A Planetary Parasol:
The Promise and the Pitfalls of Climate Engineering

By Benjamin Miller

In light of dire warnings from scientists, environmentalists, and a former vice president as to the possible effects of global warming, public outcries often demand reducing carbon dioxide emissions by switching away from fossil fuels. CO2 levels, however, have simply continued to climb. Such a dismal outlook has led many scientists to consider a radical approach: why not try to counteract the effect rather than the cause? Research groups around the world are currently investigating the possibility of engineering our way out of several predicted environmental disasters, most notably global warming, but in doing so, are we simply missing the point?

Rather than target the gasses that contribute to the greenhouse effect that warms the planet, Nobel laureate Paul Cruzten suggests that we inject sulfate aerosols into the stratosphere to reflect some of the incoming solar radiation that would normally warm the planet (1). The 1991 eruption of Mt. Pinatubo in the Philippines released twenty metric tons of sulfur dioxide into the stratosphere (2), which was then transported worldwide and oxidized into almost thirty tons of sulfate aerosol. Like a pair of sunglasses, countless sub-micron sized particles of sulfate deflected, reflected, and refracted incoming light across the atmosphere and, in large part, back into space (3). In addition to directly reflecting solar radiation, the sulfate aerosol from Mt. Pinatubo created stable nuclei for water vapor condensation, creating more clouds with finer-grained droplets. These droplets increase both the expanse and reflectivity of the Earth's cloud cover, further reflecting light back

into space (3). The sulfate remained aloft for two years, spreading out to create a thin layer over the entire planet, resulting in a reduction in solar radiation absorbed by the planet large enough to cool the Earth's surface by half a degree Celsius over the course of those two years (4). Recognizing that such an eruption roughly erased a century of global warming due to carbon dioxide buildup for those two years, scientists reason that a proportional, annual release of sulfate could effectively combat global warming.

While there is little question as to the effectiveness of stratospheric sulfate aerosol in cooling the planet, this miracle cure does come with some mild side effects. By soaking up water vapor in the lower stratosphere and upper troposphere, the injected aerosol could drastically alter tropical weather patterns and climate dynamics (5). Furthermore, in the coldest parts of the atmosphere, sulfate aerosol can crystallize into a sulfate-ice particle that takes up nitric acid vapor and, eventually, recrystallize into nitric acid-trihydrate, the major substrate for the conversion and preservation of chloroflourocarbons (CFCs) into ozone-consuming chlorine radicals (6). Even with the worldwide ban of CFC emissions, the injection of sulfate aerosols into the stratosphere could easily allow the ozone hole phenomenon to persist for decades to come.

In a century, unless we have drastically reduced our carbon dioxide emissions and sequestered much of the carbon dioxide emitted in the last century, we may need to continue injecting ever-increasing amounts of sulfate into the atmosphere to counteract our pollution. But these interventions ignore the underlying cause of this global problem and only attempt to ameliorate the major effect. Moreover, if we continue to believe that we can simply find a quick fix for every man-made environmental disaster, we may soon find ourselves trapped with a crisis that we cannot solve. And we must remember, furthermore, that science has often had the worst effects when operating with the best intentions. H

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The 1991 Eruption of Mt. Pinatubo.

credit: < http://nssdc.gsfc.nasa.gov/imgcat/html/object_page/a17_h_148_22727.html>, < http://vulcan.wr.usgs.gov/Volcanoes/Philippines/Pinatubo/images.html >

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