Supporting Information for "Evaluating an emissions inventory using atmospheric CO_2 flux measurements and source partitioning in a suburban environment"

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Specific steps to partition anthropogenic and biogenic CO_2 flux components:

Step 1: Estimate the eddy diffusivity (K) by calculating the ratio of CO_2 flux measurements (F_{CO_2}) to the vertical gradients of CO_2 mole fractions (∇ C_{CO_2}):

$$K = -\frac{F_{CO_2}}{\nabla C_{CO_2}} \tag{1}$$

Step 2: Use the vertical gradients of CO mole fractions (∇ C_{CO}) and the estimated eddy diffusivity (K) to calculate the CO fluxes (F_{CO}):

$$F_{CO} = -K\nabla C_{CO} \tag{2}$$

Step 3: Estimate the fossil fuel CO_2 emissions (F_{CO_2ff}) by combining the CO fluxes with the emissions ratio (R) of CO to CO_2ff:

$$F_{CO_2ff} = \frac{F_{CO}}{R} \tag{3}$$

Step 4: Attribute the differences between the net flux measurements and the partitioned fossil fuel CO_2 emissions to estimate the biogenic CO_2 fluxes (F_{CO_2bio}):

$$F_{CO_2bio} = F_{CO_2} - F_{CO_2ff} \tag{4}$$

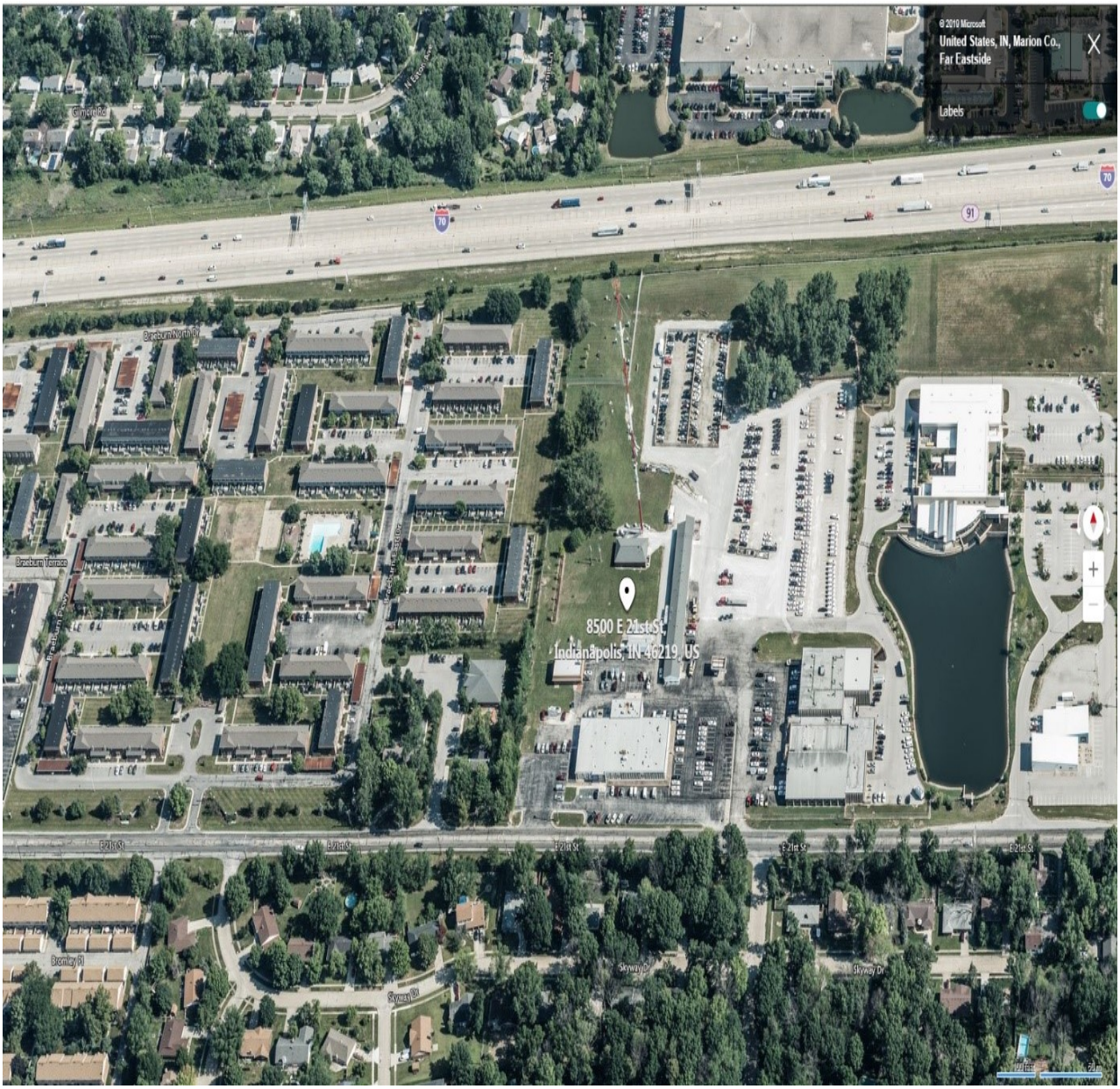

Figure S1. Surface environment around Tower 2 (39.7978°N, 86.0183°W) in Indianapolis, IN.

