Unexpected and Significant Biospheric CO₂ Fluxes in the Los Angeles Basin Indicated by Atmospheric Radiocarbon (¹⁴CO₂)

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Cities account for about 70% of global fossil fuel-carbon dioxide (CO₂) emissions, and with urban populations rising, it will become imperative to accurately account for urban emissions. Fossil fuel-CO₂ emissions are typically estimated using economic statistics on fuel consumption, and while accurate at national and annual scales, the errors are unknown at urban scales. It is therefore important to develop independent methods of estimating emissions for cities. Atmospheric CO₂ measurement networks in several urban areas have recently been established, but CO₂ alone can not distinguish biospheric and fossil contributions. Using measurements of atmospheric ¹⁴CO₂, the gold standard for identifying fossil fuel emissions in the atmosphere, we will show that CO₂-only methods can lead to substantial biases in fossil fuel-CO₂ emissions detection.

Here, we report results of an air sampling network for radiocarbon (¹⁴C) measurements within the Los Angeles monitoring network. These ¹⁴CO₂ measurements are part of NOAA’s larger effort to measure radiocarbon for fossil fuel-CO₂ identification at regional (~102 – 103 km) scales throughout the U.S., but the Los Angeles sites are concentrated spatially and exhibit much larger CO₂ and ¹⁴CO₂ signals than at any other measurement site. Mid-day CO₂ enhancements above background at our three sites in Los Angeles averaged 16 ppm, but ¹⁴CO₂ data reveal that only ~ 75% of the enhancement resulted from fossil fuel combustion. Thus, the remaining 25% originated from biospheric sources. We will quantify the contributions of possible sources to this unexpectedly large (and seasonally varying) biospheric contribution. Finally, we will discuss the implications of these results for urban emissions monitoring using surface and space-based approaches and also explore the benefits of improving fossil fuel detection by using atmospheric measurements of CO₂, CO, ¹⁴CO₂, and other tracers.

Figure 1. Correlation between enhancements over background of CO₂ and ¹⁴CO₂ at three sites in the Los Angeles Basin: U. of Southern California, Granada Hills, and Cal. State Fullerton. The slope of the correlation should be -1000 for a purely fossil fuel CO₂ signal, but the deviation shows a ~ 25% contribution from biospheric sources.