Earth Sciences

Bomb tritium in southern oceans

The thermonuclear bomb tests during the 1950s and 1960s had one positive aspect—detectable quantities of a radioactive material called tritium (^3H) fell into the oceans. For years scientists have been following the motion of the tritium, using their findings to observe the formation and movement of water in the deepest ocean. Until now the tracer has been useful only in the Northern Hemisphere because concentrations in the Southern Hemisphere were five to ten times smaller, and could not be detected by existing instruments. In the Sept. 1 NATURE, researchers from Woods Hole Oceanographic Institution in Woods Hole, Mass., report that by increasing the size of water samples and by adjusting sampling techniques and instruments, it now is possible to detect man-made tritium in Antarctic bottom water in the western South Atlantic.

Tritium has a half-life of 12.5 years, the time that it takes the material to lose half of its radioactivity. Presently, its usefulness as a tracer will last perhaps another 20 years. William Jenkens of Woods Hole says he hopes that with improved detection levels, this period may be extended to 30 to 40 years. He says that while it would have been helpful to have observed the entry and motion of the tritium in the southern oceans 20 years ago, there is still much to be learned from its presence and dispersion. Movement and formation of deep water is interesting to scientists because the water masses are coupled to the climate system in "subtle ways," he says, and because transient tracers allow observations and prediction of the paths followed by man-made products that may result from human activity, such as carbon dioxide or radioactive species that may be released if nuclear wastes are disposed of on the ocean floor.

Ozone's chilling effect on wheat yield

A variety of wheat called "Vona" thrives when grown in the winter's chill, but when exposed to heightened levels of ozone in the lower atmosphere, yield drops off by as much as 25 percent. Researchers at Cornell University's Boyce Thompson Institute for Plant Research in Ithaca, N.Y., say the problem is premature aging. The plants exposed to ozone mature faster, and are subject to leaf injury and to diminished rates of photosynthesis, leading to smaller wheat grains.

The tests were conducted as part of the National Crop Loss Assessment Network (NCLAN) sponsored by the Environmental Protection Agency. Vona is grown widely in the wheat belt, including Colorado, Oklahoma, Texas and Kansas. Of the eight wheat varieties tested in the NCLAN experiments nationwide, Vona appears to be the most sensitive to air pollution. Cornell plant pathologist Robert Kohut says that the test wheat was grown in chambers with and without charcoal activated filters (which reduce ambient ozone by half), in ambient air (no chamber), and in chambers in which ozone levels were 1.5 and 2.0 times that in the ambient upstate New York air. The ozone levels are similar to those commonly found in southern California where dense urbanization and heavy automobile traffic and exhaust cause high concentrations of pollutants such as ozone and sulfur dioxide (SO_2).

When the researchers analyzed the weight of groups of 100 seeds from the 1982 winter wheat harvest, they found that the plants grown in the non-filtered air chambers weighed 24 percent less than those plants grown in charcoal-filtered air. Kohut says that a farmer would be unable to say "I lost eight percent of my crop to air pollution," but might respond to the smaller yields by switching to a different variety of wheat, or to a different crop. This year the researchers also are looking at the effects of SO_2 on crops, and at the combined effects of the SO_2 and ozone. Once they have collected information on the effects of air pollution in the field, the scientists will assess the economic effects of air pollution on agriculture.

Radon: A message in emissions?

Measurements of radon gas emitted from the earth's crust may never be the sole tool used in earthquake prediction, but researchers are making progress toward understanding the relationship between the gas and other earthquake precursors. At the recent meeting in Washington, D.C., of the American Chemical Society, Alan P. Rice and colleagues at the California Institute of Technology in Pasadena described two instances of radon changes, which may indicate increasing compression deep in the earth. The two incidents led to quite different interpretations, highlighting the need to correlate radon measurements with other geophysical conditions less subject to environmental interference. The first example occurred in 1979 when Caltech's automated radon monitoring system noted sharp radon increases at three of the California sites where the radioactive gas is measured in boreholes drilled into bedrock. The Caltech data are recorded and relayed instantly, but at that time information was delayed on other geophysical conditions. "We saw an anomaly, but had nobody that we could confirm with that something unusual was happening," Rice recalls. "By the time other people found the anomalies in their data, it was too late." A few months after the radon increase, a Richter magnitude 6.6 earthquake struck in the Imperial Valley, 290 kilometers from the research site. It turns out that before the earthquake there *was* a change in the typical earthquake pattern in the area; seismicity had dropped by about 40 percent during the time of heightened gas emissions.

The second illustrative radon change occurred in August 1981 when radon levels jumped at stations at Lytle Creek and Lake Hughes, 100 km apart (SN: 10/17/81, p. 247). This time, the increases indicated a change not in crustal strain, but in the groundwater level. "The challenge is to find out why it happened," Rice says. "It could be that we don't adequately understand how this aquifer responds to rainfall, or, it might have been that the accumulation of strain below the surface prior to an earthquake had suddenly changed the characteristics of the aquifer." The event did suggest to the researchers that carbon dioxide acts as a carrying gas, sweeping radon from the surrounding rock and into the sample area.

Another way to watch the wind

The National Oceanic and Atmospheric Administration (NOAA) and RCA Astro-Electronics are developing a satellite-borne instrument called "Windsat" with which they hope to improve medium- and long-range weather forecasts. Researchers predict that the laser instrument, which would view the global atmosphere twice daily, could save U.S. commercial airlines up to $200 million a year in fuel costs by helping them alter flight paths to exploit tailwinds and avoid headwinds. An advanced version of NOAA's polar-orbiting weather satellite, TIROS-N, could serve as a space platform for demonstration and testing of Windsat. The new instrument could be ready for operation by 1990.

In China: Recording potent motion

Forty strong-motion seismographs installed this summer in several earthquake-prone regions of China greatly increase the number of instruments in that country capable of recording strong earthquake motion. Sensors near Tangshan already have recorded more than 70 aftershocks of the magnitude 7.8 earthquake that killed hundreds of thousands of people in 1976. The joint U.S.-China project, operated through Caltech and the Institute of Engineering Mechanics in Harbin, China, is unusual in that some of the instruments are installed as deep as 900 meters below the surface, using existing coal mines near the site of the Tangshan quake.