Quantification of Urban Fossil Fuel CO_2 Emissions from the Indianapolis Flux Project (INFLUX)

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Quantification of fossil fuel CO_2 (CO_2ff) emissions is vital to improving our understanding of the global and regional carbon cycle, and independent evaluation of reported emissions is essential to the success of any emission reduction efforts. The urban scale is of particular interest, because ~75% CO_2ff is emitted from urban regions. Measurements of $^{14}CO_2$ can be used to partition CO_2ff from total CO_2 in flask samples, but it is difficult to obtain sufficient $^{14}CO_2$ measurements to infer the urban emission flux.

In the Indianapolis Flux Project (INFLUX), we make flask measurements of $^{14}CO_2$ and ~50 trace gases from a network of towers and light aircraft. CO_2ff and other anthropogenic trace gases are consistently enhanced at tower sites downwind of the city and in the urban plume sampled from the aircraft. The choice of background is critical in isolating the urban CO_2ff component from biospheric CO_2, and we examine this in detail.

Previous studies have used the strong and consistent relationship between CO_2ff and carbon monoxide (CO) to quantify CO_2ff. In Indianapolis, we find only weak and variable correlations between CO_2ff and CO, likely due to the mix of CO_2ff sources in Indianapolis. Yet in winter, total CO_2 enhancement is consistent with CO_2ff, and we therefore use total CO_2 enhancement from the high resolution *in situ* total CO_2 measurements from the aircraft in a simple mass balance model to estimate the urban CO_2ff emissions. An initial comparison shows a ~20% difference between the top-down and bottom-up methods from aircraft samples.

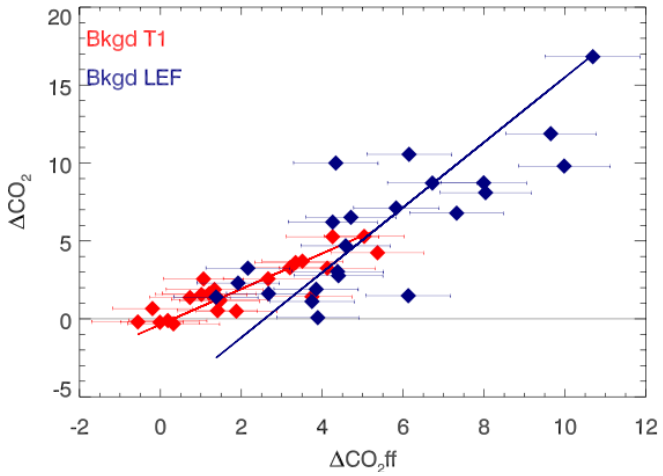

Figure 1. Correlation between fossil fuel CO_2 (CO_2ff) and total CO_2 enhancement (ΔCO_2) at INFLUX downwind tower in winter, using upwind background values from INFLUX Tower 1 (red) or using a continental background from the LEF Site in Wisconsin (blue). When the local upwind tower is used, ΔCO_2 is entirely explained by CO_2ff. When the LEF continental background is used, CO_2ff and ΔCO_2 are both larger, and only about half of ΔCO_2 is explained by CO_2ff. Choice of background is therefore critical in isolating the urban CO_2ff signal.