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Interactive comment on "Carbon monoxide, methane and carbon dioxide columns retrieved from SCIAMACHY by WFM-DOAS: year 2003 initial data set" *by* M. Buchwitz et al.

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Reviewers : Bastiaan van Diedenhoven and Ilse Aben

General :

In this paper the authors present results from the retrieval of CO, CH4 and CO2 columns from SCIAMACHY data using the WFM-DOAS algorithm. For methane, average volume mixing ratios of CH4 (XCH4) are obtained by dividing these columns with the CO2 column. For CO2 average volume mixing ratios of CO2 (XCO2) are obtained by dividing these columns with the O2 column, which are retrieved using SCIAMACHY

data as well. The paper shows a clear improvement in XCH4 compared to the previous paper by Buchwitz et al., 2005, by applying a first correction to the data to account for the time-dependent ice-layer on the detectors. As such the XCH4 results present a clear progress compared to their previous results.

However, referring to two other publications in this special issue of ACPD, i.e. van Diedenhoven et al. and Houweling et al., we have some serious reservations to the derivation of the XCH4 and XCO2 mixing ratios presented in this paper by taking the ratios CH4 and CO2 SCIAMACHY columns to the CO2 and O2 SCIAMACHY columns respectively. We believe the argumentation for this approach is only qualitative, whereas van Diedenhoven et al., and Houweling et al. show that care must be taken, because retrievals of CH4, CO2 and O2 columns have different sensitivities to aerosols and taking ratios can increase errors significantly.

We realize that the papers by van Diedenhoven et al. and Houweling et al. had not yet appeared when the paper by Buchwitz et al. was submitted and that these results could therefore not have been referred to in the current version of the paper.

Main comments :

Van Diedenhoven et al. and Houweling et al. retrieve O2 columns (converted to surface pressures) and CO2 columns, respectively. Furthermore, they study the sensitivity on aerosols of these retrievals and show that this sensitivity is strongly dependent on the aerosol optical thickness, vertical distribution and the underlying surface albedo. For these retrievals the same wavelength regions are used as used by Buchwitz et al., namely the O2 A band at 760 nm and the CO2 band around 1600 nm.

In section 6 of this paper, the XCH4 product is obtained by dividing the CH4 column by the CO2 column. In earlier WFM-DOAS versions (Buchwitz et al., 2005; and this paper v0.4) the O2 column was used to obtain XCH4. In the latest version (v0.41) CO2 was chosen for this normalization because, as mentioned by the authors (P1955, line 2-6), "errors due to aerosols, residual cloud contamination, surface reflection, etc. are

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expected to be the more similar, the more similar the radiative transfer is". With this we agree. However, this does not simply imply that "in general, this requires that the two spectral intervals from which the two columns are retrieved are located as close as possible (in wavelength)", as stated by the authors. Houweling et al. show that the sensitivity on aerosols of the retrieval of CO2 depends strongly on surface albedo. Therefore it is important that, in addition to the similar radiative transfer, the surface albedo in two wavelength windows from which the two columns are retrieved are similar. Because the used CH4 and CO2 windows are about 700 nm apart, this is unlikely to be the case for all surface types. It would be useful to see what contribution to the improvement of XCH4 retrieval in v0.41 comes from normalisation to CO2 instead of O2 and what contribution is due to the correction based on the transmission curves. Was this investigated seperately? Does the normalisation to CO2 really improve the XCH4?

Furthermore, the authors state (P1955, line 8) that when two spectral regions are used with similar instrumental/calibration errors, these errors cancel to a certain agree. However, this does not apply to the used spectral regions, because channel 6 and 8 of SCIAMACHY do not have similar instrumental/calibration errors (Lichtenberg et al., submitted to ACPD, this special issue, submitted version of paper available to authors as one is co-author). We therefore recommend to delete this sentence.

p.1954, line 27 : The normalisation used by Frankenberg et al., (2005, Science) relates to CH4 measured at 1630-1670 nm and CO2 measured at 1562-1585 nm. This is very different from the normalisation used here which refers to CH4 from spectral window at 2265-2280 nm. This should be clearly stated and the paragraph needs rewriting addressing the issues mentioned above.

p.1956, line 29 : A remark on the general behaviour of the correlation coefficent should be added. Only mentioning the 0.9 value does not give a representative view of this dataset.

