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Atmospheric Measurement Techniques Discussions

Interactive comment on "Towards variational retrieval of warm rain from passive microwave observations" *by* David Ian Duncan et al.

Anonymous Referee #1

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General comments This manuscript details a variational methodology to retrieve warm rain using passive sensors. The algorithm extracts hydrometeor and precipitation onset data from active sensors based on regime, coupled with radiative transfer models and disdrometer observations, to improve detection of raining warm clouds. This proof-of-concept provides promising results towards expanding the precipitation regimes that passive sensors can retrieve. Research presented in this manuscript is novel and reaches substantial conclusions. In particular, the care in the treatment of error provides readers with a well-informed and logical presentation of the algorithm. A few specific comments are offered as a guide to improve the manuscript.

Specific comments

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Discussion paper

1. You describe a lack of evaporation model, but included in the 2C-Rain-Profile algorithm is an evaporation model (Lebsock and L'Ecuyer, 2011, Sec. 3.4.2). Therefore, it may be difficult for a reader to discern from the text where exactly your algorithm deviates from the evaporation included in the CloudSat algorithm that information is derived from. Could you please clarify this a bit when making caveats that no evaporation model is included in the algorithm (e.g. P14L19-20, P26L2)?

2. Based on discussion and results from Figures 9 and 10, the goodness of fit provides a cursory estimate for trustworthiness of the retrieval. Figures 7 and 8 could be better served by including the goodness of fit estimates as there are locations north of 53° with 1DVAR rain retrievals but no discernable reflectivities from CloudSat in the lowest few kilometers of the troposphere. Those estimates coupled with the visual information of the reflectivity vertical profiles would provide further backing to that claim.

3. Along the lines of Point 2, was there any sensitivity analysis performed on the -8 K threshold used for higher frequency scattering by ice detection (P13L17) in the retrieval?

4. In Section 5.3, rain rates are excluded below 0.2 mm/hr for statistical calculations. It would be good to at least get an idea of the "distribution's tail" that exists from 0.2 mm/hr to e.g. 0.01 mm/hr. Though this manuscript is not intended to be an operational algorithm description and validation, it would be useful for the reader to understand the relative performance of 1DVAR compared to DPR or PR estimates in this regime specifically (which, for the latter at least, is essentially null in Berg, L'Ecuyer, and Haynes (2010), Figure 3).

Technical corrections

1. P3L25-26: “providing the best information content for sensing precipitation of any extant passive sensor”: this statement should probably have a citation or be restated as it currently conveys a quantitative information content estimate.
2. P4L24: This should perhaps be rephrased to the National Weather Service operates.
3. P7L7: Please specify in the text the two years of CloudSat data.
4. Figure 3: Please include units on the figure.
5. P28-31: Some references are missing DOIs. P30L21 has a malformed DOI.

References

- Berg, W. S., L’Ecuyer, T. S., and Haynes, J. M.: The distribution of rainfall over oceans from spaceborne radars, J. Appl. Met. Clim., 49, 535–543, https://doi.org/10.1175/2009JAMC2330.1, 2010.
- Lebsock, M. and L’Ecuyer, T. S.: The retrieval of warm rain from CloudSat, J. Geophys. Res., 116, https://doi.org/10.1029/2011JD016076, 2011.

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