We would like to thank the reviewer for their helpful and insightful comments. We have responded to the referees' general reservations about the operationalization of this technique by adding a new section which expresses the requirements to do this. In reply to the specific concerns:

It is rather evident that DOAS retrievals of tropospheric gases can be performed using earthshine radiances as a reference. Such an approach has been successfully used in many instances in the past, e.g. already with the ERS-2 GOME instrument more than 10 years ago. So there is no real innovation on this particular aspect. The results presented here just confirm what could already be logically inferred.

While we agree that this approach has been previously validated through retrievals of trace gases such as HCHO (De Smedt et al, 2008) and IO (Schönhardt et al, 2008), we assert that this work is novel, as the aforementioned gases are only prevalent in the troposphere, so the stratospheric field did not need to be accounted for in the reference sector. In the case of NO_2 the stratospheric component needs to be removed to obtain the tropospheric column, which to our knowledge has not been attempted using this method until now. Though residual biases remain because the Pacific reference does not account for zonal variation, we believe that this work has merit because of the strong spatial similarity between the ESrs-DOAS tropospheric SCDs and those retrieved by the operational retrievals.

Though the results of this work could have been inferred from first principles we believe that this work is a useful practical example indicating the advantages and issues in retrieving tropospheric NO_2. Of particular importance are the significant improvement retrieval precision, striping, and resilience to instrument degradation with this technique which has not been previously quantified until this work.

The issue of the inaccurate stratospheric NO2 correction in case of zonally inhomogeneous stratospheric NO2 fields is not really solved (the proposed approach is certainly not applicable operationally).

We agree and have concluded in the paper that zonal inhomogeneity in the stratospheric NO_2 is a significant source of error in this retrieval, particularly at high latitudes. It may be necessary to add an a priori or empirical correction based on models or local ground-based measurements to the SCDs to account for this. This discussion has been added to the new limitations section in the paper.

How to cope with cloud detection (cloud fractions and cloud top heights are necessary inputs for the trace gas retrievals)

This paper solely deals with the detection of tropospheric NO_2, so we believe this is beyond the scope of this work. However, we agree that the detection of clouds is of critical importance to measuring tropospheric trace gases. Typically, the O_2-O_2 SCD used to infer the cloud fraction and pressure (Acarreta et al, 2004) is derived from the logarithm of the surface reflectance (i.e. I/I_0). The reference spectra used in this work were specifically chosen from relatively cloud-free pixels, so it could be argued that the impact this retrieval would be small. Alternatively, instruments making use of the ESrs-DOAS algorithm may need to be supported by a dedicated cloud imager either aboard the same platform or following in convoy.

…how to estimate surface albedos?

Though the derivation of surface albedo is beyond the scope of this work, we recognise the increased difficulty in retrieving this parameter using the ESrs-DOAS algorithm. Surface reflectance retrievals from hyperspectral imagers (e.g. Kleipool et al, 2008) require a top of atmosphere reflectance, which in turn necessitates a solar reference spectrum. The Pacific reference spectrum used in this work would add a considerable bias to the derived reflectance, and so would be unsuitable for this retrieval. As a result, a satellite instrument optimised for measuring tropospheric NO_2 using the ESrs-DOAS retrieval would need to use surface albedos measured either from an additional instrument on the same platform or convoy, or from an existing dataset such as ESA ADAM database (Muller et al, 2013).

Also, with such a design, products such as ozone profiles or aerosol absorbing indices cannot be retrieved at all

Because of the restrictions posed by the earthshine reference the ESrs-DOAS algorithm could only be used for the retrieval of tropospheric columns of trace gases. We agree with this conclusion, though it is beyond the scope of this paper.

The introduction lacks references

The introductory sections contain over 20 citations. We are unaware of any statement in the introduction that has not been adequately supported with a citation. We would welcome any clarification on this matter, and would be grateful for references that we may have overlooked.

Pg. 6703, l.3: it is mentioned that the DOAS fit uses non-linear least-squares, however eq. (1) is fully linear in all parameters. Clarify what is non-linear here.

DOAS retrievals often require nonlinear terms involving wavelength shifts and squeezes to account for errors in spectral calibration (Platt and Stutz, 2008). We have amended the paper to reflect this.

Pg. 6705, l. 5: the explanation given here for the Ring correction is incorrect. This approach does not take atmospheric absorption into account, it only corrects for the impact of RRS on solar fraunhofer lines

We have corrected this section to clarify this statement.

Pg. 6706, l. 5: why describing the BEHR approach here, since it is of no use later on in the paper?

The intent of Section 1.2 was to discuss the established retrieval algorithms using OMI spectra to retrieve tropospheric NO_2, and to show that they all used the SCDs fitted using eqn 2, in order to emphasise the fact that our retrieval was focusing on a new version of the DOAS fit, rather than improved filtering or AMF computation. We concede that this subsection distracts from the overall message of the paper, and have removed it.

Pg. 6707, l. 5: why would the 405-465nm fitting interval minimize absorption by H2O and the Ring effect? In comparison to other traditionally used intervals (e.g. 425-450 nm) there is no gain on these points. The main motivation to extend the fitting interval (as stated in Boersma) is to reduce the noise on NO2 SCDs.

We have corrected the paper to reflect this.

Section 2.1: this section is in my view useless. It is obvious that on synthetic data, a perfect agreement will be obtained.

As a tropospheric NO_2 retrieval has previously not been attempted with this technique, the intention of this section was to give a first-order demonstration to show that such retrievals were possible given the limitations of the DOAS fit.

Section 2.2: the wavelength calibration scheme does not seem to be optimal. From what I can read, it is assumed that the wavelength calibrations (from L1) of the solar irradiance and earthshine radiance are fully correct, except for a potential (simple) shift of the radiance corrected before the DOAS procedure by alignment against the reference solar atlas. There does not seem to be an optimization within the DOAS procedure of the relative shift and stretch between solar irradiance and earthshine radiance. How is the Doppler shift corrected?

The simple shift we employed is the same as the one used in the OMNO2A DOAS retrieval. The use of this shift was to achieve parity with the operational product. We understand that the instrument calibration procedure adequately corrects for nonlinear spectral distortion, such that squeezing of the spectra in the fit is not required. Other shifts are likely accounted for through the interpolation procedure (eqn 5). Doppler shifting in the spectra is already corrected for in the L1B dataset as part of the spectral calibration process (Voors et al, 2006), so no further correction is required for this either.

Pg. 6710, l. 15: the SCD bias of 1.0x1015 molec/cm2 in the OMNO2A data product has been recently identified has being due (mostly) to a wavelength calibration problem in the KNMI operational algorithm (van Geffen et al., recently submitted to AMT).

We are grateful for being notified of this forthcoming publication. Future iterations of this work will use this revised dataset.

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