Dear Anonymous Referee #2,

We very much appreciate your constructive comments, which allowed us to improve the overall quality of our manuscript.

Major issues:

Anonymous Referee #2 Comment (AC): *1. You have used a wind speed product from the NCEP/NCAR reanalysis, which has a spatial resolution of 2.5◦ by 2.5◦ . Your entire study area is quite small (5◦ latitude by 6◦ longitude), and the area where your data are collected and your algorithms are defined is much smaller than that. The wind speeds used thus have a very low resolution compared to the observations, which are all inside one NCEP/NCAR grid cell. I would urge the authors to check the effect on the results from using a higher wind speed product, for example the 0.125◦ by 0.125◦ monthly average data from ERA-interim. Using a higher resolution wind speed product may not affect the MLR results very much, but I suspect that it will matter quite a lot for the calculations of air-sea CO_2 fluxes.*

Author Reply (AR): We followed your recommendation and now use 0.125° by 0.125° monthly average wind speed data from ERA-interim reanalysis as described in section 3.2 of the revised manuscript.

AC: *2. You do not present any uncertainties for your flux estimates. Have you calculated uncertainties? If not, you will have to do this as otherwise you have no basis for your comparison of different provinces nor the comparison of different studies. See for example Lauvset et al. (2013) or Omar et al. (2007) for examples of such a calculation and evaluation. It would strengthen your results tremendously if you can show that your study area is a significant carbon sink over a full seasonal cycle.*

AR: As you suggested, we used the methods from Lauvset et al. (2013) and Omar et al. (2007) to calculate our uncertainties on air-sea CO_2 fluxes, which greatly strengthen our findings. We can now argue strongly on the role of different provinces as significant sink or source of CO_2 over a full seasonal cycle. We are very grateful for this tremendous improvement of our manuscript. We now give an explanation of the method in section 3.5. based on the work of Lauvset et al. (2013) and Omar et al. (2007). All fluxes in the revised manuscript and figures are now given with their respective calculated uncertainties.

AC: 3. *The manuscript is, as mentioned, well structured but is at times difficult to read and it is repetitive. The language would probably benefit from a thorough editing. The authors should carefully revise the entire manuscript for clarity and flow, and remove the many repetitions of certain findings/results/conclusions.*

AR: Based on the remarks of all four reviewers, we have clarified several findings/results/conclusions, which resulted in the removing of several repetitions. Our manuscript has also been corrected by a native English speaker for general improvement of the phrasing.

Minor issues:

AC: *Page 5642, Line 7: The gas transfer velocity coefficient is calculated, the wind speed is the remotely sensed data.*

AR: As recommended by other referees, we now use the wind speed instead of the gas transfer velocity in our algorithms.

AC: *Page 5642, Line 10: "relative uncertainties of 17 and 16 uatm". Relative to what?*

AR: We deleted the term "relative", which made no sense here.

AC: *Page 5647, Lines 13-15: Did you calculate the uncertainty yourself (using known uncertainties in your input data), or did you use the number given by Zeebe and Wolf-Gladrow? If the latter, then the ±5.8 is likely to be the lower end of the uncertainty estimate.*

AR: We used the number given by Zeebe and Wolf-Gladrow (2001). We acknowledge that this is likely the lower end of the uncertainty estimate and we mentioned it in the revised version of the manuscript and gave more details on the DIC/TA accuracies as follow: "The methods used for the analytical determinations of DIC and TA are described in details in Marrec et al. (2014) and gave accuracies of ± 2 and 3 µmol kg^{-1}, respectively. Thus, the computed values of pCO_2 from DIC and TA have uncertainties at the lower end of ± 6 µatm (Zeebe and Wolf-Galdrow, 2001)."

AC: *Page 5647, Lines18-19: "we estimated uncertainties relative to high-frequency pCO_2 measurements of ±5.2" This sentence is not very clear. Do you mean that the underway pCO_2 measurements have this uncertainty? Do you base this on comparison with the discrete data only, or have you also done some form of error analysis for the underway measurements? If*

the former, then 5.2 is probably not different from 5.8 and it would be more correct to say that the discrete and underway measurements give the same pCO_2 values.

AR: We estimated the accuracy of the underway pCO_2 measurements based on comparison with approximately 300 pCO_2 data computed from DIC/TA as detailed in Marrec et al. (2014). In the revised manuscript, we followed your advice and clarified this section as follow: "Sensors were calibrated and/or adjusted based on these bimonthly discrete measurements as described in Marrec et al. (2014). Based on the comparison between high-frequency pCO_2 data obtained with a Contros HydroC/CO_2 FT sensor and bimonthly pCO_2 data calculated from DIC/TA, we estimated high-frequency pCO_2 measurements uncertainties at the lower end ± 6 µatm (Marrec et al., 2014), in the same range as computed values of pCO_2 from DIC and TA."

AC: *Page 5648, Line 26: It is not really binning when you regrid high-resolution data onto a coarser grid, but that is semantics. This terminology is used in other places in the manuscript also.*

AR: We now use the term grid instead of bin, excepted when we spoke about binning the SOCAT/LDEO data (true meaning in this case).

