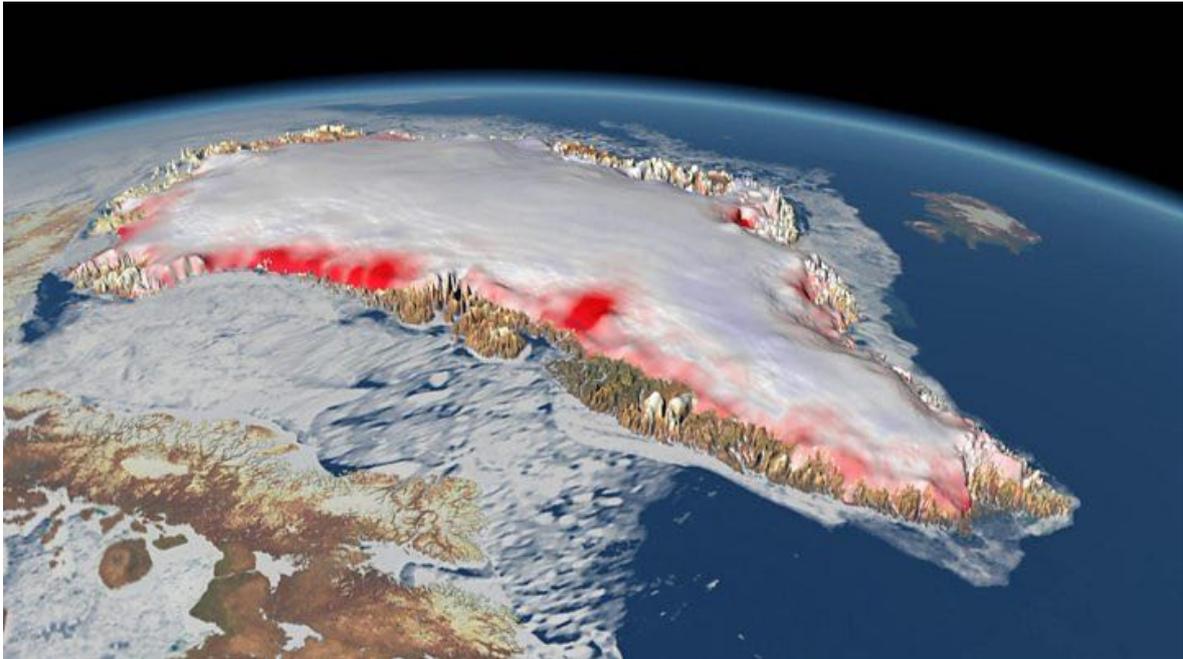


Climate change: Greenland ice melt 'is accelerating'

By Jonathan Amos
BBC Science Correspondent, San Francisco
3 hours ago



The loss of ice from 1992 to 2018 has occurred mostly around the coast of Greenland

Greenland is losing ice seven times faster than it was in the 1990s.

The assessment comes from an international team of polar scientists who've reviewed all the satellite observations over a 26-year period.

They say Greenland's contribution to sea-level rise is currently tracking what had been regarded as a pessimistic projection of the future.

It means an additional 7cm of ocean rise could now be expected by the end of the century from Greenland alone.

