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Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the variability of the Ring effect in the near ultraviolet: understanding the role of aerosols and multiple scattering" *by* A. O. Langford et al.

A. O. Langford et al.

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Reply to Anonymous Referee 1

We would like to thank the reviewer for his helpful comments on this paper. We have considered his suggestions (shown in italics) and have made the indicated revisions to the manuscript.

** The authors might want to add a remark to the paper that their results provide some justification for the empirical approach used by many groups working with DOAS who add a nonlinear intensity offset ("offset and slope" or "additive polynomial") to the fit in order to compensate the well known wavelength dependence of the Ring signal.*

We have expanded on our discussion of techniques to correct for the Ring effect in the Introduction by inserting the following text (p10155, L19).

"Several approaches have been used to correct for the Ring effect in scattered light spectra. Noxon et al. (1979) added or subtracted a small intensity offset (<2%) to the spectra he acquired near twilight before they were ratioed to a background spectrum acquired near midday. This empirical approach exploits the quasi-continuum nature of RRS and other groups have refined this technique by adding a nonlinear offset to compensate for the wavelength dependence of Rayleigh scattering."

And at the end of the summary we have added:

"Note that the addition or subtraction of a wavelength dependent intensity offset to the foreground spectrum may be, at times, a good approximation to this scaling. However, this empirical method could also capture other effects that are unrelated to FI because it is not physically based, particularly when the spectra are noisy."

** It would also be interesting to think about the implications of the findings presented in the paper on the filling in of molecular absorption lines, a small effect that becomes relevant at low sun or high precision measurements e.g. of stratospheric ozone. The corrections used so far are based on Rayleigh scattering only and modifications might be necessary in the presence of aerosols.*

We have added the following statement to the summary:

"While we have not directly examined the effects of aerosols on the FI of molecular absorption features, this will depend on the location of the aerosol layer relative to the absorber. Tropospheric aerosols will have little effect on FI of the absorption by stratospheric constituents such as NO_2, which is strongly enhanced by multiple Rayleigh scattering at twilight (Fish and Jones, 1995). However, a volcanically enhanced upper stratospheric aerosol layer such as occurred after the eruption of Mt. Pinatubo (Mills et al., 1993) might reduce the total FI in the spectra of both tropospheric and stratospheric

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absorbers."

** section 3, page 10158 bottom: please add the wavelengths used to define the background continuum for I2*

The wavelengths used to determine I_2 (343.2 and 344.6 nm) have been noted in the revised text as requested.

** section 5, page 10164: May be I miss something obvious here but it is not clear to me why eq. 3 is valid. In particular, why should the filling in from second order scattering be subtracted for NR < 1?*

We have added a little more information about the approximations involved in this equation following the short comment by C. Sioris. Note that since there must always be at least one scattering event, N_R cannot be less than one. Also, note that this equation treats N_R and N_M as delta functions.

** section 6, page 10167 top: "... and the term ... " something appears to be missing here*

The missing term (which can't be reproduced here) was lost in the file conversion process.

** all figures: in the printed paper, I had difficulties reading the labels and axis*

Thank you for pointing that out. The figures have been redone with larger fonts and will be printed larger in the published paper.

** Fig. 2 and related text: While I agree that the amount of filling in must be related to aerosol OD, the same could be said of intensity at 344.1 nm according to the figure. I suspect that just as it is the case for intensity, any attempt to retrieve quantitative aerosol quantities from FI will face problems from the interference of various other effects also affecting FI in complex ways. The wavelength dependence will help but still it will be a challenge.*

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While it is true that the measured intensities also scale with AOD, this quantity is much more sensitive to instrumental factors than FI and would require a calibrated radiance measurement to be quantitative. Any attempts to use FI as a quantitative tool to retrieve AOD will no doubt be difficult, we only note that such a technique might be possible.

** fig. 5: there is a mismatch between the colors used and the description in the figure caption*

The word “purple” in the figure caption has been changed to “dark blue” .

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