

# ***Interactive comment on “Reconstruction of super-resolution fields of ocean $p\text{CO}_2$ and air–sea fluxes of $\text{CO}_2$ from satellite imagery in the Southeastern Atlantic” by I. Hernández-Carrasco et al.***

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## GENERAL OVERVIEW

The manuscript uses a combination of remotely sensed low-res air-sea  $\text{CO}_2$  flux and high-res Chl-a and SST to arrive at high-res air-sea  $\text{CO}_2$  fluxes. The authors present a method new to this application and the publication fits within the scope of BGD. The manuscript is well written and is relatively error-free with a few inconsistencies in abbreviations. The methodology presented to arrive at a high-resolution air-sea  $\text{CO}_2$

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flux result is comprehensive, but tricky to follow if the reader is not familiar with the jargon. The authors should be aware of this and simplify wording as much as possible. There is no discussion this paper, but given the methodological nature of this study I do not think this is a critical omission.

I enjoyed reviewing This manuscript and I think this approach has great potential for high temporal and spatial resolution  $CO_2$  surface data with some refinement.

## SCIENTIFIC REMARKS

### Title

The title does capture the topic that the paper discusses; however, I do feel that fields of does not contribute to the reader's understanding of the topic.

### Introduction

The introduction introduces the topic well and do reference the appropriate work in most part. However, I feel that the authors should mention statistical learning methods in their introduction. While the approach is quite different it is also a data based approach to derive  $pCO_2$  - some noteworthy mentions are Landschutzer et al (2014) and Telszewski et al., (2009). Though none of these methods have focused specifically on coastal regions.

### Data

It is good that the authors use and compare the different datasets.

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I like the approach used in this study; however, it is fairly involved and may be confusing for some readers. It is noted that the authors do provide an overview of the methods on page 1415 L21, but it would be useful to have simple overview of the methodology such as that shown below.

1. CarbonTracker provides surface  $CO_2$  fluxes
2. Flux is used to calculate  $pCO_2^{sea}$  at low resolution ( $pCO_2^{sea(LR)}$ )
3. Use satellite SST, SSS and CCMP for winds
4.  $F = K(pCO_2^{air} - pCO_2^{sea}) \Rightarrow pCO_2^{sea} = pCO_2^{air} - \frac{F}{K}$
5. Use MMF to extract the dimensionless singularity exponents of SST, Chla,  $CO_2^{LR}$   $CO_2^{HR}$  from ROMS-BIOEBUS (various resolutions) output
6. Calculate the linear relationship between SST, Chl-a,  $CO_2^{LR}$  and  $CO_2^{HR}$  singularity exponents from ROMS-BIOBUS
7. Find singularity exponents of satellite SST, Chla and  $CO_2^{LR}$
8. Use coefficients from ROMS-BIOEBUS (step 4) and apply to the singularities from the satellite data (step 5) to infer the singularity exponent  $CO_2^{HR}$
9. Reconstruct  $pCO_2^{HR}$  from the cross-scale inference of  $pCO_2^{LR}$
10. Calculate air-sea  $CO_2$  fluxes from  $pCO_2^{HR}$ , temperature and wind.

I like the use of model data (ROMS-BIOEBUS) to estimate the MLR coefficients and estimating the accuracy of the method. This does make the assumption that dynamics

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of SST, Chla and  $pCO_2$  in the model and satellite data operate on the same scale. The authors do allude to this and justify the adequacy of ROMS-BIOEBUS. It would be good if this inference were stated a bit more explicitly. Perhaps a figure showing the PDFs of the ROMS-BIOEBUS data would address this concern?

The authors mention an error of  $2.4 \mu\text{atm}$  when the method is applied to ROMS data. A relative error of 0.6% is given - relative to the  $pCO_2$  range? This is a small error relative to the range of  $pCO_2$ . What is this average difference/error between the ROMS high-res and the ROMS low-res data? An error relative to the (high-res/low-res) may be more telling.

The authors also mention a paper by in review Sudre et al. (2015) on several occasions. I do not feel that this will be a problem once this paper has been published; otherwise I do not feel the authors should cite this work.

## Results

The use of mean error (ME) here is unusual. For their purpose of use, the use of ME seems OK, but it is essentially the difference of the means of the two datasets (the inference bias). Given its similarity in nomenclature to Mean Squared Error (MSE analogous to AE), I think that the authors should consider a different name for this error. This is especially true, as they do not use it for the same purpose as one would use MSE.

It would be good to see ( $pCO_2^{insitu}$  vs.  $pCO_2^{ctrack}$ ) and ( $pCO_2^{insitu}$  vs.  $pCO_2^{infer}$ ) plots for more data. Points could be coloured by longitude.

The comparison of in-situ, inferred and CarbonTracker data shows the potential of the method presented in this manuscript as well as the shortcomings of using CarbonTracker data for the estimation of air-sea  $CO_2$  fluxes. I think that the authors should briefly state that the output will only be as good as the input.

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## Figures

General comment on line figures: as a colour-blind reader, I struggle to see yellow lines on white back ground. It is not imperative that this changed, but would be better in a darker shade.

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**BGD**

12, C251–C257, 2015

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Page and line	Phrase or topic	Correction or comment
P1406 L26	interacts	interact
P1407 L19	Let's cite here the work of. . .	This sentence seems a little clumsy
P1407 L17-L25	Possible missing citations	The authors fail to mention statistical learning methods and associate literature – (Lachkar and Gruber, 2012; Landschutzer et al., 2014; Telszewski et al 2009 and several others)
P1409 L7	has been proved to be innovative. . .	has been proven innovative . . .
P1409 L16	relates closely the	relates closely the – a bit clumsy otherwise
P1410 L4	Section 3	Inconsistent abbreviation
P1411 L12	sea-state	Sea state should not be included here as this is part of the parameterisation – wind accounts for this.
P1411 L24	$pCO_2$ -air	Authors use Ascension Island as a reference. Would Cape Point, South Africa not be a closer reference? <a href="http://www.esrl.noaa.gov/gmd/ccgg/obspack/labinfo.html">http://www.esrl.noaa.gov/gmd/ccgg/obspack/labinfo.html</a>
P1411 L26	Garbe and Vihhrev (2012) approach	Briefly mention what their approach is – reader does not know what this approach is.
P1412 L5	retain very well the structure of the CarbonTracker fluxes	retain the structure of the CarbonTracker fluxes very well
P1415 L21	The idea	Be a little more specific about which idea
P1415 L26	Partial pressure $pCO_2$	Partial pressure ( $pCO_2$ )
P1416 L1	good characteristics	What are good characteristics of a linear regression in this case?

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Page and line	Phrase or topic	Correction or comment
P1420 L11	relative error	Relative to total $pCO_2$ . See scientific remarks section for more on this.
P1424 L18	how different can be the coverage of the $pCO_2$ field can be depending. . .	how different coverage of $pCO_2$ can be in the field depending. . .
P1426 L28	Abbreviations	Why not apply these from the start. They make it much easier to follow the discussion.
P1427 L24	Showing that have of the measurements is geographically in the coastal region of Benguela, outside the. . .	Showing that half of the measurements fall within the coastal region of the Benguela (land masked by CarbonTracker)
P1428 L8	study qualitatively	qualitatively study
P1440 Tab4	No valid intersections	Should this be number? If so add No.
P1444 Fig3	a, b	Make colour scales the same
P1446 Fig5	c, d, e, f	Ensure that scales are the same for $pCO_2$ and $FCO_2$ for inter-comparison.

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