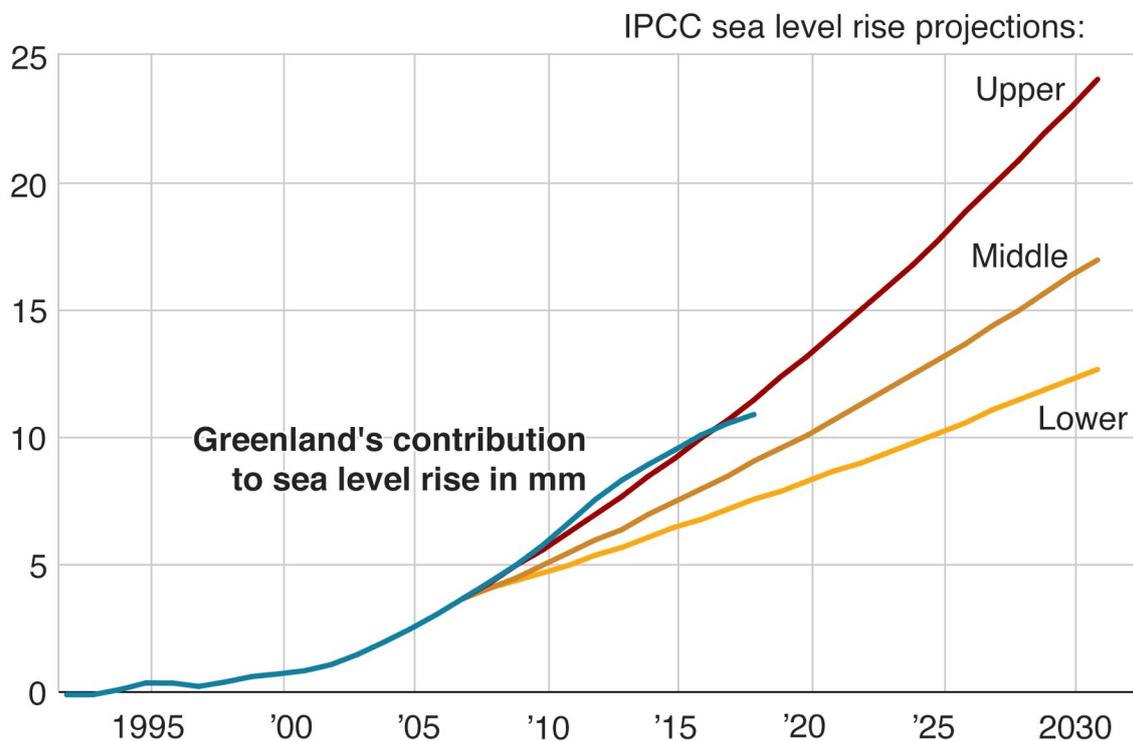
This threatens to put many millions more people in low-lying coastal regions at risk of flooding.

It's estimated roughly a billion live today less than 10m above current high-tide lines, including 250 million below 1m.

"Storms, if they happen against a baseline of higher seas - they will break flood defences," said Prof Andy Shepherd, of Leeds University.

"The simple formula is that around the planet, six million people are brought into a flooding situation for every centimetre of sea-level rise. So, when you hear about a centimetre rise, it does have impacts," he told BBC News.

Melting ice in Greenland is leading to rising sea levels



Source: IMBIE/CPOM/Leeds Uni

BBC

The British scientist is the co-lead investigator for Imbie - the Ice Sheet Mass Balance Inter-comparison Exercise.

It's a consortium of 89 polar experts drawn from 50 international organisations.

The group has reanalysed the data from 11 satellite missions flown from 1992 to 2018. These spacecraft have taken repeat measurements of the ice sheet's changing thickness, flow and gravity. The Imbie team has combined their observations with the latest weather and climate models.

What emerges is the most comprehensive picture yet of how Greenland is reacting to the Arctic's rapid warming. This is a part of the globe that has seen **a 0.75C temperature rise in just the past decade.**



Andy Shepherd: "Greenland and Antarctica are losing ice faster than we expected"

The Imbie assessment shows the island to have lost 3.8 trillion tonnes of ice to the ocean since the start of the study period. This mass is the equivalent of 10.6mm of sea-level rise.

What is more, the team finds an acceleration in the data.

Whereas in the early 90s, the rate of loss was equivalent to about 1mm per decade, it is now running at roughly 7mm per decade.

Imbie team-member Dr Ruth Mottram is affiliated to the Danish Meteorological Institute.

She said: "Greenland is losing ice in two main ways - one is by surface melting and that water runs off into the ocean; and the other is by the calving of icebergs and then melting where the ice is in contact with the ocean. The long-term contribution from these two processes is roughly half and half."

