Volcanoes and the weather: surprising, nonlinear effects

*This interview is part of a series exploring the science of climate, in particular the El Niño phenomenon, as opposed to the Chicken Little approach of the media, which have broadcast scare stories, especially in California, about the coming El Niño deluge. As previous articles have indicated (*EIR*, Sept. 19, 1997, pp. 18-25, and* EIR*, Sept. 26, 1997, pp. 13-16), the cause of El Niño is not really known, and even its effects are not known—or, there is disagreement about what they are. The typical climate model approach to El Niño is axiomatically doomed, because of the nonlinearities involved in the oceans and the atmosphere, which cannot fit the present models.*

One of the points of disagreement among climate scientists, is on the role of volcanoes. One researcher has called the theories of volcanic influence on the climate "flaky." And atmospheric scientist Hugh Ellsaesser suggested that it may be just as likely that El Niño could cause *volcanic activity. There can be as much as a meter's difference in sea levels, Ellsaesser explains, between the western and eastern regions of the Pacific Ocean. As this water flows back during an El Niño, it represents a tremendous shift in pressure on the ocean floor, which could trigger a volcano, if the subsurface conditions were right, he suggests.*

In this interview, Gerald Kuhn talks about the nature of volcanic influence on climate and weather. Kuhn is a geologist, based in southern California, who worked closely with Dr. Francis Shepard, the father of marine geology, at the Scripps Oceanographic Institution, until Shepard's death in 1985. Together they wrote many books and articles, and did pioneering work on the relationship of volcanoes to climate. Kuhn was interviewed in September by Marjorie Mazel Hecht. His article on volcanoes and climate will be featured in the Winter 1997-1998 issue of 21st Century Science & Technology *magazine.*

EIR: You've been looking at the relationship of volcanoes to climate for many years. How did your work begin, relating volcanic eruptions and weather patterns?

Kuhn: In the 1970s, the late Dr. Francis Shepard and I were evaluating the erosional history of the coastal cliffs in San Diego County, California. This was preliminary to a study of the southern California coast; an effort which in itself was the forerunner of developing erosional concepts to apply to the cliffed shores of the United States. We were working on the hypothesis that erosion of the cliffs was episodic, rather than a gradual, sand-grain by sand-grain loss of the rock material.

Even more revolutionary than that concept, was our observations that seemed to indicate that the erosion was caused by rains from storms, instead of the long-held conclusion that coastal cliffs were eroded by ocean wave action. The waves were simply the means by which the erosional debris was carried from the beaches to the sea.

We had excellent charts of the California coast that covered more than a century of surveys, along with good records dating back to the Franciscan fathers who oversaw the missions from the 1700s. The charts and the records told us when and how much erosion there had been, so we began to search for circumstances that would have initiated what appeared to be some horrendous, stormy periods. This led to the determination that an extraordinary amount of erosion took place along the U.S. West Coast after the eruption of Krakatau, August 1883.

EIR: What was so unusual about this stormy period?

Kuhn: Not only had coastal erosion greatly increased after more than a decade of drought, but there were extreme floods, especially in southern California. There, the floods in 1884 were the most devastating ever recorded, before or since. This stormy episode led us to investigate, therefore, the possible relationship to volcanic eruptions. In particular, we needed to learn which, if any, of the eruptive materials had exacerbated weather patterns.

EIR: What kinds of records did you find to look at?

Kuhn: We began a systematic study of all U.S. government weather records, going well back into the middle of the 19th century, along with records from the British Meteorological Office, records from all of the California missions, logs, and diaries of mariners who sailed along, or to, the California coast in the 1800s, along with every scientific paper dealing with weather, meteorology, and coastal seas available in the libraries of Scripps Institution of Oceanography, Woods Hole, and the Naval Academy.

Then, of course, we also addressed our attention to historical records of volcanic eruptions. It turns out that there are quite good records dating back to near the beginning of the 19th century, and lots of usable anecdotal information dating back to the 15th century.

EIR: What did you learn? Is there an obvious correlation?

Kuhn: It appeared to be usual, that a short time after an eruption, especially a Strombolian-type, in which vast quantities of sulfur products were punched into the stratosphere, that there were tremendous increases in storm conditions, including hurricanes, tornadoes, and flood-producing torrential rains, in those parts of the world thoroughly influenced by the eruptive cloud.

In other parts of the world, conditions can be quite the opposite. Droughts, frigid weather, are experienced while others feel the floods, and while still others find themselves basking in warm, pleasant weather—in each case, conditions not normal to those geographic areas at such times of the year.

In other words, it is usual for worldwide weather conditions to be perfectly nonlinear, chaotic after a decent eruption; such as, Mt. Pinatubo, 1991; Tambora, 1815; and Katmai, 1912.

EIR: Did you see any weather patterns after these volcanic periods?

Kuhn: For the significant volcanic episodes of the last 120 years, and for which the most reliable records exist, we learned that the weather following every eruption went through sudden changes, deviating well from the normal in the pertinent area at the particular time of the year. One of the most amazing circumstances we examined in post-volcanic periods is the completed displacement of seasons. The clearest of such events is the experience of a "year without a summer."

