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# *Interactive comment on* "On the role of climate modes in modulating the air-sea $CO_2$ fluxes in Eastern Boundary Upwelling Systems" *by* Riley X. Brady et al.

**Riley X. Brady et al.**

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## 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:

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-reach 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*





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*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 $CO_2$ 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 $pCO_2$ 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).*

## References

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