We would like to thank reviewer#2 for the thoughtful comments and suggestions. In the following we will respond (in italics) to each reviewer comment (printed in bold font) individually

R#2: The reviewer enjoyed this article very much because the authors described how they merged open and coastal ocean pCO2 mapped climatology. The reviewer also observed that writing nature is very clear and good and procedures that they did are very clearly described. It is however the reviewer would like to suggest some to improve this article, therefore this article can be published ESSD after minor revision as stated below.

Response: Many thanks for the positive evaluation of our manuscript

R#2: 1, Page 4 line 4- On the data treatment about the overlapping area: The authors defined the open region and the coastal region as "covering broadly the open ocean at a distance of 1°, off the coast and, the second dataset, by Laruelle et al. (2017), covering the coastal domain plus the adjacent open ocean up until 400km away from the shoreline". And in page 6 line 2 the authors stated "landward limit of the NNopen is located on average at around 1° (or roughly 100km) offshore". As the authors know 1 degree latitude is almost 110.6 km to 111.7 km but 1 degree longitude depends on latitude and varied from 111.2 km to zero. Therefore the authors should make clear how they define and treat the data as the open ocean.

Response: We concur that using ° and km interchangeably without further explanation may cause confusion. The open ocean product is defined as the ocean area 1° away from shore, which is – as stated by the referee depending on geographical position – variable in km. The Laruelle estimate on the other hand uses the 400km definition, i.e. it is not variable depending on latitude. We have clarified this in the text at the positions indicated by the referee.

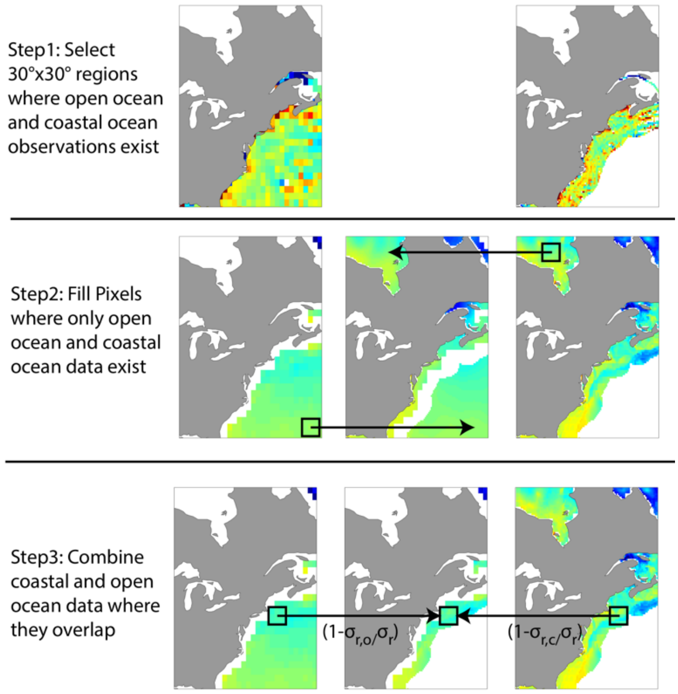
In particular, on page 6 lin2 we added: "While the landward limit of the NNopen is located at 1° (and therefore varies in km depending on the geographical position) off shore, …"

In the conclusions section we further added: " … leading to an overlap domain of roughly 300km close to the equator and increasing in extend towards the poles around the land surface"

