Atmospheric Measurement Techniques Discussions

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Comment on amt-2020-476

Anonymous Referee #3

Referee comment on "Application of cloud particle sensor sondes for estimating the number concentration of cloud water droplets and liquid water content: case studies in the Arctic region" by Jun Inoue et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2020-476-RC3, 2021

This manuscript describes the application of cloud particle sensor (CPS) sondes on free and tethered balloon systems. The CPS sondes definitely promise potential for investigation of the vertical structure of clouds in remote locations as a light-weight and low-cost instrument and the manuscript fits the scope of AMT. However, there are several points regarding the measurement technique and data analysis which need to be resolved before this paper can be recommended for publication.

How does the laser beam profile look like? In optical particle detection, the laser beam profile in the sample volume plays an important role. This is a major point that needs to be added to this manuscript. Best practice is to use optical modeling software and also measure the intensity profile at different places within the sample volume with a photodiode on a translation stage or a camera.

Another point that deserves more investigation is the correction factor for the total particle counts. The authors already mentioned inhomogeneities in the sample volume, so one of the basic assumptions is actually violated. In my opinion, this issue can only be resolved by intercomparison with state-of-the-art optical cloud particle spectrometers in a laboratory setup.

Although the flow conditions have been investigated via CFD modeling, there are no results from real measurements shown. In particular, boundary layer effects and "slow flow zones" are much clearer to see in an experimental flow characterization in a wind tunnel. Ideally, a particle generator is part of the laboratory setup to also investigate how the flow conditions influence detectability of cloud hydrometeors. In addition, a particle generator producing water droplets should be used to calibrate the CPS sondes. Further experiments in an icing wind tunnel would be helpful to investigate the ability of the sensor to distinguish ice from supercooled liquid water under realistic conditions.