Earth Science

Streaming toward a wetter United States

The amount of water flowing through U.S. streams has steadily increased during this century, although without giving rise to more frequent floods, according to a new study by scientists at the U.S. Geological Survey.

"The nation is getting wetter but less extreme" in terms of stream flow, says Harry F. Lins, a USGS hydrologist in Reston, Va., who coauthored a report appearing in the Jan. 15 GEOPHYSICAL RESEARCH LETTERS. "The water resources of the nation seem to be improving, but we're not paying a price."

Lins and James R. Slack, also of the USGS in Reston, analyzed records from 395 stations that gauge water flow in streams in the conterminous United States. They chose remote streams that had not been altered by dam construction or crop irrigation.

Their analysis indicates that 30 percent of these streams are now carrying more water than they did 50 years ago. Days when streams had low to normal amounts of water showed almost all the increase. Few stations showed an increasing trend in water flow during times of peak flow. The net result is that the driest times of year grew moister, but the nation did not experience an increase during the wettest periods.

These findings run counter to climate researchers' expectations. Simulations by some computerized climate models of global greenhouse warming suggest that precipitation should be getting more extreme, possibly with more frequent flooding. "We find no substantiation of that hypothesis," says Lins.

Measurements of actual precipitation, however, tell a different story than the stream data do. Last year, meteorologists at the National Climatic Data Center in Asheville, N.C., reported that the heaviest precipitation is more frequent and has become more intense since 1910. "The wettest side of the spectrum is definitely increasing," says the center's Richard W. Knight. —*R.M.*

Heat and humidity getting worse

People who loathe the withering days of summer will get positively steamed at the results of a new meteorological study. Records of temperature and humidity across the United States indicate that sweltering days have grown more common since 1949, a trend that increases the risk of heat-related problems affecting the elderly and other vulnerable people.

U.S. meteorologists had previously documented a long-term rise in average summertime temperatures, particularly at night. In the new study, Dian J. Gaffen and Rebecca J. Ross, both of the National Oceanic and Atmospheric Administration in Silver Spring, Md., searched for changes in the apparent temperature—an index that combines heat and humidity measurements.

Analyzing data from 113 U.S. weather stations, the two researchers determined how often the apparent temperature reached extreme values during the years 1949 through 1995. To qualify as extreme, the temperature and humidity had to exceed a threshold value—defined by the top 15 percent of the worst days in all the Julys and Augusts during that period at each station. Medical statistics indicate that heat-related deaths start to increase when temperatures top these thresholds.

Over the period of study, U.S. stations showed a significant increase in the number of extreme days, with the most dramatic changes occurring at night. Across the stations, the average number of sultry nights went from 8 per year in the early 1950s to 16 per year in the 1990s. The trends were strongest in the East and West, Gaffen and Ross report in the Dec. 10, 1998 NATURE.

The researchers also found significant increases in the number of heat waves—defined as 3 or more days in a row when the apparent temperature exceeded the threshold.

Although the scientists did not seek the cause of these changes, Gaffen says that "what we're seeing is generally consistent with what we would expect from an enhanced greenhouse effect." —*R.M.*

Materials Science

Disorderly crystals emit laser light

In order to shine perfectly synchronized photons—the sine qua non of laser light—semiconductor crystals must have perfectly arranged atoms. Any defects in the crystal scatter emitted photons, degrading the performance of the laser.

Now, researchers at Northwestern University in Evanston, Ill., have demonstrated a lasing material that actually uses scattering to its advantage. They found that a thin film of tiny, light-scattering zinc oxide crystals can emit ultraviolet laser light. Their results open the door to fabricating lasers simply by spreading a powder on a surface, says R.P.H. Chang. He and his colleagues report their findings in the Dec. 21, 1998 APPLIED PHYSICS LETTERS.

Semiconductor chips that form the basis of traditional lasers contain reflective surfaces that bounce emitted photons back and forth through the chip. These photons stimulate the release of additional photons that move in lockstep with each other, eventually emerging as a coherent beam of light.

The disordered zinc oxide film, on the other hand, doesn't need mirrors, says Chang. The emitted photons scatter from one tiny particle to another in closed loops, "like a dog chasing its tail." The irregularly shaped zinc oxide grains range in size from 50 to 150 nanometers and have numerous internal defects, which promote light scattering. If a critical number of photon circuits arises in a patch of grainy film, it emits laser light. Theorists predicted this phenomenon 3 decades ago, but his team's study is the first experimental demonstration, Chang says.

Because the particles are oriented randomly, the light shines out in all directions. This characteristic could make such films useful in flat-panel displays, whose images often fade when viewed from an angle, Chang notes. A display made with a lasing film could be a thousand times brighter than one made with light-emitting diodes, he adds. —*C.W.*

Carbon tubes pumped up with hydrogen

To some people, hydrogen has the potential to be a clean, abundant fuel for the 21st century. One obstacle to achieving this goal, however, lies in the difficulty of storing and transporting the fuel safely. Researchers have suggested that carbon nanotubes might serve as ideal containers, acting as tiny vials to encapsulate molecules of hydrogen gas.

Now, by using electricity to draw hydrogen ions into pressed pellets of carbon nanotubes, scientists at the University of Freiburg, Switzerland, have demonstrated a way to package useful amounts of hydrogen. Christoph Nützenadel, Andreas Züttel, Daniel Chartouni, and Louis Schlapbach report their findings in the January ELECTROCHEMICAL AND SOLID STATE LETTERS.

The Freiburg team compacts nanotubes with either gold or copper powder to make a pellet. The researchers then immerse the product in a solution of potassium hydroxide and run a current through it. By following this procedure, they can pack the pellets with up to 1.95 percent hydrogen by weight, says Nützenadel. He and his colleagues still aren't sure whether the hydrogen ends up inside the nanotubes, on their surfaces, or between them.

Researchers at the National Renewable Energy Laboratory in Golden, Colo., have employed pressurized gas to get hydrogen into nanotubes, but the hydrogen there represents only 0.01 percent of the weight. A practical fuel cell for a vehicle that runs on hydrogen would probably require nanotubes to reach a storage efficiency of about 6.5 percent, they say.

So far, the scientists have been able to use the electrochemical method only on single-walled nanotubes. Multiwalled nanotubes, consisting of many concentric graphite tubes, crumbled into a powder instead of forming a solid pellet. "I have the feeling that the storage capacity of multiwalled nanotubes could be excellent, but [we have] no results so far," Nützenadel says. "There are some tricks left we can try." —*C.W.*