We would like to thank all reviewers and the editor for taking the time to assess the manuscript. We have addressed each comment in the revised manuscript, as according to our responses below.

Referee comments are highlighted in bold, our original response is in normal font and our exact changes are in blue.

Response to Reviewer 1

Page 2, line 6, what atmospheric anomalies?

We agree that this should be defined. We will include the following atmospheric anomalies (zonal wind speeds, 850 hPa geopotential height anomalies, moisture transport fluxes).

We have provided examples of what atmospheric anomalies (e.g. zonal wind speeds) we mean on page 2, line 6.

Page 3, line 6, please explain what is this.

We agree the need to clarify this further. An early warning system is a protocol in which humanitarian actions (e.g., providing medical supplies, water purification tablets, and potentially evacuation) are taken before rather than after an event has taken place based on upcoming hydro-meteorological forecasts in order to reduce risk and damage. We will define this within the manuscript.

We have explained what an early warning system is on page 3, lines 8-11.

Page 3, line 20, predictability of onset of the rainy season? or the quality of the rainy season?

Here, we are referring to the Liebmann and Marengo (2001) study where they hypothesise that where the onset of the rainy season in the Amazon basin is influenced by SSTs, prediction of seasonal rainfall totals will improve if the rainfall total is regressed from the predicted onset date from general circulation models (GCMs). We plan to modify our statement at the end of the introduction to classify that the prediction of seasonal rainfall totals could potentially be used where SSTs influence the onset of the wet season in GCMs.

Liebmann, B., & Marengo, J. (2001). Interannual variability of the rainy season and rainfall in the Brazilian Amazon Basin. *Journal of Climate*, *14*(22), 4308-4318.

We have modified our statement to state that the prediction of seasonal rainfall totals could potentially be used where SSTs influence the onset of the wet season in GCMs. See page 3, line 24.

Page 3, line 26, positive and negative phases of the equatorial Pacific do not coincide with positive or negative phases in the Atlantic. What about the AMO, PNA and the Indian Ocean? Do they affect the rainy season in Amazonia?

In this study we have focused on the influence of each climate phase individually against its own neutral phase (e.g., positive ENSO – neutral ENSO) to identify whether there are significant differences in flood characteristics in either the positive or negative phases. The AMO, PNA and Indian Ocean have previously been found to affect the rainy season in the Amazon (e.g., Towner et al., 2020), however due to the scales that some of these climate indices operate on (i.e., AMO is decadal) it does not fit into the tercile approach used within this study. We propose to add a comment and associated references stating that these other indices can affect the Amazon wet season like we did for the MJO on Page 6, Line 3.

Towner, J., Cloke, H. L., Lavado, W., Santini, W., Bazo, J., Coughlan de Perez, E., & Stephens, E. M. (2020). Attribution of Amazon floods to modes of climate variability: A review. *Meteorological Applications*, *27*(5), e1949.

We have now stated reasoning why we have excluded other climate indices such as the AMO and PDO owing to the fact that the frequency of these indices do not align with the tercile approach used within this study. See page 6, lines 10-12.

Page 4, line 3, How to separate Pacific and Atlantic influences?

If you are referring to the following statement:

"The second objective is to examine and discuss in greater detail the results for particular areas of the basin to better understand the response of flood characteristics to climate variability and how the results from the two datasets compare.".

Here, we are referring to comparing how the results differ between the observations and GloFAS 2.1 and not the difference between Pacific and Atlantic indices. It is a useful point to note however and we plan to comment on how the Pacific and Atlantic can influence one another and refer to the paper by Yoon and Zeng (2010) on how to separate the influence of them. We will also add in parenthesis (i.e., observed and GloFAS 2.1), when we state how the results from the two datasets compare to avoid any confusion.

Yoon, J. H., & Zeng, N. (2010). An Atlantic influence on Amazon rainfall. *Climate dynamics*, *34*(2-3), 249-264.

We have now made it clear that we are referring to comparing the two datasets (i.e. observations and GloFAS 2.1) not climate indices on page 4, line 7. In addition, we have touched upon in the conclusions when noting the need to study the combined influence of multiple indices, how previous studies have separated the influence of the Pacific and Atlantic influences (i.e. Yoon and Zeng, 2010). See page 19, line 3.

Page 4, line 10, what land changes, deforestation?, dams?

We thank the reviewer for raising the need to define this more specifically. We will include what land changes we mean (deforestations from forest to cropland, damming) and explain that these human influences are much more common in the southern Amazon.

We have provided examples of what land changes we mean on page 4, line 14.

Page 5, line 19, See the paper by Jimenez-Munoz J et al 2019, Int J Climatology, where they describe year and wet years in Amazonia with ENSO (CP and EP) and with changes in tropical Atlantic.

