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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Comparison of precipitation measurements by Ott Parsivel^2 and Thies LPM optical disdrometers" *by* Marta Angulo-Martínez et al.

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General comments

- This paper discusses a comparison between two the outputs of 4 disdrometers of two different types. The data set is interesting and worth analysing. The topic is relevant for the hydro-meteorologists and could be published in HESS provided that some major modifications are carried out on the manuscript.

Presentation should be improved, notations are not clear and change through the text (as an example the rain rate is referred by three notations R Pr I...), ref-

erences to figure numbers are often erroneous, methodologies implemented are not properly described.

Not all figures are properly discussed within the manuscript. Some results are not properly justified from figures or tables. The authors insist on the differences for small drops. Plots of DSD (N(D)) could be helpful in the discussion.

We thank the reviewer for the insightful review and useful comments. We have tried to address all the issues raised, we hope in a satisfactory manner.

We have carefully checked the notations used, references to figure numbers, and other general issues mentioned.

We have improved the discussion of all the figures, and have better related the discussion of results with the figures or tables. We have included new plots of the particle density ND (included now in Figures 3 and 4, since they did not fit in only one figure as before), as suggested.

We provide our reply to specific comments in the following sections.

We also provide the corrected manuscript as an attached pdf file.

Specific comments: Data and methods section

- Figure 1: It seems that there is also a wind sensor, at least for direction. Since all the devices are oriented in the same direction, did you check whether this parameter had an influence on the similarities or discrepancies. Were the devices always oriented this way or part of the experiment was done with devices oriented perpendicularly?

The four sensors were oriented in the same direction and they were maintained as such during the experiment. We have stressed this in the manuscript, and we have improved Figure 1 by adding labels to the four devices and by including a graphic scale.

A wind sensor was installed later during the experiment, but we had issues with the

wind direction sensor which had a strong bias. As a result, we have valid wind data only for a small fraction of the events, and decided to not use it. We do not know, thus, if the differences between the two devices varied under different wind conditions. We have a new experimental setup since 2017 that includes disdrometers oriented in different directions. This is an undergoing experiment that will be the subject of another report.

- p.5 l.8 0.005m2, it might be helpful for the reader to express in cm2.

We have expressed the surface of the sensor in cm^2.

- p.5 l.19: is the relation between axis-ration and equivolumic diameter the same for both devices?

It seems so, although there are very few details from the manufacturers. We have not found explicit information for the Thies, but in the case of Parsivel this is better known. We have included information on this in the detailed description of the differences between both disdrometers, in section 2.1.

- Eq 1 : KE ***is not defined in the text. I would replace*** N ***by a*** $N_{i,j}$ ***which makes more visible that it is a number per bins of size and velocity. Provide units for 'a' and 'Pr'. Why not use*** R ***for 'Pr'***

We have provided units for all the variables, and included the formulas for computing all the integrated variables mentioned in the text. We have also used $N_{i,j}$ to indicate the particle count per size and velocity classes.

- p.7 l.19-20 : I guess that it is pretty minor, but did you check if the given realization of random affectation of a diameter within a bin had an influence on the results.

Given the high number of particles detected, the random component of this scheme has a negligible effect on the results, as we confirmed by repeating the procedure a number of times with different random seeds. This has been specified in the text.

- Table 2 : Please define all variables somewhere in the text (KeM, Npm...)

All variables in Table 2 have now been defined in the text.

- Section 2.3 : It is quite hard to follow and presentation should be strongly improved. The last paragraph (p.8 l. 24-26) should also be written for non R users.

We have reworked this section substantially, and we believe it will now be an easier read.

Regarding the reference to the R library and functions used in the analysis, it is mentioned for the benefit of clarity and reproducibility. Although this reference could be deleted, we are used to clearly stating the software used in all of our analyses, so we propose to leave the reference. This information is only useful for those who would be interested in replicating the analysis, but it is not substantial for understanding the methodology.

Specific comments: Results section

- p.9 l.4-8 : it could be interesting to discuss the number of time steps when Thies records some data and not Parsivel to understand more their sensitivity differences (keeping in mind potential issues already mentioned in the text).

We have added new data on Table 3 indicating the exact number of minutes with data, with errors, with detection of rain, etc. This data shows that Thies devices detected rain in 30.7% of the minutes, while Parsivel n° 1 only did so in 27.5%. We do not compare it with Parsivel n° 2 because its record is shorter due to malfunctioning, and it missed some important events.

The table also shows that only the common, high quality rain minutes were used in the analysis.

