Bob Hilton (Comments to the author)
Adrian Bender (author responses)

Dear Authors,

Two reviewers have now reviewed your work. I completed my own review independently, and was in agreement with the reviewers. This paper reports new incision rate data from the Charley River (using 10Be-26Al burial isochrons) and interprets it alongside some reanalysis of a Bering Sea sediment core to propose links between timings of Yukon River incision, sediment export, marine and terrestrial organic carbon burial, and the global changes in atmospheric CO2 and climate over this period.

The initially revised version you supplied tackles comments by reviewer #2 (reviewer #1 was overwhelmingly positive and did propose any changes). I have some further minor comments that relate to some of those comments from R2, calling for a few clarifications in places, and some more discussion of the source of organic matter.

I also think that given the nature of the study (one river basin vs global atmospheric composition and climate) and the details of the timings of incision and TOC accumulation (which Figure 4 shows leads in MAR compared to incision) mean that some of the language in the manuscript is a little to “strong”. I make some suggestions that retain the interesting message, but more fairly reflect the findings and scale of the study.
The authors and I thank you for your thorough independent review. We document revisions below that attempt to accommodate your suggestions, which clarify and honor the scope of our work.

1: “coupled to CO2 drawdown” may be a bit of a push for the title. Also, its more that you are linking Yukon river incision to marine organic carbon burial, which has implications for the global carbon cycle. Would this not be a fairer link to make in the title? Late Cenozoic could also perhaps be better put (its about the last ~10% of the Cenozoic…), perhaps as “last 3 million years” or similar.
Revised title to: Yukon River incision drove organic carbon burial in the Bering Sea during global climate changes at 2.6 and 1 Ma

22: wording is a bit strong here. I suggest changing “explain” to “contribute to”

Done.

75: can you give the modern day water depth (and perhaps distance from continental shelf) for U1341?
Revised **lines 83–85** to: "Cores at U1341, collected at 2177 m water depth ~600 km from the Bering Sea shelf, preserve changes in sediment accumulation rate, provenance, and mass proportions of total organic carbon and biogenic silica consistent with a shorter 2.4–1.25 Ma record at site U1343 near the shelf (Kim et al., 2016)."

80: what does "pristine" mean? Perhaps rephrase
Now **line 87**, changed "pristine" to "well-preserved."

82: clarify what is the "Pliocene divide" and refer to Figure 1 if that is related.
Revised **lines 88–89** to: "Similar terraces flank numerous central Yukon River tributaries east and west of the ancestral Pliocene Yukon River divide (Fig. 1), …"

123: this is quite a range of grain sizes – can you clarify exactly what was collected and roughly how much mass/volume?
Revised **lines 132–136** to: "At each of the four field sites we collected quartz-rich terrace alluvium samples comprising individual cobbles and one several-kilogram sample each of amalgamated pebbles and matrix sand in hand-dug pits from horizons up to 50 cm-thick at depths of 5–7 m below terrace treads. Individual samples ideally yield ~25 grams of pure quartz for laboratory processing (Corbett et al., 2016); cobble sizes and sand/pebble sample volumes were selected by modal estimation of quartz content to meet or exceed this target mass."

126: In addition to the changes requested by R2, can you please provide more detail on the preparation – I presume a certain grain size was targeted for consistency? Or was the whole sample crushed and processed?
Revised **lines 137–140** to: "We prepared five samples from each site at the University of Vermont (Corbett et al., 2016); one sample failed to yield sufficient quartz, however, leaving a total of 19 samples. Sample preparation involved crushing and/or sieving each sample to the medium sand size, isolating pure quartz via progressive acid etching and iterative purity testing by laser ablation inductively coupled plasma mass spectrometry, and extracting ^{26}Al and ^{10}Be via column chromatography (full methods available online at https://www.uvm.edu/cosmolab/methods.html)."

