Geoengineering and Climate Change

Implications for Asia

In Brief: Some governments are exploring geoengineering as a way to reduce or delay climate change. Geoengineering could technically take climate decisions away from all but the richest countries. Computer models[1] show that stratospheric interventions to reduce sunlight and lower temperatures may benefit some temperate zones, but negatively impact Asia's monsoons with important social and agricultural consequences.

Terminology:

Geoengineering is the intentional large-scale technological manipulation of earth systems (in the stratosphere or ocean or in the ground) in an attempt to delay or reduce climate change.

Solar Radiation Management (SRM) is stratospheric geoengineering to block or deflect sunlight aiming to lower Earth's temperature.

Sulfate Aerosol Injection (the most economic and technically practical SRM) spreads sulfate "dust" 15–20 km up in the stratosphere to reduce sunlight and lower temperatures. "Dust" can be blown by a battery of pipes (like an artificial volcano) or via specially outfitted aircraft. Direct cost could be as low as $700 million the first year to tens of billions of dollars per annum later.

Findings: A peer-reviewed paper, published in 2008,[2] offers two computer scenarios of stratospheric sulfate aerosol injections in the Tropics and the Arctic. In the Tropical scenario, sulfate injections during Dec-Feb and June-Aug show that precipitation is significantly reduced over Asia, with a decrease of up to 3 mm/day in some regions although some areas see an increase. The Arctic scenario shows reduced precipitation of up to 0.5 mm/day during the same seasons in most of Asia, although some regions could experience an increase. Contrary to intent, the Arctic scenario indicates a temperature rise in India during June-Aug of up to 0.5°C.

The June-September monsoon affects more than half of humanity and accounts for 75-90% of South Asia's annual rainfall. 50% of the farmland in the region is rainfed. Blasting sulfates into the stratosphere does not reduce CO_2 concentrations; it merely postpones the impact as long as the spraying continues but can also result in additional climate change.

Policy: In 2010, the UN Convention on Biological Diversity (CBD) adopted decision X/33 – described as a de facto moratorium – requesting governments not to pursue geoengineering as a climate change strategy. Despite this, some scientists and governments continue to consider geoengineering a viable Plan B to slow climate change. Asian governments may wish to raise this issue during the climate change Summit to be held at the UN in New York September 23 – 24, 2014.

Weather Modification in Asia: Under the CBD, weather modification is not considered geoengineering. However, large-scale weather experiments can geoengineer climates. Asia knows this best. In the mid-1960s, the US Air Force launched Operation Grommet – a major effort to increase precipitation over Bihar India during a severe famine. It didn't work. Also in the 60s, the USA attempted large-scale weather modification over the Philippines. During the Vietnam War, Operation Popeye, also by the U.S. Air Force, attempted to halt troop movements and destroy rice crop. That didn't work either but instead gave birth to the 1976 ENMOD convention.

(Doel & Harper 2006; The Sunshine Project n.d.)

Computer Model Scenario Results: In a study published in 2008 two model scenarios[3] were tested with injection of stratospheric sulfate aerosols both in the Arctic and in the Tropics. The authors concluded that precipitation patterns could significantly change over Asia, as the injections could affect the June-Aug monsoon.