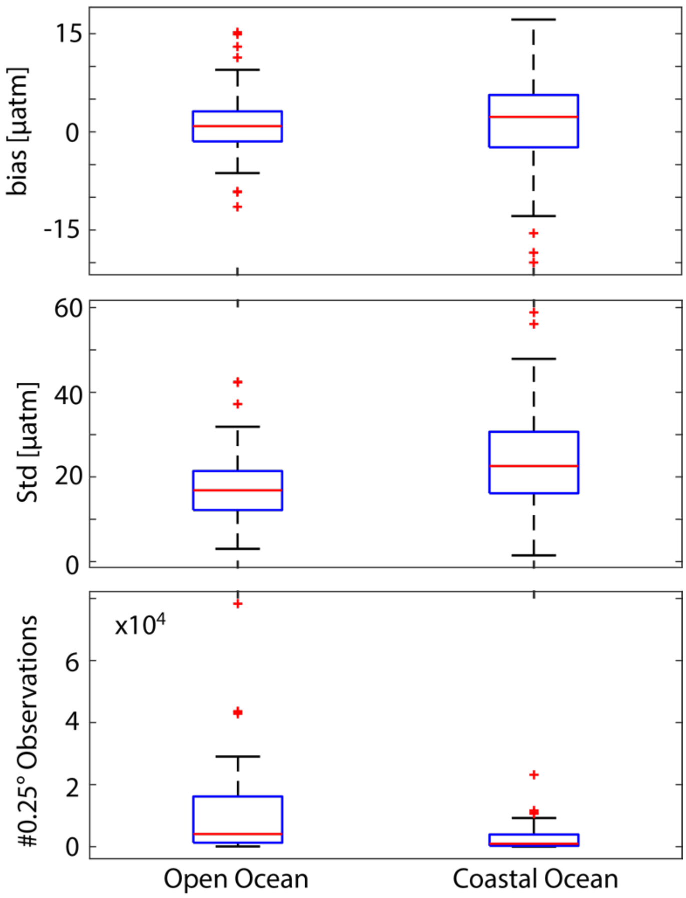
R#2: 2, page 7. Figure 3 is important to understand how the authors merged the open ocean product and the coastal region product. Therefore it might better to enlarge this figure 3. The reviewer also suggests adding a numerical table to show an example of how they merged.

Response: We have now rearranged figure 3 so it appears larger in the manuscript (see figure (a) below). Additionally, we have added another figure (instead of a table – see (b) below) highlighting the statistics of the merging algorithm (new figure illustrated below including number of observations, mean differences and std differences within each 30x30 box). We believe that the newly introduced box-whisker plot is easier to grasp than an example highlighted in a numeric table.

(a)

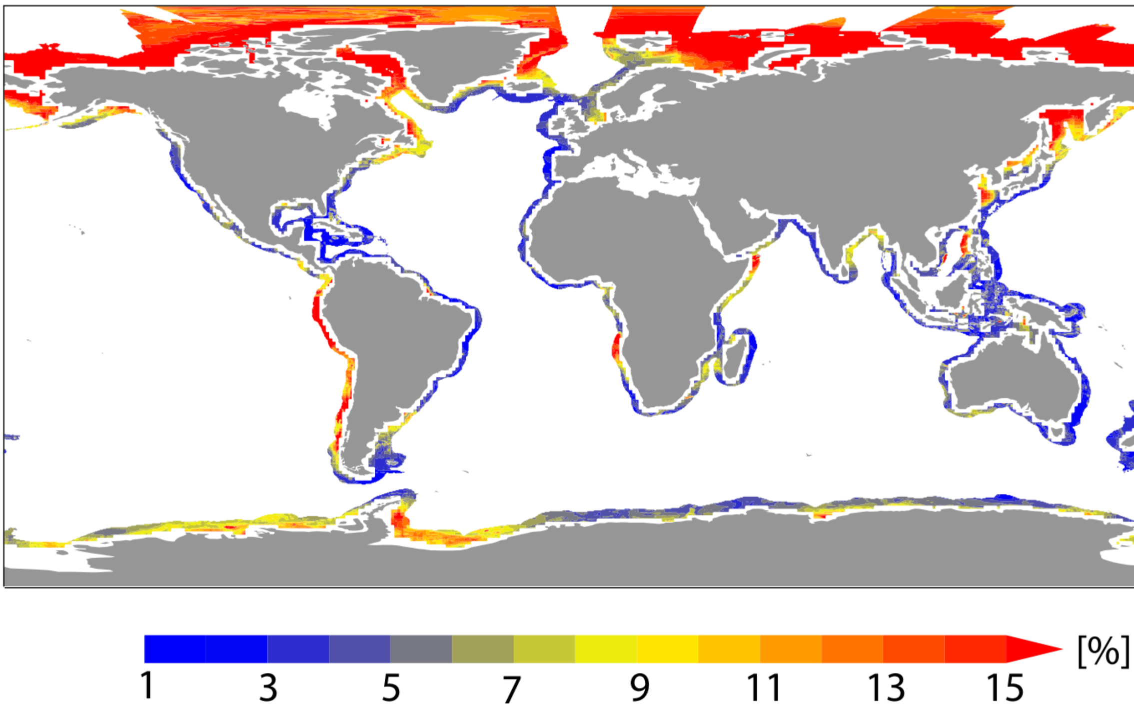

Step1: Select 30°x30° regions where open ocean and coastal ocean observations exist
Step2: Fill Pixels where only open ocean and coastal ocean data exist
Step3: Combine coastal and open ocean data where they overlap
(1-σr,o/σr)
(1-σr,c/σr)

