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Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol profile information from high resolution oxygen A-Band measurements from space" *by* A. Geddes and H. Bösch

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We would like to thank the reviewer for the helpful and detailed comments. We have revised the manuscript according to the suggestions and we address the reviewers comment with a point-by-point response below. Changes in the manuscript as per your comments are highlighted in red in the supplement.

This paper carries out a detailed theoretical analysis on the use of spectral measurements in the Oxygen-A band to retrieve the vertical distribution of the atmospheric aerosol load. The authors have simulated the expected performance of currently de-

ployed, soon-to-be deployed or planned sensors with Oxygen-A band observing capability, and evaluated obtainable levels of accuracy by four different sensors in terms of their spectral resolution and signal-to-noise ratios. The paper is generally well written and suitable for publication in AMT after the issues identified below are addressed.

My main criticism of this work is the lack of detail regarding the aerosol simulation component of the analysis. The authors used 13 aerosol mixtures reported in the literature [Kahn at al., 2001], but fail to provide enough information on the relevant aerosol properties (effective particle size distribution and effective single scattering albedo) of the mixtures to adequately interpret the reported results. The discussion in section 6.4 on the aerosol assumptions in the retrieval states that simulation retrievals were carried out for the 13 aerosol mixtures of Kahn et al [2001], and quotes in Table 4 the obtained maximum and minimum biases in retrieved AOD and aerosol height. There is no discussion, however, on which of the 13 aerosol mixtures and their corresponding fundamental properties are associated with the largest biases. In terms of aerosol particle size, the aerosol mixtures of Kahn et al [2001] go from predominantly small particles (1a) to coarse dust particles (4c). In terms of absorption the mixtures go from negligible absorption (1a) to significant absorption (5b). Characterizing the retrieval capability of the vertical distribution of absorbing aerosols layers by Oxygen-A band observations is of great importance since smoke layers are often observed in the free troposphere and UTLS. The AOD/Height bias results presented in the bottom section of Table 4 should be expanded to include the associated values of effective particle size distribution and single scattering albedo.

- The simulations have been carried out for an aerosol mixture that includes large particles (type 2b) and AOD errors are negative (i.e. the retrieval underestimates AOD) and are largest for aerosol mixtures with larger Angstrom coefficients (small particles) (types 1a, 1b, 3a, 3b, 4a, 5a, 5b, 5c). AOD errors for the higher-resolution instruments are all very similar with the largest error being found for type 5a. For S5-P, the errors tend to be smaller but otherwise the behaviour is very similar. The height errors show

an overestimation of height and there is a tendency for larger errors for mixtures with smaller particles, but largest errors are found for mixtures with lowest value of the phase-function in the direction of the scattering angle (type 3a) or lowest value of the single scattering albedo (type 5b). We have included a more detailed discussion on the impact of the aerosol mixtures in section 6.2 We have also re-run the retrieval experiment using a smaller converge criteria (ie more iterations of the retrieval have been carried out) and some of the values given in table 4 have slightly changed.

Other comments (identified by page and line number): 6022-5 In the statement that includes the expression '. . .with high coverage. . .' it is not clear what kind of 'coverage' the authors referring to. Is it spatial coverage? – This should be "spatial". This is corrected in the text.

6022-16 Suggestion: 'but the accuracy of the required priori knowledge is very high' – DONE

6024-5 The literature review fails to mention documented applications to retrieve aerosol layer height from passive stereo-viewing MiSR observations (Kahn, et al., 2007), from POLDER observations (Dubuisson et al., 2009), and from OMI near UV observations (Sathheesh et al., 2009). These applications have been successfully demonstrated under certain conditions. – We have incorporated these instruments and references into the text

6024-11 The Martin et al (2010) does not appear in the list of references. - The reference is included in the list

6025-20 In the context of this manuscript the expression 'aerosol type' is ambiguous. I suggest using 'aerosol mixtures' that specifically refers to well defined aerosol properties: particle size distribution, particle shape and refractive index of the components of the mixtures [Kahn et al., 2001].

– We have changed the text and use now 'aerosol mixtures' throughout the manuscript

6029-17 Type 2b in Table 2 of Kahn et al (2001) does not represent an aerosol model but an air mass mixture containing four aerosol types (sulfate, sea salt, accumulation mode dust, and coarse dust). The actual aerosol models associated with each type are given in Table 3 of Kahn et al. (2001). A more detailed description of the computational handling of the resulting aerosol mixture is required. Are these four aerosol components internally or externally mixed? What are the resulting effective aerosol particle size distribution, shape and single scattering albedo?

- We have given a more detailed description of the aerosol optical and their calculation in section 3

6032-8 There is a typo in last sentence of Fig. 3 caption. – DONE

6033-5 The discussion of AOD errors is carried out in terms of absolute errors. For a purely theoretical analysis as the one presented here, relative errors are often more meaningful. I suggest adding in parentheses the relative errors associated with the reported absolute errors. Figures should also be modified to reflect the relative error.

– We use relative errors in figures 8 and 9 as we feel they are useful here. For the profile retrieval, we do not think that relative errors are the best metrics as some of the height regions contain very little aerosol and thus relative errors can become very large and we feel that this will make an inter-comparisons between scenarios more challenging and less clear.

6042-5 The AOD/Height biases associated with aerosol type (reported in Table 4) are interpreted by the authors only in the context of particle size. As shown in Table 3 of Kahn et al (2001), the single scattering albedo of the constituents of the possible 13 aerosol mixtures varies between 0.1 and 1.0. Thus, the authors' interpretation of the results is incomplete. As suggested above in this review, it would be useful to list the effective particle size and single scattering albedo associated with the aerosol mixtures used in this analysis. This is important, because aerosols in the free troposphere are predominantly either desert dust or carbonaceous aerosol layers. Carbonaceous

aerosols are very absorbing in this spectral range with reported single scattering albedos of 0.84 or lower (Dubovik et al., 2002).

- A more detailed discussion has been included in the manuscript (see also response above).

Please also note the supplement to this comment:
http://www.atmos-meas-tech-discuss.net/7/C2815/2014/amtd-7-C2815-2014-supplement.pdf

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Interactive comment on Atmos. Meas. Tech. Discuss., 7, 6021, 2014.