In an average year now, Greenland sheds about 250 billion tonnes of ice. This year, however, has been exceptional for its warmth. In the coastal town of Ilulissat, not far from where the mighty Jakobshavn Glacier enters the ocean, temperatures reached into the high 20s Celsius. And even in the ice sheet interior, at its highest point, temperatures got to about zero.

"The ice loss this year was more like 370 billion tonnes," said Dr Mottram.

Back in 2013, the Intergovernmental Panel on Climate Change (IPCC) - the authoritative body that reconciles all climate science - gave a mid-range projection for global sea level rise of about 60cm by 2100. A mixture of ice melt and expansion of warming water.

But when **Imbie published its companion review of Antarctica** in 2018, it found the White Continent's contribution by 2100 was likely being underestimated by 10cm. Now, for Greenland, Imbie is saying the shortfall is 7cm. The IPCC will have to incorporate these updates when it releases its next major assessment report (AR6) of Earth's climate in a couple of years' time.

Prof René Forsberg, from the Technical University of Denmark, said the Imbie exercise underlined the importance of flying satellites, especially those that can observe the top of Greenland, higher than 83 degrees North. Only two of the present fleet can, and one of those spacecraft is operating beyond its design life.

"Most of the changes we've seen in Greenland have been in the west, south and east; and now it has slowly moved up to the north. So, yes, the next satellite in the European Union's Copernicus programme needs to go to higher latitudes, and this is being discussed by the EU and the European Space Agency," Prof Forsberg told BBC News.

The new satellite system - **for the moment known as Cristal**, but to be called a Sentinel if it flies - would be a radar altimeter to measure the changing shape of Greenland.

Imbie's Greenland analysis is published in the journal Nature. Its release has been timed to coincide with the annual COP climate convention taking place this year in Madrid, and with the **American Geophysical Union meeting** here in San Francisco, where leading Earth scientists have gathered.



UC DAVIS | The Arctic has warmed 0.75C in the past decade, relative to 1951–1980

Greenland's ice sheet melting seven times faster than in 1990s

Scale and speed of loss much higher than predicted, threatening inundation for hundreds of millions of people

Fiona Harvey *in Madrid*

Tue 10 Dec 2019 16.00 GMT

Last modified on Tue 10 Dec 2019 17.30 GMT

Greenland's ice sheet is melting much faster than previously thought, threatening hundreds of millions of people with inundation and bringing some of the irreversible impacts of the climate emergency much closer.

Ice is being lost from Greenland seven times faster than it was in the 1990s, and the scale and speed of ice loss is much higher than was predicted in the comprehensive studies of global climate science by the **Intergovernmental Panel on Climate Change**, according to data.

That means sea level rises are likely to reach 67cm by 2100, about 7cm more than the IPCC's main prediction. Such a rate of rise will put 400 million people at risk of flooding every year, instead of the 360 million predicted by the IPCC, by the end of the century.

Sea level rises also add to the risk of storm surges, when the fiercer storms made more likely by global heating batter coastal regions. These impacts are likely to strike coastal areas all around the world.

"These are not unlikely events or small impacts," said Andrew Shepherd, professor of earth observation at the University of Leeds, one of the lead authors of the study. "[These impacts] are happening and will be devastating for coastal communities."

Greenland has lost 3.8tn tonnes of ice since 1992, and the rate of ice loss has risen from 33bn tonnes a year in the 1990s to 254bn tonnes a year in the past decade. Greenland's ice contributes directly to sea level rises as it melts because it rests on a large land mass, unlike the floating sea ice that makes up much of the rest of the Arctic ice cap.

About half of the ice loss from Greenland was from melting driven by air surface temperatures, which have risen much faster in the Arctic than the global average, and the rest was from the speeding up of the flow of ice into the sea from glaciers, driven by the warming ocean.

