THE NEW YORKER

May 14, 2012

ANNALS OF SCIENCE

THE CLIMATE FIXERS

Is there a technological solution to global warming?

BY MICHAEL SPECTER

Late in the afternoon on April 2, 1991, Mt. Pinatubo, a volcano on the Philippine island of Luzon, began to rumble with a series of the powerful steam explosions that typically precede an eruption. Pinatubo had been dormant for more than four centuries, and in the volcanological world the mountain had become little more than a footnote. The tremors continued in a steady crescendo for the next two months, until June 15th, when the mountain exploded with enough force to expel molten lava at the speed of six hundred miles an hour. The lava flooded a two-hundred-and-fifty-square-mile area, requiring the evacuation of two hundred thousand people.

Within hours, the plume of gas and ash had penetrated the stratosphere, eventually reaching an altitude of twenty-one miles. Three weeks later, an aerosol cloud had encircled the earth, and it remained for nearly two years. Twenty million metric tons of sulfur dioxide mixed with droplets of water, creating a kind of gaseous mirror, which reflected solar rays back into the sky. Throughout 1992 and 1993, the amount of sunlight that reached the surface of the earth was reduced by more than ten per cent.

The heavy industrial activity of the previous hundred years had caused the earth's climate to warm by roughly three-quarters of a degree Celsius, helping to make the twentieth century the hottest in at least a thousand years. The eruption of Mt. Pinatubo, however, reduced global temperatures by nearly that much in a single year. It also disrupted patterns of precipitation throughout the planet. It is believed to have influenced events as varied as floods along the Mississippi River in 1993 and, later that year, the drought that devastated the African Sahel. Most people considered the eruption a calamity.

For geophysical scientists, though, Mt. Pinatubo provided the best model in at least a century to help us understand what might happen if humans attempted to ameliorate global warming by deliberately altering the climate of the earth.

For years, even to entertain the possibility of human intervention on such a scale—geoengineering, as the practice is known—has been denounced as hubris. Predicting long-term climatic behavior by using computer models has proved difficult, and the notion of fiddling with the planet's climate based on the results generated by those models worries even scientists who are fully engaged in the research. "There will be no easy victories, but at some point we are going to have to take the facts seriously,'' David Keith, a professor of engineering and public policy at Harvard and one of geoengineering's most thoughtful supporters, told me. "Nonetheless,'' he added, "it is hyperbolic to say this, but no less true: when you start to reflect light away from the planet, you can easily imagine a chain of events that would extinguish life on earth."

There is only one reason to consider deploying a scheme with even a tiny chance of causing such a catastrophe: if the risks of not deploying it were clearly higher. No one is yet prepared to make such a calculation, but researchers are moving in that direction. To offer guidance, the Intergovernmental Panel on Climate Change (I.P.C.C.) has developed a series of scenarios on global warming. The cheeriest assessment predicts that by the end of the century the earth's average temperature will rise between 1.1 and 2.9 degrees Celsius. A more pessimistic projection envisages a rise of between 2.4 and 6.4 degrees—far higher than at any time in recorded history. (There are nearly two degrees Fahrenheit in one degree Celsius. A rise of 2.4 to 6.4 degrees Celsius would equal 4.3 to 11.5 degrees Fahrenheit.) Until recently, climate scientists believed that a six-degree rise, the effects of which would be an undeniable disaster, was unlikely. But new data have changed the minds of many. Late last year, Fatih Birol, the chief economist for the International Energy Agency, said that current levels of consumption "put the world perfectly on track for a six-degree Celsius rise in temperature. . . . Everybody, even schoolchildren, knows this will have catastrophic implications for all of us."

Tens of thousands of wildfires have already been attributed to warming, as have melting glaciers and rising seas. (The warming of the oceans is particularly worrisome; as Arctic ice melts, water that was below the surface becomes exposed to the sun and absorbs more solar energy, which leads to warmer oceans—a loop that could rapidly spin out of control.) Even a two-degree climb in average global temperatures could cause crop failures in parts of the world that can least afford to lose the nourishment. The size of deserts would increase, along with the frequency and intensity of wildfires. Deliberately modifying the earth's atmosphere would be a desperate gamble with significant risks. Yet the more likely climate change is to cause devastation, the more attractive even the most perilous attempts to mitigate those changes will become.

“We don’t know how bad this is going to be, and we don’t know when it is going to get bad,’’ Ken Caldeira, a climate scientist with the Carnegie Institution, told me. In 2007, Caldeira was a principal contributor to an I.P.C.C. team that won a Nobel Peace Prize. “There are wide variations within the models,’’ he said. “But we had better get ready, because we are running rapidly toward a minefield. We just don’t know where the minefield starts, or how long it will be before we find ourselves in the middle of it.”

The Maldives, a string of islands off the coast of India whose highest point above sea level is eight feet, may be the first nation to drown. In Alaska, entire towns have begun to shift in the loosening permafrost. The Florida economy is highly dependent upon coastal weather patterns; the tide station at Miami Beach has registered an increase of seven inches since 1935, according to the National Oceanic and Atmospheric Administration. One Australian study, published this year in the journal *Nature Climate Change*, found that a two-degree Celsius rise in the earth’s temperature would be accompanied by a significant spike in the number of lives lost just in Brisbane. Many climate scientists say their biggest fear is that warming could melt the Arctic permafrost—which stretches for thousands of miles across Alaska, Canada, and Siberia. There is twice as much CO_2 locked beneath the tundra as there is in the earth’s atmosphere. Melting would release enormous stores of methane, a greenhouse gas nearly thirty times more potent than carbon dioxide. If that happens, as the hydrologist Jane C. S. Long told me when we met recently in her office at the Lawrence Livermore National Laboratory, “it’s game over.”