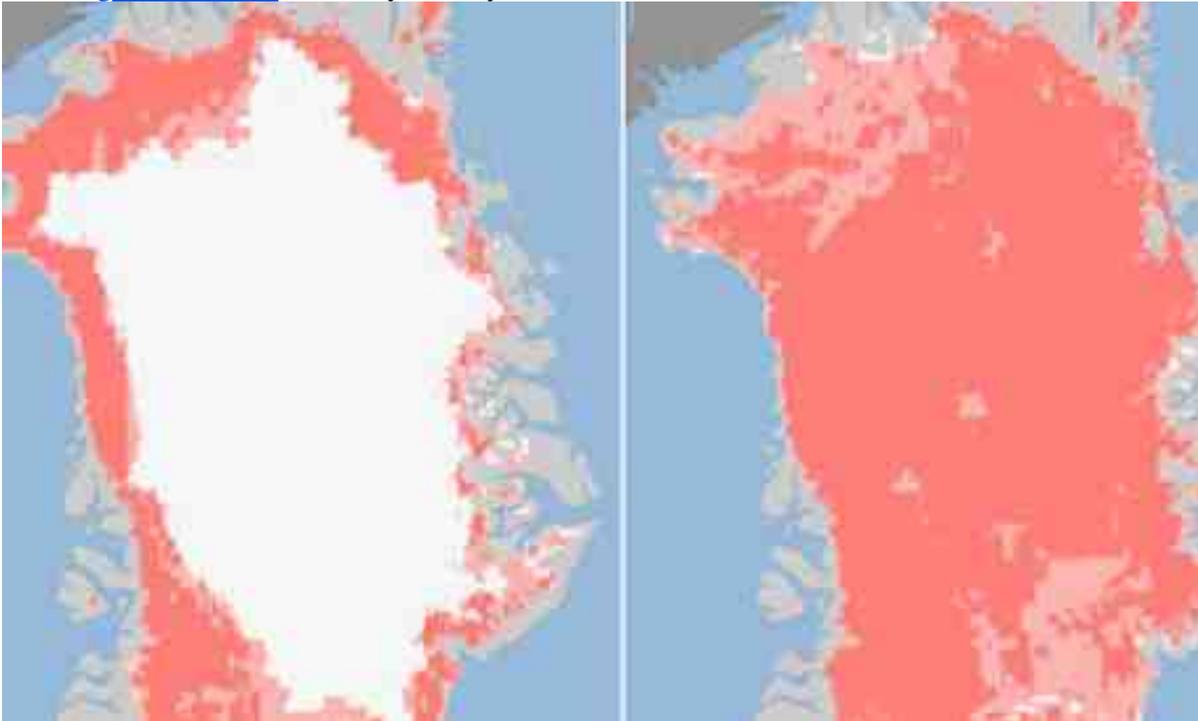


Greenland ice sheet melted at unprecedented rate during July

Scientists at Nasa admitted they thought satellite readings were a mistake after images showed 97% surface melt over four days

- [Suzanne Goldenberg](#) US environment correspondent
- [guardian.co.uk](#), Tuesday 24 July 2012 22.48 BST



The Greenland ice sheet on July 8, left, and four days later on the right. An estimated 97% of the ice sheet surface had thawed by July 12. Photograph: Nasa

The [Greenland](#) ice sheet melted at a faster rate this month than at any other time in recorded history, with virtually the entire ice sheet showing signs of thaw.

The rapid melting over just four days was captured by three satellites. It has stunned and alarmed scientists, and deepened fears about the pace and future consequences of [climate change](#).

In a statement posted on [Nasa's](#) website on Tuesday, [scientists admitted the satellite data was so striking](#) they thought at first there had to be a mistake.

"This was so extraordinary that at first I questioned the result: was this real or was it due to a data error?" Son Nghiem of Nasa's jet propulsion laboratory in Pasadena said in the release.

He consulted with several colleagues, who confirmed his findings. Dorothy Hall, who studies the surface temperature of Greenland at Nasa's space flight centre in Greenbelt, Maryland, confirmed that the area experienced unusually high temperatures in mid-July, and that there was widespread melting over the surface of the ice sheet.

Climatologists Thomas Mote, at the University of Georgia, and Marco Tedesco, of the City University of New York, also confirmed the melt recorded by the satellites.

However, scientists were still coming to grips with the shocking images on Tuesday. "I think it's fair to say that this is unprecedented," Jay Zwally, a glaciologist at Nasa's Goddard Space Flight Center, told the Guardian.

The set of images released by Nasa on Tuesday show a rapid thaw between 8 July and 12 July. Within that four-day period, measurements from three satellites showed a swift expansion of the area of melting ice, from about 40% of the ice sheet surface to 97%.

Zwally, who has made almost yearly trips to the Greenland ice sheet for more than three decades, said he had never seen such a rapid melt.

About half of Greenland's surface ice sheet melts during a typical summer, but Zwally said he and other scientists had been recording an acceleration of that melting process over the last few decades. This year his team had to rebuild their camp, at Swiss Station, when the snow and ice supports melted.

