

## Anonymous Referee #2

Haugk et al. worked on organic matter in the permafrost samples collected from the Sobo- Sise Yedoma cliff spanning the last 52 ka in the Lena River Delta. They analyzed C and nitrogen content, bulk carbon isotope and biomarkers to characterize the sources and the quality of OM in the permafrost. They discovered the high quality of permafrost OM for potential decomposition and also demonstrated the associations between permafrost OC characteristics and past climate in the spanning record. This study adds to the present chemical composition data pool of permafrost OC from the Arctic, especially from the eroding Arctic river bank rich in yedoma. This is also well-written and I would recommend a publication with minor revision.

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

### *Specific comments:*

*Line 86 Aim 2 and aim 3 might be combined as they are basically telling the same thing.*

**We decided to keep the aims as they are as aim 2 targets the present state and aim 3 the future behaviour of the organic matter.**

*Line 93 The locations of the three geomorphic units is not all clear. Only the second unit is stated in the north-western part.*

**We added a bit more information on the distribution of the geomorphic units as suggested. For details and mapping efforts the reader should read the cited literature.**

*“While the first unit consists of Holocene floodplains and could occur in the whole delta area, the second unit consists of late Pleistocene and Holocene fluvial deposits that are mostly located in the north-western part of the delta and are cut off from the current delta dynamics (Schirrmeister et al., 2011b). The third geomorphological unit consists of erosional remnants of a late Pleistocene accumulation plain with ice-rich Yedoma Ice Complex deposits and is present mainly in the west, south and east of the delta (Schwamborn et al., 2002; Wetterich et al., 2008, Morgenstern et al. 2011).”*

*Line 139 What is the precision of TOC and  $\delta^{13}\text{C}$  measurements?*

**We added the analytical accuracy of the TOC (0.1 wt%) and d13C measurements (0.15‰) to the text.**

*Line 146 The statement about radiocarbon age is misleading as those data are adopted from Wetterich et al., 2020 but not measurement in this study.*

**We moved the information about the radiocarbon ages from the methods to the results only and rephrased the sentence so that it is clear that the data and the age-depth model were published by Wetterich et al. (2020a).**

*Line 154 What is the reason of using 13 samples for fatty acids analysis and 28 samples for n-alkane?*

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

*Line 161 What is temperature of the following 5 min of heating?*

**This was unclear, the heating was to get the 75 °C so before the 20 min static phase. We revised this in the text to:**

**“Each sample was held in a static phase (5 minute heating phase, 20 min at 75 °C and 5 MPa).”**

*Line 231 I guess SOB10-01-01 should be SOB18-01-01?*

**You are right, we corrected this.**

*Line 231 What is the precision of TOC measurement? I am not sure if two decimal points is really needed.*

**Following your suggestions, we now report the values with 1 decimal.**

*Line 238 It may be better to keep consistency on the number of decimal points for the same data set.*

**As answered to the comment above, we followed your suggestion.**

*Line 254 “and” should be “showed”?*

**We split the sentence and added the wording you suggested.**

*Line 279 It should be “lowest values in unit III” for HPFA index.*

**We corrected this.**

*Line 313 Can the formation of those peat layers in this area be related to the formation of different geomorphic units?*

**Not as far as we know. In the sentence following line 313, we tried to build a regional bridge to the Kurungnakh deposits.**

*Line 349 Presumably, when the OM is frozen, decomposition should be very limited and may not cause much difference on the decomposition index. And the decreasing trend of HPFA doesn't seems to be very significant. In addition, how would you explain the change of iso and anteiso FA when HPFA shows consistency in unit III?*

**Even though it is difficult to see in Figure 3 (it is clearer in Figure 4; in the revised manuscript we now refer to this figure instead of 3), the HPFA was significantly different between the units ( $p=0.045$ ). Therefore, we argued that the OM decomposition was advanced furthest in this unit. This corresponds nicely to the highest ratio of iso- and anteiso-FAs compared to the mid and long chain FAs.**

*Line 364. “Our findings show that freshly thawed and...15.7 m/yr” may be rephrased as this study did work on the mobilization of permafrost.*

**Thanks, we rephrased the sentence making clear that the erosion rates were found by Fuchs et al. and were not part of this study.**

*L373, van Dongen et al 2008 argues that greater degree of decomposition was found in the western Eurasian Arctic. Please check again.*

**Thanks, this was a typo, we changes “greater” to “lower”.**

**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.**