

## **RESPONSE LETTER**

Prof. Dr. Didier Gastmans

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Rio Claro, November 23, 2023.

Dear. Dr. Thijs Heus,

Detailed point-by-point responses to all referee comments and specify all changes in the revised manuscript are presented below. These referee comments were essential to improve the original manuscript and have contributed for the essential modifications made in the manuscript revised version.

### **Specific response to referee report 1**

**Comments in abstract:** “Combining...” is a very vague sentence. Prefer sentences that convey information on what these processes are and how they play. Remove “While”. “Our results...” this sentence is a generalization that sounds a bit presumptuous. All the drivers that are considered in this study have already been explored in previous studies in other regions. I would remove.

**Response:** The abstract was completely modified. Please refer to lines 20-32.

**Comment:** Kurita 2013 used in-situ observations, not satellite observations.

**Response:** This sentence was removed because this part of introduction was re-written. Please refer to lines 42-62.

**Comment:** is this paragraph really necessary? The diel cycle is not a focus of the study anymore. This looks like a remnant of the previous version.

**Response:** The paragraph was removed. Please refer to lines 42-62.

**Comment:** section 2: according to the guidelines, all the links can be moved to a section called “Data availability” just before the Acknowledgments.

**Response:** The Data availability was included. Please refer to line 451.

**Comment:** Fig 3 is not really used in the paper. Remove the figure and this sentence?

**Response:** This figure was removed, and sentence modified. Please refer to lines 216-217.

**Comment:** grammar issue: The -> This?; try “despite no relationship being observed”? “a change in” -> “of”? Cut sentence: “This illustrates...”; subject missing.; verb missing; try “different from those observed”; sentence is too long. Shorten, cut.; “intra events” -> “events”; “control of” -> “on”; along the seasons -> depending on the season.

**Response:** All grammatical issues have been reviewed and corrected by a American English native speaker.

**Comment:** unclear sentence: try “there was similar duration, temporal  $\delta^{18}\text{O}$  evolution and rain rates”; this sentence is too long.

**Response:** These sentences were rewritten. Please refer to lines 291-298.

**Comment:** General comment on the description of the figures: this is very difficult and long to read. The description should be made much shorter. You don’t need to give all the values, because we can see it on the Figures. I advice to really focus on what is the main point that you are trying to make. Identify the main results and interpret it.

**Response:** The description of the figures were completely modified.

**Comment:** does this correspond to the stratiform zone of the convective system?

**Response:** Not, because there was no melting layer detected on the radar image.

**Comment:** simplify sentence, e.g. “RR and BT did not...”

**Response:** The sentence was modified. There are two new paragraphs of respectively events. Please refer to lines 328-342.

**Comment:** Fig 6 is called before Fig 5?

**Response:** Thanks for your observation. The reference to this figure has been corrected.

**Comment:** Vague and useless sentence, remove.

**Response:** It was removed.

**Comment:** Section 3.3: This is very long and messy. Paragraph l 256-261 and 288-291 could be merged. At the end of l 270 or l 287, we wonder what is the consequence on isotopes. l 298-302 need to be demonstrated. To make this section easier to read, I advice to make one paragraph per season. And for each season, use back-trajectories and meteorological conditions to interpret isotopic variations. The interpretation of isotopic variations should directly follow the description.

**Response:** To make this section easier to read, we have been modified and subdivided into results (section 3.2, please refer to line 243) and discussion sections (section 4.1, please refer to line 355).

**Comment:** clarify that this is an extreme case. If we assumed that all the vapor comes from precipitation at each recycling step, then after n recycling step, we would have  $R_v = \alpha_q^n \cdot R_{v0}$ , which is unrealistic.

**Response:** Yes, this is extreme case. It is evident from the preceding text in this section that the first condensate rainfall discussed in the text is produced entirely from the transpired moisture. However, we are not discussing any recycling here. The main purpose of the discussed case was to demonstrate the potential of transpired moisture in producing rainfalls characterized by elevated  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values and enhanced  $d$ -excess values observed at Rio Claro during autumn and spring season (Fig.2).

