

***Interactive comment on* “First direct observation of the atmospheric CO₂ year-to-year increase from space” by M. Buchwitz et al.**

M. Buchwitz et al.

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Author’s answers to interactive comments of Referee C. Frankenberg on paper Buchwitz et al., First direct observation of the atmospheric CO₂ year-to-year increase from space, Atmos. Chem. Phys. Discuss., 7, 6719–6735, 2007

First of all we would like to thank Christian Frankenberg (in the following referred to as the referee) for his constructive comments. Below we give answers to all comments. Each comment will be carefully considered for the revised version of the manuscript.

Answers to specific comments:

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Abstract, line 18:

The referee is right that accuracy (systematic error, deviation from the truth) is more appropriate than precision (random error) for the highly averaged data discussed in this paper. This will be considered for the revised version of the paper.

The XCO₂ random error due to instrument noise is typically about 1% (Buchwitz and Burrows, 2004). The retrieval precision is however somewhat worse due to additional retrieval noise arising from, e.g., variability of atmospheric and surface parameters (according to preliminary results based on the analysis of the retrieved XCO₂ at several locations the retrieval precision is typically about 1.5% (Schneising et al., 2007, manuscript in preparation, 2007)). This will be added for the revised version of the paper.

Page 6721, line 23:

We agree that systematic errors are more problematic than random errors for inverse modeling. This has now been quantified in the recent papers of Chevallier et al., 2007, and Miller et al., 2007. This new information will be taken into account for the revised version of the paper.

Page 6722, lines 1-5:

Optimized refers to, for example, better spectral and spatial resolution. The corresponding sentence will be modified for the revised version of the paper.

Page 6724, line 21:

For the CO₂ spectral fit we only use a few detector pixels located in channel 6+ at the longer wavelength end of the CO₂ spectral fitting window (outside the CO₂ band) to better define the background signal (baseline). We have not performed a very detailed

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study to investigate what the impact is of including/excluding channel 6+ detector pixels but we estimate that this impact is likely to be small based on visual inspection of various individual spectral fits (fit residuals) which have not revealed any obvious problems related to the used channel 6+ detector pixels.

Page 6724, line 28:

A better description will be added for the revised version of the paper.

Error analysis:

We agree that the error analysis is not fully satisfactory. This refers to both approaches, the error analysis based on simulated retrievals and the analyzed differences with respect to CarbonTracker over the southern hemisphere. This has also been criticized by the other referee. We think that a reliable full end-to-end error analysis is extremely challenging, especially the quantification of systematic errors for the highly averaged data presented and discussed here. This strictly speaking requires to take all relevant disturbing parameters and their correlations (scattering properties of aerosols, residual clouds, etc.) into account and seems hardly possible without introducing major assumptions and without ending up with a largely uncertain final error estimate. To some extent we tried to circumvent this using in addition the difference to CarbonTracker over the southern hemisphere to estimate the error on the seasonal cycle over the northern hemisphere but we agree that this is also not fully satisfactory as this is also based on several not fully justified assumptions. Because of this, the error analysis section will be significantly modified for the revised version of the paper. We will discuss individual error sources and provide estimates how they affect the results. However, instead of aiming at a full error analysis (with large uncertainties) we will use the difference to CarbonTracker as a (conservative) estimate of our (systematic) error of the amplitude of the seasonal cycle and the observed year-to-year increase. This difference is a

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conservative estimate of the SCIAMACHY error as it also includes the error of CarbonTracker (this requires that the CarbonTracker errors are not significantly positively correlated with the SCIAMACHY errors which is very likely a good assumption).

In this context we would like to point out that the focus of the paper is to report on the first direct observation of the year-to-year CO₂ increase from space (see title). It is not the intention of the paper to perform an independent quantitative trend analysis which probably would require or at least significantly benefit from independent error estimates.

The referee is right that the error is very likely systematic rather than random as lots of data have been averaged (see the discussion given above).

Yes, the comparison concerning the annual increase shown in Fig. 2 is also based on co-located CarbonTracker results. This will be made clearer for the revised version of the paper.

It is right that other methods exist to obtain a trend, e.g., a linear regression analysis. For this paper we discuss the differences between yearly averages to determine and compare year-to-year changes. For the revised version of the paper we suggest to limit the analysis to this method and the northern hemisphere. We are however working on a more refined analysis, including a linear regression analysis, which also comprises the southern hemisphere. Preliminary results indicate that also over the southern hemisphere we obtain good agreement with CarbonTracker with respect to the CO₂ trend (Schneising et al., manuscript in preparation, 2007) despite the fact that significantly less data are available over the southern hemisphere compared to the northern hemisphere as the analysis is restricted to snow and ice free land surfaces.

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Answers to technical comments:

All technical comments will be considered for the revised version of the paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 6719, 2007.

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7, S3242–S3246, 2007

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