

## Anonymous Referee #1

*Accept with minor revision*

*Summary of the paper: Organic matter characteristics of a rapidly eroding permafrost cliff in NE Siberia (Lena Delta, Laptev Sea region)*

*Haugk et al. studied the characteristic of organic matter (biomarkers, bulk parameters) on a permafrost erosional cliff (located at the Lena Delta, Sobo-Sise Island) that they dated and described. A good amount of samples were studied covering the whole cliff at a 0.5 m resolution which allowed the clustering of the cliff into 3 units. These units are characterized by different biomarker ratios and bulk parameters linked to the quality of the organic matter. MIS 1 and 3 deposit seems to have a stronger microbial biomass activity.*

*I really like this study because of the nice description and the clear clustering of the samples into these 3 units. I am missing a bit more of bulk sedimentological analysis, but it's already a lot of data for such a small scale study. I recommend very minor revisions, it would be amazing if mineral surface area could be measured but I know that takes time.*

**Thank you for your constructive feedback. We answered all comments below and revised the manuscript accordingly.**

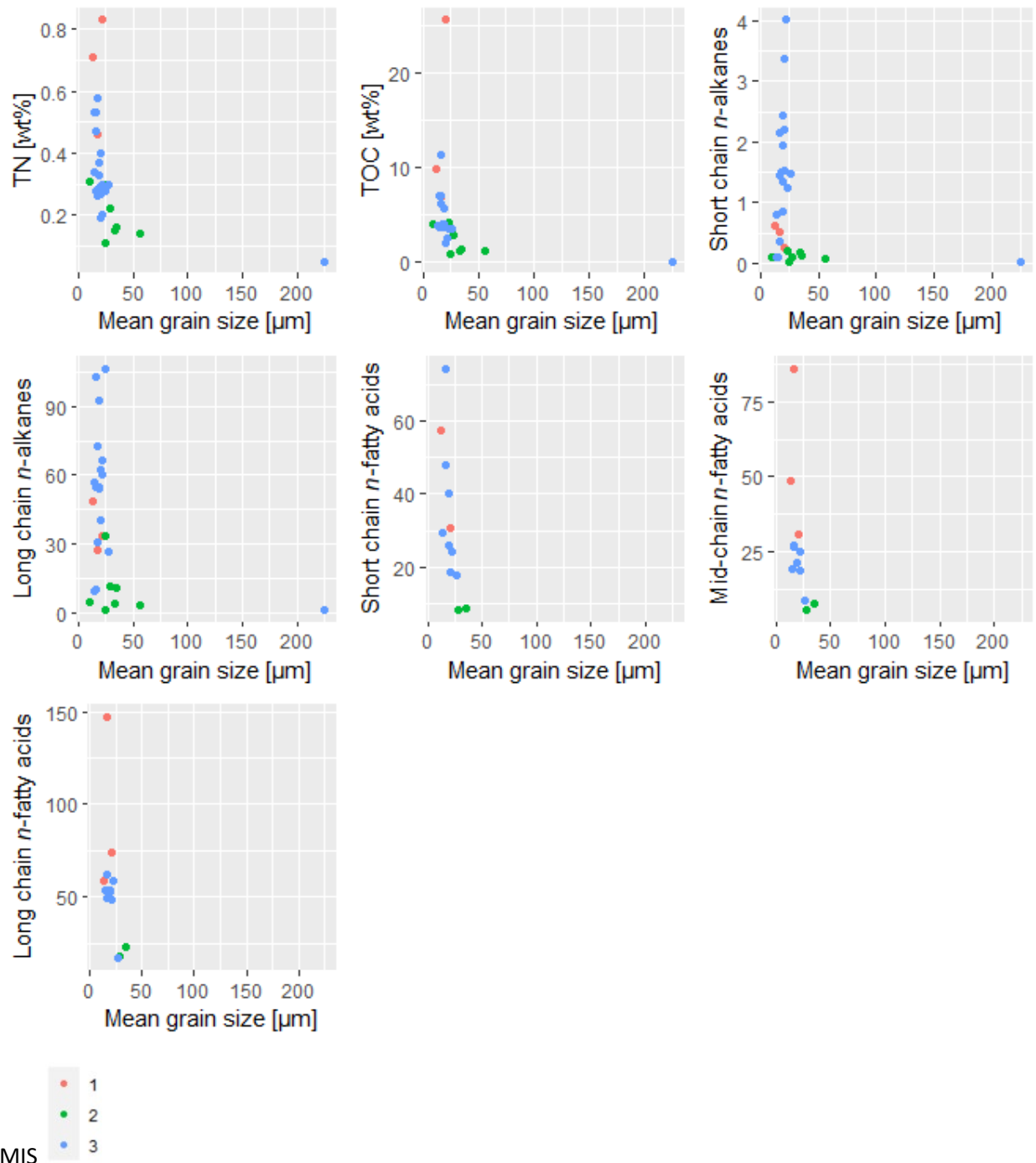
*Main comments:*

*- This study is a very well rounded descriptive study. I am missing a bit of comparison with other permafrost coastal erosion sites such as Muostakh Island (Vonk et al., 2012. Nature); or thaw slump on the Peel Plateau in Canada (Bröder et al., 2021. Environmental Research Letter).*

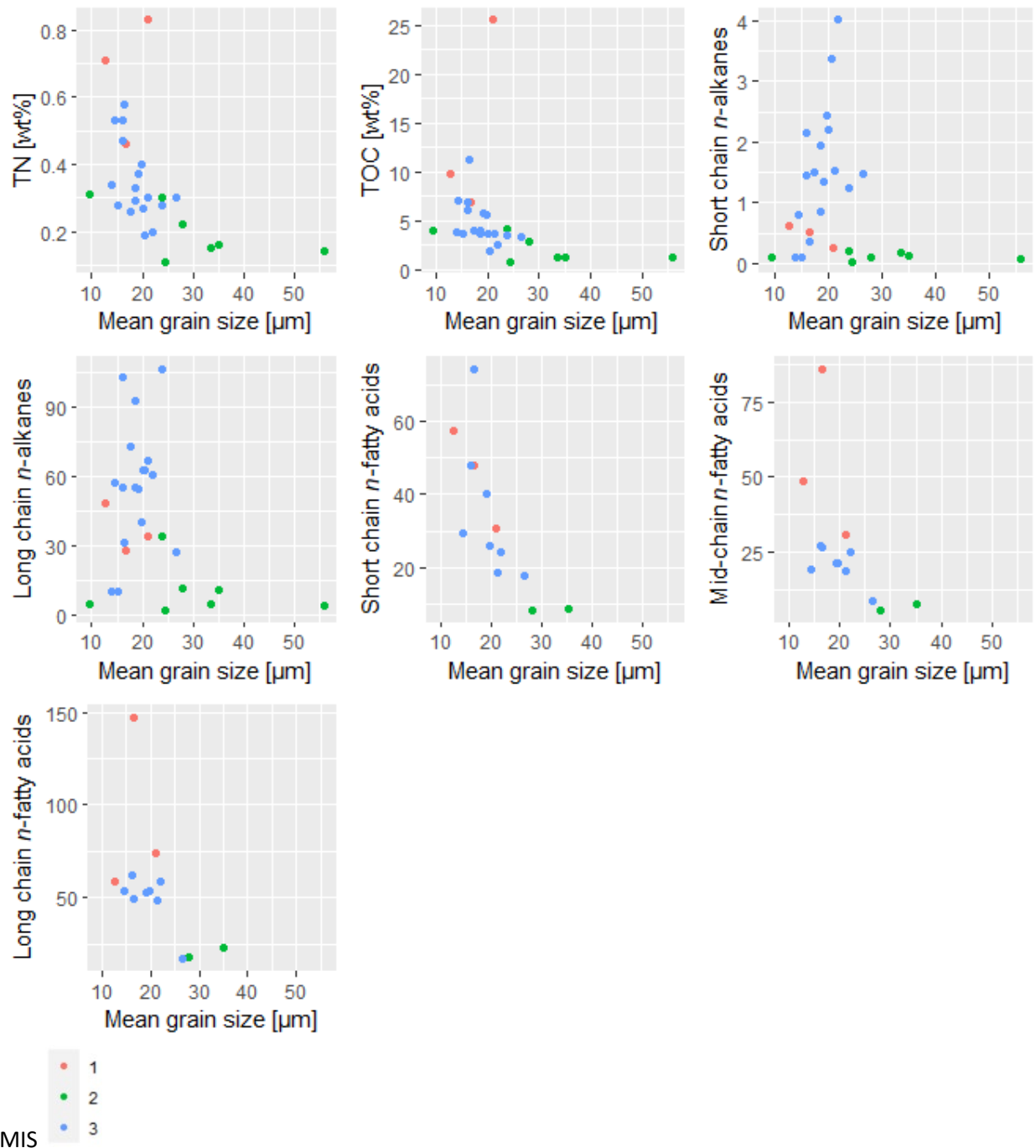
**Thank you, we added more discussion in the last chapter including the suggested studies**

