

Interactive comment on “An improved retrieval of tropospheric NO₂ from space over polluted regions using an earthshine reference” by J. S. Anand et al.

Anonymous Referee #1

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The authors present a novel DOAS-based algorithm for the retrieval of tropospheric NO₂ columns from nadir-viewing satellite observations. In this ESrs-DOAS method (EarthShine reference sector DOAS), spectra averaged from measurements over unpolluted regions are used as reference instead of a solar reference spectrum. A good consistency is obtained with other retrieval algorithms and the retrieval uncertainty is found to be reduced. ESrs-DOAS would potentially avoid the need of a solar reference, which could simplify the design of future missions.

This study fits well with the scope of AMT and the manuscript is well written and clearly structured. I recommend publishing the manuscript in AMT after addressing the follow-

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ing comments:

General comment:

The authors claim that the ESrs-DOAS method could simplify the design of future satellite missions. However, it is not clear to me whether ESrs-DOAS could be implemented in an operational algorithm (which is the case of the retrievals based on a solar reference spectrum) or is only suitable for specific studies over limited areas/regions and periods of time. The major drawback of the presented method comes from the difficulty in the selection of an appropriate reference sector: can this selection be done in an automated way based on pre-defined criteria for the location of the reference sector(s) and the level of NO₂ the latter can contain (e.g. how to automatically reject reference sectors contaminated by pollution transport events ?) ? Another point is the time difference between measurements in the reference sector and in other regions: should a reference sector be defined on daily, weekly, monthly or yearly basis ? In the case of monthly or yearly selection, what is the impacts of the stratospheric NO₂ seasonality and possible instrumental degradation on the retrieved tropospheric NO₂ columns ? How to deal with cloudy scenes ? To my opinion, these points need to be addressed more carefully in the manuscript, maybe in the form of table with recommendations for the different steps of the ESrs-DOAS retrieval. This could be very useful for people interested in implementing this method but also for the potential design of an operational ESrs-DOAS algorithm.

Specific comment:

1/Page 6701, line 4: I would use Crutzen (1979) instead of Wayne (1991).

Technical corrections:

1/Please define SCD on page 6702, line 15 instead of line 24.

2/The publication year of Platt and Stutz is 2008 and not 2006.

References:

C2319

Crutzen, P. J.: The role of NO and NO₂ in the chemistry of the troposphere and stratosphere, *Annu. Rev. Earth Planet. Sci.*, 7, 443–472, 1979.

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