Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2019-265-RC2, 2019

Atmospheric Measurement Techniques Discussions

Interactive comment on "An improved air mass factor calculation for NO_2 measurements from GOME-2" *by* Song Liu et al.

Anonymous Referee #1

Received and published: 23 September 2019

Summary

The authors propose an alternate approach to NO2 retrievals from GOME-2 based on improved, more physically realistic AMF calculations. The reference method assumes clouds are uniform, opaque reflecting boundaries (CRB), assumes climatological isotropic surface reflectivities, and uses a priori NO2 model profiles from TM5. In the new approach, clouds are treated as semi-transparent layers (CAL), the surface reflectivity over land or water has a directional dependence and the model NO2 profiles have been updated. Assumptions regarding aerosols are also explored using MAXDOAS aerosol profiles.

Previous investigations have individually examined some of these model parameters. However this study brings them together to show their combined effects and the net

improvement in the GOME-2 NO2 retrieval. The interdependence of aerosol and cloud-model assumptions is particularly interesting and well-described.

The authors methodically show how the different approaches influence retrieved NO2 and show improvement in correlations with validation data. If the new AMF algorithm can be easily implemented, it represents a very valuable advancement in NO2 retrievals from GOME-2 and potentially other satellite instruments. The paper is extremely well written and organized. I recommend publication after a few minor revisions.

General comments

(1) Please add a short paragraph with general information about the GOME-2 instrument (e.g. launch date, FOV, spectral resolution, etc). Aspects of the AMF modifications have been tested with other satellite instruments, so some context would be useful.

(2) The validations described are very limited, and the GOME-2 footprint is large (40 x 80 km2). It is hard to draw conclusions based on measurements from a single ground-based instrument at a single station, despite the large number of days of data used. The authors allude to the resolution issue by referencing Pinardi et al. (2015), but please add more details about the implications of such limitations. If any additional independent ground-based measurements are available, I strongly recommend including them in the paper.

Specific and minor comments

(1) Page 2, Lines 5 – 8: ". . .on long time scales. New-generation instruments like the TROPOspheric Monitoring Instrument (TROPOMI) (Veefkind et al., 2012) aboard the Sentinel-5 Precursor satellite and geostationary missions like the Sentinel-4 (Ingmann et al., 2012) will continue this record and deliver NO2 datasets with high spatial resolution and short revisit time."

(2) Page 2, Line 26: "...geometry in the NO2 retrieval (e.g. Boersma..."

(3) Page 2, Line 35: I suggest adding Krotkov et al., 2018 to these citations.

(4) Page 3, Line 8: "...developed and is running operationally..."

(5) Page 3, Line 18: I suggest adding Martin et al., 2002 to these citations regarding cloud influences on the NO2 retrieval:

Martin, R. V., Chance, K., Jacob, D. J., Kurosu, T. P., Spurr, R. J. D., Bucsela, E., Gleason, J., Palmer, P. I., Bey, I., Fiore, A. M., Li, Q., Yantosca, R. M., & Koelmeijer, R. B. A.: An improved retrieval of tropospheric nitrogen dioxide from GOME, J. Geophys. Res., 107(D20), ACH9010ACH9-21, 4437, doi:10.1029/2001JD001027, 2016.

(6) Page 5, Line 3: I suggest Bucsela et al., 2013 as an additional reference on the temperature dependency of the NO2 cross section.:

Bucsela, E. J., Krotkov, N. A., Celarier, E. A., Lamsal, L. N., Swartz, W. H., Bhartia, P. K., Boersma, K. F., Veefkind, J. P., Gleason, J. F., & Pickering, K. E.: A new stratospheric and tropospheric NO2 retrieval algorithm for nadir-viewing satellite instruments: applications to OMI, Atmos. Meas. Tech.,6, 2607-2626, doi:10.5194/amtd-6-2607-2013, 2013.

(7) Page 5, Line 11: "...cloud-free scenes found with a statistical method..."

(8) Page 6, Line 11: "...from OCRA as inputs."

(9) Page 7, Line 30: "...east of the orbit swath. This effect is larger over snow and ice, due to the forward scattering..."

(10) Page 8, Figure 1: Perhaps the labels over the figures could be written more clearly to show that the first two maps are monthly climatologies, while the others are date-specific.

(11) Page 10, Line 6: "...derives the surface reflectivity for the direct (sun) and diffuse

(sky) incident radiation separately...".

(12) Page 14, Lines 13: "The NO2 data is available on an hourly basis, with profiles at the satellite measurement time obtained by linear interpolation."

(13) Page 15, Lines 8 – 10: "Differences in AMFs are on the order of 0.2 for the Netherlands and 0.02 for China, due to difference in horizontal and vertical resolutions."

(14) Page 19, Lines 6 – 7: "...from an LUT with fixed reference points. This requires no projection from..."

(15) Page 20, Line 11: "...AMF calculation is likely reduced relative to the reference retrieval..."

(16) Page 28, Lines 33 – 34: You may also include Lamsal et al. (2014) in the list of satellite validation studies:

Lamsal, L. N., Krotkov, N. A., Celarier, E. A., Swartz, W. H., Pickering, K. E., Bucsela, E. J., Gleason, J. F., Martin, R. V., Philip, S., Irie, H., Cede, A., Herman, J.,Weinheimer, A., Szykman, J. J., and Knepp, T. N.: Evaluation of OMI operational standard NO2 column retrievals using in situ and surface-based NO2 observations, Atmos. Chem. Phys., 14, 11587–11609, doi:10.5194/acp-14-11587-2014, 2014.

(17) Page 29, Figure 20 and 21 captions: Please explicitly define SAT and GB and state that the light and dark data points in Figure 21 represent daily and monthly-mean differences.

(18) Page 30, Tables 4 and 5: For the uncertainties in MD, please use the standard error of the mean (although you may additionally give the standard deviation).

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-265, 2019.