Response to Anonymous Referees

Article: "How weather events modify aerosol particle size distributions in the Amazon boundary layer", by Luiz A. T. Machado et al.- ACPD 2021314.

Dear Editor,

The authors would like to thank both reviewers for their helpful comments and suggestions. Our point-to-point responses are developed hereafter, along with an indication of changes made in the revised version of the text.

. As a summary, the revisions to the manuscript include the following highlights:

- We have clarified the text. We modified the text according to the recommendations, explaining the scientific aspects and introducing each section. We also added two more subsections and renamed the former Conceptual Section to the Discussion Section. This new section was reorganized to clarify the aspects we know, the new results from this study, and the open questions.
- The gravity waves are better introduced in the text now. Thanks for the comments; the text clearly explains why gravity waves are included in the manuscript in this new version. Particle size distribution is evaluated with the diurnal, seasonal, and intradiurnal cycles. We show that the cloud intradiurnal oscillation has the same frequency oscillation as the rate of change of the particle number concentration. Further, we discuss that this intradiurnal oscillation is forced in response to the gravity waves.
- T-student tests were applied to composite studies.
- Both reviewers recommend we split the former figure 3 into two figures, one for each season. Therefore, we added in this letter the two suggested figures and the former one and try to convince the Reviewers that the actual figure brings the opportunity to compare both seasons from the particles size distribution, lighting density, and brightness temperature. However, I am fully open to follow the suggestion to change to one figure for each season. Therefore, in this new version, we maintained the figure is the former version.
- Supplementary figures were incorporated into the text.

The individual reviewer comments and responses are included in the following document (author comments in *italics*, reviewer comments in **bold**).

Sincerely,

Luiz Machado, on behalf of all co-authors

Reviewer 2:

Main comments:

General:

In their paper, the authors present a combination dataset in which particle size distribution data is combined and effects of lightning and weather patterns on the aerosol particle concentrations in the Amazonas.

Dear Reviewer, we would like to thank your suggestions and comments, they were significant for improving and clarifying some essential aspects of the manuscript content. In the Editor's letter, we explain the main changes in the manuscript, and below, we listed these aspects related to your recommendations.

The dataset is interesting, and the topic and and data is certainly fitting to be published in ACP. However, I had some difficulty in fully understanding what the findings in the paper are. The conclusions first describe the typical diurnal behavior. Then, features for the dry and wet season are presented, and then features of lightining activity. This is then connected to aerosol concentrations, but the explanations of the connections are not very clear, except that higher lightning amounts seem to somewhat increase UFP number. Also, gravity waves are shortly discussed, but their role is not clarified at all. Then, downdrafts are discussed and it is noted that they could increase the UFP number. Overall, it is difficult to discern what the really new finding here is .

We have attempted to clarify the text. We modified the text according to the recommendations, explaining the scientific aspects and introducing each session. We also added two more subsections and renamed the former conceptual section to Discussion section and the Gravity Waves section to Intradiurnal Oscillations.

The gravity waves were better introduced in the text. Thanks for the comments. Now the text clearly explains why gravity waves are included in the manuscript. Particle size distributions are evaluated with the diurnal, seasonal, and intradiurnal cycles. We show that the cloud intradiurnal oscillation has the same frequency oscillation as the rate of change of the particle number concentration. Discuss that this intradiurnal oscillation is forced in response to the gravity waves.

Our main results present statistical results showing how the diurnal cycle, the seasonal cycle, and the intradiurnal oscillations modify particle size distribution. In addition, we describe how different cloud characteristics are associated with the PSD. Finally, we present the particle size distribution changes during lighting events, but we also show how particle size distribution changes as functions of the frequency of clouds with high cloud tops, VIL, and rainfall.

The manuscript also presents a section named conceptual model, but to me this seemed mostly to be a review of previous literature and the connection to the present dataset is not very strong. The analysis here seems to show that there are three different periods: wet season, dry season, and transitions season, during which lightning activity is strongest. Would it be possible to show a clear model, for example

as a figure, that shows for each season what kind of phenomena are the most important ones affecting the PSD during each season in light of the data? This could then be discussed with the supporting data, and the open questions remaining .

The new Discussion section (replaced the former Conceptual model) was reorganized to clarify the aspects we know, the new results from this study, and the open questions.

Finally, the authors state that the dataset opens up new scientific questions, but they do not elaborate what these questions are. As of now, the paper reads like a report on data analysis, where interesting features are found, but the critical analysis of these features is missing .

