

Interactive comment on “Degradation state of organic matter in surface sediments from the Beaufort Shelf: a lipid approach” by J.-F. Rontani et al.

Anonymous Referee #2

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Review of bg-2012-60 “Degradation state of organic matter in surface sediments from the Beaufort Shelf: A lipid approach” by Rontani et al.

Rontani and coauthors here present a detailed lipid analyses on surface sediments off the Mackenzie River in Arctic Canada. They provide interesting insights into abiotic and biotic degradation processes by using (the degradation products of) a range of sterols and monounsaturated fatty acids in this environment. The authors appear knowledgeable in lipid chemistry and interpretation of lipid patterns/trends as shown by their thorough and robust analyses, description of methods and results, and literature comparison. I do think, however, that the paper would benefit largely from (i) a

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more detailed description of the study area, particularly regarding the characteristics of this Arctic estuary that are relevant for this study, (ii) a more in-depth interpretation of spatial trends, and (iii) doing a better job in describing the motivation to study lipids in this environment. If these three points (further detailed below), and other minor comments are sufficiently addressed, I would recommend publication in Biogeosciences.

(i) Arctic rivers and their estuaries are characterized by seasonal extremes; long ice cover, limited light conditions and a very strong seasonal signal in discharge, but also sediment, and POC/DOC fluxes. Even though many readers are probably familiar with this, it should be mentioned. It would be good to minimally add timing and amounts in discharge and delivered OM, and relate this to timing of sampling (August). Also, a description of prevailing currents in this region would be beneficial, and potential benthic boundary layer transport mechanisms. (ii) The authors devote one small paragraph (end of Section 3.2) to spatial variability of the results, which I think is insufficient, especially when comparing with the comprehensive description of lipid results. I do like, for example, the relation to oxygen penetration depths, but I would like to see a more elaborate discussion on spatial trends. For example: where do algal blooms typically occur (near which stations?); can more distinctive patterns in depth vs. lipid trends be observed?; where are the dominant outflow channels of the Mackenzie freshet plume, and does this relate to lipid (degradation) patterns observed? (iii) Only in the conclusions (page 3898, lines # 8-14) do the authors mention that “In the Arctic, global warming may induce changes in vegetation from tundra toward leaf-bearing plants...”. In my opinion this statement comes too late, and is also oversimplified; the Arctic landscape is very heterogeneous and warming trends will lead to different vegetation, ecological, and hydrological changes. It would be more valuable to speculate on more specific (predicted) changes in the Mackenzie drainage basin/Beaufort shelf region and how this study can improve our insights in these potential changes, and highlight this earlier in the manuscript (i.e. Introduction).

The authors often refer to a manuscript that is submitted to GCA (e.g. “it was previously

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observed. . ." line #5, page 3891 and many more places). Since the readers do not have access to this manuscript, and it might not be accepted in GCA, I think the authors should tune down on referring to the results in that manuscript or, alternatively, include a brief summary and/or most relevant results of that paper (essentially a manuscript too) in this manuscript.

Further comments: Abstract Line #14: the use of "unusually very high" is not correct, "unusually high" would be sufficient. The authors use the exact same phrasing at several locations later in the manuscript.

Introduction Lines #3-16: in addition to the extra references suggested by Mark Yunker (Interactive comment June 4th), van Dongen et al. (Marine Chemistry, 2008) and Vonk et al. (Marine Chemistry, 2008) also report on lipid degradation patterns in (sub-arctic) surface POM versus sediments.

Study area Line #4: "into the Arctic Ocean" would be better Line #24: "ice" instead of "ices" Line #8-9: this is confusing; does the 95-99% include coastal erosion and other rivers? Coastal erosion in this region is quite substantial in the Canadian part of the Beaufort Sea (Lantuit et al. 2011) with coastal retreat rates up to 10m/yr.

Sediment sampling Could you provide some more details on the USNEL box corer (e.g. dimensions, material, where produced).

Treatment of samples Could you (also) report the centrifugation speed in rpm?

