Spatial and Temporal Gradients in Atmospheric CO_2 and CO in the Los Angeles Megacity

K.R. Verhulst[1], J.B. Miller[2], V. Yadav[1], S. Lehman[3], K. Gurney[4], C. Miller[1], R. Duren[1], S. Newman[5], M. Fischer[6], J. Kim[7], P.K. Salameh[7], R.F. Weiss[7], R. Keeling[7], T. Pongetti[1] and C. Sloop[8]

[1]NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109; 818-393-5817, E-mail: Kristal.R.Verhulst@jpl.nasa.gov
[2]NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO 80305
[3]Institute of Arctic and Alpine Research (INSTAAR), University of Colorado, Boulder, CO 80309
[4]Arizona State University, Tempe, AZ 85287
[5]California Institute of Technology, Pasadena, CA 91125
[6]Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA 94720
[7]Scripps Institution of Oceanography, University of California at San Diego, La Jolla, CA 92037
[8]Earth Networks, Inc., Germantown, MD 20876

Global atmospheric observations show an unprecedented rise in atmospheric carbon dioxide (CO_2) levels since the pre-industrial era. This trend correlates with estimates of CO_2 emissions from global fossil fuel consumption during the same period. Globally, urban regions account for ~70% of fossil carbon emissions; however, there are gaps in our understanding of the urban processes that influence carbon emissions. Measurements in urban areas are critical for linking atmospheric observations with fine-scale emissions data to understand the drivers of carbon emissions. The Los Angeles (LA) Megacities Carbon Project was established to develop and test robust techniques for monitoring distributions and trends of fossil carbon emissions in large cities (megacities.jpl.nasa.gov). The project includes a fifteen-node *in situ* greenhouse gas monitoring network spanning the LA metropolitan area and surrounding regions (Verhulst et al. 2017). We estimate "excess" CO_2 and carbon monoxide (CO) levels relative to nearby background mole fractions, which result from changes in local emissions and meteorology. CO is commonly used as a tracer for anthropogenic fossil fuel carbon dioxide (CO_2fos), the mole fraction of CO_2 in dry air resulting from fossil fuel combustion relative to background, because it is co-emitted during the incomplete combustion of fossil fuels. Atmospheric CO measurements alone do not give a quantitative estimate of atmospheric CO_2fos and require calibration using radiocarbon ($^{14}CO_2$) observations. During the course of this study, $^{14}CO_2$ flask-sampling was conducted by NOAA/INSTAAR at 3 sites every ~3-4 days to derive atmospheric CO_2fos. CO_2fos signals derived from $^{14}CO_2$ suggest that ~75% of the midday CO_2 enhancements are explained by variability in CO_2fos, while the remainder may be attributed to biospheric fluxes. Utilizing the robust CO/CO_2 ratios and CO_2fos estimates derived from $^{14}CO_2$ allows approximation of a synthetic, continuous CO_2fos time series, CO_2fos_syn. CO_2fos_syn will be tested in our atmospheric modeling framework and compared with Hestia-LA, a bottom-up dataset quantifying anthropogenic CO_2fos emissions that relies on a mixture of activity data, fuel statistics, direct flux measurement, and modeling algorithms. The $^{14}CO_2$ record in LA also allows us to assess uncertainties in CO_2fos fluxes determined using methods that rely on total CO_2 observations.

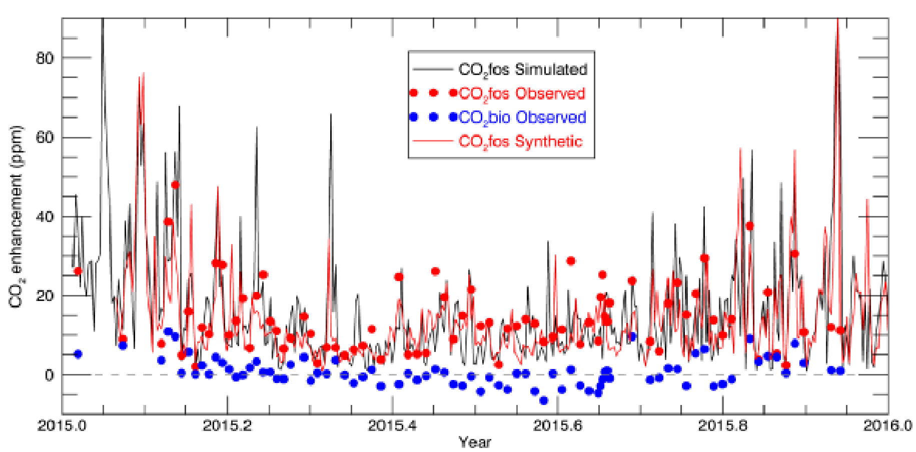

Figure 1. Time series of CO_2fos simulated using the Hestia emissions (Gurney et al. 2012) and the WRF-STILT footprint model (black), daily CO_2fos_syn (red) derived from 21:00 UTC *in situ* CO data, and observed CO_2fos and CO_2bio at a measurement site near Downtown LA (University of Southern California).