Oceans have absorbed most of the excess heat arising from our disruption of the climate to date, and much of the carbon dioxide, but they are reaching the limits of their capacity to do so. Sea level rises are driven not only by melting ice but by the thermal expansion of the seas as they warm.

The scale and speed of the ice loss surprised the team of 96 polar scientists behind the findings, **published on Tuesday in the journal Nature**. The Ice Sheet Mass Balance Inter-comparison Exercise comprised 26 separate surveys of

Greenland from 1992 to 2018, with data from 11 different satellites and comparisons of volume, flow and gravity compiled by experts from the UK, Nasa in the US, and the European Space Agency.

Erik Ivins, of the Nasa Jet Propulsion Laboratory in California, stressed that the findings – the most comprehensive survey yet of the ice sheet over the past few decades – were based on observations, rather than computer modelling.

“While computer simulation allows us to make projections from climate change scenarios, the satellite measurements provide prima facie evidence,” he said.

The peak year for ice loss, according to the observations, was 2011 when 335bn tonnes of ice were lost. Since then, the average rate has slowed to 238bn tonnes a year from 2013, but this does not include the **most recent observations from this summer**, which showed even more **widespread melting**.

Governments are meeting in Madrid for the second week of **crucial UN talks on the global response to the climate emergency**. Campaigners have been frustrated by the slow pace of the negotiations, despite growing public clamour, including a 500,000-strong march through the centre of the Spanish capital led by the **Swedish climate activist Greta Thunberg**.

Rachel Kennerley, a climate campaigner at Friends of the Earth, said: “We’re in a climate emergency – the impacts are coming thicker and faster every day. This latest research is yet more in an ever-growing pile of evidence which shows we need real action, not warm words. Governments need to stop dragging their feet and deliver real emissions cuts and real support for vulnerable people already experiencing the devastating effects of climate breakdown.”

The IPCC is the gold standard for climate science, but some experts are concerned that its findings do not take into account the potential for **“tipping points”**, thresholds beyond which climate breakdown accelerates and becomes catastrophic and irreversible.

Louise Sime, a climate scientist at the British Antarctic Survey, said of the new paper: “This finding should be of huge concern for all those who will be affected by sea level rise. If this very high rate of ice loss continues, it is possible that new tipping points may be breached sooner than we previously thought.”