We reorganized the manuscript, added new subsection and an introductory paragraph in each section. As a result, we believe the manuscript is better organized and understandable.

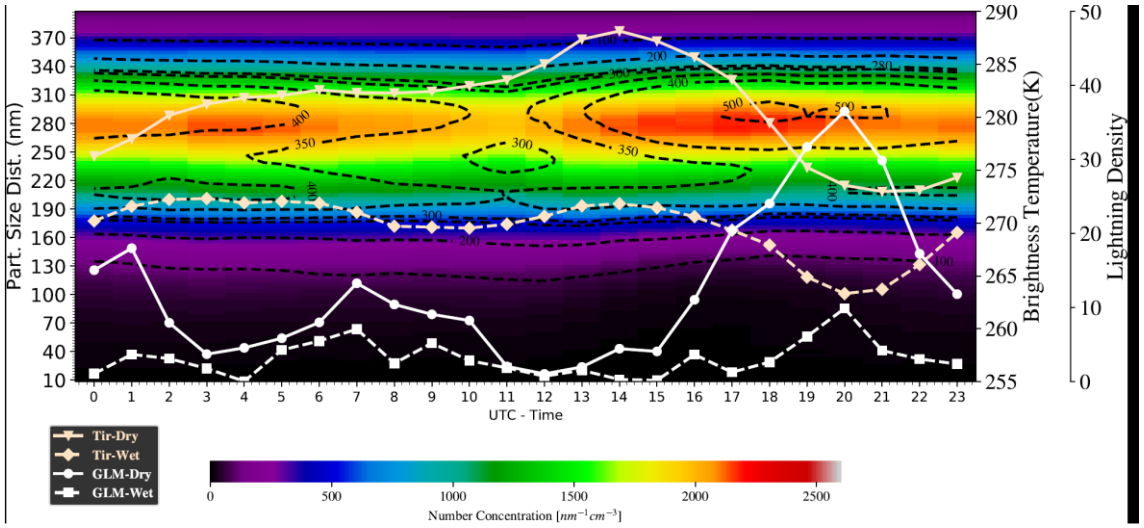
Based on this, I would suggest a major revision of the text that clarifies the novel findings - for example, instead of weather events, why not directly discuss strong lightning events? Also, more strongly present an argument of what is happening, and how the data supports this interpretation. If new questions arise, they could be stated along with the reason why they cannot be answered with the current dataset .

The study also presents how particle size distribution change as a function of cloud top, rainfall, and cloud liquid water. Therefore we consider that this study covers more than only lighting. The manuscript was reorganized, and these aspects were clarified. We study how particle size distribution changes as functions of the diurnal, season cycles and intradiurnal oscillation, the main driver of the cloud variability in Amazonia. Besides, we look at how cloud characteristics are associated with particle size distribution and how weather events modify particle size distribution. We believe this reorganization of the manuscript clarifies all these points raised by the Reviewer.

Some additional comments:

- Figure 3: In my opinion, using a different plotting scheme for dry and wet season inside the same figure is highly confusing. Two similar figures make comparisons possible .

