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An anomalous CO_2 uptake measured over asphalt surface by open-path eddy-covariance system

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Measurements of net ecosystem exchange of CO_2 in desert environments made by Wohlfahrt et al. (2008) and Ma (2014) indicate strong CO_2 sink. The results of these studies have been challenged by Schlesinger (2016) because the rates of the CO_2 uptake are incongruent with the increase of biomass in the vegetation and accumulation of organic and inorganic carbon in the soil. Consequently, the accuracy of the open-path eddy-covariance systems in arid and semi-arid ecosystems has been questioned.
A new technology merging the sensing paths of the gas analyzer and the sonic anemometer has recently been developed. This integrated open-path system allows a direct measurement of CO_2 mixing ratio in the open air and has the potential to improve the quality of the temperature related density and spectroscopic corrections by synchronously measuring the sensible heat flux in the optical path of the gas analyzer.
We evaluate the performance and the accuracy of this new sensor over a large parking lot with an asphalt surface where the water vapor and CO_2 fluxes are expected to be low and the interfering sensible heat fluxes are above 200 Wm-2. For independent CO_2 flux reference measurements, we use a co-located closed-path analyzer with a short intake tube and a standalone sonic anemometer. We compare energy and carbon dioxide fluxes between the open- and the closed-path systems. During periods with sensible heat flux above 100 W m-2, the open-path system reports an apparent CO_2 uptake of 0.02 mg m-2 s-1, while the closed-path system consistently measures a more acceptable upward flux of 0.015 mg m-2 s-1. We attribute this systematic bias to inadequate fast-response temperature compensation of absorption-line broadening effects. We demonstrate that this bias can be eliminated by using the humidity-corrected fast-response sonic temperature to compensate for the abovementioned spectroscopic effects in the open-path analyzer.