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A framework for comparing remotely sensed and in-situ CO_2 concentrations

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Abstract. A framework has been developed that allows validating CO_2 column averaged volume mixing ratios (VMRs) retrieved from ground-based solar absorption measurements using Fourier transform infrared spectrometry (FTS) against measurements made in-situ (such as from aircrafts and tall towers). Since in-situ measurements are done frequently and at high accuracy on the global calibration scale, linking this scale with FTS total column retrievals ultimately provides a calibration scale for remote sensing. FTS, tower and aircraft data were analyzed from measurements during the CarboEurope Regional Experiment Strategy (CERES) from May to June 2005 in Biscarrosse, France. Carbon dioxide VMRs from the MetAir Dimona aircraft, the TM3 global transport model and Observations of the Middle Stratosphere (OMS) balloon based experiments were combined and integrated to compare with the FTS measurements. The comparison allows for calibrating the retrieved carbon dioxide VMRs from the FTS. The Stochastic Time Inverted Lagrangian Transport (STILT) model was then utilized to identify differences in surface influence regions or footprints between the FTS and the aircraft CO_2 concentrations. Additionally, the STILT model was used to compare carbon dioxide concentrations from a tall tower situated in close proximity to the FTS station. The STILT model was then modified to produce column concentrations of CO_2 to facilitate comparison with the FTS data. These comparisons were additionally verified by using the Weather Research and Forecasting – Vegetation Photosynthesis and Respiration Model (WRF-VPRM). The differences between the model-tower and the model-FTS were then used to calculate an effective bias of approximately −2.5 ppm between the FTS and the tower. This bias is attributed to the scaling factor used in the FTS CO_2 data, which was to a large extent derived from the aircraft measurements made within a 50 km distance from the FTS station: spatial heterogeneity of carbon dioxide in the coastal area caused a low bias in the FTS calibration. Using STILT for comparing remotely sensed CO_2 data with tower measurements of carbon dioxide and quantifying this comparison by means of an effective bias, provided a framework or a "transfer standard" that allowed validating the FTS retrievals versus measurements made in-situ.

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