Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-49-AC2, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "Differences in ozone retrieval in MIPAS channels A and AB: a spectroscopic issue" *by* Norbert Glatthor et al.

Norbert Glatthor et al.

norbert.glatthor@kit.edu

Received and published: 7 June 2018

Many thanks for reading our manuscript and your helpful comments. Please find below our responses describing how the manuscript has been modified with respect to your annotations. Blue passages denote changes or updates in the revised manuscript.

General Comments

For clarification: We do not use lines of the fundamental ν_3 band for channel A retrievals, but lines of the ν_2 band and higher transitions in the spectral range 687–791 cm^{-1} only.

Printer-friendly version

Discussion paper

Comment: *"The manuscript could possibly gain more widespread interest by i) including a comparison of pressure broadening parameters to including the MIPAS data base and ii) by quantifying the impact on total ozone columns. This would allow to better estimate the impact of this particular parameter on the existing bias between UV and IR comparison measurements (see Orphal et al., 2016, and references therein)."*

Reply: (i) We think that inclusion of the MIPAS pf3.2 database in the comparison of pressure broadening parameters in the main manuscript is not very conductive, because we do not want to find the reasons for the relatively small differences between ozone retrievals using the MIPAS pf3.2 and the HITRAN-2008 spectroscopy. To address the referee's suggestion, we will add the following paragraph at the end of Section 7.1: "The rather good agreement between the channel A as well as the channel AB retrievals using the MIPAS spectroscopy or the HITRAN 2004 edition and later ones indicates largely consistent spectroscopic parameters of identical ozone lines in these databases for the spectral range of the channel A and AB microwindows. Therefore a comparison between the line parameters of the MIPAS and HITRAN databases is not presented here, but as supplemental material only." and show the requested comparison as supplemental material. To emphasize the good intra-band agreement between most of the channel A and AB profiles (MIPAS vs HITRAN) we will add two graphs showing the absolute channel A and AB profiles to Figure 5. Further, we will slightly change the first paragraph of Section 7.2.2 into "The retrieval results also indicate mostly consistent spectral parameters in HITRAN-2008 and GEISA-2015 for the ozone lines used in MIPAS channel AB, but considerable spectroscopic differences in the region of the channel A microwindows. In the following, we will compare the HITRAN-2008 and GEISA-2015 ozone lines applied in channel A as well as in channel AB to identify the parameters responsible for these differences.

(ii) To consider the referee's second point, we will add a fourth graph to Figure 11

showing the relative differences between channel AB retrievals using the unchanged pressure broadening coefficients and the two sets of modified coefficients. Since these differences are around -4% and -5% over a large altitude range, they are a good estimate for the respective changes in ozone columns. We will shortly discuss this finding in Section 7.3 in comparison with the results of Schneider et al. (2008), who found a systematic difference of 4–5 % between IR measurements in the spectral range 991–1007 cm^{-1} and UV observations. Our results show that, beside the re-scaling of line strengths of the ν_3 and ν_1 lines by 4% as discussed in Smith et al. (2012), a change of air broadening coefficients can lead to a similar adjustment to the UV measurements.

Specific Comments

Comment: *"There are two possibly important omissions in the paper. As already pointed out above, the MIPAS database/spectroscopy deserves a short presentation so that similarities and differences with respect to the other data bases become clear. It would also be helpful to see a detailed comparison of line-broadening parameters between MIPAS and HITRAN and MIPAS and GEISA (such as in Figs. 8 and 9 for HITRAN and GEISA) to better understand differences in the data bases. This also because MIPAS is finally recommended to be preferred over the other data sets. The other issue is that line intensities (see line strengths of 2 = 1 0, (J + 1, J + 1, 1) (J, J, 0) transitions in Fig. 13, for example) are compared using reference temperatures at room, but at stratospheric temperatures the lower state energies (and to a lesser extent partition sums) also contribute. The quoted line strength uncertainty might thus be too optimistic. While partition sums cannot lead to an inter-band bias, lower state energies can. For the sake of completeness a discussion of the impact of possible differences in lower state energies or a comparison of low temperature intensities would be required. "*

Reply: A short presentation of the MIPAS spectroscopy is already given in the Introduction on page 2, lines 2–4. We will add some more information on the MIPAS spectroscopy here. As mentioned above, we will present and discuss a comparison between the spectral parameters in MIPAS pf3.2 and in HITRAN-2008 such as in Figs. 8 and 9 as supplemental material. As requested by the referee, we also performed a comparison of the lower state energies of the corresponding lines in MIPAS pf3.2, HITRAN-2008 and GEISA-2015 for the spectral region of our microwindows. Except of some very weak lines there is perfect agreement between the lower state energies. We will discuss the potential bias due to inconsistent lower state energies and the result of our inspection at the end of the first paragraph on page 9.

