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Atmospheric Measurement Techniques Discussions

Interactive comment on "Towards an operational Ice Cloud Imager (ICI) retrieval product" *by* Patrick Eriksson et al.

Anonymous Referee #3

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Review on: Towards an operational Ice Cloud Imager (ICI) retrieval product

This paper describe an operational algorithm to retrieve ice cloud properties from the Ice Cloud Imager (ICI) instrument which will be part of the second generation of the EUMETSAT Polar System (EPS-SG). The retrieval algorithm is based on a Bayesian Monte Carlo approach and allows to retrieve three main quantities, the ice water path (IWP), the mean mass diameter (Dm) and the mean mass height (Zm). The main novelty of this algorithm comes from the fact that the posterior probability function is directly ÂńÂăretrievedÂăÂż (do not assume any shape like gaussian) and is used to compute the ice cloud properties. This algorithm is also tested via a retrieval database in order to test the algorithm performance. Some estimation of the errors due to remapping of the 13 channels of ICI are also presented.

General comments: The paper as a whole is rather well written. However sometime the author wants to go too fast and forget the basics which are a minimum of explanation (or reference) on the methods used to infer some scientific conclusion. This is especially true in the section about the Degree of Freedom. In the later there are absolutely no explanation on how to compute this Âńdegree of freedomÂż, no explanation on the assumption made, and no reference that could help to understand the physical meaning of this quantity. Authors often forget that potential readers of their work are not necessarily specialist in the micro-wave and ice cloud field, which in turn make sometime the paper not easy to understand or not easy to find related paper that would help our understanding. In the same idea there is often a lake of explanation on how/why an equation or a given form to simulate a physical process was chosen. For example there is no explanation on why the weigh (wi) used to compute the posterior probability was computed as in equation (9). Same concerning equation (13), we do not understand why and how the author choose to use this specific form to compute error due to a miss knowledge of the surface emissivity, or scattering within the cloud. There is also some confusion between probability and probability density function (eq 10 and 11).

So for all this reasons I think this interesting paper can be largely improved and therefore my overall recommendation is MAJOR REVISION.

Below are listed my comments related to each section:

2 - Ice Cloud Imager 2.2 The receiver package

line 19: I am not in the measurements field and have hard time to understand what is the receiver noise temperature and especially the very large values of 600 to 2600K. Maybe a reference could help the reader to find information on this receiver noise temperature.

3 - Algorithm 3.2 Overview

line 29: It is actually not evident to get this document, I tried the link ÂńÂădocumentationÂăÂż under www.nwcsaf.org, but did not find any document related to ICI. Anyway, maybe some annexe would help the reader to understand the details of the algorithm or an academic reference.

3.3 Input and Output

line 10: What is the dimension (unit) of r? Specify it in the text. You could also be explicit on the solid angle by saying that the solid angle is the one of the antenna (I guess). Concerning the cartesian coordinate we have no idea on where is the origin of this cartesian system. Please specify also if the antenna pattern is taken on the ground, or change with altitude and therefore you need to know the cloud extent (information that you do not have). It is not so evident how you concretely compute IWP.

line 12: dveq is the equivalent volume diameter but equivalent to what? Spherical particles? Specify it in the text.

line 17: the Author call Dm the mean mass size but Delanoe et al. 2014 expressed it as the volume-weighted diameter because it is the 4th moment of the size distribution over the third one. Why did you call it mean mass size? We don't see any mass weighted in the formulae!

3.4 Pre-processing part 3.4.1 Target footprint and rem apping of data

line 9: what do you mean by semi-circular?

3.4.5 Detection of clear sky data

line 23: Last sentence ÂńAs the module likely will not be applied, no details are here givenÂăÂż. So if you do not give any detail about the clear sky module detection of the algorithm, do we really need this paragraph?

3.5 Inversion part 3.5.1 Theory and retrieval representation

line 4 (eq. 9): Could you justify why wi is written like an exponential law?

line 5: Why only observation uncertainties are taken into account in S0? Can't you add the forward model uncertainties also (due to the miss-knowledge of non retrieve parameters that play in the forward model to compute yi)?

line 6: The following sentence is very hard to understand, please rephrase it. ÂńThey are not standard, but are introduced to allow tailoring of the retrieval database to the specifics of the retrievals of concern.ÂăÂż

line 14 and 16 (eq. 10 and 11): Something is wrong here because p(x'|y) is what we call a probability density fuction (PDF) in (10), we need to multiply by dx to get a probability. But in (11) p(xi|y) should be a probability but the notation is almost identical to the previous equation (10), and make this 2 equation confusing. Specify somewhere that p(xi|y) is not a PDF but directly a probability to have x=xi.

