Earth Syst. Sci. Data Discuss., referee comment RC1
https://doi.org/10.5194/essd-2022-240-RC1, 2022

Comment on essd-2022-240

Matthias Siewert (Referee)

Referee comment on "Quantifying exchangeable base cations in permafrost: a reserve of nutrients about to thaw" by Elisabeth Mauclet et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2022-240-RC1, 2022

The manuscript by Mauclet et al undoubtedly presents an interesting data set on the vertical distribution of soil exchange properties in permafrost soils at a location in Alaska. The authors provide data on CEC, base saturation and other parameters for 7 soil profiles. This data is relevant and useful for the scientific community and provides a valuable reference point to understand the role of permafrost soils in the global carbon cycle. However, the manuscript needs to be thoroughly revised before being published.

1. I believe that the authors should separate between results and discussion. The jump between both and the comparison with the litertaure is not always clear and leading to confusion. In this case, it made it really hard to read the manuscript, filter out key messages and critically evaluate them. The most interesting and relevant discussion point is only in the last paragraph. A couple of things I would be more interested in are: Is there a statistical difference between the organic layer, active layer and upper permafrost (you have this partly) and what is the relevance in an arctic greening context. What nutrients do plants mine? Are there any trends. Further, how could hydrology be relevant for future changes in these systems.

2. The described correlation (L 206-219) between organic layer and active layer thickness are by no means news. The thermal isolating properties of the OL are well understood. I suggest to reduce this result to 1-2 sentences summarizing this and to remove Fig 2 and 3. This would also help to streamline the manuscript to focus on CEC.

3. The figures need to be reconsidered. Figure 2 and 3 are irrelevant from a scientific point of view, while figure 7,8 and 9 seem to essentially show the same data in 3 different ways.
Also: There are 9 points in Fig 2 but only 7 cores are mentioned in the method section! Are you sure that all results, e.g. L221-225, refer to the mentioned 7 profiles?

4. The 7 presented soil profiles are sampled along a gradient that is not explained. There needs to be a better description of the sample location and discussion of the potential soil pedon variability due to pattern ground landforms or environmental gradients. Furthermore, I also would like to see a map of the spatial distribution of the profiles and some sort of indicator reflecting the mentioned gradient, maybe a satellite image. Turbic histic cryosols can show huge variability within a full soil pedon (sensu JL Ping) and the sample location could determine much of the variability of the patterns that you find in your exchange capacity results. This also means a throughout discussion of cryoturbation as a process and explanation for the seen pattern in exchange properties. I am also not sure of the separation between shallow active layer and thick active layer are relevant. It would be much better to express this in terms of soil type or along the mentioned gradient.

5. It is unclear if bulk density was measured or only interpolated from previous BD measurements? Please clarify this in L 128ff. If direct BD measurement is still possible on the samples, then this should be the preferred method and added to the manuscript. Then stocks of different parameters were measured, but it is unclear to which depth. Calculation of stocks should be done to a specific depth for all profiles. I suggest 1m. Otherwise you compare apples with oranges.

6. What was the average weight of the elemental analysis sample? Were loss on ignition measurements (LOI) performed on a larger sample to confirm the representativness of the elemental analysis sample? If not, then you need to discuss this.

7. I find the interpretation outlined in L213-219 relating the SOC distribution to permafrost degradation very speculative and not supported. How are these soils more degraded? I assume you don't mean eroded or slope processes, but rather a thermal driven thickening of the active layer. Even differences in the thickness of the active layer may not imply a stronger degradation of the permafrost for these profiles relative to others. Most likely their thermal forcing is rather similar at the scale of the study area. Permafrost soils are highly variable and the seen changes may be observed within a less then a meter for any given soil profile for turbic soils. The difference may also reflect different soil development along the mentioned gradient (that was reduced to two soil types, motivation?). Both would by no means be related to permafrost degradation and even loss of SOC from the system. Most likely they rather reflect inter pedon variability or less SOC accumulation due to environmental gradients. If you have a different opinion on this, then I would expect a detailed chemical or structural analysis of this and a throughout explanation of the mechanisms. Again in L306, I dont think this premise of a significantly reduced organic layer due to thawing is supported by the data shown in the manuscript, the study area description or the cited literature. For instance, Schuur et al 2021 report a loss of 781.6 g C m−2 since the switch to a C source in 1990 and a cumulative projection of 4.18–10.00 kg C m−2 by 2100. Your differences in SOC for individual pedons surpasses potential loss as GHG within a century timescale.

8. Language is overall very good, but would benefit from rephrasing a couple of sentences. e.g. L 25, 31,58-63, 291...

I hope the authors find these comments helpful and constructive. Iam looking forward to see the results eventually published as I believe that it is a relevant contribution to the field
//Matthias Siewert

Minor comments:

L 14 Which arctic tundra soils are typical?

L16 - 'poorly thawed' – never seen this, please use a different expression. How about: permafrost affected soils with a shallow active layer and soils with a thick active layer?

L 19 - CEC is not defined in the abstract.

L24 To what depth did you count the permafrost for the stocks?

L 37 You should mention the word cryoturbation here.

L 62 Do you mean lateral in the soil as ground water or in streams?

L 71 I would argue that active layer thickness changes are fairly well understood and quantified.

L79 What do you mean by contrasted? I think you should be more specific here? Do you mean a range of ALT values, or two groups? What are the mean and the SD for these in cm?

L87 Which months represent the growing season?

L 88 Your profiles Mod2, Mod3 and EXT3 have less than 35 cm thick organic horizon. The results for SOC also indicate rather different soil types. What soil type are these then? I assume you used the US soil taxonomy system?

L101 What determined the sample location? How did you chose the gradient? How representative are these locations?

L 102 what are the ranges?

L 143 and 146 What do Min1, Mod3, EXT,… stand for?

Table S1, what does n stand for?

L145 Please motivate the profile selection.

L165 Please motivate the profile selection.

L180 Contrasted ALT – The two selected profiles have almost the same ALT 60 and 65 and are the deepest and shallowest in there respective ALT group. Maybe you could give another reason why you selected exactly these two profiles.

L200 This increase in SOC due to cryoturbation is typical for the bottom of the active layer and top of the permafrost section.

Fig 1. It is impossible to distinguish individual profiles. I suggest to differentiate each line by color, or make an average and min/max lines. The lines are also rather thin.

Fig 4 Any idea why Ca may behave different?

L236 By surface you mean organic? A suggest to statistically compare the organic layer, the mineral layer and the mineral permafrost layer. It would actually be interesting to see if there is a trend across all 7 profiles.

Fig 5 Again, it is hard to see any trends in this figure.

Are Fig 7, Fig 8 and Fig 9 essentially showing the same data?

Fig 9 Not sure if the figure is effective at communicating the message. What is the typical profile shallow or thick ALT?