*- I was surprised to not see any grain-size or mineral surface area data. When looking at preservation of organic matter, grain size and mineral surface area analysis can give a lot of information as organic matter preserve better when associated with the surface of minerals, in particular long chain alkanes and fatty acids are better linked to the minerals than their short-chain counterpart. So I would advise to measure mineral surface areas or grain size (usually negatively correlated to mineral surface area) for these samples and look at biomarker as loadings ( $\mu\text{g m}^2$ , see Bao et al., 2018 Influence of Hydrodynamic Processes on the Fate of Sedimentary Organic Matter on Continental Margins).*

**The grain size distributions were measured and published by Wetterich et al. (2020; doi:10.1594/PANGAEA.919457). Following your advice, we took a closer look at these data. Please have a look hereon the following graphs showing correlation plots and correlation coefficients (Table) for grain size vs. TOC, TN and biomarker parameters ( $\mu\text{g g}^{-1}$  Sed) with mean grain size. First with all data, second set without the grain size outlier (SOB18-01-18). Likely, this information may be too far off the paper's focus, but we can add this to the supplement if needed?**



| Grain size ~            | R          | p        |
|-------------------------|------------|----------|
| TN                      | -0.4102113 | 0.03015  |
| TOC                     | -0.2631097 | 0.1761   |
| Short <i>n</i> -alkanes | -0.2211888 | 0.258    |
| Long <i>n</i> -alkanes  | -0.3159445 | 0.1015   |
| Short <i>n</i> -FAs     | -0.7727632 | 0.001955 |
| Mid <i>n</i> -FAs       | -0.5728613 | 0.04072  |
| Long <i>n</i> -FAs      | -0.5552758 | 0.04884  |



| Grain size ~    | R          | p        |
|-----------------|------------|----------|
| TN              | -0.5052386 | 0.007186 |
| TOC             | -0.3078331 | 0.1183   |
| Short n-alkanes | -0.1844215 | 0.3571   |
| Long n-alkanes  | -0.3327127 | 0.08994  |
| Short n-FAs     | -0.7727632 | 0.001955 |
| Mid n-FAs       | -0.5728613 | 0.04072  |
| Long n-FAs      | -0.5552758 | 0.04884  |

*Minor comments:*

*-L42-44: The last sentence is quite a stretch for this study, considering that you only look at a small eroding cliff in a small area of the Lena River Delta. I know that an introduction looks good when it ends with a global statement but this one is quite over the scope of the study.*

**We removed the second part of the sentence (the global statement).**

*-L45: I think that this sentence would make more sense if it was said that climate warming risk to thaw permafrost, hence arctic region underlain with permafrost might change very rapidly.*

**We rephrased the sentence accordingly.**

*-L47: maybe define what is permafrost, we are not all working in these polar regions.*

**We now added the definition of permafrost in the introduction:**

**“Permafrost is ground that stays below 0 °C for two or more consecutive years.”**

*-L53-58: The end of the paragraph comes a bit out of the blue, I would move it to the study area part or after L69.*

**We moved these sentence further down in the introduction as suggested.**

*-L114: “remarkably high” could you add other retreat rate to compare with yours?*

**We added the following sentence for comparison:**

**“In comparison, retreat rates were lower for other Yedoma Cliffs such as on the Kurungnakh Island in the central Lena Delta (4.1-6.9 m yr<sup>-1</sup>; Stettner et al., 2018), at the Itkillik exposure in Alaska (11 m yr<sup>-1</sup>; Wetterich et al., 2008) but even higher for the Muostahk Island (29.4 m yr<sup>-1</sup>; Günther et al., 2013) and Cape Mamontov Klyk (21 m yr<sup>-1</sup>; Günther et al., 2015).”**

*-L122: Maybe “Material” instead of “Fieldwork”*

**We changed the title to “Sample collection”.**

*-L144: I guess you dried the samples after washing?*

**Yes, we added the following information to the text: “the samples were filtered (Whatman Grade GF/B, nominal particle retention of 1.0 µm) after which the residue was dried and ground.”**

*-L153: Why did you only select 13 samples? Just curious: was it because of low concentration?*

