

Authors' answer to the interactive comments of anonymous referee #2 on paper Heymann et al., Atmos. Meas. Tech. Discuss., 5, 4285-4320, 2012

First of all we would like to thank the referee for the helpful comments and questions. Below we give answers and clarifications to all comments and questions made by the referee.

Referee: “Line 25, page 4287 and references; change "Saito" to "Saitoh" and "Yoshida et al. 2011a, b" to "Yoshida J. et al. 2011; Yoshida Y. et al. 2011””

Authors: Done.

Referee: “Line 13, page 4292; how many channels exist within the spectral window of 1.395-1.41 μm ? Also, please specify the typical values of measurement error for averaged signal.”

Authors: We added information about the used detector pixels and the measurement error in the following way: “We use sun-normalised radiance (“intensity”) spectrally averaged between 1.395–1.41 μm measured by 20 detector pixels of SCIAMACHY channel 6. We spectrally average the intensity to reduce the measurement error to about 0.1 %.”

Referee: “section 4.1.1; add description about the "default aerosol scenario", "viewing zenith angle", and "optical properties of cirrus cloud" used in the sensitivity study (Fig. 3 and Table 1).”

Authors: In order to give more specific information about the used simulation scenario, we added the following description: “The scenario of the radiative transfer simulations has been defined as follows: Only direct nadir conditions (viewing zenith angle of 0°) are considered. In order to simulate cirrus clouds, an ice cloud with fractal particles based on a tetrahedron with an edge length of 50 μm , with a cloud top height (CTH) of 10 km and a geometrical thickness of 0.5 km is used. The used aerosol profile (default aerosol profile) is based on a realistic aerosol scenario (see the OPAC background scenario) described by Schneising et al. (2008).”

Referee: “section 4.1.2; for my understanding, this section is the most important part in this paper. So, more precise explanation would be helpful. (a) Can you give more explanation about the root cause of XCO₂ error ?”

Authors: The root cause of SCIAMACHY WFM-DOAS XCO₂ error, we aim at reduce, are retrieval errors due to scattering by thin clouds as Heymann et al. (2012) found that the data product suffers from unaccounted scattering by thin clouds. This has already been discussed in the introduction: “Heymann et al. (2012) compared the difference of these XCO₂ data and those from NOAA’s (National Oceanic and Atmospheric Administration) modelling and assimilation

system CarbonTracker (Peters et al., 2007) with global aerosol and cloud data. They found significant correlations with clouds in several regions especially over the Southern Hemisphere and concluded that the SCIAMACHY WFM-DOAS version 2.1 XCO₂ data product presumably suffers from the unaccounted scattering by thin clouds in those regions.”

Referee: “A 2-D-histogram of non-corrected WFMDv2.1 XCO₂ as a function of the scan-angle corrected O₂-ratio might be helpful.”

Authors: The middle panel of Fig. 4a shows WFMDv2.1 XCO₂ as a function of the scan-angle-bias corrected O₂-ratio.

Referee: “(b) To show the effectiveness of the new cloud filtering, 2-D-histograms of Fig. 4(b) should be given in a full O₂-ratio range. ”

Authors: Figure 4b shows WFMDv2.2 XCO₂ (after applying the O₂ column ratio filtering and correction and the 1.4 μm filtering) against the scan-angle corrected O₂-ratio and is given in the full O₂-ratio range. Measurements with O₂-ratios smaller 0.95 or larger 1.1 are filtered out.

Ignoring the filtering thresholds for this plot can result in misinterpretations because the XCO₂ data set has been empirically corrected by a quadratic function which was statistically determined in this O₂-ratio interval. This correction leads to wrong XCO₂ values for O₂-ratios outside of the interval.

Referee: “Some plot to show the effectiveness of the 1.4 um cirrus filtering would be also helpful.”

Authors: We added a figure, which shows 2-D-histograms of XCO₂ as a function of the deviations of the measured intensity spectrally averaged between 1395 – 1410 nm from the reference intensities for SCIAMACHY WFM-DOAS v2.1 and v2.2.

Referee: “(c) Is O₂-ratio in the middle panel of Fig. 4(a) raw value or scan-angle-bias corrected value ? If corrected value, please add superscript "cor" to O₂-ratio in the label (like eq. (1)).”

Authors: The superscript “cor” was added.

Referee: “(d) To avoid confusion, please add superscript "cor" to O₂-ratio in the label of the right panels of Fig. 4 and eq. (2).”

Authors: Done.

Referee: “(e) Change superscript "fit" to "ret" in eq. (2).”

Authors: Done.

Referee: “Line 14, page 4299; according to Table 3, 7.5 ppm should be 7.2 ppm.”

Authors: Done.

Referee: “Table 4 and Fig. 6; there exists small differences between Table 4 and Fig. 6. For example, $r = 0.74$ for Lamont of WFMDv2.1 in Table 4, but $r = 0.73$ in Fig. 6.”

Authors: Done.

Referee: “Fig. 8; if possible, please add some comments about the difference in the seasonal cycle amplitude between WFMD and CarbonTracker.”

Authors: We added the following sentence in order to comment the difference in the seasonal cycle amplitude between WFMD and CarbonTracker XCO₂: “The reason for the observed difference in the seasonal cycle amplitude can be an underestimation of the net ecosystem exchange (NEE) between the atmosphere and the biosphere in the CASA (Carnegie-Ames-Stanford Approach) biosphere model which is used by CarbonTracker (Yang et al., 2007; Schneising et al., 2011; Keppel-Aleks et al., 2012; Messerschmidt et al., 2012).”

Referee: “Fig. 8; it might be better to use a different color for WFMD data. It is difficult to distinguish blue and black symbols.”

Authors: In order to better distinguish between the data, we have used black diamonds for WFMDv2.1, slightly lighter blue crosses for WFMDv2.2 and red triangles for CarbonTracker XCO₂.

References

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