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The response of climatic and oceanic conditions to a Marinoan snowball Earth

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The two large-scale glaciations of the Neoproterozoic, commonly referred to as snowball Earth events, caused extreme shifts in the climatic and geochemical conditions of the Earth. These periods are possibly linked to the approximately contemporaneous second major oxygenation event of the Proterozoic and the transition from a prokaryotic to an eukaryotic dominance of the ocean biological carbon pump. To improve our understanding of the climatic shifts associated with a global glaciation and its demise, we simulate the aftermath of the second glaciation event, the Marinoan snowball Earth, using a coupled atmosphere-ocean general circulation model. In this scenario, it is believed that the high atmospheric CO_2 concentration responsible for the termination of the pan-glacial state causes a rapid transition into a hot supergreenhouse climate. The inflow of large amounts of freshwater into the cold and salty sub-snowball ocean would further cause a stable oceanic stratification, with consequences for climate and ocean biogeochemistry. Our Simulations show, however, that the supergreenhouse climate in the snowball aftermath was possibly not as extreme as previously assumed and that the oceanic freshwater stratification breaks up rapidly on a timescale of only a few thousand years. Therefore, we derive that Marinoan cap dolostones showing signs of deposition in a freshwater-influenced environment must have accumulated during the geologically short period of deglaciation. Additional simulations cover a full cycle of initiating and melting a snowball Earth with a model including an ocean biogeochemistry component and an interactive carbon cycle. We present first results on the oceanic carbon exchange with the atmosphere and the evolution of marine biogeochemistry in response to the extreme climatic shifts.