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Supergreenhouse Warming during the Snowball Earth Aftermath

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Carbonates capping Neoproterozoic glacial deposits suggest that the Snowball Earth was melted by high-levels of CO_2. Previous simulations suggested that higher than 0.2 bars of CO_2 is required to melt the hard Snowball Earth. Such high levels of CO_2 was accumulated due to volcanic eruptions over millions of years when weathering reactions were cut off because of the coverage of snow and ice. Before the hard Snowball Earth was melted, greenhouse effect was mainly due to CO_2 because air temperatures were so low that the atmosphere contained little water vapor. Once the hard Snowball Earth was melted, large amount of water vapor got into the atmosphere, causing supergreenhouse warming, together with the high-level CO_2. To test how high surface air temperature could be, we performed GCM simulations with various levels of CO_2. It is found that surface air temperature is approximately 320 K (50 degC) for 0.1 bar of CO_2 and $\sim$340 K over ocean and $\sim$380 K over land for 0.4 bars of CO_2. Atmospheric circulations under such extremely warm climate conditions are also very different from present. How the hot-house climate impacted on life evolution remains an intriguing but unanswered question.