Summary

The authors appreciate the many detailed suggestions. They will be incorporated into the revised manuscript. The revised manuscript will include refined figures, less redundant information, and references to hydrological studies that will highlight the importance of the study to the hydrology and earth system science community. The revised manuscript will also include a URL to the first author's website where the computer software for the adopted methodology can be obtained. More detailed responses to comments are provided below. The reviewer comments are in bold text and our responses to the comments are in plain text.

GENERAL COMMENTS The manuscript investigates the relationship between rainfall and ENSO index using wavelet analysis and a wavelet coherence method is proposed to explain the changes of temporal correlation between two time series. The topic of the study is interesting may be outside the scope of the journal. This appears more so as almost all references are from climate journals where this paper sits more naturally. I think this paper should be withdrawn and submitted to an appropriate climate journal, or else reformatted to represent better arguments as to why it is of interest to hydrology directly. I have, however, read through the paper and have some comments that may help the authors publish this successfully.

Our manuscript addresses precipitation variability in the South Asian monsoon region. As precipitation in this region is critical to mountain glaciers, transboundary rivers, groundwater recharge, and functioning of many ecosystems and human systems, we believe that the topic is of considerable importance to hydrologists and Earth system scientists. However, we appreciate the reviewer's concern, and we recognize that we did not sufficiently emphasize the hydrological relevance of this work in the original manuscript. In the revised manuscript we will elaborate on both the hydrological motivation for our study and the hydrological implications of our results.

COMMENT1: Section 2, the way authors computed the monthly anomaly by subtracting the data from the whole period is not the recommended and standard way. It is recommended by WMO that a fixed reference period is defined as the 30-year period 1 January 1961 to 31 December 1990. Authors should consider use this as baseline period, especially when compared SST and Nino indices over different regions.

Although the authors agree that a 30-year base period is commonly used in climate studies, it is unclear how using the standard base period would benefit the present analysis. Using a different base period would only translate the time series up or down uniformly and would not alter the actual behavior of the time series. Therefore, the results of the wavelet analysis, which are the focus of the present study, would be unchanged. Furthermore, skewness would be made relative to that base period, which would make the more recent skewed events appear less prominent. As such, we feel that subtracting the long-term means to calculate anomalies is the best approach for the present study. By using long-term means, it is easier to see how skewness how evolved throughout the study period, which is consistent with what the wavelet analysis is quantifying.

COMMENT2: Section 3.1, there is no such Reference Schulte and Lee (2019). More importantly, the reason of adapting Event Decomposition is not well explained and how it helps quantifying the nonlinearity (i.e. skewness) of rainfall and ENSO index is not demonstrated. In the end of Method section, authors considered a synthetic example to illustrate the concept of nonlinear coherence using

original time series but following your methodology it should be transformed to event spectra before calculating the coherence. The impact of Event Decomposition on the wavelet analysis and coherency is unknown.

The authors agree that it is unclear how the event spectra benefit the paper. As such, we will remove the event decomposition method results from the revised manuscript. This removal will allow us to focus more on wavelet analysis, which is the main topic of the paper. The authors note that the coherence spectra are based on the actual time series and not on the event transformed time series.

COMMENT3: Section 4.2, the relation between skewness and correlation is not explicitly demonstrated. There is a sharp decrease of skewness of June-September rainfall around 1991. Is there any particular reason? And what is the implication of this change? "A comparison of Figures 5a and Figures 5c reveals that the weakening and reversal of the relationship occurs during the time period when the Niño 1+2 index is especially skewed, suggesting that ENSO skewness changes could be contributing to changes in the time-domain correlation between ENSO and All-India rainfall. " This conclusion is in doubt, Figure 5a doesn't include the skewness of August-September rainfall.

The main reason for showing skewness is because two time series can only be perfectly correlated if all the statistical moments are correlated. More specifically, if the skewness of one time series is increasing but another remains nearly constant, then the lack of correlation between skewness of the two time series must be contributing to changes in the correlation between the time series. This idea will be made more explicit in the revised manuscript. The sharp decrease in skewness around 1991 could be noise. A full understanding of all sources of Indian rainfall skewness would require additional analyses, which would digress from the focus of the paper, which is to relate ENSO skewness to Indian rainfall skewness. Nevertheless, an implication of the result is that noise also influences the correlation between Indian rainfall and ENSO. This possibility will be mentioned in the revised manuscript.

COMMENT4: Section 4.2 and 4.3, through the global and local auto-bicoherence analysis, they show the nonlinearity of ENSO indices and India rainfall in the frequency and spatial space individually. But how these two related to each other, authors do not explain explicitly.

The main reasons for showing the local and global bicoherence analyses is to highlight their differences. Because the nonlinear coherence between them is weak, we expected that the differences to be large. This point will be clarified in the revised manuscript.

Using the nonlinear wavelet coherence method to test your hypothesis should be the major contribution of your work, however it is only briefly discussed in the very end of Section 4.3.2. There are lots of redundant information in the manuscript, which makes the paper long and difficult to read.

In the revised manuscript, we will expand the nonlinear wavelet coherence method section. In addition, some text will be moved or deleted so that the nonlinear coherence section appears earlier in the revised manuscript. The authors agree that there is a lot of redundant information. The authors will remove the redundant information in the revised manuscript by deleting text and moving some information to the supplementary material.

SPECIFIC POINTS:

1. EL Nino or El Nino, please keep it consistent throughout the paper.

The authors appreciate the identification of this inconsistency, which will be corrected throughout the paper. The format will be changed to "El Nino" throughout.

2. Line 104, keep the numbering format consistent.

The numbering inconsistency will be corrected in the revised manuscript.

3. Please have a careful look of the format of your references.

The authors appreciate the comment about the reference formatting. The reference formatting will be corrected in the revised manuscript.

4. Line 274, keep the equation numbering format consistent.

The equation formatting inconsistency will be corrected in the revised manuscript.

5: Line 175, Because theory supports a casual link...Authors do not explain this point well. Does strong coherence or association mean causality in nonlinear system? More details are needed.

Authors agree that more details are needed regarding the causal linkage statement. There are many studies that have linked ENSO to the Indian monsoon These studies will be referenced in the revised manuscript. In addition, a few sentences will be added to describe how ENSO is physically related to the Indian Monsoon.

6. Figure 7, what monsoon rainfall is used, full monsoon or late monsoon?

The authors note that Figure 7 is the wavelet power spectrum of the All-India time series without any seasonal averaging.

7. Line 447, what is the abbreviation of AIR standing for?

The abbreviation stands for All-India Rainfall. The abbreviation will be introduced when the All-India rainfall data are first mentioned.

8. Line 135-137, keep the font format consistent.

The authors appreciate the identification of the formatting issue, which will be corrected in the revised manuscript.

I recommend authors to do a search on [hydrology and wavelets and precipitation and "el Nino"] or maybe "low frequency variability" and see how they have established the link of their paper to the hydrology audience they are presenting to. It may give authors a good idea of how they could improve their pitch.

The authors appreciate the suggestion regarding a literature search. We will conduct a literature search on wavelet analysis and hydrology and include many new references into the revised manuscript. More specifically, we well include references to papers in which wavelet coherence was used to understand hydrological processes.