

Quantification of fossil fuel CO₂ emissions from an urban region: Early results from the Indianapolis Flux Project (INFLUX)

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Emissions of fossil fuel CO₂ (CO₂ff) from anthropogenic sources are the primary driver of observed increases in the atmospheric CO₂ burden, and hence global warming. Quantification of the magnitude of fossil fuel CO₂ 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 any emission reduction efforts. The urban scale is of particular interest, since most CO₂ff is emitted from urban regions, and cities are leading the way in attempts to reduce emissions.

The Indianapolis Flux Project (INFLUX) aims to develop and assess methods to quantify urban greenhouse gas emissions. Indianapolis was chosen as an ideal test case, since it has relatively straightforward meteorology; a contained, isolated, urban region; and substantial and well-known fossil fuel CO₂ emissions. INFLUX incorporates atmospheric measurements of a suite of gases and isotopes including ¹⁴C from light aircraft (providing high spatial resolution) and from a network of cell phone towers (providing high temporal coverage) surrounding the Indianapolis urban area. The recently added CO₂ff content is calculated from measurements of ¹⁴C in CO₂, and then convolved with atmospheric transport models and ancillary data to estimate the urban CO₂ff emission flux. Comparison with bottom-up CO₂ff inventory estimates allows assessment of uncertainties in both the observational and inventory methods.

This presentation will focus on the ¹⁴C sample collection and measurement for INFLUX. Significant innovations in sample collection include: collection of hourly averaged samples to average out very short term atmospheric variability; and collection of both upwind and downwind samples, so that background values can be accurately quantified. Our results show that CO₂ff is consistently enhanced at the downwind site. Trace gases associated with combustion sources, such as CO, fossil fuel CO₂ and hydrocarbons are well correlated with CO₂ff. Total CO₂ is also consistently enhanced in the downwind samples, even in summer. In winter, total CO₂ enhancement is slightly higher than the fossil fuel CO₂ enhancement, in agreement with Indiana's requirement for 10% bioethanol use in gasoline.