Earth Science

Richard Monastersky reports from San Francisco at a meeting of the American Geophysical Union

Light at the bottom of the ocean

The oceanic mystery started off with the discovery of blind shrimp that can actually see. When biologists in 1985 first spotted a new shrimp species swarming around geysers of hot water along the deep ocean floor, they named it *Rimicaris exoculata*, a Latin term describing a shrimp lacking eyes. Further study, however, revealed that these creatures are not blind at all. Rather, they have an unusual pair of eyes on their backs instead of in the normal position on the front of their heads (SN: 2/11/89, p.90). That discovery led scientists to wonder what *R. exoculata* could be looking at in the dark ocean depths 5 kilometers below the surface.

Oceanographers who have made recent dives to these hot-water vents have now ruled out the idea that the shrimp are watching light generated by heat from the geysers. Researchers raised that theory five years ago, when divers in the deep-sea submersible Alvin photographed light emanating from the hot-water chimneys. They suspected that the light could be black-body radiation, much like the red glow given off by hot metal. That explanation made sense because the water spewing from the vents is a blistering 350°C.

But the recent dives have sunk that idea, says Alan D. Chave of the Woods Hole (Mass.) Oceanographic Institution. During an expedition last year in the Alvin, researchers used photodiodes to measure the strength of light coming from the geysers, both at their openings and 10 centimeters above the vents, where the water temperature cools to 40°C. Theoretical calculations suggest that if black-body radiation were producing the light, it should be a billion times stronger at the vents than in the cooler water above. But the photodiodes detected only eight times more light at the vents, indicating that the illumination must come from some process other than thermal radiation, says Chave.

Last January, oceanographers, biologists, chemists, and even astrophysicists met at Woods Hole to discuss what could produce the vent light. Aside from black-body radiation, they listed a number of other possible sources of illumination: crystalloluminescence, produced when chemicals crystallize; sonoluminescence, powered by the sound of bubbles collapsing; triboluminescence, created when rock crystals crack; and Cerenkov radiation and scintillation, both caused by the radioactive decay of elements in the vent water.

Cindy Lee Van Dover from Woods Hole is currently making measurements at deep-sea vents to determine what wavelengths of light are released. These results should help narrow the field of potential explanations, says Chave. Biologists are intrigued by the idea of deep-sea light because it raises the possibility that organisms may harness such energy with a type of photosynthesis completely independent of the sun.

Need pollution data? Go fly a kite

If interest in kite flying soars among atmospheric scientists, it will stem largely from the efforts of Ben Balsley, a researcher at the Cooperative Institute for Research in Environmental Sciences in Boulder, Colo. In the last several years, Balsley has pursued the idea that kites can lift meteorological instruments to high altitudes for long spans of time, thereby filling a unique niche in the arsenal of tools used by atmospheric scientists (SN: 4/4/92, p.216). He tested that idea last summer in Nova Scotia, where he used kites to measure ozone concentrations in the troposphere.

Balsley and his crew worked with a high-tech parafoil kite, constructed from mylar fabric strengthened with threads of kevlar. They flew the kite at a height of 2,600 meters for periods of up to 12 hours. While the kite remained in the air, a wind-powered tram carried ozone-measuring instruments up and down the line, taking readings at different levels in the atmosphere. Their results tracked the spread of pollution from industrialized regions in North America. Balsley says that although balloon experiments could make similar measurements, the kite technique is much cheaper because scientists often cannot recover ozone meters carried by balloons.

Balsley and his colleagues plan to test their kites next year as part of a research project to be staged in the Azores. If they receive funding, they hope to build a much larger parafoil that could, in theory, carry scientific payloads up to 19,000 meters, far above the reach of most research aircraft.

The world according to moss

Moss may be mute, but it has quite a story to tell about changes in Earth's climate, according to researchers who studied a peat bog in Tierra del Fuego, at the tip of South America. Because the cool weather of this region prevents decay, mosses and other plants have piled layer upon layer in the bog, recording information about the climate during the last 14,000 years, say Ray Kenny of New Mexico Highlands University in Las Vegas and co-workers at the University of Colorado at Boulder.

To track ancient conditions, the researchers analyzed the ratio of two hydrogen isotopes within the moss. That ratio indicates the temperature of precipitation taken up by the plants. The scientists believe that the moss data offer clues about global fluctuations in climate because they match information obtained from ice in Antarctica and Greenland, suggesting that all three sites have recorded the same events.

Because scientists can date the layers of moss with the carbon-14 method, they can pinpoint the timing of such climate shifts, something that cannot be done as easily with ice cores and sea-sediment cores, says Kenny. Moss studies, however, have their own limitations. Scientists can only study bogs in cool regions, and the peat records do not reach nearly as far back as some other forms of climate information.

Tracking ozone: Life before the hole

Like historians raiding an archive of ancient texts, two atmospheric scientists are sifting through old satellite data, looking for a means of extending ozone records back in time. On the basis of ground measurements made in Antarctica since the 1950s, researchers believe the annual Antarctic ozone hole first appeared in a mild form during the late 1970s and then grew worse in the 1980s. Yet they have lacked confirming evidence from satellites because the principal instrument used to track ozone concentrations from space was first launched in 1979. Robert D. Boime and Stephen G. Warren of the University of Washington in Seattle now report that measurements from another type of satellite sensor may provide information about ozone concentrations going as far back as 1972.

The standard ozone-sensing instrument on current satellites, called the Total Ozone Mapping Spectrometer (TOMS), makes measurements by monitoring the solar ultraviolet light reflecting off Earth's surface. Because ozone absorbs ultraviolet radiation, the amount bouncing off Earth reveals how much ozone the atmosphere holds.

But ozone also absorbs limited amounts of visible light, so Boime and Warren are studying whether visible-light measurements made by weather satellites can help track ozone in the atmosphere. To test their idea, the researchers compared the two methods, looking at the ozone hole in 1987.

Their preliminary results suggest that the two methods agree for that particular period. If further study shows that the techniques match up for other time spans, Boime and Warren hope to start studying data from the 1970s to recover ozone information for that decade.