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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Odin/OSIRIS observations of stratospheric NO_3 through sunrise and sunset" *by* C. A. McLinden and C. S. Haley

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Author responses begin with "AU:".

General Comment: Sections 2 and 3 should be revised to include information on the spread of the retrieved SCDs shown as a mean in Figure 3. More attention should also be paid to the negative SCDs - which are of the same order as the positive SCDs taken to differ significantly from zero. This point is further expanded in the specific comments below.

AU: These have been addressed and responses are given to the specific comments. It is mentioned here that the concerns of the negative SCDs raised by both referees has led to a change in the fitting window, which has resolved the issue.

Specific Comments: pg. 5903, lines 2-5: "To date all successful measurements of

stratospheric NO3 have been made by sampling the atmosphere at SZA>94." Smith and Solomon (1990) use lunar spectra taken at solar zenith angles through twilight. Coe et al. (2002) measure solar spectra through twilight, and use SZAs less than 94.

AU: The point in this statement was that at some point along the path of the sunlight, the local SZA must be larger than about 94 or else there would simply not be enough NO3 to measure. The above statement has been clarified, and the references added.

pg. 5903, Figure 1 and paragraph 1: Panels (a) and (b) show modeled profiles at two different latitudes, twilight periods, and seasons. Could you comment on the cause of the difference in the shape of the profiles? The text implies it is mainly due to sunrise/sunset differences - is this the case?

AU: Good point. The primary difference is due to local time (sunrise/sunset), but there are also some latitudinal-driven differences by the ozone and NOy profiles. A line was added to this effect.

pg. 5903, paragraph 2: Twilight zenith-sky spectra from ground-based instruments have also been used to retrieve NO3, for example Coe et al. (2002).

AU: This reference has been added.

pg. 5906, paragraph 2 and Figure 3: Figure 3 should show the standard deviation of the mean to give an idea of how representative the means are. This should also be discussed in the text. Given the large variation of the individual profiles shown in Figure 5, I imagine this standard deviation is quite large, and some of the values are very negative. The authors might also comment on this.

AU: This is a very good suggestion. The StDev has been added in a separate plot (called Figure 4 in the revised manuscript) and are discussed, as suggested.

pg. 5906, lines 11-12: "...the SCDs do not differ significantly from zero." It’s hard to comment on the significance without knowing how much the individual profiles differ from the mean.

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AU: This was originally deemed ‘not significant’ based on the uncertainties shown later in Figure 5, ˜1e14 cm-2. However, this was not stated. Further, since the SCDs shown in Figure 3 are based on an average over many scans the StDev is a better quantity to base this conclusion on.

pg. 5906, lines 13-14: "During sunset there is essentially no NO3 until a SZA of 94..." The profiles at 91-93 all have negative values reaching -1x1014, while the 94 degree profile has a max of 1 x1014 - why is the positive value significant, but the negative values are not? Generally in the discussion in this paragraph I think more attention needs to be given to the negative SCDs - they are not necessarily insignificant just because they are negative.

AU: Agreed. The negatives were systematic. As mentioned by the other reviewer, the portion of the spectrum around 603 nm has little NO3 information and so the fitting window was changed to 610-680 nm. The negatives are now absent in both the measurements and model calculations.

pg. 5906, lines 18-20: "That is, increasing the short wavelength end of the fitting window..." Again, does this eliminate the feature in the mean, or in the individual profiles? This fitting window has been chosen to improve the signal-to-noise ratio (pg. 5904, paragraph 3) - but if the window introduces negative SCDs, is it really the better choice?

AU: This is a valid question, and due in part to this and the thoughts of the other reviewer the window was changed (see above) so that no negatives are present.

pg. 5907, line 22: "Overall the magnitude and behaviour with SZA is very consistent between the modeled and observed SCDs." I wouldn’t call the agreement "very consistent". There are many differences which are elaborated on by the authors in the rest of the paragraph.

AU: Fair enough. The statement has been changed to consistent considering all

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sources of uncertainty.

pg. 5908, paragraph 1 and Figure 5: The difference in the magnitude of the profiles is explained by the larger ozone amounts in scan 1 and the differences in temperature. Can the box model be used to confirm this?

AU: A very good suggestion! This had been done and the results do in fact seem consistent, at least qualitatively. A third panel has been added to Figure 5 showing these results and a discussion of this is now included.

References

Coe, H., B. J. Allan, and J. M. C. Plane, Retrieval of vertical profiles of NO3 from zenith sky measurements using an optimal estimation method, J. Geophys. Res., 107(D21), 4587, doi:10.1029/2002JD002111, 2002.

Smith, J.P. and S. Solomon, Atmospheric NO3 3. Sunrise Disappearance and the Stratospheric Profile, J. Geophys. Res., 95(D9), 13819, 1990.

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