Dear Reviewer 1,

thank you for your review. We now included a new analysis as reaction to your and 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 points.

Best regards,
Tobias Zinner (and co-authors)

Reply to reviewer 1

Reviewer comments are highlighted in gray.

The paper presents a method to characterize the distance and height between airborne and cloud properties. The authors adapt an old concept based on the O2 A-Band absorption, usually applied to retrieve cloud top altitude of plane-parallel homogeneous cloud from satellite. The novelty and interest of the paper lie in the necessity to apply algorithm to finite clouds with sides. In this framework, authors have to realize extensive 3D radiative transfer simulations to develop look-up table based a "cloud wall". Several sensitivity tests were made concerning different geometry setup, cloud properties and cloud environment (aerosol, surface). At the end, comparisons of the distance retrieval with stereo measurement show a bias of 3.8 km that the authors attribute quite easily to 3D radiative effects.

At this point, I’m completely agree with the referee 3 that the paper cannot be published without a validation of this assumption. Before accepting the paper, I request that the authors realize the simulation mentioned in page 15 and in the conclusions using cloud resolving model output and 3D radiative transfer simulation. Applying the algorithm to this simulated data will enable to confirm that 3D effects shortened the retrieved distance of an order of 3-4 kilometers and will strengthen the interest of the paper.

We hope that we accounted for your concerns by the new synthetic demonstration case added to the manuscript. It serves as a demonstration how stereo data could be replaced by a statistically generated set of Monte Carlo simulations for modeled cloud geometry with given typical computational capabilities. In addition, we think that the manuscript lays out the way for the community to minimize this approach’s remaining uncertainties using future increased computational capabilities.

Our main goal is a determination of cloud surface orientation and cloud points’ vertical height for our cloud side view for a specific campaign data set (ACRIDICON-CHUVA). For a plausibility check we compare our data to stereo-points. We find an offset (3.8 km) which is mainly caused by 3D effects. Apart from this deviation, errors are small and within the expected and described ranges. We now demonstrate, that the offset found lies in the range of offsets caused solely by the typical deviation of 3D cloud surface orientations.

Other comments and questions:

1- In the introduction, the authors cite the papers demonstrating the concept of using O2 band to retrieve cloud top altitude (Yamamoto and Wark 1961, Wu, 1985, Fisher et Grass 1991) but do not mention the most recent papers as nothing were done since 1991. Can the authors actualize the references adding more recent bibliography concerning cloud top retrieval using O2-band?

We added some most recent activities in the field.

2- Page 1, line 24, add reference for the retrieval of cloud top from brightness temperature.

Added.

3- Figure 1. For more clarity concerning the angle definitions, the authors should add the sensor zenith angle limits that are used for the sensitivities test and LUT computation.

I'm not sure, if I get you right here. Figure 1 is just a general illustration. We extended the angle information a bit.

4- Section 2.2.1. Present here the basic cloud used for the sensitivity test. How is the LWC and microphysics variability inside the cloud? Horizontally and vertically homogeneous?

Information was given with Figure 3. Added it here.

5- Page 5, line 17: How to be sure you are in the saturation regime? If not what happens, is the distance shortened or stretched out?

We test that during the sensitivity tests Figure 3d and 3k. Nothing changes for increasing line of sight optical thickness.

6- Figure 3 and page 5, line 26: I found very weird and confusing to normalize the radiances to the minimum value. Normalizing them to the maximum value would allow to understand more easily the figure and the absorption differences according to the parameters.

We think that this is rather a matter of taste. We had the same discussion in the author group from time to time, but did not reach and mutual agreement. This is the way it was defined in some of the basic literature and we decided to stick with it.

7- Page 6, line 30-35. How to know if the cloud side is sufficiently vertical to apply the method?

A considerable part of the later analysis and discussion in the paper is now spend on this topic.

8- Figure 4. Similar to suggestion 3. Explain clearly or with a schematic why with an airborne at zs=6km, the angular range of sensor zenith angle is between 71 and 99◦ .

Added comments to the caption.

9- Figure 5. Can you add or indicate the relative standard deviation value in percent?

I do not understand? The figure shows the standard deviations in percent.

10- Page 14. Line 3. Please begin to describe the figure 7 and how are select the grey dot before analyzing the figure.

We shifted around the sentences in this paragraph and moved the information about the grey point towards the beginning. I hope it’s more clear now.

11- Page 14- line 6: What is an "objective" analysis? How do you select the horizontal cloud deck points?

The are identified using the retrieved oxygen-A distances. While their absolute position most likely carries a large error, the position of cloud deck point relative to each other is correct: the height of these areas does not show variation → a horizontal cloud deck.