

WMO Statement on Geoengineering

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This is based on the excellent statement on geoengineering by the American Meteorological Society (AMS). Their statement is considered in force until January 2017 unless superseded by a new statement issued by the AMS Council before this date. © American Meteorological Society, 45 Beacon Street, Boston, MA 02108-3693. The statement is available at https://www.ametsoc.org/policy/2013geoengineeringclimate_amsstatement.html
Changes to the AMS statement are highlighted in yellow.

Human responsibility for most of the well-documented increase in global average temperatures over the last half century is well established. Further greenhouse gas emissions, particularly of carbon dioxide from the burning of fossil fuels, will almost certainly contribute to additional widespread climate changes that can be expected to cause major negative consequences for most nations¹.

Three proactive strategies could reduce the risks of climate change: 1) *mitigation*: reducing emissions; 2) *adaptation*: moderating climate impacts by increasing our capacity to cope with them; and 3) *geoengineering*: deliberately manipulating physical, chemical, or biological aspects of the Earth system². This policy statement focuses on large-scale efforts to geoengineer the climate system to counteract the consequences of increasing greenhouse gas emissions.

Geoengineering could lower greenhouse gas concentrations, provide options for reducing specific climate impacts, or offer strategies of last resort if abrupt, catastrophic, or otherwise unacceptable climate-change impacts become unavoidable by other means. However, research to date has not determined whether there are large-scale geoengineering approaches that would produce significant benefits, or whether those benefits would substantially outweigh the detriments. Indeed, geoengineering must be viewed with caution because manipulating the Earth system has considerable potential to trigger adverse and unpredictable consequences.

Geoengineering proposals fall into at least three broad categories: 1) reducing the levels of atmospheric greenhouse gases through large-scale manipulations (e.g., ocean fertilization or afforestation, including the use of genetically modified species); 2) exerting a cooling influence on Earth by reflecting sunlight (e.g., putting reflective particles into the atmosphere, putting mirrors in space, increasing surface reflectivity, or altering the amount or characteristics of clouds) or reducing cirrus clouds to allow Earth to cool at a faster rate; and 3) other large-scale manipulations designed to diminish climate change or its impacts (e.g., constructing vertical pipes in the ocean that would increase downward heat transport).

Geoengineering proposals differ widely in their potential to reduce impacts, create new risks, and redistribute risk among nations. Techniques that remove CO₂ directly from the air would confer global benefits but could also create adverse local impacts. Reflecting sunlight would likely reduce Earth's average temperature but would also reduce global precipitation and

change global circulation patterns with potentially serious consequences such as changing storm tracks and precipitation patterns. **Stratospheric aerosols would delay the recovery of the ozone layer.** As with inadvertent human-induced climate change, the consequences of reflecting sunlight would almost certainly not be the same for all nations and peoples, thus raising legal, ethical, diplomatic, and national security concerns. **Despite claims that implementing stratospheric aerosol geoengineering would be cheap and easy, there are serious technical concerns and no geoengineering systems have been constructed or demonstrated.**

Exploration of geoengineering strategies also creates potential risks. The possibility of quick and seemingly inexpensive geoengineering fixes could distract the public and policy makers from critically needed efforts to reduce greenhouse gas emissions and build society's capacity to deal with unavoidable climate impacts. Developing any new capacity, including geoengineering, requires resources that will possibly be drawn from more productive uses. Geoengineering technologies, once developed, may enable short-sighted and unwise deployment decisions, with potentially serious unforeseen consequences.

Even if reasonably effective and beneficial overall, geoengineering is unlikely to alleviate all of the serious impacts from increasing greenhouse gas emissions. For example, enhancing solar reflection would not diminish the direct effects of elevated CO₂ concentrations such as ocean acidification or changes to the structure and function of biological systems.

Still, the threat of climate change is serious. Mitigation efforts so far have been limited in magnitude, tentative in implementation, and insufficient for slowing climate change enough to avoid potentially serious impacts. Even aggressive mitigation of future emissions cannot avoid dangerous climate changes resulting from past emissions, because elevated atmospheric CO₂ concentrations persist in the atmosphere for a long time. Furthermore, it is unlikely that all of the expected climate-change impacts can be managed through adaptation. Thus, it is prudent to consider geoengineering's potential benefits **if used as a supplement to ongoing mitigation and adaptation efforts**, to understand its limitations, and to avoid ill-considered deployment.

Therefore, the **World Meteorological Organization** recommends:

1. Enhanced research on the scientific and technological potential for geoengineering the climate system, including research on **the feasibility and costs of proposed techniques, and** intended and unintended environmental responses.
2. Coordinated study of historical, ethical, legal, and social implications of geoengineering that integrates international, interdisciplinary, and intergenerational issues and perspectives and includes lessons from past efforts to modify weather and climate.
3. Development and analysis of policy options to promote transparency and international cooperation in exploring geoengineering options along with restrictions on reckless efforts to manipulate the climate system.
4. **Research and any implementation should adhere to the Oxford Principles (Rayner et al., 2013): geoengineering to be regulated as a public good, public participation in**

geoengineering decision-making, disclosure of geoengineering research and open publication of results, independent assessment of impacts, and governance before deployment.

Geoengineering will not substitute for either aggressive mitigation or proactive adaptation, but it could contribute to a comprehensive risk management strategy to slow climate change and alleviate some of its negative impacts. The potential to help society cope with climate change and the risks of adverse consequences imply a need for adequate research, appropriate regulation, and transparent deliberation.

Reference:

Rayner, Steve, et al., 2013: The Oxford Principles, *Climatic Change*, **121**, 499-512, doi:10.1007/s10584-012-0675-2