

## Author comments

### Reviewer 1

#### General Comments:

In this edited manuscript, the authors do an excellent job stating their results and placing them within the current body of knowledge, without over interpreting them. I felt that the authors responded to all valid comments I had previously made and corrected me on comments I had made that were not valid. I was particularly impressed with their discussion on the microbial respiration rates and appreciate that the authors included data for multiple measurements throughout the thawing process. They also did an excellent job distinguishing between the three transects and the altitudinal effects which were difficult to understand in the previous version. The rewritten discussion was much clearer and easier to digest, and I thought the main points were well supported and well stated. Finally, the authors did a good job at speculating about impacts of climate change within the constraints of their results and the conclusions section did an excellent job summing up the results of this paper. One issue that needs to be taken care of is the grammar throughout the manuscript. There are too many grammatical errors to count and I've highlighted a few examples below. I suggest it be thoroughly edited by an English speaker.

We thank the Reviewer for generally positive evaluation of manuscript revision and valuable comments. To improve the language quality and avoid grammatical errors, we used professional services for language proofreading.

#### Specific Comments:

L240: Should reference Fig 2b, c.

Done. We thank the reviewer for this notice.

L249: Seems strange to start this section off with the interactive effect, when the RDA showed that most of the variation could be constrained to an altitudinal effect, while only 8% was explained by the interaction term (if I'm reading your results correctly).

We agree. The first two sentences were reworded and the comment on interaction term was moved to the second sentence (L251-252).

L252: Doesn't this indicate that ALL the effects (altitude, transect, altitude:transect) were largely driven by the soil variability rather than just the interactive term? I agree that the interaction term is interesting and it is nice you can relate it to Mg<sup>++</sup>, however, Figure3 shows all 3 transects oriented in the same ordination space from the lower left to the upper right alongside increasing elevation. It seems like the text is focusing so strongly on the interaction, when the two standalone variables have more explanatory power. I do want to note that I think the discussion section does a very nice job interpreting these results.

You are right. We wanted to say this on L252. To make it more clear, we added "separate and interactive effect of altitude and transect" to the sentence on L 253.

Table1: Please rename first column to Site Altitude [m a.s.l.]

Done

Figure 2b: Should the Y-axis title be "Potential Respiration"?

Yes. We changed the title.

Figure 2: This is completely a personal preference on my part, but I like the horizontal ticks you have in part c between the sites. You may want to consider adding the longer ticks in parts (a) and (b). This is not completely necessary though, since you nicely change the color of the bars for each transect.

The figure was edited as recommended.

L798: "Results of RDA", is this supposed to be the figure title? It is not a complete sentence and is strange in the middle of the legend.

Sentence was removed from the legend.

Also, check this figure legend in general for grammar errors. "The correlation between the abundance of the main microbial groups (**bold italic**) and the soil geochemical parameters that were retained by forward selection of all the explanatory variables collected. The altitude of sampling sites was used as a supplementary variable....Dotted lines indicate environmental variables retained by the forward selection model."

We revised the legend.

Figure 4a. Here I recommend adding the larger x-axis tick marks as seen in 4b, since there is no color change distinguishing between the transects.

Done

Grammar examples:

L20: Grammar error, "we did not observe...".

Corrected.

L22: "Mainly due to differences in bacterial PLFA compositions, but also systemic altitudinal shifts in MCS related to..."

Revised

L32: "fundamental roles..."

Corrected

L37: "Offer a great opportunity"

Corrected.

L38: "presence of vegetation, and..."

Corrected.

L65: "...we conducted a study aiming to assess..."

Corrected.

L229: "while mosses covered a very small proportion..."

Corrected.

L242-L245: The grammar issues in this sentence need to be addressed as it is difficult to understand

The sentence was reworded and clarified (L 242-246).

### Reviewer 2

Main comments:

The authors did a good job to respond to all the comments from both reviewers. They changed the figures to clarified their results, and rewritten the discussion delivering a clearer message. I only have few specific corrections and two main point that the authors need to address below.

We thank the Reviewer for generally positive evaluation of manuscript revision and valuable comments. We tried to address all the remaining reviewers concerns as follows.

Thanks for clarifying the methods used for measuring soil respiration and also to show the respiration at day 4 as well as day 13. An important point that need to be added, it is not only a question of the effect of freeze-thaw cycle, temperature and length of the incubation on the samples, but you apparently also sieved the sampled at 2 mm before freezing the samples (L94-95). Sieving the sample will have stronger effect than one cycle of freeze-thaw, releasing organic matter, breaking down soil crust and aggregates and also exposing microorganisms to different level of O<sub>2</sub>. Coupled with the temperature and length of incubation, this could drastically alter the trends in your results and stimulate activity in some samples more than others. Together, and as you mentioned, you measured potential respiration, but you need to clearly say that these conditions are not in situ, and a potential effect of the incubation procedure (sieving, temperature, thawing) cannot be discarded. You have to mention the effect of sieving (L318-319) which could have a stronger effect on soil biological crust than other soil, and have to conclude that you can't discard a method effect (L324-326). I stress the fact that this is a requirement to clearly state the potential limitation of your measurement.

We agree with the reviewer that sieving is an important treatment prior to respiration measurements, which can influence the respiration rates. In accord, we added comments on this issue in L301-307.

