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Transient climate-carbon simulations of planetary geoengineering

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Geoengineering (the intentional modification of Earth's climate) has been proposed as a means of reducing CO_2-induced climate warming while greenhouse gas emissions continue. Most proposals involve managing incoming solar radiation such that future greenhouse gas forcing is counteracted by reduced solar forcing. In this study, we assess the transient climate response to geoengineering under a business-as-usual CO_2 emissions scenario, using an intermediate complexity global climate model which includes an interactive carbon cycle. We find that the climate system responds quickly to artificially reduced solar insolation; hence, there may be little cost to delaying the deployment of geoengineering strategies until such a time as "dangerous" climate change is imminent. Spatial temperature patterns in the geoengineered simulation are comparable to pre-industrial, though this is not true for precipitation. Carbon sinks in the model increase in response to geoengineering: since geoengineering acts to mask climate warming, there is a direct CO_2-driven increase in carbon uptake without an offsetting temperature-driven suppression of carbon sinks. However, this strengthening of carbon sinks, combined with the potential for rapid climate adjustment to changes in solar forcing, leads to serious consequences should geoengineering fail or be stopped abruptly. Such a scenario could lead to very rapid climate change, with warming rates up to 20 times greater than present day. This warming rebound would be larger and more sustained should climate sensitivity prove to be higher than expected. Thus, employing geoengineering schemes with continued carbon emissions could lead to severe

risks for the global climate system.