Comments of Reviewer 1:

We thank the reviewer for the second review, which will help us to improve the manuscript. We address comment below (in bold) and describe the revisions made to the paper where appropriate.

Thanks for the authors' detailed responses. A few minor comments:

1. The authors have done a good job of addressing my first comment, however, have not used the responses to improve the revised manuscript. It will be good if the authors clarify the assumption of the vertically well-mixed plume and at the same time use transects at multiple heights to further improve the calculation, and to estimate the uncertainties.

→ We add more information of the approximation of the vertically well-mixed plume to the manuscript for clarification.

The mass balance method benefits of a large number of transects conducted downwind of an installation within the PBL. This is why the number of transects for the sampled installations in this study is minimum 4 and range up to 9 transects per installation. We use the measurements of all transects for the flux calculation of each sampled installation.

Lines 126-130:

"In general, the mass balance method is applied with the approximation that the plume is vertically well-mixed within the planetary boundary layer. However, to reduce the uncertainty of this approximation under the given meteorological conditions, we conduct horizontal transects at several altitudes to get a higher resolution of the dispersed plume in the vertical. Thereby, we subdivide the 2D vertical plane into discrete mixing layers to account for a possible non-uniformly spread plume."

Lines 144-147:

"We use all horizontal transects for the flux calculation with the highest transect, where enhancements are found, as the upper plume boundary. In the case where CH_4 enhancements were detected up to the highest transect of the aircraft, we use the boundary layer height as the maximal upper plume boundary assuming that the entrainment flux is small. "

Lines 205-207:

"The number of horizontal transects conducted downwind of the sampled installations and used for the flux calculation range from 4 to 9."

2. Is the new calculated uncertainty range of the fluxes of 23-70% consistent with those shown in Figure 2? I also wonder whether the large uncertainties are associated with very low wind speed. As the wind speed of 1-3 m/s is relatively low.

→ Yes, figure 2 and table 1 were updated with the new uncertainty ranges. The uncertainty is highest for P2 (70%) and lowest for P11 (23%). The wind speed variations/uncertainties range from 1-3 m/s, while actual wind speeds are moderate between 3-8 m/s (see line 205). In case of P2, there was a high uncertainty in wind speed relative to the low wind speed (3.0 ± 2.0) m/s, what is the reason for the total flux uncertainty of 70%.

Figure 2

Table 1

Line 205:

"The flight conditions during the flights selected for this study were generally good with moderate wind speeds (3-8 m/s)."

See Appendix B, Lines 498-508:

"The uncertainty of the wind measurement is the biggest contributor to the total uncertainty of the flux calculation (typically 90%). Uncertainties of wind speed and wind direction measurements range from 1-3 m/s (23-70% relative uncertainty at 1σ) and 8-39° (2-19% relative uncertainty at 1σ), respectively. The uncertainty of plume height ranges from 20-32 m and accounts for less than 10% of total uncertainty of the flux calculated for the uppermost layer."

1. The authors indicated "The uncertainty of the wind measurement (especially direction) is the biggest contributor to …" From the calculated uncertainty values, the uncertainty of the wind speed is by far the largest. Not sure why the authors emphasized the wind direction.

→ We apologize for this error in the first author response. We confirm that the uncertainty of the wind speed is the largest contributor.

Can the authors consider adding a panel in Figure A2 to show the plume of C2H6 measured on Aerodyne and that of CH4 measured on Picarro? I feel that such a plot will be appreciated by readers.

→ We add another panel in Figure A2 to show the enhancements in C2H6 and CH4 for peak 5 of P1, which is also shown in the first panel in Figure A2. Thereby, the areas under the peaks are highlighted, which are used to derive the C2H6 to CH4 (C2:C1) ratio.

Lines 334-335:

"As an example for the calculation, Figure A2 (b) in the Appendix A shows the simultaneous enhancements in C_2H_6 and CH_4 for peak 5 of P1."

Appendix A, Figure A2:

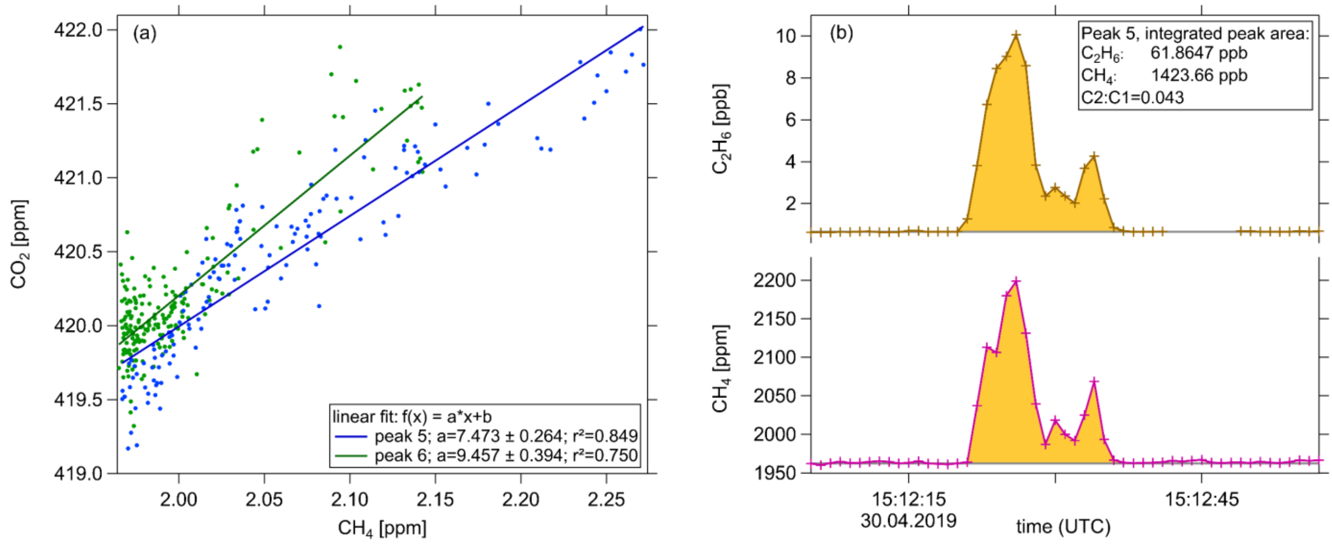

Figure A2. (a) Scatter plot for co-emitted CO_2 downwind of platform P1. Enhanced CO_2 was found for two peaks at altitudes above 240 m.(b) Time series (1 Hz) of the transect at 250 m altitude downwind of P1 (peak 5): Coinciding elevations in C_2H_6 (brown) and CH_4 (magenta) mole fractions. The C_2H_6 to CH_4 (C2:C1) ratio is calculated from the fraction of the integrated peak areas (yellow) over the background mole fractions (gray) and over the time span of the peak (18 s).

Appendix A, Lines 466-471:

“Panel (a) in Figure A.2 shows the scatter plot for CO_2 and CH_4 for platform P1, where enhanced CO_2 was found for two peaks at altitudes above 240 m. The observation of co-emitted CO_2 points to a buoyant plume adding up to the CH_4 plume at altitudes above 240 m. Panel (b) in Figure A.2. shows the time series of measured CH_4 and C_2H_6 for the transect at 250 m altitude downwind of P1 to illustrate the calculation of the C_2H_6 to CH_4 (C2:C1) ratio. The peak areas for C_2H_6 and CH_4 enhancements over the background are shown in yellow. The C2:C1 ratio is calculated by dividing the integrated peak area of C_2H_6 by the integrated peak area of CH_4, which results in a C2:C1 ratio of 4.3% in this case.”