Geophysical Research Abstracts,
Vol. 11, EGU2009-10513, 2009
EGU General Assembly 2009

Geoengineering of stratocumulus decks to counterbalance global warming: Pros, Cons, Side-Effects and time-scales

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Anthropogenic emissions of carbon dioxide from fossil-fuel burning are the primary cause of global warming and the projected rate of temperature change is very likely to increase in the future. Many geoengineering solutions have recently been suggested to reduce global warming. Here we use a state-of-the-science general circulation model of the climate to investigate the climatic impact of geoengineering via modifying stratocumulus decks. The model's climate is more than twice as sensitive to modification of the South Pacific stratocumulus area compared with the North Pacific or South Atlantic stratocumulus area. If all stratocumulus decks were geoengineered, the model suggests possibly significant precipitation reductions over South America, North America and over Europe and Asia. Thus the use of geographically inhomogeneous radiative forcing mechanisms to counterbalance global warming induces distinct geographic responses in temperature and precipitation that may be very detrimental to some areas of the Earth.

Additionally, we find that the cessation of geoengineering of these regions leads to rapid (10-20 years) recovery of the climate system to a non-geoengineered state. We have used a simple climate model to investigate more generally how delays in reducing CO2 emissions affect stabilisation scenarios leading to overshooting of a target concentration pathway. We show that if geoengineering alone is used to compensate for the delay in reducing CO2 emissions, such an option needs to be sustained for centuries even though the period of overshooting emissions may only last for a few decades. If geoengineering is used for a shorter period, it has to be associated with emission reductions significantly larger than those required to stabilise CO2 without overshooting the target. In the presence of a strong climate-carbon cycle feedback the required emission reductions are even more drastic.