

## ***Interactive comment on “Aerosol type retrieval and uncertainty quantification from OMI data” by Anu Kauppi et al.***

### **Anonymous Referee #2**

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This paper presents an analysis of aerosol type retrieval and uncertainty quantification from OMI data. The method is based on Bayesian inference approach. The aerosol types are used in forward calculation of OMI spectra and compare that with the measured one. The differences are then used to create the probability density function to estimate the uncertainty in retrieval of AOD. With this approach, this retrieval and its uncertainty can be assessed in probability terms.

The paper is interesting with sound math. For it to be published and attract wider readability, it needs significant revisions, especially in many places where Maatta et al's paper is referred. Detailed comments are

1. what is the key difference in method between this paper and Maatta et al? Is it simply that Maatta et al. didn't analyze the retrieval uncertainty (p. 11, line 5)?

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2. equation 1. To compute reflectance, one needs to know path reflectance that in turn is related to aerosol optical depth. the same is true for transmittance. Please explain how the calculation in equation 1 is implemented? what are the inputs and from where?
3. equation 2. Is observation error kept constant for each wavelength in this case?
4. page 5. line 25, "we constructed the covariance function empirically by using the wavelength distance dependent correlation structure of the residuals (See Maata et al 2014 details)". This sentence is very difficult to understand. The paper should stand alone by itself.
5. eq. 3. Where does this equation come from? how is measurement error variance computed?
6. eq. 4. It is not clear how  $p(\tau|m)$  is constructed. "In the present case, the estimation and model selection procedure seeks the solution for a one-dimensional parameters  $\tau$ , and the calculations will be fairly straightforward by numerical quadrature. The posterior distribution calculation is presented in the more detail in Maata et al 2014". Again, this reviewer doesn't understand this.
7. P6, L11-15. how the evidence is computed? this reviewer doesn't understand this paragraph. Later again, Maata et al 2014 is cited, generating a pause in text flow.
8. Overall, the method presented here lacks materials for readers to comprehend. An specific example will be helpful to illustrate how all these equations are implemented.
9. The results part also lack validation or inter-comaprison with MODIS AOD. Does the method help to interpret the inter-comparison?
10. Introduction part needs to include couple of references that reflect the research activities in U.S. (1) p2, L15. The following paper used AOD to constrain the emissions as well.

Wang, J. et al., 2012. Top-down estimate of dust emissions through integration of

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MODIS and MISR aerosol retrievals with the GEOS-Chem adjoint model, Geophys. Res. Lett. L08802.

Xu et al., 2013. Constraints on aerosol sources using GEOS-Chem adjoint and MODIS radiances, and evaluation with Multi-sensor (OMI, MISR) data, J. Geophys. Res. Atmos., 118, 6396-6413.

(2) P2, L 17-27. while LUT is widely used in operational retrieval algorithm, several research algorithm used aerosol properties from chemistry transport models. This point should be mentioned here.

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