**We made a sample selection because of time constraints.**

*-L160: is this a volumetric or weight ratio?*

**This is a volumetric ratio. We added this information in the text.**

*-L189: Please add more references to this statement or use a review. The use of longchain alkanes to trace for higher terrestrial plants has first been proposed by Eglinton and Hamilton, 1967; Eglinton and Eglinton 2008 and since then used a lot. It is diminishing to only cite Schäffer et al., 2016 although a good study. Furthermore, a reference is missing for the use of shorter chain alkane to trace for bacterial biomass.*

**We added the references you mentioned and added references (Cranwell, 1984; Rieley et al., 1991; Kuhn et al., 2010) for using shorter chain *n*-alkanes to trace bacterial/algal biomass.**

*-L190: precise what you mean by “long chain range”, is that changes above 25 or changes toward 25?*

**We removed this, as we do not want to introduce a new “long chain” starting value.**

*-L193: Why did you choose to start at C23? Is it to include potential moss influence?*

**This is because we followed previous studies Ficken et al. (1998), Strauss, Jongejans etc.**

*-L214: Similarly why not include higher chain length of FA, such as C30 and C32?*

**We did not include the C<sub>30</sub> and C<sub>32</sub> FAs to be consistent with Strauss et al. (2015) who introduced the index.**

*-L246: should it be 42 µg gSed<sup>-1</sup>?*

**We rephrased the paragraph and made corrections where necessary.**

*-L276: Please repeat which chain length you include in your short, mid and long chain fatty acids*

**We added the ranges for short (C<sub>8</sub>-C<sub>20</sub>), mid (C<sub>21</sub>-C<sub>23</sub>), and long chain (C<sub>24</sub>-C<sub>32</sub>) fatty acids in the text.**

*-L277-278: If only the short-chain alkane concentration varies between the units, how come the HPFA differs between the units? From which compounds is the variation coming from?*

**The *n*-FA C<sub>24</sub> is significantly different (p=0.015) between the units and thereby “∑ *n*-fatty acids C<sub>24</sub> C<sub>26</sub> C<sub>28</sub>” (p=0.038), so that makes for a significant change for the complete ratio (p=0.045).**

*-L283: You define the long chain alkane starting at *n*-C<sub>21</sub>, whereas before you included starting *n*C<sub>23</sub>. Can you make the manuscript homogenous or detail why you choose to change mid-manuscript.*

**We changed the long chain alkanes to start from *n*-C<sub>21</sub> throughout the manuscript.**

*-L284-288: It would have been great to obtain compound-specific δ13C for the fatty acids and alkane found in those samples, or even better hydrogen isotopes. Then tracking the differences between units to know more precisely how this permafrost was created (if all FA and alkanes originated from the same region ...). I am aware that it is not the scope of this manuscript but maybe an idea for later?*

**Thank you.**

*-L296-297: iso and anteiso FA are historical biomarkers for bacterial activity but have you thought of branched and isoprenoid GDGT? They are typical for Acidobacteria in soils as well as methanogen/methanotrophic Archaea. These biomarker can add more details to the theory of increased bacterial activity/biomass.*

**This is a great idea for future studies.**

*-L297: I totally agree, using C16 FA is tempting because of high abundance, but it has such a large range of source that its interpretation without isotopic signature is too ambiguous.*

**Thank you.**

*-L391-395: I feel like this paragraph is added without much reason. Of course there is a lot of unknown in coastal biogeochemical processes and more studies to be done, nothing new about that. You could take that paragraph out without changing the scope of this manuscript.*

**Removed according your suggestion.**

*-Figure 3: in the short-chain panel you could use a logarithmic scale to better capture the variations between SOB18-01 and SOB 18-06.*

**The suggestion is good, but for consistency we decided to keep the scale like it is. However, we did change figure 4c from the total *n*-alkane concentration to short chain *n*-alkane concentration.**

*Typographical corrections:*

*- Always add a space between number and unit except for % and ‰. At least be consistent throughout the manuscript.*

*- Liter is sometimes written “L” or “l”. Be consistent “L” is the official SI abbreviation.*

*- BG guidelines indicate that instead of “µg/gTOC”, “µg gTOC-1” should be used, please correct throughout the manuscript.*

*- L88: C25 or 25 atoms of carbon instead of “C25”*

*- L191: C23 to C25*

**We revised all suggested typographical corrections throughout the manuscript.**

**To make all changes visible we will upload a revised version with track changes and one without for further comment with adjusted/revised line numbers.**