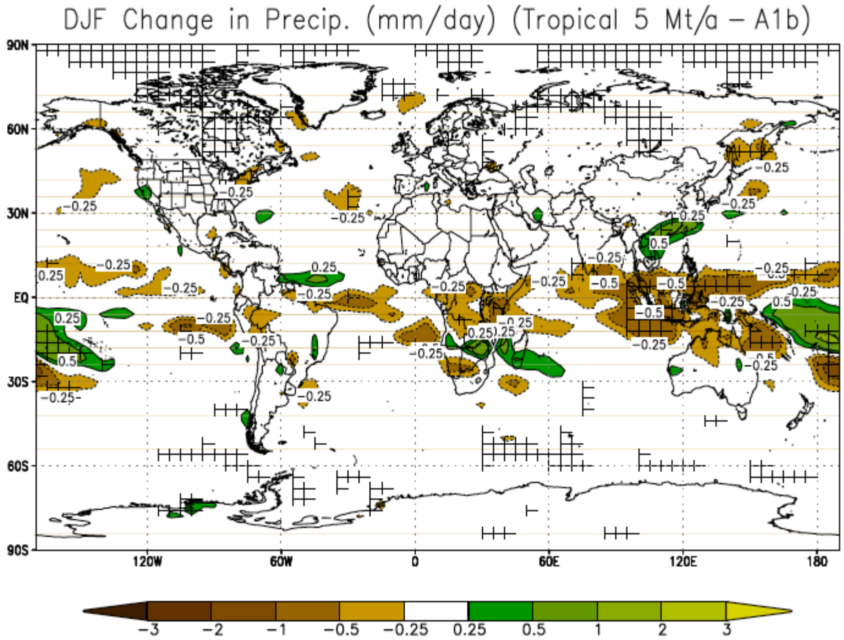

Figure 1. Showing change (color scale) of precipitation, in mm/day in a geoengineering scenario using stratospheric sulfate aerosol injections in the Tropics. The figure shows the change during Dec-Feb. (Figure from Robock et al. 2008)

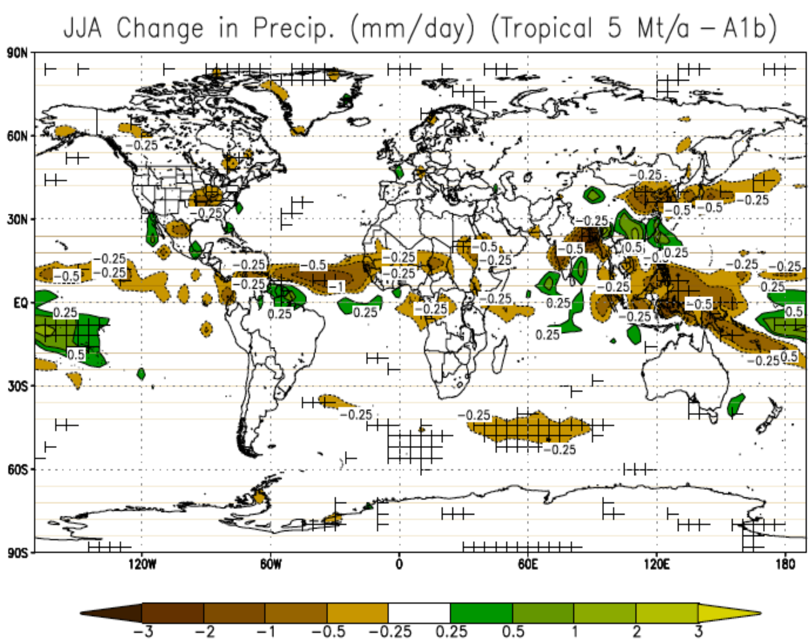

Figure 2. Showing change (color scale) of precipitation, in mm/day in a geoengineering scenario using stratospheric sulfate aerosol injections in the Tropics. The figure shows the change during June- Aug. (Figure from Robock et al. 2008)

During both Dec-Feb and June-Aug in the Tropical scenario, precipitation is significantly reduced over Asia, with a decrease of up to 3 mm/day in some regions. In particular, **Malaysia**, **Singapore**, **Indonesia**, **Philippines**, **Sri Lanka** and the Southern portion of **India** in Dec-Feb (Figure 1); and **India**, **Myanmar**, **Bangladesh**, **Malaysia**, **Vietnam**, **China**, **Japan**, **Cambodia**, **Philippines** and **Indonesia** in June-Aug (Figure 2). Note, however, that in Dec-Feb, the southeastern part of **China**, and parts of **Laos** and **Vietnam,** could see increased precipitation levels, and in June-Aug, the southeastern part of **China** could experience increased precipitation levels.

In a scenario based on stratospheric sulfate aerosol injection in the Arctic, the results are similar where certain regions could experience a reduced level of precipitation of up to 0.5 mm/day. In particular, **Myanmar**, **Sri Lanka**, **Thailand**, **Vietnam** and parts of **Indonesia** in Dec-Feb (Figure 3); and **India**, Northern **China**, **Indonesia**, **Philippines** and **Singapore** in June-Aug (Figure 4). Note, however, that parts of **China** as well as **Myanmar**, **Sri Lanka** and the southern portion of **India** could experience an increase in precipitation levels in June-Aug, and parts of **China** could also experience an increase in Dec-Feb.

Even though geoengineering is intended to lower increased temperatures from climate change, the results from the study show that in the Arctic scenario there could be a disturbing temperature increase in **India** during June-Aug of up to 0.5°C. In both the Arctic and the Tropical scenario, during both June-Aug and Dec-Feb, it is worth noting that there is little to no change in precipitation over **Europe** and **North America**, with only a few exceptions.

