Review of Merbold et al., (BG-2013-401):

Winter greenhouse gas emissions (CO2, CH4 and N2O) from a sub-alpine grassland.

This manuscript provides voluble information of greenhouse gas fluxes, in this case CO_2, CH_4 and N_2O, from a region and season where such estimates are few. The authors have used several different techniques to estimate these fluxes and a comparison between the methods has been conducted. The manuscript, its results as well as method comparison, is of importance for the scientific community and would after some careful editing be acceptable for publication.

General and minor comments will here be outlined according to page and line numbers:

p401- title. In the title the word "emission" is used. However, the result of this study also includes a consumption of CH_4. Consider the use of "emissions", maybe "fluxes" would be a better word to use.

p402- line 13-14: Please include error estimates of the winter flux. Also the range estimate for the CO_2 (631-670 g CO_2 m^{-2}) is not a range estimate. This is the result of the two methods used. Please, state the two methods separate with error estimates, or if no significant difference between the two methods can be found then give one "best guess" estimate with error estimates.

p405- line 18. I would suggest that you exclude "the permanent automatic monitored gradients" from your bullet pint (i) and instead make and bullet point (iv) with something like "also a novel permanent automatic monitored gradient method was tested and will be described and discussed". However, after reading the manuscript I'm not sure if it is advisable to actually include this ^{222}Rn method at all. This since it does not contribute to anything in the results itself. Do not get me wrong, the idea of loosely hanging tubes instead of fixed metal once is great and so it the ^{222}Rn approach. But this paper dose not really gains anything by including it. Please take a careful consideration if it will be included in the future!

p406- line 20. Here it is stated "Two majorly different techniques". But earlier studies have shown that also gradient and trace gas (^{222}Rn in this case) are "majorly different". Rephrase or deduct to two methods only.

p407- line 11. Change "(half-hourly averages)" to (30 min averages). Also the c in (c, µmol, Eq. 1) should be in *italic* as (c, µmol, Eq. 1).

p407- line 13. In Eq. 1 the term w is used. But it is not described in the text. Please do so.

p407- line 23. Here the term "SD" is used for the first time. Please explain.

p407- line 24. "$u*$" is probably the friction velocity, please state so or include "($u*$)" behind the friction velocity in line 17 p 403 in the introduction. However, if it is included at p 403, then also the soil temperature and the snow density should be given their proper notifications in the same line.

p407- line 24-25. Please explain why such overestimation occurs with an extra line.

p408- line 2. Was the ^{222}Rn also sampled manually? Or was the ^{222}Rn only sampled at the permanent automatic monitored gradients? Please change "CO_2, CH_4, N_2O and ^{222}Rn" to "CO_2, CH_4, and N_2O" if appropriate.

p408- line 13-14. Here the slope of the linear regression is mentioned, please fill in which linear regression that is referred to and how the regression was established.

p408- line 15. Here the "diffusion coefficient of CO_2" is mentioned. What about CH_4 and N_2O? Change "the diffusion coefficient of CO_2 in air (Eq. 3)" to "the diffusion coefficient in air (D_{air}, Eq. 3).

p409- line 9. I guess it should be " with a 60ml syringe" ?

p409- line 9-10. Using pre-evacuated vials works very well in temperatures above zero. However, when temperatures drop the rubber usually get stiff and, especially, when using pre evacuated tubes a leakage of surrounding air might occur when the needle is taken out of the vial. This would dilute the sample and the subsequent flux estimates might be misleading. Was any tests done to rule out the leakage effect? I.e. syringes with standard gas could be used to test this in the field. Also, include that needle was used to transfer the sample from the syringe to the vial. Well, only if this was the case off course. Otherwise fill in how the transfer was conducted.

p409- line 15. If this part about the permanent automatic monitoring is kept in the text, then the paper would greatly be improved by adding an own headline for this section. Also give the method an own shorter name, this to separate the three methods properly in the method, discussion and conclusion.

p410- line 1. Is this the same LI-COR as mentioned in line 16 (p 409)? Maybe change the text so the instrument is only mentioned once.

p410- line 11. The assumption about ^{222}Rn as a natural tracer is a really interesting idea. This since the application of any other trace gas will include a lot of assumptions, as the lateral diffusion mentioned later on in the text. Was any summer measurements conducted as well to have some background values for comparison?

p410- line 18. Here the depth of 10, 30 and 50 cm is used for sampling. This would mean that the regression lines used for the flux calculation where based on 3 points. Is three points really a sufficient number to establish a regression line? If one of the three points would be slightly out of the true line, the estimated flux would be severely changed. Was any criteria used (as R^2 valued) for rejecting regressions where data where scattered? Further, was only one sample taken at each depth? This is an massive and impressive approach that has been conducted, but please verify the method a bit deeper.

