Precipitation stable isotopic signatures of tropical cyclones in Metropolitan Manila, Philippines show significant negative isotopic excursions

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Reply to reviewer's comments:

Dear Reviewer, your comments are greatly appreciated. The following is our response regarding points that require clarification.

In the manuscript, the authors attempted to discuss how a 19-month precipitation isotope dataset could be used by government agencies for mitigation and adaptation polices related to typhoons.

Response: This is a misunderstanding of our point, where we proposed that (line 37-40) "There is a clear need for developing a better understanding of tropical cyclone (TC) dynamics and cyclone histories in the context of prediction that may allow government agencies to implement proper mitigation and adaptation policies."

We are not suggesting that our dataset is to be directly used by government agencies to base adaptation policies upon. Instead, we are highlighting the scientific significance of our study, that isotopic signals in precipitation can allow us to better understand typhoon dynamics, and inform paleoclimate studies and mitigation measures in the future. We will thus amend this sentence to bring across our point clearer.

The authors also suggested that this study could have possible implications for paleoclimate studies. However, the 19-month dataset is difficult to provide substantial contributions to the hazards related to (1) precipitation processes during typhoon, (2) spatiotemporal isotope characteristics in the region, and (3) paleoclimate studies.

Response: We affirm that our studies adds value in the understanding of tropical cyclone hazards in the Philippines, as our in-situ dataset captures information on precipitation isotope signals for normal precipitation events and tropical cyclone events – for an area such as the Philippines where the amount of studies on typhoon precipitation isotope signals are scant, despite the region being a hotspot for typhoon activities.

Being the first study investigating typhoon-related precipitation isotope signals in the Philippines, firstly we are able to learn about how precipitation isotope signals in this region respond towards typhoon events of different intensity while they pass through sampling site.

Second, we gain spatiotemporal information of captured typhoon events through studying the tropical cyclone's position and distance from the sampling station's location, and observing effects of variables such as typhoon distance and intensity on level of isotopic (e.g figure 4, 5, 6).

Third, our 19-month dataset provides modern-day baseline data for investigating typhoon activities in paleoarchives for the Philippines, or for paleoarchive data points near our sampling station at the very

least. As there is yet no precedent dataset or studies that can provide such baseline data for studying tropical cyclones in palaeoarchives for the Philippines based on precipitation isotopes, we are convinced that our study is able to make a substantial initial contribution to this area. Kindly refer to the following sections in our paper (lines 71-81, 388-414, 462-465) which discusses our findings' potential for paleoclimate applications.

However, the above topics involve diverse spatial and temporal scales. It is very difficult to justify that the 19-month observations can inform all of them.

Response: We recognize that the observations from our research would be unable to be applied to a spatial range as extensive as the whole of the Philippines. However, our findings are still able to inform and be utilized within a reasonable area in the Philippines, proximate to our sampling station. Also, with reference to our research aims in lines 103-107, the main contribution of our findings is that we are able to capture the influence of spatial distance and progression of tropical cyclones on precipitation isotopic signals at our sampling station. Although we may consider increased sampling sites and frequency for improved data resolution (spatially and temporally), our findings are nevertheless an initial contribution to such studies which are unprecedented for the Philippines, specifically Metropolitan Manila, and our research aims remain within the capability of our dataset.

In page 7, the authors provide excellent descriptions which summarise what the data could really tell us. The data can only tell us that the precipitation isotope values during typhoons were depleted. However, it is not really something very new.

Response: As outlined in our research aims (lines 103-107), not only is our data able to show that typhoon events result in depleted isotope signals – we were able to study how distance from the typhoon and storm intensity influenced the degree to which the precipitation isotope signals were depleted, for a region where research on this matter is scarce. This is discussed in great detail in the points above.

In addition, our data provided interesting findings that may indicate potential for further research in the future (see conclusions line 416 onwards). For instance, we found that strong local convective activities can induce "false signals" where precipitation isotopes are slightly more depleted than average, despite typhoons being distant (lines 316-318, 363-366). Furthermore, our findings indicated that rain-out history and topography may have effects on isotopic signals (lines 290-292, 326-331). Thus, our study provide differentiated findings on the extent to which typhoon variables can affect precipitation isotope signals, and we further discussed potential influences specific to the Philippines region, such as topography, that could influence precipitation isotope signals.

We did not learn anything about typhoon mechanisms apart form that the typhoon rainfalls were clearly depleted of the heavier isotopes. Turning to learning new spatiotemporal signatures of the regions, the daily data set is just not able to capture the typhoon dynamics. In Figure 4, we can see clear that we cannot expect that 3-5 data points for a typhoon event can tell us much about typhoon dynamics.

Response: We reiterate that our research objectives, as stated above, did not include the intention to extensively study typhoon dynamics with our data. Instead, our daily precipitation isotope measurements are suitable for analyzing certain typhoon characteristics, such as typhoon strength, track and rainfall intensity, and how this can have implications on paleoclimate studies for the region, for instance. We have also discussed the limitations of our dataset, and provided suggestions for obtaining better sampling frequencies in further studies. As for Figures 4 and 5, it is intended to show the extent of precipitation isotopic response to typhoon events, depending on the typhoon's proximity and rainfall, which is in line with our research aim – to better understand how typhoon events are captured in precipitation isotopes in the Philippines.

Overall, we did not see many substantial results related to typhoon processes here, because of the limitation of the data.

Response: The aim of our study is clearly stated (lines 102-107) and investigated with our dataset. Further, we get a first understanding about typhoon activities with isotopes, as no study has been done there before.

Moreover, the work does not have strong materials related to hazard, although the authors tried to frame the work about hazard mitigation and adaptation policies (Page 2 Ln 40).

Response: We clarify that the intention of our paper is not to frame the work around hazard mitigation and adaptation policies. Rather, we posit that our findings can be used to improve interpretation of results for typhoon paleoclimatology, specifically in the Philippines. Further, we suggest more studies similar to ours should be carried out, to mend the data gap and provide a better picture of the paleohistorical record of typhoons in the Philippines. This in turn can better inform hazard mitigation and adaptation for typhoons in the Philippines.

This paper is more suitable to be a data paper instead of a research paper. Perhaps, the authors should think about submitting this paper to Earth System Science Data (ESSD).

Response: We appreciate the reviewer's kind suggestion regarding the nature of our research paper. Despite the fact that studying typhoon dynamics extensively was not an intended research aim of our paper, we are still confident that our findings can be a contribution of scientific significance, as it provides insight into the influence of typhoon activity on precipitation isotopes in an understudied region, using a unique dataset. In addition, we also discuss on how other factors such as local convective rainfall and topography may influence precipitation isotope signals. As such, we trust that our contribution is better justified as a research paper rather than a data paper.