

Interactive comment on “Validation of NO₂ and NO from the Atmospheric Chemistry Experiment (ACE)” by T. Kerzenmacher et al.

T. Kerzenmacher et al.

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Thank you for the thorough and detailed list of comments for improvements to our paper. We were able to address all points made by anonymous referee #2 and believe that with his/her aid we were able to improve the paper. In the following we present the original comments in italics and our responses below.

General comments: The authors present a very detailed validation study of the short-lived trace species NO₂ and NO obtained from solar occultation measurements by the Atmospheric Chemistry Experiment (ACE) using an infrared Fourier Transform Spectrometer (ACE-FTS) and an ultraviolet-visible-near-infrared spectrometer (MAESTRO). An overall good agreement is found between ACE-FTS NO₂ and NO, MAESTRO NO₂, and the correlative satellite-, balloon-, and ground-based observa-

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tions. The manuscript is clearly written and well structured and will be of large interest to all potential users of the corresponding ACE data. I recommend publishing this manuscript in ACP after addressing the following comments below.

Specific comments:

Page 3029, lines 13 to 20 (abstract) and page 3078, lines 19 to 26 (conclusions): The authors mention typical deviations between the ACE instruments and the correlative observations. Unfortunately, no characterization of ACE systematic errors seems to be available to date. Concerning statistical errors: Is the precision of the ACE instruments (as described in sections 2.1 and 2.2) confirmed by the validation comparison? For instance, is the standard deviation of the difference between ACE instruments and the correlative ones comparable to their combined random errors? It would be fine if the authors could add a clarifying sentence in the last paragraph of the conclusions and in the abstract.

We included the following paragraph in the Conclusions, but not in the Abstract:

“Since the random errors for the ACE instruments are very small, combined random errors are dominated by those of the comparison instruments. The combined random errors for the ACE instruments with OSIRIS and MIPAS ESA were compared to the standard deviation of the relative differences of the ACE instruments with OSIRIS and MIPAS ESA. The combined random errors of the ACE instruments with OSIRIS were found to be around 6 to 19% compared to the standard deviation in the relative differences of 15 to 55%, and with MIPAS ESA the combined random errors were 50 to 70% compared to the standard deviation of 30 to 78%.

Page 3029, line 14: Please write out the acronym "VMR" since it occurs the first time in the abstract.

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This has been done.

Page 3029, line 18 and page 3078, line 25: Partial NO₂ columns between ACE instruments and the FTIRs are in "fair" agreement in the abstract and in "good" agreement in the conclusions. I suggest writing in both cases "quite good" agreement.

Changed, as suggested.

Page 3042, lines 6 and 8: Precision and accuracy values for the data retrieval are given in absolute units. However, since volume mixing ratios of both species are varying considerably with altitude it would be better to give such error estimates in relative (percentage) units.

We added the sentence: "At the VMR peak height, the estimated accuracy is 5 to 10% for NO₂ and 10 to 20% for NO."

Page 3047, lines 14 and 15: Why do the FTIR stations in Kiruna and Izana use the old HITRAN spectroscopic data while the other stations in the NDACC network use the newer ones? For the molecule NO₂ there has been an update in spectroscopy. This can alter NO₂ volume mixing ratios, at least in the limb emission case, by roughly 10 to 15% (see, e.g., Fig. 9 in Wetzel et al. 2008).

The error of 10–15% is for limb measurements. We have conducted calculations for comparisons of HITRAN 1996 and 2004 and reach a total column difference of about 2%, with larger values for 2004. This value of 2% is valid for the partial columns, too. This has been added to the text.

Page 3052, line 13: The text in parentheses "including the updates for ozone" can be omitted since "ozone" occurs already at the end of this sentence.

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We changed the sentence. Since version 2.2 has ozone we need to say that there is an update for the ozone of version 2.2. This has been made clearer by saying: "...and ozone (with updates)."

Page 3056, line 2: MAESTRO values are larger than SAGE II by 15 to 30% between 20 and about 40 km (Fig. 12). Please change "35 km" to "about 40 km".

We left 35 km, because at 40 km the differences become much larger than 30%.

Page 3056, line 13: The reference to Fig. 14 should be moved to the end of the sentence before since the comparison ACE-FTS to POAM III is shown (and not: MAESTRO to POAM III).

Changed as suggested.

Page 3056, line 18: What do you mean with "relative increase"? Relative to what? Why only below 25 km? Please rewrite this sentence to make it more clearly.

This sentence has been rewritten:

"This may explain the larger ACE VMRs relative to HALOE below 25 km because of retrieval errors due to concentration gradients along the scattering/absorption paths (see Section 4.2).

A reference has been made to Section 4.2 which has been rewritten to explain this.

Page 3058, line 26: Please add the clause "and to more than 100% below 18 km" at the end of the sentence.

