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Interactive comment on “Stratospheric CH₄ and CO₂ profiles derived from SCIAMACHY solar occultation measurements” by S. Noël et al.

Anonymous Referee #1

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Stratospheric CH₄ and CO₂ profiles derived from SCIAMACHY solar occultation measurements by Noel et al.

The manuscript discusses the retrieval of vertical profiles of methane and carbon dioxide in the stratosphere using SCIAMACHY solar occultation observations. These observations are highly interesting as there are not many instruments making profile observations of the important greenhouse gases. The paper introduces a new version of the methane profile algorithm with clear improvements compared to the previous version. The carbon dioxide profiles are presented for the first time from SCIAMACHY occultation observations. It is noted that some unrealistic oscillations are seen in the profiles requiring further work. External satellite data and model results are used for validating and assessing the usability of the CH₄ and CO₂ profiles. Some preliminary

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time series analysis is also presented. This is a very nicely and clearly written paper with thorough discussion on the methodologies that has been used and the existing limitations. The figures are high quality. I suggest that the manuscript is published in AMT after taking into account my rather minor comments.

Main comments:

1. It is mentioned in the manuscript that CO₂ is also retrieved from ACE-FTS. It would have been very interesting addition to compare SCIAMACHY CO₂ profiles with real observations in addition to the comparison with CarbonTracker model, even with a limited coverage. By doing that the discrepancy due to different atmosphere (pressure, temperature) would be reduced. Would there be a possibility to add this?
2. Vertical resolution of the profiles. The vertical resolution of the instruments in the stratosphere should be discussed, now only SCIAMACHY resolution is mentioned. How are the (potentially) different resolutions taken into account in the comparisons?

Minor comments:

1. P-11469 L -23: Methodology to retrieve the altitude (Bramstedt): as this is quite important, it would be nice to have few more words about the methodology: what is it based on?
2. P-11469 L-17: The sentence is unclear. Also, it seems that CO₂ profile data available from ACE-FTS. Has this data been compared with SCIAMACHY CO₂ presented here? To me it sounds very interesting addition to the model comparison.
3. P-11471 L-18: Intuitively it would be better to use all data and not a subset of the measurements. Therefore, I suggest to add more discussion why it is important to select a subset of the measurements for the analysis.
4. Section 3: How are the aerosols treated in the retrieval?
5. P-11476 L-20: Non-linear least squares fit is used here. It would be good to write

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down the actual retrieval problem. It remains unclear for me if the noise in the data is taken into account in the fit. Also, which methodology is used for solving the non-linear problem. Does the method provide error propagation from the data to the end products, (also related to sec 4.1).

6. P-11477 L-27: pre-calculated data. Some clarification to explain a bit more what the pre-calculated data actually is would be nice. What variables are taken into account? Also, it is somewhat unclear to me if the oscillations that are seen in the profiles may be related to the discretization of the pre-computed tables.

7. P-11476 L-24: refraction. Would be good here to clarify with few words more what is meant by the refractive effects here.

8. P-11479 L – 8: It seems that the error is estimated from the residual and not using error propagation – is there a reason why this approach is chosen? Which ‘covariance matrix’ is referred here?

9. P-11479 L-13: I would appreciate a bit more explanation on how the empirical correction was estimated/justified. Was this based on simulations?

10. Figures 8,9,10: panel top right. The axis of this figure could be changed to cover more interesting area, eg., something like -50% . . . 50%.

11. Fig 9: Please, check the figure. At least in my printed version the shaded area is missing (figs 8,10 and 11 ok).

12. P-11489 L-27: I suggest adding clarification to the SCIAMACHY data used here: nadir observations?

13. P-11491 Speculations on future work. Have you considered, instead of performing full retrieval for all altitudes simultaneously which requires solving a large problem, applying two step approach used e.g. in GOMOS stellar occultation retrievals: solve first horizontally integrated densities one-by-one using non-linear least squares fitting and then perform linear profile retrieval using regularization (with smoothness require-

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ment). If this sounds interesting, you might have a look on e.g. Kyrola et al, Retrieval of atmospheric parameters from GOMOS data, ACP, 2010.

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