Comments from Alexander Myagkov on the manuscript "Absolute calibration method for FMCW cloud radars" by Toledo et al. 2020

On 1st of April 2020 I was invited to review the manuscript. Previously (on 10 March 2020) I posted my comments within the opened interactive discussion. Therefore, a major part of my comments below are the same.

I find the manuscript to be devoted to the very important topic valuable for the cloud research community. The authors have done a good progress in establishing a calibration procedure aiming to reduce instrumentation uncertainty in cloud radar observations. In my opinion, the manuscript requires a major revision. Below I give comments, which can help the authors to improve the manuscript.

1. Line 113: I would expect that the calibration targets are significant and actually the main source of uncertainties, which is not discussed in the manuscript. RCS are given up to the 4th significant digit. What are the uncertainties in these values? Were there any measurements of the targets made in an anechoic chamber? From a book about the radar reflectors, I know that the manufacturing precision is super critical for the RCS of corner reflectors. In the case of reflectors, which are much larger than the wavelengths, one degree deviation from perpendicularity of the reflector planes causes a change in RCS of about 10 dB. Since the aim of the proposed calibration procedure is to reach the calibration in the order of a few 0.1 dB (such an error could be easily caused by a tiny inperpendicularity), it would be very helpful to know how the authors evaluated this and what the uncertainty is. A reference with relevant information:
    - Section 2.4 in Garthwaite et al 2015. The Design of Radar Corner Reflectors for the Australian Geophysical Observing System. (and references therein)
2. I strongly recommend to carefully check the units throughout the manuscript. Often the units do not fit. These are just occasions I noticed, there could be other.
    a. In the line 61 it is mentioned that Cgamma(T) is in dB. When I look into the Eq. 1a where this parameter is calculated I see a dimensionless number in the numerator and m^2*W in the denominator. 10log gives dB only when the ratio is dimensionless.
    b. Line 77: what does unreferenced dB mean? Power shall be in W, mW, dBm or something similar. It is not a unitless ratio and thus cannot be in just dB.

c. Lines: 195 – 200: Power is in dB. Please see the comment 1b.
d. Lines: 237 – 241: Power is in dB. Please see the comment 1b.
e. Figures 3, 4, power is in dB. Please see the comment 1b.
f. RCS has different units throughout the manuscript. In line 113 it is in m^2, line 269 dBsm (is it dB related to square meter?), in Fig. 6 it is in dB (again cannot be because it is not an unitless ratio).

3. Line 144: I would also recommend to mention which FFT window have been used for ranging, since it defines how many range bins to sum.
4. Since FMCW radars have intermediate frequency (IF) filters, the calibration can differ for different range bins due to different filter gains at different IF frequencies. How the frequency response of the IF filter is taken into account in the calibration method?
5. Correct me if I am wrong but as far as I understand C^0_gamma in lines 153-155 is different from the one calculated in Eq 4. In these lines C^0_gamma is calculated from each sample within an iteration, while the one in Eq. 4 is calculated from averages of several iterations.
6. Line 209: As far as I understand the lab pattern (Fig. 3b) characterizes only one antenna. In Fig. 3b I see a very high variability of the measurements (green and yellow dots). I do not see how based on these result the conclusion that the two antennas are parallel can be made.
7. Line 265: when I look into fig 5d I see that for some entire iterations the measurement points are not within 0.13 dB from the black line. Some iterations (like red one and violet one) have deviation exceeding 0.13 dB as well. Is the given uncertainty sigma_T = 0.13 dB reliable in this sense?
8. Are the numbers, given in line 311, resolution of the stepper or real angular accuracy? This can be tested if the same target angular position is reach from opposite rotation directions. Would the received power be the same?
9. Fig. 7a: the sharp edges on the left side of the blue curve and on the right side of the yellow curve look so much different from the rest of the curves in this figure. What causes such an effect?
10. Fig. 7a: The standard deviation of the yellow curve and the red one are close (0.09 and 0.13 respectively). But in the figure I see that the red curve is at least by a factor of 2 broader. Please double check the numbers.
11. From the table 2 I see that the uncertainty in the median values of the experiments A and B are < 0.03. 7a shows that the mean/median values for each iteration are

distributed from -275.5 to -274.7. While 7b shows that all the iterations are in range of -274.2+/-0.2. If the number 0.03 is calculated for each iteration separately, which uncertainty component in the table 2 contains +/- 0.5 dB variability of the mean in the experiment A?

12. I think Lat in Eqs . 1b and 3b is also range dependent. Please indicate this.
13. What is the difference between r0 and r in Eqs. 1b and 3b?
14. Sometimes it is hard to follow the text because of a huge number of symbols. I therefore strongly recommend to add a table with a short description of all used symbols.
15. In the Eq. 5 the authors assume that errors are not correlated from iteration to iteration. But if for example two consecutive iterations are made under similar conditions I would expect a certain correlation. In this case variances would not be reduced by factor of N^2 and N but by a smaller factor (Leith 1973, The standard error of time-average estimates of climatic means).