(b)


bias [µatm]
15
0
-15
Std [µatm]
60
40
20
0
#0.25° Observations
x10⁴
6
4
2
0
Open Ocean
Coastal Ocean

R#2: 3, page 10 In the Figure 5, the maximum of a color bar of mismatch percent means that clear red indicates exceed 10 %. The reviewer suggests extending this color bar at least 15 % or 20 % to clearly show the regions where the mismatch is large because a smaller mismatch region does not need to highlight but a larger mismatch region should be highlighted.

Response: We have now increased the maximum value of the colorbar accordingly to 15% and changed the color palette to better highlight regions with larger mismatch (see updated figure below). We concur that we could further expand the upper limit, however, we would therefore miss to represent the geographical finer scale differences (e.g. along the Antarctic continent).



R#2: 4, Page 14 line 3. The authors discussed about Sea of Japan. It is however this region is a marginal sea and it not appropriate to compare NNopen and NNcoast here because the Sea of Japan might be included into coastal region following 400 km definition from the Japanese coast and Korean/Russian coast. Furthermore, there are probably no observed data at the Korean/Russian side based on Figure 9 (c). Therefore it is better to delete this part from this article.

Response: Many thanks for this keen observation. As can been seen in Figure 2 and Figure 9 of the manuscript, both open ocean and coastal ocean datasets in the SOCAT databases include measurements from the Sea of Japan. That said, we believe that including a marginal Sea in this intercomparison is an exciting opportunity to compare how both open ocean and coastal ocean reconstructions are able to represent in a marginal sea. We see this as relevant information to users who want to use the product to investigate this and other marginal seas. As illustrated in Figure 9 e and f, both products struggle to reproduce the available data, which indeed may be related to the fact that coastal and open ocean products have difficulties reconstructing the dynamics of this marginal Sea. So instead of removing this part, we have expanded the discussion of the mismatch in light of the fact that this region comprises a marginal sea.

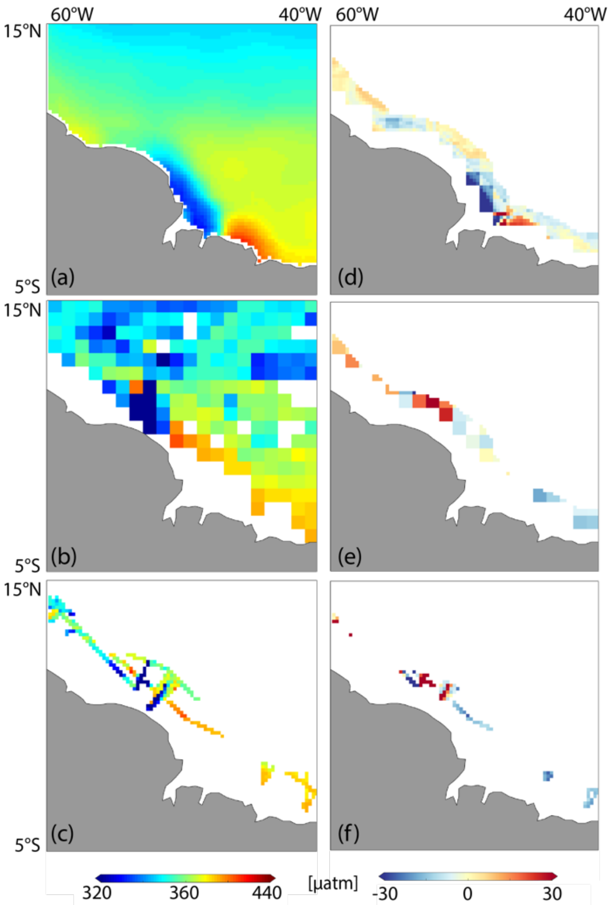
In particular, we added in the first paragraph of the Regional Analysis section: ", two data rich regions (Sea of Japan, US east coast) of which one comprises a marginal sea (Sea of Japan), one *region where seasonal data are scarce (West Coast of Australia), and a region characterized by strong river outflow (Amazon river plume)."*

