Reviewer 2

This study uses a combination of model data along with reanalysis, *in situ* and satellite observations to understand the seasonal and interannual variability of sea surface salinity (SSS) along the Senegalese coast in the northeastern tropical Atlantic Ocean. Sensitivity runs from CROCO model forced with different precipitation and river runoff datasets are analyzed to infer the impact of different model forcings on the seasonal and interannual variations of SSS in the region. A detailed description of the model data validation against the *in situ*, satellite and reanalysis SSS is provided. The study finds that the modelled interannual SSS variability off the Senegalese coast is more sensitive to river runoff forcing rather than precipitation. The seasonal cycle in SSS however remains unaffected by the different model forcings of precipitation and river runoff.
The manuscript is generally well written with decent quality figures. However, the manuscript needs some re-organization with more clear captions for the figures including the ones in the Appendices. The novelty of this study lies in exploring the impact of different model forcings on the e-NTA coastal SSS rather than analysis of the processes contributing to the SSS variability. This needs to be highlighted and stated in the Introduction section clearly. The manuscript may be considered for publication after the authors have addressed the major and minor comments listed below.

Major comments:

1. Motivation and the main objectives of the study need to be clearly stated towards the end of Introduction section. The focus of the study is on understanding the impact of different types of river runoff and precipitation model forcings on the seasonal and interannual variability of coastal SSS in e-NTA ocean. The discussion related to processes impacting the SSS variability on seasonal and interannual timescales using salt balance seems very descriptive and lacks physical understanding of the processes.

This point was raised by all reviewers, and it indeed seems necessary to clearly specify in the introduction the purpose of the paper, which is to understand the relative effect of different freshwater fluxes on the seasonal and interannual variability of salinity, using a case study in the e-NTA region. The introduction has been modified accordingly (lines 69 - 74):
"The aforementioned studies demonstrate the usefulness of salinity as a tracer for variations in the water cycle, both from the perspective of the seasonal cycle and interannual variability. However, to our knowledge, no study has yet focused on interannual variability. This is the aim of this study, in which we aim to differentiate the effects of precipitation from those of river discharges on coastal salinity in the e-NTA region. To achieve this, the surface ocean dynamics is simulated by the Coastal and Regional Ocean Community (CROCO) model with various configurations of climatological or interannual forcings."

2. There are too many subsections which can be merged (especially in sections 2 and 4). The discussion related to salt balance figures in the appendix is vague and not easy to understand. It was really difficult to go back and forth from the appendix to main article while reading the salt balance part. I suggest moving the salt balance figures in appendices B and C to the main article and the model validation plots to the appendix.

Following the reviewer's suggestion, we have reorganized the structure of these sections to simplify it and we have merged several subsections. Sections 2.2.4, 2.2.5, 2.2.6, 2.3, 2.4 are now merged in section 2.2. Sections 2.5 and 2.6 are now in section 2.3. Sections 4.2 and 4.4 are merged in section 4.2.
As suggested by the reviewer, we have moved the figures from Appendix B into the main body of the paper, incorporating them into Figure 2. However, we have kept Appendix C as it is cited only once in the paper, and we do not consider it an essential figure. We consider that model validation is an important part of the paper and given that the number of figures is not excessive, we have decided to keep the corresponding figures in the main body of the paper.

3. All figures' captions need to be written more clearly. The labels are not captioned in a chronological order. For example, Figure 6 caption includes text related to panels (a, d, g), (b,e,h), (c,f,i). It was difficult to navigate through the panels while reading the caption. Also add product name and variable as text inside each panel ('CROCO SSS' or 'CCI SSS') to make it easy for reader to understand what is plotted. This applies for other figures as well.

