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Lidar reveals CO_2 concentration field anomalies in the atmosphere

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In the framework of climate prediction, it is necessary to understand the evolution of carbon cycle and particularly biosphere – atmosphere exchanges of carbon dioxide (CO_2). The current "top-down" approach relies on a ground-based network of concentration measurements and a transport model with certain space and time resolutions to estimate continental to regional surface fluxes. This method assumes a hypothesis of time and space ergodicity for the in-situ measurements that has not yet been verified. Lidar is able to address the issue of space and time CO_2 concentration representativity. In this paper, we present outstanding high space and time resolution measurements of carbon dioxide mixing ratio and radial wind speed in the atmosphere by a new 2-μm high power coherent differential absorption lidar (CDIAL). The lidar reveals CO_2 mixing ratio variations in the atmospheric surface layer with 15min time and 100m space resolutions and 1% statistical uncertainty over 1.5 km. The simultaneous radial wind speed measurements enable to understand CO_2 gradient anomalies as a result of imperfect mixing of surface anthropogenic emissions. Preliminary advected CO_2 anthropogenic fluxes are estimated. Potential applications are discussed in details.