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Atmospheric Measurement Techniques Discussions

Interactive comment on "Influence of aerosol and surface reflectance variability on hyperspectral observed radiance" *by* C. Bassani et al.

Anonymous Referee #4

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General comments

This paper is looking at spectral radiance as a function of aerosol and surface reflectance, which were simulated in preparation for a potential spaceborne hyperspectral remote sensing instrument. It shows results from a forward radiative transfer model (6S) for varying aerosol optical depths (AOD), two aerosol models and two surface types. It compares those results to the expected spectral signal to noise ratio (SNR) of this instrument to find the corresponding minimal 'measurable' difference in AOD (retrieval fidelity).

The paper touches two important questions on how to improve state of the art in aerosol retrieval by adding more spectral bands by using a hyperspectral instrument, and on

how to remove the aerosol effect from such data to retrieve other parameters. Unfortunately, it does not provide new aspects to solve those relevant problems. It would be favorable if the paper would provide more insights to the independent information content of hyperspectral data for aerosol retrieval problems. How far can hyperspectral data compensate for missing multiple viewing geometries and polarization measurements.

The paper should be also improved by being shorter and less repetitive. In the present form, the paper contains a bit of everything. A clear focus on either sensor performance and information content or on the forward model or on the retrieval method (inversion) or on the sensitivity of various parameters on the TOA reflectance. Except from the inversion, the current paper touches all this topics. I would therefore suggest to remove common knowledge, repetitions and elaborate more on a comprehensive, realistic error (fixed, bias and random errors) or sensitivity analysis including more than just the SNR. The SNR is a measure for the theoretical instrument fidelity and is only one component of the total error. It is therefore more of engineering than of scientific interest.

With that said, I encourage the authors to perform major revisions in order to increase the scientific relevance of this manuscript. I hope the following comments provide some guideline.

Specific comments

p. 7212 l. 17-21: 'improvement of the retrieval for (. . .) aerosol' is too vague. Provide information on what exactly can be improved by using hyperspectral data. Presumably the authors refer to the retrieval of AOD. This applies to the rest of the manuscript as well. Further, the authors should distinguish between a physical based forward (radiative transfer) model and an inversion technique, which searches for the best fit between the model and obs.

p. 7215 l. 4-16: These two paragraphs should be given in the introduction. Lines 8-9 can be removed. Please mention in this part of the introduction why water and sand

targets were chosen. The term 'Costal regions' is be too general because the reader expects not only clear water and pure sandy surfaces in a costal region.

p. 7217 l. 9-10: Relax the statement which sounds like aerosols would dominate extinction. This is often not true due to Rayleigh scattering at shorter wavelengths and also not true in absorption bands. It should be always clear to the reader if the authors refer to the aerosol, molecular (Rayleigh) or total optical depth. Thus, add 'aerosol' in front of optical depth and add a sub- or superscript to tau.

p. 7217 l. 18: Use newer literature on the actual AOD retrieval accuracy of MODIS (e.g. Levy et al.(2010)), which is generally lower (less accurate) than the given pre-flight requirements. Btw., the values are not correctly reported and it should be mentioned if they apply to the ocean or land product.

p. 7218 l. 1-5: Rephrase, because an aerosol model itself describes only the optical and microphysical properties, which themselves can influence the solar radiation field scaled by their abundance.

p. 7218 l. 6-8: Check the list of given references to the used aerosol models, which were entirely defined by d'Almeida et al.(1991).

p. 7219 Sect. 2.4 l. 1-12: A sensor description should not be placed in the Methods section.

p. 7219 l. 8: How should the adjacency effect be beneficiary to the AOD retrieval? It adds a new dimension to the complexity of the radiative transfer model and the inversion.

p. 7219 Sect. 2.4 l. 13-18: See General Comments on SNR, error analysis and information content.

p. 7219 l. 22-26: The chosen case of maximal solar irradiance intensity leads to a lager SNR and therefore better results when comparing L to deltaL (SNR). An average or even low irradiance case would be more adequate to really test the required perfor-

mance for the AOD retrieval. Now, the presented results are only representative to the one singular observational case.

p. 7220 l. 1: What is the 'view factor'? Please explain your definition or use a more common term to avoid misinterpretation.

p. 7220 l. 7-21: Refer to literature supporting your findings on the impact of aerosol loading on the observed radiance (e.g. Seidel and Popp(2011)).

p. 7220 l. 4 and Fig. 2-4 on p. 7235-2737: A deltaAOD of 1.0 is (too) high. I suggest to use 0.1 and provide the results in a difference plot with L-L(AOD=0) since the authors make their point on the relative changes and not on the absolute values of L. y=0 value would be given by the L(AOD=0) results. Maybe even (L-L(AOD=0))/L would be an appropriate y-axis.

p. 7221-7225 Subsect. 3.2 and Sect. 4: Although, Fig. 3-7 contain interesting results on adjacency effects on radiance, the corresponding sections remain purely descriptive. I strongly suggest to use this opportunity and add scientific value to those sections and to add explanations of the radiative processes and the consequences to AOD retrievals. E.g. mention that the AOD retrieval in the presence of strong absorbing aerosols (urban) over dark targets is very challenging due to the missing sensitivity (see Fig. 4 lower left panel).

p. 7222 l. 8-12: This paragraph is a repetition of the two preceding paragraphs.

p. 7238 Fig. 5: Please indicate the SNR requirements of the sensor (ie. 200) with another contour plot to visualize where AOD retrievals will not be possible with the requested fidelity due to the low AOD sensitivity to radiance. Why does the provided contours show a wiggelig structure. I assume that this is related to numerical accuracy and interpolations. Please remove them non physical features or at lest describe their origin.

Technical corrections

p. 7212 l. 6: remove 'the' at the end of the line

p. 7212 l. 17-21: improve language

p. 7212 l. 25: latest IPCC report is sufficient

p. 7216 l. 3-4: improve language

p. 7216 l. 21: remove 'mainly'

p. 7217 Eq. 2: change one of the two arrows indicating the direction of the calculated transmittance from upwards to downwards

p. 7220 l. 2: Remove 'radiative'.

p. 7222 l. 20-23: improve language

References

[Levy et al.(2010)] R. C. Levy, L. A. Remer, R. G. Kleidman, S. Mattoo, C. Ichoku, R. Kahn, and T. F. Eck. Global evaluation of the collection 5 MODIS dark-target aerosol products over land. Atmos. Chem. Phys., 10(21):10399–10420, 2010.

[d'Almeida et al.(1991)] G. d'Almeida, P. Koepke, and E.P. Shettle. Atmo- spheric Aerosols: Global Climatology and Radiative Characteristics. Deepak, Hampton, Virginia, USA, 1991. 561 pp.

[Seidel and Popp(2011)] F. C. Seidel and C. Popp. Critical surface albedo and its implications to aerosol remote sensing. Atmospheric Measurement Techniques Discussions, 4(6):7725–7750, 2011. doi: 10.5194/amtd-4-7725-2011.

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