Source: Ohio State University

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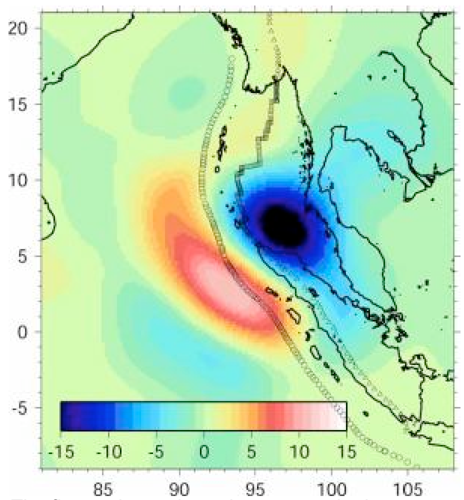
Satellite Data Reveals Gravity Change From Sumatran Earthquake

For the first time, scientists have been able to use satellite data to detect the changes in the earth's surface caused by a massive earthquake.

The discovery, reported in the latest issue of the journal Science, signifies a new use for the data from NASA's two GRACE satellites and offers a possible new approach to understanding how earthquakes work.



The figure above shows is a composite image from GRACE satellite data showing the gravity changes for the Sumatra-Andaman earthquake. (Image courtesy of Shin-Chan Han, Ohio State University)

The research paints a clearer picture of how the earth changed after the December, 2004 Sumatra-Andaman earthquake, the 9.1-magnitude temblor in the Indian Ocean which caused a deadly tsunami killing nearly 230,000 and displacing more than 1 million people.

Centered off the west coast of northern Sumatra, the event followed the slipping of two continental plates along a massive fault under the sea floor. The slippage occurred along 750 miles of the line where the Indian plate slides under the Burma plate, a process called subduction. The quake raised the seafloor in the region by several meters for thousands of square miles.

“The earthquake changed the gravity in that part of the world in two ways that we were able to detect,” explained Shin-Chan Han, a research scientist in the School of Earth Sciences at Ohio State .

First, he said, the quake triggered the massive uplift of the seafloor, changing the geometry of the region and altering previous GPS (global positioning satellite) measurements from the area. Those changes were detectable by GRACE's instruments.

And second, the density of the rock beneath the seafloor was changed after the slippage, and an increase or decrease in density produces a detectable gravity change, Han said.

The GRACE (Gravity Recovery and Climate Experiment) satellites were launched in 2002 and have been gathering global gravity measurements ever since. The identical instruments orbit some 186 to 310 miles (300 to 500 kilometers) above the planet's surface and fly 136 miles (220 kilometers) apart.

The satellites can detect changes in the density of the earth's crust, or in GPS measurements on the ground, and that can now signal changes in the planet's

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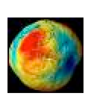

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gravity at that point.

Along with colleagues C.K. Shum and Michael Bevis, both professors in the School of Earth Sciences, Han assembled several years of data covering the Indian Ocean region and filtered out seasonal variations. The changing flow of the massive Mekong River, for example, affects gravity measurements for the area and these annual shifts must be removed from the data to detect changes caused by a quake.

The researchers then plugged the data into the latest seismic computer model which painted a picture of gravity increases on one side of the fault line and decreases on the other.

“With this seismic model we were able to explain and interpret the GRACE observations,” Han said, adding that earthquake models are still evolving. “But the observations can also be used to validate the quality of the model itself and therefore improve our knowledge about the solid earth's dynamics.”

The detection of such quakes comes only after extensive data analysis. Real-time detection is far off in the future – if possible at all. And currently, this GRACE technique was applied to understand the mechanism of “great” earthquakes – those exceeding magnitude 9 – which are very rare events.

Detecting “major” quakes – those measuring a magnitude of 7 to 8.9 – which occur frequently is being investigated. NASA's planned extension of the current mission, dubbed GRACE 2, and its enhanced instrumentation should aid in that effort.

However, Han is hopeful that NASA's planned expansion of the current mission, dubbed GRACE 2, and its enhanced instrumentation, might allow the detection of “major” quakes – those measuring a magnitude 7 to 8.9 – which occur frequently.

Chung-Yen Kuo, a post-doctoral researcher in the School of Earth Sciences at Ohio State , and Chen Ji, an assistant professor of earth science at the University of California, Santa Barbara , both participated in the study. Support for this research came from the National Aeronautics Space Administration, the National Science Foundation and the Ohio Supercomputer Center.

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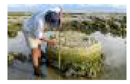

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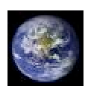

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