We thank the reviewer for highlighting this paper. We propose to add this citation to Page 5, line 19.

We have added this citation to page 5, line 25.

Page 5, line 26 define EOF

We will define the abbreviation (i.e., empirical orthogonal function).

We have now defined the abbreviation (EOF) on page 5, line 30.

Page 5, line 29 , why is this?

We have chosen to include four ENSO indices for a more complete evaluation. Wolter and Timlin (1993) explain favour for an index which includes multiple variables, while the EN3.4 index is the most common index used within the literature. The central and eastern Pacific indices have also been included as these indices have been found to be poorly correlated against one another (Takahashi et al., 2011) and we wanted to include an index that focused on the eastern Pacific Ocean to capture different type of spatial ENSO events. These statements can be found on page 5.

Takahashi, K., Montecinos, A., Goubanova, K., & Dewitte, B. (2011). ENSO regimes: Reinterpreting the canonical and Modoki El Niño. *Geophysical Research Letters*, *38*(10).

No necessary changes were required.

Page 7, line 6, Remember that the Amazon basin extends both sides of the Equator and the seasonality of rainfall varies across the basin.

We plan to add a statement to remind the reader of this within the paragraph.

We have now added a statement stating that the Amazon basin extends both sides of the Equator and thus the seasonality of rainfall varies across the basin. See page 7, lines 9-10.

Page 8, line 14, depend on seasonality of rainfall in northern and southern Amazonia

Here, we are referring to the results of Figure 1 which show when the observed data typically peaks based on taking mean of all years using circular statistics. We plan to add a statement which states that these results are based on the seasonality of rainfall in each halve of the Amazon basin.

We have not made any changes as after re-reading this paragraph we have already stated that the results are due to the differing rainfall regimes in association with the alternative warming between the northern and southern hemispheres (Espinoza et al., 2009). See page 8, lines 16-21.

Page 8, line 31, which studies? Page 9, line 1, add Marengo et al 2018-Frontiers; Jimenez-Munoz et al 2019-IJOC

The studies we are referring to are highlighted at the end of the sentence on Page 9, line 1. We thank the reviewer for highlighting this paper, we will add this to the list of citations.

We have now added Marengo et al. (2018) and Jimenez-Munoz et al. (2019) to the list of citations. See page 9, line 17.

Page 11, line 30, negative ENSO years?

Here, we are referring to the results from the negative phase of ENSO compared with the neutral ENSO phase. As we have performed a tercile analysis we are taking the difference between years identified as positive or negative with respect to neutral years. This could also be referred to as La Niña years, as all of the years within the negative phase reach the Oceanic Niño Index (ONI) threshold of at least a weak La Niña event.

We have now modified the manuscript to remove any statements that state ENSO years to ENSO phases. For example, see page 12, line 26.

Page 12, line 6, climate phases?. phases of what?

By climate phases we are referring to either the positive, neutral, or negative phase of a particular climate index. For example, the cold or negative phase of ENSO or the positive phase of the tropical north Atlantic index. We plan to include an example within the sentence to make this clearer.

We have now provided an example of what we mean by climate phases (e.g. La Niña). See page 13, line 3.

Page 12, line 12, Any influence of land use and land use changes in rainfall variability?

This is a valid point and could potentially be related to the difference found in rainfall between the upper and lower reaches of the Amazon. Where deforestation has occurred, it may induce changes reductions in latent heat fluxes and evapotranspiration, thus reducing rainfall. Silvério et al. (2015) highlighted this in the Xingu basin in the south-eastern Amazon, though the effects of land-use change are less studied in the north-western Amazon and towards Óbidos compared to the southern Amazon. We propose to include more statements to consider these factors.

Silvério, D. V., Brando, P. M., Macedo, M. N., Beck, P. S., Bustamante, M., & Coe, M. T. (2015). Agricultural expansion dominates climate changes in southeastern Amazonia: the overlooked non-GHG forcing. *Environmental Research Letters*, *10*(10), 104015.

We have included a statement about how land use change such as deforestation could impact rainfall and thus discharge in different regions of the Amazon. However, we were not able to find a particular source that has examined or discussed the impact of land use change in the Peruvian Amazon vs downstream at Óbidos. Most studies focus on the southern border. See page 13, line 7.

Page 12, line 25, phases of what?

Here, we are referring to the results of changes to flood duration for both Atlantic indices. We state that decrease in flood duration are more common for Atlantic indices regardless of whether the TNA or TSA are in their positive or negative phases (i.e., the results produce the same sign regardless of whether we are taking the difference between positive and neutral years or negative and neutral years).

We have added the word "climate" to the sentence to make it clearer.

"Overall, decreases in flood duration are more common for both Atlantic indices regardless of whether the climate phase is positive or negative for the observed dataset (Figs. 10a-d)". See page 13, line 30.