He said he was most surprised to see indications in the images of melting even around the area of Summit Station, which is about two miles above sea level.

It was the second unusual event in Greenland in a matter of days, after an iceberg the size of Manhattan broke off from the Petermann Glacier. But the rapid melt was viewed as more serious.

"If you look at the 8 July image that might be the maximum extent of warming you would see in the summer," Zwally noted. "There have been periods when melting might have occurred at higher elevations briefly – maybe for a day or so – but to have it cover the whole of Greenland like this is unknown, certainly in the time of satellite records."

Lora Koenig, another Goddard glaciologist, told Nasa similar rapid melting occurs about every 150 years. But she warned there were wide-ranging potential implications from this year's thaw.

"If we continue to observe melting events like this in upcoming years, it will be worrisome," she told Nasa.

The most immediate consequences are sea level rise and a further warming of the Arctic. In the centre of Greenland, the ice remains up to 3,000 metres deep. On the edges, however, the ice is much, much thinner and has been melting into the sea.

The melting ice sheet is a significant factor in sea level rise. Scientists attribute about one-fifth of the annual sea level rise, which is about 3mm every year, to the melting of the Greenland ice sheet.

In this instance of this month's extreme melting, Mote said there was evidence of a heat dome

over Greenland: or an unusually strong ridge of warm air.

The dome is believed to have moved over Greenland on 8 July, lingering until 16 July.

Greenland loses ice in fits and starts

- 19:00 02 August 2012 by [Michael Marshall](#)
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The surge of ice loss from Greenland between 2005 and 2010, which [drove up sea levels around the world](#), was not unprecedented. A similar spurt happened in the late 1980s, and possibly decades earlier as well.

While such surges will be tricky to predict, better models of the ice sheet mean that we can make more confident long-term predictions of its behaviour – predictions that suggest Greenland's effects on global sea levels may not be [as bad as feared](#).

In 2005, the Greenland ice sheet suddenly began [losing much more ice than before](#). As well as melting faster, [the ice was moving faster](#) and sliding rapidly into the ocean.

But we had no way of knowing whether this acceleration was a new phenomenon, says [David Vaughan](#) of the British Antarctic Survey in Cambridge. Detailed records of the ice sheet's behaviour began in 1992 with the launch of the [ERS-1 satellite](#). That means our records only cover 20 years.

Photographic evidence

[Kurt Kjær](#) of the University of Copenhagen in Denmark, and colleagues, have now pushed the record back to 1985. They used aerial photos of Greenland to construct a 3D model of the ice sheet, showing how it has changed.

While there is always some melting on the surface of the ice, Kjær also found that the ice sheet accelerated between 1985 and 1993. That resulted in an equally big loss of mass – 25 gigatonnes per year – as was seen between 2005 and 2010.

Kjær found that the sea around Greenland was unusually warm between 1985 and 1994, and between 2005 and 2010. That may be the cause of the surges: recent studies suggest that warm seas are the biggest threat to ice sheets.

There are aerial photos of Greenland going back to the 1930s. Kjær has already done preliminary analyses of some of them, which suggests that Greenland also lost a lot of ice in the 1930s. He says surges of ice loss may be a regular occurrence (*Nature Geoscience*, [DOI: 10.1038/ngeo1481](#)).

Warm seas, shrinking ice

The [Intergovernmental Panel on Climate Change](#) ignored the contributions of the Greenland and Antarctic ice sheets when it [predicted future sea-level rise in 2007](#), because [the physics were too poorly understood to model](#). The new data suggest that modelling the ice sheets' behaviour may be even more complicated.

The real problem is predicting when warm waters will swash around Greenland's coast, and exactly how that affects the ice, says [Stephen Price](#) of the Los Alamos National Laboratory in New Mexico.

"Ice sheets cannot be modelled in isolation, but must be embedded in the full climate system," agrees [Richard Alley](#) of Penn State University in University Park.

Ice flow

That said, models of the Greenland ice sheet itself are gaining in sophistication. [Fabien Gillet-Chaulet](#) of the Laboratory of Glaciology and Geophysics of the Environment in Grenoble, France and colleagues have applied one such model that, unlike previous models, is sufficiently high-resolution to model individual outlet glaciers. He has published a draft version in *The Cryosphere Discussions* ([DOI: 10.5194/tcd-6-2789-2012](#)).

There are other models, and Price says they are starting to agree in their predictions. The estimates are comforting. [A major 2008 study](#) suggested that Greenland could contribute, at most, 16.5 centimetres of sea level rise by 2100. [Much like other new models](#), Gillet-Chaulet's suggests that Greenland won't contribute as much as that.

Price says we have much less of a handle on Antarctica, though. An ocean model published in May suggests that currents may change direction, driving warm water under one of the outer ice shelves (*Nature*, [DOI: 10.1038/nature11064](#)). If these shelves collapse, it could in turn trigger major losses from the main Antarctic ice sheets.

"The door appears to be open for some truly scary rates of ice sheet mass loss and sea level rise from Antarctica during the next few decades and centuries," Price says.

Journal reference: [Science](#), DOI: 10.1126/science.1220614