- Table 3: clarify the the meaning of Nr***. The fact that N records = 26.8% for***

Parsivel M1 is the greatest one seems in contradiction with the text mentioning a greater sensitivity (or false alarm) for the Thies.

As explained above, we have included new data on Table 3, that now clearly shows the number of minutes recorded by each device, the number of error flags, minutes with rain, and common minutes.

- p. 9 l.22: the differences between the two parsivels seem very high with regards to other similar studies. Do you have any explanation or interpretation? I think that this should be mentioned.

We have corrected an error that affected the computation of rainfall totals, that was not done considering only the common minutes in the four disdrometers. The values now show differences between disdrometers of the same type, but these are low and compatible with being random. For instance, total precipitation was 244.9 and 254.5 mm for Thies 1 and 2, and 220.4 and 228.1 mm for Parsivel 1 and 2.

- p. 9 l.15-22: the figures given do not seem to be in agreement with the plot in Fig. 2 (ex âĹij 400 mm for Thies in the text and 250-300 on the graph....

It is true, and it was due to the calculation error mentioned above. It has been corrected now. Please, note that we have modified Figure 2 so it now includes the same cumulative variables (precipitation and kinetic energy), but as given by the devices firmware and calculated from the PSVD data.

- Fig. 3: it could be interesting to add plot of DSD (N(D)) for the whole events. And discuss them.

It is true, and we have included the particle density (for which we use the symbol ND) in the figure, and in all the analyses. Since adding ND implied modifying the plot with one more row of plots, we also included the time series of the median particle size, which we believe complements in a good way the information on the plot. This has forced us to split Figure 3 in two, one for each event (now Figures 3 and 4).

- Fig. 4: did you apply a filter based on discrepancies of velocity with expected velocity for terminal fall velocities formula as some authors do?

No filter was applied, but it is an interesting suggestion. Since we got the same suggestion from the other reviewers, we have decided to include a filtering in our work. In what affects this figure (now split in two, one for each event), we have indicated with a different color the size and velocity bins that would be filtered out based on a 50% discrepancy with respect to the terminal velocity model of Beard (referenced).

- p. 10 l.13: please explain more in detail what is a kernel plot, it might not be obvious for all the readers.

A kernel density estimation, or kernel density plot, is a non-parametric way to estimate the probability density function of a random variable. We have added one line at the beginning of section 2.3 to make this clear to the unfamiliar reader.

- p. 10l. 19: ref to Fig. is a mistake.

True. It has been corrected.

- p.10 l.20-23: should be mentioned that it is Fig. 6 that is discussed. Discussion should be extended by starting by explaining more precisely what is plotted (the short figure caption is not enough).

We have corrected the references to tables and figures on this paragraph.

We have explained the kernel density plots at the begining of section 2.3, and we have re-written this section in order to make it clearer.

- Section 3.3: It is not clear what you mean and how you show it from the results (not sure that it is Fig. 6 that is discussed).

Section 3.3 discusses the differences between disdrometer types found at the event scale, while it was at the minute scale before. We have stressed this, and we believe that it is now much more clear. The results discussed are now in Figure 8 and Table 5.

- section 3.5: the limited impact of rain rate is somehow surprising since I would have expected the that exceedance smaller drops would affect more strongly small rain rates (for which their influence on the total rainfall amounts is greater).

I would not say that the influence of rain rate was limited. The rain rate modulated strongly the differences found at a more general level, and the differences (more, but smaller particles sensed by Thies with respect to Parsivel) were amplified at higher intensity rates. We have rephrased the paragraph to make this clearer. We have also moved the results of the analysis at different intensities to a separated table (Table 6).

- Table 6 is not well discussed and quite hard to "digest" for the reader. It should be improved (may be a graphical representation would be more helpful for the reader).

The results of the statistical analysis are now split in Tables 4, 5 and 6. We have completely reformatted them, and the explanation of the terms and values shown has been extended. This is a formal statistical analysis that confirms what we could see in the graphical representation on Figure 7 (kernel densities) and 8 (violin plots).

Graphical results (kernel density plots) for the variables at varying intensities are given in the Appendix due to space limitations (figures A.4, A.5 and A.6).

Specific comments: Discussion and conclusions section

- Should be updated according to improvements.

We have rewritten the discussion section, and some modifications have been also done to the conclusion (now a section of its own).

– Some 'technical' issues with references (ex. P. 13, l. 22-23).

We have checked the references.

Please also note the supplement to this comment:

https://www.hydrol-earth-syst-sci-discuss.net/hess-2017-652/hess-2017-652-AC1-supplement.pdf

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