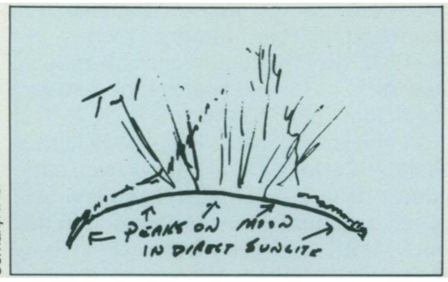
On the horizon: Clementine probes moon glow

Astronauts orbiting the moon aboard Apollo 17 in 1972 viewed two features of our solar system normally washed out by the sun's glare. Each time the solar disk rose from behind the moon, the crew witnessed the faint illumination from the sun's outer atmosphere, or corona, as well as the dim glow of zodiacal light — sunlight scattered by interplanetary dust.

Using sketchpads, the crew drew what they saw just before the sun began poking out from behind the cratered lunar surface. Their drawings, researchers later realized, show more than just the corona and zodiacal light. Near the limb of the moon, the sketches reveal the strange phenomenon of horizon glow, caused by the scattering of light from gas or dust suspended several kilometers above the moon. This puzzled researchers because they thought the moon's negligible atmosphere lacked the material to create a glow.

Cernan/NASA



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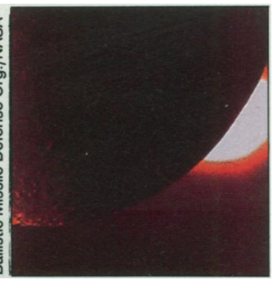

Left: Astronaut Eugene A. Cernan sketched this lunar scene from Apollo 17. Squiggly lines along the moon's limb on either side of the broad peak indicate the lunar horizon glow. Right: In this false-color image taken by the Clementine spacecraft, white glow is the solar corona behind the moon; earthshine illuminates the moon's lower edge. Red area along the limb, near the corona, may be horizon glow.

Two decades after Apollo, the Clementine spacecraft appears to have photographed the horizon glow. At the Lunar and Planetary Science Conference in Houston last week, Eugene M. Shoemaker reported that the craft — now midway through its 2-month survey of the moon — may have captured the glow in an image taken by one of its star-tracker cameras. Shoemaker, a Clementine scientist based in Flagstaff, Ariz., says a higher-resolution camera on board could verify the glow.

Herbert A. Zook of NASA's Johnson Space Center (JSC) in Houston says his analysis of the star-tracker image, conducted with JSC colleague Andrew E. Potter, indicates "an 80 percent likelihood" that Clementine recorded the horizon glow. To explain the glow, Zook says he favors a model proposed by David R. Criswell of the University of Houston.

In that model, sunlight striking the moon strips atoms of their electrons. Both the ionized atoms and the electrons would then impart a charge to lunar dust particles. The charged dust would rise several kilometers above the moon, creating the horizon glow by scattering light. But Zook adds that the glow remains a mystery "that researchers don't pretend to fully understand." — *R. Cowen*

Modeling the varied avalanches of evolution

When fossil records point to the demise of a large number of species at roughly the same time, paleontologists often invoke a catastrophe — whether a meteorite impact or a volcanic eruption — as the cause. Similarly, they look for environmental factors to explain the sudden emergence of a variety of new species.

Though such explanations may prove correct, it's also possible that some large changes in an ecosystem occur not because of a cataclysm but because a minor event has started a chain reaction that leads rapidly to widespread disruption. This avalanche behavior can occur in any complex system that automatically organizes itself into a so-called critical state, precariously poised on the edge of catastrophe.

Physicists have explored the possibility that self-organized criticality occurs when sand grains are added to sandpiles, creating avalanches ranging in size from just a few grains to entire slopes (SN: 7/15/89, p.40). They have also studied this behavior in collapsing foams (SN: 3/31/90, p.207), coalescing water droplets (SN: 10/23/93, p.261), and patterns of earthquake activity.

Now, researchers have developed an extremely simple mathematical model that displays self-organized criticality and appears to capture the way in which biological evolution proceeds via intermittent bursts of activity separated by long periods of quiescence. This model exhibits behavior strongly reminiscent of "punctuated equilibrium," a notion suggested more than 2 decades ago by paleontologists Stephen Jay Gould of Harvard University and Niles Eldredge of the American Museum of Natural History in New York City as an alternative to gradual, step-by-step evolution.

In the new model, proposed by Per Bak of the Brookhaven National Laboratory in Upton, N.Y., and Kim Sneppen of the Niels Bohr Institute in Copenhagen, Denmark, each species in an ecosystem is represented by a random number that corresponds to the "barrier" this species must overcome to evolve further. Arranging these numbers in a line, one picks at each step the smallest number (the species most likely to mutate) and replaces it and the numbers immediately next to it with new random numbers. Thus, the model incorporates the idea that the evolution of a single species also affects the evolution of species with which it interacts.

This model leads to evolutionary avalanches, in which a given species may remain unchanged for long periods, only to go through a number of mutations in a brief spurt. Sometimes, just a few species are affected. At other times, changes are widespread.

Applied to real biology, this model demonstrates that when successful mutations are rare, an ecosystem shows intermittent bursts of evolutionary activity, Sneppen says. Large events in evolutionary history may simply reflect the natural fluctuations of a self-organized critical system rather than the consequences of catastrophes.

Sneppen described the model at an American Physical Society meeting held this week in Pittsburgh. — *I. Peterson*

Climate treaty takes effect

The world's first climate treaty entered into force this week, nearly 2 years after 150 nations signed the Framework Convention on Climate Change at the Earth Summit in Rio de Janeiro (SN: 6/20/92, p.407).

The long-range objective of the convention is to pave the way for nations to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous interference with the climate system. Toward that end, the convention requires that by Sept. 21 developed countries submit national plans aimed at reducing their emissions of carbon dioxide and other greenhouse gases to 1990 levels by the year 2000. The convention does not, however, require countries to reach that goal.

International delegates continue negotiations to iron out unresolved aspects of the convention and to discuss potential additions to the treaty. At a meeting in Geneva last month, U.S. representatives said the convention did not adequately address what countries must do beyond the year 2000. "Climate change will remain a serious long-term problem that will necessitate further action," they said.

— *R. Monastersky*