3.5.2 Measurement vector and uncertainties

line 2: Why is there only one clear sky in your database? Don't you need to simulate different clear sky at least to take into account the different emissivity, surface temperature that depend of the season and location?

line 7 (and eq. 13): We don't understand why the uncertainty on emissivity take this form, could you explain a bit or give some reference? We don't even know what is tau_e,j?

line 9 (and eq. 13): I really don't understand why this last term of equation 13, in its present form, could model the uncertainty due to a miss-representation of the scattering in the model! Please explain why in the text or give a reference!

line 10: Why can you assume that the modeling error (scattering) is proportional to the deviation of clear-sky reference simulation? Where does this assumption comes from? Any Reference?

3.5.3 Database extraction and iterations: OK now I understand a bit more why there is only one clear sky in the database! You should put this paragraph before the paragraph

3.5.2!

4 Performance tests 4.1 Remapping of data

line 8: On figure 6 please indicate the units of the color scale

line 18-19: Difficult to understand the following sentence, maybe a figure could help here! ÂńÂăThis means that line-of-sights of observations and the corresponding ones after remapping cross at the ellipsoid but deviate at altitudes inside the atmosphere.ÂăÂż

4.3 ICI retrieval performance 4.3.1 Test retrieval database

line 19:what do you mean by unrealistically high? Give some number. (Correct the word spelling also)

line 22: why around 0.8? Don't you have an exact number or did you make some random choice around 0.8?

line 24-25: This comparison between ATMS observations and simulations are done over which period? Does it used every observation or is there some filtering? Are you taking into account any specific antenna pattern of the ATMS instrument? How the atmospheric profile and hydrometeors are define? Are you using Cloudsat also? Are you using the same definition for the microphysical model than for ICI? Please develop in order to help the reader to understand the limit of this statistical comparison!

line 29: Please explain how the particle orientation can explain this discrepancy?

line 31: What is GMI? Any reference?

Table 2: Could you please indicate the habit model explicitly instead of a number referring to another paper from the author.

4.3.2 Degrees of freedom

line 7-8: The degree of freedom is more commonly called DoFS, Degree of Freedom

for Signal (See Rodgers, 2000), and it can be seen as ÂńÂăthe number of independent peace of information given by the observing systemÂă(its maximum value is the size of the state vector)Âż which is not exactly Âń the effective number of channelsÂăÂż

line 9-10: Give some information on how you compute this degree of freedom for signal! At least a reference! To compute the DoFS you need to specify a state vector, could the author give this state vector here? It seems that now it contains the humidity profile, and not only the IWP, Zm and Dm? The value of the DoFS is also highly dependent of the a-priori definition and especially the prior variance-covariance matrix. Please develop!

line 13: Which surface parameter are you talking about, emissivity or surface temperature?

line 21-22: This is why we also compute the posterior error together with the DoFS!

4.3.3 Overall performance

line 6: I may have missed it somewhere but what is H?

line 8 (Fig 9): The problem with using only average is that we have no idea of the dispersion around the mean. A scatter plot presented with a 2D colorscale histogram give much more information on the overall performance of the retrieval. The author should consider this king of plot instead of presenting only the average.

line 9: What do you mean by "good accuracy"? Is it in comparison to other related retrieval from other sensor?

line 14: Are the 5th and 95th percentile also averaged values?

line 17: This precision number for Zm and Dm are average precision, specify it somewhere!

4.3.4 Test inversions

line 4: Reference on ISMAR?

line 8-9: last sentence says that ÂńÂăThese various results have been presented at conferences (e.g. Eriksson et al., 2016) and the details are not repeated here.ÂăÂż If I follow your thought, what the point to write this paper if you already presented at conference (e.g. Ericksson et al. 2016)? I still think that an academic referenced paper is deeper than a conference paper and it should therefore be the way around, the conference paper at some point should cite this paper. . .

5 Outlook

line 12-15: The cloudsat and caliop based algorithm like DARDAR for example, which retrieve IWC profile from the combinaison of both measurements, often show a layer of supercooled water above the ice layer in the polar area. Are you planing to integrate this kind of case in your database in the futur. Is microwave sensitive to this kind of situation?

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