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Discussions

Interactive comment on "Rainfall estimation using moving cars as rain gauges – laboratory experiments" *by* E. Rabiei et al.

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The authors had the innovative idea to use cars as moving rain gauges, more specifically , to use the speed of windshield wipers to gauge rainfall intensities. To this end, they conducted a laboratory experiment in which the relation between rainfall intensity (R) and wiper-speed (W) was sought. This was done by building a rainfall simulator and placing both a car, as well as the optical sensors used in automatic windshield-wiper-system under it. A tipping bucket was used as a reference rain gauge.

The paper is well written and the topic is of interest to the readership of HESS. I especially like (and encourage) authors to submit articles on (the design of) novel observational methods.

I do have some concerns about the setup of the experiment. I would like to ask the authors to address these concerns. Some of these concerns ideally would require additional experiments. I understand this may not be possible (although I hope it is), therefore, I have provided suggestions on possible ways to address the concerns with the data that is provided in the paper. I have ordered these concerns per topic

If the authors can address these concerns, I would recommend this article for publication in HESS.

0.1 On the rainfall simulator

The authors mention that the purpose of the rainfall simulator is to "replicat[e] the properties of natural rain". However, natural rain only reaches it terminal velocity after about 10 meters (depending on drop sizes, see the somewhat obscure reference van Boxel (1998) for details). The authors mention that the apparent rain density has great influence on the amount of water that reaches the sensor. If the simulator generates drops with too low a velocity, this will certainly influence the results and thus the conclusions.

To check if the setup actually provides a reasonable estimation, I would suggest to use a (laser?) disdrometer as a reference gauge. This would have given a measurement of both the drop size distribution as well as the drop velocity distribution. Those can be compared to known drop size and drop velocity distributions of real rainfall. If the authors do not posses a (laser)disdrometer, they could possibly use the speed-o-meter they use to measure the speed of the car-simulator, see Mansheim (2010). If the authors do not have access to the rain-simulator anymore, I would suggest the following: Using the work of Uijlenhoet (1999) the drop size distribution can be calculated from the measured intensities (under some assumptions). Using the relations between drop sizes and drop terminal velocities (Gunn and Kinzer (1949)) the distribution of drop velocities can be calculated. Using these distributions, an weighted average of the ratio mu can be calculated. This can be compared to the measured ratios.

Using any of the above methods, the authors can test whether , given the data, the simulator "replic[ates] the properties of natural rain". However, my educated guess would be that the the simulator generates drops with too low a terminal verlocity. This will influence, among others, the ratio's presented in figure 7. In this case, I would invite the authors to explain who this influences their conclusions.

0.2 On the homogeneity of the rainfall simulator

The authors indicate that, despite their efforts, the rainfall generated in the simulator is not spatial homogeneous. To correct for this, they use a factor to correct for the difference between the location of the sensors and that of the tipping bucket. However, the authors do not mention how stable the inhomogeneity is. If I understand the paper correctly, every line in table 4 is based on a single experiment. I would be interested if the spatial pattern, as shown by the example figure 4, is consistent between measurements, or whether it differs greatly. If the authors have no more access to the simulator, they could test this by calculating the relative deviation per experiment for all locations. If the same locations prove to bee constantly either below or above average, one could conclude that the spatial inhomogeneity is constant between experiments. This would give confidence in using the RDev factor that the authors use. If the inhomogeneity is not constant, this raises questions whether the inhomogeneity is constant within the 15 minutes duration of the experiments and thus whether the use of RDev is appropriate.

0.3 On the car speed simulator

As I understand the setup of the car speed simulator, no actual windshield is included in the setup. The absence of a windshield around the sensors will greatly influence the airflow around the sensors and thus the amount of drops, but also the size of drops, that will hit the sensor. I invite the authors to comment on how the inclusion of an

actual windshield will influence their measurements and how this would influence the conclusions they draw.

0.4 On the manual wiper speed adjustment experiment

I would like the invite the authors to explain exactly how the person in the car was instructed during the experiment and I would like the to know if the person in the car was aware of the rain intensity being applied during the experiment. Experiments in which human subjects (or other primates for that matter) need to do some task are extremely hard to design without a bias. Ideally, one would like to give the person in the car a simple instruction like "make sure you can see the text at the wall" and do not tell the person in what order the simulator will change intensities. If needed, I can look up some references on the design of experiments involving people doing tasks (I am writing this review offline).

0.5 On the conclusions

Given the concerns raised above, I feel that some of the conclusions may be worded too strongly. I would invite the authors to add remarks to the conclusions to indicate under which assumptions the conclusions are valid.

0.6 On language

I intentionally did not provide any comments on spelling and grammar, since I did not spot any. However, I am quite blind to those kinds of errors: most likely, there are numerous spelling and grammar errors in this review of mine. I found the paper to be very readable.

0.7 On future work and other publications

I would like to ask the authors to provide more details on the future work, such as the names of the authors working on said future work. This makes it easier for readers of HESS, a few years from now, to find the related work. As a note to the editor: I believe it should be easy for authors of a paper to add a “relevant work published after publication of this article” as a kind of erratum to an existing article. This would greatly facilitate readers of HESS in the future to find articles that have a logical relation.

References:

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