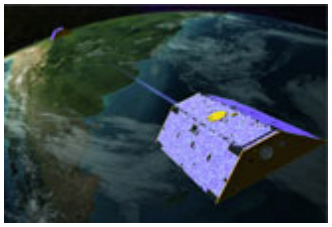

Gravity's Rainbow: GRACE Mission Pushes Forward

By Tariq Malik
Staff Writer
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Researchers have patched together a revolving map of Earth's gravity -- the most accurate ever made -- using a dynamic duo of satellites drifting around the planet.

The map, a colorful tapestry of space-based cartography, establishes the variations in Earth's gravitational field depending on location. It's the first of many gravity maps to be generated by the twin satellites of GRACE, the Gravity Recovery and Climate Experiment, underway by NASA and the German Aerospace Center.

Oceanographers can use the new gravity map and its successors to better understand ocean circulation, global weather and climate. Future GRACE studies could also help third world nations track the water supply of subterranean aquifers when modern well-monitoring devices are unavailable, researchers said.

"This instrument is really a paradigm shift in the way we do gravity measurements," said Byron Tapley, principal investigator for GRACE, in a telephone interview. Tapley is also the director of the Center for Space Research at the University of Texas. "Usually, you'd think if you measure gravity once, then you're done. For the first time, we start to think of it as an ongoing, changing thing."

GRACE

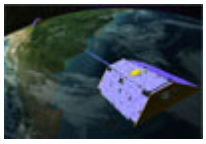
The amount of gravity tugging down at any point of the Earth is proportional the amount of mass sitting at that point. The more mass an area has, the stronger the gravitational force appears there. Such gravitational variations, however, are imperceptibly small.

For example, while American's living in the northeastern United States didn't feel any heavier during the heavy snow storms of this past winter, the weight of all that snow increased the local gravity. But just by a bit.

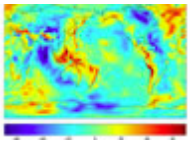
"You wouldn't feel it at all," Tapley said. "But this is precisely the type of variation GRACE will see."

A comprehensive map of the Earth's gravitational field can give scientists a better picture of the

Images



An artist's representation of how the two GRACE satellites appear in orbit around Earth.



A world map of gravity generated by the GRACE, Gravity Recovery and Climate Explorer, mission. Regions with lower than normal gravity appear blue, while those with higher than average appear red. Click to enlarge.

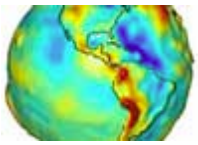
planet's surface as it would be if defined solely by gravity. The oceans, for example, would lie perfectly still on this bumpy imaginary Earth model - called a geoid - perfectly if currents, tides, winds and the Sun were absent.

The GRACE satellites measure gravitational fluctuations by flying in a caravan formation, one after the other, and constantly tracking the distance between them with microwave range finders. As the lead satellite passes over an area of greater gravity, it feels and reacts to the pull before the trailing craft. The satellites fly about 137 miles (220 kilometers) apart, with the ranging finding system between them accurate down to a micron, or smaller than the average red blood cell.

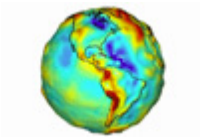
"We've been able to make a significant improvement on the gravity studies conducted over the last 30 years," said Michael Watkins, GRACE project scientist at NASA's Jet Propulsion Laboratory in Pasadena, California. "And we haven't even pulled out all the stops."

Watkins told *SPACE.com* that the new map is at least 10 times better than any other gravity study to date, and some measurements are up to 100 times more accurate depending on the size of the gravity feature targeted.

The gravity map is also just an early version of the type of data GRACE will be capable of, he added. Over the next few months, improvements in software and data management should make GRACE's gravity maps even more precise.



A globe version of the GRACE gravity map. While some bumpy hills and valleys correspond to physical land formations such as trenches or mountains, other don't. They may be due to flucuations in sub-surface densities leading to a higher than normal local gravity (red) or lower than average (blue). Click to enlarge.



WARNING: LARGE ANIMATED IMAGE This animated GIF shows the GRACE maps the Earth's gravity.

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A continuous watch on gravity

GRACE researchers plan to generate a new gravity map about every 30 days, the length of time it takes for the satellite pair to pass over each point on Earth once, and about 60 maps total over the mission's initial five-year timeframe. By building a monthly picture of the Earth's gravitational field, researchers hope to precisely determine the planet's average tug of gravity and track variations due to changes in weather or climate.

The consistent observations should also allow scientists to eliminate the effect of gravity on water cycle studies of the oceans such as the NASA's Topex/Poseidon and Jason projects run out of JPL. Both projects measure the height of the sea surface, as well as ocean heat storage and global ocean circulation.

"Basically this is just a new kind of remote sensing tool," Watkins said of the GRACE satellites. "But it's kind of amazing, knowing that we're able to take these measurements of such small differences."

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