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Interactive comment on "From fibrous plant residues to mineral-associated organic carbon – the fate of organic matter in Arctic permafrost soils" *by* Isabel Prater et al.

Anonymous Referee #3

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This is a very well-written manuscript that describes organic matter content and composition of physically-isolated density and particle size fractions collected from ice-wedge polygon centers in the Arctic. The objective of the paper is to characterize degree of decomposition of organic matter in permafrost soils with varying degrees of association with mineral surfaces to better understand potential bioavailability of this organic matter pool to warming and thawing. The authors present a thorough chemical characterization of particulate and mineral associated organic matter pools through C and N elemental analysis, stable isotopes and C13-NMR spectroscopy. The results interestingly reveal large contributions of potentially chemically bioavailable POM to the bulk soil C pool, whereas mineral-associated fractions contribute more to the soil N pool.

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Discussion paper

This work has implications for predictions of the response of similar permafrost-affected soils to warming.

Abstract:

L. 25: "We demonstrate that" It would be helpful in this sentence to operationally identify the fraction being discussed (that is, how was it isolated physically?) to better understand how it is being interpreted as "bioaccessible." Can you define the term bioaccessible? Is it synonymous with the more common "bioavailable" or does it specifically refer to physical accessibility?

Methods: The methods indicate soil drill cores are taken but do not highlight what depths are analyzed and presented. The text states in L. 102 : "Our analyses focused on selected layers only, as shown in Table 1" but Table 1 does not include this information. One would expect that the contribution of POM vs MAOM and the state of decomposition may vary with soil depth (perhaps not in the traditional predictions) yet the paper does not describe what depths are being analyzed.

Discussion:

The discussion is quite long with extensive paragraphs that have multiple ideas, which makes it sometimes a little difficult to follow all the ideas. Consider where the discussion can be streamlined and how paragraphs could be split into smaller blocks of text.

Section 4.1- The section heading is perhaps not the most informative of the text, as permafrost processes (other than one mention to cryoturbation) are not discussed in depth here. Consider renaming the section or including more information on processes. It may also be helpful to separate the text into a paragraph on C and N stocks and another one on composition of SOM, mainly C:N ratios.

Section 4.2: It is very interesting that the POM and MAOM fractions play such different roles in C and N storage in these soils.

Section 4.3: Consider starting the paragraph l. 332 with summarizing results of N dynamics or 15N and their implication as the first sentence on N fixation seems to have no context. This paragraph could also be moved after the NMR paragraph which flows better after the 13C paragraph.

Minor edits:

Introduction, paragraph starting l. 58-78 is too long with too may different ideas. Should be broken up into smaller paragraphs, one on effects of climate change on SOM, one on SOM methods, then the research objectives.

Spell out abbreviations for symbols in the Table legends. For example, fPOM, MAOM. . . Also indicate whether data reported are means and standard error or means and standard deviation.

Table 2. Should a/o-a ratio be O-a ratio? (capital O)

Figure 1. May be helpful to indicate what the white and blue colors are on the image. Ice and open water? Unclear because the ocean is black.

l. 240: add ppm after 70-75 ppm /52-57 ppm

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