Review of manuscript AMT-2019-222

Supersaturation (s) in cloud is hard to measure even with an in-situ instrument that aims at measuring it directly in cloud, mainly due to the difficulty of measuring humidity in cloudy environment. Estimating it utilizing ground remote sensing instruments would be even more challenging. The authors in this manuscript propose a new approach to estimate s in such a way. The formulation of the equation that derives s seems to be done solidly and the key variables in the equations seem to be obtainable from radar and lidar output with some assumptions. If s can be estimated reasonably well by the proposed method, it would benefit a lot on the effort to estimate cloud supersaturation profile in a continuous manner, which would be impossible from aircraft measurements that are inherently episodic and expensive. Despite such enormous benefits, however, the uncertainty of estimated s with ground remote sensing data seems insurmountably high, according to the results described in this manuscript. Not only the PDF of the estimated s is much narrower than those obtained from in-situ cloud microphysics measurement but also the mode values of s do not seem to match well among each other, about which the authors did not mention anything. Moreover, there is no guarantee that the estimated s from the in-situ cloud microphysics measurement represent true s in cloud because such estimation itself is based on the big "quasi-steady state assumption," rather than from direct and correct humidity measurement. So even if they do match well, that does not mean that the estimated s from ground remote sensing data represent the true s. Therefore, I am not sure if realistic in-cloud supersaturation values are obtainable from this approach. Perhaps this approach of estimating s can still be very useful as a way to get a relative measure of in-cloud supersaturation. In that sense, I urge the authors to do s estimations in some other clouds using the same approach and see how much they are different from the one presented in this manuscript. Matching in situ cloud microphysics measurement may not be available for these other clouds but that is ok. Here the purpose is to demonstrate the capability of this approach to estimate different s distribution for different clouds.

Some specific comments:

P2, L12: Why might this method (Yum et al., 1998) overestimate s due to kinetic limitations? Due to counting unactivated but large haze droplets as activated cloud droplets in cloud

probes? Explain more clearly.

P4, L26: No explanation is given on ground remote sensing instruments. Add brief explanation.

P5, L8: N_d is estimated using a lognormal distribution assumption. This distribution is similar but different from the Weibull distribution that was originally used for formulating s equation (Eq. 11). Explain the effect of such change.

P9, L11-12: 20% overestimation is not exactly meaning that the true value is 0.8 times the retrieved value. Just use one metric to avoid confusion.

P10, L4-5: Similarly confusing. We do not usually say “overestimate 0.5 times.” Just say 0.5 times the true value (underestimation) or 1.2 times the true value (overestimation).