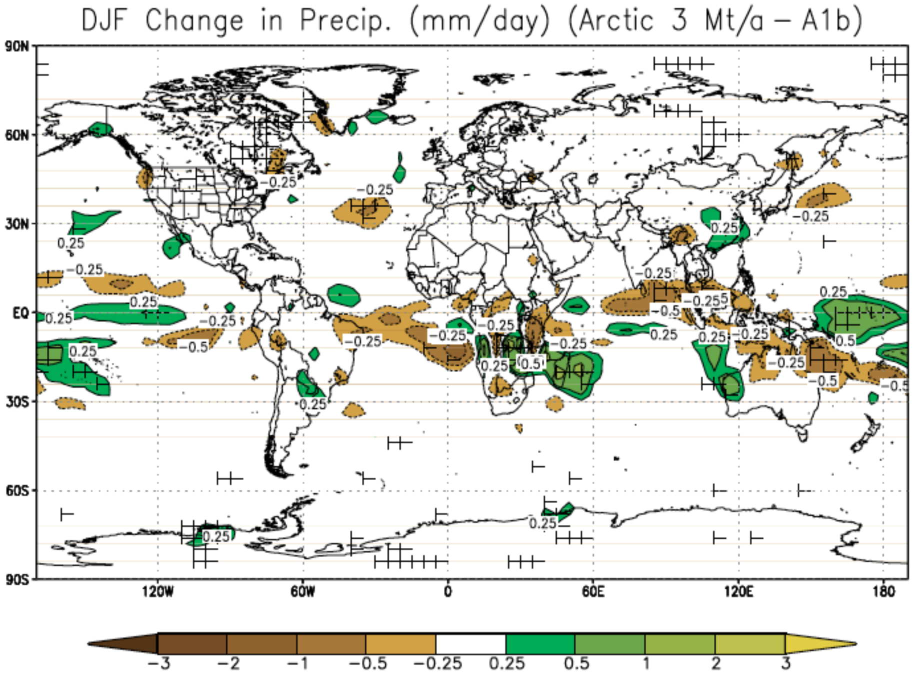

Figure 3. Showing change (color scale) of precipitation, in mm/day in a geoengineering scenario using stratospheric sulfate aerosol injections in the Arctic. The figure shows the change during Dec-Feb. (Figure from Robock et al. 2008)

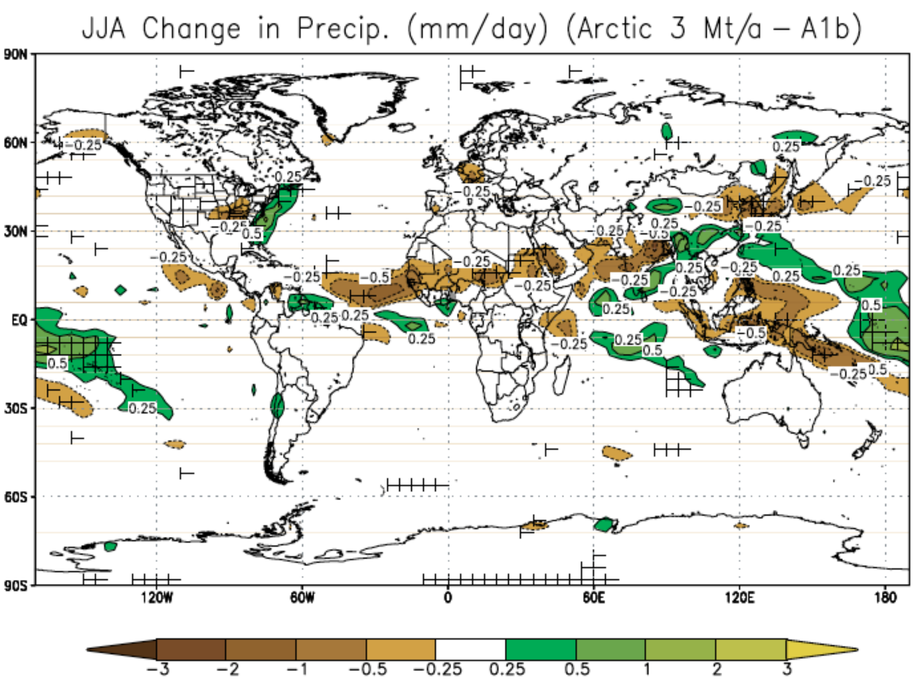

Figure 4. Showing change (color scale) of precipitation, in mm/day in a geoengineering scenario using stratospheric sulfate aerosol injections in the Arctic. The figure shows the change during June-Aug. (Figure from Robock et al. 2008)

