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Interactive comment on "A 21,000 year record of organic matter quality in the WAIS Divide ice core" *by* Juliana D'Andrilli et al.

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RC2 The reviewer comments are numbered for reference. Each reply is listed below the numbered reviewer comment.

1. You state that "Ice core studies rely on the paradigm that atmospheric deposition is the sole mechanism for specific gases and materials to become trapped in the ice" (Lines 47- 48) yet it is unclear if you apply this paradigm to your work. If you do not allow even a remote chance for in-situ production of this organic matter, then please explicitly state so in your work.

We apply this conservative approach for organic matter preservation in ice cores, however, do so acknowledge the chance for in situ production of organic matter. We can only speculate on the possibility of in situ organic matter production due to method-

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ological limitations. We will clarify our approach and acknowledgement of this fact in the text.

2. In lines 179-183 you mention the possibility of in situ OM processing but then do not discuss if such transformation could affect the samples in this work.

A discussion of in situ processing of OM affecting the samples will be added to strengthen this work.

3. You mention that tryptophan-like florescence in C2 may derive from microorganisms, and then mention that the presence of microorganisms may result in in situ OM processing, but step back from linking the two aspects.

We would welcome a section that describes the interwoven nature of microorganisms and organic material, however, with our methodological limitations, were hesitant to include such ideas as no experimental evidence from this project can differentiate labile OM deposited and preserved, or freshly produced material transformed by englacial microorganisms. A more detailed description of fluorescing chemical species will be provided upon revising the manuscript, however only acknowledging the microbial processing loop will be appropriate with our current methodological limitations.

4. In the following paragraph you then mention that Holocene terrestrial plants and soils are the likely source of the C3 OM yet do not mention if in situ processes may affect this material or if you ascribe this material to be solely brought in via atmospheric transport. Please clarify your stance on the source and possible post-depositional processes affecting the samples as both aspects are essential to your interpretations of the data.

Upon clarification of the points mentioned above from the previous comment, this section will be edited accordingly.

5. Please check that all figures are cited in the text. In lines 128-144 you mention Supplemental Figures 1a-b. You do not refer to Figure 2 in the text. As you refer to the

Supplemental Figures but not Figure 2, then perhaps their roles should be reversed with the current Figure 2 included in the Supplementary Information and vice versa.

Figure 2 is cited in Line 129. We will double check to make sure all figures are cited accordingly.

6. The left bars and corresponding explanation in the caption of Figure 3 are confusing. In the article text you explicitly state that C3 only occurs during the Holocene. As most readers will likely first look at the figures and captions before reading the article, it bears mentioning in the caption that C3 is specific to the Holocene. Demonstrating the variation in C2 by various time periods (LGM, LD and Holocene) is useful but then makes the reader immediately wonder what is the variation in C1 between climate periods. If there is no substantial variation between time periods for C1, please mention this fact in the caption.

Figure 3 caption will be edited to specify that C3 is specific to the Holocene and that no variation between time periods for C1 was observed. Specifically, the variation in C2 is discussed in the main text, along with the result of no variation for C1, so an addition of that information to the caption will help clarify any confusion for the figure.

7. This sentence is confusing (Lines 227-229): "During the LGM, tundra ecosystems covered more expansive areas of the Earth (Ciais et al., 2012) and while C was cycling, productivity in the environment differed from warmer climates (Ciais et al., 2012 and references within)". Do you mean due to the colder temperatures and increased ice cover and tundra during the LGM, that net C productivity was less than in the other warmer times periods of this study?

Yes, that was the intended meaning of that sentence. The text will be revised to clarify that point.

8. The final conclusion overstates the results of the study. To state that labile, microbially derived OM "were the greatest contributors to Earth's atmospheric composition

throughout history" is not correct. Labile OM may have been the greatest contributor of total OM in the atmosphere over the time periods covered in this paper, but this situation may not be the case before the LGM. In addition, in this sentence it is not clear what aspect of the "Earth's atmospheric composition" that you mean.

Correct, this sentence is an overstatement, and will be adjusted to reflect that labile OM (and restate the potential chemical species determined from our fluorescent analyses) may have been the greatest contributor of total OM in the atmosphere from 27,000 to 6,000 years ago. We will clarify which aspect of the Earth's atmosphere we are referring to in this section.

9. Line 16 = Define PARAFAC as this is the first time that you use this acronym.

A definition of multivariate parallel factor analysis (PARAFAC) will be edited in this line.

10. Line 48: Place "idea" after "that" in "Extending that to include".

The word "idea" will be included. The omission was an oversight.

11. Line 222: Remove the comma after "LGM".

Indeed, this was a typo, thank you.

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