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Quantifying calcareous nannoplankton extinction and origination rates at the Paleocene-Eocene Thermal Maximum

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The Paleocene-Eocene Thermal Maximum (PETM, ∼55 Ma) is our best analogue for modern fossil fuel burning because it represents a transient interval of global warming and ocean acidification that resulted from the rapid release and oxidation of methane from ocean sediments. Despite much recent attention, we have little idea as to the evolutionary consequences associated with this climatic perturbation, or in fact any other interval of abrupt climate change during the Cenozoic. Here we present the first global estimates of extinction and origination rates associated with the PETM using fossil calcareous phytoplankton data from sections in New Jersey (U.S. Geological Survey Wilson Lake drillhole and ODP Leg 174AX Bass River), the palaeo-equatorial Pacific (Ocean Drilling Program (ODP) Site 1209), and the Southern Ocean (ODP Site 690). We show that the onset of the PETM carbon cycle perturbation, as measured by δ^{13}C in marine sediments, coincides with a 10 to 60 times increase in origination and extinction rates. Intriguingly however, despite the significant changes in temperature, productivity and ocean chemistry that took place at this time, the pattern of extinctions and originations lack a calcification or ecological bias. Instead our records indicate that the rate of environmental change was the controlling factor, affecting the more susceptible taxa close to their ecological limits. Given that projected rates of anthropogenic carbon emissions and ocean acidification are up to an order of magnitude greater than for the PETM, we may expect even higher rates of planktonic turnover over the coming century than the estimates calculated here.