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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol optical depth and fine-mode fraction retrieval over East Asia using multi-angular total and polarized remote sensing" *by* T. Cheng et al.

Anonymous Referee #3

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This paper offers an alternative algorithm to retrieve total aerosol optical depth and fine mode fraction from POLDER measurements over land in East Asia. The operational POLDER algorithm, over land, provides only fine mode AOD and not TOTAL AOD and definitely not fine mode fraction, which would require an additional piece of information. Thus, if successful the algorithm described in the current paper would provide an important new tool for aerosol studies in East Asia.

There is hope that more information can be attained from the POLDER instrument. With its multi-channel, multi-wavelength and polarization signal, previous studies in-

vestigating information content suggest that such an instrument is actually currently under utilized. Dubovik et al. (2011), Hasekamp et al. (2011), both referenced in the current paper, are suggesting optimization and inversion techniques, applied to POLDER that may advance the original operational algorithm, significantly more than the important though modest in comparison advance proposed here.

There is always room for a a regionally-specific algorithm, like the one presented here, to fine tune assumptions for a specific region and improve upon a generic global retrieval. Such a regional algorithm must be presented in context with the standard operational one. How do the two differ? What makes the regional one better? The new algorithm must be presented with sufficient detail for a reader to be able to evaluate the principles and assumptions in the algorithm. There should be sensitivity studies and understanding of WHY the new algorithm works better, not just that it does.

In my opinion this paper fails to meet this standard. I find it very interesting that the results look so good against AERONET. I would like to understand why it works so well. The authors owe the community a more comprehensive description of the physical reasoning or strong empirical support behind every decision. While as a reviewer I was grateful to have to read only 6 pages of text, this is insufficient to introduce a new algorithm. It is not as though this is a short summary paper of a long history of papers describing the different components of the algorithm creation. The authors only self-reference two papers and neither sufficiently fills in the holes missing here.

For this reason and for the specific reasons I describe below, I would recommend rejection of this paper at this time and encourage the authors to resubmit a more comprehensive description of their algorithm that explains how they overcame the challenges of the operational POLDER algorithm.

1. Comparison with operational POLDER retrievals over land

The operational POLDER algorithm avoids the challenge of characterizing the INTENSITY surface reflectance over land and relies only on the multiangle, multispectral PO-

LARIZED reflectance to retrieve aerosol properties. Because most of the polarization signal results from small spherical particles, the operational algorithm ignores coarse mode in the retrieval and returns only fine mode AOD, not total AOD and definitely not fine mode fraction. The POLDER LUT consists of only fine mode lognormals.

This has to be where any description of a new POLDER algorithm must start. None of what I wrote in the above paragraph makes it into the current paper. Referencing POLDER papers without describing them is not enough. The current paper must clearly explain how they will extract more information from POLDER.

Then, they should show by sensitivity study or reference previous work explicitly the source of the new information. Where does the sensitivity to coarse mode particles come from?

Finally, at the end there should be comparison with standard algorithm retrieved fine mode AOD, as well as AERONET. The new algorithm retrieves AOD in both dust and pollution. The old algorithm should severely underestimate AOD when compared with the new algorithm. Is this so?

2. The aerosol models

The authors describe a set of 12 aerosol models, six fine and six coarse mode, obtained from AERONET clustering, and reference a paper by Lee and Kim. The modes presented in Table 2 are not very distinctive, and it is hard to see how a retrieval algorithm is going to find unique solutions.

Most importantly the current work misuses the results from the Lee and Kim paper. In that study, AERONET inversions were clustered into six bimodal models. Two look like dust, and four look like various stages of pollution or cleaner background conditions. Lee and Kim make no attempt to separate their 6 bimodal models into independent monomodal models. They cannot because the AERONET inversions allow independent size bins to make the size retrieval, but require that there be only one set of

refractive indices retrieved for the aerosol as a whole. They cannot assign different refractive indices to the different modes. I would expect the values of refractive index in the current paper's Table 2 to be the same for pairs of fine and coarse mode coming from the Lee and Kim analysis. Indeed, Fine 1 and Coarse 1 have the same refractive indices. However, something changes for the pairs representing Lee and Kim's dust models. I do not see where the dust refractive indices come from. Dividing the bimodal clustered models into mono-modal models is ill=posed because of the partitioning of the refractive indices.

This splitting of the Lee and Kim bimodal models into monomodal models and allowing all of them equal weighting in an inversion scheme is just wrong, even if the refractive indices were understandable. There needs to be subsequent analysis of the Lee and Kim results showing that the optical properties (spectral single scattering albedo, asymetry parameter, phase matrix) are sufficiently different for each entry in the table to justify their remaining in the table. There is a statement saying that these properties were studied, but the results of that study have to be shown. Size distributions should be shown also.

3. Surface intensity reflectance

The current paper makes its most major departure from operational POLDER retrievals in characterizing surface intensity reflectance in order to make use of POLDER-measured intensity reflectance in the aerosol retrieval. The procedure employs a technique described by von Hoyningen-Huene (2003). The procedure uses average surface reflectance measured by aircraft instrument at three wavelengths in Germany near Berlin and divided into 'vegetated' and 'bare soil' categories. Then the method uses NDVI to weight the categories.

The problem with using NDVI is that NDVI calculated from top of atmosphere radiances is affected by aerosol. In heavy aerosol loading, NDVI decreases and the fraction of bare soil will be artificially increased.

The more important problem is the use of surface reflectance characterization based on vegetation and soils in Germany, now applied to East Asia. It defeats the whole advantage of creating a regional aerosol retrieval.

4. Presentation and results

Why false color images? True color would be much easier to understand. Lee and Kim used true color and the aerosol plumes are much easier to see in their paper. At the very least, the channels used to mix the false color must be stated.

More information needs to be given with each case study. What are the distributions of the residual terms (chi value) in each case? Which modes are chosen? How unique is each choice? These hard diagnostics are as important as the AERONET scatter plots in proving a new algorithm.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 5689, 2011.