We added titles on top of the three columns of Figure 6, and modified and clarified the legend of Figure 6 to ensure that the panels are in alphabetical order (lines 405 – 412):

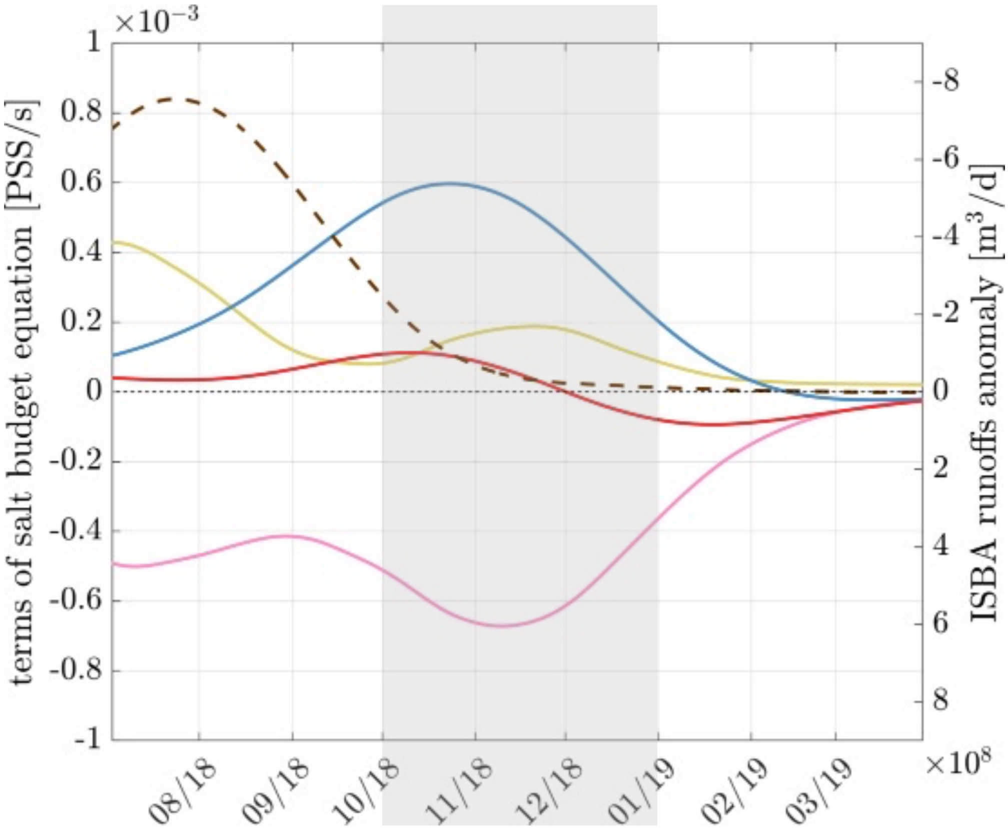
"Figure 6: SSS anomalies over the three analysed periods: late 2011 (a, b, c), late 2015 (d, e, f), and late 2018 (g, h, i). Left column (a,d,g): anomalies of the terms in the salinity balance equation (in pss/day) for CROCOimerg. The color code used is the same as that used in Figure 2a. Only pixels where CCI data are available have been considered in generating these curves. The black dotted line is the ISBA runoffs anomaly (the y-axis has been reversed). The grey shading indicates time periods of strong salinity variations. Central column (b,e,h): simulated SSS maps (in pss) averaged over 3 months for CROCOimerg. Arrows show the surface currents anomalies. Right column (c, f, i): CCI SSS maps (in pss) averaged over 3 months. Grey contours depict IMERG precipitations (in mm/d, contour spacing is 1 mm/d; darker grey correspond to higher precipitation)."

All the legends of the article have been slightly modified for clarification.

4. The discussion related to salt balances in Figure 6 for the 2011, 2015 and 2018 episodes is not clear. In 2011, the positive SSS anomaly is attributed to advection, but the forcing term also shows the same sign and has magnitude comparable to the advection term (Fig. 6a). For 2018 positive SSS anomaly case, the rate term is negative (Fig. 6g). This needs to be checked. The negative entrainment (or residual) term in Fig.6a,g doesn't make physical sense as you would expect SSS to increase if there is entrainment of deeper saltier water to the surface.

