



Geoengineering: a critical review

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We present a critical review of the geoengineering suggestions for climate change mitigation that have been mooted in the literature in recent years. Geoengineering options can be broadly divided into those that seek to rectify the current radiative imbalance via (1) reducing incoming solar radiation or (2) removing CO₂ from the atmosphere and isolating it from interaction with the atmosphere for a substantial period of time. We calculate radiative forcing values for the geoengineering options together with a decay term for their transient cooling effect, where appropriate. We frame our review from an Earth system perspective over a centennial to millennial time scale, highlighting the temporary nature of certain carbon stores, which we illustrate with a concise Earth system model. Drawing on published literature, we present an evaluation of geoengineering options by comparison of their deployment time scale, failure risk, failure time scale and notable Earth system interactions. This enables a number of critical issues to be brought to light, relating to risk, limitations in system understanding and interactions with other Earth system components. In particular, deployment time scales and cooling capacity are highly relevant to recent interest in geoengineering options with respect to avoiding potentially critical tipping elements in the Earth system.