El Chichón Climate Effect Estimated

Climate modelers are now hazarding their first guesses that the El Chichón volcanic cloud will cool the Northern Hemisphere perhaps as much as any volcanic eruption of the past 150 years. The cloud from the El Chichón eruption in the spring of 1982 is now moving northward over the United States on its way to enveloping the Northern Hemisphere. Stratospheric circulation had kept it bunched between 10°S and 30°N (*Science*, 10 September 1982, p. 1023), but the expected fall wind shift seems to be spreading the cloud northward. An airborne expedition in early November headed by Patrick McCormick of the National Aeronautics and Space Administration's (NASA) Langley Research Center found that the bulk of the cloud extended as far as 35°N. Another NASA mission headed by James Pollack of NASA's Ames Research Center encountered dense cloud as far north as San Francisco in mid-December. Ground-based observers are detecting increasing cloud density as far north as Virginia and Colorado.

As the cloud moved north, the first atmospheric temperature effect had already been confirmed. "It's pretty safe to say that there's warming of the stratosphere" by the cloud, says James Angell of the National Oceanic and Atmospheric Administration in Silver Spring, Maryland. Twenty-six kilometers over Guam, the altitude of the bulk of the cloud, the temperature has risen 3°C, making the stratosphere there the warmest it has been since record-keeping began in 1958. The El Chichón cloud, by absorbing sunlight, caused almost all of that rise, Angell says.

The cooling near the surface, caused by the cloud's blockage of sunlight, will be slower to develop and more difficult to predict. As Brian Toon of Ames notes, "It's somewhat daring to come out with a prediction now." Nevertheless, researchers are publicly predicting a cooling of the Northern Hemisphere of about 0.5°C that will peak some time toward the end of 1983 or in 1984. A cooling of 0.5°C would put El Chichón on a par with the largest perturbers of climate of the past 150 years, including the mammoth eruption of Krakatau of 1883.

In spite of the variety of methods used for estimating the climatic effects, the early results are surprisingly consistent. On the basis of coolings observed after other eruptions, Toon expects that a maximum hemispheric cooling of about 0.5°C will occur by the summer or fall of 1983. An energy-balance climate model developed by Alan Robock of the University of Maryland also produces a 0.5°C cooling, but not until the winter of 1984–1985. A 500-day delay in the decay of the model cloud, which is intended to take into account its unusually high altitude, may lie behind the cooling's late arrival. The effects of snow and ice feedbacks may play a role as well. A meteorologically more complex computer model developed by Albert Arking, Ming-Dah Chou, and Li Peng of NASA's Goddard Space Flight Center calls for immediate cloud decay but does not allow the cloud to spread beyond the equator or 30°N. This model also produces a cooling that peaks at about 0.5°C in mid-1984. Preliminary results from a similar model of Frederick Luther and Michael MacCracken of Lawrence Livermore National Laboratory are "not inconsistent with" the magnitude of cooling seen in Robock's model, MacCracken says.

El Chichón's cloud may become one of the major perturbers of climate in recent times, but it would have been hard to predict that on the basis of its eruption alone. According to a compilation by Stephen Self of Arizona State University and Michael Rampino and James Barbera of NASA's Goddard Institute for Space Studies, eight eruptions during the past 160 years were more violent or produced as much as ten times the ash of El Chichón. Several times that number of eruptions were probably the same size as this year's eruption of El Chichón. The difference, Self and Rampino suggest, is that El Chichón and other climate perturbers spew large amounts of sulfurous gases into the stratosphere that eventually convert to sulfuric acid droplets. These are the persistent cloud particles, not the ash, that block the sunlight, they note. Mount St. Helens, for example, had the power to lift plenty of ash into the stratosphere but lacked the gases needed for a lasting effect (*Science*, 23 January 1981, p. 371).

Although researchers expect El Chichón's hemispheric cooling to be relatively large, it may still be hard to detect. Angell notes that 1981 was the warmest year since 1958, being 0.6°C above average. Since 1981, the hemispheric temperature began a precipitous decline, reaching 0.2°C above average by the time of the 1982 El Chichón eruption. Any cooling caused by the eruption cloud "is going to be very hard to see," Angell says. Confident detection will probably not occur for several years at least. Even then, daily weather-watchers may have noticed only unpredictable extremes in regional weather patterns such as changes in the amount of storminess, precipitation, heat, or cold.

Conventional thinking allows the cloud only these kinds of delayed effects, but researchers are not ruling out more immediate ones. Some are considering the suspicious coincidence of the tropical eruption and the unanticipated appearance of El Niño, the warming of equatorial Pacific surface waters that can periodically decimate the anchovy population of the eastern Pacific. The coincidence seems particularly suspect to some because this El Niño was rather odd. It began developing in May rather than during October to November, as is usual. According to Eugene Rasmusson of the National Weather Service in Camp Springs, Maryland, the last out-of-season El Niño appeared in 1963. That was shortly after the eruption of Agung, the most recent eruption having a major climatic effect. He also notes that this ocean warming was unique in appearing across the Pacific all at once rather than propagating westward from the South American coast; such unusual behavior caught El Niño forecasters by surprise. The suggestion that the stratospheric warming somehow diminished the trade winds, which in turn leads to the ocean warming, has not been well received. No alternative mechanisms have been offered, but the possibility that one exists is not being rejected out of hand.

In the meantime, long-range weather forecasters have had to decide what this strange El Niño might mean for this winter's weather (*Science*, 7 May 1982, p. 608). At the end of November, researchers at the National Weather Service guessed that this El Niño's effect on the mid-latitudes would be above average temperatures in the East and below normal ones in the West.—**Richard A. Kerr**