

Review of BG-2013-401, Winter greenhouse gas emissions (CO₂, CH₄ and N₂O) from a sub-alpine grassland; Merbold et al.

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General comments

The authors present a good dataset on greenhouse gas fluxes from a snow-covered grassland during the under-measured winter season. This work was carefully performed and is of strong interest to the scientific community. I think more studies should analyze these three major greenhouse gases, use a variety of methods to cross-validate methods and investigate spatial heterogeneity, and take a year-round approach that includes the winter season presented here. The data and its presentation are generally of the quality expected by Biogeosciences, and I think the work should be published there. However, before its publication there are considerable revisions necessary to work out how to be present the data collect, how to contextualize it with respect to other studies at this and other sites, and in improving the quality of the written English.

I do not wish to re-examine the points raised in the other reviews, so present my key suggestions in the comments below. I strongly recommend going over the writing with a fine-toothed comb to work through the structural, textual, and conceptual issues raised in this and the other reviews, and suggest letting a native English speaker assist in the final editing.

Specific comments

p. 402, line 13 – I suggest putting the study time period (November – April) before you present anything about the results (ideally in the first or second sentence of the abstract); additionally I wonder why in the abstract the time period is Nov-Apr but in the text the measurements began in December and went only to mid-April, the snow cover started 19 Nov, and the upscaling starts 16 Nov.

p. 403, lines 8-11 – I rarely find one-sentence paragraphs warranted and suggest either expanding the thoughts presented in this paragraph or folding it into one of the paragraphs above or below it.

p. 404, lines 5-1 – This paragraph requires a topic sentence giving us some context and thesis for what the paragraph will present. Also please be more specific when saying “the most important N₂O sources” – is there some quantitative proportion or magnitude available?

p. 404, line 28-page 405, line 2 – this long line of citations deserves a bit more explanation. Are these papers which include other GHGs, or do not? Are they relevant comparisons (e.g., of the ecosystems and time periods studied here)?

p. 407, More information should be provided about the EC set-up, particularly as the valley sounds quite small and possibly steep. Is there flat enough terrain to suit the EC method? What is the average footprint size? Do any wind directions require screening out? At the maximum snow depth the measurement system is less than 1 m above the surface – are there any additional considerations during this period? Does any of the spatial heterogeneity uncovered during the transect measurements make an appearance in a footprint model (or even by wind direction)?

p. 410, line 2? I would have suggested starting a new paragraph somewhere in this region, but seeing the (non)results from the ²²²Rn work, I suggest shortening this section considerably – it is not so important to get into the details of how this would measure. I do appreciate that you left this work in the text even though it failed as I think it can provide useful lessons for others in the community – both about an interesting tracer for use in measurement and about the potential

challenges this work entails. Probably lines 4-12 can be put into one sentence with a reference. [Reduce also the discussion on the bottom of page 418; perhaps you could measure R_n in the samples from the ski-pole method?]

p. 411, line 20 “In March...” – to what temperature did the air reach? Was the temperature increase maintained?

p. 412, line 10: Was there truly a significant linear relationship in 100% of the measured gradients?

p. 413 Driving factors – have you tried a day-of-year variable? This may help sort out whether SWE is a true driver of fluxes or is just a convenient indicator for time and/or snow height. I also wonder if you can derive a roughness length (i.e., z_0) from the eddy data to see if the landscape “smoothness” could correlate to the fluxes.

p. 414, line 16; it should be obvious which methods you are referring to (i.e., the 670 g/m²) is from the gradient approach, right?

p. 415, section 3.5: I suggest putting this section above the budget part as the reader wonders why it isn’t being used or mentioned yet.

p. 416, Section 3.7: Are there differences in the edges of the valley in terms of solar radiation received or aspect? It appears there could be some justification for exploring these questions in the transect’s margins as presented in Fig 8.

p. 416, line 8: What is “the filled ground”? This should be defined in the study site description and also not used independently in Figs 8-9 since its meaning is unclear.

p. 422, line 4: Are these studies all for wintertime fluxes? If so add “wintertime” before “values”.

p. 422, line 24-5: Aren’t the units g m⁻²?

p. 424, line 2: here there is a reference to the annual budget, but do we know a range of the annual budget (or even the non-wintertime budget) of this site? Can this work’s results be contextualized in this way?

p. 424, line 5: “is crucially needed” – but why? If it is only 5% of the flux terms is such a detailed analysis really justified? If it is “crucial” please expand on why (perhaps in view of land use changes).

