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Reply on RC1

Wagner Wolff et al.

Author comment on "Rainfall retrieval algorithm for commercial microwave links:
stochastic calibration" by Wagner Wolff et al., Atmos. Meas. Tech. Discuss.,
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Author's reply to the referees comments to manuscript AMT-2021-34

Anonymous referee 1

The original referee's comments are written in bold and the author's replies are written in regular font.

Review summary for "Rainfall retrieval algorithm for commercial microwave links: stochastic calibration"

In this paper, the authors address a known problem: many different algorithms and approaches to retrieve the rainfall via commercial microwave links have been presented in the past. However, most of the presented model-based approaches are sensitive to various design parameters of the specific algorithm. The authors return to a previously published algorithm - the RAINLINK, describe the problematic-sensitivity to specific design parameters, and suggest a methodology to pinpoint the most important parameters, and to better calibrate these parameters (which the authors did previously via empirical calibration).

We gratefully thank the Referee for the constructive comments and recommendations.

The problem at hand is indeed important, and the results presented by the authors are encouraging. However, in my opinion there are two major issues that should be resolved prior to the publication of this paper:

Focusing on model-based only approaches is limited. Once training data is available, and stochastic models are considered, many current deep-learning algorithms can be implemented, which can potentially solve the parameter-calibration problem by suggesting a data-driven solution. E.g., see [1], among others. Thus, the solution presented by the authors here should be compared to such updated tools, or at least be discussed regarding the disadvantages and advantages between the presented approach and such data-driven approaches.

Reply:

We appreciate this comment. Data-driven approaches indeed deserve further investigation (as in Pudashine et al., 2020), but are beyond the scope of our manuscript (a perspective referee 2 seems to agree with, according to his/her introductory statement). However, we will add a discussion on the disadvantages and advantages of our approach and data-driven approaches to our manuscript. We think that a data-driven solution is not doable for places or countries without sufficient reference data to train the model, such as a gauge-adjusted radar dataset which provides full coverage over a CML network. Although a data-driven solution could be used in our study, we focus on a stochastic calibration approach, which we expect to be more widely applicable since it does not require a large training dataset. This is especially important for the low- and middle-income countries in (sub)tropical regions, which would benefit most from the complementary rainfall information CMLs can deliver, and which often lack extensive reference datasets.

The authors emphasize that their approach gives at least a partial solution for different climate regions. However, in these cases, it is important to consider some physical parameters that might affect the accuracy of the outcome, such as the power-law coefficients themselves. Specifically, these parameters are climate-sensitive, as was presented in past studies. How the implementation of such parameters into the calibration scheme affect the results?

Reply:

Thanks for the suggestion which definitely helps to improve this paper. As the power law parameters are physically-based, we used values obtained in dedicated experiments representative for the Dutch climate (Leijnse, 2007, p. 65). For other countries, the International Telecommunication Union (ITU) presents recommendations (ITU-R Recommendation P.838-3), but these are not representative for all climates. In our opinion, a physically-based approach which derives these coefficients from drop size distribution observations and scattering computations is preferred compared to optimizing these coefficients in a statistical manner. We will add this to the discussion and also mention that taking these parameters in the optimization into account may be a way forward for regions which lack disdrometer data. For such regions, an alternative approach would be to use disdrometer data from a similar climate as for the CML data.

At the same time, the importance of the power-law coefficients and their estimation through a physically-based approach should not be overrated either. Since the value of the exponent is close to 1, other parameters can compensate for the values of the power-law coefficients as long as the non-linearities are not too large. Moreover, previous studies show the exponent is quite invariant to the shape of the drop size distribution. We will add a discussion on the power-law coefficients in the manuscript.

All in all, this paper provides an interesting approach, and is well written. However, it should relate also to recent advancement in this field that address the same general problem via machine learning tools.

We appreciate your feedback and will add recent machine learning tools to the manuscript discussion.

[1] H. V. Habi and H. Messer, "Recurrent Neural Network for Rain Estimation Using Commercial Microwave Links," in *IEEE Transactions on Geoscience and Remote Sensing*, doi: 10.1109/TGRS.2020.3010305.

Leijnse, H., Uijlenhoet, R., and Stricker, J. N. M.: Rainfall measurement using radio links from cellular communication networks, *Water Resour. Res.*, 43, WR005631, <https://doi.org/10.1029/2006WR005631>, 2007.

Pudashine, J., A. Guyot, F. Petitjean, V.R.N. Pauwels, R. Uijlenhoet, A. Seed, M. Prakash, and J.P. Walker, 2020: Deep Learning for an improved prediction of rainfall retrievals from commercial microwave links. *Water Resour. Res.*, **56**, e2019WR026255, doi:10.1029/2019WR026255.