Please see in our comments and discussion points below in blue.

The manuscript describes tower- and balloon-based observations, and the application of a boundary layer budgeting method to determine farm scale emissions of CH4 at the research farm Chamau in Switzerland. Resulting estimates are compared to inventory based estimates. The manuscript is well written, with well-prepared figures and a clear structure. I recommend publication after the following comments have been addressed.

General comments:

1) Advection seems to be a major issue as with many studies. This is discussed fairly detailed in the paper, however I would recommend the following additions:

- When neglecting Fa in section 2.3, it should be mentioned that this will be discussed in more detail in the discussion section. Otherwise the reader wonders how one can characterize the Chamau area as “horizontally sufficiently large and flat terrain with a homogeneous source distribution”

> *According to the reviewer's suggestion this information will be additionally given on P21775-Line12: “The impact of neglected horizontal advective processes on the overall NBL budget estimates will be part of the discussion section.”*

- The fetch of the different profile measurements should be assessed a bit more quantitatively, e.g. by making use of the wind profiles (velocities and directions). Also changing wind direction can cause changes in fetch, and can lead to inclusion or exclusion of emission locations from upwind areas.

> *We agree, that the length of the fetch of the respective NBL budget estimate will change according to the wind speed. However, as the NBL budget estimates were mostly restricted to measurements with a mean wind direction of the SSE-SW sector, the wind direction were of no direct concern for the fetch of the NBL budget estimates. After having calculated footprints for the measurements at height zi, we found that with a roughness length of 0.3m (which corresponds to the typical value for landscapes with trees, hedges, but few buildings) the distance of maximum contribution to the sensor laid in the range 0.5-5km. In order to include this aspect in the paper we suggest to improve our text as shown in point 2.*

- The selection of the wind sector is not very consistent: Section 2.3 mentions the SSE- SW sector, i.e. a wind direction between 202.5 and 225 degrees; the wind direction limits shown in Fig. 3 are at 90 and 270 degrees, and the wind direction observed during the different soundings varies much stronger than the narrow SSE-SW sector. Given the dimension of the farm (buildings cover about a 200 m x 200 m area, estimated using Google Earth), the distance of 150m of the measurement to the nearest farm building seems relatively small. A sketch showing the main farm buildings and the location of the balloon and tower measurements sites would be helpful to the reader to better grasp the geometry.

> *The reviewer correctly notes that confusion may arise due to different wind direction designations in the text. Furthermore, the dashed vertical lines in Figure 3(c) are wrongly designated as lower and upper wind direction limits, while they were drawn as reading aid. In order to prevent confusion and to clarify this aspect within the text, we suggest following corrections:*
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> *P21775 Line10: “ In addition, only measurements with an average wind direction from the SSE-SW (157.5°-225°) sector were used for the flux calculation, i.e., where the main barn building of the Chamau station and the grazed pastures were located. During very calm weather conditions when mean wind speeds reached zero, measurements were not restricted to wind directions.”*
>
> *P217800 Figure 3(c): remove dashed vertical lines.*

2) It remains unclear whether the limitation of the vertical integration to the level where delta-theta/delta-z approaches zero really avoids influence on the NBL budget from sources further upwind than the Chamau farmstead. This seems especially problematic for the 2012 observations, where profiles show no clear top of the NBL, and where CH4 shows no vertical gradient. This should be explained in more details, as also the various references cited in the manuscript do not really provide this information.

The reviewer correctly mentions the possible influence of advective processes on the resulting NBL budget estimate, even if the integration height was set very low. As the effective height of the NBL could not be reached during the campaign and as the atmospheric boundary-layer was highly stratified in 2012 (see P21779-Line10), the integration height z_i was set to a height where the first transition from stable to neutral stratification was detected. In combination with the selective wind direction criteria, it was therefore assumed that the resulting NBL budget flux will represent the emissions of the Chamau farmstead as a best-practice estimate. Including the atmospheric layers lying above z_i into the NBL budget calculation will introduce further uncertainties about the local representativeness of the NBL budget estimates, will very likely include the emissions from sources further upwind. Nevertheless, we agree on improving our text and pointing out the possible influence of further upwind lying sources on the well-mixed CH_4 concentration profiles more clearly:

P21784 Line11: „ Since the upper limit of the NBL height was not reached in 2012 and the well-mixed CH_4 concentration profiles pointed to the presence of advective processes, the emissions from sources further upwind might had an impact on the resulting NBL budget estimate.“

3) Usually a budget estimate cannot be given from a single profile as done in Table 1, as a change in the mixing ratio needs to be determined (see Eq. 1). It should be made more clear in the manuscript that this is only possible due to the use of Kriging in time and space and by taking the local derivative. Furthermore, ordinary Kriging algorithms usually also provide an estimate of the uncertainty in the interpolated variable. Have those been used in error propagation to determine the resulting contribution to the uncertainty in estimated NBL budget fluxes?

A sounding consists of an ascent and a descent, so in principle a flux could be estimated from a single sounding since there is a time difference between ascent and descent. The shortcoming of such an approach would be that the time difference between ascent and descent depends on the height above ground (as is best seen in Fig. 4). Moreover, some systematic differences between ascents and descents were found as we described in detail in our error assessment, hence our approach using Kriging to interpolate between existing ascents and descents, and extrapolate outside the time-height domain covered by tethered balloon soundings.

