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Atmospheric Measurement Techniques Discussions

Interactive comment on "Near infrared nadir sounding of vertical column densities: methodology and application to SCIAMACHY" *by* S. Gimeno García et al.

Anonymous Referee #2

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Review of AMTD-4-3685-2011 (AMT-2011-59)

"Near infrared nadir sounding of vertical column densities: methodology and application to SCIAMACHY."

By Garcia et al., 2011, submitted to AMT.

This paper describes – at length – a retrieval algorithm for CO, CH4 and CO2 from the SCIAMACHY instrument onboard ENVISAT. Retrievals are done in the near-infrared, around 1600 and 2300 nm. The paper discussed the many factors that impact the retrieval and show some results as well as a brief validation.

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Interactive Discussion
Discussion Paper

I could support publication of this paper, but some crucial information is missing from the paper, and there are quite a few questions. Including the missing information may take some effort, but I think it is very important to include that information already here.

Major remarks.

1) Information about averaging kernels is missing. Although averaging kernels are available for SCIAMACHY CO/CH4/CO2 for other methods, it appears that depending on the method different kernel shapes are found. Hence it is vital to know what the kernels look like, and actually it is information that I expected in an AMT-paper like this.

2) A discussion of instrument-noise related errors is missing. Instrument-noise related errors of individual SCIAMACHY measurements are large and strongly related to the surface reflectance. Keep in mind that instrument-noise errors are not the same fit-errors which are also part of the selection criteria (see sections 2.3.2 and 4.2.1; one could have a perfect fit but still a wrong retrieval). This is crucial information for any (future) use of the data. However, there appears to be no instrument-related error coming out of the retrieval method. Yet, large variations can be expected in data accuracy and measurement errors also should show certain spatio-temporal patterns. Without such information, additional studies using these data will become problematic as it will be unclear where differences might originate from. It should be explained how these errors are incorporated in the retrieval, or otherwise they should be included.

Other questions/remarks.

- It is unclear which a priori is used in the retrieval. Please specify. This is also important with regard to the averaging kernels, see previous point.

- It is unclear which methane columns - ch. 6 or ch. 8 - are used for the scaling of Carbon Monoxide as outlined in equation (19). Please clarify. I assume it is channel 8, but if it is channel 6, additional discussion of the different vertical sensitivities and their effect on this scaling is needed.

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- Section 2.3.2. It is unclear which data is used to determine cloud fractions. Please specify.

- Section 2.3.2. Although it is not specifically explained, if I understand it correctly, for ocean pixels the total CO columns are actually derived by scaling them with the CH4 column. Even if I am incorrect, it should be explained. However, scaling of CO with CH4 provides several problems. First of all, it becomes unclear which part of the atmosphere is represented by the COx measurement. And secondly and in particular for high clouds, certain errors in CH4 could be inflated by this scaling (systematic errors, for example, which could be small for the total CH4 column could become large for partial columns over high clouds). Some discussion on this is needed. There are other methods for using ocean data – Gloudemans et al. [2009; acp-9-3799-2009] only use ocean measurements for cloud top heights below a certain altitude. They determine the cloud top from methane by comparison with model results, the latter which are accurate to within a few percent. Hence, discussion of how errors in CH4 translate into errors in CO should be discussed.

- Section 3 presents a whole range of factors that may have an impact on the retrievals. However, I lost overview of which of those had a potential large impact and which not. A short summary of which factors matter and which don't – including numerical values where possible - would be very helpful.

- Section 3.8. For atmospheric temperature and humidity information the method relies on external data – as other methods do. In the case of the BIRRA algorithm this is a climatology (CIRA from COSPAR). However, it is discussed before – see figure 5 – that there is some sensitivity to water vapor and temperature. The use of a climatology to represent atmospheric conditions will introduce errors. It should be possible to come up with an estimate of how large such errors could be. In addition, and this is probably more advice than recommendation to perform here, NCEP atmospheric (re)analysis or even ECMWF data is to some extent publicly available with sufficient spatio-temporal resolution to be used for the retrieval. I strongly suggest to start using that data in order

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to reduce errors in the retrieval due to incorrect meteorological information.

- Section 4.1, page 3705, line 4-6. It is noted that the effects of the ice layer is not removed by scaling xCO with CH4. Some discussion on how the authors think they then can identify this impact and how they want to correct this is warranted. The channel 8 ice layer is one of the most important instrumental issues of SCIAMACHY CO and requires special attention. Furthermore, it would be helpful to provide some indication of the magnitude of errors or biases that are being introduced because this method "does not remove the impact of the ice layer".

- Section 4.2 presents a short introduction of CO as scientific topic and is more something for the introduction. However, since this is an AMT submission and the focus of AMT is on technical issues, this whole section 4.2 can be removed.

- Section 4.2.1. References on why certain spatio-temporal patterns are related to physical processes is missing. The authors could use some of the publications with MOPITT data, for which these relations have been identified and reported. Otherwise it cannot be checked why the claim that a certain increase in CO is linked to a certain process is true.

- Figure 16, comparison with ground-based measurements. Please provide some basic statistics (correlation, bias, rms difference; could be included in the figure itself). The question could be asked whether or not it is fair to compare total column measurements from SCIAMACHY with surface measurements, and although it is not necessary for this paper, basic statistics of this comparison could be useful for future discussions and publications.

- Section 4.2.1 and 4.2.2. Figures 3 or 5 suggest that the global CO distribution as measured by SCIAMACHY is very noisy, yet figures 13-14-15 suggest that the distribution is rather smooth. How is this possible? Does this mean that the scaling as defined in equation (19) helps in smoothing, i.e. there are biases in the CO VCD that are also present in CH4 VCD which then sort of cancel out when dividing both? Is there then an

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interdependency between CO and CH4? This comes back to the lack of a discussion of instrument-related errors as mentioned before.

- Figures 3,5,7,9,13,14,15,17, please provide the sampling area of each figure in the figure caption – I assume that data is resampled on a regular grid. Furthermore, indicate how the averaging is done. Instrument-noise related errors of individual SCIAMACHY measurements are large, hence should be considered when averaging data.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 3685, 2011.