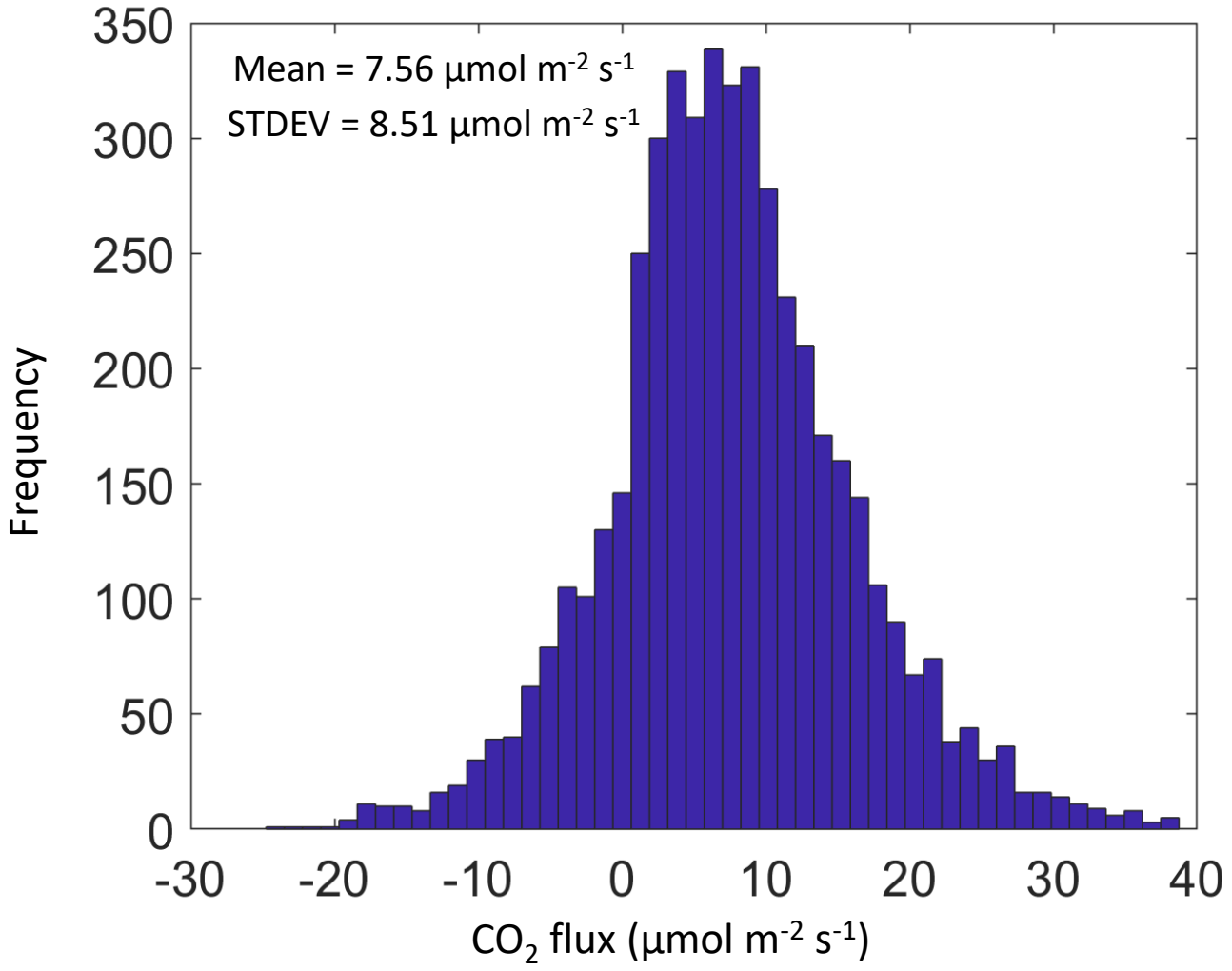

Figure S2. Histogram of eddy-covariance CO_2 flux measurements at Tower 2 from January to July in 2013.

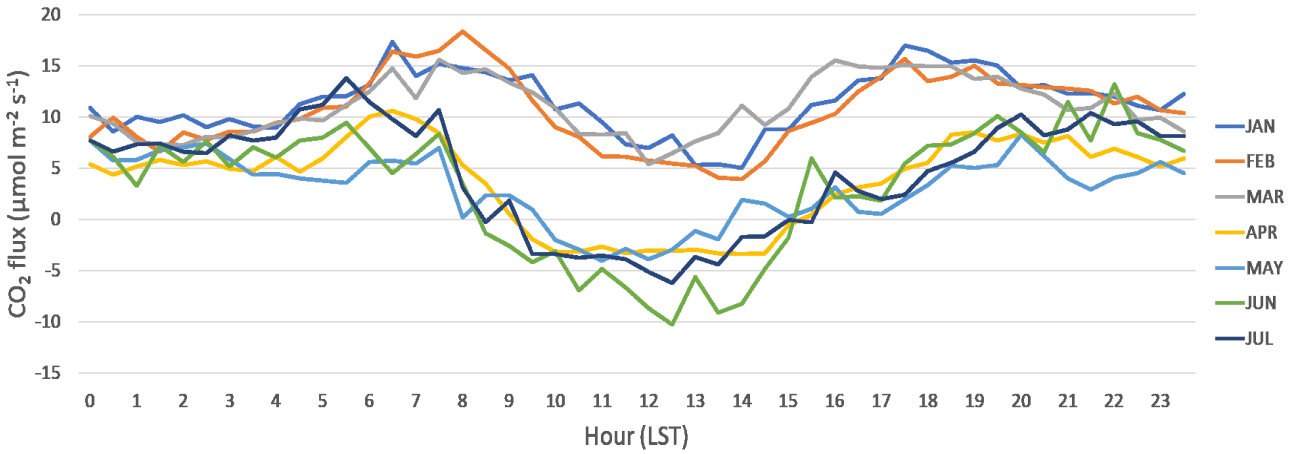

Figure S3. Diurnal variation of monthly-averaged eddy-covariance CO_2 flux measurements from January to July in 2013.

