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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Limb scatter ozone retrieval from 10 to 60 km using a Multiplicative Algebraic Reconstruction Technique" *by* D. A. Degenstein et al.

D. A. Degenstein et al.

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We would like to thank the reviewer for the thoughtful and carefully laid out comments. We believe the incorporation of these suggestions has improved our work.

Response to the General Comments

1) The issue of the vertical range is addressed in a paragraph that has been added to the manuscript. The paragraph states:

"Figures 6 and 7 show that there are significant biases between the SAGE II and OSIRIS retrieved ozone profiles at altitudes above 53 km and below 18 km. Figure 7 may hint at a reason for the differences at high altitudes. This figure indicates the

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standard deviation in the SAGE II profiles is discontinuous at approximately 51 km. This is near the altitude where the systematic differences between the SAGE II and the OSIRIS profiles begin to occur. It appears there is some change in the SAGE II retrieval process at this altitude and this is not surprising as the Chappuis absorption used exclusively in the SAGE II retrievals is extremely small at these altitudes. Another reason for the differences at high altitudes could be the diurnal variation in ozone expected as a result of the photochemistry. SAGE II is an occultation instrument and always measures at local twilight while the OSIRIS observations were limited to those where the solar zenith angle at the tangent point was less than 88 degrees. The systematic bias between the SAGE II and OSIRIS retrieved values at altitudes below 18 km may be caused by high altitude clouds or an incomplete knowledge of the tropospheric aerosol component. A full validation of the OSIRIS data product, to be done at a later date, will hopefully prove useful in diagnosing these biases."

2) and 3) The paper we have written demonstrates a proof of concept that a MART approach, combined with the SASKTRAN model and the OSIRIS measurements, can be used to consistently merge the Hartley-Huggins and the Chappuis absorption band information into a single algorithm for the retrieval of vertical ozone number density profiles using spectrally dispersed limb scattered sunlight. As such we feel that full algorithm performance analysis including complete validation belongs in follow on publications. For information related to the MART algorithm performance including smoothing error, the averaging kernels, bias and impact of the initial guess we have referred the reader to previous works done by Roth et al. and Bourassa et al..

Specific Comments

1) The abstract has been slightly modified to indicate that the higher of the cloud top altitude or 10 km determines the lowermost altitude for the retrieval. Other phrases throughout the paper as well as Table 1 have been slightly modified to indicate this more clearly.

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2) The statement has been changed to there is no visible knee above 10 km.

3) The caption for Table 1 has been modified to indicate the normalization altitude is the same for the reference and absorbing wavelengths.

4) There is no intention to state that other techniques cannot use multiple vector elements to retrieve the state parameter at any altitude. The statement indicates that this is an important feature of this retrieval technique. The line has been modified to make this more clear.

5) We agree the vertical resolution varies with altitude, decreasing towards the top of the retrieved profile. It is extremely difficult to gauge the exact vertical resolution associated with the MART retrievals. In an optically thin atmosphere Bourassa et al., 2007 showed that the MART technique results in averaging kernels that approach delta functions. This of course does not imply the vertical resolution is anywhere near that good. We believe this is a topic for considerable further study and is beyond the scope of this proof of concept paper.

6) A statement has been added to clarify that the sulphate aerosol and NO2 profiles are retrieved using the same OSIRIS scan.

7) The statement "do not occur" has been changed to "occur rarely"

8) We have added a paragraph that better discusses the discrepancies between the SAGE II and OSIRIS measurements at both the upper and lower altitudes. This paragraph does not refer to the issue of baffle scatter as all of our analysis to date has shown that this is not a significant problem for the OSIRIS 351 nm radiance measurements at altitudes below 65 km.

9) The sentence has been reworded to indicate this agreement is on average not at each geolocation or solar zenith angle. We address the issue of a full validation in our response to the general comments.

10) The data can be obtained through the ESA portal http://eopi.esa.int/esa/esa but

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since this may change we do not want to include this link in the paper.

Typos: fixed

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