

Author Reply

The authors thank Dr Chris Boone for his constructive, insightful and encouraging comments. In our reply, the original comments are printed in **bold face**, our replies are printed in *italic face*, and the resulting modifications in the paper are printed in normal face.

Comment: This paper offers a detailed accounting of error estimates for retrievals from the MIPAS instrument. The analysis is rigorous and is as complete as can be expected. There will always be error sources that cannot be estimated because there is insufficient information in the measurement system, such as the impact of measuring from a moving platform. Retrievals always implicitly assume a vertical column, but measurements are smeared geographically, which could cause problems if measuring something with high variability or moving across the polar vortex boundary partway through an altitude scan. Note that a changing scene over the course of a single FTS measurement (e.g., when moving through a region of high variability in H₂O) would give rise to a contribution to the imaginary component in the Fourier transform, which is the source of the noise information in the analysis, but perhaps the effect would be negligible compared to the noise level for an instrument measuring in emission.

Reply: *We agree that there will always be error sources that cannot be estimated because there is insufficient information. As soon as there is information available to quantify a new error source, this can be done by perturbation or sensitivity studies as mentioned in our Section 8 “Further sources of error”. With respect to line shapes, it should be kept in mind that the spectral line shapes in MIPAS spectra are dominated by the ILS and the spectral resolution of MIPAS, so that the true lineshapes are not the leading part in many cases.*

Horizontal variability along the line of sight and/or along the flight track is indeed an issue. With regard to level-2 related issues, we report the horizontal information smearing and information displacement in our gas-specific retrieval papers, following the method by von Clarmann et al., Atmos. Meas. Tech. 2, 47-54, 2009. We, however, do not think that this issue belongs into the paper under discussion.

Beyond this, there is indeed a level-1 related issue due to signal variations during the recording of an interferogram. We agree that this affects the imaginary component of the interferogram that is the basis of our noise estimate. Clouds cause an even larger effect of this type than water vapour variations. In the early phase of MIPAS level-1 processing this caused indeed unrealistic noise estimates. High-pass filtering of the imaginary part of the interferograms (as mentioned in our manuscript) was found to substantially reduce this problem. Noise estimates as provided by ESA along with the latest version of level-1 data are considered as fairly realistic.

Comment: There will be systematic errors from using Voigt profiles in the calculated spectrum rather than more accurate line shapes, but one would hope the available uncertainties on the Voigt parameters would encompass this effect.

Reply: *We agree that deviations from the Voigt line shape and the true line shape are hopefully covered by the Voigt parameter uncertainties. Furthermore, details of the line shape are deemed less visible at MIPAS spectral resolution than with better resolving instruments such as ACE-FTS. If need be, related errors can still be evaluated as discussed in Section 8 “Further Sources of Error”.*

Action: We have added to Section 8: [The assessment of these uncertainties will be discussed in the corresponding retrieval papers, where relevant.] The same holds for error sources not discussed so far, such as inaccurate line shape models. The relevance of such effects is deemed highly dependent on the target gas under analysis. [The assessment of these uncertainties will either be ...]

Comment: Some of the labels are a bit whimsical (e.g., headache errors), but their meanings are clear. I had to look up some of the Latin phrases, not being familiar with the language.

Reply: *We have tried to find equivalent English expressions, although these sometimes seem to sound a bit clumsy.*

Action: *a fortiori*: replaced with “with even greater force” and elsewhere with “with even greater reason”
mutatis mutandis: replaced with “with the necessary changes in place”

Comment: I have no suggestions for changes, other than a few typos and minor changes, listed below

Line 51: variable definitions: Every variable is defined except for \vec{y} (unless you count it as being defined by the phrase “the signal y ” on line 94, well after the fact.

Reply: *agreed.*

Action: We have added the definition to the tabular list of definitions.

Comment: Line 67: “... denotes the errors source”
errors → error.

Comment: Line 325: “witht”
with.

Comment: Line 358: “... between to independent measurement systems”

to → two.

Reply: *Thanks for spotting*

Action: all three corrected

Comment: Line 378: “The component of the instrument line shape error related to the phase does not need to be considered explicitly, because it affects the frequency shift only and thus is implicitly included in Δ_{shift} .”

A non-zero phase in the modulation function would imply a physical asymmetry in the ILS (unless it is just a straight line as a function of optical path difference), the effect of which is not just a frequency shift; it affects the shape of the calculated line..

Reply: *We agree that our original wording was incorrect. We have replaced it by a weaker statement.*

Action: We have replaced the sentence by: “Spectral shift errors caused by instrument line shape errors do not need to be considered as part of the instrument line shape error, because the total spectral shift is empirically corrected as the first step of the data processing chain (see Fig 1) and the residual spectral shift uncertainty is propagated as an error source in its own right (see Section 6.3.4)”

Comment: “Table B1: CFC-22”
CFC-12

Reply: *Thanks for spotting.*

Action: Corrected.