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In section 7 the XCO2 product is obtained by dividing the CO2 column by the O2 column. Because these bands are about 800 nm apart, also for this retrieval the issues raised in the above paragraphs apply. Moreover, the radiative transfer in the Oxygen A band is not similar to that in the CO2 band. Firstly, the absorption lines in the Oxygen A band are far stronger than those in the CO2 band. Secondly, Rayleigh scattering is negligible in the CO2 band but important in the Oxygen A band region and has a significant effect on the relative sensitivity of the radiative transfer on aerosols, as shown by van Diedenhoven et al. Thirdly, comparing results from van Diedenhoven et al. and Houweling et al., it is concluded that the sensitivity on aerosols of the retrieval of the O2 column and CO2 column are quantitatively different for similar surface albedos in the two spectral regions. For these reasons we believe many significant errors are introduced by this normalisation which should (at least) be mentioned.

p.1957, line 17: It is stated that, to compensate a not yet understood systematic underestimation, the CO2 columns have been scaled with a constant factor of 1.27. In the paper giving the details about this scaling (Buchwitz et al., 2005), it is also stated that the O2 column is scaled by a factor of 0.85. Is this still the case with the current version of WFM-DOAS? If so, we believe this is crucial information because it affects the XCO2 product directly and must be mentioned by the authors in the current paper.

In addition, above moderate to high albedos, Van Diedenhoven et al. find an overestimation of about 2-5 % of the O2 columns retrieved from SCIAMACHY data, compared to actual meteorological data (see Fig. 7). This is in contrast to the observed 15 % overestimation of the O2 column concluded by the authors. Of the overestimation found by Van Diedenhoven et al., 2 % can be explained by an offset on the measured reflectance, that can be corrected for. The remaining overestimation is likely due to aerosols, as shown in Fig. 2 of Van Diedenhoven et al. Could the authors comment on possible origin of the large overestimation of their O2 columns?

Furthermore, no indication of a systematic 27 % underestimation of the CO2 columns is observed by Houweling et al. Can this be understood ?

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Minor comments :

p.1949, line 5: the following reference should be included regarding ice-layer and slit-function: Gloudemans et al., The impact of SCIAMACHY near-infrared instrument calibration on CH4 and CO total columns, this special issue ACPD (2005)

p.1957, line 15: 'within a few percent' : looking at the differences in XCO2 variability observed in TM3 (2%) and the variability in SCIAMACHY data (7%) I would think a few percent is more something like 5%.

p.1960, line 3: same point, few percent more like 5%.

- In section 3 of the paper the WFM-DOAS algorithm is summarised. For WFM-DOAS method, look up tables are calculated for a US standard atmosphere including a tropospheric maritime and stratospheric background aerosol scenario and a surface albedo of 0.1 (Buchwitz, 2005). However, the information about the assumed atmospheric conditions is not mentioned in the description of the algorithm in section 3, but only briefly in section 7. Based on the conclusions made in the papers by van Diedenhoven et al. and Houweling et al. and references therein, we believe this is crucial information which needs to be mentioned in section 3.

- Table 1 should read XCH4 and XCO2. The bias apparently does not include the scaling factors used by the authors. A footnote should be added to Table caption mentioning this for completeness.

- It would be helpful for Fig.2, 4 and 6 to also plot the differences between the SCIAMACHY product shown and the MOPIT or model output shown. It is otherwise very hard and time-consuming to extract the differences from the plots themselves.

References:

van Diedenhoven, B., Hasekamp, O. P. ,Aben, I. : Surface pressure retrieval from SCIAMACHY measurements in the O2-A Band: Validation of the measurements and sensitivity on aerosols, This special issue of Atmos. Chem. Phys. Discuss., 2005

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Houweling, S., Hartmann, W., Aben, I., : Evidence of systematic errors in Sciamachy observed CO2 due to aerosols, This special issue of Atmos. Chem. Phys. Discuss., 2005

Buchwitz, M., et al., Atmospheric methane and carbon dioxide from SCIAMACHY satellite data: initial comparison with chemistry and transport models, Atmos. Chem. Phys., 5, 941-962, 2005

Lichtenberg, G., et al.,SCIAMACHY Level1 data: Calibration concept and in-flight calibration, submitted to Atmos. Chem. Phys. Discuss., 2005

Gloudemans et al., The impact of SCIAMACHY near-infrared instrument calibration on CH4 and CO total columns, This special issue of Atmos. Chem. Phys. Discuss., 2005

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1943, 2005.