We also extended the discussion regarding the Sea of Japan which now reads: "The strong variability in the observed pCO2 reflects the complex carbon dynamics in the Sea of Japan (Chen et al 1995, Park et al 2006), which is also reflected in the larger mismatch between products and towards the SOCAT observations (figures 10 d-f). The disagreement may indicate that the global scale NNopen and NNcoast products are not particularly skilled in representing the strong regional dynamics of marginal sea."

Finally, we added to the conclusions: "However, stronger differences exist in other parts of the world, particularly in the Peruvian upwelling system, the Arctic and Antarctic, the African coastline in the South Atlantic and the Arabian Sea, where fewer observations exist. Additionally, we find larger discrepancies in the marginal Sea of Japan."

R#2: 5, Figure 6,7,8,9,10,11,12: In (d)(e)(f) of these 7 figures, it is a little bit difficult to see the differences. Especially to distinguish difference zero region and no data region because the authors assigned no fill to both regions. Please re-draw these figures.

Response: We concur that differences close to 0 are more difficult to spot, and we have therefore adjusted the colorbar accordingly so that 0 values are not displayed white. We nevertheless chose a "soft color", i.e. yellow, to display values close to 0 as we intend to highlight discrepancies from 0 in these plots. Below is an example of the reworked figures (using the Amazon outflow as example region)



R#2: 6, P21 line 19- The authors stated that "Despite the lack of seasonal observations along the West coast of Australia, both products agree well with regards to the seasonal cycle and differences stay within of 8-10µatm between the different products.". The reviewer observed in figure 13 that in these three regions NNopen and NNcosat products showed a minimum or a maximum although there are no observed data at the time of a minimum or a maximum, eg. a minimum in September on the west coast of Australia. The reviewer cannot understand how NNopen and NNcosat products there were produced and showed a minimum/maximum. Please explain this.

Response: Both products (coast and open ocean) are the result of a neural network interpolation of all available observations regressed onto driver data (see also methods here and in Landschützer et al 2014 and Laruelle et al 2017 cited in this work). Whenever there are no local observations available, the pCO2 is reconstructed from observations that fall within the same biogeochemical province, defined by a self-organizing map algorithm. In a second step all observations from the same province are regressed against physical (temperature, salinity, mixed layer depth), chemical (atmospheric CO2) and biological (chlorophyll a) driver data using a non-linear neural network-based regression approach (a feed-forward network). Based on the variability of these driver data the resulting pCO2 fields show variability in space and time and – in this particular case – a minimum in September largely owing (as we believe) to the solubility pump.

R#2: 7, Page 21 line 17- The authors stated that "Therefore, the combined pCO2 climatology is not only a step forward in including the full oceanic domain with all its complexity into carbon budget analyses, but also help identify areas where additional continuous observations are critically needed to close current knowledge gaps.". The reviewer completely agree this statement and would like to suggest to add some recommendations explicitly from the authors to the community about areas where additional continuous observations are critically needed to close current knowledge gaps. If the authors do so, the contribution of this article to the community will increase much.

Response: We now expanded on this statement to provide explicit recommendations based on the findings of this manuscript. In particular, we mentioned the Peru upwelling system and high latitudes as prime example, since we face a critical monthly difference between open ocean and coastal ocean reconstructions, and we believe that this huge gap cannot be closed improving the methods, but only by observing the true pCO2.

In particular, we added to the conclusions: "The overlap analysis proposed here and particularly the Percent mismatch and RMSE analysis, further serves as a benchmark on how well we understand the coastal-to-open ocean continuum and its spatial variability and where we still lack essential measurements to close the gap between existing estimates, such as e.g. the Peruvian upwelling system or the seasonally ice-covered high latitude regions, in particular the Arctic Ocean"