Geoengineering for Climate Change: Nature Has Already Demonstrated the Process and Some Effects

Dr. Russ Schnell
NOAA Global Monitoring Division
325 Broadway
Boulder, CO 80305

Global Monitoring Annual Conference
May 20-22, 2019
Increasing Atmospheric CO₂ and CH₄ is Unplanned Geoengineering

Global CO₂ Trends

CO₂

CH₄
Volcanic eruptions provide test cases for the effects of planned stratospheric geoengineering. NOAA Global Monitoring Division has measured such natural effects in Hawaii and the Arctic.
Overt Stratospheric Geoengineering may be coming soon.

Frank Keutsch, ZhenDai and David Keith (left to right), Harvard University, have been funded to conduct the “Stratospheric Controlled Perturbation Experiment (SCoPEx)” for releasing calcium carbide into the stratosphere from balloons, possibly in 2020.

At MLO, the El Chichon eruption had a greater effect on solar radiation than Pinatubo.

El Chichon and Pinatubo aerosols had similar lifetimes (Barnes and Hofmann (1997), Lidar measurements of stratospheric aerosols over MLO, GRL, 25, 1923-26).
On March 14, 1983 the NOAA WP-3D was dedicated to measuring El Chichon eruption debris in a stratospheric fold west of Thule, Greenland. The red line shows the track along which El Chichon aerosol shown in the following figure was collected.
Optical Depth Records from Barrow, Mauna Loa and Arctic Aircraft Measurements

Surface Measurements

Airborne Measurements

Pinatubo aerosol took longer to fall out in the Arctic than at a sub-tropical latitude.
El Chichon Debris in the Arctic Stratosphere, One Year Post Eruption

El Chichon crustal material and $\text{H}_2\text{SO}_4$ droplets in the Arctic stratosphere, March 23, 1983.

El Chichon aerosol size spectra from 6786 particle sizes measured on Nucleopore filters with an electron microscope and with ASAP-100X and FSSP NOAA WP-3D wing mounted probes. (Shapiro et al., 1984, G.R.L., 11, 421-424.)
Effective aerosols size distributions inferred from the optical depths for WP-3D flights in the U.S. Arctic sector, March-April 1992.

Measured volume extinction on April 11, 1992 (blue line) compared to models from LOWTRAN 7 with tropopause height on that day for reference.
Atmospheric Cooling from Pinatubo Aerosols

Zonal mean MSU temperature anomalies. **Pink and red** areas are above the 10-year average and the **light and dark blue** areas are below average. Contour level is 0.05°C. By September 1991 the global and northern hemisphere temperatures had decreased by 0.5°C and 0.7°C respectively. (Dutton and Christy, 1992, G.R.L. 19, 23, 213-2316).
Oceans Absorb CO₂ and Become Acidic

- Mauna Loa Atmospheric CO₂ (ppm)
- Aloha Ocean pCO₂ in situ (μatm)
- Aloha Ocean pH (in situ)
Summary

- Aerosol effects on solar radiation from volcanic effluents have been well documented by NOAA in the sub-tropics and Arctic.

- These data are readily available, but have rarely been utilized in models used to predict stratospheric geoengineering effects.

- Even if atmospheric temperatures could be stabilized by the geoengineering proposals being put forward, the effects on stratospheric chemistry and cloud nucleation must be better understood.

- Even if stratospheric geoengineering was able to turn down the thermostat, greenhouse gases must still be controlled, because:

- Ocean acidification will still be a problem with dire consequences for marine life as we know it.

Conclusion

“Political economy suggests that geoengineering is likely to be used, and certain to be contentious” (The Economist, A Hot Mess, April 27, 2019, pg. 66).
Volcanic Aerosols Affect Sunlight On Earth

- El Chichón
- Pinatubo

**MLO Aerosol Lidar Measurements**

**MLO Solar Radiation Measurements**

- El Chichón
- Pinatubo

- Agung 8.3 S VEI 4
- Fuego 14.5 N VEI 4
- Pinatubo 15.1 N VEI 6

Graphs showing the impact of volcanic eruptions on aerosol backscatter and solar radiation transmission.