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Atmospheric Measurement Techniques Discussions

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7, C1438–C1445, 2014

Interactive Comment

Interactive comment on "FAME-C: cloud property retrieval using synergistic AATSR and MERIS observations" *by* C. K. Carbajal Henken et al.

Anonymous Referee #1

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The authors describe a daytime cloud property retrieval algorithm using measurements from the instruments AATSR and MERIS onboard ENVISAT. In fact, three algorithms, one for cloud optical thickness and particle effective radius as well as two for cloud-top height, are introduced. The retrieval approaches are generally clearly described and appear to be sound. Evaluation results are mixed but appear to be comparable to what is commonly found for cloud properties derived from passive imagers.

The authors are encouraged to more explicitly outline the novel features of their algorithms, because there are many similar algorithms around. One such feature could be the synergy between two instruments, but I do not really get this synergy from the manuscript (except that radiances reprojected on the same grid as well as a synergistic cloud mask are used as input). It seems there are two stand-alone algorithms for

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Interactive Discussion
Discussion Paper

AATSR and one for MERIS. Thus, there are actually two independent cloud-top height products instead of one synergy product, which may leave the reader wondering which one to use. Perhaps the outlook could be extended to give at least some ideas for synergetic products, e.g. cloud vertical extension. Another novel aspect, that may be worth some more attention, is the use of vertical extinction profiles from CloudSat observations for the cloud-top pressure retrievals.

Below are a number of specific and textual comments.

Specific comments

P4910: Acronyms should be written out in the abstract.

P4910, L6-8: There is a problem with the use of the term micro-physical: cloud optical thickness and water path are macro-physical rather than micro-physical properties.

P4910, L22-23: MODIS observations are not a true reference; therefore it is more correct to speak about root mean square difference rather than error.

P4910, L19: Better to write agreement instead of accuracies.

P4910, L24: several suggests more than two sites.

P4910, L27: There is so much variation for so few data points, that I think this value of the bias is not meaningful (see later comment). Suggest to remove this from the abstract.

P4910: Do you have a conclusion on the MERIS versus AATSR cloud heights?

P4911 and further: Acronyms should be written out at first occurrence in the manuscript (GEWEX, MODIS, CALIOP, ARM, etc.).

P4911, L13-17: Suggest to mention first amount and height, and then the other properties. Also suggest to write cloud-top thermodynamic phase and effective radius, as well as particle instead of droplet to include also ice crystals.

AMTD

7, C1438–C1445, 2014

P4912, L2-4: This was indeed an important finding but applies mostly to the differences between the group of sensors mentioned here and other sensors such as lidars and IR sounders.

P4912, L10: It should be AMSR-E on Aqua.

P4912, L15: I believe ORAC did not take part in the CREW inter-comparison.

P4912, L18: A reference to the CREW CTH paper by Hamann et al., AMTD, 2014 might be appropriate.

P4913, L26: These are not only visible but also near-infrared wavelengths.

P4914, L5: AATSR has one more channel at 0.56 micron. Also, the central wavelengths of two of the mentioned channels are 0.7 (0.66) and 0.9 (0.87) instead of 0.6 and 0.8 micron, respectively.

P4914, L15-16: Which data were used as truth cloud mask in the neural network?

P4914, L18: Is cloud flag the cloud mask? Is cloud abundance a cloud fraction? If yes, is it also used in this study?

P4915, L1: This seems strange since one expects the center wavelength to be fixed. On P4921-4922 it is explained (the spectral smile effect). I suggest to give this explanation already here.

P4915, L5: Again, the use of micro-physical is not correct here.

P4915, L21-22: What do you mean with the wavelength dependency not being used in the text? I do see the wavelength appearing in most of the equations.

P4915, L14: Observed should be simulated. Also, the forward model equation (2) is not really at top of cloud because it does not consider in- and below-cloud absorption.

P4915, L16-17: Couldn't Rayleigh scattering below the cloud be important for semi-transparent clouds?

AMTD
7, C1438–C1445, 2014

P4915, L22: What is meant with ‘amount of extinction’?

P4917, L11: What does ‘therefore setting the airmass to 2’ mean?

P4917, L6-10: Write out the equation used for transmittance with the coefficients from Table 2.

P4918, L4: what kind of observations?

P4919, Eq. (8): The notation appears to be inconsistent. Why T_ct instead of T_c as in L15-16? Why t_ct-1 instead of t_a as in Eq. (3)?

P4922, L11-13: To pick one of the extinction profiles from the ISCCP classes, a cloud-top pressure is needed. What is used?

P4922, L20: It seems the resolution of ERA-Interim is 0.8 rather than 1.125 degrees.

P4923, L12: DCHP gives the impression of being one algorithm, but it seems that these are actually two independent OE algorithms (both with a 1-element state vector). Is that correct, or is there any connection?

P4923, L22-23: I would say that optimal estimation can be cast as a minimization of a cost function.

