Iceland rises as its glaciers melt from climate change

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This global positioning satellite receiver is part of Iceland's network of 62 such receivers that geoscientists are using to detect movements of the Icelandic crust that are as small as one millimeter per year. Langjökull glacier can be seen in the background. Credit: Richard A. Bennett/ University of Arizona

The Earth's crust under Iceland is rebounding as global warming melts the island's great ice caps, a University of Arizona-led team reports in an

upcoming issue of *Geophysical Research Letters*.

The paper is the first to show the current fast uplift of the Icelandic crust is a result of accelerated melting of the island's glaciers and coincides with the onset of warming that began about 30 years ago, the scientists said.

Some sites in south-central Iceland are moving upward as much as 1.4 inches (35 mm) per year - a speed that surprised the researchers.

"Our research makes the connection between recent accelerated uplift and the accelerated melting of the Icelandic ice caps," said first author Kathleen Compton, a UA geosciences doctoral candidate.

Geologists have long known that as glaciers melt and become lighter, the Earth rebounds as the weight of the ice decreases.

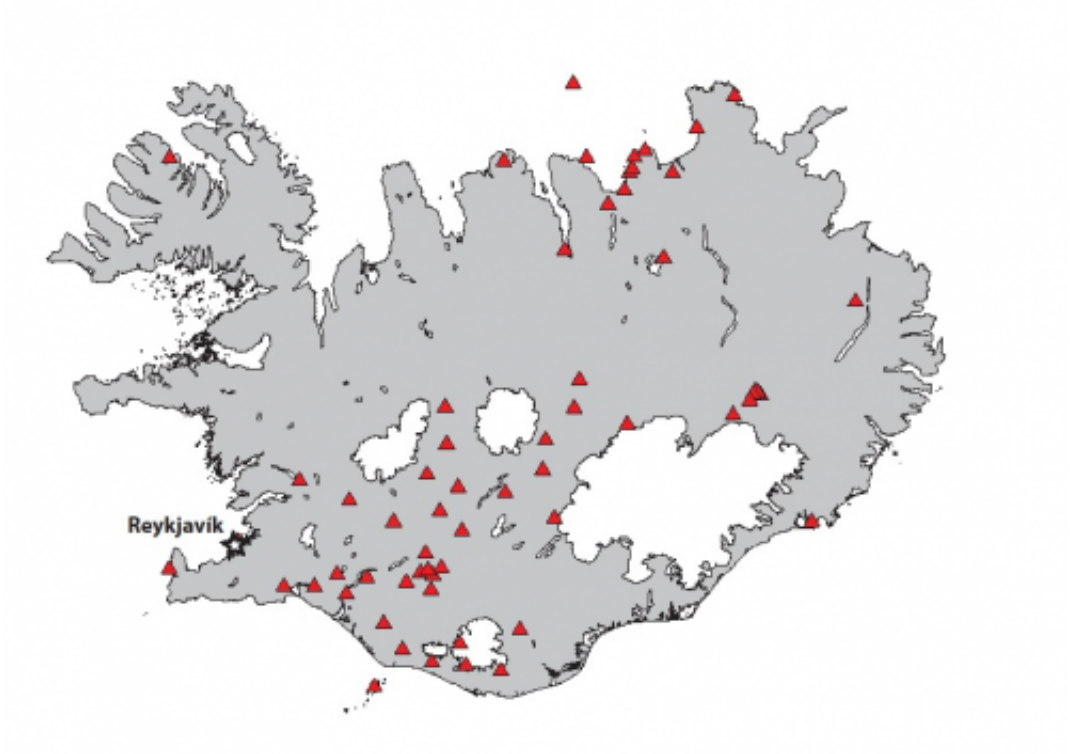
Whether the current rebound geologists detect is related to past deglaciation or modern ice loss has been an open question until now, said co-author Richard Bennett, a UA associate professor of geosciences.

"Iceland is the first place we can say accelerated uplift means accelerated ice mass loss," Bennett said.

To figure out how fast the crust was moving upward, the team used a network of 62 global positioning satellite receivers fastened to rocks throughout Iceland. By tracking the position of the GPS receivers year after year, the scientists "watch" the rocks move and can calculate how far they have traveled - a technique called geodesy.

The new work shows that, at least for Iceland, the land's current accelerating uplift is directly related to the thinning of glaciers and to global warming.

"What we're observing is a climatically induced change in the Earth's surface," Bennett said.



Iceland's glaciers (white) are melting faster and faster. As a result, the Icelandic crust near the glaciers is rebounding at an accelerated rate -- in some cases as much as 1.4 inches (35 mm) per year, found a University of Arizona-led team of geoscientists. The researchers used Iceland's geodesy network of sensitive GPS receivers (red triangles) to figure out how fast the land is rising. Credit: Kathleen Compton/University of Arizona

He added there is geological evidence that during the past deglaciation roughly 12,000 years ago, volcanic activity in some regions of Iceland increased thirtyfold.

Others have estimated the Icelandic crust's rebound from warming-

induced ice loss could increase the frequency of volcanic eruptions such as the 2010 eruption of Eyjafjallajökull, which had negative economic consequences worldwide.

The article "Climate driven vertical acceleration of Icelandic crust measured by CGPS geodesy" by Compton, Bennett and their co-author Sigrun Hreinsdóttir of GNS Science in Avalon, New Zealand, was accepted for publication Jan. 14, 2015, and is soon to be published online. The National Science Foundation and the Icelandic Center for Research funded the research.

Some of Iceland's GPS receivers have been in place since 1995. Bennett, Hreinsdóttir and colleagues had installed 20 GPS receivers in Iceland in 2006 and 2009, thus boosting the coverage of the nation's geodesy network. In central and southern Iceland, where five of the largest ice caps are located, the receivers are 18 miles (30 km) or less apart on average.

The team primarily used the geodesy network to track geological activity such as earthquakes and volcanic eruptions.

In 2013, Bennett noticed one of long-running stations in the center of the country was showing that site was rebounding at an accelerated rate. He wondered about it, so he and his colleagues checked the nearby stations to see if they had recorded the same changes.

"The striking answer was, yes, they all do," he said. "We wondered what in the world could be causing this?"

The team began systematically analyzing years of signals from the entire network and found the fastest uplift was the region between several large ice caps. The rate of uplift slowed the farther the receiver was from the ice cap region.

Other researchers had been measuring ice loss and observed a notable uptick in the rate of melting since 1995. Temperature records for Iceland, some of which go back to the 1800s, show temperatures increasing since 1980.

To determine whether the same rate of ice loss year after year could cause such an acceleration in uplift, Compton tested that idea using mathematical models. The answer was no: The glaciers had to be melting faster and faster every year to be causing more and more uplift.

Compton found the onset of rising temperatures and the loss of ice corresponded tightly with her estimates of when uplift began.

"I was surprised how well everything lined up," she said.

Bennett said, "There's no way to explain that accelerated uplift unless the glacier is disappearing at an accelerated rate."

Estimating ice loss is laborious and difficult, he said. "Our hope is we can use current GPS measurements of uplift to more easily quantify ice loss."

The team's next step is to analyze the uplift data to reveal the seasonal variation as the ice caps grow during the winter snow season and melt during the summer.

Provided by University of Arizona