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# Comment on amt-2021-264

Anonymous Referee #1

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-RC1, 2021

This is a very solid and well written paper describing the optimal estimation (OE) algorithm for retrieval of microphysical characteristics of ice using combined polarimetric and dual-frequency radar measurements. The algorithm was tested on the data collected during the ICE-POP 2018 experiment in Korea. Although certain microphysical features of ice / snow are well captured, an overall quality of the algorithm performance is quite modest which might be possibly or partially attributed to the instrumental biases of the radar measurements (and the dual-wavelength ratio DWR in particular).

A fundamental question this study raises regards the feasibility of utilizing a very complicated and computationally intense OE methodology to solve multiparameter problems with large uncertainties in the state and observed vectors. I do not exclude that combining more simplistic retrieval methods with careful data quality control might be more efficient under such scenario.

Here is a list of more concrete comments and suggestions,

- The authors avoid using specific differential phase $K_{DP}$ in their formalism and resort to the total differential phase instead. Radial dependencies of $\Phi_{DP}$ in Fig. 4 and temporal plots of $K_{DP}$ in Fig. 8 (bottom panels) show that $K_{DP}$ can be quite reliably estimated at both Ku and Ka bands. $K_{DP}$ is very sensitive to a lower end of the particle spectrum and the results of this and similar studies indicate that $K_{DP}$ is strongly correlated with the total concentration of smaller-size ice. In other words, $K_{DP}$ has very strong informative content and is immune to attenuation, resonance scattering effects (even at Ka band), and radar miscalibration.
- Since the D3R radar was able to do genuine RHIs during the ICE-POP experiment, would it be possible to display composite RHIs of Z, $Z_{DR}$, and $K_{DP}$ and generate vertical profiles of the radar variables (at Ku and Ka bands) over the PIP location in a height vs time format? This would give a better idea about the vertical microphysical structure of the storm and possible problems in the radar – PIP comparison which are mentioned in the manuscript such as enhanced vertical gradients of Z likely responsible for underestimation of snow rate and size.
- Captions to Figs. 4 and 5 are the same.

- Correct the reference the Ryzhkov et al. (2016) paper. It is not in press.