AC: *Page 5652, Line 4-5: It is not necessary to inform the reader that 1.7 times 10 is 17.*

AR: Agree, deleted.

AC: *Page 5652, Line 22: SOCATv2, which has data until 2011, contains 10.1 million measurements from more than 2660 cruises. The information you state here is for SOCATv1.5 which contains data only up to 2007.*

AR: Corrected to SOCATv2.

AC: *Page 5653, Line 8-9: "averaged over each defined province (Fig. 2, Sect. 2)". This needs more explanation, it sounds like you compared one average data point in each province to the algorithm based estimate.*

AR: We included a new figure in the supplement material (Fig. S2) and a short explanation on our methods in Section 3.4.: "We binned the SOCAT and LDEO data into 0.05°*0.05° grid and computed the mean monthly value in each grid cell. The performance of the model was obtained by comparing the mean observed and predicted monthly value in each cell (see

Figure S2 in supplement material and Fig. 2). For each province, the observed and predicted monthly mean based on this 0.05°*0.05° grid cells were plotted on Fig. 8."

AC: *Page 5654, Line 7-8: Like for wind speed, there are higher resolution sea level pressure data products available.*

AR: We now use sea level pressure data products from the ERA-interim re-analysis for higher resolution and mentioned it in Section 3.5.

AC: *Page 5654, Line 22: use smaller than rather than inferior to*

AR: Corrected.

AC: *Page 5655, Line 1-5: These two sentences repeat the same information and are awkwardly written. Please revise.*

AR: We revised these sentences in the revised manuscript in the second paragraph of Section 4.1.: "The seasonal pCO_2 signal followed an average dynamic closed to a sinusoidal signal, with maximal values in fall and minimal values in spring, with transitional values in winter and summer. Therefore, the time variable TI, which is a sinusoidal function, contributed to more than half of the variability of the pCO_2 signal, highlighting the strong seasonality observed on this signal (Fig. 5a). "

AC: *Page 5655, Line 6: Have you checked what the result is if you do not include Chl a in your MLR? It would be interesting to see.*

AR: We made the computation and found that if we do not include Chl-a in our MLR, we obtained R^2 of 0.77 and 0.78 with RMSE of 17.3 µatm and 18.7 µatm, in sWEC and nWEC, respectively. We added the following sentence in the revised manuscript in Section 4.1.: "It is worth noting that when excluding Chl-a in the MLR, R^2 decreased by 0.03 and 0.05 and RMSE increased by 1.4 µatm and 2.1 µatm in sWEC and nWEC, respectively."

AC: *Page 5656, Line 1: do you mean intra-annual?*

AR: We meant inter-annual variability, but we acknowledge that the sentence was not at the good place, which could be misleading. We moved this sentence 4 lines further.

AC: *Section 4.2: You are inconsistent in how you compare the observations (i.e. SOCAT) and the model (i.e. pCO_2 calculated using the algorithms). Always compare the model to the*

observations, not the other way around. In addition, it would be worthwhile to use some of the statistical tools for data-model comparison outlined in (Stow et al., 2009).

AR: We agree and now compare the model prediction to the observations explicitly in section 4.2. We also included a new figure in supplement material (Fig. S2) for statistical data-model comparison as outlined in Stow et al. (2009).

AC*: Section 4.3.1 and 4.3.2: These subheadings do not adequately relate to what is presented in the sections. Both sections mostly discuss variabilities in Chl a, and not pCO_2 or air-sea CO_2 fluxes. Please revise such that the presented Chl a data is better related to the pCO_2 and flux results.*

AR: These subheadings are now called: "Seasonal and biogeochemical controls of pCO_2 in stratified / permanently well-mixed systems". We clarified the discussion and deleted repetitions.

AC: *Figures: Some of the figures, especially Figure 3, have quite poor resolution which makes them difficult to read. Please increase the resolution.*

AR: We increased the resolution as suggested.

References:

Lauvset, S. K., Chierici, M., Counillon, F., Omar, A., Nondal, G., Johannessen, T., and Olsen, A.: Annual and seasonal fCO_2 and air–sea CO_2 fluxes in the Barents Sea, Journal of Marine Systems, 113–114, 62-74, 2013.

Marrec, P., Cariou, T., Latimier, M., Macé, E., Morin, P., Vernet, M., Bozec, Y.: Spatio-temporal dynamics of biogeochemical processes and air–sea CO_2 fluxes in the Western English Channel based on two years of FerryBox deployment, J. Marine Syst., doi:10.1016/j.jmarsys.2014.05.010, 2014.

Omar, A. M., Johannessen, T., Olsen, A., Kaltin, S., and Rey, F.: Seasonal and interannual variability of the air-sea CO_2 flux in the Atlantic sector of the Barents Sea, Marine Chemistry, 104, 203-213, 2007.

Stow, C. A., Jolliff, J., McGillicuddy, D. J., Jr., Doney, S. C., Allen, J. I., Friedrichs, M. A. M., Rose, K. A., and Wallheadg, P.: Skill assessment for coupled biological/physical models of marine systems, Journal of Marine Systems, 76, 4-15, 2009.