Response to Reviewer 1

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

Referee comments are highlighted in bold with our response in normal font.

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).

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.

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.

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.

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.

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.

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.

Page 5, line 26 define EOF

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

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).

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.

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.

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.

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.

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.

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.

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).

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.

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.

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.

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.

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 aformentioned points.

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.

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.

Figures are fine.