CO2 vertical profile retrieval from ground-based IR atmospheric spectra

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In the present work, an algorithm for retrieving the CO2 vertical profile is developed. A continuous (24h/day) CO2 vertical profile would be of high potential for studying the carbon cycle, the evaluation of satellite measurements or the assessment of numerical models, which forecast the near-surface CO2 flux. We use the atmospheric ground-based zenith spectra in the mid IR which are provided by an Atmospheric Emitted Radiance Interferometer (AERI). AERI was installed at the Jülich ObservatorY for Cloud Evolution (JOYCE), in Germany in 2012. It measures the downwelling infrared radiance from 520 cm-1 (3.3 μm) to 3020 cm-1 (19 μm) with a spectral resolution of 1 cm-1 and a temporal resolution of 1 minute. We demonstrate that there are several spectral bands with high sensitivity to the CO2 volume mixing ratio (VMR) in the AERI spectral region. In the first step, we retrieve the mean column amount of CO2 VMR for simulated radiances in clear sky cases using an algorithm known as AERIoe (Turner and Löhnert 2014). AERIoe is a variational retrieval algorithm based on the Optimal Estimation method. A line-by-line radiative transfer model (LBLRTM) is used to provide the AERI simulated radiances using model temperature and humidity. The algorithm shows high accuracy for retrieving the mean column amount of CO2 VMR. In the next step, it is modified to retrieve the CO2 vertical profile. We show that there is more than 1 degree of freedom for retrieving the CO2 vertical profile. First results reveal that the retrieved CO2 profiles are in a good agreement with true ones.

Key Words: Infrared Radiance, CO2 Profile, Optimal Estimation, Radiative Transfer, Retrieval Algorithm