Page 13, line 15, A simple regression can explain how much of the flood peak variance is explained by the ENSO or the tropical North Atlantic. Other factors at regional scale can also affect this relationship. This could be applied to some stations in the Peruvian Amazon

We thank the reviewer for this suggestion and plan to perform a regression analysis for the Tamshiyacu gauging station in the Peruvian Amazon which fits in well with Sect. 3.4.1.

In Sect. 3.4.1 we have now stated the R^2 value to explain how much ENSO can explain the variance of flood peaks at Tamshiyacu gauging station in the Peruvian Amazon. See page 14, line 30. The variance of flood peak timing and duration explained by ENSO can also be found in Figure 11.

Page 13, line 33, Yes, local factors, including topography can explain this behaviour.

We will add local factors, including topography to the list of variables to consider.

We have added local factors such as topography to the list of variables. See page 15, line 3.

Page 14, line 9, what mechanisms?

Here, we are referring generally to climate mechanisms (e.g., La Niña, ITCZ migration) that can lead to particular atmospheric conditions (e.g., certain geo-potential height, wind and moisture anomalies). With this statement we are referring to how one particular climate feature does not influence the Amazon uniformly, as suggested by Espinoza et al. (2013).

Espinoza, J. C., Ronchail, J., Frappart, F., Lavado, W., Santini, W., & Guyot, J. L. (2013). The major floods in the Amazonas River and tributaries (Western Amazon basin) during the 1970–2012 period: A focus on the 2012 flood. *Journal of Hydrometeorology*, *14*(3), 1000-1008.

No necessary changes were required.

Page 14, line 20, what is the physical mechanism of this connection?, what changes in low and upper level circulation are detected in NE Amazon during La Nina?

We will add a composite plot of lower and upper zonal winds speed against neutral years to show how the circulation changes during La Niña. We plan to add this Figure to the Supplementary materials.

We have chosen to use the existing literature to describe the circulation patterns during La Niña as the plots we planned to produce already exist. In Espinoza et al. (2013) they show how intensified humidity transport is intensified over the Caribbean Sea and is directed towards the north-western Amazon and then across to the north-eastern Amazon. See page 16, lines 3-6.

Espinoza, J. C., Ronchail, J., Frappart, F., Lavado, W., Santini, W., & Guyot, J. L. (2013). The major floods in the Amazonas River and tributaries (Western Amazon basin) during the 1970–2012 period: A focus on the 2012 flood. *Journal of Hydrometeorology*, *14*(3), 1000-1008.

Page 15, line 16, How does this affect the accuracy of measurements?

Here, we are referring to the fact that some gauging stations within the analysis may not be stationary. A hydrological time series may be non-stationary for various reasons such as climate change, anthropogenic change, low-frequency climate variability and, land use change (e.g., the inclusion of a reservoir). Non-stationarity therefore can occur gradually or as a sudden shift and can influence the accuracy of the stage to discharge relation and produce uncertainties within the discharge time series.

We also might see changes in the observed time series because of differences in measuring technique. We plan to add a few more points to this sentence to expand on these aforementioned points.

We have included further statements to what we mean by non-stationarity and how this may affect the accuracy of discharge measurements and produce uncertainties within the observed data. See page 17, lines 1-4.

Page 16, line 28, Positive ENSO years?

Here, we are referring to the 12-year tercile of the 36-year analysis period that are classified as positive ENSO years or the positive phase of ENSO as described in Sect. 2.

We have now changed ENSO years to ENSO phases throughout.

Page 17, line 12, How much of the variability of Amazon rivers is attributed to ENSO?

We propose to include a regression analysis covering this in Sect. 3.4.1.

In Sect. 3.4.1 we have now included the R^2 value to explain how much ENSO explain the variance of flood peaks at Tamshiyacu gauging station in the Peruvian Amazon. See page 14, line 30.

Figures are fine.

No necessary changes were required.

Response to Reviewer 2

The study examines the influence of ENSO on the flood characteristics in the Amazon basin. While the article is packed with the statistical analyses, it fails to explore the large-scale physical mechanism associated with ENSO and flood characteristics, which plays a important role in the prediction and projections. Therefore, the article in the present form is not in the publication level of HESS and requires major modifications.

We disagree with the reviewer that this article in present form is not in the publication level of HESS due to the following reasons:

- The major criticism does not reflect on the research objective of this paper.
- Statistical analyses play a huge role in meteorological and hydrological research and are consistently published in many established journals including HESS.
- A multitude of highly cited papers use statistical analysis to identify relationships between hydrometeorological variables and climatic drivers without exploring the physical mechanisms directly. Examples include Ward et al. (2014) global analysis of discharge sensitivities to ENSO, Emerton et al. (2017) description on the complexities of ENSO driving flood hazard, and Nobre et al. (2017) analysis into how climate variability affects flood damage in Europe.
- The findings of this research can inform further studies that wish to characterise the large-scale physical mechanisms behind the conclusions.

