

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

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### **Response to reviewer**

#### **General comment**

In this manuscript the authors analysed the isotopic signature of precipitation from March 2014 to October 2015 in Metropolitan Manila, Philippines. They found that rain water collected during the landfall of some tropical cyclones had a progressive more depleted isotopic composition compared to rain water sampled during other rainfall events. Based on the data analyses, the authors found a significant relation between the daily isotopic composition of precipitation and the distance of the tropical cyclones from the sampling site.

I think the authors presented an interesting and valuable dataset of the isotopic composition of precipitation in Metropolitan Manila, Philippines. Despite the interesting presentation of the data collected during the landfall of some tropical cyclones, there is still a lack of a thorough analysis of the dataset, and particularly of the isotopic fractionation, which was speculated in section 4, and the meteorological characteristics (e.g., rainfall amount, air temperature etc.) that could influence the isotopic signature of precipitation during the landfall of tropical cyclones and the other rainfall events (please see the specific comments). There is a vast literature on these topics, and the authors could give a read to manuscripts which presented analyses of long time series of precipitation isotopic data (e.g., Guo et al., 2021). Furthermore, I think the authors should have accepted the valuable indications of the previous reviewer 3 because most of those comments were feasible to implement in the revised manuscript.

In addition, I think the current version of the manuscript still lacks some clarity. For example, the authors should clearly present and organize the research questions and the specific objectives. At the moment, the results are presented in only one section, but the authors could split them into 2-3 sections, and move the results of the statistical relations from the discussion to the proper section of the results.

**Response:** Dear reviewer, we thank you very much for your helpful review and valuable suggestions. We appreciate your feedback and incorporated your remarks into the manuscript, which is now stronger as a result. The focus of our manuscript is not to study the isotopic variability throughout the seasons and to investigate the associated drivers of isotopic changes. Instead, the manuscript's aim is to get a better understanding of tropical cyclones' signals in precipitation in the Philippines and to provide much needed data for paleotempestology. However, we admit that a detailed presentation of our timeseries along with meteorological parameters provide additional information and adds value to our manuscript. We therefore added several new figures and provide more insights into the isotopic variability throughout the measurement period.

#### **Specific comments**

**- L104-105: Please clearly formulate the research questions.**

**Response:** We have rephrased these lines to clearly point out the objectives and research questions and organized them into bullet points at lines 103-109: The major objective of this research is the following: - To understand if there is an isotopic variation in precipitation associated to the TC landfall in the Philippines and if tropical cyclones leave clear isotopic signals. - To identify the isotopic signals measured for Metropolitan Manila and the intensity of the isotopic depletion associated to TC activities, and to identify how it is represented spatially. - To understand the isotopic variation with

distance from the TC track in the Philippines.

**- L105-106: Please clearly report the specific objectives of this research study.**

**Response:** Please see the response above.

**- Section 3: Why is there only one sub-section? The authors could organize the results based on the specific objectives and move here some of the results presented in the discussion (e.g., L348-353). In addition, I suggest to provide in this section the results for  $\delta^2\text{H}$ , and improve the section by the analysis of deuterium excess (Dansgaard, 1964) and the relations between the two isotopes, and between them and some meteorological characteristics (e.g., rainfall amount and air temperature).**

**Response:** Thank you for this helpful suggestion. As explained above, we did not intend to analyze in our study in detail the seasonal/atmospheric controls on isotopes, however we now provide more information on the relationship between isotopes and other meteorological parameters in order to display our 15-month timeseries. Additionally, we included several new figures (Figure 2, 3 and 4) and a table (Table 2) which help to visualize our dataset. We therefore added two new sections (3.1 and 4.2) and present these results at lines 201-243.

**- L241-243: Please expand the description of the results for Figure 5b.**

**Response:** We now describe Figure 5b in more detail at lines 294-297: This is also seen in a spatial representation in Fig. 8b, visualizing the track of Kalmaegi and the respective  $\delta^{18}\text{O}$  values. Kalmaegi was first approaching the sampling site on 14 September and passed away on 15 and 16 September. The lowest  $\delta^{18}\text{O}$  was measured on 15 September and is indicated in the figure in dark blue colour.

**- L247: I suggest to not use the term 'proxy' because stable isotopes cannot be assumed as representative of tropical cyclones. Please rephrase the title.**

**Response:** Thank you for highlighting this, we have changed it accordingly to "tracer" at line 301.

**- L253-254: I have not found the hypothesis in the introduction. The authors should add it or clearly address it.**

**Response:** As mentioned above, we have rephrased the research questions and now clearly address the hypothesis with the following at line 105: "... and if tropical cyclones leave clear isotopic signals".

