

### Answers to the Reviewer 3

We would like to thank the Reviewer for his constructive comments, suggestions and corrections. Please, find below our response to your comments, on a point by point basis. Your comments are recalled in red and our responses are written in purple.

**RC3:** 'Comment on esd-2021-46', Anonymous Referee #3, 17 Sep 2021

#### 1. General Comments

The authors of this manuscript investigate the present-day and future boreal summer (JAS) rainfall and sea surface temperature (SST) variability in the eastern and equatorial Atlantic using 31 historical and scenario simulations from the sixth phase of the Coupled model Intercomparison Project (CMIP6). They show that the rainfall annual cycle, computed for the period 1985-2014, in the Guinea Coast is generally well simulated. Yet, a wet bias persists in boreal summer due to a large SST bias in the eastern equatorial Atlantic and south Atlantic regions. The rainfall variability is strongly linked to the SST variability in this region and therefore the SST variability in the eastern equatorial Atlantic is also investigated. The authors show that relative to the present-day situation, in a climate with a high anthropogenic emission of greenhouse gases, the eastern equatorial Atlantic JAS SST variability weakens. They show that the reduced SST variability in the equatorial Atlantic could be due to a weakening of the Bjerknes feedback. As a result, relative to the present-day situation, in the future they also find a reduction of the rainfall variability over the equatorial Atlantic Ocean and Guinea coast in a majority of the CMIP6 considered.

The article is well written and addresses an important topic with detailed results. In my view the results are within the scope of ESD and therefore, I recommend minor revision before publication following the different aspects provided bellow.

#### 2. Specific Comments

##### Abstract

**L3.** I would state that both historical and scenario (SSP5-8.5) simulations from 31 GCMs from CMIP6 are used throughout the study.

We will modify the statement as suggested, thank you.

**L6.** Add “boreal” to the sentence “This bias is associated with too high mean summer SSTs”

The boreal summer will be explicitly mentioned in the revised manuscript.

##### Introduction

**L31.** The acronym ATL3 is used in this study to refer to the Atlantic Niño. It is generally more used to define the region where the Atlantic Niños occur (20°E-0°E; 3°E-3°N). The authors have defined this region with the acronym ATL3B in Table 2 but ATL3B is never used in the manuscript.

We will remove the acronym ATL3B, and keep ATL3 for the Atlantic Niño region.

## Data and methods

**L132.** Please, can you explain how the anomalies were computed. Do you remove the climatological monthly-mean seasonal cycle?

The climatological monthly mean is first removed from each data set, for each considered period. The resulting anomalies are then quadratically detrended and averaged over three months, July-August-September. In the revised paper, we will linearly detrend each monthly anomalies of each data before averaging over the JAS season. We will add this information in the revised manuscript.

## Section 3.2

**L200.** The title of the section says “JAS mean” but the JAS mean is not discussed.

We missed this discussion. It will be taken into account in the revised version of the paper. Thank you for this remark.

**L214.** “The winter Atlantic Niño” was defined as the “Atlantic Niño II” by Okumara and Xie (2006).

We will refer to this article in the revised manuscript.

Okumura, Y., & Xie, X. (2006). Some overlooked features of tropical atlantic climate leading to a new Nino-like phenomenon. *Journal Of Climate*, 19, 5859-5874. doi:10.1175/JCLI3928.1

## Figures 1 and 3:

I would like to see the cross-correlation between the GC rainfall anomalies and ATL3 SST anomalies. As in the CMIP6 ensemble, both the ATL3 SST variability and the GC rainfall variability peak in JJA and assuming that the maximum of correlation is found at 0 lag then why not regressing JJA SST (rainfall) anomalies on the standardized JJA ATL3 index in Figure 4 (Figure 5)?

