Comment on amt-2022-149

Anonymous Referee #2

Referee 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-RC2, 2022

This paper presents a deep convolutional neural network (CNN)-based retrieval method (i.e., VOODOO) to analyze radar Doppler spectra to identify the probability of the existence of supercooled liquid in vertical radar columns. The training of the CNN was realized using the Cloudnet processing suite. Both case studies and long-term predictions of 18 months in total of cloud observations at two mid-latitude locations (Punta Arenas and Leipzig) are used to test and evaluate the retrieval method. Results show that VOODOO achieves good precision and accuracy and is best for multi-layer stratiform and deep mixed-phase cloud situations. VOODOO also shows a better correlation between MWR-based LLT and LWP, compared with Cloudnet which is limited in deep mixed-phase clouds due to lidar attenuation. The authors clearly present their methodology and the results are convincing. I have one general comment and some minor comments below.

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 bi-modal 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.

Minor comment:

1. Line 343: Remove bracket around Fig. 4D

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

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

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