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Retrieval of atmospheric Carbon Dioxide from Space: Technique and Validation

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The aim of this study is to develop a radiative transfer algorithm for the retrieval of CO_2 total column dry air mixing ratio (XCO2) from space borne observations of near-infrared (NIR) solar radiation reflected by the Earth's surface and atmosphere. Accuracy and spatio-temporal coverage of the targeted data set should be high enough to allow for an improved quantification of the sources and sinks of CO_2 by inverse modeling.
So far, SCIAMACHY on ENVISAT is the only Earth observing instrument that can measure CO_2 absorption in the NIR spectral range providing information on CO_2 down to the Earth's surface. In a first step, we have developed a retrieval algorithm that infers the CO_2 vertical profile in a non-scattering atmosphere from SCIAMACHY NIR nadir observations. The retrieval method is based on a Phillips-Tikhonov regularization scheme. For validation purposes, the algorithm has been further adapted to ground based observations by a Fourier Transform Spectrometer (FTS) at Park Falls, Wisconsin, USA. The vertical CO_2 profile is estimated with 1 to 2 degrees of freedom for SCIAMACHY observations and 3 to 4 degrees of freedom for the FTS. Our XCO2 retrieved from the ground based FTS at Park Falls compares very well with the corresponding reference data published via the TCCON database. Comparing the ground based FTS retrievals with SCIAMACHY retrievals under cloud-free and clean-air conditions indicates that SCIAMACHY retrievals are biased by a few percent. Our validation approach accounts for the different sensitivities of the sensors.
We plan to advance the algorithm by retrieving atmospheric aerosol properties simultaneously with the CO_2 profile. Park Falls measurements will be used to test the expected improved performance of the algorithm. Depending on data availability, we

will extend our validation efforts to more sites within the TCCON network.