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New focus on the early Eocene Greenhouse World: rates and dates of ancient global warming events or what makes the X event special

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The early Eocene Greenhouse World was punctuated by multiple transient global warming events, or hyperthermals. The most prominent hyperthermal was the Paleocene-Eocene Thermal Maximum (PETM), one of the largest global warming events of the Cenozoic. Additional Eocene Thermal Maxima (ETMs), informally named Elmo horizon (ETM-2, 1̃.8 Myr after the PETM) and ‘X’ event (ETM-3, 3̃.1 Myr after the PETM) exhibit many characteristics similar to the PETM including negative carbon isotope excursions, carbonate dissolution horizons, and biotic perturbations, although of reduced magnitude and duration. Recently, more hyperthermals have been identified or postulated. This raises the question what the nature of a hyperthermal is; are hyperthermals normal variations at orbital frequencies or are some of them outstanding events outside the Eocene carbon cycle variability?

Here we will focus on a 3rd thermal maximum in lower Eocene (about 52 Ma) sediments. The prominent X event clay layer is characterized by an up to 0.9 per mille carbon isotope anomaly, and shows typical biotic changes at least at some locations: e.g., benthic foraminifera assemblages have low diversity and high dominance, and are dominated by small individuals of Nuttallides truempyi and various abyssaminids, resembling the post PETM extinction assemblages, with more severe effects at deeper sites. Calcareous nannofossil assemblages show similar trends to the PETM, with major changes in the genera Discoaster and Zygrhablithus, but with differences in magnitudes and fluctuations.

Although the X event shows several similar characteristics to the PETM and Elmo, the events are not equally spaced rejecting the assumption that these horizons share a common orbital related triggering mechanism. However, the Elmo and X event seem to have special orbital configuration which might indicate that other still unidentified hyperthermals are related to carbon cycle feedbacks driven by orbital cycles.