NASA outlines recent changes in Earth's freshwater distribution

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Recent space observations of freshwater storage by the Gravity Recovery and Climate Experiment (GRACE) are providing a new picture of how Earth's most precious natural resource is distributed globally and how it is changing.

Researchers are using the mission's almost five-year data record to estimate seasonal water storage variations in more than 50 river basins that cover most of Earth's land area. The variations reflect changes in water stored in rivers, lakes and reservoirs; in floodplains as snow and ice; and underground in soils and aquifers.

"GRACE is providing a first-ever look at the distribution of freshwater storage on the continents," said Dr. Jay Famiglietti, professor of Earth System Science, University of California, Irvine. "With longer time series, we can distinguish long-term trends from natural seasonal variations and track how water availability responds to natural climate variations and climate change."

Several African basins, such as the Congo, Zambezi and Nile, show significant drying over the past five years. In the United States, the Mississippi and Colorado River basins show water storage increases during that time. Such information is vital for managing water resources in vulnerable parts of Africa and Southeast Asia, since increasing populations and standards of living place demands on water resources that are often unsustainable. The data can be used to make more informed regional water-management decisions.

The twin GRACE satellites monitor tiny month-to-month changes in Earth's gravity field that are primarily caused by the movement of water in Earth's land, ocean, ice and atmosphere reservoirs. Hydrologists are analyzing GRACE data to identify possible trends in precipitation changes, groundwater depletion and snow and glacier melt rates, and to understand their underlying causes.

Dr. Matt Rodell, a hydrologist at NASA's Goddard Space Flight Center, Greenbelt, Md., said the data correspond well with ground observations. As a result, hydrologists can now apply GRACE data in ways that will impact regional water management. "GRACE data improve our understanding of the water cycle and simulations of soil moisture, snow and groundwater in computer models," he said. "This is a key step toward better weather, stream flow, flood, drought and water resource forecasts worldwide."

Dr. Michael Watkins, GRACE project scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., said GRACE is the only element in NASA's broad water cycle research program that measures changes in all types of water storage. "GRACE detects water storage changes from Earth's surface to its deepest aquifers. Water can't hide from it," he said.

The mission's abilities to detect water are particularly vital for the emerging field of groundwater remote sensing. "Remote sensing of groundwater has been a Holy Grail for hydrologists because it is stored beneath the surface and is not detected by most sensors," said Famiglietti. "Outside of the United States and a few other developed nations, it is not well monitored.

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It's been speculated that many of Earth's key aquifers are being depleted due to over-exploitation, but a lack of data has hampered efforts to quantify how aquifer levels are changing and take the steps necessary to avoid depleting them. With additional data, such as measurements of surface water and soil moisture, we can use GRACE to solve this problem."

GRACE is also allowing scientists to estimate another key component of the water cycle for the first time: water discharged by freshwater streams from Earth's continents. Stream flow measurements are often not shared for economic, political or national defense reasons. GRACE measurements of the total water discharged by continental streams are important for monitoring the availability of freshwater and understanding how surface water runoff from continents contributes to rises in global sea level.

Scientists from NASA and the University of California, Irvine, are presenting their research today during the American Geophysical Union meeting in San Francisco.

GRACE is a partnership between NASA and the German Aerospace Center (DLR). The University of Texas Center for Space Research, Austin, has overall mission responsibility. JPL developed the two Grace satellites. DLR provided the launch, and the GeoForschungsZentrum Potsdam, Germany, operates the GRACE mission.

For more information about GRACE, see http://www.csr.utexas.edu/grace/. For more on NASA water and energy cycle research, visit http://watercycle.gsfc.nasa.gov/index.php. Additional information on NASA news from the American Geophysical Union conference is at http://www.nasa.gov/agu.

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