Atmospheric Observations of Carbon Monoxide (CO) and Fossil Fuel CO_2 Emissions from a Medium Sized City: Sacramento, California

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Accurate measurement of recently added fossil fuel carbon dioxide (CO_2ff) in the atmosphere is needed not only to quantify CO_2ff emissions, but also aids in understanding emissions of other anthropogenic trace gases. We use measurements of the radiocarbon content of atmospheric CO_2 ($\Delta^{14}CO_2$) to determine recently added CO_2ff in flask samples taken by aircraft over and downwind of Sacramento, California on February 27 and March 6, 2009. We determine the CO to CO_2ff emission ratio from the flask measurements as 14 ± 1 ppbCO/ppmCO_2ff (figure 1). Our results support the bottom-up inventory estimate of 15.4 ppbCO/ppmCO_2ff obtained from the CEPAM (CO) and Vulcan (CO_2ff) databases for the Sacramento region. However, if total CO_2 enhancement is assumed to represent CO_2ff in the urban plume, the CO:CO_2 ratio is much lower (figure 1), and would have suggested lower overall CO emissions. We use the ^{14}C-derived CO:CO_2ff emission ratio to obtain a high resolution CO_2ff record from continuous CO observations made on the February 27, 2009, flight. Comparison with total CO_2 mole fraction, also measured continuously in the same flight, shows that while CO_2ff emissions dominate the CO_2 variability in the Sacramento plume, they are not sufficient to explain all of the CO_2 variability, indicating some contribution from biospheric CO_2 (CO_2bio) exchange. Furthermore, within the Sacramento plume, a positive CO_2bio flux is observed, indicating net respiration and/or biofuel use. Conversely, CO_2bio is negative outside the urban plume, indicating net photosynthetic uptake in the rural Sacramento Valley. In a second flight, on March 6, 2009, the same type of analysis, using only the flask samples, shows that CO_2bio within the city was negative.

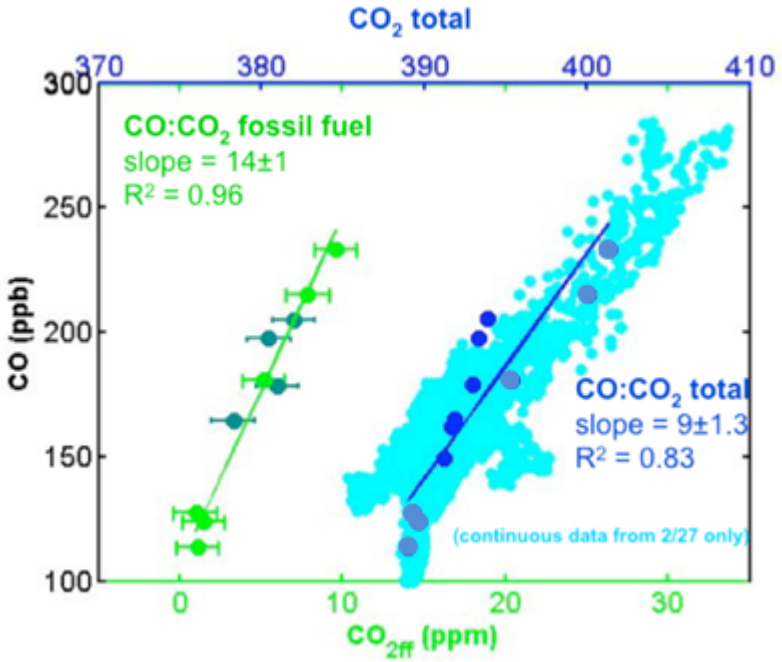

Figure 1. Relationship between CO_2ff (green symbols, bottom axis) and CO, and between total CO_2 (blue symbols, top axis) and CO. Flask measurements are the large circles, with the different shades indicating the two flights. The small, light blue circles are continuous measurements made on February 27, 2009. The lines are the best fit to the combined datasets, and the slopes are the obtained CO:CO_2ff or CO:CO_2total emission ratio.