Reconstructing Cretaceous climate: Insights from a new calcareous nannofossil occurrence database

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The Cretaceous Period is recognized as a prototypical greenhouse climate interval, which is regarded as a potential analog for predictions of future climate change. Historically, geochemical and paleontological proxies, such as $\delta^{18}O$ of carbonates, TEX_{86} paleothermometry, fossil assemblage abundances, and biogeography were used to reconstruct paleotemperature evolution during the Cretaceous. However, a comprehensive and integrated database of microfossil occurrences, which is essential for thorough Cretaceous paleoclimate reconstructions, remains elusive.

Calcareous nannofossils were the dominant group of phytoplankton living in the photic zone of the Cretaceous oceans, and their sensitivity to environmental factors makes them robust biotic proxies for sea surface temperature reconstructions. While the Neptune database has provided substantial insights into the occurrence and distribution of calcareous nannofossils, it predominantly features data that are over two decades old, with sparse coverage of the Cretaceous (~2600 samples) and a massive bias toward the Recent. To address these limitations and enhance the reliability of scientific research, we have compiled Cretaceous occurrence data from 111 sections that include onshore outcrops and deep-sea drilling sites, which have new age-depth models with revised and robust age information. Around 8000 samples and 200,000 nannofossil occurrences from the Berriasian to Maastrichtian were added to the existing Neptune database, tripling the data available. This initiative aims not only to investigate the paleoecological dynamics and environmental responses of nannofossils but also to ensure meticulous documentation of their stratigraphic occurrences, which will be detailed in a forthcoming version of Nannotax. Although access to this enriched dataset is currently restricted pending publication, it is anticipated it will be made publicly available by the end of 2024.

Utilizing this novel database, our research quantitatively evaluates the latitudinal distribution of common and paleoenvironmentally diagnostic nannofossil taxa at a high resolution through the Cretaceous. Our objectives include (1) assessing the paleotemperature preferences of Cretaceous calcareous nannoplankton to establish refined temperature indices and (2) constructing a detailed evolutionary trajectory of Cretaceous sea surface temperatures, thereby contributing a novel perspective to the discussion of Cretaceous paleoclimate evolution.