Ward, P. J., Eisner, S., Flörke, M., Dettinger, M. D., & Kummu, M. (2014). Annual flood sensitivities to El Niño–Southern Oscillation at the global scale. *Hydrology and Earth System Sciences*, *18*(1), 47-66.

Emerton, R., Cloke, H. L., Stephens, E. M., Zsoter, E., Woolnough, S. J., & Pappenberger, F. (2017). Complex picture for likelihood of ENSO-driven flood hazard. *Nature communications*, *8*(1), 1-9.

Nobre, G. G., Jongman, B., Aerts, J. C. J. H., & Ward, P. J. (2017). The role of climate variability in extreme floods in Europe. *Environmental Research Letters*, *12*(8), 084012.

My comments/suggestion are:

1. **Authors should explore more towards explaining the physical mechanism associated with the relation they found in the present article.**

   While we understand the importance of research that tackles the physical mechanisms that lead to teleconnections, there is a wide body of literature that addresses the statistical link between climate variability and natural hazards that underpins both operational forecasting products (e.g., IRI forecasts; see https://iri.columbia.edu/our-expertise/climate/forecasts/iri-real-time-seasonal-climate-forecasts-and-models/) and decision-making on the ground (e.g., IASC, 2018). We believe that our research article falls within this bracket and provides important information on how climate variability impacts poorly researched flood characteristics (i.e., flood timing, and duration) in the Amazon basin.

   IASC, 2018. Inter-Agency SOPs for Early Action to El Niño / La Niña Episodes, Inter-Agency Standing Committee. (https://interagencystandingcommittee.org/iasc-reference-group-risk-early-warning-and-preparedness/iasc-inter-agency-standard-operating).

We have now described using the existing literature some of the physical mechanisms behind the wet signal identified in the north-eastern Amazon. See page 16, lines 3-6. We have chosen not to make major changes to explore the physical mechanisms for the reasons highlighted above.

2. **Zhang et al. (2017) found that Pacific Meridional Mode (PMM) also influences the precipitation over Amazon basin through a classical baroclinic Gill responses. It should be noted that PMM could also incite or trigger the ENSO (Larson and Kirtman, 2013). Considering these, it would be also necessary to analyse the association between PMM and flood characteristics over the basin.**

   We thank the reviewer for sharing the findings of these interesting papers. The Zhang et al. (2017) paper focuses on the effects of the Pacific Meridional Mode (PMM) on June-July-August rainfall which falls after most Amazon basin rivers have reached their peaks (see Fig. 1b of our manuscript). The effects on other seasons were stated to be much weaker (Zhang et al., 2017). Though interesting we believe this could be more beneficial to investigate the effect on drought predictability or possibly how this might affect the onset (ending) of the wet (dry) season. We intend to mention this link within the manuscript when describing which climate drivers, we choose to investigate (Sect. 2.4).

   Zhang, W., Villarini, G., & Vecchi, G. A. (2017). Impacts of the Pacific meridional mode on June–August precipitation in the Amazon River Basin. *Quarterly Journal of the Royal Meteorological Society*, *143*(705), 1936-1945.

   We have added a sentence to discuss the importance of PMM (for rainfall anomalies in JJA) and have mentioned why we have chosen not to use this particular climate index (i.e. PMM has previously been identified in the literature to not be as important for the Amazon wet season, as the dry season). See page 6, lines 11-12.

3. **The manuscript needs some changes in the orientation. The author can move some of the figures to supplementary and just keep important ones in the main document, specifically Figures 2 to 10.**

   We have considered each figure in turn but believe they all have a role in the narrative of the paper that would not work in the supplementary material. We believe that including all of the figures within the main manuscript actually improves the readability of the manuscript. This is because all figures are referred to consistently throughout the results and discussion section and this prevents the reader from having to keep going back and forth through different files when interpreting the results. It also allows the paper to flow in a consistent manner with each flood characteristic section maintaining the same number of figures and in the same order (i.e., EN3.4, CP, and EP, and then TNA/TSA).

   We have decided against changing the orientation of the manuscript for the reasons noted above.

Response to Reviewer 3

This paper investigates whether the differences between positive/negative and neutral phases of various climate indices in the tropical Pacific and Atlantic Oceans affect flood characteristics in the Amazon basin for the period 1979-2015. This statistical study do not imply much explanation (which is not the purpose of the work). It is an original work as it addresses not only flood magnitude but also the timing and the duration of the floods. It is interesting as it covers the whole Amazon basin. River data are both observed and simulated (GloFAS 2.1), the indices are the usual one, but attention is paid to the differences between the impact of Central and Eastern Pacific events. For these reasons, this paper is interesting but it is not very original in its form and methods.

