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Limited effectiveness of solar radiation management geoengineering in preventing sea-level rise from the Greenland Ice Sheet

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The Greenland Ice Sheet (GIS) is an important contributor to present-day sea level rise, and the ice sheet's importance for sea level rise will likely increase with Arctic temperatures. Some scientists have recently suggested that geoengineering, the deliberate management of Earth's climate, could prevent sea level rise from the ice sheets. Previous efforts to assess geoengineering's effects on the GIS and sea level rise have broken important new ground, but neglect key feedbacks and/or are silent on the short-term effects of geoengineering that are perhaps most important for decision-making. Here, we use a simplified, three-dimensional model of the GIS (SICOPOLIS by Ralf Greve) to examine the response of the Greenland Ice Sheet under plausible geoengineering scenarios. We find that i) the GIS generally continues to melt over the first 100 yr after geoengineering initiation; ii) reductions in GIS sea level contributions over these first 100 yr are small; and iii) there is a delay of decades to centuries between the initiation of aggressive geoengineering and any regrowth of the ice sheet, and the rate of this regrowth is slow. However, geoengineering produces appreciable reductions in the rate of sea level rise contributions from the GIS within the first few decades. Our results suggest that past studies have overestimated the effectiveness of geoengineering in preventing mass loss from the Greenland Ice Sheet and in reversing sea level rise once it has occurred. We comment on the importance of feedbacks in the ice sheet system in assessing geoengineering's effectiveness in reducing sea level rise from the GIS.