Quantifying terrestrial temperatures during the early Paleogene: new insights from novel organic geochemical proxies

B.D.A. NAAFS[1], G.N. INGLIS[1], M. ROHRSSEN[1], RICH PANCOST[1], AND T-GRES PEAT DATABASE COLLABORATORS

[1]Organic Geochemistry Unit, School of Chemistry and Cabot Institute, Univeristy of Bristol, Bristol, UK
david.naafs@bristol.ac.uk

The early Paleogene is characterized by a long-term maximum in atmospheric carbon dioxide (pCO_2) levels and can provide valuable information about the operation of the Earth system in an equilibrium high pCO_2 world. Existing estimates of terrestrial temperatures for this period indicate higher temperatures than modern, but are significantly lower than sea surface temperature (SST) estimates. This difference between marine and terrestrial temperatures is difficult to reconcile given our current understanding of the climate system. Within this context there is a need to obtain new and independent early Paleogene terrestrial temperature estimates. Such estimates are also critical because terrestrial temperatures govern diverse components and potential feedback mechanisms of the Earth system and have a large impact on biogeochemical processes.

We therefore developed peat-specific organic geochemical temperature proxies based on the distribution of both bacterial and archaeal membrane lipids in a global database of peat (n=470). The results highlight that the degree of methylation of bacterial brGDGTs is lineraly correlated with mean annual air temperature. Although the general response of brGDGTs in peat to temperature is similar to that previously observed in mineral soils, the calibration is different from the available mineral soil calibrations.

We then applied this organic geochemical proxy to early Paleogene lignites (fossilized peat) to provide novel and independent terrestrial temperature estimates. We demonstrate that peatland temperatures during the early Paleogene were higher than previously thought with values in the mid/high latitudes above 22.5 °C. The identification of unusual archaeal biomarkers at all locations, heretofore observed only in thermophiles and hyperthermophilic settings, further support these high temperature estimates. Our results demonstrate that terrestrial temperatures were not only much higher than present at mid/high latitudes but were likely tropical, in-line with SST-estimates. These results can now be used to constrain the next generation of climate models.