Earth Sciences

Cheryl Simon reports from San Francisco at the joint meeting of the American Geophysical Union and American Society of Limnology and Oceanography

Deep waters run warmer

There was no good reason why the properties of the deepest ocean waters should not change over time; it was just that such a change had never been observed, says James Swift of the Scripps Institution of Oceanography in La Jolla, Calif. So he was more relieved than surprised when measurements taken in 1981 in the North Atlantic during the Transient Tracer Program indicated for the first time a small but unmistakable reduction in saltiness and increase in temperature. At first researchers aboard the cruise on which the changes were first detected thought that the flow of deep water had been obstructed, impeding mixing of the water. However, measurements taken during subsequent cruises revealed a widespread though subtle shift in two of the properties that are intimately involved in driving circulation in the deepest parts of the world's oceans.

While Swift cautions that such changes may occur "all the time" the finding is significant because it shows in naked detail that oceans not only change but change quickly, on a time scale shorter than 10 years. Prevailing wisdom might have predicted that the oceans could change in 50 or 100 years. The finding could ultimately mean that the oceans are capable of responding far more quickly than expected to the increasing levels of carbon dioxide in the atmosphere. Swift says the changes in saltiness and temperatures may be related to freshening of surface waters, probably caused by a fluctuation in the atmosphere in the North Atlantic and Norwegian Greenland Sea.

The change is apparent because ocean waters carry traces of radioactive isotopes, such as tritium and "bomb carbon-14" that were injected into the atmosphere during bomb tests in the early 1960s. The only places where an ocean can respond to atmospheric changes is at high latitudes, the last places where ocean water is at the sea surface before cooling and sinking slowly to the bottom, where it is renewed. Such bottom water bears the chemical signature of the atmosphere the last time the water was on the ocean surface.

VLF: Getting particles excited

Each time one of the world's 50 or so very low frequency (VLF) transmitters emits its signal, streams of excited particles rain down to the earth from the radiation belts in the outermost regions of the earth's atmosphere, including the magnetosphere. Scientists from Lockheed Space Sciences Laboratory in Palo Alto, Calif., and from Stanford University described an experiment that confirms the belief that even low frequency radio waves leak into the magnetosphere, causing the phenomenon. There, the radio signals are amplified as much as 1,000 times, altering the motion of free electrons thousands of miles out in space. Because there is so much natural movement of electrons along the magnetic field lines arcing over the globe, it is usually difficult to "sort out" the effects of VLF signals, said Joseph Reagan of Lockheed.

In the study, a satellite was used to record the effect of the VLF signals transmitted in a series of distinct patterns by four transmitters. Sensitive instruments were able to detect faint aurora-like glows and X-rays that occur when excited electrons interact with the atmosphere. Reagan said it is still unclear why the amplification occurs at some times and not at others. The finding suggests that the use of VLF signals could allow global communications in which VLF waves would be captured and amplified along magnetic field lines into the magnetosphere. This would allow broader communications range at lower frequencies. The study also opens the possibility of conducting controlled experiments in the ionosphere, rather than continuing simply to observe natural processes, said Amran Iman of Stanford. The research is sponsored by the Office of Naval Research, which is interested in the results for its "basic science" and military implications, a spokesman said.

The private lives of mid-water fish

Until recently the life styles of organisms living in the mid-ocean depths were a private affair. But during a recently concluded pilot program to test the use of a one person submersible suit called Wasp (SN: 8/28/82, p. 134), researchers observed for the first time unexpectedly dense concentrations of minute crustaceans called copepods, a critical part of the base of the food web. Researchers Bruce Robison and Alice Alldredge, both of the University of California at Santa Barbara, said that as they hoped, the suit allowed them to observe the animals in the mid-water column in an unobtrusive manner impossible with standard sampling methods such as towed nets. The researchers found a dense layer of copepods between 15 and 25 meters thick at depths of 450 meters. The tiny animals were "lethargic and unresponsive to direct stimulation," Robison said. The researchers estimate that in the layer there were 2 million to 4 million copepods per cubic meter, and that they apparently were entering "diapause," a stage in the copepod life cycle something akin to hibernation. Levels of oxygen were "significantly" lower in the layer than they were 20 or 30 meters either above or below the layer.

The Wasp also allowed divers to observe mid-water fish in greater diversity and abundance than predicted. While earlier estimates placed the abundance of mid-water fish in the Santa Barbara Basin at about 20 per cubic meter, direct observation showed that they are about 10 times as plentiful. Part of the reason for the underestimate is that many of the mid-water fish, such as jellyfish and medusae, are "gelatinous" and easily damaged by trawling nets. Robison said that when he imitated the horizontal motion of the net the animals swam backward and easily avoid being snared. Alldredge described the mid-water fish as "superior competitors" because they grow fast, and when food is abundant they apparently consume it in enormous quantities, which enables them to out-compete other aquatic animals with less voracious appetites.

Less sulfur dioxide from El Chichón

A tremendous amount of sulfur dioxide entered the earth's atmosphere when the Mexican volcano El Chichón erupted in April 1982 (SN: 5/15/82, p. 326; 8/21/82, p. 120), but less than scientists thought initially. The Total Ozone Mapping Spectrometer on NASA's Nimbus 7 showed that the cloud carried only 3.3 million tons of the gas, rather than 5 million to 30 million tons, as mathematical models estimated, reported Arlin J. Krueger of NASA's Goddard Space Flight Center in Greenbelt, Md. The observations, the first detailed measurements of volcanic gases, will be used in computing the amount of sulfuric acid that will form as the sulfur dioxide combines with water vapor at high altitudes. Two days after the eruption on April 4, the cloud covered an area of 1 million square miles.

Lake Tahoe blues

The crystal-blue waters of Lake Tahoe provide a pleasing backdrop for skiers schussing down the mountain slopes nearby. Inside the lake, the scene is less rosy. Earl R. Byron and Charles R. Goldman of the University of California at Davis have analyzed sediment cores from the central area of Lake Tahoe. During nearly all of the last 600 years, they report, the lake changed very little. But in the last 20 years water clarity decreased sharply and growth of algae doubled when construction boomed and people began to flock to the area in unprecedented droves. Sedimentation rates today are four times those natural to the lake. The sediments do not reveal any effect from the extensive logging of the Lake Tahoe basin in the 1800s, researchers note. The difference may stem from the recent introduction of impervious surfaces, construction of buildings, and erosion from woodcuts.