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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Detection of water vapour absorption around 363 nm in measured atmospheric absorption spectra and its effect on DOAS evaluations" *by* Johannes Lampel et al.

Anonymous Referee #3

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The paper discusses important new information about water vapour absorption in the UV spectral region and its effects on DOAS retrievals. With this it presents important results which are suitable for publishing in ACP. However, the presentation is at many points confusing and I suggest publication only after major revisions. Due to the lengths of this paper of 40 pages the content is hard to follow and this isn't helped by the fact that section titles don't always fit the content (e.g. section 4.9 is about the accuracy of the wavelengths axis and this should be spelled out in the title; section 1.3 lists science questions and not an outline). Another problem is that the authors clearly have lost track themselves, e.g.: there is no proper introduction about the differences of HITRAN 2009, 2012, HITEMP, or BT2 in the beginning of the manuscript, but there are bits and

pieces of information later on in the text; the lower panels in Figure 1 are not referred to in the text at all; the text refers to a figure 4.2 which I believe is actually Figure 6; on the other hand, there is no reference in the text to the right panel in Figure 4; the spectral resolution of the instruments is stated 3 times in the manuscript, but some important information is only listed in captions, e.g. how the upper limit is calculated for Table 4; there are 2 different symbols used for absorber concentrations in the equations. More details/corrections below. However, I would like to encourage the authors to give this manuscript a thorough read themselves and to restructure some of its content, especially double-checking if the information provided in the figures/tables and their captions is actually used and sufficiently described in the manuscript.

Specific comments:

p.1, l.5, 11, 13: 363 nm or 362.3 nm. I understand that the authors refer to the peak of the absorption and the feature in general. But using two different numbers without further explanation in the abstract is confusing.

p.1, l.8: Add: 'For MAX-DOAS measurements, we observed. . .'

p.1, l.8: 'It correlates. . .' refers to something like 2 months of data. That should be made clear at this point.

p.1, l.10: Add: '. . .line intensities at 362.3 nm are underestimated by. . .'

p1., l.12: 'spectral retrievals'

p.1, l.15: 'It'

Figure 1, top panel: The y-axis on the inset plot seems to have a different extent, especially at the lower end. This makes it appear as if the POKAZATEL has more lines in that inset than in the large plot.

p.3, l.6 and following: Why not refer to Figure 1 at this point already? The intro would read easier if you structured it like this: In Lampel et al. (2015b) you already suspected

additional water vapour lines. But those could not be found in the line list available back then. Describe the available line list until then. Then you introduce the new POKAZATEL list and that this new information will be investigated with additional field measurements. Splitting the intro into subsections actually interrupts the flow of the argument.

p.3, l.16-17: Add that those were lab measurements.

p.3, l.20: 'structures in the spectral range'

p3., l.24: 'individual line cut-off': what is that?

p.3, l.28-29: No new paragraph needed here

p.3, l.34: '(in principle)': Any explanation what this refers to or remove?

p.4, l.15: I would remove 'potential' here

p.4, l.18,21: O4 was already used without being introduced as were the other species.

p.4, l.22: Please add reference for 'unaccounted tropospheric absorber'.

p.4, l.23-26: This statement at this point is difficult to understand for a person not very familiar with MAX-DOAS measurements and the corresponding radiative transfer. Either remove or give more explanation. See also below.

p.5, l.2: formatting: brackets should be within the sentence.

Section 2: Maybe add here that LP-DOAS is active and MAX-DOAS a passive technique

p.5, l.12: remove space after 15.

p.5, l.15: Full stop after 0.45nm.

p.5, l.16: The latitudinal extent has nothing to do with variations of the water vapour mixing ration. Also, Figure 2 is misleading since the satellite in the background is from

a different time than the M91 cruise.

p.5, l.17-19: S.a.

p.5, l.20: 'therefore': s.a. water vapour changes because it changes and not because the measurements are at a different latitude.

p.5, l.22-24: Maybe make that 2-3 sentences. Your point that O4 and H2O absorb in similar region in the UV as well as in the visible doesn't fully come across. You could also refer to Figure 1 here.

p.5, l.3: lambda is not introduced

Figure 2: It's not clear how you get from a slant column ratio to a vertical column of one of the species. Also these results are not discussed in the manuscript.

p.7, l.1: I0(lambda) is introduced a second time

p.7, l.2: OD is not introduced yet

p.7, l.3: why only 'partly'?

Eq (1), (2): please use same symbol for concentration

Eq (1): add a bracket to indicate the summation; the polynomial p(lambda) is a different one than the one introduced in the line 3 above for the measurements and the cross section here should be a 'differential' cross section

p.7, l.9: See above; maybe add somewhere before already that MAX-DOAS measures scattered sunlight and LP-DOAS is an active technique.

p.7, l.12: 'spectral width'

p.7, l.14-15: The sentence about the residual is confusing at this point. Maybe remove?

p.8, l.4-6: The total light path is from the institute to the train station and back to the institute?

p.8, l.6: The spectral resolution is redundant information here. Was mentioned before.

Section 3.1: I suggest swapping the first 2 paragraphs.

p.8, l.11: Not the measurement sequence but the correction with the background spectra ensures the independence.

p.8, l.17: 'high-pass filtered literature cross-sections': aha! That should be mentioned before.

p.8, l.27: s.a., symbol for concentration.

p.8, l.31: A Fraunhofer spectrum always refers to the extra-terrestrial spectrum of the sun (or another star).

