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Comment

Interactive comment on “Retrieval of nitrogen dioxide stratospheric profiles from ground-based zenith-sky UV-visible observations: validation of the technique through correlative comparisons” by F. Hendrick et al.

F. Hendrick et al.

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We would like to thank Anonymous Referee #3 for his/her helpful comments and suggestions.

Referee comment: The presentation of the comparison between the retrieved profiles and balloon and satellite data also reads very interesting. However, as it stands now, this part of the paper is somewhat confusing. E.g. in the abstract, the authors say: “In order to validate the technique, the retrieved NO₂ vertical profiles and columns have been compared to correlative balloon and satellite observations.” But then they continue to rather use their own profiles as a basis to discuss the shortcomings of the satellite profiles and to a lesser extend of the balloon observations. In my opinion, this

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part of the paper is not correctly handled and might need some careful thought: you can't really at the same time claim that you use a data set to validate the results of your new technique AND use your results as the basis to criticise the same data set. This probably becomes clearest in their conclusion, where the authors say: "Retrieved NO₂ stratospheric profiles . . . have been validated through comparisons with . . . balloon and satellite observations." But then continue on to say: . . . the satellite instruments systematically overestimate the GB UV-visible data below 25-27 km . . .

Reply: We fully agree with the fact that it is unclear who is validating who when reading the manuscript. We have corrected the whole manuscript including the abstract taking this comment into account. Also, the relative differences between GB profile retrievals and correlative data are now calculated as (GB-correlative)/correlative instead of (correlative-GB)/GB.

Referee comment: Although I certainly don't disagree at all with their discussion and findings, it would be good if the authors could clarify the issue a bit better (actual validation versus discussion of the comparison between the different data sets). I don't think that this is a major issue but would be good if the authors could give it some more thought.

Reply: Since a good agreement has been found in the 20-30 km range with balloon measurements, we think that the discrepancies between satellite and GB below 25 km would be more likely due to a limitation of both satellite solar occultation instruments at these low altitude levels. The possible error sources on the HALOE and POAM III data are described in detail in Gordley et al. (1996) and Randall et al. (2002). A source of systematic error is the strong variations of NO₂ along a solar occultation measurement line of sight. Neglecting a correction for the line of sight variations can result in a systematic overestimation in NO₂ below 25 km. According to Randall et al. (2002) and Newchurch et al. (1996), this overestimation is ~20% at 20 km whereas Roscoe and Pyle (1987) estimate it to maximum 1% for the conditions of the present comparisons. The uncertainty on the diurnal effect correction is therefore very large, mainly because

this correction strongly depends on the photochemical model used for calculating it. Nevertheless, the absence of such a correction in the POAM III retrievals could at least partly explain the large discrepancies systematically observed between the GB profile retrievals and POAM III below 25 km since this explanation is consistent with the significantly better agreement observed with HALOE - which included a correction for the diurnal effect - than with POAM III in sunset spring and summer conditions. The comparison of the relative differences in these conditions (below 20% for HALOE and comprised between 20% and 40% for POAM III) suggests that the magnitude of the diurnal effect correction could reach at least 10%. This effect could also play a significant role in the difference observed between sunrise and sunset in the agreement between GB retrievals and HALOE data (larger discrepancies at sunrise than at sunset) since the uncertainty on it can be 2 to 3 times larger at sunrise than at sunset (Gordley et al., 1996). More investigations - which are beyond the scope of the present study - are required to go one step further in the determination of the exact impact of this error source as well as others (e.g., the errors due to interfering absorbers and uncertainties on spectral parameters) on the agreement between GB retrievals and satellite instruments.

Referee comment: Abstract: Be consistent with your locations: e.g. also use (69 N, 16 E) for Andoya or add another digit for Harestua's lat/lon.

Reply: We have corrected this.

Referee comment: Page 2870, line 1: should be (the concentration of NO₂ and BrO . . .)

Reply: We have corrected this.

Referee comment: Page 2871, line 15: . . . Langley plots . . .

Reply: We have corrected this.

Referee comment: Page 2871 etc.: The authors refer in the text to sections which are

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not there anymore, e.g. Sect. 3.2 in line 25, page 2872. This was correct in the original draft but when the authors renumbered the sections, several references to these sections were not changed in the text. This needs to be checked through and corrected. E.g. also now there is a subsection 3.1 under section 3 but no further subsections (3.2, etc.) - is subsection 3.1 then really necessary? Page 2873, line 19: Again, there is no Sect. 4.2 Page 2876, line 9: there is also no Sect. 5.4 Page 2883, line 23: Sect. 5.4 should probably be Sect. 11

Reply: The numbering of the sections and subsections has been modified during the production process at the EGU Office and we did not detect the changes when we proofread the manuscript. So the right Sections numbering is the following: Section 3.2 instead of Section 4; Section 4 instead of Section 5; Section 4.1 instead of Section 5.1; Section 4.2 instead of Section 6; Section 5 instead of Section 7; Section 5.1 instead of Section 8; Section 5.2 instead of Section 9; Section 5.3 instead of Section 10; Section 5.4 instead of Section 11; Section 6 instead of Section 12.

Referee comment: Page 2873, line 8: Shouldn't that read: . . . statistical error of the NO₂ DOAS fitting . . . ?

Reply: We have corrected this.

Referee comment: Page 2874, line 6: In reality, . . . (delete 'the')

Reply: We have corrected this.

Referee comment: Page 2879 "Our retrieval algorithm has been validated through comparison of . . ." This sounds like there has been a validation effort in the past but since there is no reference provided, I assume the authors actually mean something along the lines: "Our retrieval algorithm is validated here (i.e. in this paper) through . . ."

Reply: We have replaced "Our retrieval algorithm has been validated through comparison of . . ." by "Our retrieval algorithm has been validated in the present study through

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comparison of . . .”

Referee comment: Page 2880, line 13: delete ‘it’; . . . as can be seen in . . .

Reply: We have corrected this.

Referee comment: Page 2882, line 3: should read: . . . consists of two . . .

Reply: We have corrected this.

Referee comment: Page 2883, line 16: Examples of profile comparisons . . .

Reply: We have corrected this.

Referee comment: Page 2887, line 5: comma missing? . . . and forward model errors, profiles . . .

Reply: A comma is not missing. These are the profiles of the smoothing, measurement, and forward model errors which have been compared to the NO₂ natural variability. However, to avoid any confusion, the sentence is modified in the revised version of the manuscript.

References

Gordley, L. L., Russel, III, J. M., Mickleby, L. J., et al.: Validation of nitric oxide and nitrogen dioxide measurements made by the Halogen Occultation Experiment for UARS platform, *J. Geophys. Res.*, 101 (D6), 10,241-10,266, 1996.

Newchurch, M. J., Allen, M., Gunson, M. R., et al.: Stratospheric NO and NO₂ abundances from ATMOS solar-occultation measurements, *Geophys. Res. Lett.*, 23, 2373-2376, 1996.

Randall, C. E., Lumpe, J. D., Bevilacqua, R. M., et al.: Validation of POAM III NO₂ measurements, *J. Geophys. Res.*, 107 (D20), 4432, doi:10.1029 / 2001JD001520, 2002.

Roscoe, H. K., and Pyle, J. A.: Measurements of solar occultation: the error in a naïve

retrieval if the constituent's concentration changes, J. Atmos. Chem., 5, 323-341, 1987.

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