Reviewer #2:

General comments:

1. The mass balance approach applied in this paper relies on measurements downwind of emission sources that are strong enough to produce mixing ratio variations that dominate over variations in upwind inflow mixing ratios. In this case, estimating background mixing ratios from the edges of horizontal transects alone is seems appropriate. I would emphasize that systematic survey flight upwind of the source region of interest to show that cross-wind variations in the upwind mixing ratios are small as a prerequisite for application of this approach.

We agree with the reviewer that systematic survey flights upwind of the source are important to ascertain that variations in the background inflow are small relative to the measured downwind incremental concentrations. Thus, we now state in our revised manuscript that our modified procedures are such that we now fly an upwind transect, which allows us to identify point sources flowing into the city. This is now explained on page 24 lines 724 – 729 and on page 32 lines 958 - 969 of the revision.

2. The mass balance approach also assumes that only horizontal advection is responsible for transport of emitted gases in the boundary layer. It would seem likely that some entrainment air between the boundary layer and free troposphere would produce an additional exchange term. Please comment on the relative importance of entrainment compared to uncertainties in emission estimates. If it could be significant, how could it be best diagnosed with the existing flight data or alternative sampling strategies?

We again agree with the reviewer that entrainment can potentially be an important term in the budget of greenhouse gas emissions. We now discuss in our revised manuscript how we account for entrainment in page 21 lines 634 – 642 of the revision.

3. Arguably, level terrain facilitated estimation and application of mean wind fields in the mass balance approach. It might be useful to point this out in the abstract following description of the estimated measurement precision.

Thank you for this suggestion. We now include this point in our abstract.

4. I suggest using the term "flux" to express emission rate per unit surface area and using the word "emissions" to refer to area integrated fluxes throughout.

We have indeed used the term "emission rate" instead of "flux" in our revised manuscript, as the former is the more appropriate term in our analyses.

Specific comments:

Page 27, section 3.4.3. I would expect gas emitted from HSPP to have stack velocity and be thermally buoyant. Please report the stack height and discuss whether the emitted gas might mix differently from other surface emissions from the city.

We now report the stack height of HSPP, as well as discuss the expected mixing characteristics of its thermally buoyant plume in the CBL on page 27 lines 825 - 828.

Page 29. I am surprised by the different results for CO2 emissions from the Harding St Power Plant (HSPP) in June 1, 2011 versus 2012 (see Tables 1 & 3, and Figure 8). It would be nice to add a comment about reason for the very large and uncertain estimate for 2011.

We now discuss in the revised manuscript the variability of the emissions from the HSPP station due to its electricity production variations, as initially reported by Gurney et al. (2012), and now mentioned on page 29 lines 888 – 892.

Page 22 and Table 2. Are uncertainties due each parameter (Background, CBL Depth, Perp Wind, and Interp Method) independent of each other? What is the expected total

uncertainty for each gas and date and how does that estimate compare with the observed variability at different distances?

No, the variables that contribute to uncertainty are not all independent of each other (e.g. background is connected to CBL depth), and for this reason, propagation of errors is complex, while observation of precision is relatively tractable. We expected the uncertainty of the approach to be larger when applied to urban city centers relative to isolated point and area sources with large source strengths such as landfills and power generating stations where the uncertainty due to the variability of the background is minimized (page 15 lines 448 – 453 of the revision). As discussed in page 24 lines 719 - 723, this is in large part due to the relatively smaller incremental concentrations for the downwind urban plume, with more distributed sources that may be contributing to the overall emission rate. Thus, we discussed how we account for the overall uncertainty of the approach when applied to an urban environment such as Indianapolis in page 28 lines 839 – 844 of the revision.

Fig 4. Please show the measurements of CO_2 and CH_4 collected during vertical profiles and evaluate whether CBL mixing depth obtained with the GHGs is consistent with that obtained from dTheta/dZ.

We now include the vertical profiles of CO_2 and CH_4 in Figure S7 (supplementary information) to demonstrate that the CBL depth obtained from dTheta/dz (Figure 2) is consistent with the capping inversions showed in the vertical profiles of the greenhouse gases.

Fig S7. The data from April, suggests detectable uptake of total CO_2 relative to $ffCO_2$. Is this the case?

Indeed the total CO_2 vs fossil fuel CO_2 flask data show possible uptake for the April 29, 2011 flight experiment, and we now discuss this on page 19 lines 569 – 572.

Fig S8. How large is the variation in estimated CH_4 emissions using single transect approach?

We quantified the variability of the CH_4 emissions using the single transect approach and it ranges from 42% to 65% as reported in Table 4 of the original and revised submission.