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Orbital chronology for the Cenomanian-Turonian Oceanic Anoxic Event 2 and the timing of the "Plenus Cold Event"

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The Cenomanian–Turonian OAE 2 is reflected by one of the most extreme carbon cycle perturbations in Earth's history possibly triggered by massive volcanic CO_2 degassing during the emplacement of large igneous provinces (LIPs). Severe climatic, oceanographic and biotic feedbacks are reported from different depositional settings. The nature of these changes as well as their spatial and temporal dimension is still not well understood to date. The main difficulty to integrate different observations in different locations is the insufficient resolution of available timescales and stratigraphies. Although new radiometric ages exists for the stratotype section at Pueblo and regional orbital age models are developed from shelf settings from both sides of the Atlantic Ocean, their correlation to the open ocean is not unequivocal.

Here, we present a cyclostratigraphic correlation based on time series analyses of relative changes in XRF-element concentrations derived from two sites, the oceanic ODP-Site 1261 (Demerara Rise, tropical Western Atlantic) and a mid-latitude shelf-sea locality exposed in the Wunstorf Core (Germany). Both successions expose distinct sedimentary cycles as well as a brief period of intermittent surface-water cooling and bottom water oxygenation ("Plenus Cold Event" in western Europe) during the early OAE 2 which is considered as synchronous event by several authors. The estimated overall duration of OAE 2 is about 5 and 4.5 short eccentricity cycles for both Site 1261 and Wunstorf. For correlation purposes the independently derived floating orbital time scales of Site 1261 and Wunstorf are tied to each other using the first prominent increase of the δ13C anomaly, a characteristic feature of all OAE 2 successions. Sedimentary cycles, interpreted as short eccentricity cycles during OAE 2, are correlated between the two different depositional settings. Based on this correlation the cooling pulses recorded in the tropical Atlantic and the European mid-latitude coastal sea are not coeval. The "Plenus Cold Event" in Wunstorf leads the cooling pulse in the tropical Atlantic by about 100 kyr. Independent evidence for a different timing of both events comes from the consistent duration of the non-radiogenic Os-isotope shift in seawater that occurred during the first 200 kyr of OAE 2 (Du Vivier et al. 2014). The range of this excursion clearly shows the European "Plenus Cold Event" to predate the tropical Atlantic cooling.

Both cooling events are related to orbitally triggered climatic feedbacks of OAE 2, and refer to a climate system that responded much more sensitive than previously assumed. The oceanic anoxic event OAE 2 led to a complex pattern of multiple regional feedbacks, which are different in their timing, spatial dimension and external control. Future projects, dealing with the climatic consequences of OAE 2 need improved time scales to decipher lead-lag relationships which will bring us to a new era in the understanding of the climate system during times of extreme perturbation.