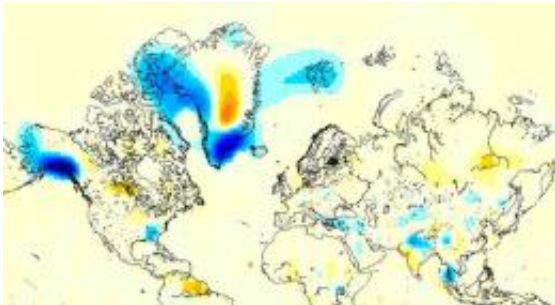


NASA uses new method to estimate earth mass movements

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Global present-day trends in the transport of water mass around Earth, as determined using data from GRACE, surface measurements and an ocean model. Darker areas represent greater loss of mass. Image credit: NASA-JPL/-Caltech

NASA and European researchers have conducted a novel study to simultaneously measure, for the first time, trends in how water is transported across Earth's surface and how the solid Earth responds to the retreat of glaciers following the last major Ice Age, including the shifting of Earth's center of mass.

To calculate the changes, scientists at NASA's Jet Propulsion Laboratory, Pasadena, Calif.; Delft University of Technology, Delft, Netherlands; and the Netherlands Institute for Space Research, Utrecht, Netherlands, combined gravity data from the NASA/German Aerospace Center Gravity Recovery and Climate Experiment satellites with direct

measurements of global surface movements from GPS and other sources and a JPL-developed model that estimates the [mass](#) of Earth's ocean above any point on the ocean floor. Results are reported in the September issue of Nature Geoscience.

Using the new methodology, the researchers, led by Xiaoping Wu of JPL, calculated new estimates of ice loss in Greenland and Antarctica that are significantly smaller than previous estimates. According to the team's estimates, mass losses between 2002 and 2008 measured 104 (plus or minus 23) gigatonnes a year in Greenland, 101 (plus or minus 23) gigatonnes a year in Alaska/Yukon, and 64 (plus or minus 32) gigatonnes a year in West Antarctica. A gigatonne is one billion metric tons, or more than 2.2 trillion pounds. The smaller but significant ice loss estimates reflect the revised role that post-glacial rebound was found to play in relation to current ice mass loss in Greenland and [Antarctica](#). Post-glacial rebound (known as glacial isostatic adjustment) is the response of the solid Earth to the retreat of glaciers following the last Ice Age. After the weight of ice from the land surface was removed, the land under the ice rose and continues to slowly rise.

In addition, the team found that the shift of water mass around the globe, combined with the post-glacial rebound of Earth's surface, is shifting Earth's surface relative to its center of mass by 0.88 millimeters (.035 inches) a year toward the North Pole. The estimate of the shift due to rebound--0.72 millimeters (.028 inches) per year--is believed to be the first estimate based on actual data, rather than a model prediction.

Wu said the shift of Earth's surface is due primarily to the melted Laurentide ice sheet, which blanketed most of Canada and a part of the northern United States around 21,000 years ago. "The new estimate of shift is much larger than previous model estimates of 0.48 millimeters [.019 inches] per year," said Wu. "This suggests that either Earth's lower mantle must be much more viscous than previously believed, or that the

history of Earth's deglaciation needs to be significantly revised."

Wu said previous GRACE-based estimates of the movement of mass at Earth's surface have been calculated by correcting the data using a post-glacial rebound model, while estimates of post-glacial rebound itself have been estimated using a hydrological model. These models are not as precise as the geodetic data, however, and contain unknown and potentially large errors that will throw off estimates of the other process.

GRACE project scientist Michael Watkins of JPL, who was not an author on the paper, said that although some of the new results, such as those for Greenland, are surprising, they are not due to a reanalysis of GRACE or GPS data alone. Rather, they are a result of the simultaneous use of GRACE, GPS and other geodetic measurements to help objectively sort out the relative sizes of post-glacial rebound and present-day [ice](#) mass loss. "Both the GPS and gravity measurements are accurate on their own, but untangling the relative contributions of the two processes as observed by satellites is difficult. This technique provides a first global attempt at doing that," Watkins said.

"The Earth system is so complex that measuring and understanding it requires scientists to combine observations from as many satellites and ground-based measurements as possible," Watkins added. "With each new study like this one, we learn more and more about how to conduct future studies and interpret their data. The more data, and different types of data we collect, the better we'll be able to answer fundamental questions about how our planet works."

Provided by JPL/NASA

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