

## Review “Estimation of wet radome and rain induced attenuation in cloud radar observations” by Bernd Mom and Dmitri Moisseev

I greatly appreciated reading the proposed article, which addresses a highly relevant topic for precipitating cloud radar observations. With the increasing number of cloud radar systems—such as those deployed within the ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) network—there is a growing need to improve correction methods for wet radomes and rain attenuation. Such corrections are essential for accurately retrieving the reflectivity of precipitating ice and mixed-phase clouds, and ultimately for improving cloud microphysical retrievals.

The manuscript includes a well-written introduction and a good results section, supported by informative and well-designed figures. In particular, the discussion raises an important practical question regarding how the authors assess the degradation of the radome. This issue is highly relevant for operational networks such as ACTRIS, and the authors could further strengthen the paper by sharing their expertise on this aspect.

In the methodology section, I especially appreciated Sections 3.1, 3.2, and 3.3 for their clarity and completeness. However, I am less satisfied with Section 3.4, which addresses the inverse problem and, in my opinion, constitutes the core contribution of the article. While the conceptual ideas are clearly presented, the implementation details remain insufficiently described, limiting the reproducibility of the work. Section 3.4 would benefit from significant clarification and expansion (see detailed comments below).

For these reasons, I recommend major revisions before the article can be considered for publication.

### Recommended revisions

#### **3 Methods**

##### **3.1 Difference in heights of radar and disdrometer sampling volumes**

3.1.a) **Lines 136-137:** “*The increase between the first and third gates is in the order of 1 dB. This feature is consistently present in most if not all radar reflectivity profiles.*”

For the two study cases considered or for all rain data of HYDRA-W?

3.1.b) **Lines 144-145:** “*It should be noted that the correction factor decreases with altitude and can be neglected for the range gate three and higher.*” That depends on how large is the pointing error?

3.1.c) **Lines 182-185:** Which pointing error can explain the 1 dB increase of the reflectivity from range gate 1 to range gate 3? For this pointing error, what will be the error for the range gate 3?

## 3.2 Computation of DSD parameters and radar variables

3.2.a) **Line 208** (typo): ....and  $\theta$  is the elevation angle in radians.....

## 3.3 Forward model of disdrometer measurements

3.3.a) **Lines 3-4**: “*For simplicity sake, we will assume that DSDs follow a Gamma functional form and therefore can be described using three parameters, as presented in the previous section.*” To strengthen this statement, the authors may cite the following article: “A critical evaluation of the adequacy of the gamma model for representing raindrop size distributions” by C. Gatidis et al. (2020), which shows that most of the DSDs at 30 s time resolution are not far away from the gamma model, unless a rain transitional period is considered.

3.3.b) **Lines 229-230**: “*Given a number of observed droplets, i.e. by sampling the Poisson distribution, a simulated distribution of droplets can be obtained by sampling the Gamma probability density function defined by the intrinsic DSD parameters.*”

Rewrite to make this content more understandable/clear for the reader. Rather than a long sentence, more sentences (shorter) could lead to clarify this content.

3.3.c) **Lines 242-244**: Compared to Fig. 1, what is the rationale for choosing a uniform distribution for  $\log_{10}(N_w)$ ? What is the rationale for choosing a normal distribution for  $D_0$  and  $\mu$ ? What are the mean and standard deviation of the selected distributions?

3.3.d) **Line 244**: “*For  $\log_{10}(N_w)$ , a uniform distribution is fitted in between the range 2 to 5  $\text{mm}^{-1}\text{m}^{-3}$ .*” Correct the unit.

## 3.4 Inverse problem: from observations to an ensemble of intrinsic DSDs

3.4.a) **Fig. 2 caption** (typo): “*Schematic illustrating the steps taken in the forward (a) and inverse (b) models*”.

3.4.b) **Eq. 9**: Mention what the variable  $x$  is: .... where  $x$  is ....

3.4.c) **Lines 287-288**: “*This procedure is repeated for every observed DSD, and a single intrinsic DSD can be linked to multiple observations.*” I could follow the idea of the methodology (Lines 283-287), but from this sentence, I don’t understand how the observed DSD can be linked to a single intrinsic DSD. Which single intrinsic DSD will be selected? Here I miss a stepwise methodology (implementation), which makes this part of the research not reproducible. Explain like in the forward model with a stepwise approach: step 1, step 2, .... or an extra schematic or a small annex.

3.4.d) **Lines 288-290**: “*Because the forward model includes statistical uncertainties, DSD truncation and filtering, this link allows estimation of statistical uncertainties and possible biases of computed DSD parameters and radar variables.*” How are the statistical uncertainties, bias of computed DSD parameters and radar variables estimated? Related to this: how are the black boxes in Fig. 4 estimated? Develop this

part (stepwise approach or schematic or annex). Like in 3.4.c) the concept is clear but that is not the case for the implementation. Explain to make this work reproducible.

3.4.e) **Line 302:** “*As was shown in (4b-c) the ensembles of reflectivity and rain rates can also be estimated.*” Following on 3.4.d) How are the ensembles of reflectivity and rain rates be estimated? What is the meaning of the number of simulations in Fig. 4 (b)-(f)?

3.4.f) **Lines 305-306:** “*Because the uncertainties associated with the ensemble of rain rate are correlated, the standard deviation of the accumulated precipitation cannot be directly added over time.*” I suppose you mean: the variances of the accumulated precipitation cannot be added....

3.4.g) **Lines 306-307:** “*Therefore, the propagation of uncertainty is calculated by  $\sigma^2 = a \sum^x a^T$ , where  $a$  is a row vector and  $\sum^x$  is the variance-covariance matrix (Mardia et al., 1979).*” How are the uncertainties related to the accumulated rain obtained? Explain the provided equation,  $\sigma^2 = a \sum^x a^T$ . What does contain the row vector  $a$ ? What is  $x$ ? Which variance-covariance matrix is considered?

3.4.h) **Line 309** (typo): “.....is computed from the disdrometer observations.”

## 4 Results

### 4.1 Radome attenuation

**Lines 335-336:** “*This is illustrated for an event with minimal radome attenuation and one with a degraded radome resulting in strong radome attenuation.*” When was the radome changed in 2023? **How do the authors assess the degradation of the radome?** That is an important question for the ACTRIS network. The event 28-29 July 2023 (radome attenuation case) shows a heavy precipitation event (53 mm hr<sup>-1</sup>), while the event 26 May 2022 (minimal radome attenuation case) presents largest rainfall rates less than 2.5 mm hr<sup>-1</sup>. Therefore, radome attenuation could result from heavy rainfall rates, while having the radome not necessarily damaged? Can the authors comment on this?

**Lines 356-358:** “*It should be noted that during the second event, there is also a notable difference in observations of precipitation accumulation. The weighing gauge measures about 47 mm of total precipitation accumulation during the event and disdrometer derived accumulation is only 42 mm. This difference exceeds expected uncertainty of disdrometer observations.*” Do the authors have some ideas on the possible reasons of this difference?

### 4.2 Specific attenuation

**Lines 396-398:** “*A second, less restrictive criterion is to compare projected and observed reflectivity values just below the melting layer. If the difference is less than 1 dB, than the attenuation correction can be applied.*” What is the rationale of this criterion? Explain.