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Atmospheric Measurement Techniques Discussions

Interactive comment on "Discrete-wavelength DOAS NO_2 slant column retrievals from OMI and TROPOMI" *by* Cristina Ruiz Villena et al.

Anonymous Referee #1

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The manuscript "Discrete-wavelength DOAS NO2 slant column retrievals from OMI and TROPOMI" describes a NO2 retrieval algorithm based on the DOAS method with discrete spectral channels. The idea of discrete channels has been applied for ozone retrieval, and its potential for NO2 retrieval is shown in this manuscript, addressing the advantage of simpler instrumental design. The retrieval is implemented for OMI and TROPOMI data with good agreement with respect to reference products (5% difference for OMI and 11% difference for TROPOMI). Critical issues like the selection of discrete channels, uncertainties, and limitations are discussed. The topic of the manuscript is within the scope of AMT.

My major concern with this manuscript is the verification or validation. In principal the overall quality of a retrieval needs to be evaluated by comparisons with independent

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satellite retrievals or by comparisons with correlative ground-based measurements (e.g., direct sun measurements from Pandora). Since the authors have shown only specific days as examples for comparisons with reference datasets, the retrieval quality can hardly be analyzed without a longer timeseries reprocess of OMI and TROPOMI slant column data and additional comparisons, which are particularly important for discrete-wavelength DOAS (with no wavelength calibration). Therefore I recommend that the authors include more verification or validation results to check for possible systematic bias or temporal drift of differences.

Another general request is that please follow the standard use of mathematics notation in the literature. For instance, an upright bold symbol needs to be used in the equation and text to make it clear where vectors and matrices are discussed, and also a matrix is usually written enclosed in square brackets.

The absolute differences are plotted in the appendix, but the analysis in the manuscript only focuses on the relative differences. For instance, “the largest differences around the equator” is actually only valid for the relative difference figure 5 (due to the small absolute values). Please add more discussions of the absolute differences.

Specific comments

P2 L21 Generally the observation is separated into in situ measurements and remote sensing measurements, and the remote sensing technique can be further separated into space-based and ground-based category.

P4 L3 What has been decreased by 0.5%? Do you mean 0.5% of the degradation?

P4 L19 Please give the full name of SNR.

P7 L5 x shall be a column vector.

P8 Table 1. Should the fitting window for DW-DOAS be 425-450 nm (425-450 nm appears also in Table 2)?

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P9 L26 Why are the negative biases related to the differences in the fitting window? Theoretically the differences in the fitting window shall affect only the scatter of the NO2 columns (i.e. noise) but not the fitted value of NO2 column.

P10 L17 What is the reason of more outliers for lower cloud radiance fractions for OMI and the opposite for TROPOMI? Also what is the impact of cloud height on these plots? Generally the retrieved column should depend strongly on the bulk height of clouds. High clouds mask the signal from surface NO2 while for low clouds the satellite observations remain sensitive to the NO2 in the free troposphere.

P12 L14 The spatial patterns might be related to the intensity offset correction. The intensity offset correction included in the TROPOMI reference algorithm compensates spectral structures of liquid water, vibrational Raman scattering on H2O molecules, and possible instrumental issue, leading to a difference over the cloud-free tropical ocean. Please refer to the QA4ECV report for more discussion. In addition, the pattern can also be seen a bit from the OMI absolute difference plot, but it is overwhelmed in the relative difference plot. Therefore more analysis about the absolute results has been required (see the major comments).

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