**Comment:** this assumes that the sub-cloud layer is well-mixed. You can probably cite a paper to justify this assumption.

**Response:** References were added (Risi et al., 2019; Sarkar et al., 2023). See lines 167-168.

**Comment:** why not simply using the kinetic fractionation from Stewart 1975:  $\alpha_K = (D/D_{iso})^n$

**Response:** The expression for kinetic fractionation coefficient (eq.5 in the main text) is a direct consequence of the generally accepted conceptual framework for isotope effects accompanying evaporation of water into a humid atmosphere (for details see e.g. Gat et al., 2001; Horita et al., 2008). The dependence of  $\epsilon_{kin}$  on the humidity deficit cannot be simply omitted. For  $h_N = 1$  (vapour saturated atmosphere)  $\epsilon_{kin}$  vanishes, as it should be ( $\alpha_{kin} = 1$ ).

**Comment:** isn't 1mm a bit large for a raindrop? Are there any previous studies showing disdrometer observations in this region, that could help justify this value?

**Response:** References were added (Zawadzki and Antonio, 1988; Cecchini et al., 2014). See line 196.

**Comment:** "cloud level" -> "cloud base"

**Response:** It was removed.

**Comment:** General section 3.4: what value was used for  $\delta_A$ ? How was it chosen? How were the 2 events selected? Because they show extreme conditions? Or to contrast day and night? Clarify.

**Response:** All relevant details are reported in Table 2. Isotopic composition of water vapor below the cloud base level was calculated from the measured isotopic composition of rainfall, assuming isotopic equilibrium at (interpolated) mean temperature of local atmosphere below the cloud base:

$$\delta_A = (\delta_{rain} + 1000) * (1/\alpha_{eq}) - 1000$$

The preliminary assessment of evaporation processes were calculated for all events, now. See table 2.

**Comment:** think this was already known, already before this study. I don't think it's fair to say that isotopes variations allowed to demonstrate this. Rather, isotope variations are consistent with atmospheric dynamics in this region that have already been known for a long time. Previous studies describing the atmospheric dynamics and moisture origin for this region can be cited. e.g. for moisture origin: [van der Ent et al., 2010, Gimeno et al., 2012, Zemp et al., 2014].

**Response:** The previous conclusions have been revised. The current focus is on how regional moisture transport controls the initial isotopic composition. This study differs from previous studies mentioned in that there has been no use of high-frequency sampling.

**Comment:** "It's hard to overestimate": strange and vague sentence. Rather, cite previous studies on the impact of deforestation to make a more precise statement.

**Response:** The sentence was removed.

**Comment:** "reduction in precipitation amount": there is an extensive literature on the impact of deforestation on South American rainfall, and results are not always obvious and consistent. These previous studies should be cited to make a more precise statement.

**Response:** The sentence was removed.

**Comment:** "high-resolution": it's not clear to me what was the added value of the high-resolution sampling. What conclusion couldn't have been drawn if you had done only event-scale sampling? This needs to be clarified.

**Response:** To clarify this, we aim to examine the disparities between the initial, median and range of isotopic values ( $\Delta\delta$ ) of intra-events. Therefore, the interpretation was divided into inter and intra-event analysis to maximize the level of detail and comprehension of the changes from regional processes to during the rain event.

**Comment:** This fig is too small, it's hard to read. Maybe cut it into 2 pieces?

**Response:** Yes, this figure was modified in two pieces. See figures 5 and 6.

**Comment:** why discussing only the impact on *d*-excess, and not also on deltas?

**Response:** The discussion of delta was included throughout section 4.2. The semi-quantitative assessment we used focused on *d*-excess due to the greater range of values in relation to the deltas, and to avoid repetitive explanations.

