

Supplement to:

Improving algorithms and uncertainty estimates for satellite NO₂ retrievals: Results from the Quality Assurance for Essential Climate Variables (QA4ECV) project

1. GCOS guidelines for generation of NO₂ ECV datasets

The guidelines established in GCOS report 138 [GCOS, 2010] are paraphrased below in Table S1, together with the response by the QA4ECV NO₂ consortium.

Table S1. Summary documenting point-by-point the extent to which GCOS guidelines for the generation of an ECV dataset [GCOS, 2010] has been followed, here for NO₂.

	GCOS guideline	Addressed how?
1.	Full description of all steps taken in the generation of the QA4ECV NO ₂ product, including algorithms used, and characteristics and outcomes of validation activities.	This paper, QA4ECV D4.2 (Muller et al. [2016]), QA4ECV D4.5 (Muller et al. [2018]), QA4ECV D6.1 (Compernelle et al. [2018]).
2.	Application of appropriate calibration/validation activities.	This paper, QA4ECV D4.2 (Muller et al. [2016]), QA4ECV D5.6 (Compernelle et al. [2017])
3.	Statement of expected accuracy, stability and resolution (time, space) of the product, including, where possible, a comparison with the GCOS requirements.	This paper (section 6, Section 2.3) QA4ECV D5.5 (Boersma et al. [2017])
4.	Assessment of long-term stability and homogeneity of the product.	QA4ECV D6.3 (Boersma et al. [2018]), Zara et al. [2018]
5.	Information on the scientific review process related to	This paper (section 4), QA4ECV D4.2 (Muller et al. [2016]), Lorente et al. [2017], Zara et al. [2018]

	FCDR/product construction (including algorithm selection), FCDR/product quality and applications	
6.	Global coverage of products where possible	Global coverage is achieved in 1 or more days, depending on the sensor. See daily QA4ECV NO ₂ maps on www.qa4ecv.eu/ecv/no2-pre/data .
7.	Version management of products, particularly in connection with improved algorithms and reprocessing.	Thusfar a QA4ECV NO ₂ ECV algorithm v1.0 and v1.1 have been developed. The former contained a bug in the stratospheric correction, and was superseded with v1.1, which constituted the final product. v1.1 is publicly available from www.qa4ecv.eu/ecv/no2-pre/data , and via digital object identifiers.
8.	Arrangements for access to the products and all documentation.	QA4ECV NO ₂ ECV data are freely available via the project website (www.qa4ecv.eu/ecv/no2-pre/data), and relevant documentation including a Product Specification Document and the DOI's is provided along with the data.
9.	Timeliness of data release to the user community to enable monitoring activities.	Data for July 1995 – November 2017 has been released.
10.	Facility for user feedback	The QA4ECV website contains a so-called 'NO ₂ ECV Forum' (http://www.qa4ecv.eu/forum/267), where users can ask questions and provide feedback.
11.	Application of a quantitative maturity index if possible	A maturity matrix analysis has been carried out twice for the QA4ECV OMI NO ₂ products, once via self-assessment in the QA4ECV Quality Assurance Report (http://ec2-52-56-155-184.eu-west-2.compute.amazonaws.com/#/summary-reports?id=04335219574c), and once by EUMETSAT in QA4ECV D6.1 (Compernelle et al. [2018]).
12.	Publication of a summary (a webpage or a peer-reviewed article) documenting point-	This table.

	by-point the extent to which this guideline has been followed.	
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2. Mapping QA4ECV OMI NO₂ columns to the MAX-DOAS location of Tai'an

In our validation of OMI QA4ECV NO₂ columns with independent MAX-DOAS data, we account for the location of the pixel relative to Tai'an. Figure S1 below shows the average (June 2006) OMI NO₂ columns as a function of distance to Tai'an. The figure shows that, on average, OMI pixels within 20 km of Tai'an are within the $5-7 \times 10^{15}$ molec. cm⁻² range, i.e. within 1×10^{15} molec. cm⁻² of the June 2006 average value at Tai'an. This shows that the correction factor in Eq. (6), the ratio of the climatological column at Tai'an to the climatological column at the location of the individual OMI pixel, is always in the range 0.85-1.15.