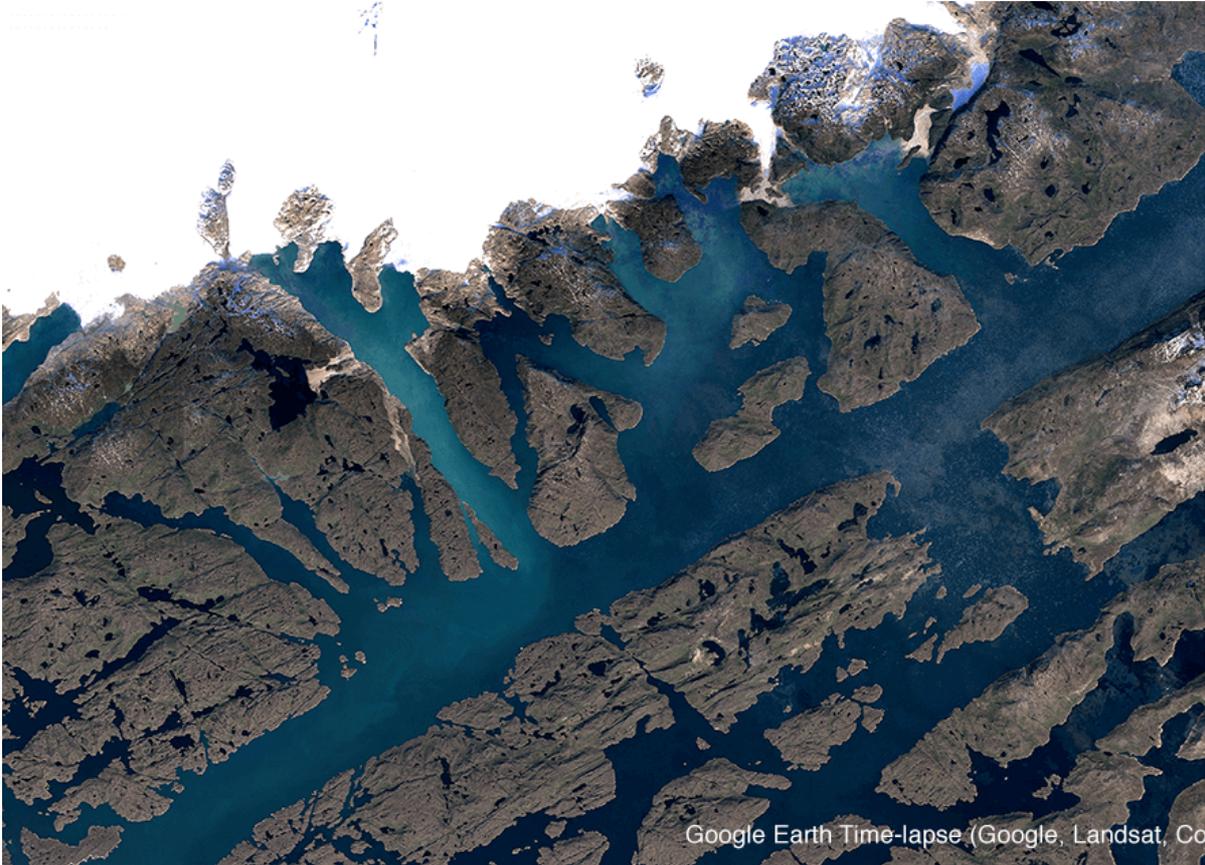
Climate change: Greenland's ice faces melting 'death sentence'

By David Shukman
Science editor
3 September 2019



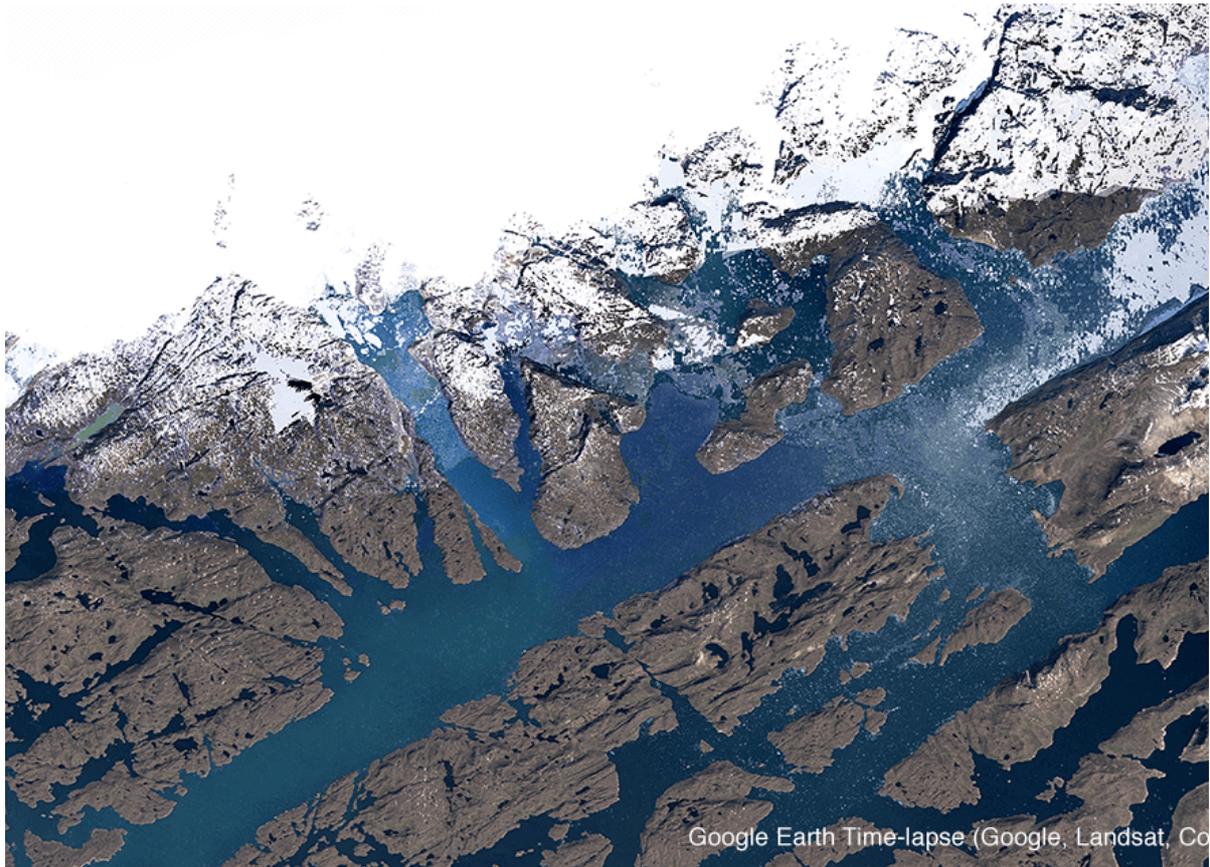
Greenland's massive ice sheet may have melted by a record amount this year, scientists have warned. During this year alone, it lost enough ice to raise the average global sea level by more than a millimetre. Researchers say they're "astounded" by the acceleration in melting and fear for the future of cities on coasts around the world. One glacier in southern Greenland has thinned by as much as 100 metres since I last filmed on it back in 2004.