Comment: *" The manuscript preparation guidelines request that "works cited in a manuscript should be accepted for publication or published already" and the authors should therefore avoid utilizing personal communications. The communications used are not really required and seem to be problematic. For example, in Section 3 (Error estimates of ozone lines and band intensities), a pers. communication (J.-M. Flaud) is given to motivate relative errors of the three fundamentals. Eq. (1) indicates that the relative error is the same for the 1, 2 and 3 bands. However, the comparison of experimental data with intensity calculations from the same author shows that the agreement in the 2 cold band is usually worse than in the other two fundamental bands (See section 5.2.2. of Wagner et al., 2002). This information therefore seems to be conflicting. Later it is stated that "These inappropriate halfwidths (M. Birk, pers. comm.) are the reason for the stronger ozone lines in the model spectrum using HITRAN-2008 data in Figure 12. This deficiency is still present in later versions up to HITRAN-2016." A priori, it is not clear which set of half widths should be correct and which not and why these half widths cause problems. Non-continuous behaviour is visible in both data sets (see Fig. 13 right). Wouldn't it be more informative and*

decisive to show the direct comparison between modelled and experimental spectra? ”

Reply: To address the referee's objection against personal communications we will change the phrase on page 2, lines 26-28 into "Since the uncertainties in line intensity of many lines of the ν_2 and ν_1/ν_3 fundamentals observed in channels A and AB, respectively, have been determined to be less than 2% (Wagner et al., 2002) ...". Further we will remove the phrase "(M. Birk, pers. comm.)" on page 10, line 20. However, the error estimates given in Section 3 are from an internal technical note by J.-M. Flaud and C. Piccolo for MIPAS data evaluation only and can not be cited in a more convenient way. The referee critizises that the relative error given in Eq. 1 "is the same for the 1, 2 and 3 bands". But exactly these error estimates were provided by Flaud and Piccolo. Wagner et al. (2002) with Flaud as co-author indeed state a lower accuracy for the ν_2 band at the end of Section 5.2.2, but obviously a weak degradation only ("The results are a little bit worse for the ν_2 band ..."). Coming to the issue of inappropriate halfwidths: As correctly noticed by the referee, non-continuous behaviour is visible in both data sets (Fig. 13, right), but the jump in HITRAN-2008 at 797.05 cm^{-1} is considerably larger than the jump in MIPAS pf3.2 (and HITRAN-2008) at 713 cm^{-1}. As suggested, we will add the results of broadband retrievals in the region 795–825 cm^{-1}, which clearly show that the halfwidths of MIPAS pf3.2 of the respective lines at 797.05, 805.02 and 812.99 cm^{-1} lead to much better agreement with the measurements than those of HITRAN-2008.

Comment: *" The study of Janssen et al. (2016) needs to be mentioned in the paper. It has evident methodological links and has already identified differences in pressure broadening parameters between GEISA (version of 2011) and HITRAN (version of 2012) being the main reason for ozone column retrieval differences in the 3 spectral region at 10 μm. It seems that the surprising effect (section 8: Additional observations)*

of systematic biases in the air broadened half width potentially leading to positive and negative feedbacks depending on the optical thickness of the atmosphere is discussed there as well. "

Reply: After having read the Janssen et al. (2016) paper, we think that its main link to our paper is the discussion in Section 3.2.2 (Sensitivity on pressure broadening coefficient). In this section these authors discuss the results of Table 4 and show the "striking feature" that for lines of the ν_3 band an increase in γ_air similar as an increase in line intensity leads to a negative change in the ozone column. This is consistent to the results in Section 8 of our manuscript. We will cite Janssen et al. (2016) and mention their similar findings after the last sentence of Section 8 (page 10) in our manuscript.

Comment: *" Fig. 6 requires correction. On the one hand some technical information on averaging kernel thresholds and orbit numbers are probably not very informative. On the other hand, the difference plot and the absolute values of the GEISA retrievals are not compatible in the altitude range $<$ 10 km. There is a clear offset (AB - B $>$ 0) between the two bands on the left panel, but the difference plot on the right shows AB = B. "*

Reply: The referee is right. The inconsistency below 10 km occured, because the cloud filter was switched on for calculation of the mean differences, but erroneously not applied for calculation of the mean absolute profiles. This error will be corrected. Further, we will remove technical information on averaging kernels, orbit numbers etc. in Fig. 6 and in similar figures.

Comment: *" Absolute deviations at the per cent level are difficult to perceive on the*

Printer-friendly version

Discussion paper

logarithmic scale. The left plot of Fig. 13 should show the relative deviation between intensities from HIT-08 and PF-3.0. "

Reply: We agree and will change Fig. 13 accordingly.

Technical corrections

Comment: *"p. 3, l. 27–29 : Phrase is incomplete/wrong"*

Reply: We can not find a clear omission or error in these sentences and ask the referee to give a more specific comment, please.

Comment: *"p. 4, l. 22 : The acronym IAA appears for the first time. Please explain.*

Reply: Since the acronym IAA will already be explained in Section 2 of the updated manuscript (cf. reply to referee 1), it does no longer need to be explained here.

All other technical corrections will be performed as suggested.

References

Schneider, M., Redondas, A., Hase, F., Guirado, C., Blumenstock, T., and Cuevas, E.: Comparison of ground-based Brewer and FTIR total column O_3 monitoring techniques, Atmos. Chem. Phys., 8, www.atmos-chem-phys.net/8/5535/2008/, 5535–5550, 2008.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-49, 2018.

Printer-friendly version

Discussion paper