P4924, L10: K is not the averaging kernel but the weighting function matrix (or Jacobian), i.e. the derivative of F to x. Also, y are observations which by definition do not depend on state parameters.

P4924, L14-15: Add that the observation errors should also obey a Gaussian distribution. And again, the measurements do not depend on the state parameters.

P4925, L4-5: Same comment as above.

P4925, L12: Optimal estimation is a maximum likelihood method (independent of the weight given to the prior).

P4925, L14-19: This is a bit confusing. Is a new cloud phase category ‘uncertain’

AMTD

7, C1438–C1445, 2014

Interactive Comment

introduced here? If so, it is better to do this on P4918. Also, explain more clearly which LUT (water or ice) is used to retrieve COT-REF for this phase category, and how exactly the forward model parameter uncertainties are set.

P4927, L22: Agree very well with what?

P4927, L25-26: Use the word difference instead of error, because MODIS is not a true reference (so this is rather an inter-comparison, not a validation)

P4927-P4928, discussion of Table 3: A limitation of these comparisons appears to be that the portions of the sky being cloudy or having a certain cloud phase may be quite different, in particular for the uncertain-phase class. This affects the other statistics, and should be clearly mentioned in the paper.

P4928, L15: The meaning of REF and REF16 is not explained.

P4929, L18-23: Why are not the standard ARM cloud-top heights used? Also, explain why the mean Doppler velocity is used.

P4930, L1-2: Why does the MERIS retrieval fail more often?

P4930: discussion of Fig. 8: The smallest bias is obtained for AATSR for single-layer clouds (as quoted in the abstract). However, this small bias is to a large extent a compensation of large positive bias for two low cloud cases with large negative bias for up to five high cloud cases. So is this bias meaningful?

P4929-4930 (Section 5.2): The measurements at two sites are combined here. I realize this may be needed to reach a reasonable number of observations, but can anything be said about differences between the sites?

P4930, L7-8: One would expect an O2-A band approach to yield a cloud top lower than the physical cloud top. So please explain this result.

Table 2: Can you give a reference for the 4% uncertainty in reflectance?

AMTD

7, C1438–C1445, 2014

Figure 4: A lot of the cirrus flagged pixels as well as some of the water phase pixels seem to have a reflectance pair located above the forward model solution space. How does the retrieval of COT-REF proceed for these pixels? Is it considered to be failed, or is the closest point in the LUT returned?

Figure 5: The caption is not clear about whether these pixels are from the orbit segment in Fig. 3 or from all pixels collected over the GER region during three years. The latter may be preferable to reduce the noise in the figures.

Textual comments

P4910, L18 and furtheron: TERRA should be written as Terra

P4910, L28: replace for by of

P4911, L22: Typo objective

P4911, L25: PATMOS-X should be PATMOS-x

P4912, L17: replace has by have

P4912, L26: Remove last e from Universitat.

P4913, L7: replace for by to

P4913, L11; remove hyphen between cloud and micro

P4914, L14: replace due to by because of

P4914, L23 and 26: replace on by to

P4916, L1: change the order of reflected and radiance

P4916, L3: Write relative azimuth angle instead of relative azimuth angle difference because relative already implies a difference.

P4917, L5: Dobson Units with capitals.

AMTD
7, C1438–C1445, 2014

Interactive Comment

P4918, L1: here should be where

P4921, L12: replace are by have been

P4922, L9: Introduce the figures in correct order (i.e. exchange Figs. 1 and 2).

P4922, L18: Typo re-analzses

P4923, Eq. (25): For clarity add that J is a function of (and is minimized with respect to) x. So write J(x).

P4924, L23: change the order of S_a and S_y.

P4925, L9: remove a

P4925, L11: constraint instead of constrain

P4926, L24: add the before same

P4926, L25: replace for by from

P4928, L20: horizontal should be horizontally

P4928, L28: replace and by which

P4928, L29: Start new sentence with this.

P4929, L19: doppler should be Doppler

P4929, L23: threshold should be thresholds

P4929, L27: It seems 23 should be 22.

P4930, L7: replace underestimated by too low

P4930, L27: replace retrieval is by retrievals are

P4931, L12: What does ‘Efforts are shown’ mean?

P4931, L15: remove for

AMTD

7, C1438–C1445, 2014

P4931, L21: replace errors by differences

Table 2: Use consistent notation in the table, i.e. either tau or COT.

Figure 2: Add the COT-CTP borders determining the ISCCP cloud classification.

Figure 3: What does ‘COT+cirrus’ mean?

Figure 4: The lower end of the water LUT seems to be invisible. Could you plot it on top of the points?

Figure 5: Expand caption, mentioning the parameters shown. For example, upper left panel is not a ‘mean relative uncertainty estimate’.

Figure 5: The GER region has not been introduced yet (it will be in Fig. 6).

Figure 8: Add in the caption AATSR (top) and MERIS (bottom) as well as for single-layer (left) and multi-layer (right) clouds.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 4909, 2014.