Atmospheric Measurement Techniques Discussions

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Comment on amt-2021-264

Anonymous Referee #2

Referee comment on "Snow Microphysical Retrieval from the NASA D3R Radar During ICE-POP 2018" by S. Joseph Munchak et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-264-RC2, 2021

Title: Snow Microphysical Retrieval from the NASA D3R Radar During ICE-POP 2018

Manuscript summary:

The manuscript introduces an algorithm retrieving the particle size distribution and various microphysical properties of snow from dual-wavelength dual-polarization radar via optimization estimation. These estimations include characteristic particle size, shape parameter of the size distribution, rime fraction, mean aspect ratio, orientation distribution and snowfall rate (volumetric and water equivalent). The results are verified with the ground instrument during ICE-POP 2018. Most of the comparisons indicate high biases but with high correlation coefficients.

The major concern of the algorithm is trying to estimate various parameters (Eq. 13, 9 parameters at each gate) at the same time, yet the information for retrieval is limited (EQ. 12, 5 measurements). The validation indicates high biases. The manuscript needs substantial revision. Major revision is recommended.

Major comments:

- Considering the number of variables (nine) is higher than measurements (five), it's highly possible the final retrievals are mostly from the "background" value (e.g., Prior in Table 5). The manuscript did not compare the PPI (or RHI)simulated measurements

from "Prior" and "last iteration". This is important to ensure the retrieval is not mostly from "background" term (2nd term of RHS in Eq. 11). Figure 4 is the only figure to show that the final simulated measurements from optimal estimation. Yet, a ray data is not convincing. Please do show the PPI or RHI simulated measurements for all of the experiments including Hu-only, DWR-only, Ku-pol and All-obs.

- Since the observational information is limited, fixing the value of some parameters (e.g., axis-weighted ellipse ratio, riming fraction). Figure 10 and 11 indicate that the effective density and ellipse ration has little change compared to other variables. Has author considered to reduce retrieved variables?
- Three cases are show for validation. Two of the cases (9 Jan. and 28 Feb.) has pronounced bias between radar measurement and PIP simulation (Fig. 8). Later, the retrieval bias can also be noticed among those two cases (Figs. 9 and 10). In terms of snowfall rate, author can consider perform more comprehensive validation by including more Pluvio data.
- Overall, the validation is rather disappointing. The bias and MAR are around +/- 30% in snowfall rate, nearly 40% in volume-weighted diameter (Dp), 40% in area-weighted ellipse and box aspect ratio. It's a good sign that the correlation coefficient is high. Moreover, there is no PPI or RHI retrieval to ensure that the retrievals are consistent in spatial domain.

Minor comments:

Figure 4, please change the color of simulated measurements of the last iteration to red color for clarity.

Figure 9, please show the snow fall rate from "background" simulation.