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Spatial patterns of fossil carbon mobilisation during the Paleocene-Eocene Thermal Maximum

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The Paleocene-Eocene Thermal Maximum (56 million years ago; Ma) is a transient carbon cycle perturbation associated with rapid global warming and intensification of the hydrological cycle. These changes will impact various terrestrial carbon cycle feedbacks and previous studies have found an increase in the lateral transport of terrigenous sediments from land to sea [1]. If the mobilised material includes exhumed fossil or 'petrogenic' organic carbon (OC_{petro}), this may oxidise and act as a CO_2 source. Existing evidence shows an order-of-magnitude increase in the delivery of OC_{petro} to the ocean, ~1-20 thousand years after the PETM onset, and may explain the prolonged carbon isotope excursion during the "body" of the PETM [2]. However, this is limited to only two regions (Atlantic Coastal Plain and Tanzania) and may not be globally representative. Here, we aim to determine if: 1. enhanced transport and subsequent burial of OC_{petro} in the ocean was a global phenomenon; and 2. whether it occurred exclusively during the "body".

To achieve this, we utilise different lipid biomarker thermal maturity ratios (e.g. hopanes) to fingerprint and quantify OC_{petro} in a global compilation of PETM-aged shallow marine sites (n=9, including 6 new sites). Our results show that OC_{petro} mass accumulation rates (MAR) vary spatially, with relatively high input in the high-latitudes (e.g. Spitsbergen and New Zealand) and relatively low input in the mid-latitudes (e.g. Atlantic Coastal Plain). This is consistent with the meridional variability that is observed in proxy and model-based hydrological reconstructions [1]. On average, OC_{petro} MAR increased during the PETM, but that the magnitude of change was lower than previously inferred [2]. In addition, a few sites show a decrease in OC_{petro} MAR during the PETM (Spitsbergen, SW Pacific, and New Zealand). Subsequently, its role as a positive feedback may be less important than previously thought. However, OC_{petro} MAR remained elevated during the recovery stages of the PETM. If some of this OC_{petro} was oxidised, the rise in atmospheric CO_2 level would require other mechanisms to stabilise the climate system.

[1] Carmichael et al (2017), *Global and Planetary Change*, 157

[2] Lyons et al (2019), *Nature Geoscience*, 12