We first would like to thank the reviewer for taking the time to review the paper in detail and for providing valuable feedback which will improve the paper. We would like to highlight that all of the comments raised, including the major ones, are all addressable without any significant undertaking of any new analysis or methods. The only major point raised which we do not agree with is that this study is "not very original study in its form and methods". This is because, as the reviewer has highlighted above, it is original as it addresses not only flood magnitude, but also the timing and duration of floods, in which analysis is limited for the Amazon basin.

The importance of how climate variability can affect flood timing has already been shown by Ficchí and Stephens (2019) for Africa, whilst Langill and Abizaid (2019) have highlighted the importance of the timing and duration of floods for different types of flood events in the Peruvian Amazon. In addition, Towner et al. (2020) concluded the need to look at other indictors (e.g., variations of ENSO, MEI, CP, and EP) to account for possible variations in results which we have applied across the entire basin, with many studies focusing on less indices, consider only a specific region of the basin, and or for one particular flood year.

Ficchì, A., & Stephens, L. (2019). Climate variability alters flood timing across Africa. *Geophysical Research Letters*, *46*(15), 8809-8819.

Langill, J. C., & Abizaid, C. (2019). What is a bad flood? Local perspectives of extreme floods in the Peruvian Amazon. *Ambio*, 1-14.

Towner, J., Cloke, H. L., Lavado, W., Santini, W., Bazo, J., Coughlan de Perez, E., & Stephens, E. M. (2020). Attribution of Amazon floods to modes of climate variability: A review. *Meteorological Applications*, *27*(5), e1949.

In addition, it suffers some imperfections that are listed underneath. The major ones are the following:

- You do not define precisely what the flood duration is

We intend to clarify our definition further by saying:

For each gauging station/grid point we consider the duration of flooding as the number of days (not consecutive) spent above the 95th percentile of the climatology. On page 7, line 22.

We have now stated the following "For each gauging station/grid point we consider the duration of flooding as the number of days (not consecutive) spent above the 95th percentile of the climatology" on page 8, line 2.

- You do not pay attention to the significance of the correlations. This cannot be accepted.

In all plots the significance level is clearly denoted, but we agree with the reviewer that it would be useful to include more discussion on the significance of correlation results within the main text. We intend to include more descriptive statements in terms of the number or percentage of stations for both datasets that are significant. We do feel it is important to note that focusing on the P value, whilst very important, is only one way of looking at things. If the P value does not reach an arbitrary threshold, but a whole region is presenting the same behaviour then this is important, likewise if the P value does reach that threshold but agreement in that region is poor we might think that it is just a reflection of the measure being used.

Throughout Sect. 3 we have now made further comments regarding the significance of the results. For instance, "Of these 11 (17) are statistically significant for the observed (GloFAS 2.1) dataset, with GloFAS 2.1 observing more significant results in the north-west of the basin". See page 9, lines 13-15.

- You do not always comment all your results. See various remarks on this topic, below.

We agree with the reviewer that more of the results could be brought out into the results and discussion section. The reason not every single result is highlighted is purely to prevent the paper from becoming too long. We intend to bring out more of the results highlighted by the reviewer, particularly surrounding the results of GloFAS 2.1.

We have now brought out more of the results suggested by the reviewer in the detailed comments. For instance, we now discuss why the magnitude of change might be greater in GloFAS relative to the observed dataset and have included the results from GloFAS 2.1 for the negative EP phase (Fig. 9h) along the Madeira and Purus Rivers.

- in section 3.4.1, you comment three topics. Two are thematic; one is related to the data. How? Why did you chose these topics?

The reasons why we choose to focus on these particular topics are as follows:

Response in the Peruvian Amazon – we chose to focus on this region as extreme floods there have been consistently linked to cooler SSTs in the tropical Pacific (i.e. La Niña) (e.g. see Espinoza et al., 2013). However, we do not find this in our results and so wanted to explore why this might be further.

Response in the north-eastern Amazon – we chose to focus on this region as the results for both datasets stand out for the negative phase of ENSO, with a significant number of stations showing increased flood magnitude and duration. However, this was the region where the results differed particularly between the central and eastern Pacific indices and we wanted to explore why this might be by examining rainfall data.

Observations vs GloFAS 2.1 – we feel this section would be particularly beneficial to readers interested more on the hydrological modelling side and could help us understand why certain periods of modelled data perform better than others relative to the observed dataset.

We intend to make this clearer at the start of Sect. 3.4, including statements on the benefits of comparing the modelled data against the observation in more detail.