p412- line 9-10. Back to the same question as above: Is the snowpack at Dischma valley really that homogenous and without layers that a proper linear regression could be made at all occasion (even during the 10, 30 and 50 cm sampling)? Please include a figure to show this. Well, such a figure might be tricky but it might work if you normalize all your data. Further, consider the use of "significant" in this context. Significant here would probably mean that the regression lines are significantly separated from a zero increase. This is no doubt the case, but is the regressions representative for the true fluxes?

p413- line 7. How did you test this influence? Did you start with testing one by one of the parameters, or did you to include all of them in your glm?

p413- line 10 and 13. The SWE used here can, as mentioned, be a seen as a measure of the mass of the snow pack. However, the true outcome is a height. As included in figure 5 it is given in cm in this case. Please change the denotation from SWE to h_{SWE} throughout the text. This since you already use h as a symbol for height in you snow height (h_s).

p413- line 17. Usually fluxes can be denoted as F, so please change "CO_2 fluxes (Eq. 6)" to "CO_2 fluxes (F_{CO2}, Eq. 6)".

p413- line 18. Eq. 6 should then be changed to:

$$F_{CO_2} = 5.09T_{s-s} - 0.12h_{SWE} - 0.35T_{s-s}h_{SWE} + 2.26$$

This looks much better and is easier to follow.

p413- line 22-24. Please rephrase the sentence starting with "Average flux…" since it is hard to understand.

p413- line 25. Which of the gradient techniques is it referred to here? Name all three methods in a way that is easy to deviate from the other methods and use the same name throughout the text.

p414- line 3-4. Change "temperature at the soil snow interface" to "T_{s-s}" and "snow water equivalent" to "h_{SWE}" and include which figure or table this can be referred to.

p414- line 8. Change the equation to:

$$F_{CH_4} = 0.02h_{SWE} - 0.46$$

p414- line 16-20. Here a error estimate of each individual flux is needed! I expect that with such error estimate you might not really be able to separate your "gradient" and "EC" methods. This might need some effort to get these error estimates but they are indeed needed for this manuscript. Also include these error estimated throughout the text.

p414- line 21. You have already defined the winter season and can simply denote it "this winter season".

p414- line 22. Why the use if "respectively" here?

p415- line 1-7. This part might fit better in the method description.

p415- line 1-10. Again, this part might be removed from the MS or restructured depending on if you still feel like including the [222]Rn gradient method.

p416- line 18-19. This sentence need to be rephrased so there is no doubt which if the methods that under estimated the flux.

p417- line 1-5. Here it would be nice with a shot discussion about the natural convection in snow (work by Matthew Sturm), and the possible channeling of air flow in layered snow (e.g. Colbeck 1997), and how such things might affect the EC measurements. For example, the EC might pick up emissions from "hot spots" of CO_2 emissions, while the transect and traverse sampling might have missed such "hot spots".

p417- line 12. Which method of CO_2flux is it referred to here?

p417- line 20.Hence the notation on regression lines based on 3 points.

p418- line 5-6. Please include references for the different trace gases used. And if the purpose was to measure GHG's then CO_2 would be a rather strange trace gas to use…

p418- line 15-17. Would not the water also percolate down into the soil and by this alter the biogeochemistry in the soil?

p420- line 8-9. There and increase in CO_2 is mentioned and relater to a constant soil water content. Is this what is meant, or did the soil water content in Liptzin et al 2009 change over time?

p420- line 21. Insert "negative" in front of "correlation" to make the direction clear.

p421- line 10-13. Sentence starting with "Still, the reported…". Here it is hard to follow which uptake rates that is lower in respect to what. Please rephrase this sentence to make it easier to follow.

p422- line 4. Include error estimates for the flux.

p422- line 20-22. The paper by Mohn et al., 2013 is referred to here. But what did this paper say, it is mentioned that isotopes where used, but what was the emissions rates found? Please include these numbers to meth the sentence and reference complete.

p422- line 23. Name the two different methods that is referred to here.

p422- line 24-25. Include error estimates!!!

p422- line 28-29. Which period is it referred to here? In the sentence above you have three "periods" mentioned: peak winter, the beginning and the end.

p435- Table 2. Is the error estimate here standard error or standard deviation?

p436- Table 3. Please include error estimates for all the numbers given!

p437- figure 1. Change "meteo tower" to "meteorological tower" and change "profile sampling unit" to "profile sampling units".

p438- figure 2. Change "Meteorological conditions" to "Environmental conditions" since soil temperatures and soil moisture is not really meteorological data… Furthermore, for Fig. 2, 3 and 4 change so the same labeling occurs on the x-axis. As it is now you have month in some figures and Julian days in others. This is confusing and will be better if you chose only one labeling method. Also, the error bars here is standard deviations? Please include in text.

p439- figure 3. Include if it is standard error/deviation or other error estimates used in the figures.

p441- figure 5. Change "meteorological variables" to "environmental variables".

Thanks for a nice manuscript and good luck with the corrections!