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Determination of the Emission Rates of CO_2 Point Sources with Airborne Lidar

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Abstract

A large fraction of global anthropogenic greenhouse gas emissions originates from localized point sources. To monitor their emissions active remote sensing by airborne lidar is a promising measurement approach, such as provided by the integrated-path differential-absorption lidar CHARM-F. Installed on board the German research aircraft HALO, CHARM-F serves as a demonstrator for future satellite missions, e.g. MERLIN. CHARM-F simultaneously measures weighted vertical column mixing ratios of CO_2 and CH_4 below the aircraft. In spring 2018, during the CoMet field campaign, anthropogenic CO_2- and CH_4-emissions of point sources were determined, among others at the coal-fired power plant Jänschwalde in Germany. By transecting the isolated exhaust plume, the corresponding emission rate is derived from the enhancement in concentration, along the plume crossing. We find that on average our measurements are consistent with reported numbers, but observe high discrepancies between successive plume crossings of up to 50 %. As an explanation for these high discrepancies, we assess the influence of atmospheric turbulence by employing the Weather Research and Forecasting Model (WRF). The simulation demonstrates a pronounced diurnal cycle of plume inhomogeneity associated with local turbulence, predominately driven by midday solar irradiance.