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# *Interactive comment on* "Ideas and perspectives: Emerging contours of a dynamic exogenous kerogen cycle" *by* Thomas M. Blattmann

**Anonymous Referee #2**

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This short paper presents an interesting discussion on the role of the kerogen cycle onto the overall carbon cycle and the climate system. I basically agree with the author that it is an important piece of the puzzle. Such a short paper might therefore be a valuable contribution to the EGU journal Biogeosciences and I would encourage publication. Still, I mostly disagree with the author on the question of glacial-interglacial cycles. Perturbations in the kerogen fluxes are probably far too small to generate a 100 ppm atmospheric CO2 change over a few thousands of years. This can be explained through simple back-of-the-envelope calculations, something which is lacking in the current manuscript. I would therefore recommend some major changes in this direction.

Back-of-the-envelope calculations:



According to the author (eg. line 27), the kerogen flux is approximately 0.15 PgC/yr, with a reburial efficiency of the order of 30% (between 10% and 70%). The net flux might therefore be about 0.1 PgC/yr. The key question is to decide how large this flux might change through time, in particular across a glacial-interglacial transition. If major erosional changes are expected at high latitudes, this is certainly less true at lower latitudes, where much of the current weathering is taking place today. It seems therefore quite unlikely that glacial-interglacial changes would affect kerogen fluxes by more than 100%. Such an overestimated perturbation, that would persist during the whole duration of the last deglaciation, about 10 thousand years, would therefore change the Earth carbon budget by 1000 PgC. This would have two consequences: - First, it would raise the overall carbon content at the Earth surface (actually, mainly the ocean, with is today around 38000 PgC) by about 2,5%. The atmospheric part scales with the square of this overall content, and could therefore rise by about 5% or equivalently by about 10-15 ppm. Such an extreme hypothesis leads therefore to a change one order of magnitude smaller than the observed glacial-interglacial one, with a rise from 180 ppm at the last glacial maximum to about 280 ppm at pre-industrial times. - Second, and more importantly, it would lower significantly the Earth carbon $\delta$13C signature. Assuming a kerogen $\delta$13C of -25‰ this would translate into a change of about -0.6‰ of the ocean DIC $\delta$13C. But the observations from marine cores are well-known to show just the opposite signal, with a very significant increase of about +0.3‰ across all deglaciations, generally attributed to the re-growth of forest (Shackleton et al., 1977; Shackleton et al., 1983). In other words, we know that glacial-interglacial carbon transitions are not linked to a release of isotopically light carbon, but on the contrary are most probably associated with an increase of the organic carbon reservoir on Earth. Overall, these facts show that the "kerogen hypothesis" cannot explain the bulk of glacial-interglacial carbon cycle changes. In contrast there are many indications, both from paleoclimatology and from modeling experiments, that glacial-interglacial CO2 changes are tightly connected to Southern ocean processes. This does not mean that kerogens must be entirely overlooked, but they are obviously much more likely to be important on longer time scales. In particular, when citing Paillard, 2017 (lines 29-31), the manuscript is somewhat misleading. In this paper, it is suggested that organic carbon does contribute significantly to the 400-kyr oscillations found in the carbon isotopic records, not specifically during the Quaternary, but also during many other time periods. The Quaternary context is used to assess consistency with available CO2 and 13C data over the last few millions of years, when assuming that kerogens are involved in carbon and climate variability on time scales of a few hundreds of thousands of years (as detailed above, there is no such consistency for glacial-interglacial transitions). Furthermore it might be interesting to better understand how glacial erosion during the Quaternary affects kerogen fluxes when compared to the Pliocene or earlier periods. Such a million-year time scale is likely a much better framework for discussing the role of kerogen on CO2 and climate.

References:

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