Section 4.1 is still too long and mainly describe the site and present results instead of discussing them. The section brings little information. For example, the first sentence is similar than the material and methods, just a site description; L277, this result is already given L199 in the results section. And this is true for most of the section. Unless, you have

novel results compared to the literature, or those results can directly explain the microbial results, this section is not useful and could be reduced in few sentences or deleted. This is especially true from L272-285. The sentence L285-287 is unclear and should be rephrased (if kept) and related to the microbial community. Line 287-290 is also detached from the microbial data and miss linking those results together.

Even though the microclimatic measurements could not be directly linked to the presented microbial characteristics, we considered these data as important and valuable to portrait the soil conditions along the elevational transects. However, we agree with the reviewer that the section was too long and the given information was in some cases mentioned twice throughout the manuscript. We thus significantly shortened the first paragraph of the discussion (L272-284).

The next section (L291-300) is not at his place in section 4.1. This is (Mg) partly discussed L366-380. I would merge both sections and avoid repetition.

We reduced the paragraph to avoid repetitions and merged the information into the last paragraph of our discussion (L 356-365).

Overall, I don't think you need section 4.1 and 4.2 but just one discussion nicely split in different section without headers.

In accord with reviewer recommendation, the current discussion is a continuous text without headers.

Specific comments:

L12: delete "proceeding"

Done

L18: change in the whole text "basal respiration" to potential respiration"

Done

L20: change "in" by "on"

Done

L32: "play a fundamental"

Done

L39: delete "The proceeding"

Done

L52, 55, 56, 58: this was already in my initial review (reviewer 1); you need to clearly state which ecosystems the articles you site work on. As you said in your reply, the altitude trend for microorganisms does not work like for plants and animals. So, where the study took place is likely to have a strong effect on the results. You have to state which ecosystems the study you site work on, this will help the reader to have a better understanding. As it read, the

reader could think that all these studies took place in the Arctic but it is not the case. Please, give the ecosystems. This is also true for the discussion.

Done (L52-62)

L65: delete “alpine”

Done

L65: change “the arctic alpine” to “arctic”

Done

L65 “we conducted a study”

Done

L142: it is difficult to believe there is no significant difference between day 4 and day 13 when figure 2 b and c shows that at day 4 (Fig 2c) potential respiration is around 2 times higher than at day 13 (Fig 2b). Unless what you want to say is that you have the same difference between the altitude regardless of the measurement date? Be more clear.

Corrected

It is also not true that you only present day 13 as suggested at the end of Line 142, as you present day 4 and 13. Please correct the sentence.

Sentence deleted

L144: change “defined” by “determined”

Done

L186-187: it is not true that you can't consider the triplicate as independent. Microbial ecology shows that you can have more similarity in samples taken km away from each other than few cm away. This is especially true for your design when you sample from vegetated area to bare soil, while you clearly show in your study that bare soil are different. So, you could consider your triplicate as independent. This is a general comment, as I am not asking to change the statistics here.

We partly agree with this reviewer comment on soil microbial characteristics. However, with respect to geochemical properties of soil and underlying bedrock, which will be perhaps more similar in the few meter range compared with km away, we decided to evaluate the data as we described. Nevertheless, the effect of such choice on the output statistics is very low and rather decreases the statistical significance of performed tests.

L221: change “Oppositely”, by “In contrast”

Done

Section 3.3: it is worth mentioning that the daily rate is around 2 times higher at day 4 than day 3. Would be also interesting to mention how it compare with day 12. Even if this is not

the main message you want to deliver, it is an interesting result which could be briefly presented.

Done (L240-245)

L233: “was significantly positively correlated”

Done

L243: “change “had” by “at”

Done

L258: change “Oppositely” by “In contrast”

Done

L260: delete “an”

Done

L265: change to “The soil with the poorest TOC and richest Mg concentration at the highest site on Tr1...”

Corrected

L272: “characterised by a four”

Corrected

L294: delete “In result,”

Done

L316, 327, 328, 329, 330: give the ecosystems the studies are working on

Locations given according to the reviewer recommendation

L320: give the days of incubation in brackets with what you define as flush, adaptation, stabilization

Done (L308)

L323: change “accord” by “agreement”

Done

L330: “the majority... was associated with...”

Done

L354: change “at more elevated sited” by “with altitude”

Done

L355: change “typical” by “characterised”

Done

L355: “unfavourable” depends of the microorganisms as you mention, what is unfavourable for one is favourable for the other. It is better to characterise the conditions rather than saying favourable or not.

Done (L343)

L357-358: you need to acknowledge here that you did not measure the F/B ratio on the incubated samples use to measure soil respiration. Thus, you can't be sure that the fungi explain such results. You could have a complete shift of your community as stated L327.

Done (L351-352)

L358: change “prosper” by “grow”

Done

L361: what do you mean by “benign”. Don't use such word but rather define the type of soil/conditions

Done (L350)

L 364: change “likely” by “could”

Done

L370: “Tr1 had higher actinobacteria and phototrophic microorganisms abundance”

Sentence reworded

L390: delete or rephrase, what does “uniform” mean in that context? Do not use “concurrently”

Sentences were reworded

Figure 2: b and c are both potential respiration, it would make more sense to give the incubation day (4, 13) which is more clear, especially in the caption and y axis. “flush respiration” and “potential respiration” are not self-explanatory in the figure. The caption should not need the support of the text to be understood.

The Figure 2 was edited as recommended