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Atmospheric Measurement Techniques Discussions

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Interactive Comment

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 #1

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'Synergy of stereo cloud top height and ORAC optimal estimation cloud retrieval: evaluation and application to AATSR', by D. Fisher, C. A. Poulsen, G. E. Thomas, and J.-P. Muller, submitted to AMTD.

Cloud top height retrievals from the Advanced Along Track Scanning Radiometer (AATSR) instruments are evaluated and compared against the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) coincident observations. There are three separate types of cloud top height retrievals presented: (1) a stereo imaging approach using the multi-angle capability of AATSR (called STEREO); (2) an optimal estimation-based retrieval methodology of cloud top height, optical depth, ef-

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fective radius, cloud phase, and surface temperature (called ORAC); (3) and a third variant in which the stereo retrieval is used as a first guess to the ORAC retrieval (ORAC+STEREO). The paper shows comparisons of the cloud top height differences between the three different methods and how they compare to upper-layer cloud top height retrievals in the presence of single and multi-layered clouds according to spatially and temporally coincident CALIPSO observations. Some improvements in cloud top height with the combined ORAC+STEREO approach is shown.

The paper is fairly well written and is organized well enough to follow most of the logic of the comparison experiments. However, there appears to be two problems with the manuscript. First, lots of detail is missing in how the comparisons were actually made and comments will follow under 'specific comments' regarding this point. Secondly, and more importantly, the authors appear to stop short of completing a more interesting, extensive, and relevant analysis that includes the other variables retrieved, including optical depth, cloud phase, and particle size. These three variables are obtained from the CALIPSO platform (via combinations of CALIOP and IIR observations) and are publicly released at the NASA Langley data server, but the authors merely report on cloud top height results. Differences in particle size and optical thickness between ORAC and ORAC+STEREO are shown, but unlike the cloud top height comparisons, there is no ground truth comparison against CALIPSO or any other platform. The same can also be said about cloud phase. This paper would be a significantly stronger contribution if the authors spent additional effort going further in their analysis. In particular, the reviewer suggests the following:

(1) Compare the particle size for ORAC and ORAC+STEREO against the CALIPSO IIR retrievals that are now publicly available. (2) Compare the optical depth from ORAC and ORAC+STEREO against the CALIPSO IIR (passive infrared) and/or lidar (active visible) retrievals of optical thickness. Obviously, the optical depth range reported by CALIPSO saturates at values of 2-3 for the lidar and perhaps 5-10 for the passive infrared, but at least for the thin cloud features in which ORAC and ORAC+STEREO

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report optical depth < 10 or so, it would be very insightful to do this comparison. For values > 10, one would need to compare against an instrument like MODIS, but a publication based on statistical comparisons with 1 deg lat x lon gridded AATSR and MODIS data is already in the literature (Sayer et al., 2011, ACP). (3) Compare the cloud phase estimate from ORAC and ORAC+STEREO (are they even different? There is absolutely no discussion on this.) (4) For points (1) to (3), the results could be presented in a similar form as Figures 1 and 2, or perhaps in a different manner if the authors see fit.

The paper would greatly benefit if the authors went further and characterized a more complete exploration of the ORAC retrieval parameter space. It is impossible to assess the value of the cloud top height results (e.g., an improvement with the ORAC+STEREO approach over ORAC alone) in isolation of the other variables since compensating errors and problems in the cloud height can fall into the other variables, and vice-versa.

Specific comments:

p. 5285, l15: Intergovernmental

p. 5289, l2: . . .is built into. . .

p. 5289, l14: awkward phrasing

Section 3.2: there is a lot of technical jargon in this section. For instance, the first sentence alone includes ‘census stereo’, ‘bit vector’, ‘image pixel’, ‘pixel pattern’, and ‘pixel’s local neighbourhood’.

