What impact would sun dimming have on Earth's weather?

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Solar radiation management projects, also known as sun dimming, seek to reduce the amount of sunlight hitting the Earth to counteract the effects of climate change. Global dimming can occur as a side-effect of fossil fuels or as a result of volcanic eruptions, but the consequences of deliberate sun dimming as a geoengineering tool are unknown.

A new study by Dr Peter Braesicke, from the Centre for Atmospheric Science at Cambridge University, seeks to answer this question by focusing on the possible impacts of a dimming sun on atmospheric teleconnections.

Teleconnections, important for the predictability of weather regimes, are the phenomenon of distant climate anomalies being related to each other at large distances, such as the link between sea-level pressure at Tahiti and Darwin, Australia, which defines the Southern Oscillation.

"It is important that we look for unintended consequences of any sun dimming schemes," said Braesicke. "We have to test our models continuously against observations to make sure that they are 'fit-for-purpose', and it's important that we should not only look at highly averaged 'global' quantities."

Dr Braesicke's team believes that the link between tropical temperatures and extra-tropical circulation are well captured for the recent past and that the link changes when the sun is dimmed.

"This could have consequences for prevailing weather regimes," said Braesicke, "particularly for the El Nino/Southern Oscillation (ENSO) teleconnection. Our research allows us to assess how forced atmospheric variability, exemplified by the northern polar region, might change in a geoengineered world with a dimmed sun."

A dimmed sun will change the temperature structure of the atmosphere with a cooling throughout the atmosphere. In the troposphere, temperatures drop because less solar radiation reaches the ground and therefore less can be converted into heat. In the stratosphere, less shortwave radiation is available for absorption by ozone and, therefore, heating rates in the stratosphere are lower.

"We have shown that important teleconnections are likely to change in such a geoengineered future, due to chemistry-climate interactions and in particular, due to changing stratospheric ozone," concluded Braesicke. "In our model, the forced variability of northern high latitude temperatures changes spatially, from a polecentred pattern to a pattern over the Pacific region when the solar irradiance is reduced. Future geoengineering studies need to consider the full evolution of the stratosphere, including its chemical behaviour."

The Geoengineering Model Intercomparison Project

In an accompanying paper Ben Kravitz, from Rutgers University, reviews the new project to coordinate and compare experiments in aerosol geoengineering and evaluates the effects of stratospheric geoengineering with sulfate aerosols.

Since the idea of geoengineering was thrust back into the scientific arena many have wondered whether it could reduce global warming as a mitigation measure. Kravitz's team argues that one of the most feasible methods is through stratospheric sulfate aerosols. While geoengineering projects are not yet favored by policy makers this method is inexpensive compared with other such projects and so may prove more attractive.

However, stratospheric geoengineering with sulfate aerosols may have unintended consequences. Research indicates that stratospheric geoengineering could, by compensating for increased greenhouse gas concentrations, reduce summer monsoon rainfall in Asia and Africa, potentially threatening the food supply for billions of people.

"Some unanswered questions include whether a continuous stratospheric aerosol cloud would have the same effect as a transient one, such as that from a volcano, and to what extent regional changes in precipitation would be compensated by regional changes in evapotranspiration," said Kravitz.

A consensus has yet to be reached on these, as well as other, important issues and to answer these questions the team propose a suite of standardised climate modeling experiments, as well as a coordinating framework for performing such experiments, known as the Geoengineering Model Intercomparison Project (GeoMIP).

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