**- L255-256: 'isotopic fractionation' was not assessed in the data analyses. I think the authors could significantly improve this manuscript by adding an analysis of deuterium excess, and of the dual-isotope plot (please see also my previous comments).**

**Response:** Thank you for the suggestion, as mentioned above, we have added new sub-sections and several figures accordingly.

**- L262 and L266-273: Please refer directly to the amount effect.**

**Response:** Thank you for the suggestion. We have now presented the amount affect in section 3.1. which is observed at our site on monthly timescales.

**- L304-306: Please refer to a specific figure.**

**Response:** We added reference to Figure 6 at line 358.

**- L312-317: Rainfall amounts are not shown in Figure 2, and these sentences are not well supported by the results.**

**Response:** Rainfall amounts are now shown in Figure 2 in order to provide additional information.

**- L319: Why should we use stable isotopes of precipitation to detect or predict the landfall of tropical cyclones? It does not make sense to use isotopes in precipitation when satellite and radar data are available, particularly if the isotopic samples are collected at the daily timescale.**

**Response:** We agree as seen at line 319, but our statement is referring to possible applications in paleotempestology (lines 372-374).

**- L331-332: Rainfall amount data should be shown in the figures and not only on the supplementary material.**

**Response:** We have added rainfall data along with various other parameters at Figure 2, in order to display the dataset in detail.

**- L424-425: It is very unclear why the authors should suggest the sampling of stalagmites or trees, instead of precipitation. Why in the same location should we expect a different isotopic composition in precipitation and water used by vegetation (assuming that vegetation exploits mainly waters associated to tropical cyclones)?**

**Response:** In this part we are referring to potential applications in paleotempestology, as for instance stalagmites might provide information on past cyclone activity from centuries ago. This is also a reference to the introduction section, where various studies are presented that use stalagmites or tree rings to study past cyclones.

**- L435-436: Distance cannot be considered as a factor controlling/determining the isotopic signature of precipitation.**

**Response:** Our analysis clearly shows that distance plays an important role, therefore we changed it to “influencing” at line 510.

**- Figure 2: Please add the time series of the main meteorological characteristics, i.e. daily rainfall and mean daily temperature measured at a local weather station.**

**Response:** We have added these parameters to Figure 2 which displays the whole timeseries of data.

**- Figure 4: Please show rainfall amount as vertical bars.**

**Response:** Thank you for the suggestion. We tried implementing rainfall amount as vertical bars, but realized that vertical bars do not work for this kind of figure and would be very confusing to the reader. We specifically chose lines for  $\delta^{18}\text{O}$ , distance and rainfall amount as this representation clearly visualizes the various spikes in data, such as the drop in  $\delta^{18}\text{O}$  value and a spike in rainfall with a drop in distance.

**- Figure 5 and 6: I suggest to connect the dots associated to the same tropical cyclone (this should help to understand the trajectories/direction of the tropical cyclones).**

**Response:** We also thank you for this suggestion, similarly, we tried to add this for figure 6 but unfortunately, having lines connecting the dots results in a figure that is very hard to understand. Connecting lines in figure 5 are redundant as the few points are clearly labeled with the date and therefore clearly show the cyclone trajectory.

### **Technical corrections**

**- L24-25: ‘isotopic response to tropical cyclones’ is unclear. I suggest to replace with ‘isotopic variation related to tropical cyclones’.**

**Response:** Thank you, we have changed it accordingly at lines 24-25.

**- L104: I suggest to rephrase as follows: ‘if there is an isotopic variation in precipitation associated to the TC landfall’.**

**Response:** Thank you, it is now changed according to the suggestion at line 104.

**- L340: ‘causes’; I am not sure the authors could refer to a cause-effect relation.**

**Response:** We have replaced the word ‘causes’ with ‘produces’ at line 387.

- L349: Please put sample size, p-value and confidence interval between parentheses.

**Response:** We have added parentheses accordingly at lines 426-430.

- L365-366: Please refer to Figure 6 and clearly identify the two outliers in the figure.

**Response:** We included a reference to Figure 6 “(see points a and b in Fig. 9)” and also marked the two outliers in the figure (line 443).

- L372: ‘a “false non-TC signal” of very negative rainfall unassociated with TC activity’ is quite difficult to understand. I suggest to rephrase.

**Response:** Thank you, we slightly rephrased the sentence at line 449: “... inducing a “false non-TC signal” of very negative  $\delta^{18}\text{O}$  which is not related to TC activity”