

***Interactive comment on* “Evaluation of OMI operational standard NO₂ column retrievals using in situ and surface-based NO₂ observations” by L. N. Lamsal et al.**

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We would like to thank the reviewer 3 for his/her helpful comments that are helpful to improve this manuscript. Below in *italics* please, find our replies to the reviewer's comments.

General comments:

This manuscript evaluates the OMI NO₂ Standard Product using a variety of data sources, including aircraft, MAX-DOAS, and in-situ measurements and an emissions inventory, allowing a detailed evaluation of several of the factors that govern the uncer-

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tainties in the retrieval algorithm. They generally find good agreement between OMI observations and measurements and find that day-to-day variability in NO₂ profiles largely influences the retrieved daily columns. Overall, I believe it is a strong and well written paper that provides interesting new insights into the factors governing retrieval validation and accuracy, and feel that the manuscript is suitable for publication in ACP after the following minor comments are addressed.

Specific comments:

While the use of different types of datasets (aircraft, in-situ, etc) for validation is clear, it is unclear how the data were chosen. It seems the authors intended to cover a variety of geographical regions and capture seasonal variation but I suggest further discussion of these choices and clearly stating throughout the document and perhaps also in the title that the conclusions were drawn from several specific regions and may not be representative elsewhere or under certain conditions given the limited spatial and temporal coverage.

We agree with the reviewer that the validation study is still limited in scope due to scarce and sporadic NO₂ measurements. We have acknowledged this in the revised manuscript. For example, we have added “Since validation data sets are scarce and are limited in space and time, validation of the global product is still limited in scope by spatial and temporal coverage and retrieval conditions” in abstract, and “The spatial and temporal coverage of the comparisons we have examined in this paper are limited; they may not be representative of other locations and seasons” in the conclusion section.

It may be worth mentioning the updates to the standard product in Section 2.1 and elsewhere when comparing results to previous studies that used earlier versions of the standard product.

We added a paragraph as follows: “The OMNO2 retrievals used here, version 2.1 (Bucsela et al., 2013), represent a significant advance over previous version 1.0 (Bucsela

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et al., 2006; Celarier et al., 2008). The main changes include the use of monthly, rather than annual, mean a priori NO₂ profiles, and improvements in the estimates of stratospheric NO₂ columns, correction of calibration artifacts (de-stripping), and the calculation of scattering weights”.

Please clarify whether all OMI cross-track pixels were used for comparisons.

We use data from all cross-track positions. This information is included in Section 2.1.

Page 14531 Line 17-18: Please explain what is meant by “Day-to-day variations in aircraft NO₂ shape factors are up to a factor of two”.

The statement is modified as follows: “These measurements also reveal considerable day-to-day variation in NO₂ profile shapes within a given month, suggesting that the use of a monthly mean profile in the operational algorithm is potentially a significant source of error in individual retrieved tropospheric NO₂ columns”.

Page 14532 Line 10-14: The author suggests that “inaccurate removal of stratospheric NO₂ on July 2” may have contributed to the discrepancy between measurements but earlier provide an uncertainty of only 2E14 molecules/cm² for the stratospheric subtraction step of the retrieval. I suggest omitting the reference to the stratospheric subtraction here.

We deleted the statement on uncertainty in stratosphere-troposphere separation.

Page 14543 Line 3-6 and Page 14545 Line 18-20: The author’s discuss the importance of surface reflectivity and its potential influence on retrieved NO₂ columns. I suggest mentioning results from previous studies that have attempted to reduce AMF uncertainties related to surface reflectivity.

We have added the statement: “Some previous retrieval studies have used high-resolution MODIS albedo data in an attempt to reduce uncertainty in tropospheric AMF [Russell et al., 2011, Zhou et al., 2010]”.

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Technical corrections:

Page 14523 Line 19-20: Is there a typo in “This study takes advantage of state-of-the-art NO₂ measurement technique: : :”?

Done.

Page 14548 Line 23: Typo, should be SCIAMACHY

Thanks. Corrected.

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 14519, 2014.

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