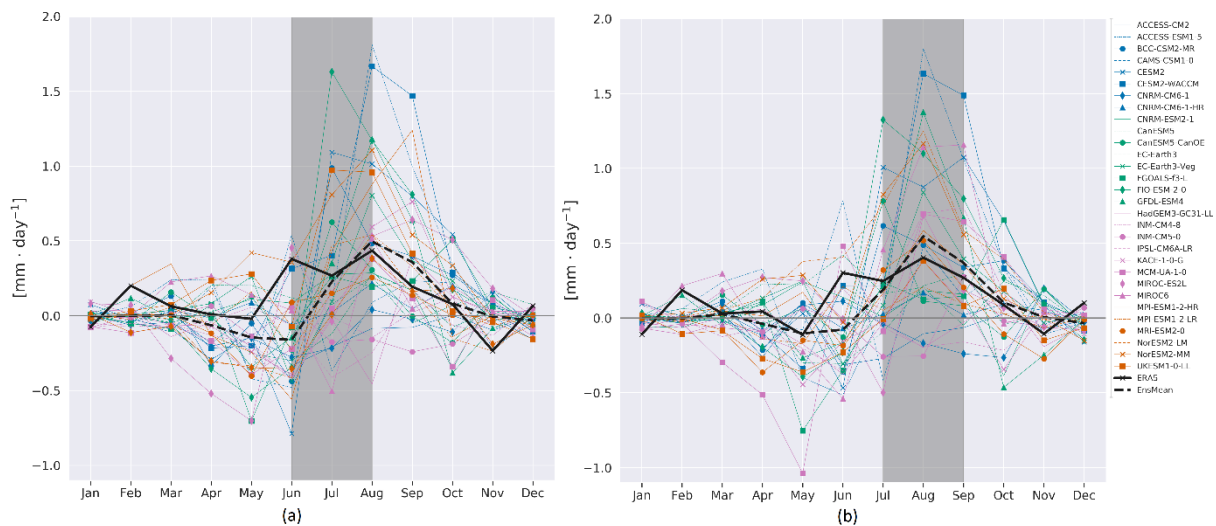


Figure R 1 Monthly rainfall anomalies of Guinea Coast regressed onto the JJA (a) and JAS (b) standardized ATL3 index over the 1985-2014 period. Outputs from 30 CMIP6 historical simulations and ERA5 are analyzed. Gray vertical bands indicate the SST season considered in each case.

The Figure R4 shows the monthly stratified regression of the Guinean Coast rainfall onto the JJA and JAS standardized ATL3 index over the 1985-2014 period. Results indicate that the CMIP6 ensemble mean response of the Guinean Coast rainfall is maximum over the JAS season in both cases. As our study is focused on the impact of the Atlantic Niño on the Guinea Coast rainfall, we therefore consider the JAS season instead of the JJA and we will explain this choice in the revised manuscript

#### Section 4.1:

To investigate the boreal summer Atlantic Niño pattern why not regressing the JJA SST anomalies onto the standardized JJA ATL3 index?

As shown and discussed in section 3.2 the ATL3 variability peaks in JJA in the CMIP6 ensemble corresponding to the Atlantic Niño activity in the ATL3 region. Therefore, when looking at future Atlantic Niño changes, I would recommend to use JJA and not JAS.

We are interested in the covariability between the Atlantic Niño and the rainfall in Guinea Coast, which peaks in JAS in the CMIP6 models, as displayed in Fig. R4. This is our motivation for the choice of this season. However, we verified that our conclusions remain unchanged whether we choose JJA or JAS. For instance, Figure R5 shows a weakening of the SST pattern related to the Atlantic Niño in the future periods relative to 1985-2014 both in JJA and JAS.