Table 2: What is this 'Add. Polynomial degree'?

p.10, l.1: Fraunhofer: s.a. and another time below as well.

p.10, l.2: full stop after bracket

p.10, l.3: Remove the last 'the' of the line

p.10, l.6: ANT XXVIII/1-2 or ANT XXVIII? Please unify in manuscript.

p.10, l.16: spectral resolution is redundant information

p.10, l.20: Why Figure 5 before Figures 3 & 4?

p.10, l.21: 40° telescope angle.

p.10, l.21: 'Spectra recorded at. . .': why not remove the sentence in l.1-2, p.10 then?

p.10, l.25: Are those the dSCD measurement errors? Please clarify. Also state that this disregards possible systematic errors.

p.10, l.26: This section is about the DOAS spectral fitting. So a reference to a 'linear fit' is confusing here. Please add more explanation or move/remove this sentence.

p.11, l.25: OD; s.a.

p.11, l.28-30: Please elaborate or state reference.

p.12, l.3: 'when co-adding spectra from more than'

p.12, l.12: Remove paragraph break.

p.12, l.16: Is the stated time period different from the one in Table 1?

p.12, l.20: Are you really losing 15 min for each hour? Please clarify.

p.12, l.25: The data in Figure 3 does not support this statement. Also, this is the only time Figure 3 is mentioned in the text of the manuscript (besides in the caption for Figure 2, but Figure 2 is barely mentioned either. Those would be candidates for removing in order to shorten the manuscript.).

p.12, l.29: 20% is not low humidity?

p.13, l.2: Maybe remove the uncertainty estimate at this point since it has just been stated in the line above and the actual interesting number is 0.7 and not 0.05.

Figure 4, caption: 2.31? The text states 2.4. The right panel of the figure is not mentioned in the text at all.

p.14, l.1-3: Please rephrase.

p.14, l.10: The figure states R2 = 0.74 for both cases. Please clarify!

Figure 6, caption: There is only 1 error bar and that is attached to the linear fit. Does it refer to the error bars of the measurements though? Please clarify! For the green box in the top right panel, how are the measurement uncertainties combined? The figures say O4 at 476nm and not 477 as in the caption.

p.17, l.5-7: I don't understand this paragraph. Worse in comparison to what? Did you state the number of the combined correlation somewhere? 0.91 is a pretty good correlation.

p.17, l.8-11: This information should already be stated on p.14,l.9-10. Also maybe mention somewhere that this is the reason for the different numbers for n in Table 3.

p.17, l.14: 'see also Table 3'

p.17, l.16: 'latitudinal' s.a.

p.18, l.16: 'includes more measurements': see comment above

p.18, l.31: could not be identified for either of the two line lists or cruises? Please clarify!

Figure 7, caption: add space after DMS

p.19, l.12: 'an RMS'

p.19, l.15: 'than in either the BT2 or the HITEMP'

p.19, l.15-18: This information should have been in the intro .

Figure 8: gridlines would be helpful in this figure.

p.22, l.18: '3° elevation angle'

p.22, l.16: 'polynomials with degrees 0-2 were applied in order to test. . .'

Table 4: Last sentence of the caption seems to be quite important, however, is not explained in the text.

Section 4.9, title: Please add that you investigate the accuracy of the wavelength calibration here

p.23, l.7: why is there an R introduced for the residual spectra? It's not used anywhere else.

p.24, l.5: Within 0.1 cm-1 in comparison to what?

p.25, l.1: Section title is misleading. This section only refers to the visible range.

p.25, l.5: '. . . magnitude of the water vapour. . . blue wavelength range. . .'

p.25, l.5-8: Where does this information come from?

P.25, l.14: formatting issue H2O-dSCD

p.25, l.21-23: Please split sentence

p.25, l.27-29: Please split sentence

p.25, l.30-31: 'No direct correleation. . .' I don't understand this. Please elaborate.

p.26, l.1-3: Maybe use the term water vapour contamination here.

p.27, l.2: formatting issues for references

p.27, l.4: formatting issues for reference

p.27, l.20: section 1.2 does not mention the correction factor

p.27, l.30: formatting issues for reference and brackets

p.28, l.5-8: Why didn't you perform this analysis separately then for cases with and without HONO?

p.29, l.1: 'alternative' to what?

p.29, l.7: remove 'itself'

p.29, l.16: rephrase sentence

p.29, l.22: Maybe join these two sections?

Figure 11, caption: 'different bands listed in Table6'; use unity instead of '1'.

Table 6, caption: 'relative integrated absorption values': relative to what? Please elaborate; The second to last, not last row shows the scaled HITEMP data.

p.31, l.10: Who are 'they'?

Table 7, caption: formatting issues with reference

Appendix: Why are table 7 and 8 in an appendix? Then the text discussing those should also be moved to the appendix.

Table 8: I'm not sure what is done here. What are the 'relative DOAS fit errors'? There is no Window 5 in here.

More general comments:

* The abstract doesn't list anything about the O4 studies or the failed identification of other water vapour lines in the UV

* References to dissertations cannot be accessed if no link is provided.

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