## **Specific response to referee report 2**

**General comments:** As suggested by a reviewer, an English speaker reviewed the manuscript, and it was reorganized. The method section now includes the semi-quantitative assessment, and the results are

divided into sections for inter-event and intra-event data. The discussion is separated into regional and local processes, which detail the main controls on isotopic variability. We maximized the level of detail in our sampling strategy, gaining an understanding of the regional processes and changes during rainfall events. For this, we examined the contrasts among the initial, median, and range of isotopic values ( $\Delta\delta$ ) within events. Upon recommendation by the reviewers, the diurnal variations were omitted from the analysis.

**Comment:** Abstract needs to be rewritten.

**Response:** Abstract was entirely rewritten, and all suggestions were accepted.

**Comment:** Word not a proper word used here.

**Response:** The word was removed.

**Comment:** "climat projections" is too general. These projections are model simulations or actual observation and so on. Here, you should be very specific about this

**Response:** The model was pre-CMIP6 and was included in the text. Please refer to line 39.

**Comment:** This sentence is too long. For the convenience of readers, I would split it into two sentences.

**Response:** This sentence was modified. Please refer to lines 42-50.

**Comment:** In Southeast Asia region, convective events occurring in the afternoon are largely local, and of course large-scale convection does occur in th afternoon. For regional convectie events like Squalls normally occur in the early morning. Please see this paper: He, S., Goodkin, N. F., Kurita, N., Wang, X., & Rubin, C. M. (2018). Stable isotopes of precipitation during tropical Sumatra Squalls in Singapore. *Journal of Geophysical Research: Atmospheres*, 123, 3812–3829. <https://doi.org/10.1002/2017JD027829>. I don't think your sampling strategy can answer this diurnal effect on isotopes.

**Response:** As the daytime differences has been omitted, we have not included the corresponding references.

**Comment:** There are more papers talking about squall lines in tropics apparently you missed it.

**Response:** Yes, thanks for suggestions. However, we've only added a few examples so as not to pollute the text too much.

**Comment:** These papers are not in the reference list at the end.

**Response:** Risi et al., 2010 and Tremoy et al., 2014 were included in reference list.

**Comment:** "belongs to" is not an appropriate word. GNIP was initially established by IAEA and WMO with participation of many member states. You should go to IAEA website to check the background of GNIP.

**Response:** The sentence was rewritten. Please refer to lines 77-78.

**Comment:** rephrase the sentence to make it more clear

**Response:** The sentence was rewritten. Please refer to lines 88-89.

**Comment:** This sentence sounds like that you collected day-time and night-time samples at different locations. Please rephrase this sentence to make it clear.

**Response:** The sentence was rewritten. Please refer to lines 89-90.

**Comment:** I think 10 days back is a little bit too long. What is the average retention time of moisture in the air at your region?

**Response:** Around 10 days. The articles cited in the sentence justify the use of 10 days (Gimeno et al., 2010, 2020; van der Ent and Tuinenburg, 2017).

**Comment:** I didn't find this paper in the reference list.

**Response:** dos Santos et al., 2023 was included.

**Comment:** Did you also investigate monthly precipitation and analyze its isotopes during your study?

**Response:** Yes. However, we solely utilize the monthly isotopic composition of precipitation depicted in Figure 2 to characterize the seasonal pattern. The analytical information was identical to that of high-frequency samples. The details regarding the monthly samples and their analysis have been incorporated into the explanation of Figure 2.

**Comment:** Please try to organize this section discussion in more systematic way for readers to follow.

**Response:** Section 3.2 was divided into two parts: results (section 3.3, which separated the season events) and discussion (section 4.2).

**Comment:** This sentence has some grammar issues and please rephrase it. Also, your description of trends is not that accurate. For example, increase trend meant that value from low at the beginning to higher at the end, but it is not the case you described. Likewise, decrease trend mean values from higher to lower from start to end. It is more appropriate to say that the isotope values varied through these event. Anyway, I am confused with what you are talking about in sentence.

