A mysterious shift in Earth's gravity

Earth's field is getting flatter, and scientists don't know why

Since 1997, Earth's gravitational field has been flattening out at the poles and bulging out at the equator, as indicated by the arrows in this picture.

By Robert Roy Britt
SPACE.COM

Aug. 1 — Something strange has been going on under our feet for the past four years. Earth's gravity field suddenly shifted gears and began getting flatter, reversing a course of centuries during which the planet and its gravity field grew rounder each year.

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THE SCIENTISTS who noticed the change and report it in Friday's issue of the journal Science suspect Earth itself may be flattening out, with the oceans rising near the equator, but they aren't sure.

What they do know is that Earth has never been round. It has always bulged at the equator and is about 0.3 percent fatter there, partly a result of the planet's rotation.

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GETTING ROUNDER

Yet ever since the last Ice Age, the planet has been getting rounder as ground beneath the polar regions, relieved of the weight from ice that was miles thick in places, has been rebounding. In some parts of Scandinavia and Canada, the ground rises a quarter-inch (a centimeter) per year.

Since the late 1970s, satellite measurements have shown that this post-glacial rebound, as it is called, generates a corresponding rounding of Earth's gravity field.

Suddenly the trend has reversed.

"Sometime around 1998, something began to make the Earth's gravity field flatter," says Christopher Cox of Raytheon Information Technology and Scientific Services. "The result is it looks as if post-glacial rebound has reversed itself. But we do not have any reason to think that post-glacial rebound has in any way stopped or changed."

In effect, Cox said in an interview, while post-glacial rebound continues to make the Earth rounder, some movement of mass on the surface of Earth must be making the gravity field flatter. It's not a change anyone could notice; it's only revealed by sensitive satellite measurements.

The shift, however, is significant.

"The effect is twice as large as post-glacial rebound in terms of effect on the gravity field, and it's in the opposite direction," Cox said. "Whatever it is, it's big."

LIKE A RUBBER BALL

Cox, who also works at NASA's Goddard Space Flight Center, described post-glacial rebound as similar to pushing a rubber ball in at the top and bottom with your fingers. "The sides come out, and the top and bottom go in. Take your fingers off that rubber ball, and the sides are going to go in and the top is going to come out again."

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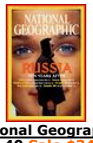
What does this have to do with Earth?

"You have material moving inside," Cox explained. The rubber is compressed, but air is also pushed around. Some of the post-glacial rebound is caused by the ground simply decompressing. But scientists have long known that to account for what they've measured, Earth's physical shape must change. Material — ground, water or air — must be moved around. Though the planet's shape and its gravity field are not directly correlated, they are related.



Cox and his colleague, Benjamin Chao of Goddard, were at first baffled by the sudden reversal and flattening of the gravity field. They considered that ice melting at the poles and raising the overall sea level could be the culprit. Calculations showed, however, that "you would have to drop a 10-by-10-by-5-kilometer cube of it into the ocean every year for the past five years." Separate measurements of sea surface height from NASA's TOPEX/Poseidon mission don't support this scenario.

Material in Earth's crust can't be responsible — it couldn't move so quickly from the poles to the equator. Molten rock oozing around in Earth's core might be to blame, but data do not support such a scenario. Changes in the atmosphere might be involved, but no data supports that being the primary cause, either.

SO WHAT IS IT?

Instead, Cox said, long-term circulation patterns in the ocean seem to be the most likely cause.

Shifts in huge ocean currents — similar to El Niño but on larger scales and moving in a north-south direction — might transport enough water toward the equator to account for the flattened gravity field. One such cycle is called the Pacific Decadal Oscillation.

"We have a strong suspicion that it's in the ocean," Cox said.

"Whatever the cause, the results of Cox and Chao emphasize the importance of gravity variations as a barometer of integrated mass changes in the Earth system," write scientists Anny Cazenave and R. Steven Nerem in an analysis of the research for Science. "Monitoring these variations with improved spatial and temporal resolution would provide an important tool for studying Earth system changes."

Since Cox and Chao submitted their paper to the journal, they've continued to look into the mystery and are more confident that the ocean is behind it all. "But we need more data," Cox said.

That data could come from NASA's GRACE (Gravity Recovery and Climate Experiment) satellite mission, which will provide the most precise measurements ever made of Earth's gravity field. GRACE launched in March.

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