Integrated Path Differential Absorption Lidar: A new Perspective for Global Observations of Atmospheric Carbon Dioxide with Unprecedented Accuracy

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Active remote sensing by Lidar (Light Detection and Ranging) offers the possibility to monitor the concentration of atmospheric trace gases such as carbon dioxide with unprecedented accuracy. Comprehensive modelling activities in the framework of ESA's A-SCOPE Mission assessment have shown that a Lidar instrument embarked on a polar orbiting satellite could dramatically enhance our capability in CO_2 flux estimation with uncertainties less than 0.02 Pg C yr^{-1} at the scale of 1000 km x 1000 km. Such a high accuracy in CO2 flux estimation using satellite observations in combination with inverse modelling cannot be provided by passive measurement techniques because of their strong limitations on accuracy as well as spatial and temporal coverage due to cloud cover, aerosol interference, and the lack of sunlight. A Lidar instrument will have its own light source emitting pulsed narrow-line radiation, not relying on the sunlight. The CO_2 values will be provided with no bias due to particle-scattering in the light path, which can have a strong regional variability. The use of range-gated receiver for detection of the Lidar echoes from clouds or the Earth surface enables to distinguish surface from cloud or aerosol backscatter. This permits high-precision retrievals of CO_2 in the presence of particle layers with small/moderate optical depth, such as thin cirrus or aerosol layers. The Lidar beam can also reach the surface when gaps between clouds occur, due to the small footprint and the possibility of near-nadir-view which is also advantageous for high-precision soundings over the ocean due to the strong signals resulting from specular reflection over water. A further advantage of the Lidar technique is the possibility to choose appropriate sounding wavelengths matching temperature-insensitive CO_2 absorption lines to guarantee a minimum error contribution from unknowns in the temperature and humidity profiles. Soundings in the line wing enable a proper weighting function for high-sensitive measurements near the surface. In this presentation we will give a brief overview on the measurement principle, the expected performance from simulation runs, and the result from an airborne campaign which was dedicated to investigate the measurement performance over complex terrain and water surfaces. The next step is development of an airborne A-SCOPE demonstrator.