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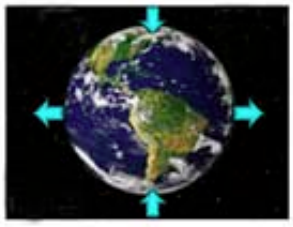
Satellites Reveal Mystery of Large Change in Earth's Gravity Field
August 5, 2002



Earth gravity field since 1997

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Satellite data collected since 1998 from the U.S./French ocean-observing satellite Topex/Poseidon, managed by NASA's Jet Propulsion Laboratory, Pasadena, Calif., indicate the bulge in Earth's gravity field at the equator is growing, and scientists think that the ocean may hold the answer to the mystery of how the changes in the trend of Earth's gravity are occurring.

Before 1998, Earth's equatorial bulge in the gravity field was getting smaller because of post-glacial rebound that occurred as a result of the melting of the ice sheets after the last Ice Age. When the ice sheets melted, land that was underneath the ice started rising. As the ground rebounded in this fashion, the gravity field changed.

"The Earth behaved much like putting your finger into a sponge ball and watching it slowly bounce back," said Christopher Cox, a research scientist supporting the Space Geodesy Branch at NASA's Goddard Space Flight Center, Greenbelt, Md.

Currently, Earth has a significant upward bulge at the equator, and a downward bulge at the poles. "Observations of the Earth's gravity field show that some phenomena are counteracting the gravitational effects of post-glacial rebound. Whereas the rebound has been decreasing the bulge in the Earth's gravity field at the equator, this recent phenomena is causing the bulge to increase," Cox said. Such changes in the gravity field can be sensed using ultra precise laser tracking of satellites to observe tiny changes in the orbits of those satellites and by tracking changes in the length of day or rotation of the Earth.

Scientists believe movements of mass cause this recent change from the high latitudes to the equator. Such large changes may be caused by climate change, but could also be part of normal long-period climatic variation. "The three areas that can trigger large changes in the Earth's gravitational field are oceans, polar and glacial ice, and atmosphere," Cox said.

Cox and colleague Dr. Benjamin Chao, also of Goddard, have ruled out the atmosphere as the cause. Instead, they suggest a significant amount of ice or water must be moving from high latitude regions to the

equator, and oceans could be the vehicles of this movement.

Estimates of today's glacier and polar ice melting are too small to explain the recent changes in the gravity field. If melting ice were the cause of the recent changes in the gravitational field, it would require melting a block of ice 10 kilometers (6.2 miles) on each side by 5 kilometers (3.1 miles) high every year since 1997 and pouring it into the oceans.

"The recent reports of large icebergs calving in Antarctica can't explain this, because they were already floating in the ocean," Cox said. Further, radar altimeter observations of the average sea level rise provided by Topex/Poseidon show no corresponding change in the rate of the global sea level increase.

Consequently, mass must have been redistributed within the oceans. That's where the ocean circulation theory comes in. Ocean currents can redistribute mass quickly, such as the 5-year time frame that these changes were first observed. The Topex/Poseidon observations of sea level height do show an increase in the equatorial bulge of the oceans corresponding to the observed gravity changes, but the data are not yet conclusive. One critical factor is the temperature of the world's oceans, and its salinity, for which detailed data are not yet available.

In 2002, NASA launched the JPL-managed Grace and Jason Missions, which will help to more precisely track and explain these sorts of changes in the Earth, and will launch the Icesat mission this winter. Aquarius, a JPL-managed mission that is part of NASA's Earth System Science Pathfinder small-satellite program and is proposed for launch in 2007, will provide the first-ever global maps of salt concentration in the ocean surface needed to understand heat transport and storage in the ocean.

An article on this NASA-funded study appears in the August 2 issue of the journal Science.

For more information and images on Topex/Poseidon and Jason, please see:

http://sealevel.jpl.nasa.gov/mission/mission.html.

More information on Grace may be found at:

http://www.jpl.nasa.gov/missions/current/grace.html.

JPL is a division of the California Institute of Technology in Pasadena.

Contacts: JPL/Alan Buis (818) 354-0474
Goddard Space Flight Center/Robert J. Gutro (301) 286-4044
NASA Headquarters/David E. Steitz (202) 358-1730

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