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The influence of orbital variations on the climate around the Carboniferous/Permian boundary

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The time around 300 million years ago during latest Carboniferous/earliest Permian marks the culmination of the late Paleozoic glaciations with atmospheric carbon dioxide (CO_2) levels falling to levels as low as about 100 ppm (parts per million). High-resolution records from that time also reveal considerable fluctuations in atmospheric CO_2 on timescales indicative of orbital cycles. Here I use simulations using a coupled climate model and based on the appropriate boundary conditions to explore the sensitivity of the late-Carboniferous climate system to orbital forcing. The coldest orbital configurations are characterised by large axial tilt and small eccentricities of Earth's orbit, whereas the warmest configuration occurs at minimum tilt, maximum eccentricity, and a perihelion passage during Northern hemisphere spring. Given the large swings in CO_2, the differences in global mean temperature between late Carboniferous interglacials and glacials is at least 10°C and thus considerably more pronounced than during the Quaternary. Finally I show that Earth's climate came surprisingly close to global glaciation at the beginning of the Permian, largely due to the massive drawdown of atmospheric carbon dioxide due to coal formation.