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Ponds to oceans

By Mike Lafferty
THE COLUMBUS DISPATCH

As he leaned over the side of a bridge at O'Shaughnessy Reservoir, Cliff Yamamoto studied the domed contraption dangling 30 feet above the water.

Then he glanced at the screen of his laptop.

"It's a good strong signal," said Yamamoto, a radar expert with the Jet Propulsion Laboratory at the California Institute of Technology.

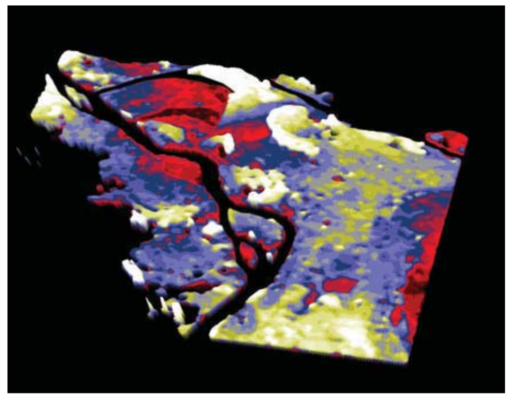
That's exactly what he and other scientists gathered round the laptop wanted from the radar antenna that bounces signals off the reservoir's surface.

The unit is a prototype for a more-advanced model that should probe Earth's water resources from space in a few years.

New satellite technology aims to measure water around the globe

Before the instrument is launched into space, scientists have to interpret the radar reflections in a variety of situations, from the windblown surface of the reservoir to the glassy stillness of an indoor swimming pool at Ohio State University.

Called KA band, the radar promises to collect data at least 1,000 times more detailed than

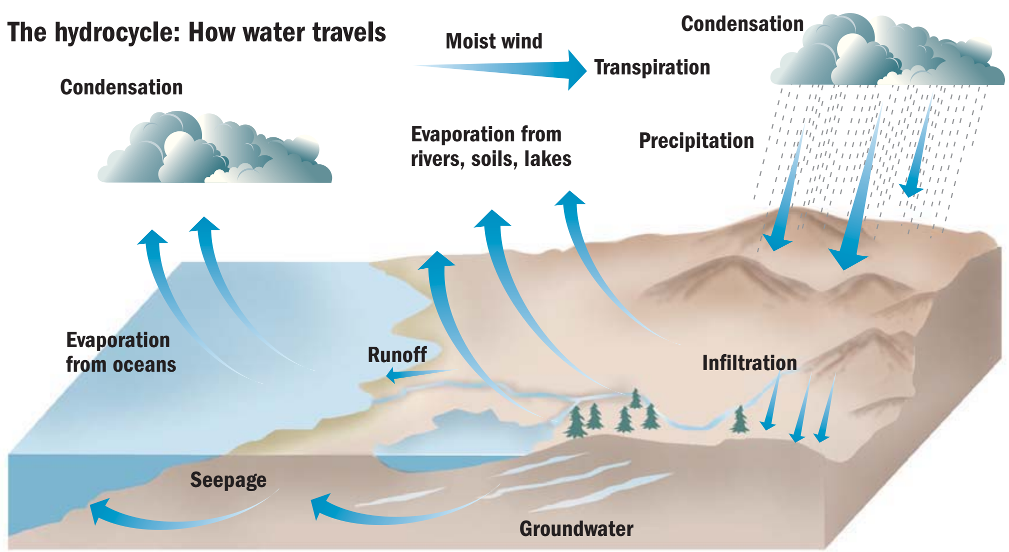


Keeping track of Earth's water

The total amount of water on Earth is pretty constant and, no matter its form, is part of the global water cycle. Understanding how evaporation from the land, oceans, lakes and rivers is linked to precipitation and how water flows through watersheds back to the oceans is important in estimating water for agriculture, weather forecasts and climate-change prediction.

For example, water flowing through a wetland such as the floodplain of the Amazon River is part of a complex puzzle of depth and current. The satellite image to the left shows how water depth in the system changes over time, with red being the slowest change and white the fastest.

The hydrocycle: How water travels



Source: Ohio State University

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that currently available. The information would boost understanding of how water moves among the atmosphere, streams, oceans and underground aquifers, a complex system known as the global water cycle. Understanding the nitty-gritty workings of the cycle is vital to make more-accurate global-warming models. The need is so great that the National Academy of Sciences has listed the radar mission as a NASA priority.

