

Interactive comment on “Investigation of NO₂ vertical distribution using two DOAS retrievals for GOME-2A measurements in the UV and vis spectral range” by Lisa K. Behrens et al.

Anonymous Referee #1

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The paper "Investigation of NO₂ vertical distribution using two DOAS retrievals for GOME-2A measurements in the UV and vis spectral range" by Behrens et al. presents a retrieval of NO₂ vertical columns in the UV spectral range and discusses how far the comparison to the "standard" retrieval in the blue spectral range provides information on the vertical distribution of NO₂ within the troposphere. The manuscript is well written, clearly structured and overall convincing in its conclusions. It matches well in the scope of AMT.

I have two fundamental comments:

1. The goal of investigating the vertical distribution of NO₂, as stated in the title, seems

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quite ambitious to me; one measured spectrum just provides information on the integrated column (SCD), without any information on the vertical distribution. It is not clear to me why the authors seem to have expected to get direct quantitative information on the vertical distribution by just adding one further piece of information (the SCD at a different wavelength). So the aim of deriving vertical information in the troposphere seems to be rather a second step; as first step, I would have expected improved stratospheric estimates. The separation of stratospheric and tropospheric column is still a fundamental challenge for the retrieval of tropospheric NO₂ VCDs. While it is often no problem over highly polluted regions, it is still a crucial prerequisite for accurate emission estimates of large-scale sources such as soil emissions. Thus I miss some discussion about how far a UV retrieval might improve stratospheric estimates. Empirical approaches such as the RSM and modifications (allowing for longitudinal gradients) as well as assimilation approaches use the measured total column for the estimation of the stratospheric fraction. This requires some kind of a-priori knowledge on how large the tropospheric contribution is expected to be. For a UV retrieval, the sensitivity to the tropospheric column is weaker. Thus, a modified RSM approach might benefit from UV measurements since it can include more measurements over weakly polluted regions. This topic should be discussed in the manuscript.

2. The authors use the established blue spectral range plus a fit window in the UV. But what about the green spectral range? As shown in Fig. 1, the NO₂ cross section still shows absorption bands above 550 nm. This would be another complementary piece of information, even more sensitive towards the lower troposphere than the standard retrieval. Of course the noise will be higher, and the choice of the fitting window and the water vapour cross section might be challenging. I understand that such a "green" retrieval would require major data processing; but still the authors should discuss the potential of adding additional wavelengths for the goal of assessing profile information, and I would appreciate if they could provide some sensitivity studies.

Minor comments:

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Page 3 line 32: "can provide information about the accuracy": I would suggest a different formulation such as "allows to infer the validity of a-priori profiles".

Page 4 line 12: should be "summary and conclusions".

Section 2.1: Please add Munro et al., 2016 also as reference for GOME-2 A.

Page 4 line 30: add "before launch" or similar.

Section 2.2: The details of the cross sections and respective references might be shifted to Table 1.

Page 5 line 6: Which were the criteria for identifying "best results"?

Page 5 line 11: For a focus on stratospheric patterns, this would probably be crucial.

Page 5 line 12: So daily Earth is the alternative, but what is the default?

Page 5 line 20: Details and references for O4 (vis) and H2O are missing (might also be added to Table 1).

Page 6 line 21: What does "upper atmospheric" mean?

Page 6 line 30: What is meant by "this correction method"? The RSM? Then write it. Or any correction of the RSM close to the polar vortex? Then provide further details.

Page 7 line 2: "This correction" -> RSM?

Page 7 line 5: "no negative values are expected": if the model is correct!

Page 7 line 9: "... using a linear approach" -> "the NO2 VCDs are scaled by a correction factor linear in T in order to correct for the temperature dependency of the NO2 cross section, as suggested in Boersma..."

Page 12 line 24: avoid "believe"; you have provided several arguments for this conclusion.

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