

***Interactive comment on* “Determination of aerosol properties from satellite observations of the Ring effect” by T. Wagner et al.**

Anonymous Referee #1

Received and published: 11 October 2010

Title: Determination of aerosol properties from satellite observations of the Ring effect

Author(s): T. Wagner et al. MS No.: amt-2010-105 MS Type: Research Article

Overall Rating: Scientific Significance: Fair Scientific Quality: Fair Presentation Quality:
Fair

Recommendation: Significant revisions needed.

In this manuscript the Ring effect (filling-in of Solar Fraunhofer lines by Raman scattering) is studied and compared to the depth of O₂ and O₄ absorptions. The authors claim that the Ring effect has potential for the retrieval of aerosol properties from satellite spectrometers.

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My main concern about this manuscript is that it presents only a sensitivity study based on simulations and some selected observational cases. Although there is a claim (also in the title of the manuscript) that aerosol properties can be derived from the Ring effect measurements, I find no direct evidence in the manuscript. Showing that the spectrum is sensitive to aerosols is not the same as being able to derive quantities on aerosols from the spectrum. This manuscript is only a sensitivity study and no other claims can be made. The manuscript has not convinced me that aerosol retrieval using the Ring is feasible.

For the O₂ analysis the relative weak band at 630 nm is used. From many studies it is concluded that the O₂ A band contains much more information on aerosol and their vertical distribution. The choice of the O₂ band at 630 nm is not motivated in the manuscript. Given the importance of the O₂ A band for current and future mission, the analysis shall also include this band.

The manuscript contains too many figures. Some of these figures are trivial and should be removed. For other figures the information should be condensed. Rethink of each figure its purpose for the manuscript and if it can be removed or placed in an appendix. Given the large number of figures and sub-figures compared to the text, I get the impression that the reader is doing the analysis instead of that the authors explain there analysis in the manuscript. To give an example, to explain the variation with solar and viewing angle 9 plots are used, included many subplots. I strongly recommend to bring this back to at most 5 plots, with only a few subplots.

One of the reasons that Raman scattering has not been used for the retrieval of aerosol properties is because the forward modeling is very complex. Especially the interaction with the surface, for example of water, is difficult to model and depends on the optical properties of the water body. The authors briefly touch upon this on page 3541 line 25. This shall also be discussed as part of the conclusions.

The manuscript focusses on extreme aerosol events. In the sensitivity analyses aerosol

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optical depth of 1 and 4 are used. Explain why these values were chosen. Does this imply that the potential of the Ring effect for aerosol retrieval only holds for large plumes? In the simulations an unphysical aerosol model is used. For an aerosol size distribution with a size parameter of 0.68 the AOD will decrease as a function of wavelength. This is not accounted for in the simulations. Therefore there is no aerosol size distribution that has these optical properties. Discuss the aerosol model and its limitations in the manuscript.

Specific points:

The title of the paper is not appropriate. In the paper no aerosol properties are derived from Ring satellite observations. At most the title could be “On the potential of determination”

page 3538 line 25. An important difference between clouds and aerosols in the short-wave part of the spectrum is that aerosols can significantly absorb part of the Solar radiation. This is missing in the discussion on the two effects.

Section 2.2.4. Mix-up of symbols and terminology. The radiance is normally denoted by I and the Solar irradiance by F . On line 7 of 2.2.4 a statement is made on the reflectivity. However the statement is only true when the cosine of the solar zenith angle is in the denominator of equation 2.

From section 3 it is unclear if polarization is taken into account in the radiative transfer model. If not how provide argumentation why the results are representative.

Figure 4. Why does the y-axis for O4 start at -1?

What is the point of showing Figure 6. The fact that the normalized radiance decreases with SZA seems rather trivial because the TOA irradiance decreases with the cosine of the SZA. I recommend to remove this figure from the manuscript.

Page 3546 line 26. Describe in the manuscript the procedure to ensure that only cloud-free sciamachy observations are used?

In section 4.3 the point is made that the O2 and O4 absorption depend more on the surface albedo than Ring effect. However, looking a figure 15 this is arguable. The O2 at 630 nm doesn't vary more with wavelength compared to the 380 and 630 nm Ring. Here also the argument on the complex modeling of water surfaces should be included; now the manuscript oversimplifies on the surface reflectance discussion.

Section 4.4. The strongest and most direct effect that the AOD increases have is on the radiance itself. Therefore this section should start with a discussion on figure 16, followed by a discussion on figure 15, which is much more complex.

Section 4.5, figure 17. The dependence on the aerosol height for the ring effects seems very small considering the very large AOD of 1 and 4. Discuss how these numbers of about 0.001 RSP /km compare to measurement errors.

Section 4.5, page 3556, line 1. The MODIS images shows that underneath the aerosol layer there are significant amount of clouds. The claim that this is mostly cloud-free is not convincing.

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 3535, 2010.

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