Espinoza, J. C., Ronchail, J., Frappart, F., Lavado, W., Santini, W., & Guyot, J. L. (2013). The major floods in the Amazonas River and tributaries (Western Amazon basin) during the 1970–2012 period: A focus on the 2012 flood. *Journal of Hydrometeorology*, *14*(3), 1000-1008.

We believe that the reasoning for choosing these three particular findings are clear within the opening paragraph and at the start of each of the three sub-sections. See Sect. 3.4.

Detailed comments:

Page 2, line 17: ". . .the largest rainfall anomaly" Largest in mm? in length ?

This is in terms of accumulated rainfall anomaly in mm. We will include this on Page 2, line 17.

We have now stated that the magnitude of the annual rainfall anomaly is in mm. See page 2, line 19.

Page 2, line 26: the reference Bazo 2018 is a web page where nothing is told about the duration of the inundation. Please give a more precise reference or avoid it.

We will remove this reference from the paper.

This reference has now been removed from the manuscript. See page 2, line 27.

Page 3, line 3: Apart from Tomasella, see also https://halshs.archives-ouvertes.fr/hal02987838/ on the topic of the timing of peak river flows.

We thank the reviewer for sending the link to this interesting paper. We intend to cite this paper also when referring to the magnitude of the travelling flood wave from coinciding tributaries, page 3, line 3.

We have included this citation on page 3, line 2.

Page 3, line 19: the prediction of the end of the wet season could also be useful for population. See https://www.sciencedirect.com/science/article/pii/S2214581817303543

We intend to cite this paper when discussing the how the timing of the wet season could provide skill in determining seasonal rainfall totals (see page 3, line 19).

We have included this citation on page 3, line 4 when discussing the impact of wet season timing and duration on agriculture.

Page 6, lines 3-4: why do you justify not using the MJO ? While you do not justify not using for instance the PDO, that combining with ENSO can promote extreme events (see the authors you mention in Towner et al 2020).

We felt it was important to give an example of why certain indices which we have described in a previous paper (i.e. Towner et a., 2020) that affect Amazon flooding were not used (i.e. because they do not fit into the tercile methodology). We plan to extend the reasoning to state why the Pacific Decadal Oscillation and the Atlantic Multidecadal Oscillation were also excluded to page 6, line 3.

Towner, J., Cloke, H. L., Lavado, W., Santini, W., Bazo, J., Coughlan de Perez, E., & Stephens, E. M. (2020). Attribution of Amazon floods to modes of climate variability: A review. *Meteorological Applications*, *27*(5), e1949.

We have now added statements to explain why we have not chosen to use other climate indices such as the PDO and AMO (i.e. due to their frequency not fitting the tercile methodology). See page 6, lines 10-12.

Page 7, section 2.7: Are the days above the 95th always consecutive during an annual cycle? The answer is no. There can be a sequence of days above 95th, then a few days below and again days above 95th. How did you determine the duration of the flood? Did you count the days above

95th? Did you include in this count the intermediate days? Do the duration of the flood and the date of the beginning of the flood allow to know the date of the end of the flood? Or not?

We did not state anywhere in the manuscript that the number of days above the 95th percentile had to be consecutive. However, we will add in a statement as previously highlighted to remove any uncertainty and state that the days do not need to be consecutive. Only days above the 95th percentile are counted.

We have added a statement which confirms that the days above threshold does not need to be consecutive. See page 8, line 2.

Page 8, line 16: what is the relationship between the fact that the annual maximum of GloFAS 2.1 occurs earlier than observations and dams? Explain, please. What about the role of the large floodplains in the Upper Madeira basin (Llanos de Mojos) ?

This is because dams can affect the navigation and timing of water passing through and GloFAS 2.1 does not currently include all dams into the model. Thus, in real life (i.e. observations) the peak at the gauge downstream of a dam might be later than it otherwise would and GloFAS 2.1 would not account for this delay. The role of large flood plains is an interesting point and could also affect not only the timing of the annual maximum but also the duration of flooding. In GloFAS, river-floodplain simulation works by incorporating a simple loss function to mimic river-floodplain interaction, however, this is considered one of the main sources of errors within the model and could lead to earlier peaks than in the observed data (Alfieri et al., 2013). We intend to add statements surrounding these uncertainties when explaining the results in Sect. 3.

Alfieri, L., Burek, P., Dutra, E., Krzeminski, B., Muraro, D., Thielen, J., & Pappenberger, F. (2013). GloFAS–global ensemble streamflow forecasting and flood early warning. *Hydrology and Earth System Sciences*, *17*(3), 1161-1175.

We have now extended to state that not all dams and reservoirs in the Amazon are represented by GloFAS and why this can lead to a timing issue in the model. Moreover, we describe the lack of floodplain interactions with GloFAS as a likely factor in the model producing early flood peaks. See page 8, lines 27-31.

