

## ***Interactive comment on “Investigating differences in DOAS retrieval codes using MAD-CAT campaign data” by Enno Peters et al.***

### **Anonymous Referee #2**

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#### General Evaluation:

The paper by Peters et al. investigates differences in NO<sub>2</sub> DOAS retrieval due to differences in different DOAS retrieval codes. A same set of MAX-DOAS observations and DOAS retrieval settings were provided to various groups using different DOAS retrieval codes to retrieve NO<sub>2</sub> differential slant column densities (dSCD). Resulting NO<sub>2</sub> dSCD and RMS were then compared and a range of possible sources for their differences were investigated. In the end, the authors provide a list of 5 recommendations aimed at improving the NO<sub>2</sub> DOAS retrievals. These recommendations are fairly straight forward and largely constitute best practices that are already followed to improve DOAS retrievals. Overall, the paper is very nicely written but way too long. I suggest the authors make changes to shorten the length of the paper.

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#### Recommendation:

The paper fits the scope of AMT journal as it documents differences in DOAS retrieval codes and hence the paper is acceptable for publication in AMT with modifications to (i) make the differences between the codes more explicit and (ii) shorten the manuscript.

#### Specific Comments:

There are two parts to the paper and they could very easily be two separate papers. The first part focuses on the intercomparison of NO<sub>2</sub> from different retrieval codes. While in the surface it seems like a nice and interesting idea to compare different DOAS retrieval codes, it becomes very clear after section 3.1 (Part 1) that differences due to retrieval codes are very small compared to differences due to instrumental design (see Roscoe et al, 2010). The second part investigates the potential sources of these differences. However it appears like a sensitivity study to determine best features to have in a retrieval code. The authors performed the sensitivity tests first, and then compared the results from the sensitivity tests to the results from various groups. Based on the results the authors went back to the groups to verify their findings. There is disconnect between section 3 and 4 as there is lack of basis for the tests being performed. I suggest the authors include an overview table (using the survey data) which highlights the differences between different retrieval codes to connect section 3 and 4. This table could replace most of the text describing the retrieval codes.

The amount of details for different retrieval codes are not comparable. Some codes are described in details while others (e.g. IUPHD) barely include a sentence.

The authors make 5 recommendations to improve fit quality and harmonization between MAX-DOAS retrievals. Is there one/many DOAS retrieval code which already have these features? If so please include this/these codes as the current state of the art. This would be especially useful for new users.

Why does the reference after the scan (T6 settings) results in larger differences? Is it

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simply due to the time difference between 2 degree EA and reference spectra? What is the time difference between the two spectra? Also do you see similar behavior between references taken before the scan and spectra further away? For example between refA and spectra EAnA, or refA and spectra EA2B in the following scan sequence (refA, EA2A, . . . , EAnA, refB, EA2B, . . . , EAnB, refC, . . .).

There is no specific need to include all the QDOAS results in the paper. I suggest the authors consolidate the QDOAS results. This could be done by either presenting select QDOAS results or grouping all QDOAS results together for clarity (e.g. similar symbol in figure 3 or one side of the plot in figure 4). It would help compare and contrast the results between QDOAS and other codes.

Line 790: "differences of up to 8% have to be expected" – Does this also hold true for other elevation angles where dSCDs are smaller? To some extent quoting 8% as expected uncertainty is somewhat misleading knowing that the particular spectrum was affected by direct sunlight and such a scenario is not common in MAX-DOAS measurements. I suggest the authors make this distinction clear in the manuscript in order to avoid misuse of 8% as inherent uncertainty in DOAS retrievals.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-358, 2016.