Reviewer comments in gray italics, my answer in black and the changes in the text in "…" and bold

Answer to referee 1:

"The authors state that "Our primary intention is to make use of the coarse resolution existing pCO2 estimates to provide novel and fine-resolved coastal estimates". However, the use of the Rödenbeck open-ocean data in the interpolation leads to incorrect patterns in particular to an artificial west-east gradient in the North Sea. While I understand that the authors cannot resolve the problem related to the resolution of the Rödenbeck data, I do not understand how this can generate the west-east gradient in the North Sea, since the North Sea is only open to the North Atlantic in the far North, and the west-east gradient in the North Sea is observed all along the eastern coast of the UK. Does this mean that the data in the North Sea are somehow interpolated with the North Atlantic data assuming the UK is transparent? In conclusion, I fail to see to usefulness of "fine-resolved coastal estimates" that are simply wrong (bluntly artificial patterns in the North Sea) and do not compare satisfactorily with the original data."

We see in this comment two major points, that we would like to address separately: the question about gradients in the North Sea on one hand and a technical question about how the interpolation scheme used by the Rödenbeck open ocean product effects our coastal maps on the other hand.

First of all, we want to mention that we never claimed our maps to perfectly reflect all variability. Our aim is to provide a new state-of-the-art estimate for pCO_2 and CO_2 flux variability over the entire North Sea. For the North Sea, we report an uncertainty of 26 µatm for fCO_2 and 0.5µatm/yr for the trend in fCO_2. These uncertainties are important to keep in mind when discussing possible gradients in the pictures we show in this manuscript as they are in the same order as one step in the colorbar.
Secondly, we disagree with the claim of the referee that this west-east gradient in the North Sea is entirely artificial. E.g. in the southern North Sea, studies revealed that there are different seasonal cycles of pCO_2 reported in the literature (Voynova et al., 2018), where they found a larger amplitude in the eastern part of the North Sea than in the western part. This will lead to a longitudinal gradient at least during some parts of the year. In the northern North Sea, Omar et al. (2019) found a slightly different seasonality in pCO_2 as well as a larger trend in pCO_2 west of 5˚E (2.39±0.58 µatm/yr) than east of 5˚E (1.2±1.5 µatm/yr).

We think that the technical aspect of the referee's comment is very valid. Here, we first want to clarify that the position of the 5x4 grid boxes in the open ocean product is not a problem, as the grid box border passes through the 2.5˚W line, which crosses the UK almost completely on. The second aspect here is the interpolation scheme that is used to produce the Rödenbeck et al open ocean product. This indeed ignores land masses as if they are not existing. While this certainly is not perfect, we do not think that this is a big problem at this place. Firstly, the British Isles are still relatively small compared to the correlation length. Thus, the distance going around the isles presumably is not that much longer than going across the isles. Therefore, one would expect correlations between west coast and east coast, of course smaller than for a direct ocean connection. Secondly, this is a region with a lot of observations available, which reduces the effect of the correlations on the final product. Thirdly, running the MLR and fitting the Rödenbeck et al. pCO_2, together with other driver data, to fCO_2 observations in the North Sea will adjust for possible Atlantic influences at least partly. We believe that this is actually one

of the reasons, why we reach a much better performance with our MLR compared to the original Rödenbeck et al product.

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> **«Another impact that the open ocean *p*CO_2 product of Rödenbeck et al can have on MLR 1 is the potential introduction of patterns from regions further away as the spatial correlations used in producing the Rödenbeck et al. *p*CO_2 just ignore land barriers. However, the influence of these spatial correlations is relatively small in regions with a high data density (as the European shelf) and the multi linear regression used to produce MLR 1 corrects at least partly for it. »**