Carbon dioxide from SCIAMACHY on ENVISAT

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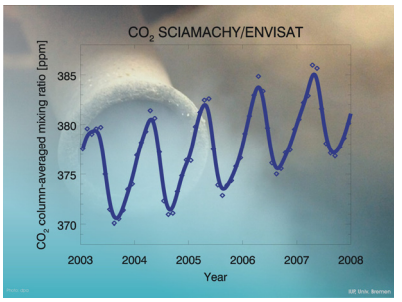
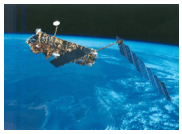
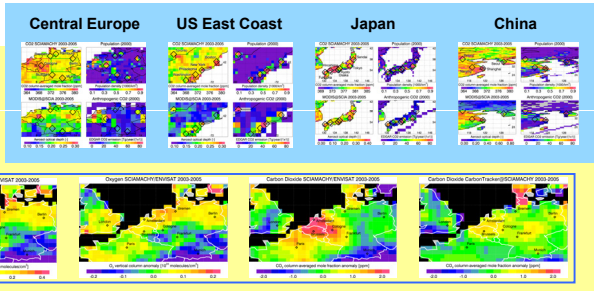


Overview

Global satellite observations of the column-averaged dry-air mixing ratio (mole fraction) of CO_2, denoted XCO_2, has the potential to significantly advance our understanding of regional CO_2 sources and sinks. This requires very high accuracy and high measurement sentitivity for the lower troposphere.

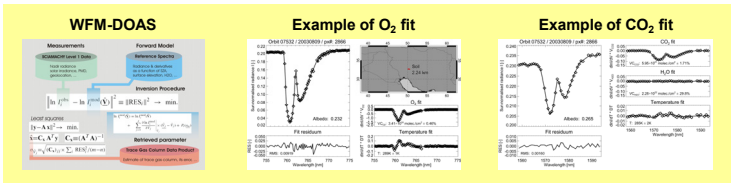
The only satellite instrument in orbit with high CO_2 surface sensitivity prior to the launch of GOSAT (2009) is SCIAMACHY. At the University of Bremen the WFM-DOAS (WFMD) algorithm has been developed to retrieve XCO_2 [1,2] and other gases such as methane [3]. Detailed comparisons of WFMDv1.0 XCO_2 with global models such as NOAA's CarbonTracker show clearly correlated spatio-temporal pattern but also significant differences, which are not well understood [2]. A potentially very useful method to understand to what extent retrieval biases contribute to the observed differences is to apply several different retrieval methods to the same satellite data. For this purpose - and in order to generate an improved SCIAMACHY XCO_2 data product in the future - a new algorithm is under development, the Bremen optimal EStimation DOAS (BESD) algorithm.

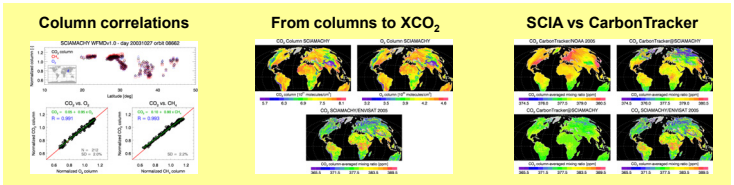




Retrieval algorithm WFM-DOAS

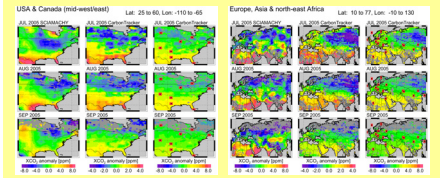
WFM-DOAS is a very fast least-squares algorithm based on a look-up-table (LUT) approach. A-priori knowledge about the atmospheric state is only used for the linearization of the radiative transfer but not to constrain the retrieved columns. Single (constant) vertical profiles are used for the retrieval (CO_2, aerosols, etc.). WFMDv1.0 is described in detail in [2].





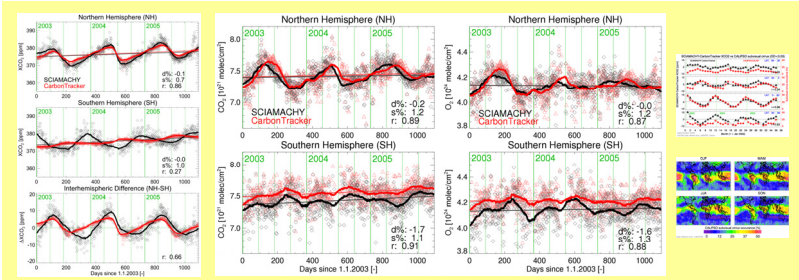
Regional pattern at 7° x 7°

Comparisons of monthly averages of all quality filtered SCIAMACHY WFMDv1.0 XCO_2 retrievals with CarbonTracker show significant correlations of the spatio-temporal pattern but also large differences. It is planned to reprocess all SCIAMACHY data with the new BESD algorithm to investigate to what extent the differences are caused by shortcomings of WFM-DOAS (e.g. simplified treatment of aerosols).



