

Hydrogen Cycle in Mexico City: Diurnal Variation, Holiday Effect and Source Fingerprinting

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Mexico City with a population of 25 million, the largest mega-city in North America, provides a testing ground for regional and global impacts on air quality and climate of increasing urbanization. To help understand the biogeochemistry of Mexico City a comprehensive international multi-agency Megacity Initiative: Impact on Regional and Global Environment (MILAGRO) field campaign was conducted in March 2006. We report diurnal and weekly observations of molecular hydrogen, CO, and CO₂ in Mexico City. A regular diurnal profile with peak concentrations of hydrogen in early morning caused by the high traffic and shallow boundary layer was revealed. A record level of hydrogen of 5 ppm, a factor of 10 above background levels, was measured. We hypothesize that most of the hydrogen is coming from automobiles; however, we did observe emissions from other industrial or power plant sources. Analysis of the H₂/CO, CO/CO₂, and H₂/CO₂ ratios are developed as a chemical fingerprinting method to delineate these sources and relate them to combustion efficiency. We utilize H₂/CO ratios to diagnose traffic patterns, for example the early morning H₂/CO peak is attributed to sluggish rush our traffic. We also observe significantly (25%) lower hydrogen during the weekend holidays than workdays. Finally, regional scale modeling of the Mexico City hydrogen cycle is performed using the Weather Research Forecast: Chemistry (WRF-CHM) model at 1 km resolution. The model results are compared to our measurements to gain a quantitative understanding of hydrogen sources and sinks in Mexico City. Our findings are significant to the understanding of the global hydrogen cycle and developing an urban baseline for hydrogen to assess potential perturbations to it from transitioning to a hydrogen economy.