Results and discussion In my opinion, there is some basic information missing here, such as exact coordinates and sampling depth, and bulk geochemical characteristics of the sediment samples (i.e. % sediment OC, $\delta^{13}\text{C}$). These data could easily be added as a Table. Interpretation of spatial trends would be much easier with this information at hand. The manuscript does not contain any lipid concentrations nor distributions. This would also be of great value, and could be included as Supplementary Information. Also, could Brassicasterol not (partly) originate in freshwaters as is the case, for

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example, in the Yenisey River (Fahl et al. 2003)?

Section 3.1 I think the heading should read "sterols" instead of "sterol". Line #19, page 3890: I am not a native speaker, but the usage of "well distinct" (multiple locations in the manuscript) does not sound correct. Line # 10-13, page 3891: An alternative explanation to this statement could be lateral sediment transport, i.e. lipid patterns in the surface sediment do not need to be representative of the water column POM directly above (in fact, they probably are not). The sediment could consist of particles that have settled much closer to land (and as such have spent less time in degradative environments?) and have been transported over the bottom instead. Regarding the extra sentences that were added based on the comment of Mark Yunker (Interactive comment by Rontani et al. 11 June, page C1867, end of first paragraph): Where on the shelf where the sterols by Belicka et al. measured? If the "quick degradation" happens in the "second cm of sediments", it would be worth comparing it with spatial patterns of oxygen penetration depth that are mentioned in the manuscript (page 3897, line #16-19), to see if this can indeed be the case. Another note regarding the Interactive comments of Yunker: he states that "Sitosterol and campesterol are primarily associated with the particulate phase [. . . .] However, higher proportions of sitosterol are observed in the dissolved (<0.7 μm) fraction than in the particulate phase . . .". The authors do not answer to this specific comment, but I think this is an interesting and valid remark and worth a response.

Section 3.2 Lines # 21-23, page 3894: the authors write multiple times that a "very high trans/cis ratio" was observed, and only here relate this to the 0.1 value (>0.1 indicator of oxidative stress). Readers that are not familiar with this could be confused (any ratios <1 still mean more cis than trans!), so I suggest to move this more forward, and/or also include this in the Figure captions. Line # 20, page 3896: "(see above)", where exactly do you refer to? In Section 3.1 you report that autoxidation processes appear only minor in sediments (lines #7-10, page 3891)? That seems contradictory.

Conclusions Page 3898, line #8: it should be "In the Arctic" instead of "In Arctic".

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Suggested references – Van Dongen, B. E., Z. Zencak, and Ö. Gustafsson (2008b), Differential transport and degradation of bulk organic carbon and specific terrestrial biomarkers in the surface waters of a sub-Arctic brackish bay mixing zone, *Mar. Chem.*, 112(3–4), 203–214, doi:10.1016/j.marchem.2008.08.002. – Vonk, J. E., B. E. van Dongen, and Ö. Gustafsson (2008), Lipid biomarker investigation of the origin and diagenetic state of sub-Arctic terrestrial organic matter presently exported into the northern Bothnian Bay, *Mar. Chem.*, 112, 1–10, doi:10.1016/j.marchem.2008.07.001. – Lantuit et al. The ACD coastal database: A new 1120classification scheme and statistics on Arctic permafrost coastlines. *Estuaries and Coasts* 2011, DOI 10.1007/s12237-010-9362-6 – Fahl, K., Stein, R., Gaye-Haake, B., Gebhardt, C., Kodina, L.A., Unger, D., Ittekkot, V., 2003. Biomarkers in surface sediments from the Ob and Yenisei estuaries and the southern Kara Sea: evidence for particulate organic carbon sources, pathways, and degradation. In: Stein, R., Fahl, K., Fütterer, D.K., Galimov, E.M., Stepanets, O.V. (Eds.), *Proceedings in Marine Science 6: Siberian River Run-off in the Kara Sea*. Elsevier Science, pp. 329–348.

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