"Climate-change models are really good at temperature (prediction), but not so good at precipitation," said Ohio State geophysicist Doug Alsdorf, a lead investigator on the project.

Take Ohio summers, for example, which are forecast to have temperatures like Arkansas' in coming decades.

But how much will it rain or snow? And how deep will the Scioto River be at the Broad Street bridge? More important, public-water planners will need to know how much water they can depend on from rain and snowfall.

The answers depend not only on precipitation, but evaporation from the land and the seas as well.

Alsdorf also wonders how much water there really is on Earth.

Current estimates are iffy at best. The U.S. Geological Survey has calculated that there is about 321 million cubic miles of ocean water. And there is more in the form of fresh water.

The calculation is complicated because the planet is uneven.

Water in a street gutter might be 1 inch deep. Then there's the Marianas Trench in the Pacific Ocean, which falls 36,000 feet. In between, there are seas, gulfs, bays, lakes, rivers and creeks, not to mention water in the atmosphere.

Understanding the hydrologic cycle is vital because past swings in global-warming gases have fueled temperature swings that have altered water availability.

During the last ice age, about 50,000 years ago, glaciers covered nearly one-third of Earth and oceans were about 400 feet lower than today, according to the Geological Survey.

During the last big warm spell, about 125,000 years ago, oceans were about 18 feet higher. About 3 million years ago, they were 165 feet higher.

Before the scientific work, Cliff Yamamoto, an engineer with the Jet Propulsion Laboratory in California, must do the physical work.

Knowing how much water flows through a watershed also is important. Estimates from current models are way off, even in the United States, where there are 7,000 stream gauges.

In a remote region such as the Congo River basin in Africa, where there are three stream gauges, the ability to estimate water flow is nearly impossible.

Satellite science surveillance is routine these days, using techniques honed in Earth's orbit and now used to survey Mars and other planets.

Satellites help predict weather, make maps, chart ocean currents, track the demise of Arctic sea ice, estimate the extent of forests, deserts and rangeland, and gauge mineral resources.

A pair of satellites called GRACE, which measure minute changes in gravity, detected fluxes in Earth's mantle after the massive earthquake and tsunami that hit Sumatra in 2004.

More than 40 Earth-scanning satellites are in orbit.

"Remote sensing is available to all. Morocco is launching a satellite. Nigeria is about to launch an Earth satellite," said Gilbert Rochon, chief scientist for the Rosen

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The radar dome hanging over the Scioto River from the Home Road bridge in Delaware County is a prototype, using the KA band, for a future space mission.

SATELLITE

Center for Advanced Computing at Purdue University in Indiana.

An additional three dozen Earth-tracking satellites, including the OSU-JPL radar mission, are planned.

In space, the KA band satellite will be mounted on two radar units suspended at either end of a 33-foot boom. They would bounce 200 pulses each millisecond off the Earth.

Operating in tandem, the radars would create what is known as parallax, a critical feature to measure elevation.

"They can do very precise stereo mapping," said Victor Klemas, a marine scientist at the University of Delaware and co-director of the school's Center for Remote Sensing.

Doug Alsdorf of Ohio State

The radar would measure the altitude of water surfaces to within an inch. Because the satellite passes over the same spot every eight days, changes can be measured.

Scientists will be able to use the data to estimate water depth, especially for lakes, rivers and wetlands in Africa and other remote parts of the world where data is scarce.

Measuring the height of the water surface also allows scientists to calculate the fall of a streambed, which helps calculate water flow.

Alsdorf is an old hand at teasing such knowledge from satellite data. In 2005, he and fellow OSU researcher Michael Bevis used satellite scans to estimate that the annual flooding of the Amazon River depressed the planet's crust beneath the floodplain by about 3 inches.

Depressing the river bed affects the flow of the world's largest river. Most scientists think the Amazon carries 10 times the flow of the Mississippi, but, of course, that's only an estimate.

"The old joke is, we know the discharge of the Amazon, give or take the Mississippi," Alsdorf said.

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Radar engineers Delwyn Moller, left, and Cliff Yamamoto monitor radar readings on the water at O'Shaughnessy Reservoir on a laptop computer. The research is testing the technology before it is launched into space to monitor all of Earth's water resources.