Volcanic analogies: Stratospheric sulfate aerosol injection mimics volcanic eruptions that lower surface temperature by blowing sulfur into the stratosphere. In 1991 the Philippines Mt. Pinatubo blasted about 20 million tons of sulfur into the stratosphere, leading to a global average reduction in temperature of 0.4˚C.

Apart from the temperature decrease major volcanic eruptions also affect precipitation patterns. In the year after the eruption of Mt. Pinatubo a substantial decrease in precipitation, and a record decrease in runoff and river discharge into the ocean was recorded. A study looking at historical data from 54 volcanic eruptions, from the past 800 years, found that major eruptions tend to dry up much of Central Asia but bring more rain to Southeast Asian countries such as Vietnam, Laos, Cambodia, Thailand and Myanmar. The research showed that following an eruption, large areas of southern China, Mongolia and surrounding regions dried up in the first one to two years after the eruption, while mainland Southeast Asia received increased rain.

This has led scientists to conclude that major adverse effects, including drought, could arise from sulfate injections since it would severely affect atmospheric fluxes and the global hydrological cycle.

(Robock et al. 2008; NSF 2010; Trenberth & Dai 2007; Haywood et al. 2013)

Conclusion: Climate change is an anthropogenic phenomenon arising from the unanticipated side effects of rapid technological transformations. Without immediate action to mitigate and adapt to climate change, the impact on the people, the economy and food supply of Asia could prove devastating. Sea levels will rise, crop yields will decline, weather patterns will be erratic and health will be at risk. In this light, geoengineering, specifically – but not exclusively – solar radiation management, can seem an inexpensive and technologically easy and effective interim quick-fix that could postpone change and buy time. But, the quick-fix could be worse than the problem. It is, once again, an anthropogenic techno-fix with potentially powerful side effects. Computer modeling scenarios all identify very real risks. Ultimately, however, perhaps the biggest risk is that developing countries will inevitably have to turn over control of the planetary thermostat to the technologically powerful nations and industries that caused climate change in the first place. Developing countries will be exposed to changes that – by intent – will be more rapid and extreme than is predicted for climate change.

The advocates of sulfate aerosol injection argue that the costs are much less than virtually every other adaptation or mitigation strategy. This is not true. Advocates have only calculated the relatively minor costs of pumping sulfates into the stratosphere. There are huge indirect costs including the damages that will be caused by solar radiation management. The cost will shift from the adaptation and mitigation expenses that should be borne by industrialized countries to become the costs and damages of those who did not cause the problem.

About ETC Group: The Action Group on Erosion Technology and Concentration (ETC Group) is an international non-profit civil society organization established in 1977 with ECOSOC status as well as observer status with many UN agencies including UNFCCC, FAO, CBD, UNEP, and UNCTAD. ETC is headquartered in Canada with regional offices in Africa, Asia, Latin America and USA. ETCs mandate is to monitor economic, environmental and technological developments important to the well-being of marginalized peoples around the world. For further information please go to: www.etcgroup.org. ETC's director for Asia is **Elenita (Neth) Daño (neth@etcgroup.org)**

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[1] Although there have been many studies using models in attempts to simulate SRM scenarios, in this briefing, the aim has been to pick scenarios that are realistic and that address injection of SO_2 specifically.

[2] Robock, Alan, Luke Oman, and Georgiy L. Stenchikov. 2008. Regional climate responses to geoengineering with tropical and Arctic SO_2 injections, *Journal of Geophysical Research*, vol. 113, D16101.

[3] The authors used the NASA Goddard Institute for Space Studies ModelE atmosphere-ocean GCM (general circulation model) and based their experiments on a 40-year run using IPCCs A1B business-as-usual global warming scenario. The A1B is a scenario forced by greenhouse gases (CO_2, CH_4, N_2O, and O_3) and troposphere aerosols (sulfate, biogenic, and soot). The Arctic scenario is based on an injection of 3 Tg SO_2/year and the Tropical scenario is based on an injection of 5Tg SO_2/year.