

Interactive comment on “On the relative absorption strengths of water vapour in the blue wavelength range” by J. Lampel et al.

Anonymous Referee #2

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This paper investigates the effect of various water cross-sections on DOAS fitting at blue wavelengths. Cross-sections reflecting revisions to the HITRAN dataset are found to yield significantly improved DOAS fitting using both Long-Path and Multi-Axis instruments. The results further indicate that adjusting the relative strengths of different bands leads to even better agreement. The derived correction factors range from 0.5–1.9 relative to the strongest band, suggesting changes to the cross-sections are large. I recommend the paper for publication, once the following comments are addressed:

Technical questions and major comments:

1) In the introduction, the authors address the fact that the weak water absorption features in the HITRAN and HITEMP databases are often based solely on theory, or

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on a limited number of validations at specific wavelengths. Where experimental data is available, it is sometimes used to scale bands whose shape is specified by theory, or else to adjust band positions. The former is similar to the method used by the authors to scale bands in the paper. While the latter relates to shape effects the paper addresses more obliquely.

A comparison of the scaling factors arrived at in this paper with those used to generate the HITRAN and HITEMP cross-sections should be included. Since both BT2 and HITEMP are being considered and evaluated, the adjustments suggested by this paper should be put in this context.

2) In Figure 1, the absorption spectrum shown is convoluted to an instrument function, however, the line indicating the "single line cutoff in HITEMP" is shown as it would apply to an unconvoluted line. This is potentially misleading. A line showing the maximum peak absorption of an isolated line convoluted to the instrument function would more accurately show which features HITEMP resolves.

3) Some DOAS terms are referred to by redundant abbreviations, e.g. "S" = "SCD", " ΔS " = "dSCD". The former are generally found in equations while the latter dominate in the text. A single standard method of referring to these would increase clarity.

4) When discussing the vibrational Raman effects on the MAX-DOAS retrieval, N₂ and O₂ are mentioned, what of water vapor? Liquid water water is mentioned in section 4.3.1, why not here?

5) Page 5906, lines 18–20. After establishing an upper limit of 30ppt for glyoxal, it's cross-section is removed from the analysis. Is this necessary? What is the effect of retaining the glyoxal cross-section in subsequent fits? Even if the trace gas optical depth is insignificant, it can still exert effects of interference and contribute to the residual.

6) Page 5908, lines 13–25. The discrepancies between BT2 and HITEMP may also stem in part from corrections applied to obtain the latter from the former, see comment

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1. I am confused as to what precisely the authors are saying here. What is the result when using other O4 cross-sections? There is fit instability, but with respect to what parameters? Residuals are large, but are the systematic in a way that suggests differences specifically as regards the water cross-section?

7) The results show that the bands W0, W3, and W5 consistently scale relative to each other by factors not statistically different from 1. These represent bands from 3 different vibrational transitions. In contrast, the results within the 7v and 7v+d bands have significant relative scaling. This could be coincidence, or as the authors state in the discussion (Page 5913, lines 16-20) it could reflect the challenges of modeling intensities for these lines in models. Specifically it could indicate that the relative transition probability of different vibrational modes is not properly captured. The authors note in particular that transitions involving the bending mode are especially troublesome.

Meanwhile, discussion of the individual bands indicates that band-shape in particular has improved with the revision of HITRAN. The spectral databases include transition assignment, and partition function information. Discussion of the above hypothesis would be greatly improved if the authors comment on whether the latter observations regarding line shape are consistent? Do remaining residuals correspond to bending mode transitions? How do residuals scale within the polyad as the same dipole moments are leveraged by different state degeneracy?

Grammatical and minor technical corrections.

- 1) Page 5896, line 13. Change "from 0.5 and 1.9" to "from 0.5 to 1.9".
- 2) Page 5896, lines 21-22. Resolve number disagreement in "absorptions also needs"
- 3) Page 5897, line 10. Change "extend" to "extent"
- 4) Page 5897, line 21. Change "determining" to "determination"
- 5) Page 5898, line 8. Specify "Iodine monoxide" rather than "iodine oxide", this is inconsistent.

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- 6) Page 5901, line 2. Change "also cross-sections can be subdivided" to "cross-sections can also be subdivided"
- 7) Page 5901, line 11. Change "Each elevation" to "Each elevation angle". A list of elevation angles would be helpful to understanding which are considered "low".
- 8) Page 5902, lines 6-7. Change "largely cancel out" to "largely canceling out".
- 9) Page 5908, line 6. Change "currently no considered" to "currently not considered"
- 10) Page 5909, lines 1-2. Change "are exceeding" to "exceed"
- 11) Page 5913, line 26. Change "by 60 +- 10% too high" to "too high by 60 +- 10%"
- 12) Page 5914, line 9. Change "BT2 even by" to "BT2 by even"
- 13) Page 5914, lines 22-23. Which specific observations of glyoxal are being referred to? A citation may be helpful.
- 14) Page 5914, line 25. Change "can be also seen" to "can also be seen"
- 15) Page 5915, line 13. Change "argumentation" to "argument"

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