Page 8, lines 19-22: Neighboring stations are also subject to ITCZ migration. Why would only stations 45 and 51 behave differently?

This is a good point raised by the reviewer. We plan on removing this statement.

This statement has now been removed. See page 9, line 4.

Page 8, 3.1.1: You show on the figures the significant values, but do not say in the text how many (or what %) of them are significant. This is essential, as non-significant values are not very interesting! This remark is true for all the indices.

We plan to add comments regarding the percentage of stations that are significant for all indices and flood characteristics, though non-significant values, where regional patterns emerge we believe have value as they describe a large location where you could then extend analysis to look at the atmospheric circulation in these regions.

We have now added several additional statements within Sect. 3 that highlight how many significant values there are for all indices. For example, see page 9, line 13.

Page 9, line 17: Northwestern or northeastern?

Northwestern, here we are referring to the Peruvian Amazon region that have previously seen floods associated with La Niña conditions (e.g. Espinoza et al., 2013). We do find this pattern also in the northeastern Amazon but here we are not referring to this.

Espinoza, J. C., Ronchail, J., Frappart, F., Lavado, W., Santini, W., & Guyot, J. L. (2013). The major floods in the Amazonas River and tributaries (Western Amazon basin) during the 1970–2012 period: A focus on the 2012 flood. *Journal of Hydrometeorology*, *14*(3), 1000-1008.

No necessary changes were required.

Page 10, lines 1-10: are these signals consistent with what is found for rainfall?

Yes, the same wet signal in the north-eastern Amazon is identified in the composite rainfall plots (Figure 12) for EN3.4 and the CP index but not for the EP. We intend to state this in the paragraph.

We have stated that the wet signal identified in the north-eastern Amazon is also found for rainfall, referring the reader to Figure 12. See page 10, lines 16-17.

Pages 8-10: Why the signals are stronger with GloFAS 2.1? Why don't you comment that in the text?

In some cases, the signals are stronger as GloFAS 2.1 fails to pick up on smaller scale processes and does not represent the floodplain interactions well. This means the signal is likely due from the increase or decrease of rainfall associated with climate variability without any smaller scale interactions involved. We intend to insert comments on these factors in the results, though the results are not always stronger in GloFAS as can be seen in Figs. 3c, 4c, and 9a for instance.

We have now discussed why the signals in several instance are stronger in GloFAS 2.1 relative to the observed data. We hypothesise that this is due to GloFAS failing to accurately simulate floodplain interactions and smaller-scale processes that could dampen the magnitude of change in river flow. Therefore, it is likely that the results of GloFAS is more of a direct reflection to how different climate phases increase or decrease the magnitude of rainfall relative to the neutral phase. See page 10, line 33.

Page 10, lines 30-31, last sentence: this is also true for TNA in Western Amazon.

We will state that both results found in the western Amazon and along the Madeira River are replicated in GloFAS 2.1 for the positive phase of TNA.

We have stated that the result for positive TNA years in the western Amazon is also replicated by GloFAS. See page 11, line 25.

Page 11, line 21: not only in the Jurua, but also in the Madeira, Purus, Negro

We will state that early peaks are also found in the Madeira, Purus, and Negro rivers.

We have stated that early peaks are also found in the Madeira, Purus, and Negro rivers which likely contribute to the significantly early peak flows in and around the Amazon River in Brazil. See page 12, line 16.

Page 12, line 2: You could explain that the extra days in Obidos may be related to the extra days along the Negro ad Branco rivers.

We thank the reviewer for raising this point. It is worth noting that the results identified at Óbidos could be related to increased flood duration from northern tributaries such as the Negro and Branco rivers and we plan to add statements to discuss this.

We have mentioned that the increased flood duration during La Niña at Óbidos could also be related to the increase in flood duration in the northern tributaries (i.e. the Negro and Branco Rivers). See page 13, lines 1-2.

Page 12, line 4: What is DOT ?

DOT stands for days over threshold. We will define this.

DOT has now been defined. See page 12, line 22.

Page 12, section 3.3.1: Figure 9h shows some consistent positive anomalies along the Purus and the Madeira. You do not comment them. Why?

We will comment on this in Sect 3.3. The results are similar to what is found in the observations, although statistically significant.

We have now mentioned the positive anomalies found along the Purus and Madeira Rivers and highlighted how the results are similar for the observed data but are not statistically significant. We hypothesise that reasoning for this could be due to damming along these rivers which are not modelled in GloFAS 2.1 and due to floodplain interactions. See page 13, lines 20-22.

Section 3.4: why do you focus on these 3 topics. You should explain that in the introduction of this section.

We will include an explanation in the introduction to this section as mentioned in reply to the major comment.

Same as major comment above.