152: In addition to the clarifications called for by R2, it would be useful to note that the C/N ratio is a somewhat crude proxy, in that degraded soil organic matter (and rock organic matter) can have lower C/N ratios that are similar to that of marine phytoplankton. Some discussion of this caveat would be useful. For instance, there are some C/N data published for the Yukon, with McClelland et al., 2016, Global Biogeochemical Cycles, reporting a molar C/N ratio weighted by discharge as 11.7 mol/mol (C/N %/% = 10.0). So the terrestrial input value may be quite a bit lower than used by Kim et al.,

Added a paragraph and a few references to describe C/N approach and limitations, **lines 167–178**: "We estimate the proportions of terrestrial and marine organic carbon in Bering Sea sediment using molar C/N ratios from TOC and N measured in core U1341 (Kim et al., 2016). This approach approximates organic matter provenance crudely due in part to the wide range of C/N values reported in either environment (Lamb et al., 2006), and because degraded land- and marine-derived particulate organic matter in sediment can yield similar C/N ratios (e.g., Thornton & McManus, 1994). Although higher terrigenous organic sediment fractions likely occur on the Bering Sea shelf near the Yukon River outlet, deep-water molar C/N ratios imply both terrestrial and marine TOC sources since 4.3 Ma. Low C/N molar ratios that average 7.3 in deep-water sites U1341 and U1343 (Kim et al., 2016) imply organic matter predominantly (~85%) derived from marine NEP based on endmember molar C/N ratios of 5.4 and 19 for marine and terrestrial organic matter, respectively (Perdue and Koprivnjak, 2007). Alternatively, discharge-weighted measurements of particulate organic carbon and nitrogen taken between 2003 and 2012 set an endmember C/N molar ratio of 11.3 for Yukon River suspended sediment (McClelland et al., 2016), and thus indicate a higher average proportion of terrigenous organic carbon (~86%) assuming the 5.4 marine endmember ratio."

Figure 3B – I wonder if additional annotation might make it a little clearer which horizontal surfaces T1 and T2 refer to?

An earlier draft of this figure featured lines delineating the terrace tread boundaries for the T1 and T2 surfaces. Unfortunately, this additional annotation substantially cluttered the photo and obscured the actual landforms. We agree that more annotation could be useful, but adding it would likely require a much larger format figure than the medium-sized one we have intentionally prepared. Hence, we favor the minimally annotated photo depiction of the terraces in the figure in its current form.

221: this section (and/or previous one about the location of the cores used in this

study) could better explain the caveats associated with interpreting this U1341 record in terms of Yukon inputs alone. And perhaps expand on the links mentioned with U1343 around line 78.
Revised section into two paragraphs. First paragraph describes first incision and sedimentation pulse and concludes with new **lines 251–254**: "Linking this Bering Sea productivity and carbon burial pulse to concurrent Yukon River incision by the sediment provenance indicators detrital ε_{Nd} and Al_2O_3/SiO_2 provides an alternative explanation to the prior interpretations of North Pacific nutrient leakage as a driver of increased Si_{xs} MAR (i.e., productivity) from 2.6–2.1 Ma at U1341 (März et al., 2013) and from 2.4–1.9 Ma in the shorter record at U1343 (Kim et al., 2016)(Fig. 1)."

221: Also in this section, the source of carbon could be better explained and linked to the results discussion. And how this is different or not from the inferred source of carbon in the U1343 core which is closer to the continental shelf?
Revised section into two paragraphs. First paragraph (above) should partially address this suggestion. Additionally, we conclude the second paragraph with a word about organic matter provenance in Bering Sea cores on new **lines 251–254**: "Despite the potential ambiguity of C/N ratios in distinguishing organic matter provenance (e.g., Thornton & McManus, 1994), such ratios imply up to 40% terrigenous organic matter from 2.4–2.0 Ma at U1343 near the shelf (Kim et al., 2016), consistent with our C/N ratio-based interpretation of mixed terrestrial and marine organic sediment sources since 4.3 Ma at U1341."

231: this final sentence should be split. The last bit is conjecture – the timing is consistent – although one could argue the incision is happening after the burial peak (?), and so the wording here should be more cautious.
Revised **lines 257–259** to: "Consistent timing among these records strongly suggests that Yukon River incision and sediment export increased Bering Sea carbon sequestration both by burial of terrestrial organic carbon and by boosting marine NEP during global climate changes at ~2.6 and ~1 Ma."

252: remove "tight"
Done.

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