

Interactive comment on “Molecular and radiocarbon constraints on sources and degradation of terrestrial organic carbon along the Kolyma paleoriver transect, East Siberian Sea” by J. E. Vonk et al.

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Final response to all interactive comments:

We have carefully considered the overall supportive review comments, and find them helpful toward further improving this ms. Below, we are detailing our responses and revisions in response to the interactive comments of the two referees.

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Reviewer #1

1) Page-5207, line 26: should “the erosion OC” read “the eroded OC”

Yes, we agree. We have changed this in the manuscript.

2) Section 3.4: The benthic boundary layer transport is a very likely mechanism, but should not be repeatedly stated.

Yes, we agree. For instance, “Benthic boundary layer transport” is stated three times in section 3.4. We have removed the second one, and replaced it with “bottom transport”. The sentence now reads: “This will allow for very slow but long-distance bottom transport, moving the terrestrial OC up to several hundreds of kilometers offshore.”

3) Section 3.5 and other places: Just a question here; why marine OC has to be young in the ESS? Are there any radiocarbon measurement for DIC samples? Considering the old nature of arctic riverine DIC and large methane fluxes in this region and the degradation of old OC during their transport, the C-14 age of DIC and thus marine OC in arctic coastal waters could be “old” although riverine DOM has been shown to be contemporary.

While it is plausible that there is an “old nature of riverine DIC”, we are unaware of any published data to this end for the Eurasian Arctic rivers. Furthermore, such fluvial sources are strictly speaking not marine and we think they can therefore not be used as marine endmembers. For the Canadian Arctic shelf, there are reports of very limited measurements, showing $\delta^{14}\text{C}$ -DIC values around -50 per mille (Östlund, Possnert & Swift, 1987; Schlosser et al., Radiocarbon, 1994). If we would apply -50 per mille as a marine endmember for our Eurasian Arctic system, this would result in only very minimal increases in the marine OC contribution to the SOC (1-2%). Additionally considering that there is an inflow of water from the north Pacific to the East Siberian Sea, we therefore suggest it is reasonable to maintain the N Pacific based 25 per mille endmember. We have added a sentence to the ms on line 23, page 5205: “For the

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Canadian Arctic shelf, limited measurements show ^{14}C -DIC values around -50 per mille (Östlund, Possnert and Swift, 1987; Schlosser et al., 1994b). Considering the direct influence of Pacific waters on the ESS (Semiletov et al., 2005) we believe the assumption of using $\Delta^{14}\text{C}$ DIC data from the northern Pacific to be a reasonable one." Also, we have added these two references to the reference list.

4) Table 1: if data available, I suggest the list of both suspended particle concentrations and POC concentrations in addition to OC (in mg/gdw) for better comparison with other studies.

Indeed, this could have been a valuable addition, but unfortunately we did not measure suspended particle concentrations.

5) Figure 2: should be cleaned up a little bit. Also, the lower panel in Figure 3. 6) Figure 4: again, the horizontal lines could be removed.

Good point, all three figures have been cleaned up by removing the horizontal lines and thinning the axes.

Reviewer #2

(1) The key conclusion of the study is that a major fraction of the eroded organic matter is deposited on the shelf and potentially preserved rather than degraded to CO_2 . The distinction between river derived and coastal erosion derived organic matter rests to a large degree on the choice of the ^{14}C -age endmembers. I think that the major conclusions of the study are valid and pertinent but at the same time there is some room for variability if different endmembers are chosen. One key measurement that is missing from the study and would have answered important open questions is the ^{14}C age of DIC. With this in hand the algal or marine endmember could have been better constrained.

We agree that the exact distinction between the contributions to sedimentary OM from river vs coastal erosion depends on the choice of the $\Delta^{14}\text{C}$ of the endmembers. How-

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ever, there is a large difference in bulk $\Delta^{14}\text{C}$ of riverine (-296 per mil) versus eroding (-788 per mil) material. Eroding coastal bluffs will deliver OM from the complete profile and this flux will therefore consist mostly of old OM with only a small fraction of surface layer OM. On the contrary, riverine OM will contain much younger surface soil OM since most of the river/surface runoff washes through the surface active layer with only limited water flow through deeper (i.e. older) soil layers due to the permafrost underlying the Kolyma drainage basin. The Monte Carlo simulations provide a balanced mathematical assessment of the effect of the uncertainties of the end member composition on the final source apportionment values. In the ms, we now have addressed this issue (after last sentence, page 5205): "The end-members values are subjected to some variability due to our incomplete knowledge of the Arctic system. However, the use of an MC simulation method that includes the standard deviations of the chosen end-members will account for some of this uncertainty in the source apportionment." Regarding the ^{14}C age of DIC, the relative contribution to ^{14}C -SOC from river-OC vs erosion-OC is not affected by ^{14}C -DIC. However, that information would certainly be instructive for several other reasons, including constraints on marine plankton contribution to SOC, as espoused above in connection to our response to Reviewer 1 comment 3.

(2) I also wondered if the study allows the authors to distinguish between erosion happening on the river banks and SPM coming from surface runoff. I suspect that river SPM also transports a significant amount of eroded and old permafrost derived material to the Arctic coast. If the authors would like to add a couple of sentences to address the two points raised above I would appreciate it as a reader.

The issue of river bank erosion is indeed an interesting aspect, and we have considered this. The extent of river bank erosion will vary from river to river. The Lena delta is known to undergo significant erosion. In comparison, the lower reaches of Kolyma River have lower bluff heights and also large areas of flat floodplain banks. Hence, in this region, erosion OC is likely to originate mostly from the coastline. Nonetheless,

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we like to include this aspect in our reasoning and have now added a sentence at the end of the first paragraph on page 5205 (where we describe the riverine endmembers): “These riverine endmembers include a fraction of old OC from river bank erosion. However, these inputs are likely small in the Kolyma drainage basin compared to the erosion OC input from the East Siberian coast, where thermal degradation is enhanced by the mechanical energy of tides, waves and storms.”

Interactive comment on Biogeosciences Discuss., 7, 5191, 2010.

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