Figures, tables generally: use capital letters to start labels (including the word “mean” in Table 1; “contribution” in table 3, “Julian” in Fig 4, and elsewhere).

Table 2: I would suggest the following caption: “Monthly averaged (measured weekly and modeled with meteorological drivers) and winter season mean of CO₂ flux data ...”

Table 3: Can this include error bars on the terms?

Fig 1: Maybe laying these maps horizontally would be more space efficient? In my printed version (a) and (b) are not very clear, but perhaps it will look better in the final.

Fig 3: The “average seasonal fluxes” could be more clearly distinguished from the other measurements (maybe with coloring and/or different marker shapes). Could “continuous” be a better word than “permanent”?

Fig 4: Please be more specific than “standard procedures” and than “deviation” – is this the standard deviation or range?

Fig 5: I think the second (d) should be (e); I would also end the caption with “...the 95% confidence intervals on the fit lines”. I would change the x-axis label on figures a and c to “Temperature at the snow-soil interface” or “Snow-soil interface temperature”.

Fig 6. I tend to agree with Reviewer 1 that this is unnecessary; if you do include it add “are” before “incorrect” and make “photo credit” two words.

Fig 7 – do not connect lines at the points where the transverse and longitudinal “transects” (not “cuts”) meet.

Fig 8: replace “done” with “performed” and don’t let “ArcGIS” be split at the end of the line.

Fig 9: can you add an “n” value of samples analyzed for each? Also add to the caption something about how the fluxes were estimated so that it can be read independently (i.e., via the gradient method; what time period).

Technical comments

p. 402, line 20: emission → emissions

p. 402, line 22: according snow → according to snow

p. 404, line 13: system → systems

p. 404, line 14: “two of them being conducted” → “two of them conducted”

p. 405, line 13: contradicting → contradictory

p. 405, line 25: the Dischma valley → Dischma Valley [** and change throughout **]

p. 406, line 20: eliminate “majorly”

p. 406, line 26: following the ... → following the orientation of the ...

p. 406, line 21: eliminate the comma before “which”

p. 406, line 24: provide units for u^* (I presume 0.01 m/s?)

p. 408, line 12: the “dash” separating the units looks like “divided by”, perhaps use a semicolon instead? (also between CH₄ and N₂O?)

p. 409, line 1: please indent the start of a new paragraph

p. 409, line 9: “with 60 mL” sounds funny – rewrite two sentences; e.g., 60 mL gas samples were collected from the ski pole and immediately transferred into pre-evacuated 12 mL vials.

p. 409, line 11: few → a few

p. 409, line 17: 1b → 1c

p. 411, line 19, 20: add “its” before “lowest”; remove “the” before giving dates (also throughout text)

p. 413, line 22: eliminate “above given” and add “tested above” after “variables”

p. 414, line 13: eliminate “actual”

p. 414, line 20: ecosystems → ecosystem’s

p. 414, line 22: “respectively” is not clear – I suggest changing this to say “using the range of values derived between the EC and gradient approaches”

p. 417, line 2: than → as

- p. 417, line 8: adjective → adverb
- p. 417, line 19: seems unclear (is it a double negative?)
- p. 417, line 26: eliminate “being”
- p. 417, line 29: can not → cannot
- p. 418, line 6: such approach → such an approach
- p. 418, line 16: “slower” is not a verb
- p. 418, line 20: subj-verb disagreement in “methods underestimates”
- p. 419, line 21: The second → A second
- p. 423, lines 4-5: in both cases I suggest using “GHG budget” and not “Budget” or “-budget”
- p. 423, line 12: “this being” is unclear
- p. 423, line 14: “can not” → cannot
- p. 424, line 10: there is no verb in this sentence.