March 19, 2002

New Satellites to Map Gravity More Precisely

By WARREN E. LEARY

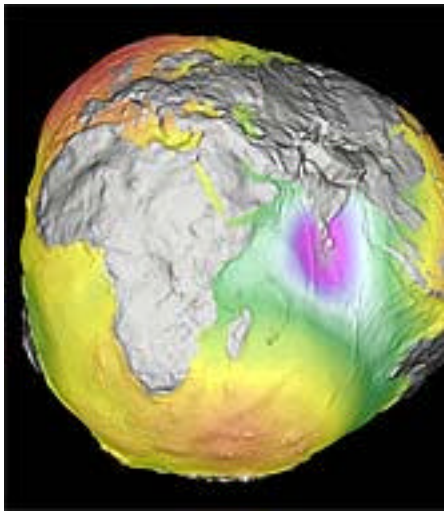
WASHINGTON, March 18 — No one thinks that much about gravity, one of the most powerful, yet subtle, forces on the earth. It is just there, seemingly never changing, holding feet to the ground.

Now scientists say it is time for a new look at gravity. Minute variations around the globe, they say, can tell us about the earth and what's going on beneath the surface of the land and the oceans, where dynamic processes are constantly moving around masses of material.

To get the most detailed measurements ever taken of these changes, scientists have launched the Gravity Recovery and Climate Experiment, or Grace.

The project, sponsored by the National Aeronautics and Space Administration and the German Aerospace Center (or DLR), consists of a pair of satellites nicknamed Tom and Jerry, which will follow and monitor each other in space and, in the process, produce a gravity map of the planet 100 times as accurate and detailed as any done before.

"The Grace measurements are going to revolutionize our understanding of the earth's structure, the oceans and the changes going on underneath," said Dr. Michael Watkins, project scientist at NASA's Jet Propulsion Laboratory. "Measuring gravitational variations gives us a window for watching the



Data from the satellites will be used to m more detailed versions of the rendering, above, showing gravity's variations.

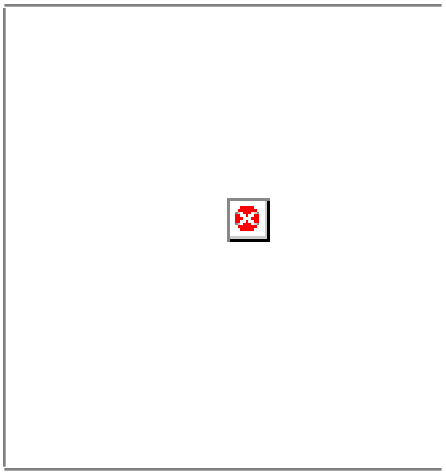
MULTIMEDIA
Graphic: Twins in Orbit

transport of masses around the planet, changes that can affect climate and many other things."

Gravity measurements can be used to track the movement and changing density of ice at the poles, the transport of huge volumes of water in deep undersea currents, the movement of water in and out of underground aquifers and even the slow shift of magma in volcanically active regions, Dr. Watkins said. As scientists refine the Grace data, they hope to measure snowfall and how much water it contains.

The satellites were launched on Sunday from the Plesetsk Cosmodrome in Russia using a single rocket supplied by Eurockot Launch Services, a German-Russian commercial launching company.

Both 950-pound satellites are to fly in the same 311-mile-high circular orbit that crosses the poles of the planet, as it turns beneath them during their 16 orbits each day. More important, one satellite is to trail the other by 137 miles, each using microwave range finders to measure the precise distance between the two, which is the key to the experiment.



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Two satellites, nicknamed Tom and Jerry have been launched to detect minute chan in earth's gravity.

Sir Isaac Newton formulated the basic law of gravity in the 17th century. All objects, he said attract one another with a force that is proportional to their masses and that is dependent up the distances between them. Although the force of gravity is relatively constant everywhere earth, small variations exist because the planet is not a homogeneous structure with equally distributed mass. The planet is lumpy, with materials of different densities scattered above a below the surfaces of land and water.

"Gravity varies," said Dr. Byron D. Tapley, director of the Center for Space Research at the University of Texas and the principal investigator in charge of Grace. "Gravity is less on a mountaintop than at the seashore."

Previous gravity maps of earth have been created by using gravitational fluctuations that affe a single satellite, or by combining ground- tracking data on the orbits of several spacecraft. B these imprecise snapshots of the planet's gravity are no longer adequate, scientists say.

"Before, scientists wanted to measure gravity one time, and be done with it," Dr. Tapley sai "Now we realize that gravity is not constant and is continually changing."

Grace is to produce a gravity map of earth's entire surface every 30 days; during its five-yea service, it should produce 60 maps, showing subtle changes over time. "It's this temporal element that will make the data so valuable," Dr. Tapley said.

The Grace measurements should be very exacting because each satellite should track the othe with extreme precision. The trapezoidal- shaped spacecraft are equipped with Global Positioning System receivers that use information from the navigational tool to pinpoint its position relative to the other and to the ground. The satellites also contain highly sensitive sensors, called accelerometers. These detect changes in motion caused by atmospheric drag o

even by sunlight hitting its solar power panels, thus allowing scientists to cancel the effects o these forces as they make their measurements.

The satellites' microwave range finders will constantly measure the distance between them to sense any change in separation greater than one micron — about one-fiftieth the width of a human hair.

"This is like measuring the precise distance between a car in Los Angeles and one in San Dieg to within the thickness of a particle of smoke," Dr. Watkins said.

Variations in distance caused by gravity difference on earth produce data points for the grav map.

As the satellites move in their orbit, the first one senses a mass change caused by a mountain glacier or swell of water in a deep ocean current. This mass pulls the first satellite a little tow it before it tugs the second spacecraft, slightly changing the separation between the two. Aft the first satellite passes an object below, it slows down slightly (because of the attraction), before the trailing spacecraft is similarly affected, again registering a slight change in distance between the two.

These fine pulls and tugs on the spacecraft slowly sketch out a map of the masses below.

Researchers said data from the $127 million mission — $97 million coming from NASA and $30 million, including launching costs, from Germany — would initially benefit ocean and climate research. Information from other spacecraft using radar or laser scanning to measure s height, like the Topex/Poseidon satellite, can be combined with the gravity data to obtain bet estimates of sea-surface temperatures that affect weather.

For instance, if researchers notice a rise in water levels in the Pacific Ocean, it can be from he expanding the water, a sign of future El Niño conditions. The water level rise, however, may also be because of winds deforming the ocean surface and pushing up a mass of water, a condition that Grace could spot. This additional data, therefore, can help improve the accura of weather and climate forecasting, scientists said.

Tracing the gravity signature of moving masses can also help monitor the movement and changing size of polar ice, which is affected by global warming.

"You can determine, for example, if the sea level is rising because there is actually more wate melting into it or if the water is expanding simply due to heating," Dr. Watkins said.

Subtle gravity differences can also provide information about the structure of earth's interior, including the tectonic processes that continue to reshape the surface and move continents.

Previous orbital studies have revealed an area of lower-than-normal gravity off the coasts of India, as well as a gravity-high area in the South Pacific, both possibly due to the structure o mantle material beneath the crust.