Qaleraliq glacier, southern Greenland 2018



Google Earth Time-lapse (Google, Landsat, Co

1993



Google Earth Time-lapse (Google, Landsat, Co

Why does Greenland matter?

Essentially because its ice sheet is seven times the area of the UK and up to 2-3km thick in places. It stores so much frozen water that if the whole thing melted, it would raise sea levels worldwide by up to 7m.

No one is suggesting that could happen for hundreds or even thousands of years but even a small increase in the rate of melting in coming decades could threaten millions of people living in low-lying areas.

Bangladesh, Florida, and eastern England are among many areas known to be particularly vulnerable to rises in sea level over the course of the century.

And although the island of Greenland is remote, stretching from the north of the Atlantic high into the Arctic, its fate could have major implications for the severity of future flooding and may even alter coastlines and force communities to move inland.



A visit to the Sermilik glacier, which is rapidly melting

One of the scientists studying the ice sheet, Dr Jason Box of the Geological Survey of Denmark and Greenland (GEUS), says he's unnerved by the potential dangers and that coastal planners need to "brace themselves".

"Now that I'm starting to understand more of the consequences, it's actually keeping me awake at night because I realise the significance of this place around the world and the livelihoods that are already affected by sea level rise," he told me.



Dr Jason Box, Geological Survey of Denmark

How much is Greenland melting?

Until recently, the ice sheet was generally in a state of balance - the amount of snow falling in winter was roughly equal to the amount of ice melting in summer.

Greenland's ice sheet has lost almost four trillion tonnes of ice since 2002

Change in mass of the ice sheet in Gigatonnes
(one Gt = one billion tonnes)



