

Interactive comment on “What millimeter-wavelength radar reflectivity reveals about snowfall: An information-centric analysis” by Norman B. Wood and Tristan S. L’Ecuyer

Anonymous Referee #1

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This is a clearly written and carefully presented manuscript describing an optimal estimation retrieval of snowfall from W-band radar reflectivity and the associated uncertainties. In particular, the very neat description of the optimal estimation framework and of the separation of the different factors contributing to the uncertainty of the retrieval makes it a very good introductory paper on optimal estimation applied to snow retrieval. Overall, the research is sound, but I have two major concerns and few minor comments. I recommend the paper for publication after these points are addressed.

Major comments:

- 1) I think that the conclusions about the overall performances of the retrieval for the

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whole C3VP field campaign is misleading and should be toned down. The retrieval presented in this paper requires assumptions on the snow particle properties that were obtained in Wood et al. (2015) by exploiting (at least partly) the same dataset. On one hand, I can accept that the observations used for deriving the properties of the snow particle “microphysical model” (mass-size and area-size parameters) can be considered as independent since the in-situ observations were combined with X-band radar measurements. On the other hand, the particle “scattering model” has been specifically selected to get the best match between W-band radar measurements and reflectivity computed from in-situ observations. It is therefore not surprising that the retrieval of the current paper provides an accumulated snowfall in such a good agreement with in-situ data. Therefore, I suspect that this impressive agreement is more due to a compensation of errors between the different snowfall cases than a very accurate performance of the retrieval as the instantaneous errors suggest. I have serious doubts that the same overall accuracy could be obtained when using a fully independent dataset. In the current version of the paper, a reader could really wonder why we would need more accurate observations of snow.

- 2) There is no question about the value of the optimal estimation retrieval described in this paper, in particular for assessing the different contributors to uncertainty. However, since the retrieval is applied to a single radar range gate and attenuation is neglected, and based on the conclusion that the W-band reflectivity is much more sensitive to $\log(\lambda)$ than $\log(N_0)$, it sounds that a much simpler retrieval (such as Z- λ statistical relation) could be proposed with performances probably similar the optimal estimation proposed in this study. Please comment.

Minor comments:

- 1) L145: In order to emphasize that observations are independent, I would specify that X-band radar observations were used in Wood et al. (2015) for deriving the snow particle “microphysical model”.

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2) L300-303: Related to my major comment, by checking Wood et al. (2015), it appears that the 3 cases mentioned were indeed used for deriving the snow particle “microphysical model”. However, practically the same overall dataset (Wood et al. (2015) say: “13 days from 2 December 2006 to 26 February 2007”) was used to select the particle “scattering model”.

3) Table 1: While I was trying to understand which part of the C3VP dataset was used for each part of the work in the current study and in Wood et al. (2015), I realized that the 3 common cases reported both in Wood et al. (2015) and in the current study don’t show the same FD12P snow accumulation in LWE mm (0.8 vs 3.2 mm for the 6 Dec. 2006 ; 0.093 vs 10.2 mm for the 7 Dec. 2006 and 1.06 vs 4.6 mm for 27 Jan. 2007). These numbers are very different, please clarify. The accumulation is always smaller in the current paper. If the data on those days was only partially used, please explain why.

4) L381-388: It would help the understanding if you introduce the sensitivity of the forward model to both $\log(\lambda)$ and $\log(N_0)$ at the same time while saying that the sensitivity to N_0 is not shown in a figure because it is constant and equal to 10.

Typos and awkward phrasing: 1) L57: evaluate is used twice 2) L125: “based on information theory” 3) L191: “Northwest” 4) L276: missing number after comma? 5) L444: reduce is used twice

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