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Repeated occurrences of marine anoxia during highly oxygenated Late Paleozoic icehouse

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Atmospheric oxygen concentration potentially reached its highest level of Earth history during the late Paleozoic icehouse (~360–260 Ma). Yet, abrupt global warming still caused a distinct marine anoxic event, a phenomenon often characteristic of the greenhouse climate state. Here, we present a high temporal resolution record of carbonate uranium isotopes ($^{238}U/^{235}U$, denoted as $\delta^{238}U_{carb}$, a proxy for marine oxygenation state) from a continuous carbonate succession in South China to reconstruct the long-term marine anoxia landscape during the deep glacial of the late Paleozoic icehouse (310–290 Ma). We report a generally long-term increase in $\delta^{238}U_{carb}$, upon which repeated, short-term (~1 Myr) negative excursions in $\delta^{238}U_{carb}$ occur, coincident with negative C isotopic excursions and increases in atmospheric CO_2. To quantitatively explore the interplay among marine anoxia, carbon cycle perturbation, and climate evolution at this time, we refine a previously established CPU biogeochemical model and employ Bayesian inverse methods to rigorously constrain model parametersThe modeling outcomes, integrated with proxy data, suggest a long-term atmosphere and seafloor oxygenation driven by enhanced marine organic carbon burial. The study also highlights that episodic pulses of C emission can cause repeated occurrences of marine anoxia even under more oxygenated conditions than today.