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A practical CO_2 flux remote sensing technique

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An accurate quantification of CO_2 flux from both natural and anthropogenic sources is of great interest in various areas of the Earth, environmental and atmospheric sciences. As emitted excess CO_2 quickly dilutes into the 400 ppm ambient CO_2 concentration and degassing often occurs diffusively, measuring CO_2 fluxes is challenging. Therefore, fluxes are usually derived from grids of in-situ measurements, which are labour intensive measurements. Other than a safe measurement distance, remote sensing offers quick, spatially integrated and thus a more thorough measurement of gas fluxes. Active remote sensing combines these merits with operation independent of sunlight or clear sky conditions. Due to their weight and size, active remote sensing platforms for CO_2, such as LIDAR, cannot easily be applied in the field or transported overseas. Moreover, their complexity requires a rather lengthy setup procedure to be undertaken by skilled personal.
To meet the need for a rugged, practical CO_2 remote sensing technique to scan volcanic plumes, we have developed the CO_2 LIDAR. It measures 1-D column densities of CO_2 with sufficient sensitivity to reveal the contribution of magmatic CO_2.
The CO_2 LIDAR has been mounted inside a small aircraft and used to measure atmospheric column CO_2 concentrations between the aircraft and the ground. It was further employed on the ground, measuring CO_2 emissions from mud volcanism. During the measurement campaign the CO_2 LIDAR demonstrated reliability, portability, quick set-up time (10 to 15 min) and platform independence.
This new technique opens the possibility of rapid, comprehensive surveys of point source, open-vent CO_2 emissions, as well as emissions from more diffuse sources such as lakes and fumarole fields.
Currently, within the proof-of-concept ERC project CarbSens, a further reduction in size, weight and operational complexity is underway with the goal to commercialize the platform. Areas of potential applications include fugitive CO_2 detection at carbon capture and storage sites, volcano monitoring and bottom-up quantification of CO_2 fluxes, such as from urban areas or natural sources.