Dear Reviewer 2,

thank you for your review. In the new revision we tried to consider your comments and we included a new analysis as reaction to the other reviewers requests: A synthetic cloud test field from a cloud resolving model and a simulation of measurements with the 3D radiative transfer code demonstrate how O2A derived distances could be “calibrated” for certain cloud types as long as the type of cloud geometry expected can be provided by cloud modelling. The results largely corroborate our earlier conclusions.

Please find below our reply to your review.

Best regards,
Tobias Zinner (and co-authors)

Reply to reviewer 2

Reviewer comments are highlighted in gray.

This study examines the reliability of a promising method for estimating the distance and altitude of clouds observed by airborne radiometers. The analysis includes both a theoretical sensitivity study and the validation of results using independent measurements. I believe that the study presents significant results that will be of interest to the community and are worthy of publication. The methodology is sound and the presentation is clear. Even so, I recommend some important revisions before publication, mainly in explaining or discussing some key details. Please find my specific comments below.

Major:

Page 8, Lines 6-9: I am not sure if simulations would be more difficult and time consuming for tilted cloud sides than for vertical cloud sides. If one used the maximum cross section method, the higher spatial resolution (required for tilted cloud sides) should not affect the computational demands as long as the volume extinction coefficients are in a similar range for tilted cloud sides as they were for vertical cloud sides.

The reason for the high computational demand of titled cloud sides compared to vertical ones lies in the large number of grid cells that have to be set up in the simulation domain. For a 10 km distance and a vertical cloud of 2 km horizontal extent, only 12 1km-sized grid boxes are needed. To simulate a smooth tilted slope, 50 m resolution is needed extending the domain to 240 50m-sized grid boxes. For the Monte Carlo method this increases the time for tracing photons through this grid by about factor 200. We included some new comments explaining this in the manuscript.

Page 16, Lines 16-18: Does the stability of the 3.8 km offset mean that the tilt of cloud sides is similar in all observed scenes? I wonder why the observed scenes display less variability in the tilting of cloud sides than in aerosol properties or surface albedo (which were mentioned in Lines 15-16 as possible alternative explanations for the 3.8 km offset).

Yes, it implies that we observe a predominant type of cloud orientation. We do not expect aerosol or surface albedo to cause variation within the single analysed scenes of around a minute/ a few 10s of

km distance. Nonetheless, the typical aerosol/albedo situation could affect the scene's offset, but only to a secondary degree. We added some lines of discussion of this at the end of the manuscript.

Regarding Lines 19-23, I wonder if the assumption of tilted (and not vertical) cloud sides may work better in building look-up tables for future studies, as this could reduce or even eliminate the required offsets. Finally, it would help to mention whether and how the offset (or the typical cloud side tilt) may be obtained in future cases where stereo (or lidar or radar) data is not available.

We mention this additional possibility in the discussion now.

Minor:

Page 4, Line 16: I suggest adding "As mentioned above, " (in Lines 8-9) to the beginning of the sentence "Figure 2 shows the spectral region of the oxygen-A band at different spectral resolutions. ".

Done

Page 4 last line: "Detail like the" should be replaced by "Details like the".

Done

Page 6, Lines 27-30: It would help to point out that the spherical cloud is shifted only up and down but not sideways.

Mentioned now.

Page 8, lines 3-4: The sentence "As mentioned before, the geometry of the observation situation involves time consuming Monte Carlo simulations to simulate these ratios." should be reworded for improved clarity. I also suggest refining the subsequent sentence, for example by adding a comma after "consequently".

Done.

Page 8, Line 30: What exactly is meant by 1.5% in the sentence "Here the standard deviation is 1.5%."? Is it a relative or absolute quantity, and is it for reflectance or A-band ratio?

Added "of reflectivity results".

Page 8, Lines 32-33: "Sensor zenith angle" is mentioned twice. I guess one of them should be switched to "solar zenith angle".

Thanks. Corrected.

Page 12: It would help to include a brief discussion of stereo distance uncertainties-for example the uncertainties due to variations in camera pointing direction (caused by slight changes in aircraft attitude)-or at least to mention that uncertainties are discussed in Jakel et al. (2017).

We mention reasons for general stereo uncertainty now.

Page 14, Line 5-8: It would be important to mention how the 233 excluded points were identified. Did subjective manual analysis or quantitative criteria decide whether a point was too close to (or even part of) a cloud top, or occurred in a shadow?

It was a subjective analysis. We removed the missleading “objective”. A fully automated shadow and cloud masking is a topic for a whole series of further studies. We did it manually.

Page 15, Lines 9-10: It would help to discuss here why 3D effects can reduce the Oxygen A-band distances. This is discussed in detail in the conclusion section (Page 16 Lines 11-18) but I feel that the discussion would fit better into the main text than the conclusions. Also, it would help to explain or illustrate (either here or in Page 6) why photon pathlengths are shorter for tilted cloud sides than for vertical cloud sides.

This is not easy to do and understand. We had the feeling that such a lengthy discussion here would distract from the line of argumentation.

Page 15, Line 32: the word "band" seems to be missing between "A" and "absorption". In the subsequent line, "straightforward" should be a single word.

Done.

Page 16, Line 2: The word "is" is missing between "goal" and "the".

Done.

Page 17, Line 2: "Proofed" should be replaced by "proved".

Done.