

Interactive comment on “Remote sensing of aerosols with small satellites in formation flight” by Kirk Knobelspiesse and Sreeja Nag

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The paper by Knobelspiesse and Nag performed a systematic information content analysis to evaluate the performance of using multiple small satellites for aerosol and surface (land + ocean) remote sensing. As one of the major advantages, small satellites have the flexibility of multiple path location and being replaceable when necessary. The information content analysis demonstrates that such a flexibility results in a similar accuracy as achieved by setting the same number of view angles with a single instrument on a single platform (such as MISR on Terra). Moreover, it is found that the information content does increase with the increase of number of viewing angles.

This work provides important theoretical support to the design and development of

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multi-platform sensors for aerosol remote sensing and is highly appropriate for AMT. I have the following comment for the authors to consider and clarify.

1. Page 10: The authors correctly pointed out three pre-assumptions for applying information content analysis. Should there be another one that “The relationship between measurement errors and retrieval uncertainties are assumed to be linear around the solution” ?

2. Earlier work performed by O. Hasekamp et al. 2010 (theoretical study), L. Wu et al. 2015 (using RSP data), and F. Xu et al. 2017 (using AirMSPI data) used direct retrieval test (alternative to information content analysis) and found a significant gain of AOT retrieval accuracy when the number of viewing angle increases from 2 to 5 and then a limited gain once the number of viewing angles exceed 5. Though the number of viewing angles in this work starts from 3, it will be helpful to add into simulation the 2-angle case and compare these earlier work the retrieval uncertainty as a function of view angles (such as Fig. 7, but plotting absolute AOT error), and comment the difference if there is. This may help the readers be aware of the errors caused by using different analysis approach.

3. Do I understand correctly that the authors conclude the specific location of viewing angle (or “observation geometry” as in the paper) has very limited impact on aerosol/surface retrieval accuracy as long as their number are same ? If so, I’m confused. For a certain number of viewing angles, the spread of the degree of freedom (DOF) in Fig 6 spans a range that can cover the difference in mean DOF caused by varying 4-5 view angles. This is indeed a huge impact. Please clarify.

4. Page 19, paragraph 2, it is not easy for readers to capture these remarks from Figure 6. It is better to add another plot showing the Δ_{DOF} as a function of number of viewing angles. Moreover, I see from the bottom right panel of Fig 6 a gradual increase of DOF from using 5-6 angles, 6-7 angles, and then 7-8 angles. And convergence seems not achieved by use of 9 angles. I suggest the authors setting more angles for

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test and plot ΔDOF to justify the convergence. Even claimed as "seven or eight satellite configuration" are capable enough, it is different than earlier finding that AOT retrieval accuracy gain converges at five angles. This needs some comments.

5. The authors correctly uses the chain rule to calculate the AOT uncertainty. To be more complete, please describe more explicitly after Eq.(2) that the square root of the diagonal term of S matrix represents the uncertainty of the retrieval parameters. This would be better than describing it in the figure caption.

6. P23, Section 4,5, the authors are trying to use the off-diagonal terms of the retrieval error correlation matrix (Eq.6) to analyze the cross-contamination between different retrieval parameters. It is stated that "large off diagonal values indicate a smaller volume in retrieval State space, an indication of higher information content for that pair of parameters." Please be more explicit about the physical interpretation behind the relation between diagonal and off-diagonal terms. For example, does the author mean in contrast to the diagonal term, large off-diagonal term means retrieval error of the two quantities are less correlated and therefore easy to decouple ?

7. In addition to the DOF and retrieval uncertainty analysis for the AOT (e.g. Figs 6-7), could the authors add a similar analysis for aerosol single scattering albedo (and maybe an extra case for smoke or dust aerosols) ? This will help the readers understand the role of using polarization in constraining aerosol single scattering albedo retrieval.

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