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Interactive Comment

Interactive comment on "Quality assessment of O_3 profiles measured by a state-of-the-art ground-based FTIR observing system" *by* M. Schneider et al.

M. Schneider et al.

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We would like to thank the referee for all their comments. All of them are very welcome and help to further improve the quality of our publication. Below we answer them in detail:

(1) The measured solar absorption spectra contain information about the vertical distribution of a trace gas mainly due to the pressure broadening effect, i.e. the shape of the absorption line depends on the pressure where the absorption takes place. If we consider an optically thin line the information in the absorption signature is the larger the stronger the line. However, if the line gets saturated the information about

the trace gas at high altitudes (low pressure), is reduced, since the signal for the absorption at low pressure is concentrated at the center (saturated part) of the line. The best sensitivity is achieved by combining a set of weak (always unsaturated) and strong lines. It is also an advantage if the wings of different lines are overlapping. Overlapping lines increase the sensitivity in the troposphere (Barret et al., 2002). The O_3 lines fulfill all these criteria. We mean these criteria when we talk about "absorption signatures similar to those of O_3". Furthermore, the O_3 spectroscopic parameters are very well known. Many other important trace gases have weak, strong, isolated and overlapping lines in the infrared (e.g. N2O, CH4, H2O, ...). Potentially, these profiles can be retrieved with similar good precision as exercised for O_3.

We will change the sentence at page 4979, line 12 to: "The quality of the FTIR O_3 profiles presented in this paper reflects the current potential of ground-based FTIR systems in monitoring the vertical distribution of atmospheric trace gases which possess weak, strong, isolated, and overlapping absorption features."

(2) We agree with the Referee that the distribution of the O_3 VMRs is not as clearly log-normal than the distribution of the H2O VMRs.

However, in our opinion assuming log-normally distributed VMRs is overall more realistic than assuming normally distributed VMRs: For large variabilities a normal distribution is physically impossible (negative values). Then only a log-normal distribution is reasonable (for example for H2O or for O_3 in the tropopause region). For low variabilities the log-normal shape parameter is low and log-normal and normal distribution are quite similar. This is, for example, the case for O_3 in the subtropical middle stratosphere. Then it doesn't matter if we assume a normal or a log-normal distribution.

Furthermore, only the retrieval on a logarithmic scale allows to include a constraint against ratio profiles.

(3) The main and secondary O_3 isotopologue profiles are constrained against

each other (see Schneider et al., 2006b). If there is no sensitivity for the secondary O_3 isotopologue, it will follow the value of the main isotopologue in the way that the retrieved secondary/main O_3 isotopologue ratio agrees with the a priori assumed ratio.

(4) ... of O_3 total column amounts. We will correct this in the manuscript.

(5) Ok, we will cancel the sentence starting in line 7: "it is argued [...]".

(6) We do not understand what the Referee means with this comment. The values on pages 4988 and 4990 are given in %, i.e. ratio multiplied by 100.

(7) We think that the recommendation to use the same a priori during all seasons is important. If we were using a seasonally varying a priori, it would be difficult to decide how much of the retrieved O_3 variabilities comes from the varying a priori and how much from the measurement itself. This would strongly reduce the validity of the FTIR data.

Concerning the mentioned convergence problems, it is important to make a clear distinction between the first guess profile and the a priori profile. If the search is started not too far from the final solution, the first guess should have no impact on the final solution, whereas the a priori always leaves its imprint on the solution. Therefore, if one fears to miss the valid global optimum solution, the appropriate measure might be to improve the first guess, there is no need to modify the a priori. A proper analysis code should support this distinction. Our own practical experience is that even in case of species with very high variability over the year (e.g. O_3, H_2O, ...), convergence problems practically do not occur. This is also true for polar O_3 profiles (this example was mentioned by the Referee). In addition to Izaña we run a FTIR experiment at a polar site (Kiruna, Northern Sweden), with relatively high O_3 variabilities in the lower and middle stratosphere. However, we very rarely have to deal with convergence problems. In this case our recommendation is of special importance: the application of

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a unique a priori assures that the observed $\mathrm{O_3}$ depletion comes from the measurement and is not artificially introduced by an a priori assumed $\mathrm{O_3}$ depletion.

(8) Will be done.

(9) The term ρ_{ij} is misleading here and will be deleted from the Graph. What is shown in Fig. 1 is the a priori correlation correlation matrix R. It is related to the a priori covariance matrix $\mathrm{S_a}$ by $\mathrm{S_a} = \mathrm{Z_a R Z_a}^T$, whereby $\mathrm{Z_a}$ is a diagonal matrix containing the variabilities at a certain altitude. For all altitudes above 32.8km, where no sonde data are available, we assumed that the correlation length keeps the same as at 32.8km.

(10)-(54) These comments will be considered when preparing the final version of the manuscript. Many thanks!

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 4977, 2008.

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