**Response:** We completely agree. The sentence has been rewritten. Please refer to lines 286-289.

**Comment:** so you put events from different years in the same group, although they both were from Feb? I dont know about this statemet, as you compared the event from different years, not the same day at the same year over 24 hour. If this is true, then how you can explain the event 2020/201 and 2020/01/20. Did you check the data from other seasons, I mean the difference between day and night in other seasons?

**Response:** We have organized the events by season to enhance readability. Nevertheless, in this updated version, we display the findings of all intra-events, elucidating each one, irrespective of the sampling period (day, night, or month).

**Comment:** It is no that obvious though and both exhibit no change

**Response:** The variation of these events has been explained in detail. Please refer to lines 322-323.

**Comment:** Change in 4v is clear but not in 4u.

**Response:** The variation of the event has been explained in detail. Please refer to lines 330-332.

**Comment:** This section is kind of wordy. Things discussed are largely known already and not new to readers anymore.

**Response:** Section 3.3 was divided into two parts: results (section 3.2) and discussion (section 4.1). Consequently, there was rewritten.

**Comment:** We can obtain the similar conclusions using daily or monthly precipitation isotope data. Do need to have high-resolution event isotope data.

**Response:** Agree. Therefore, we connected the local and regional processes by utilizing the disparity between the initial, median, and range of isotopic values. The intra-event analysis illustrated the impact of cloud evolution during events and how these local mechanisms altered the regional isotopic composition. This change can only be discerned through intra-event data collection, which is why a significant portion of the article concentrates on this aspect.

**Comment:** This part needs to reorganized. The detailed methods and calculations should be located to method section and here, you should focus on the results and your hypothesis. You should look at all the events examined in this study. The arguments in this section are also very weak. Also, the water line defined by water isotopes of earch event can tell the rain evaporation.

**Response:** The methodology and computations are now included in section 2.6 of the methods chapter, which has been updated and embellished. Calculations have been made for all events studied. The arguments are justified in respected articles within the field of isotopy. It is solely from the knowledge acquired through these articles that we recommend determining the sub-cloud process. This semi-quantitative determination is not used as a primary means of understanding the change in local isotopic

composition due to a lack of data. We are only using it as a secondary evaluation to support the interpretation that is derived from the intra-event isotopic evaluation. Despite this, we have included this section in the text as it is essential to enhance the discussion and quantify the local isotopic processes studied. We opted not to use the local meteoric water line for each event, due to limited isotopic value variation in some cases. Consequently, the points are closely grouped, resulting in a meaningless straight line.

**Comment:** The first sentence is too long and please try to split into two.

**Response:** The sentence was rewritten. Please refer to lines 161-162.

**Comment:** This sentence is redundant as it is not informative at all.

**Response:** The sentence was removed.

**Comment:** Did you check the correlation between rainfall amount and rain isotopes?

**Response:** Yes, the correlations were weak ( $r < 0.5$ ).

**Comment:** some papers cited in the main text are not in the reference list!

**Response:** All papers cited were checked in the reference list.

**Comment:** The style of paper's titles should be consistent; the sentence style is common but uppercase for all words is not very common.

**Response:** The style of paper's titles was corrected.

**Comment:** Table 2: Why you only look at two events?

**Response:** Now, we look all events. Please refer to Table 2.

**Comment:** The figure caption can be better. Please rephrase it.

**Response:** The figure caption was modified. Please refer to Figure 1.

**Comment:** Figure 2: The figure caption can be better. Please rephrase it. Are these monthly precipitation isotope data from your own observation or obtained from others? Please indicate this information in the caption or somewhere in the main text. Please indicate the sources of these data or if not, how you calculated them.

**Response:** The information was included. Please refer to Figure 2 (line 755).

**Comment:** Figure 4: the marks on y-axis are too crowded, and it is hard to read them.

**Response:** this figure was modified in two pieces. See figures 5 and 6.



**Comment:** some sub-figures have two arrows in opposite direction and can you explain more?

**Response:** The arrows were removed.