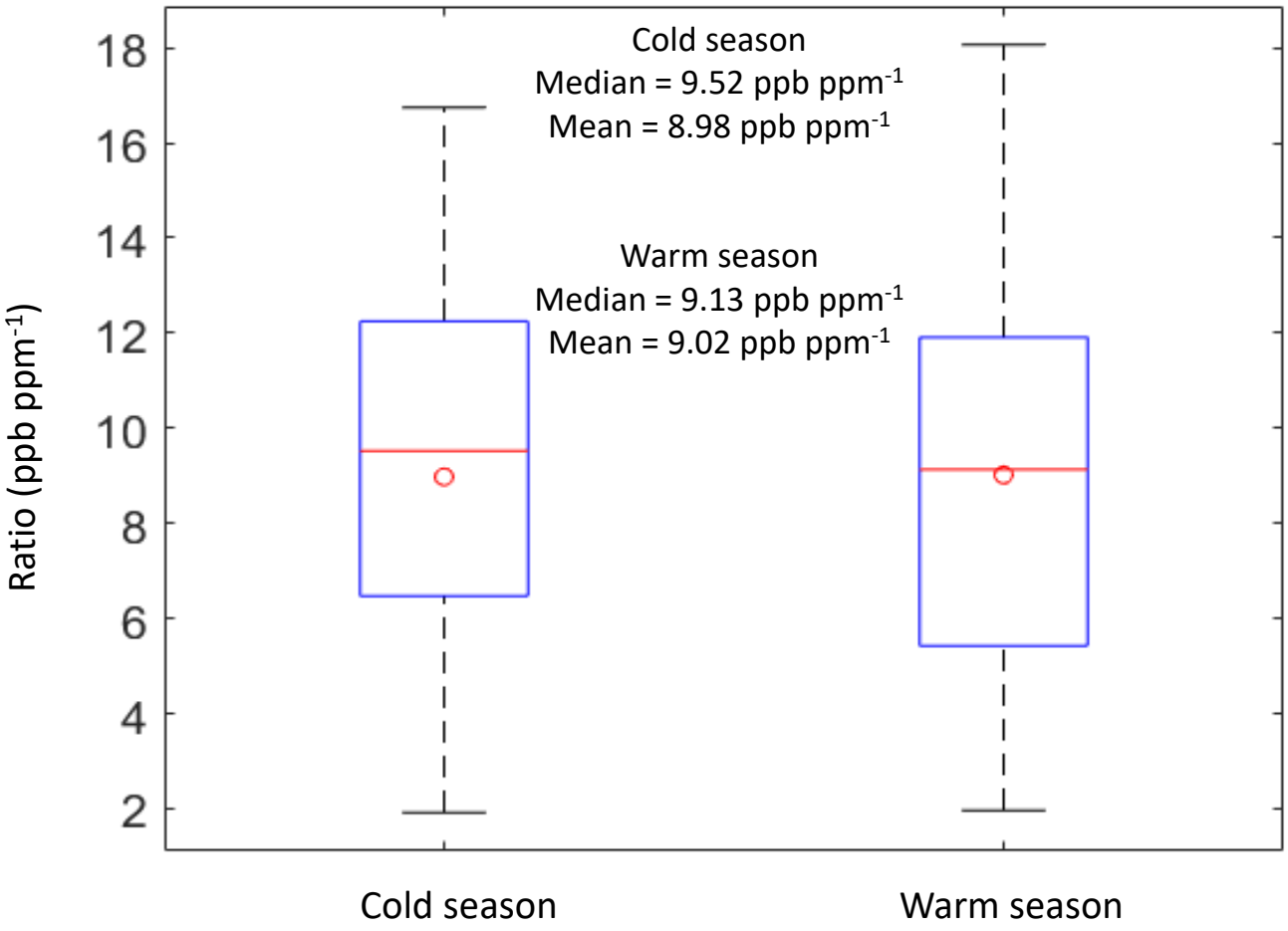

Figure S4. Ratios between the CO enhancements and the ^{14}C-based CO_2ff during the cold (JFM) and warm (AMJJ) seasons in 2013. The red circle and line mark the mean and median, respectively. The bottom and top edges of the box indicate the 25th and 75th percentiles. The whiskers extend to the most extreme data points not considered outliers that are defined as more than 1.5 times the interquartile range away from the top or bottom of the box.

