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Geoscientific Model Development Discussions
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Interactive comment on "A method for retrieving clouds with satellite infrared radiances using the particle filter" *by* Dongmei Xu et al.

Anonymous Referee #2

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Recommendation:

Minor revision

General comments:

The aim of the paper is to introduce a new retrieval cloud method, based on the particule filter approach. Since several very different configuration of cloud can lead to the same observed radiance, PF appears as nice tool for this problem. While similar use of the PF have been introduced in other domains (see comment 1 below), this is a new applications in this fields. The proposed method is compared with state of the art (MMR) where several particle generating technics have been considered. The results are well presented with an pedagogical situation to explore the potential of the method, and real cases. The benefit of the PF are a better retrieval at a lower cost compared

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Discussion paper

with the MMR. The manuscript can be improved to facilitate its reading following the comments, and minor revision are required.

Comments:

1) The bibliography on PF focuses on classical data assimilation consideration to estimate initial state. However, PF can also be used to parameter estimation or disaggregation which is similar to what introduced here, see eg Mechri et al. (2015). Hence you should clearly state the difference between the use of PF in classical DA and the present one, even if this relies on the same formalism, and improve the bibliography on this aspect.

2) Par 1, sec 2, l82: Precise the idea of cloud retrieval: this is implicit but for self consistency it is better to explain (generation of radiance from model, compared with observation, if they match then the cloud structure is found)..

3) l87: Precise the level associated with upper script k (k=1 means near the surface .. or top atmosphere as encountered in NWP models – Fig. 1 explains it corresponds to the surface, but this should be written) ?

4) l87: "effective" is not clear, it should be better to explain as the fraction of top of cloud as seen from a sensor.

5) l88: Following the previous point 4), with the condition $0 \leq c^k \leq 1$, precise that $\sum_{k=0}^{K} c^k = 1$ at this place, with a label for this equation (the sum can be suppressed from l101).

6) l111: the definition of what is a particle is crucial since it use to be model state in classical dynamical system that is not the case here. Hence, you should precise explicitly that P stands for the vector $c = (c^0, \cdots, c^K)$. In the notation, P can be interpreted as a function c^k.. I think better to use $C = (c^0, \cdots, c^K)$ for the particle in place of the notation P that could lead to confusion with the probability notation underlined with the particle filter approach. (see point 13 below)

7) l113: “typical” provide reference to previous work showing the method is known or suppress “typical”.

8) l115: add an subscript b to c^k in P_b as c_b^k

9) l115: “inflating, deflating, moving” should be illustrate using a regular 2D mesh, a simple figure would illustrates the fact that moving can suppress some fraction (a cloud becoming masked by another at upper level).

10) l111-126: the two approaches (l113) are not clearly separated, make two different paragraph one for each method (l114: the perturbation; l120 l123 the full/fractional one level top cloud)

11) l126: precise that for one-layer cloud at level i, the clear sky fraction is $c^0 = 1 - c^i$

12) l130: Eq.(3) means the comparison is done for one frequency.. what happens with other frequency (robustness, sensitivity) ? MMR relies on multiple frequency. At the opposite the PF seems to be used with only one. Please clarify this point / explain more precisely what is done.

13) l134: with the notation C, Eq.(4) becomes $C_a = \sum_i w_i C_b^i$ which is less confusing than with notation P.

14) l135: what is mean by updating ? (resampling strategy? analysis step?) I guess you mean analysis step for the particule filter, this should be clarified.

15) l135: precise that the average cloud fraction is no more normalised since the constraint (equation labelled from the above comments point 5) is not respected from the average Eq.(4) – average of state is no more a real state.

16) l202: Eq.(7) $\rightarrow$ Eq.(3)

17) l203: modify the notation for the prescribed ratio o_f is meaningless (use r, or something else, or explain why this notation is used).

18) l221-224: The particle used there corresponds to the groupe2 described previously, this should be reminded.

19) l224: Detail that the observation can be explained by different possible state and in particular as a fraction c^i of one-cloud layer at a given level i and a fraction of $c^0 = 1 - c^i$ of clearsky since $R_\nu^{cloud} = c^i R_\nu^i + (1 - c^i) R_\nu^0$ for levels i upper than level 5. Hence the theoretical one-layer cloud fraction is solution of $R_\nu^{obs} = c^i R_\nu^i + (1 - c^i) R_\nu^0$ that is by $c^i = \frac{R_\nu^0 - R_\nu^{obs}}{R_\nu^0 - R_\nu^i}$. No cloud can be present below level 5 since this would implies an R_ν^{cloud} larger then the observation (or a c^i larger than 100%). Provide a representation of the theoretical one-layer fraction so to introduce Fig2. This said, it is then easier to conclude that the weight in Fig2a 2b reproduce these possible situation with a maximum weight concentrated when the fraction is near the theoretical one given above.

20) l236: What is the normalized Jo ? I guess this should corresponds to the exponent in Eq.(3), but this is not introduced before. Provides the expression of Jo as a function of cloud fraction, it will be easier to understand what represents Fig. 2(c-d) $J_o(C^k) = o_f^2 \left(\frac{c^k R_\nu^k + (1-c^k) R_\nu^0}{R_\nu^{obs}} - 1 \right)^2$, when $C^k = (0, \cdots, c^k, 0, \cdots, 0)$ with c^k set to $0, 0.1, .., 1$ (c) and $\ldots$ (d)

References:

Mechri, R.; Ottle, C.; Pannekoucke, O. Kallel, A. Genetic particle filter application to land surface temperature downscaling Journal Geophysical Research: Atmospheres, 2014, 119, 2131-2146.

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