Earth Sciences

Weather satellite GOES blind

The GOES West satellite, a key U.S. tool for tracking severe storms, abruptly ceased to transmit weather information to Earth on Jan. 21. Although the satellite exceeded by nine months its five-year life expectancy, the failure leaves the United States temporarily shorthanded for the job of spotting and following such deadly weather phenomena as Atlantic hurricanes, Western winter storms, tornadoes and strong rainstorms that produce flash flooding.

Normally two satellites, GOES West and GOES East, both operated by the National Oceanic and Atmospheric Administration (NOAA), split the duty of tracking storms over North America and large portions of the Pacific and Atlantic. From an altitude of 22,300 miles, they orbit at precisely the right speed to remain stationed over a particular spot on the rotating globe. Every half-hour the satellites transmit visible and infrared images of cloud cover as well as temperature profiles of the atmosphere. These GOES images are the basis of satellite cloud pictures seen on TV weather forecasts.

NOAA's technical assistant for satellites, Jamison Hawkins, in Suitland, Md., says GOES West went blind because its last backup light bulb burned out. The satellite carried four incandescent bulbs into orbit, and these are essential to the imaging system.

A series of mishaps over the past few years have left NOAA without an immediate replacement for GOES West. Several GOES satellites failed prematurely in the early 1980s, and the agency lost one satellite in 1986 when a Delta rocket carrying the instrument to orbit suffered mechanical problems during liftoff and was subsequently destroyed. The next GOES satellite is not scheduled to be ready for launch until mid-1990.

Until then, NOAA is moving the remaining GOES East to a more central location. While the single satellite will provide images of both the Atlantic and Pacific coasts, its coverage will not extend far enough into the oceans. Hawaii, for example, will sit just within the satellite's westernmost range, while the Gulf of Alaska will probably not fit into the coverage. The agency plans to supplement the GOES data with information from European and Japanese satellites as well as from U.S. polar orbiting satellites.

Hole in ocean floor

The deep-sea floor generates more excitement each year, as scientists continue to uncover signs that they need to revise their image of this realm as a quiet and static place. Recently, oceanographers have observed storms of intense currents that occasionally sweep patches of the ocean floor. Now a group of researchers has discovered evidence that a natural seafloor explosion blew open a large crater in the bottom of the Gulf of Mexico, they report in the Jan. 27 Science.

Using high-resolution sonar equipment, David B. Prior from Louisiana State University in Baton Rouge and his colleagues identified the crater in 2,176 meters of water southeast of the Mississippi River delta. The elliptical hole measures 280 meters across, 400 meters long and some 58 meters deep, and sits atop a small hill. Downslope lies approximately 2 million cubic meters of ejected sediment.

Because the area is known for its reservoirs of hydrocarbons, Prior surmises these substances caused the explosion that produced the crater. As one possible explanation, he suggests hydrocarbons seeping upward along cracks in the seafloor might have collected under some impermeable barrier until pressure forced the buoyant gas to blow off its cover. Based on the crater's appearance, the researchers think it may be younger than a century old. In 1906, sailors in the area reported seeing bubbling water, which may have been caused by such an eruption.

Physical Sciences

Ivars Peterson reports from San Francisco at the American Physical Society/American Association for the Advancement of Science meeting

A grazing view of melting

Although freezing is a complicated process, scientists generally agree on its essential features. Melting, on the other hand, is still very much a mystery. For example, water can be cooled well below its freezing point of 0°C if the water contains no impurities around which ice crystals can begin to form. But ice always melts at 0°C; it can't be "superheated." One possible explanation is that solids begin to melt before they reach their melting points. Researchers have recently found experimental evidence for just such an effect, known as "premelting," in lead at temperatures well below its melting point.

The experiments were done by Sean Brennan of Stanford University and his collaborators at AT&T Bell Laboratories in Holmdel, N.J. The researchers used a special technique that strictly limits the depth to which X-rays, coming in at a grazing angle, penetrate a solid. By observing any scattered radiation, they could detect the presence of a liquid lead layer on the surface of a single crystal of lead.

Brennan and his colleagues found that the initial stages of premelting may occur at temperatures well below a material's melting point. Because the arrangement of lead atoms on different surfaces of a single crystal looks somewhat different, the researchers also noted that these surfaces behave somewhat differently. Although both of the two types of surfaces studied showed traces of premelting at similarly low temperatures, one surface ended up with a thicker liquid layer than the other at temperatures closer to the melting point.

Brennan has also used "grazing-incidence" X-ray scattering to study the structure of thin iron-oxide films on various surfaces (a matter of interest to the magnetic recording industry) and to follow the growth of alternating layers of zinc and selenium atoms on a gallium-arsenide base. "We can watch while we're growing the material how its surface structure changes," Brennan says. "It's exciting to know what that structure is under varying conditions."

An X-ray peek into electrochemistry

Most techniques for studying surfaces require that experiments be conducted in a vacuum. But the electrochemical deposition of one metal onto the surface of another metal is a wet process, in which the layer of liquid covering the solid electrode is an integral part of the system. To provide a way of studying such immersed surfaces, Owen R. Melroy and his colleagues at the IBM Almaden Research Center in San Jose, Calif., use high-intensity X-rays, generated by accelerated electrons, to penetrate the liquid and provide information about the underlying surface.

In their first experiments, Melroy and his team looked at the structure of metal layers, only one atom thick, electrochemically deposited on well-defined surfaces. In the case of lead deposited on silver, the researchers discovered that the larger lead atoms do not line up with the silver atoms below. But as the applied voltage increases, the lead atoms are squeezed together about 2.4 percent — an effect never before seen in a two-dimensional metal layer. As a result, the spacing between rows of lead atoms in a two-dimensional "monolayer" is quite different from that found in bulk lead, which probably influences the way in which electrochemically deposited lead grows into the bulk material.

The researchers have also found that atoms of silver deposited on gold enter specific sites, filling the deep depressions formed by groups of three neighboring gold atoms. Moreover, negative ions found in the surrounding liquid, or electrolyte, end up occupying well-defined sites on the silver monolayer. Such ordered structures in the electrolyte were quite unexpected, Melroy says. "The first layer is better defined than people had thought."