Regarding the year 2011, Reviewer 2 notes that the forcing term is of the same magnitude as the advection term and questions why the anomaly is attributed solely to advection. Here, it is the comparison of different simulations forced with various precipitation products (Figure 5b) that allows us to reach this conclusion: We find that the positive forcing term is systematically overcompensated by the entrainment term, thus it has only a minor impact on salinity. We have added a sentence to clarify this in the document (lines 419 - 421): "The fact that the SSS increase is also found in the simulation with climatological precipitations (CROCOprclm), and that the IMERG and ERA5 rainfall anomalies are of opposite sign (Figure 5c), suggests that this anomaly does not result from a rainfall anomaly."

In Figure 6, it is important to keep in mind that the time series represent the interannual anomalies of the terms in the salinity budget equation, not the terms themselves. Thus, the negative value of entrainment anomaly in 2011 and 2018 indicates that entrainment tends to add less salt to the mixed layer during these years compared to the climatology. Indeed, these anomalies are on the order of -1.5 10^{-3} pss/s, while the climatological term (see new Fig. 2c) is ~5 10^{-3} pss/s, meaning the total entrainment remains positive despite this negative anomaly.
The negative rate obtained in 2018 was indeed an inconsistency as presented in the first version of the paper. We thank the reviewer for pointing this inconsistency to us. The sign difference in the rate between Figure 5 and Figure 6 came from a difference in the flags applied: In Figure 5, we removed points too close to the coast that cannot be observed by satellites and thus are not represented in the CCI fields, ensuring a valid comparison between CCI and model simulations. In the previous version of the manuscript, we did not remove these points in Figure 6. By removing the same points and focusing exactly on the same region, we obtain the new Figure 6g (see below), which is consistent with the 2018 positive anomaly shown in Figure 5b. We have specified this application of flags in the legends of Figure 5 and Figure 6 (see previous comment).



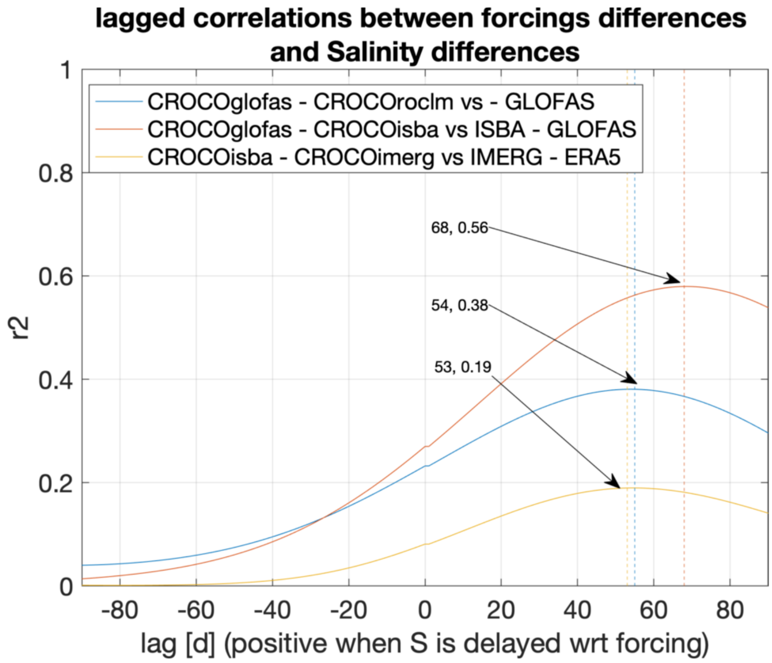
5. In Fig. 5, the 2010 negative SSS anomaly event is interesting. This event could also be analyzed in addition to the 2011, 2015 and 2018 events, if that's easy. Also, can you comment on why the freshwater forcing terms estimated from GLOFAS and ISBA have huge differences in 2010, 2017 and 2018 (Fig. 5c)?

