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Atmospheric Measurement Techniques Discussions

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.

Anonymous Referee #4

Received and published: 3 November 2015

Summary of the Paper

In this paper the authors describe and validate a method of supplementing spectral observations of cloud properties with spatial stereo observations in the retrieval of cloud properties. The stereo and spectral observations are taken with the same instrument, and the paper outlines what is essentially an extension of the processing of the spectral data that results in more accurate products. The stereo data is reduced into a cloud top height product and injected into the spectral retrieval algorithm as an a priori constraint. The authors then apply this improved retrieval method to a fairly large set of observations and compare the results to high quality space based LIDAR observations. They

demonstrate that under many circumstances the results are improved by the addition of the stereo data.

Summary of the Review

I found this to be a useful and interesting paper. There are some minor modifications that would make it more clear and useful which I will outline below. On balance it is well written, though it tends to use more acronyms than it needs to (and some of them are not defined). In addition, there are some quantities (e.g. cost function) that I would really like to see the equation for. Also, there are places where the text could be usefully replaced with figures of tables.

I've answered the reviewers questions below, and will the offer specific comments afterward

____ Does the paper address relevant scientific questions within the scope of AMT? I believe so. This paper outlines a successful and fairly general extension to an operational atmospheric measurement technique.

Does the paper present novel concepts, ideas, tools, or data? Yes, the combination of spatial and spectral methods for cloud remote sensing is rare enough that studies such as this are quite useful.

Are substantial conclusions reached? Yes, particularly because of the systematic validation that has been provided. This paper provides a way forward for future cloud remote sensing systems.

Are the scientific methods and assumptions valid and clearly outlined? Suitably so.

Are the results sufficient to support the interpretations and conclusions? Yes.

Is the description of experiments and calculations sufficiently complete and precise to allow their reproduction by fellow scientists (traceability of results)? In a general sense, yes, although I would have liked more equations in the text that describe exactly what

was being done.

Do the authors give proper credit to related work and clearly indicate their own new/original contribution? Yes.

Does the title clearly reflect the contents of the paper? Yes.

Does the abstract provide a concise and complete summary? For the most part yes.

Is the overall presentation well structured and clear? I would say so, though it could be made more clear (I've made some suggestions below)

Is the language fluent and precise? Yes, though it could use a copyedit.

Are mathematical formulae, symbols, abbreviations, and units correctly defined and used? Yes, though there are some undefined acronyms and there are some quantities that could be more precisely defined in equations.

Should any parts of the paper (text, formulae, figures, tables) be clarified, reduced, combined, or eliminated? I think some of the text should be moved to tables to make this easier to use.

Are the number and quality of references appropriate? Yes.

Is the amount and quality of supplementary material appropriate? N/A

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Specific comments

line 10 (Abstract) the acronym AATSR should be defined in the abstract

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 ..."

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 quanti-

tatively - 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 fr a full requirements review, just a mention of what kind of accuracies are required.

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.

5288 line 19 - LUT is not defined (look up table?)

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).

Section 3.2 This whole section could be made much clearer. First, you should probably repeat the reference to Zabith 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.

5293 line 20 what is CCI?

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 persistance 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.

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 sigle uncertainty to all of these cases?

5297 line 5 what is RAL?

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.

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.

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.

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.

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.

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