Section 3.3: how do the various retrieval approaches deal with the presence of aerosol features? Is this accounted for in the ORAC algorithm? Is any comparison done with the CALIPSO aerosol feature mask provided by the CALISPO Science Team?

p. 5294, l26: the cited value of 20mK is really low. At what value of brightness temperature is this estimate? Won’t the channel be noisier in colder scenes?

Section 4, p. 5295: The description of the a priori uncertainties for the STEREO CTH is nicely described and outlined. But how do the look-up tables with ERA-Interim work? Isn't each profile unique? Is this based on some average temperature lapse rate and surface temperature value?

p. 5295, l19: assessments

Section 5, first paragraph: This is where I started to get confused by the lack of detail and also the direction of the evaluation of optical depth, and effective radius. First, with regard to the STEREO first guess (but not used as a cloud mask), how does it work if STEREO detects a cloud but ORAC does not, and vice-versa? How common are mismatches between them, either because of the pixel-scale mismatches and geometry of the observations themselves (as discussed in Sect. 3), or because of the relative sensitivity of cloud features? Furthermore, it is claimed that the optical depth and effective radius will be 'assessed' in a similar manner as cloud top height (meaning spatial and temporal coincidences), but in fact, all that is done is the difference between ORAC and ORAC+STEREO is plotted in Figure 7 and Sayer et al. (2011) is referred to for the other variables (even though these comparisons are based on gridded averages with MODIS).

p. 5299: with regard to the binning of single versus multilayered ice or liquid, it appears the ice versus liquid is done with the height bins. It is unambiguous if a CALIOP cloud is ice because that feature is identified as ice in the cloud feature product – although there could be vertical stratification of phases and/or overlapping phase types, not to mention the spatial heterogeneity of phase over the AATSR pixel area – none of these details are discussed. How is cloud identified as liquid versus ice for AATSR – using the ORAC retrieved phase? Or is it assumed there is a perfect match between CALIOP and AATSR? If the latter, that implies that there could be retrievals of cloud properties populated in the wrong phase bin. Are there any references and/or publications regarding the skill of AATSR cloud phase and how well it matches up with other well-characterized estimates from CALIPSO and MODIS? A simple table of occurrences of

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ice vs. ice, ice vs. liquid, liquid vs. ice, and liquid vs. liquid would be very helpful, and also clarification on whether the sample data set used is for liquid vs. liquid and ice vs. ice only.

p. 5301: ‘stereo matcher’ is not clear

p. 5302, l5: isn’t this an ‘increase in the negative bias’?

p. 5302, l10-l25: The low cloud agreement (nearly zero bias) seems unusually good, even for the ORAC only version. So many other passive instruments have struggled with cloud height assignment of low clouds in the presence of inversions. If there is something unique in the ORAC algorithm that achieves this result, it needs to be discussed further.

p. 5304, l15: median differences

p. 5305, l8-l9: But there is no way to assess this description in the results since no phase results from ORAC are presented. For l11-l14, the authors describe exactly the reviewer’s reasoning on why the same approach should be taken with these additional variables as done with CALIPSO to evaluate cloud top height, but yet it is not done in the paper.

p. 5305, l22: scenarios that do

p. 5306, l22: On the contrary, there is nothing clear at all about Figure 3. Why is a map of sea ice shown in a box, with empty space to the Tropics? Wouldn’t it be more instructive to zoom in on the segment near Greenland? Also, the cross-section should use the full two-column width and stretched vertically. The font is small and it is impossible to see the different heights overlaid with CALIPSO data.

p. 5309, l15: macrophysical retrievals.

p. 5309, l15: multi-layer

Figure 1 suggestions. First, stretch the y-axis. Second, reduce the range of the y-axis

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from -10 to +5 km. Third, place the red numbers (these are the means which are red circles?) on top of each panel so that some space is created within the figure for the whiskers and boxes.

Figure 5. Is the first set of bars for the bin 0-500m? Why is it centered on 0 m? Why does the figure go below the surface?

Figures 7 and 8 can use some similar treatment as Figure 1.

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

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