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'Amazing' tool tracks earth's tiny changes

Twin satellites help in study of ice melts, earthquakes

By Carrie Peyton Dahlberg - Bee Staff Writer
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Linked by a constant stream of microwave signals, a pair of satellites have been taking Earth's measure in a way the planet has never been measured before.

By tracking tiny changes in gravitational pull, the system known as the Gravity Recovery and Climate Experiment, or GRACE, has been refining our understanding of polar ice melts and massive earthquakes.

Now, researchers are also improving the system's ability to monitor the way groundwater moves around the globe, so it can spot places where thirsty populations are draining aquifers faster than they can be replenished.

In addition, "we are starting to look very carefully at California," to see what the new technology might reveal about Sierra snowpack, said Jay Famiglietti, an earth system science professor at the University of California, Irvine. Later, he plans to turn his focus to the state's groundwater.

Famiglietti is one of many GRACE fans -- few can resist tossing around the word "amazing" to describe it -- who are gathering this week at the American Geophysical Union fall meeting in San Francisco to talk about what the system can accomplish.

"We have a new tool that can get at this completely hidden thing in the earth, and the sky's the limit in terms of applications," said Michael Watkins, project scientist for the system at NASA's Jet Propulsion Laboratory in Pasadena.

Launched in 2002, what GRACE tracks best is change -- the way the Earth's gravitational pull in the exact same spot varies from month to month.

Water is the biggest factor that changes in such a short time frame, once analysts eliminate little distractions like the weather (a high pressure system will yank at a GRACE satellite a bit more than a low pressure one).

"Water weighs a lot. As water slogs around the Earth, we track it in any form. Water in the form of ice, in the ocean, in the ground," Watkins said.

Even before the satellites went up, Watkins and others anticipated GRACE would be able to measure how quickly polar ice is melting. It came through, producing data earlier this year on the dwindling of Antarctic ice and faster-than-expected losses in Greenland.

Several researchers are looking to GRACE as a way to monitor the effects of climate change, detecting changes in sea level that could affect how ocean currents move warm water around the globe.

Such insights are possible because gravity -- a force that in daily life seems pretty uniform -- actually varies from place to place. It's affected by changes in water movement, denser or lighter

structures in the Earth's mantle, denser or lighter formations above ground, such as mountain ranges, and even the way the Earth flattens at the poles, putting everything there just a bit closer to the core. (If you want to lose weight, says Watkins, go to the equator. You'll drop a tiny fraction of an ounce.)

In theory, one satellite alone would have been enough to measure those varying pulls from orbit. GRACE uses two because it was easier and cheaper to have each satellite monitor the other than to set up a huge network of ground tracking stations.

For groundwater movements, the system today works best on vast basins covering 80,000 or more square miles. But Famiglietti and colleague Matt Rodell of NASA are combining it with other water models to sharply narrow its focus, perhaps down to levels useful to local water managers.

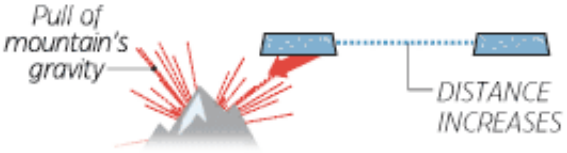
That would be critical, said California's chief hydrologist Maury Roos, because people want to know what's going on in individual watersheds.

And while GRACE doesn't have the precision to replace river gauges or snowpack testing, the big-picture data it produces should help water watchers refine their existing models, said JPL's Watkins.

Any little bit could help.

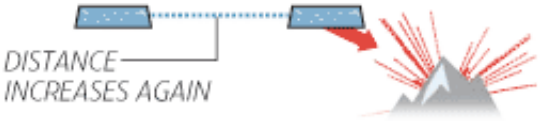
"We've got some holes up in the high Sierras," state hydrologist Roos said, where snowpack measurements can't be taken because of wilderness rules or other restrictions.

How GRACE works



1. Anything below the satellites' path with more mass – such as a mountain – tugs the lead satellite toward it, making it move a little faster. The space between the two satellites increases.

2. As the second satellite moves over the same area, the space between the two equalizes because both now are feeling about the same tug from below.



3. As the first satellite moves on, the second satellite is still being influenced by the large mass. It slows down slightly and increases the space between the two satellites.

What GRACE can measure (partial list)

- Changing mass of polar ice caps
- Groundwater fluctuations
- Shallow and deep ocean currents

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