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# Retrieval of atmospheric $CO_2$ from satellite near-infrared nadir spectra in a scattering atmosphere

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Atmospheric $CO_2$ is the dominant anthropogenic greenhouse gas. Satellite measurements of the $CO_2$ mixing ratio ($XCO_2$) derived from the SCIAMACHY instrument aboard ENVISAT and in the future from OCO and GOSAT can provide valuable information to quantify regional $CO_2$ sources and sinks. Such an application requires high accuracy and precision in the order of $1\%$ or better to provide an added value compared to the highly accurate but sparse ground-based measurement network. $XCO_2$ can be derived by simultaneously retrieving the atmospheric column of $CO_2$ and $O_2$. Therefore, simulated sun normalized radiance spectra within the $O_2$-A absorption band at around $760nm$ and of the $CO_2$ absorption band at $1580nm$ can be fitted to SCIAMACHY measurements. Unfortunately, both bands have a relatively large spectral distance and show also large differences of the strength of absorption. For this reason, path length modifications due to scattering by aerosols and clouds in both bands are also not identical, resulting in possible retrieval errors of $XCO_2$. Sub-visible cirrus clouds with an optical depth of $0.03$ can already significantly affect the retrieval. SCIAMACHY measurements within the $CO_2$ band do not hold enough information to correct for this effect. However, valuable information about cirrus clouds can potentially be obtained from SCIAMACHY measurements in the $O_2$-A band. We will present an optimal estimation based retrieval scheme that accounts for cirrus clouds by transferring cirrus information obtained from the $O_2$-A band to the $CO_2$ band. Additionally, the algorithm is able to account for a priori information to further constrain the inversion. In this context, we will present statistics of cirrus fraction, optical depth, and effective height obtained from CALIPSO data.