In the aggregation of fluxes shown in Table 1 several time slices of 0.3 h each (between interpolated/extrapolated profiles at fixed times obtained via Kriging) were available to determine the NBL flux. The uncertainty of the flux for each sounding was expressed as SD from the kriged profiles, which is already a more conservative estimate than if one had used the standard error. In principle we could use the uncertainty estimate of the Kriging in combination with the standard error of the mean (instead of SD), but since the main concern about the uncertainty of our estimate is associated with the estimate of the inversion height (see Fig. 5, where it is quite clear that this error is much larger than the random error from Table 1, which is shown by the black error bars to the left and right of the black circle),

It is however important to realize that our flux averages in Table 1 are averages of several kriged profiles (and hence due to averaging the error propagation aspect is of no concern), we will improve the wording to avoid potential misunderstandings associated with this aspect.

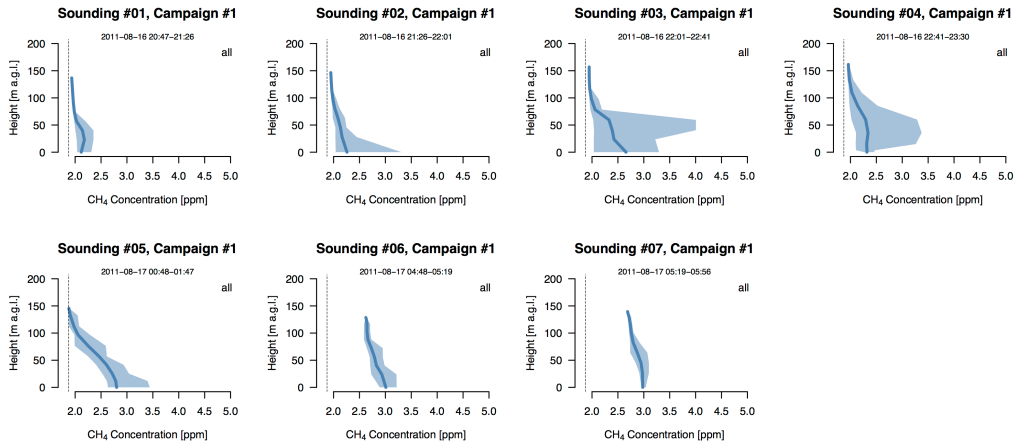
Specific comments:

P21771 L10: Are there any tube effects on CH4 when using 220 m tube for tethered balloon measurements?

We used a polyethylene inlet tube of very high chemical and ageing resistance. Before deploying the inlet tube on the field, pre-test with pure methane gas probes were conducted under laboratory conditions. It could be shown that no concentration difference was detected for measurements with and measurements without the polyethylene tube. Due to these results any further tube effects were neglected.

P21778 L20, Fig. 2a: It is unclear how the observations from the different soundings listed in Table 1 support the Kriging results shown in Fig. 2a. The text mentions a maximum around 3:00 LT, while the last sounding was made around 00:48-01:47. It would be helpful if the measurement locations (height vs. time) supporting the Kriging results could be shown as thin black lines in Fig. 2a.

Table 1 lists only soundings, whose measurements were used for NBL budget estimates. During the measurement campaign 2011 we had to reject two balloon soundings of the night 16/17 August due to unfavorable meteorological conditions for further NBL budget analysis (see P21772 Line 21). Nevertheless, these rejected soundings were integrated into the CH_4 concentration kriging. The Figure below shows the vertical profiles of each sounding during the period shown in FIgure 2a. Data were layer-averaged with the mean concentrations per layer shown as a bold line, and the variation around the mean within each layer shown as a color area. We used the 95% confidence interval for the color area (thus, 5% of the raw concentration measurements within each layer were considered outliers in this graph). From this it should be clearly seen that the Kriging procedure does an adequate job. It however also clearly shows that information from layers above 150 m is scarce or absent. Also included in the kriging results presented in Fig. 2a are the CH4 concentration measurements of the lowest 10 m from the guy-wired tower, which covered the whole night. To clarify this aspect we suggest to refrain from adding the sounding heights to the kriging plot but adding a clarification statement in the caption of Fig. 2a instead: "(a) Kriged time-space interpolation of the CH4 concentrations obtained from the balloon measurements during 16/17 August 2011, including rejected measurements not used for NBL budget estimates."



P21780 L25: I suggest replacing "gradient" with "difference"

We agree to the reviewer's suggestion and will exchange the word 'gradient' by 'difference' accordingly.

Caption Fig. 5: "The circles (A) show the NBL budget flux that was achieved if no interpolation was done beyond the height range" I suggest using "extrapolation" rather than "interpolation"

We agree to the reviewer's suggestion and will exchange the word 'interpolation' by 'extrapolation' accordingly.

P21782 L25: Also here I suggest using “extrapolation” rather than “interpolation”

We agree to the reviewer’s suggestion and will exchange the word ‘interpolation’ by ‘extrapolation’ accordingly.

P21785 L10-12: This seems like circular reasoning: If the good agreement between NBL budget fluxes with the CHAI estimates is used to validate the experimental approach, the NBL budget fluxes cannot be used to then validate the inventory estimates.

Thanks for drawing our attention to this mislucked wording. We will modify the wording. What we wanted to express is that there is no absolute reference, but we agree that we should phrase this differently.