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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.

C. Frankenberg et al.

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We thank R. de Beek for his thorough review and helpful comments. In the following we give detailed answers to all referee comments and comment in which way we implement the suggestions in the revised version of the paper.

Reply on specific comments

General remarks

- We agree that the description of the IMAP method might be a little confusing. We referred to the IMAP method as given in Eq. (17) and will explain this in more detail in the renamed section "Implementation of Optimal Estimation" itself.
- The choice of the atmospheric layering is, so far, just an example and not the outcome of an optimization procedure (will be mentioned in the paper) but can always be modified if necessary. However, this choice turned out to yield very reasonable results but can, of course, be further optimized. All derivatives for these height layers are calculated integrating cross sections calculated at a fine height resolution.
- The US standard atmosphere has always been taken as a priori, i.e. pressure and temperature profiles as well as trace gas concentrations have been taken from the US standard atmosphere (scaled to present concentrations). We will mention this more explicitly at the end of section 3.1. Since we didn't include surface elevation as a priori (as mentioned at the end of Sec. 3.1) and the modeled spectra were based on highly reduced total columns due to surface elevation, this model study includes cases where the actual state deviates strongly from the a priori. This effect is most strongly visible in Figures 6 and 7 where it becomes clear that iterations are necessary when the actual state largely deviates from the a priori state.

1. We fully agree, modeled total optical density is more convincing.
2. At the time of submission, the Buchwitz et al. paper was not yet published. We

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will, of course, incorporate this reference as well as the missing reference to the Buchwitz et al. CO paper.

3. We refer to the term "differential optical density" as the high frequent part of the optical density, i.e. the polynomial is supposed to be already applied. We will mention this more explicitly.

4. We agree and stick to the term "optical density"

5. Will be changed

6. This is a very good remark since our formulation might be misleading. Of course only the shape of the absorption lines is changed by pressure broadening. We will change this.

7. The lack of using different height layers in the Buchwitz et al. paper (2000) was not meant as criticism. Neither is the suggestion of an iterative scheme. However, after having read this paragraph again, we agree that the Buchwitz et al. papers have to be more strongly acknowledged since Buchwitz et al. wrote a pioneering paper with respect to DOAS retrieval in the NIR. We fully acknowledge this work and simply try to contribute to the evolution of algorithms for the NIR.
Concerning the usage of iterations we will reference the Buchwitz and Burrows paper in the following way:
"Thus, the linearisation point has to be close to the actual state which is only possible by means of iterations. This is of special importance for the retrieval of strongly absorbing gases with highly variable concentrations such as water vapor (see e.g. Buchwitz and Burrows (2004)".
It would be, however, interesting to clarify, whether an iterative scheme basing on a coarse lookup table approach (e.g. for H_2O 0.5, 1.0, 1.5, 1.5, 2.0, and 4.0 times US standard atmosphere) would lead to the same results as the approach given in this paper which is not based on a lookup table.

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Interactive Comment

Furthermore, we didn't intend to claim that we introduced the usage of iterations since this is already part of the framework of Optimal Estimation by Rodgers (1976).

8. Since the cross correlation of errors strongly depends on the chosen retrieval window and state vector, we think that a comprehensive analysis would be outside the scope of this paper.

9. The expression "This is prevented by ..." will be changed since it was not actually implemented in the retrieval scheme.

10. We apologize for neglecting these references, they will be added.

Technical corrections

We are very grateful to the referee for his comprehensive technical corrections, especially for the detection of slightly embarrassing typos, misleading formulations and non-compliance with international standards.

1. will be changed.

2. will be changed.

3. will be changed.

4. will be changed.

5. will be changed.

6. Figure 3 was 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 Fig. 3 should be large enough.

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7. will be changed.
8. will be changed.
9. the reference to the table will be added.
10. We would like to keep Section 3.2 in order to discriminate this case from the standard profiles used in 3.1.
11. will be changed.
12. of all rather homogenously distributed gases (will be added)
13. will be changed.
14. it is not the effect on CH4 but on H2O. The caption in the figure was wrong! This will be changed.
15. The shortcut will be deleted but we don't agree that the figure is too small.
16. will be changed

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