Earth Sciences

There's earthquakes in the wind

Southern Californians would love to find some way of knowing a month in advance whether a damaging earthquake will likely strike. One meteorologist suggests atmospheric pressure patterns might provide some clue. Jerome Namias of the Scripps Institution of Oceanography in La Jolla, Calif., proposed this idea in 1988 when he reported that an unusually strong high-pressure system developed in the North Pacific before quakes struck southern California in 1986 and 1987 (SN: 5/7/88, p.299). Now Namias has greatly expanded his analysis by studying the summers between 1947 and 1987.

From a list of all southern California earthquakes with magnitudes of 4.5 or greater during that period, Namias picked out the summers with many quakes and those with no quakes. His analysis of the meteorology during these summers shows that quakes were more likely under a particular set of conditions: a stronger-than-normal North Pacific high pressure, a low-pressure trough over the far western United States and a high-pressure ridge over the continental interior. Summers with no quakes usually had a weak Pacific high and a poorly developed continental high, he reports in the Dec. 10 JOURNAL OF GEOPHYSICAL RESEARCH. Namias cannot explain the apparent correlation between pressure and seismicity, but he speculates that variations in seafloor pressure or in sea-surface temperature might influence both the atmospheric pressure and the ground stress in California.

Volcanoes on Earth may follow the sun

Does the timing of volcanic eruptions around the globe fit any sort of pattern? According to a statistical study of hundreds of eruptions over the last four centuries, the solar cycle may have an influence on when volcanoes blow their cool.

Before he began the study, Richard B. Stothers of NASA's Goddard Institute for Space Studies in New York City held little hope of finding any correlation between eruption frequency and the 11-year solar cycle — a faint waxing and waning in the sun's energy output. Several researchers over the past 150 years had proposed such a connection but did not conduct large-scale statistical studies to test the theory, says Stothers.

Stothers analyzed two immense catalogs, published in the early 1980s, that list more than 55,000 known eruptions since the year 1500. Concentrating on several hundred of the moderate-to-large eruptions, he found statistically significant patterns in eruption frequency that match the solar cycle. Eruptions seemed most numerous during the weakest portion of the solar cycle, he reports in the Dec. 10 JOURNAL OF GEOPHYSICAL RESEARCH. He cautions, however, that these tests are not perfect: The observed correlation may result from a statistical coincidence rather than reflecting a relationship between the solar cycle and volcanoes.

For instance, one analysis detected a 10.8-year period in the frequency of 114 large eruptions. To check whether the apparent periodicity arose from a statistical accident, Stothers performed a Monte Carlo test, in which a computer generates 1,000 lists, each containing 114 random dates between the years 1500 and 1980. The computer then determines how many random lists had strong periods close to the length of the solar cycle. Stothers found that only three out of every 100 random lists produced a solar cycle period. This gives a 97 percent confidence level to the conclusion that the 10.8-year period in the real eruption record is not a statistical accident, he says.

How on Earth could the sun influence eruptions? One possibility, Stothers says, is that during the peak of the solar cycle, emissions from the sun cause small but abrupt changes in the Earth's atmosphere, jarring the planet slightly. This might trigger tiny earthquakes that relieve stress under volcanoes, thereby staving off a large eruption.

Space Sciences

Figuring out the fragments of Hyperion

Some scientists believe Saturn's moon Hyperion, photographed in 1981 by Voyager 2, consists of fragments that recombined after a collision with another large object shattered it. Rather than rotating with the same side always facing Saturn as moons normally do, Hyperion moves "chaotically" on its axis. It also has an irregular shape and a shortage of large craters, both cited as possible evidence of such a catastrophic event.

But did the fragments indeed recombine into a satellite after such a collision? And if not, where did they go?

Hyperion's present shape suggests its fragments could not have reunited, say Paolo Farinella of the University of Pisa, Italy, and colleagues from there, the University of Arizona in Tucson and Italy's Torino Astronomical Observatory. They note that the fragments would have separated with escape velocities of several hundred meters per second — higher than the gravitational attraction of any surviving large chunk could overcome. Instead, the scientists suggest, the fragments might have crashed into the planet's big satellite Titan or else spread through the inner portion of the Saturnian system.

"Our models predict that in fact the vast majority of fragments were swept up by Titan," with the total energy of fragments (the product of their masses and velocities) declining rapidly as they moved inward, the researchers write in the January ICARUS.

Farinella's group calculates that if such a Hyperion debris storm took place, it should have created more impact craters on the inner moons' rear portions than on their front-facing hemispheres. Yet Voyager 2 photos of the satellites show no consistent difference. The researchers conclude that "only a tiny fraction of fragments escaped a collision with Titan and could hit the other satellites."

The one exception, they say, is the moon Rhea, Saturn's "only satellite for which there is evidence of a leading/trailing asymmetry." Photos sharp enough for detailed crater studies do not show the whole of any of the satellites' surfaces, but the researchers acknowledge a more fundamental problem: the difficulty of distinguishing craters produced by Hyperion shrapnel from those due to other chunks that were presumably hurtled around in the solar system's early days.

Analyzing Io's complexion

Although several researchers have studied the striking palette of colors on Jupiter's moon Io, spectral measurements have left uncertainties about the principal materials there. On a surface known only from data gathered by distant instruments, slight temperature differences and other factors, such as the varied tendencies of different molecules to stick where they first touch the terrain, can often make spectra difficult to read.

Farid Salama and colleagues at NASA's Ames Research Center at Moffett Field in Mountain View, Calif., have now compared details in Io spectra taken as long ago as 1976 with spectra the group derived in the laboratory. They describe their findings in the January ICARUS.

Io's surface probably contains hydrogen sulfide and water mixed with sulfur dioxide, the researchers report. In addition, the Io spectra "are well matched qualitatively" by lab spectra of sulfur dioxide ices containing about 3 percent hydrogen sulfide and 0.1 percent water, condensed onto a cold surface as a mixture of gases. One question has been whether the different ices on Io are mixed or instead were somehow deposited in separate layers. The group concludes that only a mixture can account for observations of solid hydrogen sulfide on Io at temperatures and pressures above which pure hydrogen sulfide would have turned to a gas.