Section 3.4.1: you do not mention that Espinoza et al 2013 tell that the intensity of floods is more likely related to an early La Nina event, as observed during the 2011– 12, early rainfall and simultaneous peaks of both tributaries of the Amazonas Rivers. You should consider this in yours reflexions.

We will add this information when discussing the response to SSTs in the Peruvian Amazon (Sect. 3.4.1). This is an interesting point to discuss and it could be that the timing (i.e. onset and ending) of a La Niña event is more important with regards to flooding in this region than whether there is a La Niña event or not.

We have now mentioned that the intensity of flooding in the Amazon basin could be related to the timing of climate phases and raised the question on whether the timing, duration or location of La Niña is more important for flooding in the basin. See page 15, lines 28-33.

Page 13, line 24: show these years in figure 11.

We will add text denoting the years 1998, 1999 and 2007 in Fig. 11.

1998, 1999, and 2007 have now been added to Figure 11.

Page 14-15, section 3.4.2: why the differences between EP and CP? Rapidly. This has been commented in the literature (see your review paper).

The differences found in the results between the EP and CP indices are described in Sect. 3.4.2 for the north-eastern Amazon. In negative EN3.4 and CP years a positive rainfall anomaly is identified in the north-east, whereas a deficit in rainfall is identified for negative EP years (see Fig. 12).

No necessary changes required.

Page 15, line 20: again, tell whether the correlation are significant or not.

We will add a statement regarding the median number of significant values between the observed data and GloFAS 2.1.

Reviewing this, this statement simply states the median value of the correlation results across all indices and thus no statistical test is performed. For the correlation tests between observed and simulated data (i.e. Table 1), significant results are now highlighted in bold.

Page 17, lines 10-13: Can combining indices be a perspective?

This is an interesting point which we want to include into the conclusions when discussing future work. Previous studies have found links between flood events in the Amazon and simultaneous SST anomalies in different ocean basins. For instance, the 2012 Peruvian Amazon flood has been linked to both La Niña and a warm TSA ocean (Espinoza et al., 2013), while the 2014 flood in the Madeira basin has been associated with warm conditions in the western Pacific-Indian Ocean and exceptionally warm SST conditions in the sub-tropical south Atlantic (Espinoza et al., 2014). Therefore, it would be important to consider a similar analysis in which the combined influence of indices are considered.

Espinoza, J. C., Ronchail, J., Frappart, F., Lavado, W., Santini, W., & Guyot, J. L. (2013). The major floods in the Amazonas River and tributaries (Western Amazon basin) during the 1970–2012 period: A focus on the 2012 flood. *Journal of Hydrometeorology*, *14*(3), 1000-1008.

Espinoza, J. C., Marengo, J. A., Ronchail, J., Carpio, J. M., Flores, L. N., & Guyot, J. L. (2014). The extreme 2014 flood in south-western Amazon basin: the role of tropical-subtropical South Atlantic SST gradient. *Environmental Research Letters*, *9*(12), 124007.

We have included statements in the conclusions discussing the use of investigating the effects of co-occurring indices. See page 18, lines 33-34.

Tables and figures

Table 1: which are the significant values?

We will highlight these in bold font in the revised manuscript.

Significant values have now been highlighted in bold font and the caption has been updated to reflect this. See Table 1.

Figure 1:

1) **Are "mean annual maximum river flows" monthly values? Extreme annual values? Tell it in the caption.**

Mean annual maximum river flows take the average of all the yearly maximum values within the analysis period. This is already described in the title above the plots (see Fig. 1a, d) and in the figure caption.

No necessary changes required.

2) **Give more information in the caption about the index that is represented in 1c and 1f. Are all the figure essential in the main text? Some figures could be supplementary.**

   We will define the interannual variability coefficient, r, more clearly by stating that it refers to how consistent the date of the annual maximum is over time (i.e. values closer to 1 have a consistent flood regime as described on page 7, line 14).

   We have updated the caption of Figure 1 to describe that r values closer to 1 have a consistent flood regime and that r values closer to zero have a highly variable regime (i.e. flood peaks are spread evenly throughout the year). See Figure 1.

Figure 1S: Fazenda Vista Alegre is not at the confluence of the Madeira and Solimões. Check it.

We thank the reviewer for highlighting this mistake. Apologies for this. The coordinates used to map this station were incorrect. We will correct this as it should be further upstream along the Madeira River.

We have adjusted Figure S1 to represent the location of Fazenda Vista Alegre. See Figure S1. This has also been updated on Figures 1-10. There was no change in the results at this station when using the correct coordinates for GloFAS 2.1.

Table S1: List the stations in number order and not alphabetical order. It will be easier to find the stations mentioned by their numbers in the text.

We thank the reviewer for this suggestion. We plan to change the layout of Table S1 to order stations by gauging number.

We have now changed the layout of Table S1 to order station by station number. See Table S1.