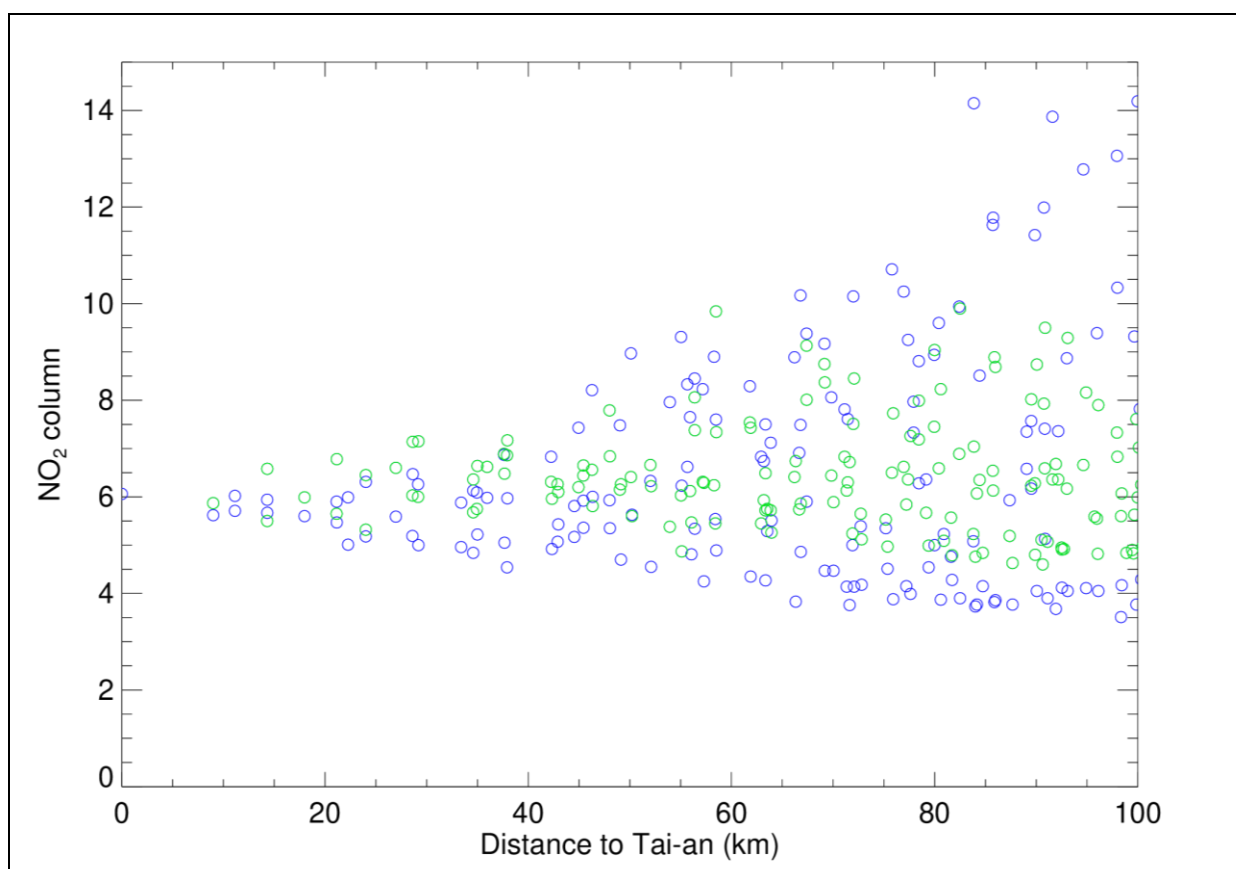


Figure S1. Campaign-mean QA4ECV OMI tropospheric NO₂ columns (May-June 2006, in 10^{15} molec.cm⁻²) as a function of distance to Tai'an. Blue circles indicate values of cells east of Tai'an (Figure 13), green circles west of Tai'an. The value for a distance of 0 km, is the campaign-mean (OMI) tropospheric NO₂ column over Tai'an itself (6.06×10^{15} molec.cm⁻²).

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