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Urban-focused satellite CO_2 observations from the Orbiting Carbon Observatory-3: a first look at the Los Angeles Megacity

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The OCO-3 instrument was launched on May 4, 2019 from Kennedy Space Center to the International Space Station. Since August 2019, the instrument has taken measurements of reflected sunlight in three near-infrared bands from which column averaged dry-air mole fractions of carbon dioxide (XCO_2) are derived. The instrument was specifically designed to measure anthropogenic emissions and its snapshot area map (SAM) and target (TG) observational modes allow to scan large contiguous areas (up to 80×80 km^2) on a single overpass over emission hotspots like cities, power plants, or volcanoes. These measurements result in fine-scale spatial maps of XCO_2 unlike what can be done with any other current space-based instrument. Here, we present and analyze XCO_2 distributions over the Los Angeles (LA) megacity derived from multiple OCO-3 TG and SAM mode observations using the vEarly data product. We find that urban XCO_2 values are elevated by 2-6 ppm relative to a clean background. The dense, high resolution OCO-3 observations reveal fine-scale, intra-urban variations of XCO_2 over the LA megacity that have not been observed from space before. We further analyze the intra-urban characteristics and compare the XCO_2 enhancements observed by OCO-3 with simulated values from two models that can resolve XCO_2 variations across the city: an Eulerian (WRF-Chem) and a Lagrangian approach (X-STILT). We show that the observed variations are mainly driven by the complex and highly variable meteorological condition in the LA Basin. Median XCO_2 differences between model and observation are typically below 1.3 ppm over the entirety of the LA megacity with slightly larger differences for some sub regions. Further, we find that OCO-3's multi-swath measurements capture about three times as much of the city emissions compared to single-swath overpasses. In the future, these observations will help to better constrain urban emissions at finer spatiotemporal scales.