Climate

Coastal lakes hold hurricane history

Catastrophic hurricanes elude long-term forecasting, in part because their historic documentation dates back only 120 years – a span too short to reveal how often such storms tend to recur. Now, two scientists have found a way to extend that record back thousands of years. By tracing the fingerprints that ancient hurricanes left in lake sediments near the Alabama coast, they have taken the first step toward calculating the risk of a devastating storm in that region.

"We have reconstructed hurricane activities in that part of the Gulf [of Mexico] during the last 5,000 years," says geographer Kam-biu Liu of Louisiana State University in Baton Rouge.

Using radiocarbon dating to determine the age of hurricane sand deposits, Liu and graduate student Miriam L. Fearn found that extremely violent hurricanes have raced through the area about every 600 years. Given that the last such storm hit this region 770 years ago, "the Alabama coast is likely to be struck by a major hurricane within the next century," Liu says. He and Fearn describe their study in the September GEOLOGY.

Focusing on coastal Lake Shelby allowed them to date the ancient hurricanes to within 200 years, says Liu. "Previously, geologists looked at much older, mostly marine sediments that are often too perturbed for exact dating," he explains. Coastal lakes are better preserved and hold organic material that can be accurately dated, he says.

The researchers started out by locating the sand that Hurricane Frederick – a strong storm that struck in 1979 – had hurled away from beaches and into the lake. Guided by the appearance of the sand layer left by Frederick, they scanned lake sediment cores for older hurricane-sand strata. Then they radiocarbon-dated the older hurricanes, measuring the proportion of carbon-14 in the sediment layers around the sand.

These deposits must have stemmed from catastrophic hurricanes, Liu reasoned, because the winds managed to fling them into the middle of the lake – an area so far from the beaches that Frederick's sand deposits hadn't reached it.

Liu is now extending this pilot project to a dozen sites along the Gulf of Mexico, hoping to assemble an overall pattern of prehistoric hurricanes within the next two years.

Seafloor, ice core: Wobbling in tandem

Water-temperature changes imprinted in Atlantic Ocean sediments correspond to air-temperature fluctuations frozen in Greenland's ice cap, scientists report in the Sept. 9 NATURE.

The two temperature records match nicely, helping to draw a broader picture of the turbulent climate changes that occurred during the most recent ice age, 100,000 to 10,000 years ago, the researchers say.

"That the warm-cold oscillations in the ice [SN: 12/12/92, p.404] also would show up in the ocean record had been proposed but never documented before," says Gerard Bond, a geologist with Columbia University's Lamont-Doherty Earth Observatory in Palisades, N.Y. He and his co-workers tracked sea-surface temperature changes through the past 90,000 years by checking ocean sediment cores for the abundance of *Neogloboquadrina pachyderma,* the main zooplankton in surface water, whose numbers increase as the water cools. They found that the jittery temperature switches lumped together into cycles of 6,000 to 10,000 years. During these phases, both air and water temperatures wobbled toward cooling.

The ocean record also shows that each cooling cycle culminated in a brief but hefty burst of ice-sheet calving, sending armadas of icebergs drifting out across the northern Atlantic. Most of the icebergs broke off the Laurentide ice sheet, a huge glacier in Canada that advanced through the Hudson Strait. Then, temperatures jumped several degrees within decades, followed by a new cycle of gradual cooling, Bond says.

Physics

Putting a new spin on the neutron

Composed of quarks and gluons, the proton should have characteristics, such as spin, reflecting those of its constituents. But how much of a proton's spin (which is the source of this particle's magnetism) comes from the spins of its three quarks has remained a puzzle. Five years ago, measurements at the European Laboratory for Particle Physics (CERN) in Geneva, Switzerland, suggested that only a small fraction of a proton's spin is carried by the quarks. Instead, the gluons, which bind the quarks together, apparently make a significant contribution to the total.

This surprising finding prodded a host of theorists to try to explain the result (SN: 4/8/89, p.215) and prompted two independent follow-up experiments, one at CERN and the other at the Stanford Linear Accelerator Center (SLAC). At CERN, researchers studied how elementary particles known as muons bounced off a target made up of deuterons (each comprising a proton and a neutron). The SLAC group tracked electrons scattered by a target made up of helium-3 nuclei (each composed of two protons and a neutron). In both cases, taking advantage of the close relationship between the proton and neutron, the groups determined the neutron's spin content as a check on the original proton findings. Now the results of the follow-up experiments are in, and the question of the origin of the proton's (and neutron's) spin is still unsettled.

In the Aug. 16 PHYSICAL REVIEW LETTERS, the SLAC team presents results suggesting that a neutron's quarks carry about 57 percent of the neutron's spin, with an error margin of 11 percent on either side of this value. On the other hand, the CERN group deduces from its results that a neutron's quarks carry only 6 percent of its spin, but the margin of error (25 percent) is much larger. The CERN determination supports the original proton-spin findings, whereas the SLAC result is more in line with theoretical expectations.

Because the two experiments were performed under quite different conditions, comparing the two sets of measurements directly has proved difficult. "There is a range of possible values that sort of spans what the two experiments say," says Timothy E. Chupp of the University of Michigan in Ann Arbor, who participated in the SLAC effort. What's needed is a second round of experiments to narrow that range and reduce the error, he says.

"We're making good measurements, and in a relatively short period of time on the scale of high-energy physics, we're converging on definitive answers," Chupp notes. "Even the current results are allowing theorists to focus their efforts quite a lot."

Resistance at low magnetic fields

Certain materials change their electrical resistance when placed in a magnetic field. Known as magnetoresistance, this effect can be detected in such metals as iron. In 1988, researchers discovered that they could enhance this minor effect considerably by using the right type of layered material, and since then scientists have vied to formulate new materials that show larger and larger resistance changes for a given magnetic field (SN: 8/29/92, p.140).

Now, Todd L. Hylton and his colleagues at IBM ADSTAR in San Jose, Calif., report in the Aug. 20 SCIENCE the discovery of a new method of producing "giant magnetoresistance" at much lower magnetic fields than previously possible – comparable to those required for storing data on magnetic disks. They achieve the effect by creating alternating layers of silver and nickel-iron, then quickly heating and cooling the structure to allow some silver atoms to diffuse into the nickel-iron. Such materials may eventually allow the storage of 30 times more data on a computer disk than now possible.