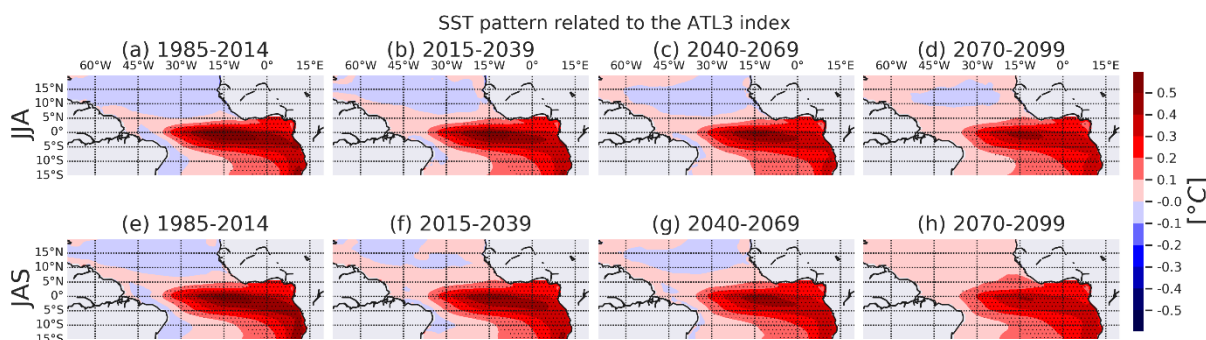


Figure R 2 Regression maps of the SST anomalies onto the standardized ATL3 index for the JJA (a-d) and JAS (e-f) seasons and four different periods. Displayed maps correspond to the multi-model ensemble mean patterns from 30 CMIP6 models. Stippling indicates grid points where more than 50% of the models show significant coefficients at 95% level and more than 80% of the models agree on the sign of the regression coefficient.

**Figure 4:** One could draw the TAB1 and TAB2 boxes on Figure 4 if it stays legible.

TAB1, TAB2 and ATL3 regions will be drawn on the figure.

#### Section 4.2:

**L241.** Should be: “Figure 5(a) displays the regression maps of the JAS rainfall anomalies onto the standardized JAS ATL3 index”, correct?

Yes, the statement is correct. Thank you, we will take it into account in the revised manuscript.

**L254-L256:** 31 models are present on Figures 4, 5 and 6 but only 30 models are in the GC groups (24 + 6).

Yes, this is because the model GISS-E2-1-G has been discarded, as the sign-dependent average of the rainfall anomalies related to the Atlantic Niño is insignificant over Guinea Coast. In the revised manuscript, the GISS-E2-1-G model will not be used, so that the total number of models will be 30. We will add this information to the revised manuscript.

**Figure 6. caption:** Should “associated with the standardized ATL3 index” be “associated with the JAS standardized ATL3 index”?

Yes, the correction will be applied in the revised manuscript.

#### Section 5.1:

**Figure 7:** From (a) to (b) I recommend the authors to keep the same color for the different periods.

The same color will be kept for the same periods.

**Figure 9 caption:** Should “Rainfall anomalies associated with ATL3” be “JAS rainfall anomalies associated with JAS standardized ATL3 index”? Same question for the rest of the subpanels.

Yes, the remark is correct. However, this figure will be removed from the revised manuscript, as suggested by the reviewer 5, as it contains redundant information already depicted in Figure 8.

**L384.** Should “First, the GC+ group (the 24 models in Sect. 4.2 which simulate a realistic GCB rainfall associated with one standard deviation of the ATL3)” be “First, the GC+ group (the 24 models in Sect. 4.2 which simulate a realistic JAS GCB rainfall associated with the standardized JAS ATL3 index)”?

Yes, the remark is correct, we will take it into account, thank you.

### **Section 5.2:**

Throughout this section, the authors should state that they investigate the JAS rainfall, SST, 850 hPa zonal wind, moisture flux associated with the JAS standardized ATL3 index.

This comment will be added to the beginning of the section 5.2 in the revised manuscript.

**Figure 10 caption:** Should “Long-term changes of the JAS rainfall (a-e), SST (f-j), 850 hPa zonal wind (k-o), sea surface height (p-t), moisture flux (vectors) and moisture flux divergence (in colors) (u-y) regression patterns associated with the standardized ATL3 index ” be “Long-term changes of the JAS rainfall (a-e), SST (f-j), 850 hPa zonal wind (k-o), sea surface height (p-t), moisture flux (vectors) and moisture flux divergence (in colors) (u-y) regression patterns associated with the standardized JAS ATL3 index”?

Yes, the suggestion is correct. It will be taken into account in the revised version of the figure and the manuscript.

### **Appendix:**

**Figure A8, A9, A10. caption:** Should “regression maps of rainfall anomalies onto the standardized ATL3 index” be “regression maps of the JAS rainfall anomalies onto the JAS standardized ATL3 index”?

Yes, the season will be added to the standardized ATL3 index in the three figures.

**Figure A6** is not discussed.

This figure will be removed from the revised manuscript. Thank you a lot for your comments.