RC1: 'Comment on egusphere-2022-1284', Referee #2

Reviewed by Matthew Lebsock

This paper describes three radar-only algorithms for the upcoming EarthCARE mission. The algorithms presented include a vertical feature mask, a Doppler correction product, and a pointing characterization product. The presentation is technically correct and relatively straightforward. The paper will provide an important citation for the at-launch product suite. I have only minor revisions regarding a few details of the presentation and some missing citations.

The authors would like to thank Matthew Lebsock for his useful and insightful feedback. A point-by-point response to the reviewer's comments is provided below.

Line 25: add 'Cloud Profiling Radar' or 'radar' after CloudSat. (line 26).

Line 25: change 'compare' <- 'compared' (line 26).

The revised manuscript was modified as suggested.

Section 2: It would be useful for many readers to understand the relationship between the three algorithms described here within the larger suite of EarthCARE products. Can an algorithm flow chart be incorporated? Or at least in words described?

The manuscript is part of an AMT special issue on the EarthCARE mission. There is another paper contribution (Wehr et al., 2022) that describe the mission and the EarthCARE L2 data production model. In the preparation of the manuscript, we were given specific instructions to avoid any repetition and refer to other manuscripts in the special issue that contain any needed material. Once we are close to the finalization of the special issue, we will make sure that the proper references are included in the manuscript to provide the necessary background.

Lines 93-95: The non-expert reader is not going to know what you are referring to. Add wording to the effect of 'beneath the convection near 4100 km'.

In the revised manuscript the following sentence was added: "In some cases, the hydrometeor-induced attenuation can result to a complete extinction of the radar signal and loss of

information. This is clearly visible by the lack of hydrometeor echoes in the low levels around 3740 - 3760 and 4070 - 4130 km."

Line 112-114: Mention the small temperature dependance.

The revised version of the manuscript was modified according to this suggestion (lines 122-123).

Line 114: Cite Lebsock et al., 2011 https://doi.org/10.1175/2010JAMC2494.1,

Citation added in line 124.

Lines 122 and 123: Is it X-MET or X-Met?

Correction made in line 133 of the revised manuscript.

Lines 140-145: Lebsock and Suzuki, 2016 (https://doi.org/10.1175/JTECH-D-16-0023.1) discuss the errors in this approach including (1) attenuation by undetected clouds, (2) systematic differences between water vapor in clear and cloudy columns, and (3) non-uniform beam filling (NUBF). The first two are small for the shallow subtropical cumulus clouds where this approach is best implemented. NUBF errors can be significant.

Section 3.2 Regarding Non-uniform beam filling errors for PIA - Even if you estimate a perfect PIA (averaged over a footprint) you have to translate that PIA into a TWP. The NUBF changes the relationship between PIA and TWP which can introduce significant errors. I understand the product won't produce a TWP but this limitation in the utility of PIA for deriving TWP deserves mention somewhere in the PIA section.

Section 3.2 You should mention somewhere in this section that MS signals frequent in stronger precipitation are often going to bias the PIA estimate low.

The revised manuscript was modified as follows to include this important information (lines 148-154):

"In addition to the uncertainty introduced in the LWP estimation by the PIA measurement uncertainty, Lebsock and Suzuki (2016) discussed additional error sources including 1) attenuation by undetected clouds, (2) systematic differences between water vapor in clear and cloudy columns, and (3) non-uniform beam filling (NUBF). The first two are small for the shallow subtropical cumulus clouds where this approach is best implemented. On the other hand, the NUBF errors can be significant. Battaglia et al., 2020b discussed in detail the significant errors

that can be introduced in the LWP estimation by NUBF conditions. Another source of uncertainty is the presence of multiple scattering (section 3.3) that can cause biases in the PIA estimation."

Line 154: Cite MS model.

The MS model citation was revised in the revised version of the manuscript (lines 171-172).

Line 169: '?' as a reference.

Correction made in line 189 of the revised manuscript.

Section 4.1.2: This section is too general. You don't describe the specific EarthCARE algorithm. Can you provide some details here on how you do the unfolding?

The last paragraph of this section was re-written and the formula used is now clearly stated in the revised version of the manuscript (lines 276-282).

Line 341 add '()' around 'Fig 6a' (line 365).

Line 432: add 'than cloudsat cpr' (line 456).

 The revised manuscript was modified as suggested.