Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., author comment AC2
https://doi.org/10.5194/amt-2022-149-AC2, 2022

Reply on RC2

Willi Schimmel et al.

Author comment on "Identifying cloud droplets beyond lidar attenuation from vertically pointing cloud radar observations using artificial neural networks" by Willi Schimmel et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-149-AC2, 2022

Dear Referee,

Thank you very much for your feedback and for concidering the submission for AMT publication. Below are my answers and corrections to all of your questions and remarks.

Best regards,

Willi Schimmel

General comment:

Bi-modal spectra in Figure 1 nicely separate the fast-moving ice particles and slow-moving cloud droplets. But it is not clear to me how VOODOO identifies the presence of cloud droplets if the radar Doppler spectra are single-mode but skewed or if the spectra have multiple modes (more than 2). Slowly falling secondary ice particles might also generate a peak in the Doppler spectra (e.g., Luke et al., PNAS, 2021). Around Line 370, it said that "Below 2.6 km, smaller ice crystals are falling out of the mixed-phase cloud top, which are melting and form drizzle drops at approximately 1 km altitude." However, the temperature at about 1 km at that time is still below 0 C (Fig 5). Is it possible the bimodal spectra are due to the existence of fast-moving ice particles and slow-moving secondary ice particles instead of drizzle?

Luke, Edward P., Fan Yang, Pavlos Kollias, Andrew M. Vogelmann, and Maximilian Maahn. "New insights into ice multiplication using remote-sensing observations of slightly supercooled mixed-phase clouds in the Arctic." Proceedings of the National Academy of Sciences 118, no. 13 (2021): e2021387118.

- change sentence (starting @ Line 370): "Below 2.6 km, smaller ice crystals are falling

out of the mixed-phase cloud top. Multiple ice populations are present at altitudes between 0.7 – 1.8 km, indicated by the skewed Doppler spectra (see Fig. 7A) which separates into a bi-modal distribution between 1.1 – 0.7 km. This bimodality might be caused by secondary ice production at temperatures below -10°C \cite{Luke2021}. At 0.7 km the ice crystals melt and form drizzle drops with Doppler velocities below 2 ms-1 (see Fig. 5 B)."

- Also see multichannel Raman polarization lidar PollyXT plots in Fig. X (**attached file 20190801_pollyXT.png)** below: Colocated PollyXT raman lidar during 1. Aug. 2019 in Punta Arenas with focus on 2 – 4 UTC. Aerosol layer visible in att_bsc 532 and 1064 channel below 1 km altitude. PollyXT captures the few larger precipitating ice crystals below the liquid bearing layer at ~3 km altitude (light blue streaks), which are also visible in the linear volume depolarization (532 channel) with low values of ~6% depolarization. Ergo, low amounts of larger non-spherical particles can be assumed. However, below 1 km altitude the particles become spherical (depol < 2 %).

Minor comment:

Line 343: Remove bracket around Fig. 4D

- removed brackets

Line 400: "second columns"->"third columns"?

- yes, changed to "third"

Line 444: add "LLT (XXX)" after "MWR-based"?

- rephrase sentence, see line 443-445: "Nevertheless, for the long-term observations, VOODOO achieves good precision (>0.60) and accuracy (>0.73), confirmed indirectly by a strong correlation between MWR-LWP and LWP$_\mathrm{ad}$ (>0.45) compared to the correlation with LWP$_\mathrm{ad}$ of Cloudnet (<0.22). "

Line 445: "LWP (>0.63)". 0.63 is not consistent with the value before.

- Please check. changed to 0.45

Please also note the supplement to this comment:

https://amt.copernicus.org/preprints/amt-2022-149/amt-2022-149-AC2-supplement.zip