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Interactive comment on "Iterative maximum a posteriori (IMAP)-DOAS for retrieval of strongly absorbing trace gases: Model studies for CH_4 and CO_2 retrieval from near infrared spectra of SCIAMACHY onboard ENVISAT" *by* C. Frankenberg et al.

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We thank A. Maurellis for his review and helpful comments especially on spectroscopic issues such as water vapour spectroscopy. In the following we give detailed answers to all referee comments and comment in which way we implemented the suggestions in the revised version of the paper.

0.0.0.1. Reply on specific comments

1. Section 2.2. is indeed supposed to give "only" a more comprehensive overview over possible deviations from the Voigt lineshape without analysing its impact quantitatively. Since the deviations from the Voigt lineshape are rather complex and not easy to compute, a full consideration of this issue would be, in our view, a topic for a separate paper and more interesting for high resolution spectroscopy. We will add a sentence that clarifies that we used the Voigt profile throughout our study.

2. We will add the following sentence at the end of section 2. 2: "Hence, the convolution is applied only in the intensity space throughout this study."
Concerning an unknown slit function: We are aware of the fact that the slit function itself can play an important role and introduce large biases in the retrieval. Slit functions varying in time pose an even more challenging problem (as the referee mentioned in the case of an ice layer on the detectors of SCIAMACHY with resulting biases of more than 25%) We will add a small Section for this topic and are glad that the referee reminded us not to omit this important issue in the paper.

3. We are aware of the high uncertainties of line strength, especially in the case of water vapor. However, we believe that this is a rather complex issue and we intended to keep the focus on specific near infrared problems, i.e. all problems that are related to strong and nonlinear absorptions. If, for instance, only one water line would reside within a fit window, the error in the retrieved water column would be of the order of the error in the integrated line strength. However, if several water lines reside within the fitting window, it gets much more complicated since some lines may actually have a higher and some a weaker line-strength than given in the database. In the end, the column error would be somehow related to the mean error of the respective line-strength. One of the main problems is that large fit residuals would be induced and that these residuals might

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be larger than the absorption structures of some minor absorbers such as CO. However, these effects are hard to quantify and care has to be taken when water vapor lines reside within a retrieval window and overlap with minor absorbers.
If the referee thinks that a treatment of uncertainties in line strength is indispensable, we will implement it. Otherwise we would like to omit this topic in this paper.
We are grateful for the remark to the HITRAN 2004 database (with its additional error estimations of spectral parameters) and will include the updates in future publications.

4. We feel a bit uncomfortable to put a table with the error sources into the conclusions since these errors depend on a variety of factors, ranging from the actual slit function to the strength of the absorption itself. Thus, we would prefer to put a summarizing paragraph at the end of the conclusion which shortly describes the possible error sources. In the revised version, we implemented these sentences: "Some error sources still remain: uncertainties in the light-path due to aerosols, inhomogeneous surface elevation or partial cloud cover giving rise to errors of a few percent that can only be circumvented by using a suitable proxy. Incorrect specification of the instrumental slit function can lead to a rather constant bias of 1-5 %, in extreme cases of up to 25 %. Using a climatological derivative, the errors induced by perturbations in the temperature and pressure profile can be reduced to mostly below 1 %. "

5. To our knowledge, aerosols certainly alter the photon path but seldom block a significant portion of the column from being traversed by photons (at least in the NIR and sufficiently high albedo). So far, we experienced that aerosols can enhance the effective light path by up to 5% (e.g. dust-storms in desert regions) and reductions in the light-path by other types of aerosols are hard to discriminate from reductions of the light-path due to clouds. Since most of these changes in the light-path certainly take place in the lower atmosphere, the choice of subcolumns with higher a priori covariance at the lowest levels is also sensible with

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respect to aerosols. Thus, in the presence of aerosols the algorithm still converges (in exactly the same way as it does when the total column is much smaller than the a priori as in the case of very low surface pressure!) but the retrieved columns can have a slight bias which is, however, not wildly inappropriate as the referee mentions. This bias can then be avoided by using a proxy for the light path as described in Section 4.1.1.

Technical corrections

We will incorporate almost all technical corrections as suggested.

Exceptions:

In some cases we have used 'measurement' rather than 'the measurement' in order to indicate measurement in general, as opposed to a particular measurement.

Figures 1 and 3 were created with the final print version in mind. Thus, we intended a two-column figure whereas the other figures are only one-column figures. In our opinion, the figures in the resulting print versions should be of similar size and Figs. 1 and 3 should be large enough. We will change the font size in a way that the fonts in all figures are comparable (in size) with the font size of the final print version.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 6067, 2004.