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## ***Interactive comment on “Statistically optimized inversion algorithm for enhanced retrieval of aerosol properties from spectral multi-angle polarimetric satellite observations” by O. Dubovik et al.***

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General Comments: The paper “Statistically optimized inversion algorithm for enhanced retrieval of aerosol properties from spectral multi-angle polarimetric satellite observations” by Dubovik et al. (2010) introduced an new state-of-the-art algorithm for deriving detailed properties of atmospheric aerosol and underlining surface from POLDER/PARASOL type satellite observations. I am really enjoying reading the paper and have to say it is an excellent paper based on very solid research studies. Since

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I am very interesting in the work introduced in the paper, I have some comments that would like to discuss with the authors. The discussions of these comments not have to be included in the current paper since the paper has already been in a very good shape. However, if authors prefer, they may decide include some of the discussions in their revision.

My first comment is on the sensitivity studies in Section 5. It would be interesting to see how the polarization measurement influence the retrieval proposed here by including and excluding the polarization input. If we look at the results in Table 7, aerosol optical thickness (AOT) retrieval is better at 0.44 micron than at 1.02 micron while the situation is revised for single scattering albedo (SSA) retrieval. The explanation for this tendency probably lays in the relative contribution of information content from total radiance and polarized radiance.

The 2nd comment is on the efficiency of the proposed approach. Many optimizations have been discussed and implemented to improve the speed of the retrieval in the current paper. It would be helpful to provide some quantitative information, for example, an efficiency comparison with current relatively simple operational POLDER/PARASOL retrieval algorithm. I know this new algorithm provide more retrieved variables than current operational POLDER/PARASOL algorithm. This is not a fair comparison strictly speaking. However, it can provide somewhat reasonable judgment for the efficiency of the new algorithm. I am interested in this efficiency issue is because I want to know the potential application of the algorithm to, for example, future NOAA operational satellites. The latency requirement for NOAA operational satellite aerosol retrieval is about 5-15 minutes in order for near-real time monitoring of aerosol pollutions. Thus, the quantitative information on the efficiency is very helpful for the evaluation of potential operational application. I am also curious about the efficiency of multi-pixel implementation relative to the pixel-by-pixel implementation, such as for those studies shown in Figs 7-14.

The algorithm introduced in the paper is quite comprehensive and involves many equa-

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tions so that some typos are identified in my review and are provided in the itemized comments below. Some of these typos have also been identified by other reviewers and my lists may be redundant. In summary, the paper is well written and contents are novel so that I strongly recommend publish it after the minor typos are fixed. Thanks to the authors for providing such a unique work on satellite aerosol retrieval.

## Itemized comments:

- (1) Page 4969, line 12: remove the first word “is” of the line.
- (2) Page 4973, line 13: replace “that” with “than” in “... narrower than spectral...”.
- (3) Page 4979, line 4: add a space between “in” and “referred”.
- (4) Page 4979, lines 13-15: subscript of SSA looks like “j” but should be “i”.
- (5) Page 4979, Eq. (3): “3” is missing in the equation caption.
- (6) Page 4979, Eq. (4): I would assume  $\omega\Delta$  is used as weighting factor together for averaging. If this is the case, then  $\omega$  is missing for the aerosol component and gas term should be dropped off in the denominator. Anyway, I feel there are some inconsistent between the numerator and denominator.
- (7) Page 4981, line 23: replace the 1st word “filed” of the line with “field”.
- (8) Page 4982, Eq. (7): Should “ $dN(\varepsilon)/dlnr$ ” in the equation be “ $dN(\varepsilon)/dln\varepsilon$ ”?
- (9) Page 4982, line 22: similar to item (8).
- (10) Page 4983, right side of Eq. (8): replace “ $dN(\varepsilon)/dlnr$ ” with “ $dN(\varepsilon)/dln\varepsilon$ ” and replace subscript “ $k=1, \dots, N_\varepsilon$ ” of the 2nd sum symbol with “ $i=1, \dots, N_r$ ”.
- (11) Page 4983, line 11: remove the 2nd word, “the”, of this line.
- (12) Page 4985, lines 4, 6, 7: replace “ $dN(\varepsilon)/dlnr$ ” with “ $dN(\varepsilon)/dln\varepsilon$ ” .
- (13) Page 4986, Eq. (10c): seems term  $A_k(\varepsilon)$  is missing in the inner integration for  $dln\varepsilon$

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comparing to Eq. (9).

- (14) Page 4986, line 6: replace “faction” with “fraction”.
- (15) Page 4995, line 16: remove “for” in the “...in for calculations...”.
- (16) Page 4995, lines 18-19: Why using single scattering approximation is not sufficient for conducting retrieval from satellite observations but is sufficient for surface AERONET retrieval?
- (17) Page 5001, line 8: “Eq. (18a)” seems should be “Eq. (18c)”.
- (18) Page 5002, line 23: “Eq. (17a)” should be “Eq. (18b)”.
- (19) Page 5005, Eq. (21d): Should last “ $\varepsilon_p$ ” on the right hand side be removed?
- (20) Page 5005, line 10: Change “Equation (23a)” to “Equation (23)”.
- (21) Page 5005, line 16: Should the word “the” in “...the a priori estimates...” be removed?
- (22) Page 5009, line 2: “ $\Delta 1$ ” in the last equation for  $\Delta 3$  should be “ $\Delta 2$ ”.
- (23) Page 5009, line 3, the right side of last equation for  $x$ : the double prime symbol on the shoulder of subscript “ $i$ ” for  $x$  should be a triple prime.
- (24) Page 5011, line 6: seems “not” is missing between “does” and “implement”.
- (25) Page 5011, line 9: seems “is” is missing behind “approach”.
- (26) Page 5016, line 17: There is no Eqs (B22-B25) in Appendix B.
- (27) Page 5016, line 22: There is no Eqs (B34) and (B24) in Appendix B.
- (28) Page 5020, line 8: seems “of” is missing between “retrieval” and “all”.
- (29) Page 5023, line 4: remove “no” from “...with no noise added...”.
- (30) Page 5025, line 8: change “Figure 11” to “Figure 10”.

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(31) Page 5026, lines 21-22. Authors indicate “the retrieval outliers with the fitting residual higher than 5% were eliminated from the final results”. What may be the causes of these outliers and what is the rough percentage of outliers relative to the valid retrievals?

(32) Page 5051, Table 1: “faction” should be “fraction” in description text for Cspf.

(33) Page 5052, Table 2: How to handle the situation that unknown variables fall outside the limits in the inversion? Do we just discard this pixel in the retrieval?

(34) Page 5053, Table 3 and Page 5054, Table 4: For the  $\sigma$  and  $h\sigma$  of BRF parameters, their  $\gamma$  values are set to 0.005 and 0.01, respectively, for spectral smoothness constraints of 3 and 2 orders in Table 3. But for the temporal smoothness constraints of 3 and 2 orders in Table 4, the corresponding  $\gamma$  values are set to the same 0.1. Why?

(35) Page 5055, Table 5: for  $h\sigma$ , the single-pixel constraints should be “mild” rather than “weak” since the order of constraint is 2.

(36) Page 5060, Fig. 3: mistake of the right panel has been noticed by another reviewer and has been fixed already.

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