

Review: The tilt-effect in DOAS observations

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General comments

The manuscript *The tilt-effect in DOAS observations* concerns with the effect of the non-commutativity of atmospheric absorption and convolution. The authors could show that this effect, labeled “tilt-effect”, manifests itself as wavelength shift which was, up to now, solely attributed to instrumental shifts. This manuscript hence offers new insights in understanding and interpreting this error source when doing DOAS like data analysis. This well structured and fluently written manuscript is ideally suitable to be published in the journal *Atmospheric Measurement Techniques*. Only a few comments and minor suggestions need to be addressed before publication.

Specific comments

- P2, L27**
2.5e-3 peak-to-peak residual structure. Where is this coming from? Is it related to section 5.2?
- P4, Figure 1**
Figure 1 in the manuscript has the goal to illustrate the tilt-effect. The good concept behind the figure is, however, not straight forward catchable (lines, colors, label size are not chosen adequately). I attached a re-design sketch, which could serve as a motivation.
- P9, L8**
It would be clearer for the reader to mention at this point that the visualized instrumental spectral shift is rectified from the tilt effect already.
- P10, L8**
... the shift due to the tilt-effect (up to 2 pm)... Where is the 2 pm coming from? How relates this number to the estimation of $\approx 1\text{pm}$ based on equation (13), mentioned in P7, L7?
- P11, Table 2**
From section 5.2 the difference between case 4 and 6 becomes clear, but not before. The reader would benefit from a more explicit description of the cases in the table and the caption.
- P11, L8**

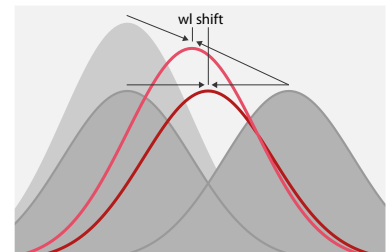


Figure 1: Redesign proposal for Figure 1, P4.

How is the percentage impact of instrument function width and shift weighting estimated?

7. **P12, Figure 3 caption**

The reader would benefit from a more detailed description to subfigure 4.

8. **P13, L13**

At which wavelength are the aerosol parameters defined?

9. **P17, L1 to L4**

If I have understood this correctly, the authors want to explain the iterative process to calculate the final tilt-correction spectrum, by first utilizing the tilt-uncorrected DOAS polynomial to get the first tilt-correction spectrum, and so on. I suggest to reformulate this paragraph to make the procedure more clear.

10. **P17, L9 to L19**

The authors state that calculating the correction spectra is in most cases obsolete when shift and squeeze is implemented in the fitting anyway. Also the change in the RMS is discussed for the cases in Table 2. Providing that I have got the correct meaning of Table 2, cases 1, 2 (shift and squeeze applied) yield significantly different dSCD HONO values than cases 4, 5, 6 (with tilt-correction spectrum applied). Based on this the method used to correct for the tilt-effect (shift, squeeze or correction spectrum) seems to be rather important considering trace gas dSCD (usually the primary retrieval product). What is the authors comment about that?

11. **P18, section "The impact of the "tilt-effect" on the spectral retrieval of trace-gases"**

This relates to comment 10. In my opinion the impact on the retrieved trace-gas amount is the most important aspect. Thus I think the manuscript would benefit if this section would be outlined with a little bit more detail, especially the way how the impact of the tilt-effect on trace gas retrievals is quantified.

12. **P19, section "Conclusions"**

It would further round up the conclusions section if the authors conclusion about the impact of the tilt-effect on the accuracy of dSCD of trace gases would be added.

Technical corrections

1. **P3, L23**

... around each of the lines (dashed, cyan and red) ... (possibly obsolete, see comment 2. in former section)

2. **P8, Figure 2**
When I am not mistaken, the bottom figure is never mentioned (or referred to) in the text explicitly. I suggest rectify this or to remove the bottom figure.
3. **P9, L10**
Instrument slit function “H” should be lowercase “h” as introduced earlier in the text.
4. **P9, L20**
Table 1 is not mentioned yet in the text. This could be a place to do this.
5. **P9, L29**
Eq (17), LaTeX typesetting issue
6. **P11, Table 2 caption**
Last sentence: squeeze definition
7. **P17, L27**
To these Gaussian instrument functions the derivation ...
8. **P18, L28**
..., can result in a
9. **P19, L2**
... artificial shifts **and** enhanced residuals ...
10. **P19, L24**
... approximated from a given difference ...