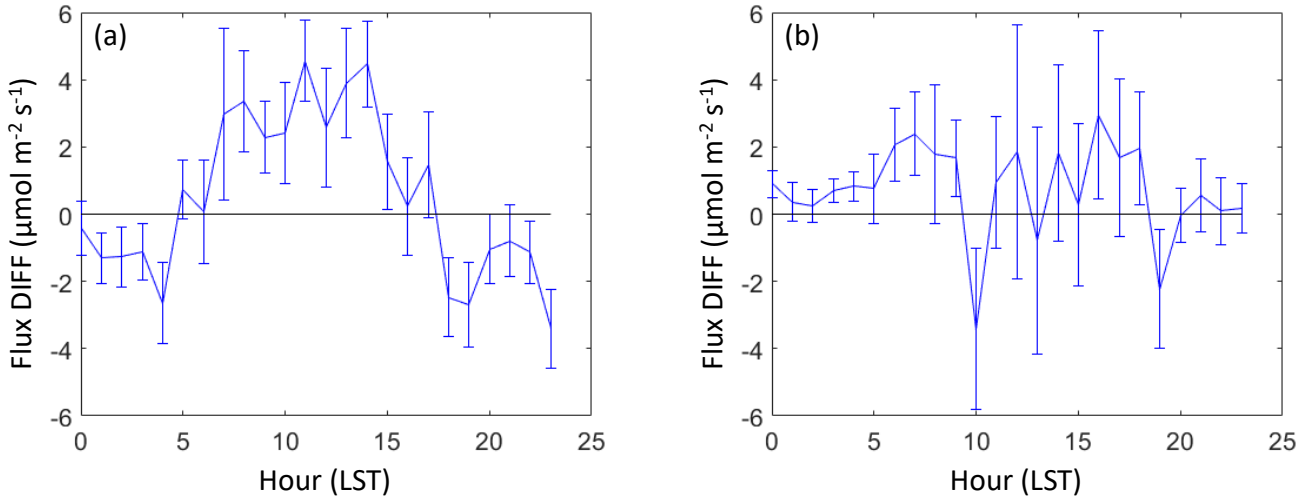

Figure S5. Diurnal variation of seasonally-averaged flux differences between the Hestia inventory and the partitioned fossil fuel CO_2 emissions (Hestia minus OBS) in the cold (JFM) (a) and warm (AMJJ) (b) seasons in 2013. Error bars are the standard errors of the seasonal means.

