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Interactive comment

Interactive comment on "Distinguishing between old and modern permafrost sources 1 with compound-specific δ^2H analysis" *by* Jorien Vonk et al.

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Vonk et al. evaluate the potential to use stable hydrogen isotope ratios of fossil terrestrial plant n-alkyls as a tracer for shallow vs. deep carbon sources, which are later blended and deposited on the Siberian continental shelf. This work is important for a number of reasons, including understanding the impact of interglacial warm climates on the stability of the cryosphere and northern landscapes, and with obvious implications for climate-carbon feedbacks. The authors compare this novel compound-specific proxy to other carbon source proxies already known in the literature, and they do a very good job of highlighting the advantages/disadvantages of each. While the sample size was small, the analysis was rigorous and accounted for the major uncertainties. The authors also discussed the influence of various uncertainties and assumptions on their end-member modeling results. They follow this with thoughtful discussion on how to advance this research future. The manuscript + figures + tables are well formatted and easy to follow. I believe this work is well suited for publication in the Cryosphere. I have only a few general and specific comments that I would like the authors to address, and following these very minor revisions this paper should be accepted.

General comments: -Title should indicate the study region (e.g., Laptev Sea catchment, NE Siberia).

-Abstract is one of the longest I've read in recent years. It includes a lot of useful information, but could (and probably should) be more concisely written. I leave this to authors and editor to decide.

-There is now a large body of literature on the isotopic composition of relict ice from ICD's in this very same region (see Opel et al. 2017 Climate of the Past; and references therein). These studies find that precipitation isotope composition recorded in these ICD's was highly variable during Pleistocene cold stages; for example, texture and pore ice δ2H values range from roughly -250‰ to -160‰ between ca. 50-30 cal ka BP, while ice wedge values (winter precip) during the same interval range from roughly -260 to -230‰İf the fossil plants were using the same water that is preserved in the pore ice, then there may be a significant amount of variance not yet captured in the n-alkyl dataset from the (n = 9) ICDs sampled in this study. The spatial distributions of distinct ICD units in this region are not equal (see Opel et al., 2017) and, thus, have different potentials for erosion and contribution to the blend of n-alkyls deposited on the shelf. I would like the authors to acknowledge this potentially major source of uncertainty. I would also ask the authors disclose any information they have on the age of the sampled ICDs and, if possible, cross-reference to the regional stratigraphy scheme outlined in Opel et al. (2017).

-This paper would benefit from another figure that provides photographic examples of the ICDs and topsoil sections.

Specific comments: L44, The n-alkane sum and interquartile range given (210±350 ug/gOC) implies negative concentrations are possible, and is not consistent with Figure 2a. This also occurs on L299.

L149, instead of citing the IAEA website, better to cite a peer-reviewed article that supports your statement. Dansgaard (1964, Tellus) is appropriate.

L158, it might be worth stating the underlying assumption, that colder air temperatures during the Pleistocene generally correlate with 2H-depleted precipitation; therefore, long-chain n-alky δ2H during Pleistocene cold-stages should also be depleted compared to present. Also note that 'colder' and 'drier' could have opposing effects. All other factors equal (e.g., biochemical fractionation), a drier atmosphere during Pleistocene cold-stages could result in a larger leaf water enrichment and δ2H n-alkyls (if RH is lower, despite lower air temps), which would lessen the overall offset between modern and Pleistocene n-alkyl δ2H.

L199-201, if species information is available for the grasses and birch, please indicate.

L308, the sphagnum index could also include C23 (see Bush and McInerney, 2013, GCA). For modern sphagnum samples I've collected in NW Canada (>65°N), C23 is usually abundant (unpublished data). This suggestion isn't critical, but might be a more accurate metric for sphagnum vs. woody plants.

L345, please delete 'it seems'. If there is uncertainty, this can be described in a more quantitative way.

L519-521, unclear if you are talking about potential overprinting of the fossil δ2H in situ (e.g., with water in the frozen ICD), or following transport and deposition on the shelf. Please clarify. Also, give a citation that supports the statement that overprinting is enhanced in low pH environments.

Trevor Porter.

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