Early Eocene climate changes in the North Sea Basin: a Belgian perspective

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Abstract

Abrupt climate changes, involving threshold crossings towards new climate states, frequently occurred in the past with the early Eocene rapid global warming events (hyperthermals) as the most conspicuous. The environmental impact of these hyperthermals has been primarily studied in deep-sea sites under comparably stable conditions, while their impact on shallow-marine ecosystems is relatively unexplored, specifically for the less prominent hyperthermals that occur after the Paleocene-Eocene Thermal Maximum (PETM). Here we present the lithologic, biotic, and geochemical expression of the successive hyperthermals as recorded in the classical Belgian Ypresian Clays, deposited in shallow-water setting at the southern edge of the North Sea Basin.The stable isotope record ($\delta^{13}C_{org}$) indicates the presence of distinct facies changes within a succession of multiple CIE's in the Belgian Ypresian deposits. These levels are biostratigraphically correlated with coeval isotope excursions at DSDP site 550 (Gulf of Biscay) using a regional mid-latitudinal nannoplankton subzonation. Major regional biotic events and changes in depositional settings seem to relate to these isotope events. During the H1/H2-CIE's (Elmo/ETM-2) a lowermost incursion of planktic species occurs, coincident with the establishment/preservation of calcareous benthic foraminiferal faunas, marking the end of stagnant corrosive bottom-waters. The I1/I2-CIE's mark the consistent occurrences of planktic foraminifera and incursion of *Nummulites*. This establishment of a well-diversified foraminiferal fauna is indicative of an improved marine connection with the Atlantic Ocean. During the J and K-CIE's (X-event/ETM-3), a temporary major influx of characteristic planktic foraminifera (*Subbotina patagonica*) and an acme of *Asterigerina bartoniana kaasschieteri* are recorded. The latter is considered indicative of the vicinity of a shallow tropical sea and may thus represent a basin-wide zonal expansion of its life habitat or massive downslope displacement. The onset of the Early Eocene Climatic Optimum (EECO) probably coincides with the basin-wide deposition of fine-grained sediments, marking the beginning of a new distinct foraminiferal fauna. Although Early Eocene hyperthermals in shallow-water sequences still need to be fully characterized relative to regional background conditions, our results seem to indicate that also these less extreme hyperthermal events had short-term impacts on the development of regional shallow-marine ecosystems, although the evolutionary impact is very limited. These regional lithologic and biotic expressions of early Eocene climate evolution thus reflect dissimilar paleoenvironmental responses to short episodes of global warming in a greenhouse world. Our data also emphasize the potential application of hyperthermal event stratigraphy to correlate over a wide range of environmental settings in the North Sea Basin.