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Poster
Globally distributed atmospheric CO_2 concentration measurements with high-precision, low-bias, and full seasonal sampling are essential to advance carbon cycle sciences and assess carbon-climate changes. However, two thirds of the Earth's surface is typically covered by clouds, and passive remote sensing approaches from space are limited to measurements in sunlit cloud-free scenes without significant aerosol loading. NASA Goddard Space Flight Center has developed an integrated-path, differential absorption (IPDA) lidar approach to measure atmospheric column-averaged CO_2 concentration (XCO_2) and has conducted several airborne campaigns as demonstrations during the past decade. This pulsed laser approach uses a step-locked laser transmitter, a fiber laser amplifier, and a high-efficiency detector to measure time-resolved laser backscatter profiles along with the CO_2 absorption line shape. This allows retrieving XCO_2 to any significant reflective surfaces with precise knowledge of the photon path-length even in the presence of aerosols and clouds.

We demonstrated the measurement capabilities of this active remote sensing technique with the data from the summer 2017 airborne campaign in the U. S. and Canada. We demonstrated the lidar's capability to measure XCO_2 to ground and to cloud tops, and CO_2 enhancements from wildfires through dense smoke plumes. We validated the lidar's XCO_2 retrievals against airborne in situ measurements during spiral-down maneuvers. The lidar measurements can be used to resolve the vertical and horizontal gradients of CO_2 and quantify CO_2 enhancement from wildfires. This active remote sensing technique can provide all-sky data coverage and XCO_2 measurements in low-bias and high-precision for future airborne science campaigns. It is a strong candidate for future active space missions to observe the global distribution of XCO_2, like the Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS) mission studied by NASA.
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