The 2010 negative anomaly also caught our attention. However, we chose not to focus on this year due to the disagreement between CCI, GLORYS and simulated SSS anomalies. The simulated anomalies are relatively weak while, during that period the CCI dataset relies only on SMOS dataset which absolute calibration in 2010 is questionable. A study of the terms in the salinity budget equation (not shown) shows that the 2010 anomaly is primarily due to a positive precipitation anomaly (i.e. deficit of precipitation), modulated by a runoff anomaly, which differs drastically between the forcing products (see Figure 5c). the year 2010 is discussed in section 4.1. (lines 568 - 572).
The large difference between the various runoff forcing products is indeed an important point to note. An explanation is provided in the discussion (section 4.2, lines 586 - 601), where we highlight the link between the runoffs (GLOFAS and ISBA) which are outputs of hydrological models and the precipitation products (ERA5 and IMERG) used to force the hydrological models. The significant disparity in river discharge estimates thus likely stems from disparities in precipitation estimates over the African continent between ERA5 and IMERG. We have added a sentence in the description of Figure 5 that refers to this discussion (lines 401 - 402): "There is a significant disparity in the anomalies of the two river discharge forcing products, with anomalies sometimes having opposite signs (Figure 5c). This disparity is explored in the discussion (Section 4.2)."

6. Figure 7 needs modification. There are no brown lines plotted in the figure (Line 456). For each case study, can you add spatial plots of SSS, currents with box regions marked for e-NTA and south of e-NTA? Select the period during which you observe the advection of freshwater from the southern region to the north. How is the lag determined? Is the correlation coefficient maximum at this lag period? Include a plot of the correlation coefficient as function of lag in appendix if possible.

The mention of brown lines on line 456 was an error. Adding a map for each case study does not seem necessary to us. Indeed, the figures represent runoff differences and salinity differences, which are difficult

to visualize on a map. A contour showing the location of the southern e-NTA region has been added to Figure 1.
The time lag is determined to maximize the correlation between the curves. This is explained in section 2.3 (Analysis of cross-correlations, lines 255 - 259). A figure showing the correlation curves as a function of the lag has been added in Supplementary file (Figure S.4):



Minor comments:

1. The title needs to be modified to make it relevant to the main results presented in the study.

We have changed the title according to Reviewer 1's suggestion: "Influence of River Runoff and Precipitation on the Seasonal and Interannual Variability of Sea Surface Salinity in the East Northern Tropical Atlantic."

2. Eastern Southern North Tropical Atlantic (e-SNTA) is confusing. I suggest changing it to east northern tropical Atlantic (e-NTA).

e-NTA is indeed clearer. We have modified the text accordingly.

3. Mark the 2011, 2015 and 2018 periods in Figure 7 as well.

We have added the shaded bands on Figure 7.

4. Cite the appendix figure number instead of just saying Appendix in the main article. For example, Fig. D.1 instead of Appendix D in line 591. Same applies elsewhere.

Agreed. We have transferred the figures from the appendices to a supplementary materials file, where they are listed from S1 to S10, as suggested by Reviewer 3. References to these figures now use this new notation.

5. Font size of axes labels and legend in Fig. 6, Fig. B.1 needs to be increased.

We have increased the font size on the cited figures.

6. Remove the label for zero line in the legend of figures 5 and 6.

We removed the corresponding labels.

Line 13 – "relatively high cumulative river discharge" – relative to what?

The sentence was modified. We suppressed the term "relatively" (line 13).

Line 14 – precipitations – precipitation

Agreed

Line 28 – Forcing does not create mixed layer but impacts the mixed layer depth and dynamics.

The sentence has been modified (line 27 - 28): « Air Sea forcings (e.g., wind) generate turbulence in the surface layer, leading to the formation of a surface mixed layer »

Line 30 – What does flows exogenous to ocean mean?

We suppressed this term and reformulated as follows (lines 30 - 31):
"This layer receives various freshwater flows, such as precipitation and river discharge. »