

Interactive comment on “On the role of climate modes in modulating the air-sea CO₂ fluxes in Eastern Boundary Upwelling Systems” by Riley X. Brady et al.

Riley X. Brady et al.

riley.brady@colorado.edu

Received and published: 14 December 2018

Reviewer #1:

Review of manuscript bg-2018-415 “On the role of climate modes in modulating the air-sea CO₂ fluxes in Eastern Boundary Upwelling Systems” by Riley X. Brady, Nicole S. Lovenduski, Michael A. Alexander, Michael Jacox, and Nicolas Gruber.

Summary:

C1

This is a nice piece of work trying to link modes of natural climate variability to fluctuations of air-sea CO₂ fluxes in Eastern Boundary Upwelling Systems (EBUS). The latter regions reveal strong upwelling of cold and nutrient-rich water masses, a prerequisite for ecological richness and diversity. Although small in area, EBUSs play an important role in the air-sea exchange of CO₂. Utilizing 34 ensemble members of simulations with the Community Earth System Model (CESM-LENS) the authors have analyzed the correlations between natural climate variability (ENSO, PDO, NAO, ...) and air-sea CO₂ fluxes for each of the four EBUSs.

The manuscript is clearly written and the conclusions comprehensible. Therefore, subject to very minor revisions I recommend publication in Biogeosciences.

We would like to thank referee #1 for their time in reviewing this paper. Their suggestions substantially improved this manuscript. Please see the supplemental pdf to this response for a tracked changes version of the revised manuscript.

Specific Comments:

1. page 5 equation 2: The variable U is not defined (presumably wind speed).

Thank you for catching this error. We now define U as wind speed in page 5 line 10, since it is introduced as being a factor in calculating k .

2. page 5 last sentence: “To compensate for autocorrelation ...” This should be explained a bit more in detail. Readers not familiar with the statistical methodology will not understand it.

Thank you for this suggestion. We agree that in its original form, the explanation

C2

was not entirely clear. We have now updated the manuscript to the following:

Autocorrelation is prevalent in climate indices such as the NPGO and ENSO (Di Lorenzo and Ohman, 2013), and our annual smoothing further enhances autocorrelation in CalCS and CanCS air-sea CO₂ fluxes (see Sections 3.3.1 and 3.3.3). To compensate for this autocorrelation, we replace the t-statistic sample size N with an effective sample size N_{eff} , which quantifies the number of statistically independent measurements: . . .

3. page 6 lines 18+19: "... the data density of pCO₂ in EBUS informing the SOM-FFN is on the order of the Southern Ocean, ..." This statement is too vague. It would be good to be a bit more quantitative.

Thank you for this suggestion. We have quantified this by taking the mean number of observations informing the SOM-FFN for each EBUS (following the regions shown in Figure 2e and 2f) and for the Southern Ocean (south of 40S). Page 6 lines 18+19 were updated to the following:

Another important caveat is that the average number of pCO₂ observations in EBUS informing the SOM-FFN (637, 119, 517, and 195 for the CalCS, HumCS, CanCS, and BenCS, respectively) is on the order of the Southern Ocean (536), a notably undersampled region (Figure 2e and f; Bakker et al., 2016).

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