

A short-lived warming event in the middle Eocene of the Gorrondatxe section (Western Pyrenees): evidence of a Lutetian Thermal Restoration

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The Paleogene climate was characterized by a late Paleocene to early Eocene warming, which peaked in the so-called Early Eocene Climatic Optimum (EECO, ca. 51–53 Ma), followed by a progressive cooling that culminated at the early Oligocene. Superimposed on this long-term climate evolution were several short-lived warming events referred to as hyperthermal events. Most of them occurred before the EECO, in the Paleocene and earliest Eocene, being the Paleocene-Eocene Thermal Maximum (PETM) the most prominent one. The occurrence of hyperthermal events during the long-term middle-late Eocene cooling is scarcely documented, with the exception of the Middle Eocene Climatic Optimum (MECO, ca. 40 Ma). This poor knowledge is most likely due to recovery problems to obtain high quality cores from the deep-sea and the widespread occurrence of hiatuses around the early-middle Eocene (Ypresian-Lutetian) transition.

The Gorrondatxe section (Western Pyrenees) exposes one of the most complete and expanded deep-sea early-middle Eocene successions on land. Due to its suitability for multidisciplinary stratigraphic studies, the Global Stratotype Section and Point for the base of the Lutetian Stage has recently been defined in this section, at approximately 47.76 Ma ago. Detailed sedimentological, geochemical and paleontological studies across the Ypresian-Lutetian transition revealed the occurrence of a distinct clay-rich interval in the lowermost Lutetian, which bears many of the hallmarks of other early Paleogene hyperthermal events. A sharp ~1‰ decline of $\delta^{13}\text{C}$, a decrease in pelagic carbonate sedimentation and an increase in terrigenous supply mark the onset of this interval, which is followed by a gradual and long recovery to former characteristics. A simultaneous environmental change is recorded by an increase in low-latitude planktic foraminifera and changes in benthic foraminiferal assemblages, including an increase in the relative abundance of opportunistic species such as *Spiroplectammia spectabilis* and *Aragonia aragonensis*, showing that the disruption affected both the sea surface and the sea bottom. This disruption lasted about 160 ky, similar to the duration of the PETM. The sequence of events across the Gorrondatxe clay-rich interval and the correlation among the faunal turnover, the $\delta^{13}\text{C}$ decline and the sedimentological changes, altogether suggest the occurrence of a previously unknown hyperthermal event. As this short-lived warming event occurred during the long-term middle-late Eocene cooling, it is here regarded as a transient Lutetian Thermal Restoration.