Comment on amt-2022-213
Anonymous Referee #1

Referee comment on "In orbit cross-calibration of millimeter conically scanning spaceborne radars" by Alessandro Battaglia et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-213-RC1, 2022

Review of the manuscript: In orbit cross-calibration of millimeter conically scanning spaceborne radars.

By Battaglia A. et al.

I enjoyed reading this work that address a key prerequisite for any satellite radar: calibration. The Authors developed two approaches. The first one considering comparison of coincident measurements in ice clouds between a reference satellite system (typically nadir looking) and the other one having conically scanning strategy. In the second approach, the radar measurements being calibrated are compared with a climatological reference calibration curve (climatological PDF). The results are convicting to me as well as the methodology adopted. I suggest the Authors to put more efforts in description of their experiments that sometimes are difficult to follow although the main rationale is clear.

Major comments/suggestions

- My main concern is on the criteria used to find coincidences. It seems that the Authors considered surface footprint coincidences only (with a given imposed uncertainty in the definition of coincident foot prints as in their Tab. 1) between a reference nadir- (or quasi-nadir) pointing radar platform and a conically scanning one. However, in the studied configurations you could have coincidences not only in the ground footprints (i.e. the lon, lat surface level) but also aloft (lon, lat, altitude) whenever two radar ray paths intersects each other. I think that last case is more relevant when considering natural ice clouds for calibration. It would be nice if the Authors could better elaborate this point in the main text. In addition, as I can understand, two parameters are important in the definition of a calibrating natural target: $Z_{min}$ and $h_{min}$ being the former
the sensitivity of the radar system whereas the latter the minimum altitude wrt. to the surface considered to identify an ice clouds. Maybe these two parameters could be added in the scheme of Figure 1.

- In Section 2.2 you state that “the measured reflectivity of an ice cloud observed at nadir and at slant incidence angles are almost identical”. In general, I agree with you but I am thinking that the slanted geometry maybe could be more prone

- With reference of results argued in figure 8, what happens if you also a random noise to the “biased measurements” of Z. Maybe this could help to check the calibration performances when assuming a different error structure in the system being calibrated.

**Minor comments/suggestions**

- Do you have some evidence of scan strategy of Tomorrow-io radar, i.e. reference or personal communication? It will be nice to add them in the manuscript.

- L 35. The general statement: near nadir looking “normalised backscattering cross section is insensitive to changes of the wind speed and the wind direction” seems to disagree with common radar altimeters applications (es. AltiKa). AltiKa is a nadir looking altimeter in Ka band and it is sensitive to wind speed as testified by its products (https://space.oscar.wmo.int/instruments/view/altika). Maybe, in this case, the range resolution (hundred meters) of meteo Ka and W-band with respect to radar altimeters (order of cm) can play a role in the ocean wind insensitivity. When you say that the W-band nadir-looking calibration procedures are impractical for conically scan systems, maybe you can mention that at slanted (>40°) off zenith angles, the sea surface is specular, isn’t it?

- Section 2. Step1. Maybe the term “coincident footprints” is misleading because it recalls surface footprint. If I understand well you are interested to any “range path intersection” between vertically and slanted pointing radar system.

- L 85 there is a repetition in the word: “calibration”.

- Page 8, Figure 4a is not found. Please specify Figure 4, left panel, or add labels on figure 4.

- Section 2.3. At the beginning of this section it is not clear to the reader why you should sample two PDFs at a given separation distance? I think that this is made to simulate differences in the sampling position when actual conical scan measurements will be available compared to the nadir-based ones. Please explain.

- 7. Not clear of the PDFs A and B are those extracted by vertical slices 500 km apart.

- 8 Not clear, from the figure’s legend, compared with main text and inner figure text, if the two panels differ from the frequency band considered only or they also differ by the separation distance considered in the selection of Z profiles.