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Interactive comment on "Synergy of stereo cloud top height and ORAC optimal estimation cloud retrieval: evaluation and application to AATSR" *by* D. Fisher et al.

D. Fisher et al.

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We would like to thank Referee 1 for their helpful and constructive comments. We address each specific comment in turn below.

Referee Comment 1: line 10 (Abstract) the acronym should be defined in the abstract.

Response: Thank you for the suggestion we will make this edit.

Referee Comment 2: line 15 The sentence starting "The impact" is incomplete. I think you mean "The impact of the stereo information on the retrieval of the microphysical . . ."

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Response: Thank you for the suggestion we will make this edit.

Referee Comment 3: Introduction - first paragraph. The importance of the accurate cloud retrievals is described, but it would be very helpful to describe the requirements a bit more quantitatively - to put the improvements that are being proposed into context. That is, what kind of precision is required by the climate models? Are changes of 1km in cloud height significant? How accurately do they require total optical depth, etc. I'm not asking for a full requirements review, just a mention of what kind of accuracies are required

Response: Thank you for the suggestion. We will include quantitative requirements.

Referee Comment 4: 5287 line 5 - description of the instrument. A small drawing of the instrument geometry would be really helpful here. I certainly don't understand what the "viewing zenith angle" means from the text. If I'm looking 55 degrees from zenith, I'm looking above the horizon. A small sketch would make things much clearer.

Response: Thank you for the suggestion. We will consider including a small drawing of the ATSR imaging geometry.

Referee Comment 5: 5288 line 19 - LUT is not defined (look up table?)

Response: We will define LUT (it is look up table)

Referee Comment 6: 5289 lines 13-21 - I don't understand very well what you are saying about the radiative transfer method. An equation (or equations) here would be worth 1,000 words. Perhaps a reference would be helpful too (a reference to the entire algorithm is given somewhere above this, but it doesn't hurt to remind me)

Response: Thank you for the suggestion - we will include a reference here, as the method is described in detail in Poulsen et al. (2012).

Referee Comment 7: Section 3.2 This whole section could be made much clearer. First, you should probably repeat the reference to Zabih and Woodfill at the beginning

of the section. Next, a small figure to supplement the first paragraph could make what you're doing much clearer. Finally, a brief example of constructing a bit vector could be helpful if space permits.

Response: Thank you for the suggestion. We will consider inserting a figure, though we will try to clarify the section first.

Referee Comment 8: 5293 line 20 what is CCI?

Response: Climate Change Initiative (we will define this in the text).

Referee Comment 9: Section 3.3 Is there any correction for winds? You're treating the clouds as essentially earth fixed, but the clouds will drift between the first and second observations. The real question is how far the cloud will move between the observations, and how big this difference is in pixel space. The time scale for persistence of the features being matched may also be an issue. It may be a good thing to include some information about the relevant time and spatial scales to give the reader some context.

Response: We do not correct for wind displacement effects. We agree that this needs to be discussed in the text and will do so. Though in general the errors that could be introduced are less than the pixel level accuracy of the sensor.

Referee Comment 10: Section 4 The uncertainties in the stereo method are determined through differencing with lidar observations. It would seem that the uncertainties in the height derived by this method could vary widely depending on cloud characteristics. Certainly, the amount of spatial contrast, optical thickness, wind speeds, etc could change the quality of the retrieval. Is it really valid to apply a single uncertainty to all of these cases?

Response: You make an interesting point, and perhaps it is not valid and the uncertainties could be improved. However, we feel that this is beyond the scope of this paper. However, we will include these potential sources of error in our definition of uncertainty

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so that the reader is aware of them.

Referee Comment 11: 5297 line 5 what is RAL?

Response: Rutherford Appleton Laboratory - we define this in the text.

Referee Comment 12: Section 5.2 You have entire paragraphs that describe the figures in detail. These are not very easy to read and could be replaced with a table.

Response: Thank you for pointing out this issue. It has similarly been brought up by our other referees and we will address it using the suggestions from referee 3.

Referee Comment 13: Section 5.3 It would be very helpful for you to define (with an equation if possible) what the cost function is that you are using. Further, it is not at all surprising that the cost function increases with the addition of the a priori information. The retrieval algorithm, in the absence of the a priori, BY DEFINITION minimizes the cost function. The additional information added by the a priori will always push the retrieval away from this minimum.

Response: We will include the reference to the cost function (Poulsen et al. 2012).

Referee Comment 14: Section 6.1 2 points 1) The amount of smoothing, and indeed the stereo retrieval in general will depend on the specific algorithm you use. There are other algorithms that could give higher spatial resolution than the census algorithm applied here (likely at the expense of higher statistical spread). In fact, using the census algorithm with different window sizes could modify the amount of smoothing. You may want to mention somewhere that these effects are party a result of the choice of algorithm.

Response: Yes, this is a good point. We will discuss these issues as a drawback of the stereo algorithm, which we plan to include after discussing the advantages.

Referee Comment 15: 2) Cloud top height is a fairly ill defined concept so it is not surprising that there are systematic variations between different methods of determining

it. Even if we define the height as the place where the vertical optical depth is unity, this will be different at different wavelengths. Response: Thank you for this comment. We will include this caveat in our discussion.

Referee Comment 16: Figures/Tables - What would be very helpful would be a table or plot that explicitly shows the improvement of the performance of the retrieval when the stereo data is added. This is shown indirectly in many of the figures, but there isn't a place were I can see that under a given set of conditions, that including the stereo information results in a 500m or 20% improvement in cloud height determination or 4 OD or 10% improvement in optical depth determination. (Of course I'm making numbers up here). A simple table that summarizes you validation would really help.

Response: Thank you also for this comment. We will consider how to include such a summary table in the paper to better guide the reader on the key findings.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 5283, 2015.