

Response to the editor.

We thank the editor for the evaluation of our paper and useful comments that helped improve the manuscript. We appreciate editor's time and effort in reviewing the manuscript. Below are responses to each comment. All editor's comments are in the standard font while the responses are in the italic font.

We also added the following reference to a recently published paper in Line 84 of Introduction: Lamsal, L. N., Krotkov, N. A., Vasilkov, A., Marchenko, S., Qin, W., Yang, E.-S., Fasnacht, Z., Joiner, J., Choi, S., Haffner, D., Swartz, W. H., Fisher, B., and Bucsela, E.: Ozone Monitoring Instrument (OMI) Aura nitrogen dioxide standard product version 4.0 with improved surface and cloud treatments, *Atmos. Meas. Tech.*, 14, 455–479, <https://doi.org/10.5194/amt-14-455-2021>, 2021.

On behalf of the authors, Alexander Vasilkov

The main weakness of this paper is the limited data base presented and absence of any validation, which makes it difficult to judge on the suitability/added-value of the proposed approach. Also the approach is not innovative per se (similar approaches have already been published) but it includes new elements with a high potential for larger scale application (if the performance issue is solved). Despite these elements, I appreciate the completeness of the responses to the reviewers and the efforts done to improve the manuscript. Also the justification given for a 2-step publication strategy seems acceptable to me. So I support publication after attention to the few minor comments below:

Thank you for supporting publication of our manuscript. We agree that the approach is similar to that has already used in a few publications. However, there are two significant new elements which allows for a global rather than regional methodology. First, we are using a global assimilated aerosol product constrained by MODIS AOD observations. Second, we developed a new treatment of surface BRDF for the ocean that allows a global processing of satellite instrument data.

pg. 3, l. 87: although validation goes beyond the scope of the paper, please indicate in which way you would proceed to validate the proposed aerosol correction

We extended the future work paragraph (Lines 420-430) by replacing it with the following text:

“We also plan to analyze global NO₂ retrievals with implicit (standard OMI NO₂ product) and explicit aerosol corrections and assess the impact by comparing with independent NO₂ observations. We plan to carry out comprehensive comparisons of our retrievals with ground- and aircraft-based NO₂ observations during field campaigns such as DISCOVER-AQ and KORUS-AQ as well as with ground-based Pandora and MAX-DOAS NO₂ observations over various times and locations. The NO₂ retrievals will be performed using the measured NO₂ profiles, if available, or high-resolution regional NO₂ simulations with implicit and explicit

aerosol corrections. A reduction of the biases due to the implicit aerosol correction would prove the validity the approach.”

pg. 12, l. 306: note that the OMI LER does not provide the minimum LER but the 'most probable' LER, which is meant to implicitly account for the effect of persisting aerosol layers. The observed difference is therefore in a way expected.

We agree and rewrote the corresponding sentence as follows:

“It is seen from Fig. 6 that values of GLER are noticeably lower than climatological LER values because the latter represent the most probable values of LER, which implicitly account for persisting aerosol layers.”

pg. 16, l. 63: contrary to what is written (and based on Fig.10), I understand that the aerosol correction decreases the retrieved ECF

Thank you very much. You are right. We correctly stated in Conclusions that “... our explicit aerosol correction over polluted areas (1) decreases the retrieved ECF by 0.015 on average;” but mistakenly wrote “increases” in this Line. We corrected this.

Typos:

pg. 3, l. 77: replace 'On the other hand...' by 'As an alternative...'
Done.

pg. 11, l. 89: there are 'in' total 114 OMI pixels...
Added.

pg. 13, 315: ...this value is much lower 'than' the reported average...
Corrected.

pg. 16, l. 371: ... is true 'for' all cloud pressure algorithms...
Added.

pg. 16, l. 373: ... can be considered as 'an estimate' of the OCP retrieval bias...
Corrected.