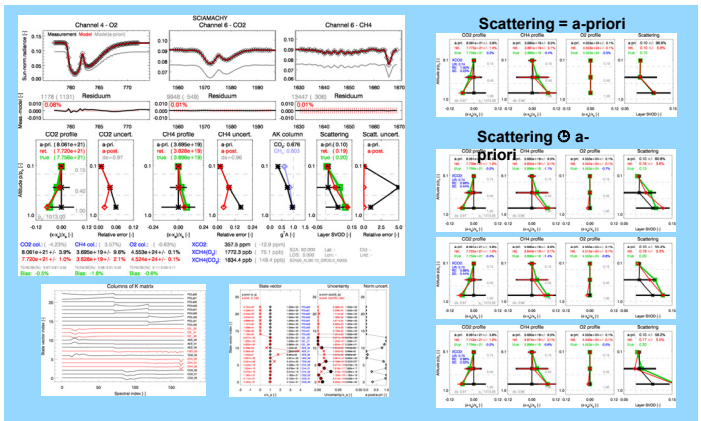
Time series over the northern and southern hemisphere

The annual CO_2 increase of about 2 ppm/year as observed by SCIAMACHY/WFMDv1.0 over the northern and southern hemisphere is in good agreement with CarbonTracker. Over the northern hemisphere the phase of the seasonal cycle is also in good agreement. The observed amplitude is however significantly larger. Over the southern hemisphere the time dependencies differ significantly. A possible explanation could be unaccounted scattering due to thin cirrus clouds.



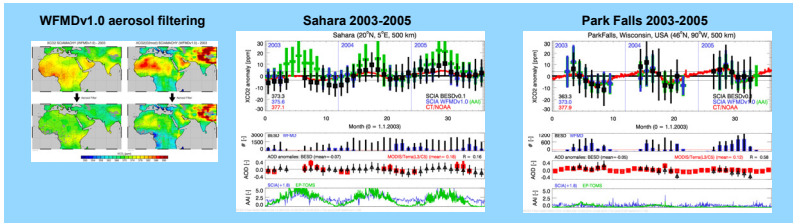
The BESD algorithm

BESD will aim at combining the advantages of DOAS and optimal estimation, e.g., to better consider light path variations due to changes of aerosols, residual clouds and variations of the surface reflectivity. BESD will be more flexible and will enable simultaneous multi-fitwindow retrievals using, e.g., the oxygen A-band and the 1.58 Qm CO_2 band.



First BESD retrievals

An initial version of BESD has been implemented which will be further optimized in the future. Below first results are shown for two sites: left: Sahara (to study the retrieved XCO_2 under desert dust storm conditions); right: Park Falls, Wisconsin, USA (to study the retrieved XCO_2 in northern mid-latitudes).



Acknowledgements

We thank NOAA for providing us with the CarbonTracker CO_2 fields, E. Martins, LMD/IPSL, France, for preliminary CALIPSO sub-visual cirrus occurance retrievals, NASA for MODIS AOD and TOMS AAI, and KNMI for SCIAMACHY AAI.

This work would not be possible withouth funding from DLR-Bonn, ESA (PROMOTE, ADVANSE), the EU (FP7 CityZen and MACC), and the University and the State of Bremen.

Selected references

[1] Buchwitz et al., First direct observation of the atmospheric CO_2 year-to-year increase from space, Atmos. Chem. Phys., 7, 4249-4256, 2007.

[2] Schneising et al., Three years of greenhouse gas column-averaged dry air mole fractions retrieved from satellite – Part 1: Carbon dioxide, Atmos. Chem. Phys., 8, 3827-3853, 2008.

[3] Schneising et al., Three years of greenhouse gas column-averaged dry air mole fractions retrieved from satellite – Part 2: Methane, Atmos. Chem. Phys., 9, 443-465, 2009.

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www.iup.uni-bremen.de/sciamachy/NIR_NADIR_WFM_DOAS/

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