Both reviewers recommend splitting the former figure 3 into two figures, one for each season. We added on this document the two suggested figures and the former one and try to convince the Reviewers that the actual figure brings additional information, it allows the reader to compare both seasons among the particles size distribution as well as from lighting density and brightness temperature. However, I am fully open to follow the suggestion to change to one figure for each season. In this new version, we maintained the figure in the former version.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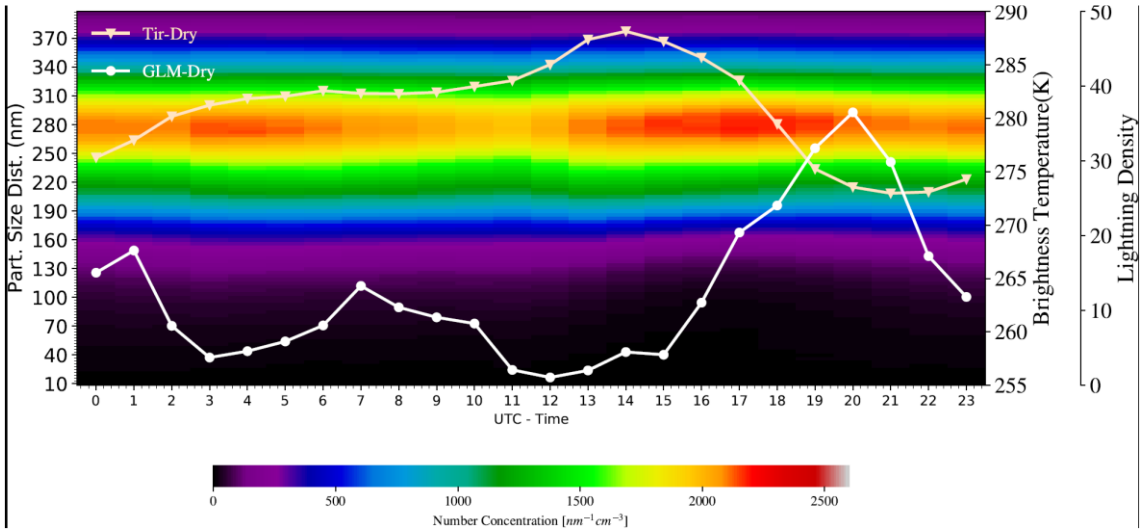
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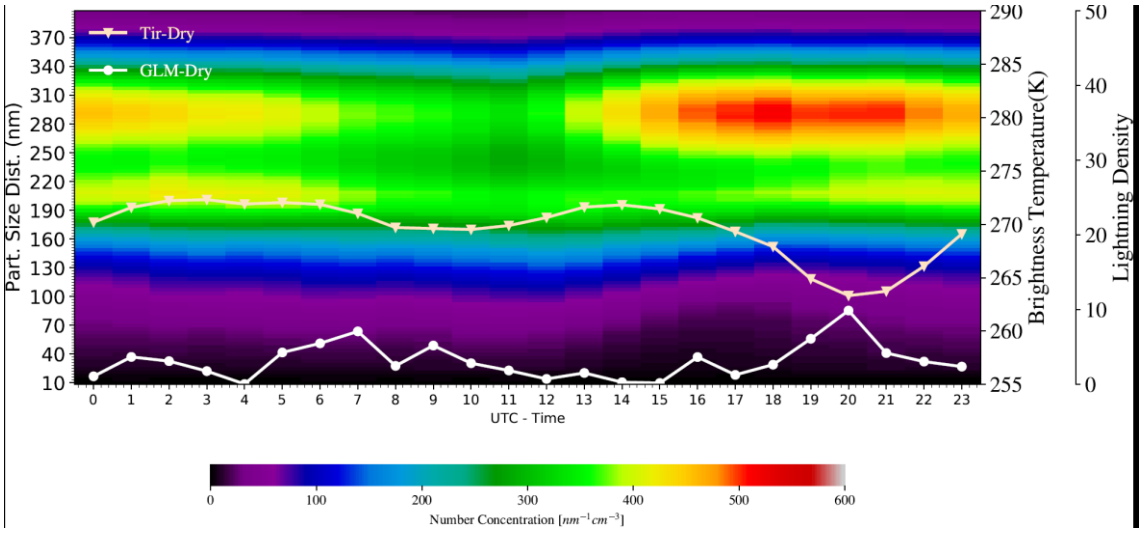
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Number Concentration [$nm^{-1}cm^{-3}$]

- Diurnal cycle: The figures in the appendix seem very contradictory to the presented diurnal cycle. In the conclusions, a diurnal cycle where UFP has a maximum at sunrise and Aitken and accumulation particles have a minimum is presented. However, the averaged diurnal cycles in Figs A3 and A4 are very different from this, as the maxima and minima seem to occur around 10-12 o'clock, much later than the sunrise. This should be clearly clarified, as such data interpretation seems very strange .

These figures were added to the main text. The time is in UTC, LST – 4, we comment on this feature in the text, but we decided to add to the legend to clarify this point.

- Statistical testing: In many cases, the differences between cases seems to be a small signal in the number concentration data. Therefore, statistical testing is important to show that the signal is not just chance.For example, figure 5 seems bring a clear distinction to the particle concentration data, and it is also very interesting. The difference between low amount of lightning and high amount of lightning seems significant, but would it be possible to statistically test whether the shown data is also statistically significant? I assume it is, based on the high number of measurements, but it would be good to have an analysis on this. The same can be said for Fig. 6: I think here, it is essential to show via statistical testing whether there is any significant difference between the particle numbers when the GLM number changes. I think quite straightforward tests should be applicable here.

T-student statistical tests of significance were applied to the composites, and the results are now commented in the text.