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Can the Cretaceous Inform Estimates of Future Climate Sensitivity?

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Palaeoclimate data is increasingly being used to evaluate models used for future prediction, and to provide observational constraints on climate sensitivity. However, the applicability of climatologies older than the Pliocene (c. 3 Ma) for future sensitivity has been questioned. In particular, palaeogeographic boundary conditions which are different from modern (i.e. continental positions, mountain extents and height, ocean floor depth, ice sheet extent and geometry) will influence climate and climate sensitivity, but to an extent which is unknown.

In this study, we use a modelling framework to explore the role of palaeogeography in controlling climate and climate sensitivity during the Cretaceous interval of 'greenhouse' climates (c. 145-65 Ma). We carry out GCM simulations at 'high' and 'low' CO_2 through all 12 Stages of the Cretaceous, and investigate the evolution of mean climate and of climate sensitivity. We evaluate our findings by comparing the model results with observations, both temporal global signals and time-slice geographical patterns.

By comparing the palaeo results with modern climate sensitivity predictions, the work allows us to evaluate which time periods within the Cretaceous are most relevant for determining future climate sensitivity, and therefore where palaeodata collection can most usefully be targeted. It also provides insights into the relationship between single-site estimates of temperature vs. global mean, and the evolution of temperature at single sites due to continental drift and paleogeographical change alone.

Overall, we provide insights into how our planet operates on long (multi-million year) timescales, and assess the utility of observations of past warm climates for informing future climate sensitivity.