Source: National Space Institute, Technical University of Denmark

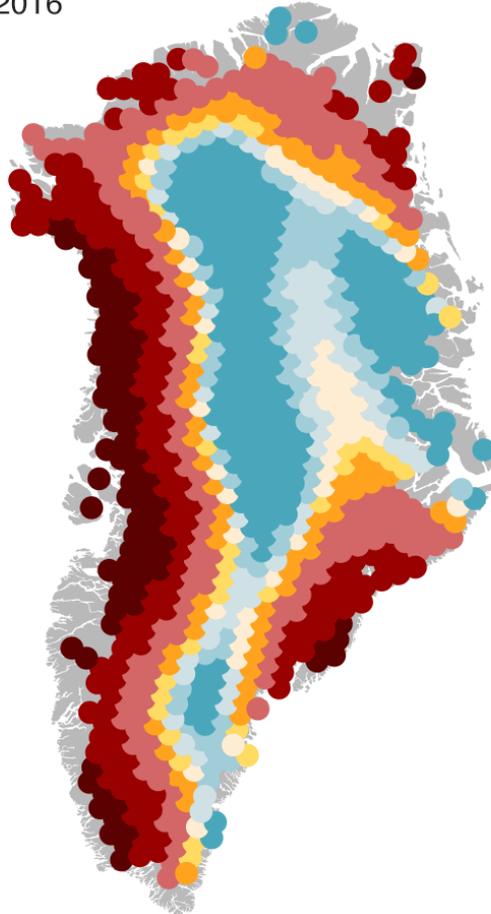
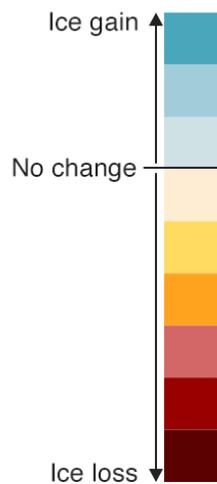


Last year, there was actually a gain in ice but that was relatively unusual. Over the last 30 years, decade-by-decade, Greenland has tended to shed more ice.

Either the ice melts at the surface which sends torrents of water down to the surrounding seas or huge chunks of ice break off from the margins and float away as icebergs, gradually to melt.

Heaviest ice loss around Greenland's coast

January 2012 to December 2016



Source: National Space Institute, Technical University of Denmark



Recent years have seen hundreds of billions of tonnes of ice lost - and a rough guide to the effect on sea level is that 362 billion tonnes of melt raises the average ocean level by a millimetre.

That doesn't sound a lot but in 2012 Greenland's loss totalled about 450 billion tonnes, and this year's melt is on course to produce about the same, or even slightly more, with some researchers suggesting it could raise sea levels by up to 2mm.

And on top of that you have to factor in the ice melting in Antarctica plus the effect of water expanding as it warms. It all raises the level of the oceans.

Arctic sea ice minimum extent

1980



Source: National Snow and Ice Data Center



According to Dr Box, it's the recent increase in the average temperature that's being felt in Greenland's ice: "Already effectively that's a death sentence for the Greenland ice sheet because also going forward in time we're expecting temperatures only to climb," he said. "So, we're losing Greenland - it's really a question of how fast."

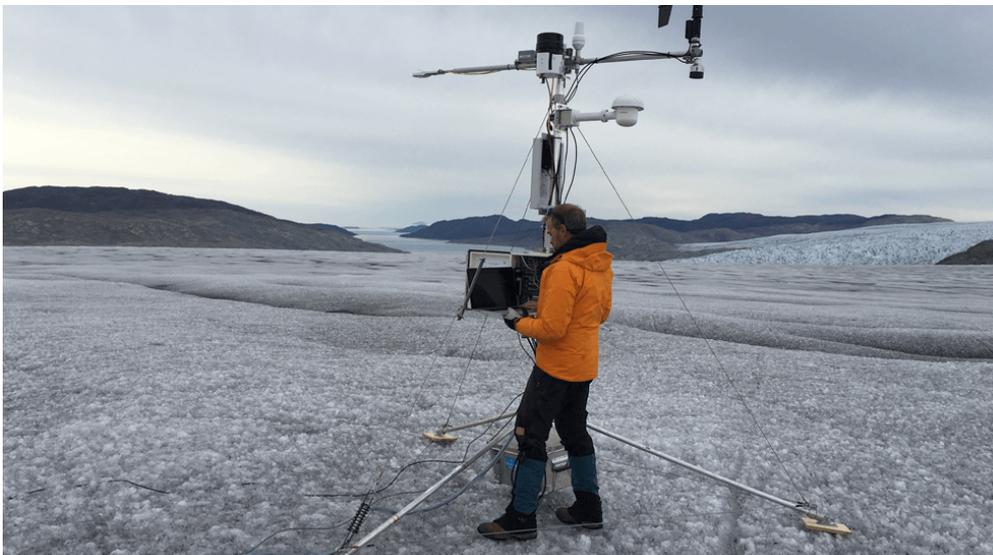
How rapidly is the ice sheet changing?

