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Interactive comment on "Soil microbial biomass, activity and community composition along altitudinal gradients in the High Arctic (Billefjorden, Svalbard)" *by* Petr Kotas et al.

Anonymous Referee #2

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General Comments

The study by Kotas et al. was focused on changes in microbial biomass, activity, and broad community structure (based on PFLA) along altitudinal gradients in the Artic. This question has great significance concerning the implications of global warming on these ecosystems. The study consists of 3 different transects represented by 4 different elevations, and for each sample the authors collected substantial amounts of data representing soil type, soil chemistry (pH, ion content and concentrations, TOC, TN, moisture content, and temperature ranges), and very briefly mention vegetation coverage. The authors try to disentangle the impacts of all these along with elevation

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on microbes using partial redundancy analysis as well as several other statistical approaches. They have a robust sample design with good replication to try and address this question.

I did have several issues with the manuscript. First, I found it very confusing that the authors kept referring to two different gradients, altitudinal (the main gradient of interest), and horizontal. However, this horizontal aspect is never discussed in the methods section and I assume it is referring to the south to north orientation of the 3 transects along the Petunia Bay. This needs to be clarified explicitly and its significance needs to be discussed. Is it expected there is a strong S-N effect? I assumed these 3 gradients were expected to be replicates of each other, but they have strong differences in soil characteristics and microbial community (particularly Gr1). This becomes more apparent in the Discussion, but the author's need to make this clear early on.

I also had concerns with their microbial respiration data and the authors need to justify their choice of a 2 week pre-incubation at 6 C. The pre-incubation will burn off all the labile carbon and drastically alters this respiration rate. This needs discussed as it can substantially alter the conclusions of a large portion of the paper.

The discussion is too long and wordy. I found it difficult to understand the main points the authors were trying to convey. It seemed to be rushed relative to the excellent writing of the rest of the manuscript and has multiple grammar issues. I also think that there was too much superfluous material that distracts from the main message. The authors spend a great deal of time discussing impacts due to plant biomass, but have no data presented quantitatively examining plant communities, biomass, root biomass, etc... A lot of this can be safely removed, especially in sections 4.1 and 4.4, as the degree of detail discussed doesn't add too much to the broader implications of the study.

With some mostly editorial changes focusing on clarifying the findings I think this paper represents a significant contribution towards Arctic research and understanding the

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environmental parameters shaping microbial communities in this sensitive area.

Specific Comments

L124: I was interested in why the authors decided to pre-incubate the soils at 6 C (far above the mean of -3.8C, and below the max of 16.2, as well as different from the 5 C cut-off used in L186])? Also, why did the authors choose to pre-incubate for 2 weeks at this temperature? Is this typical for these kinds of measurements? I would think you want to minimize the pre-incubation time to prevent a strong bottle effect, as well as removing all your labile carbon.

L126: Is the specific respiration ratio typical to compare with the field? Is it possible to convert PLFA to a more generalizable unit (such as per cell, per g biomass etc. . .) using conversion factors?

L144: Is there a reference to support this sum? Are you not overcounting the bacterial contribution by summing general bacterial biomarkers with specific bacterial group biomarkers (Actinos, G-, G+)? Would it not be preferable to us general fungal : general bacterial only?

L189: Maybe change “In contrary” to “In contrast”.

L214: Maybe add at the end “and was instead transect specific”. I realize this is implied, but I feel it makes it clearer.

L213 – L227: This section is confusing to me. It is very surprising that microbial activity (as you assayed it) is not related to carbon or nitrogen content and is instead related to positively with Ca and negatively with Mg. I worry the trend in increasing respiration with altitude is due to the pre-incubation.

L228: Write out “Microbial Community Structure” in the header of this section.

L229: Gradient here is the transect? Does this mean there is a continuous change along the S-N transects or that each is different?

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L230: Nice to see so much explained due to altitude!

L231: Which gradients? Elevation or between the transects? Please fix or clarify this terminology!

L229 – L233: These few sentences are quite confusing and I think readers would be helped if you clarify. If I understand, the microbial community structure is impacted by elevation, but even more so by how the soils change with elevation? You ran multiple different tests to parse out these effects at different levels? Also, is microbial community structure here a relative score or absolute values?

L237: Re-running the analysis with the selected variables was non-significant? Can you clarify this statement? Why do you want to run the forward selection if the variables selected do not significantly explain the microbial community composition? Is the main message of this part, that these variables are not significant while altitude is?

L240 – L251: Nice results! I think this is more interesting that the previous paragraph. However, there are a lot of grammar mistakes here, some listed below. Maybe re-write this section for clarity.

L243: missing a space

L247: “A similarly significant trend”

L248: Change to PFLAs.

L249: change discrepant to disparate

L249: Consider re-writing, this is a very long sentence that can be shortened, maybe “The most disparate site in terms of MCS was the highest elevation sampled along Gr1. It was typified by a high abundance of PLFAs specific to Actinobacteria and a lower abundance of fungal PFLAs compared to analogous sites along Gr2 and Gr3.”

L255: What does this sentence mean?

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L265: “positive surface energy balance had a strong. . .”

L273: This is an incredibly important but difficult to decipher sentence. I think a lot of the sentences above it can be shortened or removed, but this should be clarified. Do you mean that “Mean temperatures and temperature stability did not change with altitude in this study”? [Therefore, variations in your parameters due to altitude are not simply due to temperature differences?] Here I would start off with a stronger statement of what you mean, and then offer your support.

L277: Extremely important to clarify what gradient you are talking about here.

L277: Are you missing a “not”. This is a confusing sentence.

L281 – L296: Simplify this! It is too wordy and difficult to follow. E.G. “We explain this discrepancy by the proximity of glacier stream, which could wash away the upper soil organic layer during abnormal spring-melt events in the past”, can be changed to “The only exception was the lowest site of Gr2 which had similar OM content to higher elevation sites along the other transects. This is likely due to the proximity of a glacier stream, which would wash away the topsoil during a flood.”

L284: “vascular plants also influenced”

L286: Please provide a citation for this.

L288 – L290: Is this important for your findings?

L290: Lots of grammar issues.

L292: Or high lichen components at high elevation?

L298 – L314: You need to discuss the implications of your pre-incubation step in this section. It can also be clarified or simplified for the readers.

L304-L308: Please include relevant concentrations of the Mg inhibitory effect here.

L309 – L314: This is a nice summary. However, the normalized characteristics are

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inherently dependent on the soil OM, so isn't their increase directly due to the OM decrease?

L323 – L324: Please clarify this statement. What shift in resources lead to the slow accumulation of low quality OM? What are the ramifications of your pre-incubation when you are suggesting some samples are enriched in more recalcitrant OM?

L327 – L336: A lot of speculation. Is all this necessary?

L337 – L347: Very speculative.

L384: "bedrock chemistry were recognized as the main factors. . ."

L387 – L388: A confusing sentence, consider revising.

Figure2: Consider moving either this figure, or Table1 to the supplemental information to shorten the main paper.

Figure 4: How much variation is there between altitude replicates? Maybe add a supplementary figure showing ellipsoids or individual sample points.

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