Responses to comments from reviewers on the paper "Reconstruction of super-resolution ocean pCO₂ and air-sea fluxes of CO₂ from satellite imagery in the Southeastern Atlantic", *by I. Hernández-Carrasco et al.*

Dear Editor,
Please find enclosed a new version of our manuscript and a detailed response to the comments of the reviewer.

Sincerely,

The authors

Comments to authors:

Some of the comments from a reviewer have not been properly addressed by the authors. Before publication all comments listed must be satisfactorily addressed:

Authors:

We would like to thank the Reviewer for his/her useful comments that helped us to improve the manuscript.

Reviewer:
Particularly a valid discussion why the authors use their set predictor data is vital: Please provide interpretation as to why chlorophyll and SST are the only predictor data used in the method. Indicate and explain why not e.g. sea surface height? There are many possible combinations which might influence your overall results and errors.

Authors:
We have chosen SST and Chlorophyll variables as predictor data because of two major reasons : i) the dynamics of SST and Chlorophyll variables are related to the dynamics of pCO₂ (we refer Reviewer to Sec. 3.2 of the manuscript for more details), and ii) the availability of high spatial resolution satellite images of SST and Chlorophyll (~5km). This allows us to incorporate the small scale information to the low resolution pCO₂ images by means of the microcanonical cascade. In this study we focus on the use of physical variables which are correlated spatially and temporally to pCO₂ and that can be obtained from satellite at high resolution. Any physical variable can be incorporated into the linear regression process as long as a linear relationship between its singularity exponents and those of pCO₂ has been established; basically such a linear relationship is an indicator of a strong correlation between respective coherent structures and their temporal evolution in the nonlinear process of ocean dynamics. In order to get a more reliable inferred pCO₂, future studies could be addressed, for instance, to include in the methodology salinity and/or SSH parameter. Salinity is usually an excellent proxy for total alkalinity so it could be logical to add it in the linear regression (Eq. 3 of the manuscript) from the model outputs to construct the Singularity Exponents proxy for super resolution pCO₂. In the case of Sea Surface Height, SSH, it could be connected to the dynamics of pCO₂ but the spatial resolution from satellite is still presently far too poor to resolve the submesoscale.
We have included one sentence at the end of the first paragraph in Sec. 3 (page 5 lines 404-408) in order to clarify this choice.

Reviewer:

Regarding possible misunderstanding on the reviewer's comment regarding the atmospheric xCO2: you use GLOBALVIEW atmospheric xCO2 data, but for the flux calculation you use the partial pressure difference between ocean and atmosphere, hence (pCO2ocean - pCO2atmosphere). However, GLOBALVIEW xCO2 is not available in partial pressure units, but reported as molar fraction (in ppm). As mentioned in the initial review, GLOBALVIEW CO2 data needs conversion from xCO2 to pCO2 in order to calculate the partial pressure difference and the flux, e.g. using the equations in Dickson et al. 2007 (otherwise you calculate pCO2ocean - xCO2atmosphere). The question is: have you converted xCO2atmosphere to pCO2atmosphere, since the difference between the two can make a difference locally, depending on the sea level pressure?

Authors:

Our sincere apologies, we did not understand your original query. Indeed the partial pressure of CO_2 (pCO_2) is determined from its mole fraction (xCO_2), which is the number of moles of CO_2 divided by the total number of moles of all components in the sample, by the following equation (Dickson et al., 2007): $pCO_2 = xCO_2 \cdot p$, where p is the total pressure of the mixture. Both pressure values are expressed in microatmosphere (μatm) and $xCO2$ is in $\mu mol.kg^{-1}$. We assumed the pressure to be close to 1 atm (where most equilibrators function) for the conversion, following ORNL/CDIAC 105 report (Program developed for CO_2 Systems calculation). We are aware this is an approximation since we did not consider seal level pressure variation. However at Ascencion Island, the average sea level pressure has varied from the atmospheric value of 29.92 inches of Hg from $\pm$ 0.4% over the year 2008 for instance (between 29.80 and 30.04 inches of Hg).