Added the clause as suggested.

Page 3059, line 8: "...slightly tighter criteria were chosen...". A tighter coincidence criterion normally decreases (not increases) the number of coincidences. Hence, something must be wrong in this sentence. Please correct it.

Thank you, this was obviously wrong. The sentence was revised:

"For MIPAS, correlative data were only available for a two-month period in early 2004 for northern mid- and high latitudes, and the coincidence criteria were chosen to be 300 km and 6 h to have a sufficient number of coincidences for the statistics of the comparison."

Page 3061, line 5: Why is the diurnal correction only important below 25 km? Could you please explain this a little bit?

The following text has been added:

"Retrieval errors due to concentration gradients along the scattering/absorption paths (due to varying local times/solar zenith angles) are only important below 25 km, because usually biases in the near field are compensated for opposite biases in the far field. This is, however, not the case below 25 km, where the signal is getting saturated and is henceforth weighted toward the near side."

Page 3065, line 29: "...the sensitivity of the FTIR measurements, which was required to be 0.5 or greater..." What do you mean with this? Is it the signal to noise ratio? Please explain this more clearly.

This has been explained by adding the following text to the paper:

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“The sensitivity of the FTIR measurements was calculated using the sum of the elements of the columns of the averaging kernel matrix. This results in a sensitivity with respect to altitude (Vigouroux et al. 2007). This sum indicates the contribution to the retrieval at this altitude from the measurements. If the sensitivity is greater than 0.5, than more than half of the information is gained from the measurement itself and less than half remains from the a priori VMR profile.”

Page 3066, line 26: I am not convinced that the correlation shown in Fig. 25 is excellent; I think "good" is more appropriate. Is the scatter seen in the Kiruna data related with measurements inside and outside the vortex. What is the comparison period here? The comparison period should be included in the Figure caption of Figure 25 or as an additional column in Table 1.

“Excellent” has been changed to “good”. All the dates for the coincident measurements have been added to Section 3.4.

The following text has been added:

“For Kiruna, 8 out of 12 days of available measurements are during the strong vortex winter of 2005, but these data do not show more scatter than Ny lesund which has only two available measurement days during the same period. There also do not appear to be significant gradients in NO and NO₂ across the vortex edge for the ACE-FTS measurements. Therefore we do not think that the larger scatter at the northern high latitude stations is due to the polar vortex.”

Page 3074, line 10: If I understand this right, the problem is that the retrieval grid and the model atmospheres of the ground-based stations end at 100 km. High NO values above this altitude must then be compensated by too high values in the actual layers below this upper altitude limit leading to a high bias. Hence, from my point of view it would be more clearly to write "as the retrieval grid and the model atmospheres

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of the ground-based stations extend only to 100 km" instead of mentioning averaging kernels here.

Thank you for the better wording. The text has been rewritten as suggested.

Page 3075, line 25: Please rewrite the sentence like: "MAESTRO reports larger values than ACE-FTS in the lower and middle stratosphere (see Fig. 6)". Since in the upper stratosphere, the situation is vice versa.

This has been changed as suggested.

Technical corrections:

Page 3030, line 7: The citation Wolff et al. (2007) should be changed to the year 2008.

Page 3030, line 10, and page 3094, line 16: Strong et al. (2007) should also be changed to the year 2008.

Page 3031, line 10: The citation Nakajima et al. (2006) occurs also in line 11 and should therefore be deleted in line 10.

Page 3031, line 18: Please delete the word "instruments" between "Experiment" and "GOME".

Page 3050, line 2: Dupuy et al. (2007) should also be changed to the year 2008.

Page 3054, line 24: The word "comparison" should be plural.

Page 3065, line 3: One "n" is missing in the word "lightning".

Page 3068, lines 22 and 26: The exponent before "molec" should probably be "15" instead of "13".

Page 3077, line 6: Please insert an "e" in the name "Aire-sur-l'Adour".

Page 3114, Figure 11 (a): Please write "SAGE II" in the legend (instead of "SAGE2").

Page 3129, Figure caption 26, line 3: Please write "comparison" instead of "compan-

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ion".

Page 3134 to 3137: Please change "MIPAS" to "MIPAS IMK-IAA" in the Figure captions 31-34 to make it more clearly that this is not MIPAS ESA data here. Please add the character "r" in the word "February" in Figure caption 32, line 1.

References:

Wetzel, G., Sugita, T., Nakajima, H., Tanaka, T., Yokota, T., Friedl-Vallon, F., Kleinert, A., Maucher, G., and Oelhaf, H.: Technical Note: Intercomparison of ILAS-II version 2 and 1.4 trace species with MIPAS-B measurements, *Atmos. Chem. Phys.*, 8, 1119- 1126, 2008.

All the technical corrections have been made as suggested.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 8, 3027, 2008.

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