea CO₂ exchange in the Baltic Sea” by Gaëlle Parard et al.

Anonymous Referee #2

Received and published: 21 June 2017

The study by Parard et al. focuses on the very important and interesting aspect of the present-day oceanography, namely on the role of coastal and marginal seas in the global carbon cycle. There is an ongoing debate in the scientific literature if these regions act as sink or source of CO₂. Parard et al. propose to use for the studies on CO₂ fluxes in coastal regions remote sensing tools. In the revised manuscript, they present results from the Baltic Sea. The worldwide context (though poorly presented in the paper) and importance of the problem raised by the authors places, in my opinion, the manuscript within the scope of interests of Earth System Dynamics. However, the manuscript should be first improved in several aspects mentioned below and thus requires further revision.

General comments:

1). The goal of the presented manuscript is ambiguous. It is unclear what is the novelty in the presented research especially in the context of previous publications of the authors in the field. Please specify clearly what is the added value of the presented study.

The goal of the paper is to present from 2005-2011 the air-sea CO₂ flux variability computed with pCO₂ estimated from satellite data in order to study the variability at a seasonal and interannual scale. We will rewrite this part in order to clarify the message. Previous studies from the group has not focused on the flux or the flux variability.

2). The importance of the study could be better presented in the worldwide context of carbon cycling and role of the coastal and marginal seas.

We will rewrite this part to better present the worldwide context.

3). The manuscript should contain better review on the pCO₂ fields and CO₂ fluxes reported for the Baltic Sea in the recent years. There were several papers published on that recently. Important contribution to that issues are also regular measurements of pCO₂ made on the VOS line operated by IOW between Germany and Finland. This comment refers to the entire manuscript but especially to the introduction section where only the paper by Wesslander et al. (2010) is mentioned in that context.

The pCO₂ from the VOS line were used to compute the pCO₂ in our study like it is presented in the paper Parard et al., 2016. In order to improve the paper we will better present a review of the pCO₂ field and in particular the air-sea CO₂ flux. We agree that there are several studies (in particular from German and Polish groups) to include.

4). The methods used in the study are not well described and documented. It is relatively clear how the winds data were established. However it is unclear how the remote sensing data are transferred into pCO₂. I am aware of the ongoing debate on the obstacles with the application of remote sensing in the Baltic Sea. Since I am not an expert on remote sensing I

do not want to judge on that. However, at least the limitations of the remote sensing methods should be discussed in the manuscript in the context of pCO₂ calculations.

The method is fully described in the method paper Parard et al.,2016, and the plagiarism software forced us to remove everything in that section. So in this paper we wanted to focus on the air-sea CO₂ flux variability. We will try to rewrite the method part in a way that the plagiarism software finds non plagiarizing.

5). The CO₂ flux across the air/sea interface is a function of the wind speed and pCO₂ difference between seawater and the atmosphere. Both these parameters are critical for accurate CO₂ flux estimations. It would be meaningful to demonstrate that the pCO₂ fields obtained from the remote sensing data are correct. This could be done by comparison with the available pCO₂ measurements.

The part titled “uncertainty analysis” is where we develop all the discussion about the impact of the parameter on the air-sea CO₂ flux. For the validation of the pCO₂ field from the satellite data, it is already done in Parard et al,2016. To clarify the message we will add a discussion develop this part.

6). Experimental data suggest that there are two minima in seasonality of pCO₂ in the Eastern Gotland Basin, which are related to the spring bloom and mid-summer N₂ fixation. Why this is not seen in the modelled pCO₂ (Fig. 2)? Please comment on that.

This is a good question and we need to develop this part, we used monthly mean data, it could be the reason that we missed this signal.

7). How the accuracy in the determination of pCO₂ fields influence the calculated CO₂ fluxes? The latter, as it appears from Fig.8, are burdened with a relatively high uncertainty. As explain in 5 we need to develop this part.

8). Presenting the results as annual means is not very informative. Fig. 3b gives the impression that seawater is permanently undersaturated with CO₂ (seawater pCO₂ lower from the atmospheric one). This is misleading.

We will present the result differently in order to clarify the message.

9). The entire manuscript requires careful editing. Now it contains number of technical defects. As a part of this work English could be also improved. However I leave this as a suggestion only as English is not my mother tongue.

We will correct the manuscript.

Minor comments:

10). It would be meaningful to add a map of the Baltic Sea showing the places mentioned in the manuscript.

We will do that.

11). Page 2, line 25. Not the best choice of references – paper by Omstedt et al. 2009 does not refer to the global scale

We will change that

12). Please add how big the river runoff is (page 2, line 32) 13). Page 3, line 12. Mixed layer depth is not always on 60m.

We will change that

14). Section 3.2.1. The discussion on seasonal and annual means are mixed up in the text. This causes that it is difficult for the reader to follow the text.

We will correct that

15). Page 6, line 22. I think it should be Fig. 3. 16). Page 6, line 30. Fig. 3 does not show seasonality

We will correct that

17). Page 6, line 30. Outgassing can happen only when seawater pCO₂ is higher from the atmospheric one. It is impossible in summer in open sea.

We will correct that

18). Page 7, line 7. Please name these different satellite products.

We will add the name

19). Page 7, line 12. "flux from the coastal region" – this suggests flux in only one direction – please rephrase.

We will correct that

20). Page 7, line 34. What data this refers to? Fig. 3 shows data for GF also for the period before 2008.

We will rewrite this part

21). Page 8, line 2. Should be these

We will correct that

22). Page 8, line 15. Wrong unit of the wind speed

We will correct that

23). Page 8, line 16. "in function of the basin" – unclear.

We will correct that

24). Page 8, line 26. Please rephrase

We will rephrase

25). Page 9, line 1. Over or in the marginal seas

We will correct that

26). Page 9, line 7. Please reduce the number of figures after comma.

We will change that

27). Page 9, line 11. Please correct citation.

We will change that

28). The abbreviations of the different water basins (GB, CB, GF, SB, BS) should be explained when first time used in the paper 29). Fig. 3a, name data 1, data 2 etc.

We will change that