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Climate consequences of employing geoengineering as an alternative to carbon emissions reductions

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Geoengineering (the intentional modification of the earth's climate) has been proposed as a means of reducing CO_2-induced climate warming, while allowing continued emissions of greenhouse gases. Most proposals involve managing incoming solar radiation in such a way 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; as such, we argue that there is little cost to delaying the deployment of geoengineering strategies until such a time as "dangerous" climate change is immanent. Carbon sinks in the model respond favorably 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 artificial 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, at some point over the next century. 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.