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GRACE: Giant Water Scale in the Sky

On October 26, 2012, Dr. Jay Famiglietti delivered an eye-opening presentation about the challenges that we face concerning water resources. An essential tool in his research is a cutting-edge satellite system that Dr. Famiglietti described as "a giant water scale in the sky". This system is part of the Gravity Recovery and Climate Experiment (GRACE), and its bold mission is to track the impact of climate change on the planet's vast tracts of freshwater, saltwater, and ice. So how does a pair of satellites orbiting earth in space track changes in the amount of water on and below the earth's surface?

The answer lies in the principle of Gravity:

Water is heavy! Large amounts of water can affect earth's gravity field. GRACE has two satellites following the same orbit around earth. They are each the size of a large SUV or van, and orbit the earth one behind the other in an orbital plane at a distance of 137 miles. As they pass over large features on the Earth's surface (like a large body of water) the gravitational field of the feature causes the first satellite to accelerate, *temporarily* expanding the distance between itself and the second satellite. A laser beam between the two satellites records tiny changes in the distance between the satellites. Thus, a measurement of the feature's gravitational pull (or "anomaly") is recorded. The second satellite ultimately "catches up" to the first satellite as it accelerates over the same feature of the earth.

Not only does this system record a measure of a water body's magnitude through its gravitational pull, GRACE satellites can estimate ***changes*** in the mass of a water body over time by taking multiple measurements over a period of several months that scientists can compare. This aspect of the system is essential to estimating the changes in volume our water resources take. It is important to note that the system cannot distinguish between different forms of water such as snow, soil moisture, ground water, and surface water. It can detect changes in overall mass of water bodies, and scientists on the ground can use data from other sources to estimate the volume of various water bodies to understand how different components of water stored on earth add up to a total amount within a given geographical area.

In essence, the satellites can be best thought of as a giant water scale in the sky; however it is used to precisely measure *changes* in overall water mass over a period of time. The system is used to estimate changes to relatively large geographical areas (approx. 150,000 km^2) so it is not used to detect small scale structures.

Sources and Links to Further Information:

- **Dr. Jay Famiglietti's Hot Science – Cool Talks Lecture: "Last Call at the Oasis: Will there be Enough Water for the 21st Century?" October 26, 2012, UT Austin (see minute mark 18:35):** http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/last-call-at-the-oasis-will-there-be-enough-water-for-the-21st-century
- Gravity Recovery and Climate Experiment (GRACE) Homepage: http://grace.jpl.nasa.gov/