Investigating Hydrocarbon Tracers for Anthropogenic CO_2 at Indianapolis, IN

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Anthropogenic emissions of hydrocarbon compounds may provide information about carbon dioxide (CO_2) emissions in an urban environment. The Indianapolis FLUX experiment (INFLUX) has produced an eight-year time series of urban CO_2, methane (CH_4), carbon monoxide (CO), and several hydrocarbon species. We combine these measurements with the Hestia data product for Indianapolis, as well as footprints for each tower to learn about emissions of benzene (C_6H_6) as they relate to fossil fuel produced CO_2.

Using carbon-14 dioxide ($^{14}CO_2$) measurements to quantify the urban enhancement of fossil CO_2 (CO_{2ff}), we calculate the ratio of benzene to CO_{2ff} observed for 5 years at Indianapolis. We then use benzene data from the Environmental Protection Agency (EPA) National Emissions Inventory 2014, and estimates of fossil fuel produced CO_2 from the Hestia data product for Marion County, Indiana to calculate ratios for eight distinct sectors represented by Hestia (Airport, Commercial, Industrial, Mobile, Non-road, Residential, Utility, and Rail).

Using these ratios, we calculate a "Hestia Benzene" product for a twelve-month period in 2012-2013. This is then multiplied by model footprints for each of the tower sites at Indianapolis. This produces modeled tower data, which we compare to the real measurements. This gives us two pieces of information. First, it provides a metric to determine how well the reported EPA emissions of benzene are represented by the measurements at Indianapolis. Second, we can begin to assess if benzene is a unique tracer for any of the sectors within Hestia. If a tracer is unique to a single sector, it becomes a very powerful tool for troubleshooting the Hestia and tower footprint models.

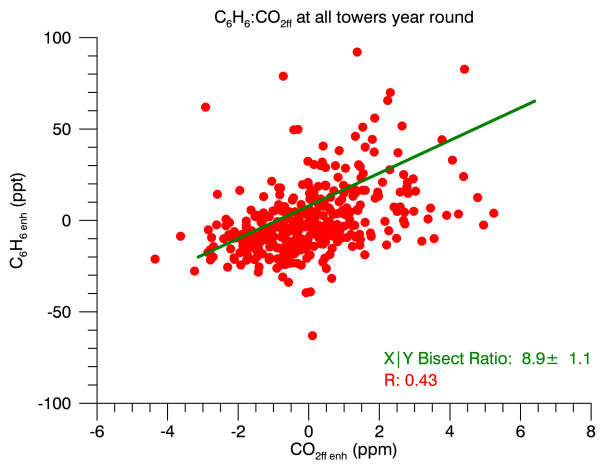

Figure 1. Benzene vs Fossil Fuel CO_2 (CO_{2ff}) enhancements at Indianapolis. Regression was done using an X|Y Bisector approach. Data was filtered for desireable atmospheric conditions. R represents the Pearson correlation coefficient for the benzene vs CO_{2ff} data, not the r^2 of the linear model.

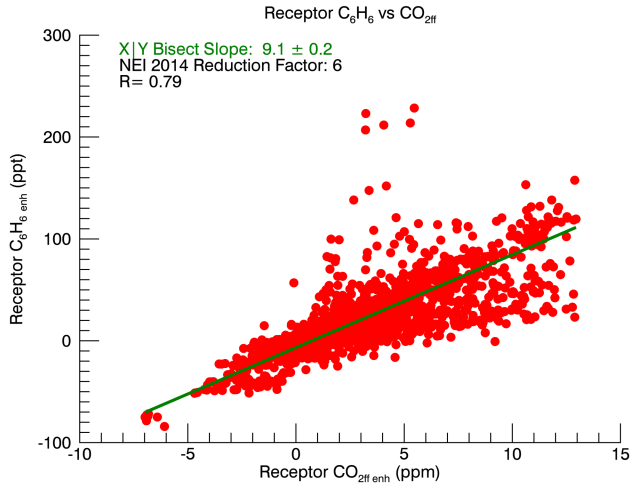

Figure 2. "Hestia Benzene" vs Hestia Fossil Fuel CO_2 (CO_{2ff}) enhancements at Indianapolis. Regression was done using an X|Y Bisector approach. Data represents 12 months of receptor data from November 1, 2012 - October 31, 2013. R represents the Pearson correlation coefficient for the hestia benzene vs hestia CO_{2ff} data, not the r^2 of the linear model.