Reply to Reviewer #1

We would like to thank you for providing highly technical comments regarding our manuscript. We substantially modified the content in the revised form and believe the modifications will be satisfactory and suitable for publication. The point-by-point responses (in blue) are made below.

The CPS is a sensor that is clearly needed for makinng profiles in clouds with upsonds, dropsonds or even teathered balloons. The original description by Fujiwara et al. was a good introduction but left out four very important details that also limit the usefullness of the present paper. 1) What is the intensity profile of the lasr beam across the sample areas of the two detection systems, 2) What is the shape of the elaser beam, 3) What are the actual dimensions of the two parallelagrams and 4) For the collection geometry what do the Mie scattering cross sections look like for water droplets.

Lacking this information in the present paper, all of the corrections that are related to the pulse width and the sizing are irrelevant since they all assume a beam shape and laser intensity that is uniform, assumptions that are likely not the case. I am puzzled that readily available software like Zmax was not employed to model the actual optical system. The figures in 3a and b are speculative, in the words of the author. Speculation has no place in a technical article.

The reviewer may consider that we are the original members who developed the CPS sondes (this is probably because the title of our original manuscript might provide misleading information); however, this is not the case. Note that we have not been involved in the development of the CPS sondes. We contacted the manufacturer (i.e., Meisei Electric, Co. Ltd.) to obtain the technical information.They explained to us that the shape of the laser beam is not uniform as it is but is adjusted to be uniform with Biconvex lends (the reference is not available); the actual dimensions of the two parallelograms are not evaluated by a optical software.

At this moment, it is difficult for us to answer the four questions raised by reviewer #1 in a satisfactory manner, because we have used CPS sondes as an end user and this paper wanted to propose a practical method based on our field experiments. Nevertheless, we substantially revised the paper, including its title, from the viewpoint of a CPS sonde user to clarify our approach and deliver the message to the manufacturer for further development and experiments (e.g., mapping of the sampling area as suggested by the reviewer). Based on CPS sonde measurements of Arctic low-level clouds, we demonstrated that the original approach published in AMT (Fujiwara et al., 2016) should be improved. For this reason, we still believe that AMT is the best platform for reporting our experiences of CPS sonde measurements in the Arctic and then discussing the need for a new correction method.

The structure of this paper has been simplified as (1) Introduction, (2) Experimental designs, (3) Data processing, (4) Comparison with other data sources, (5) Discussion, and (6) Conclusions. The previous Figs. 3 and 7 and their explanations related to the optical design and sampling area mapping have been deleted because we would like to highlight the observed data, particularly the smaller particle signal widths (PWDs) than those expected by Fujiwara et al. (2016). We also removed some simulated results (previous Figs. 9 and 13) to keep the manuscript simple. Since we realized that additional laboratory experiments would be necessary in future work, their needs have been discussed in the new section by citing literature. The correction factor was newly estimated in section 3.4 by the idea of collection efficiency based on Noll and Pilat (1970), improving the theoretical robustness of estimation of the factor, although the main result was not changed.

The size calibration is based on water equivalent sizes of crown glass and PSL particles, but these water equivalent sizes have to come from theoretical considerations. Nowhere is this described. The cloud physics community that uses optical spectrometers are now using precise droplet generators to map the sample areas of spectrometers similar to the CPS. This needs to be done for the CPS if this technology is to be accepted and inversions have to be applied as there is no qualifier in the system to constrain the particles through the sample area. I recommend that the authors read the papers related to the IAGOS Backscatter Cloud Probe.

As suggested by the reviewer, additional laboratory experiments using optical spectrometers and precise droplet generators would provide more realistic data but we consider that it is beyond the scope of this research because the aim of this study is to provide a practical method to correct the CPS data under the existing system from a user perspective. However, we also agree the need for some laboratory experiments as suggested by the reviewer, we cited papers Lance et al. (2010) and Beswick et al. (2014) to introduce how the state-of-art has been applied to calibrating cloud microphysics probes, which must stimulate the manufacturer (i.e., Meisei Electric, Co. Ltd.) for further development of CPS sonde. This issue is discussed in the first paragraph of the new section 5.3. The information on the shape of the laser beam is also mentioned based on personal communication with the manufacturer.

Finally, trying to model the flow through the CPS with no measurement validation is unconvincing. The much siimpler and more convincing approach is to do the measurements in a low speed wind tunnel that are employed around the world to calibrate anemometers.

In this paper, we used the data based on the field experiments. We do not conduct laboratory experiments to validate the simulated flow field. Instead, we compared the flow speed data at the bottom of the CPS inlet observed by anemometers in Fujiwara et a. (2016). The flow speed was 15% smaller than the ascending speed. Our simulations also have the same tendency even if the ascending speed is changed from 4 m/s to 6 m/s, suggesting that our simulations are valid for further investigating flow characteristics around the CPS housing. This content has been included in the new section 3.4. This issue is discussed in the second paragraph of the new section 5.3.

From a presentation perspective of the material, once the study is repeated more vigorously, this is an AMT paper so most of the introduction is irrelevant except for the last paragraph that *describes the objectives. The title is misleading and needs to be more explicit and the photos, while pretty, are also irrelevant to the topic.*

We have conducted many CPS sonde measurements in the Arctic region based on the original protocol. As a result, we noticed that the original approach published in AMT (Fujiwara et al., 2016) should be improved. To avoid misleading, we changed the title to the case study in the Arctic. On the other hand, we believe that the scientific background of the role of clouds in global and polar regions is still needed in the introduction.

Finally, comparisons in the field are irrelevant until the corrections are justified properly and in additions the OPCs against which they are compared have their own uncertainties that have to be explain to put the comparisons into context.

In the revised form, the correction factor was introduced by the idea of collection efficiency in the new section 3.4 based on Noll and Pilat (1970). The value has been changed from 5.8 to 7.5; however, the main conclusion did not change. We also mentioned the coincidence loss (10%) of the OPC as the product specifications.

References newly included

1. Baumgardner et al. (2017), Cloud ice properties: In situ measurement challenges, Meteorological Monographs, 58, 9.1–9.23.

2. Beswick et al. (2014), The backscatter cloud probe – a compact low-profile autonomous optical spectrometer, Atmospheric Measurement Techniques, 7, 1443–1457.

3. Craig et al. (2013), Design and sampling characteristics of a new airborne aerosol inlet for aerosol measurements in clouds, Journal of Atmospheric and Oceanic Technology, 30, 1123–1135.

4. Lance et al. (2010), Water droplet calibration of the Cloud Droplet Probe (CDP) and inflight performance in liquid, ice and mixed-phase clouds during ARCPAC, Atmospheric Measurement Techniques, 3, 1683–1706.

5. Murakami and Matsuo (1990), Development of the hydrometeor videosonde, Journal of Atmospheric and Oceanic Technology, 7, 613–620.

6. Noll and Pilat (1970), Inertial impaction of particles upon rectangular bodies, Journal of Colloid and Interface Science, 33, 197–207.