Such a dramatic seasonal "exchange" has taken place five times since 1800. An excellent example, quite well documented, occurred after the eruption of Tambora in 1815. The frigid summer of 1816, including snow and ice, throughout New England, including Cape Cod, ruined all of the crops. There wasn't a lot of sunbathing or boating at Hyannisport either.

EIR: Is there a clear correlation between volcanism and El Niño; that is, warm-water periods in the tropical Pacific Ocean?

Kuhn: No, not at all! In fact, our research leads toward the impression that the great stormy periods at mid-latitudes are more intense during cold-water episodes; that is, a time of an El Viejo.

As my research continues, it becomes clear that we have a long way to go, before we understand all of the parameters that influence weather and/or climatic variations, of whatever magnitude. We simply must realize that every weather system, and every input into long-term variations that we might possibly term "climatic," is composed of a bunch of nonlinearities which are not now, and may never be, possible to put into a solution. The best we can do is point out some relationships that seem to follow a chosen event, recognizing that "cause and effect" remain questionable.

For example, we know that stormy years of record have followed great, sulfur-rich volcanic eruptions, and at times when there is no warm-water event at all; that is, no El Niño. On the other hand, after other large sulfur-rich, Strombolian explosions, the same kind of stormy weather has struck mid-latitude lands and there has been a nicely measureable El Niño in the eastern tropical Pacific.

It is just so obvious that we are really far from understanding the interactions, the interplays, and the influence of the great, natural, nonlinear characteristics of our Earth.

EIR: What are the variables of volcanic activity that seem to be involved in creating abnormal weather?

Kuhn: For the past three decades, atmospheric scientists and volcanologists have investigated volcanic glass for sulfur volatiles. It was becoming apparent that any possible volcanic impact on weather, or climate, was not the result of the size of the eruption, or how much dust was ejected, but rather the magnitude of the sulfur compounds produced. There was good evidence that even a relatively moderate eruption, such as sulfur-rich El Chichón, 1982, can have a major impact on the atmosphere when the sulfur products are punched through to the Junge Layer in the stratosphere.

Then, when along comes a super-eruption of a sulfur-rich volcano, as was Mt. Pinatubo, whose Strombolian eruption cast 20 million tons of sulfur volatiles to 18-25 km, you can bet that the weather systems, the "weather-guesser's" models, and the climatologists' incantations are going to be disrupted for a few years.

EIR: How was the Mt. Pinatubo aerosol cloud measured?

Kuhn: The eruption was monitored, day after day, by the Total Ozone Mapping Scanner (TOMS) on the Nimbus-7 satellite. The space-borne sensors detected a total mass of sulfur-rich aerosol cloud at a height of 22+ km in the stratosphere that indicated the volume was double that produced by El Chichón. Within three weeks, the sulfurous cloud had encircled the Earth, and formed into an almost continuous band between 20°N and 20°S.

The TOMS instrument had been refined to measure sulfur after the El Chicón eruption in 1982.

EIR: Why is the sulfur content so important?

Kuhn: Detailed examination of the aerosols from Mt. Pinatubo, by Brasseur and Granier, shows that about a month after the eruption (June 1991), "The sulfur dioxide was converted into sulfuric acid (H_2SO_4), which in the stratosphere condenses into small particles (aerosols). The aerosol load after this volcanic eruption was one or two orders of magnitude larger than that produced by biological and anthropogenic sources." They went on to point out that the sulfur volatiles appear to be the single most contributing source to "temporary ozone depletion."

There are still many questions unanswered about the sulfur—such as, how far does it get up, and why are some volcanoes sulfur-rich and others not—but it is rather clear, now, that the sulfur compounds play a key role in the formation of the vast "haze" or "Dry Fogs" experienced in the northern U.S. after the North American and European eruptions in 1783, 1831, and Katmai, Aleutians, 1912.

Benjamin Franklin was one of the first to describe the effects of the great European "Dry Fog" in 1783. Franklin, as the first U.S. ambassador to France, prepared a memorandum in May 1784 that was communicated to the Royal Academy by a Dr. Percival on Dec. 22, 1784.

Old Ben wrote: "During several of the summer months of the year 1783, when the effect of the sun's rays to heat the earth in these northern regions should have been greatest, there existed a constant 'fog' over all of Europe, and a great part of North America. This fog was of a permanent nature; it was dry, and the rays of the sun seemed to have little effect toward dissipating it, as they easily do for moist fog, arising from water. They were indeed rendered so faint in passing through it, that when collected in the focus of a burning glass [magnifying glass], they would scarcely kindle brown paper. Of course, their summer effect in heating the earth was exceedingly diminished.

"Hence, the surface was early frozen.

"Hence, the first snows remained on it unmelted, and received continual additions.

"Hence, the air was more chilled and the winds were more severely cold.

"Hence, perhaps, the winter of 1783-84, was more severe, than any that had happened for many years.

"The cause of this universal fog is not yet ascertained. Whether it was adventitious to this earth, and merely a smoke, proceeding from the consumption of fire of some of those great burning balls or globes which we happen to meet upon our rapid course around the sun, and which sometimes [are] seen to kindle and be destroyed in passing our atmosphere, and whose smoke might be attracted and retained by our earth; or whether it was the vast quantity of smoke long continuing to issue through the summer from Hekla in Iceland, and that other volcano which rose from the sea near that island, which smoke might be spread by various winds, over the northern part of the world, is yet uncertain."