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Proxy data constraints on Cretaceous sea surface temperature evolution

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It is well established that greenhouse conditions prevailed during the Cretaceous. However, constraining the exact nature of the greenhouse gas forcing, climatic warming and climate sensitivity remains an ongoing topic of research. Proxy temperature data provide valuable observational constraints on Cretaceous climate. In particular, much of our understanding of Cretaceous climate warmth comes from marine temperature proxy data reconstructions derived using planktic foraminiferal oxygen isotope (δ18O) palaeothermometry and, more recently, the TEX86 proxy, based on the distribution of marine isoprenoidal glycerol dialkyl glycerol tetraether lipids (GDGTs). Both of these proxies provide estimates of sea surface temperature (SST), however each technique is subject to a number of proxy-specific caveats. For example, δ18O values in planktic foraminifer may be compromised by preservation and/or diagenetic alteration, while the TEX86 proxy has undergone several temperature calibration re-evaluations and the exact mechanism that relates GDGT production to SST is not fully understood. Here we synthesise and reinterpret available TEX86- and δ18O-SST proxy data for the entire Cretaceous. For the TEX86 data, where possible we re-evaluate the fractional abundance of all individual GDGTs. By utilising fractional GDGT abundances we are also able to compute methane indices and branched and isoprenoid tetraether (BIT) indices, as well as apply both the TEX86H and TEX86L temperature calibrations. For each of the two SST proxy techniques, TEX86 and δ18O, we apply consistent temperature calibrations and place all data on a common timescale.

Our new data-based SST synthesis allows us to examine long term temperature trends in the Cretaceous, including latitudinal temperature gradient variations, and evaluate global versus regional temperature patterns. Through considering both TEX86 and planktic foraminiferal δ18O data we critically compare the application of these two techniques in the Cretaceous and identify proxy biases, for example geographical constraints on these proxy archives, and also investigate proxy specific trends. This new SST proxy data compilation for the Cretaceous presents a more complete picture of Cretaceous climate evolution and provides the basis for an informed discussion of the likely ranges of Cretaceous warmth, identification of global (potentially CO_2-driven) trends and an exploration of the current knowledge 'gaps', highlighting key locations for future data-based Cretaceous SST reconstructions.