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Modelling the primary control of paleogeography on Cretaceous climate

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The low thermal gradients and clement winters characterizing climates of the Cretaceous period reveal that the climate system has modes of behaviour quite different from the present. Recent proxy data analyses suggest that some aspects of climate change within the Cretaceous appear to be decoupled from CO2 evolution at the geological time scale. Here, we investigate the impact of paleogeography on the global climate with the climate model FOAM, using a Early, Mid and Late Cretaceous continental configuration. We find that changes in geography from the Early to Mid-to-Late Cretaceous cause a large decrease of the seasonal cycle. First order identified processes are the decreased continentality of the mid-to-high latitudes from the Mid Cretaceous and the increase of the latent heat transport into the winter hemisphere which induce a wetter and a cloudier atmosphere capable of diminishing the winter cooling of the continents. Owing to the modifications of the seasonal cycle in response to the tectonic forcing, the equator-to-pole thermal gradient is reduced from the Early to Mid-to-Late Cretaceous. Our study also suggests a mechanism that can weaken the correlation between CO2 and climate changes during the Cretaceous as evolving geography from the Early to Late Cretaceous, through the response of the water cycle and the changes in the thermal gradient, results in a 3.8°C global warming at a constant atmospheric CO2 level. This demonstrates that the paleogeography may affect the relation between pCO2 and the climate history and consequently has to be accounted for when linking the atmospheric CO2 evolution and the climate record at geological timescales.