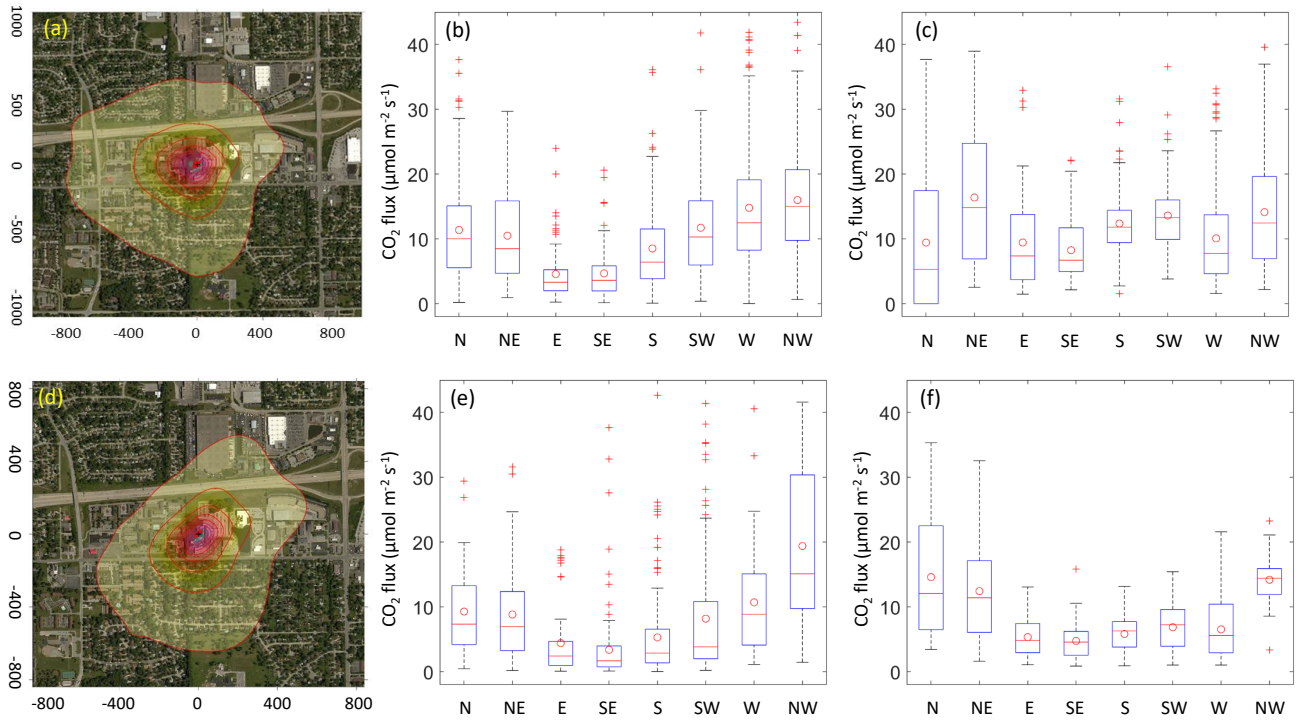

Figure S6. Cumulative flux footprints (a and d), the partitioned fossil fuel CO_2 emissions (b and e) and the Hestia inventory (c and f) for different wind directions. Panels a to c are in the cold season (JFM) and panels d to f are in the warm season (AMJJ) in 2013. The coordinates in the left panel indicate the distance (m) to the measurement site. In the middle and right panels, the red circles, the lines and the plus marks represent the mean, the median and the outliers, respectively. The bottom and top edges of the box indicate the 25th and 75th percentiles. The whiskers extend to the most extreme data points not considered outliers that are defined as more than 1.5 times the interquartile range away from the top or bottom of the box.

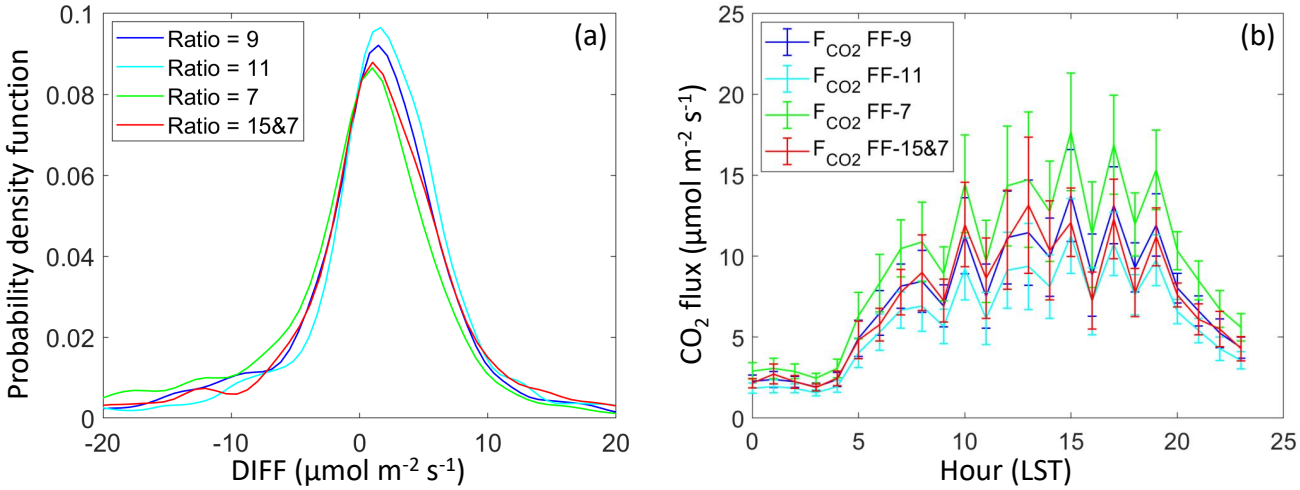

Figure S7. Probability density function of flux differences between the Hestia inventory and the partitioned fossil fuel CO_2 emissions (Hestia minus OBS) for different CO to CO_2ff emission ratios (ppb ppm^{-1}) in the warm (AMJJ) season in 2013 (a). Ratio = 15&7 represents the ratio is 15 ppb ppm^{-1} (traffic emissions) for the north wind and 7 ppb ppm^{-1} (building emissions) for other wind directions. Diurnal variation of seasonally-averaged CO_2ff fluxes for different emission ratios in the warm season (b). Error bars indicate the standard errors of the seasonal means.

Table S1. Bias (μmol m^{-2} s^{-1}), bias percentage compared to the mean partitioned CO_2ff emissions (%), and root mean square error (μmol m^{-2} s^{-1}) of the Hestia inventory for different CO to CO_2ff emissions ratios (ppb ppm^{-1}) in the warm (AMJJ) season. Ratio = 15&7 represents the ratio is 15 ppb ppm^{-1} (traffic emissions) for the north wind and 7 ppb ppm^{-1} (building emissions) for other wind directions.

Ratio	9	11	7	15 & 7
Bias	0.62	1.86	-1.34	0.77
Bias PCT[a]	9.1	33.3	-15.2	11.5
RMSE[b]	7.54	6.76	9.44	8.86

[a]percentage
[b]root mean square error