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

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Geoengineering to reduce atmospheric air temperature is becoming a hot topic with recent articles in *Science*, *Nature*, and the *Bulletin of the American Meteorological Society* discussing the pros, cons, and methods of "solar engineering." The proposed method of choice is to inject millions of tons of sulphur or calcium carbonate aerosols (two of the proposed) into the stratosphere to reflect solar radiation back to space.

Through volcanic eruptions that spewed mineral particles and sulfur dioxide into the stratosphere, nature has provided excellent examples of geoengineering: El Chichón, Mexico (29 March, 1982, ~7 MT) and Mount Pinatubo, Philippines (14 June, 1991,~ 20 MT).

Reductions in solar radiation measured at the Mauna Loa Atmospheric Baseline Observatory (MLO), Hawaii from these eruptions (Figure 1) showed a 14% reduction from El Chichón and 11% reduction from Pinatubo at the peak of the respective stratospheric aerosol loadings. Lidar measurements of the eruption aerosols showed they were concentrated between 15 and 30 km altitude and took 4–5 years to return to background levels (Figure 2). These aerosols reduced the global and Northern Hemisphere temperatures by ~0.5ºC and ~0.7ºC respectively.

NOAA WP-3 aircraft measurements in the Arctic stratosphere off Greenland, one year after the El Chichón eruption, collected crustal debris in the 10^{0} to 10^{1} micron diameter range in concentrations of 10^{-3} to 10^{-2} cm^{-3} and sulfuric acid (H_2SO_4) droplets in the 10^{0} to 10^{-1} micron diameter range in concentrations of 10^{-1} to 10^{2} cm^{-3}.

Peak aerosol optical depth anomalies measured at the surface at MLO were 0.2 for both El Chichón and Pinatubo eruptions and 0.17 and 0.21 respectively at the Barrow Atmospheric Baseline Observatory (BRW) in Utqiaġvik, Alaska. From NOAA WP-3 measurements in the stratosphere over BRW on April 22, 1992 (Pinatubo, 10 months post eruption), the stratospheric aerosol depth was in the 0.19 to 0.2 range.

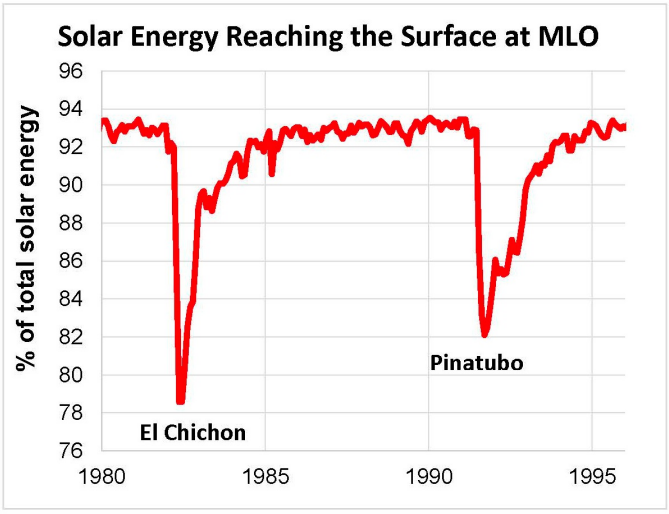

Figure 1. Solar energy reaching the surface at MLO following the El Chichón and Pinatubo eruptions.

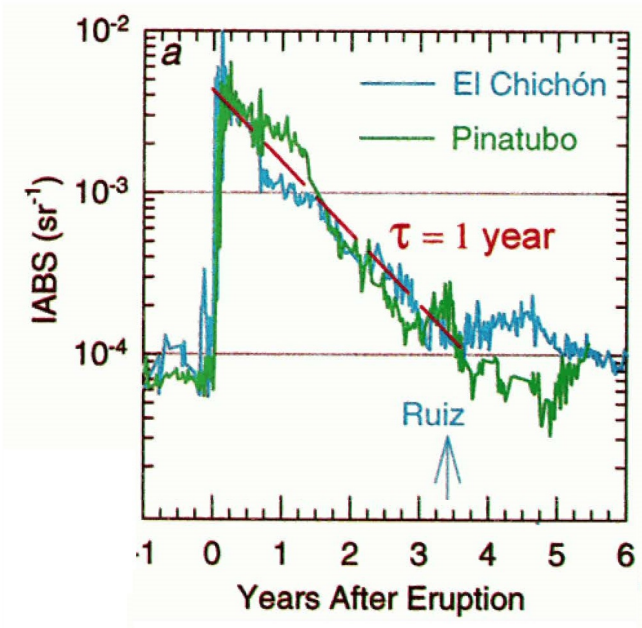

Figure 2. MLO lidar aerosol backscatter (16–33 km) above MLO after the El Chichón and Pinatubo eruptions. Nevado del Ruiz (located in Colombia) erupted November 1985.