Astronomical calibration of a key Early Eocene Boreal section: implications for the climate response to the North Atlantic Igneous Province

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Sections of the Fur formation exposed on the islands of Fur and Mors (N. Jutland, Denmark) expose well-preserved diatomites and over 140 interbedded ash layers spanning >1 Myr of the Early Eocene from the top part of the Paleocene-Eocene Thermal Maximum (PETM; 55.9 Ma). The Fur Formation is a Konzentrat-Lagerstätten with an extremely rich fish fauna as well as numerous exquisitely preserved invertebrates, vertebrates, plant material, and siliceous microfossils. Due to its peculiar bentonite record, the Fur formation also constitutes a reference for the North Sea area, recording phases of active North Atlantic Igneous Province (NAIP) volcanism. Recently, a sea-surface temperature (SST) record was derived from Tex86 values for this formation, showing anomalously cool SSTs immediately after the PETM (~11–23°C, Stokke et al., 2020) while near-freezing bottom-water temperatures (BWTs) have been inferred from clumped isotopes analysis of giant glendonite crystals (Vickers et al., 2020). The section is constrained by three radiometric dates of ash layers but cyclostratigraphic analysis of the section has proved difficult due to the apparent homogeneity of the diatomite and multitude of interbedded ash layers. We performed a high-resolution analysis of the magnetic susceptibility and carbon isotopes on bulk organics (δ13Corg) from across the top PETM to the top of the Silstrup Mb. The magnetic susceptibility depicts all the apparent ash layers as well as additional hidden ash layers with peaks of various heights, and thus constitutes an excellent stratigraphic tool for its potential of correlation to other sections and deep-sea sites of the North Atlantic. Our δ13Corg record is characterized throughout by periodicities of 65 to 90 cm and 3.6 m that match well precession and short-eccentricity cycles. Long-term trends and filtered 100 kyr cycles from our record correlate very well to the recent benthic δ13C Cenozoic compilation, leading to an astronomical calibration of the section which spans ~1300 kyr from 55.88 to 54.6 Ma. Our calibration allows for a precise illustration of the drastic contrast between the post-PETM warm tropical SSTs/BWTs and the surprisingly cool SSTs/BWTs of the North Sea.

References