I've seen for myself what's happened to one corner of it. Sermilik glacier at the southern end is not one of Greenland's largest but it does rank as one of the fastest-shrinking streams of ice anywhere in the world.

To reach it back in 2004, we flew past towering cliffs of ice, the front of the glacier an immense wall of pale grey and blue standing high above the sea.

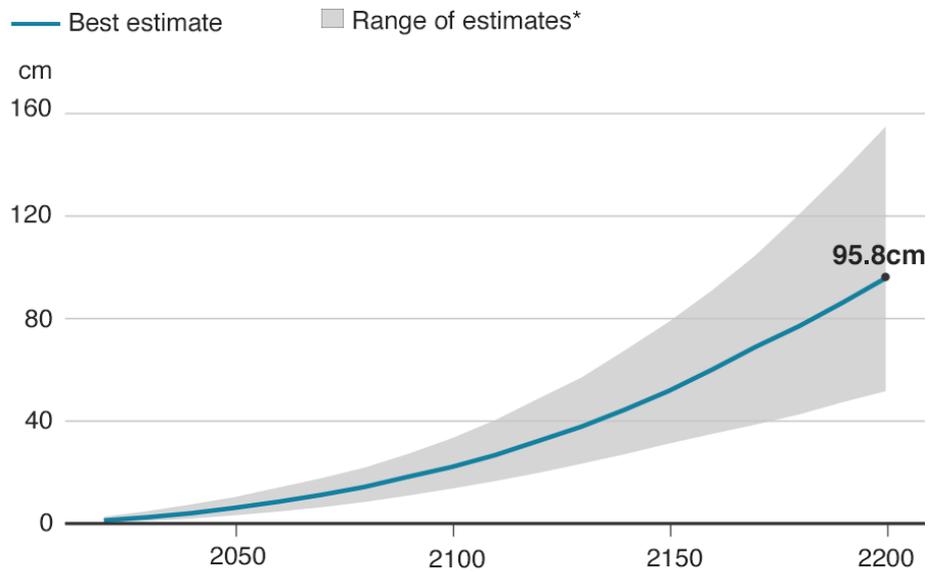
At that time, we accompanied a scientist who checked instruments positioned on the ice and he was stunned to see how the surface of the glacier was dropping by as much as a metre every month.

And over the past 15 years, that rate of shrinking has continued so aggressively that now, on a return visit to the same glacier, the ice looks diminished, almost battered, and far less dominating in the landscape.



Jason Box is with me and he gathers the latest readings which show that over this summer alone the glacier has shrunk by an estimated 9m. "That's an astounding rate of loss," he said. Since my last visit, the surface of this margin of the ice sheet has lowered by an extraordinary 100m, more than halving in thickness, exposing the remaining ice to the relatively warmer temperatures of lower altitudes.

Greenland's melting ice sheet predicted to raise global sea levels



* Two thirds of estimates fall within this range

Source: Aschwanden, A et al. (2019), Science Advances

BBC

What's happening to the ice itself?

While you might think of the Arctic as a pristine white landscape, the startling feature of the surface is how dirty it looks. Walking on it feels like arriving on the Moon.

There are big areas of pale grey and smaller patches that are much darker, covered with what appears to be mud or silt - it's a grim and rather depressing sight.



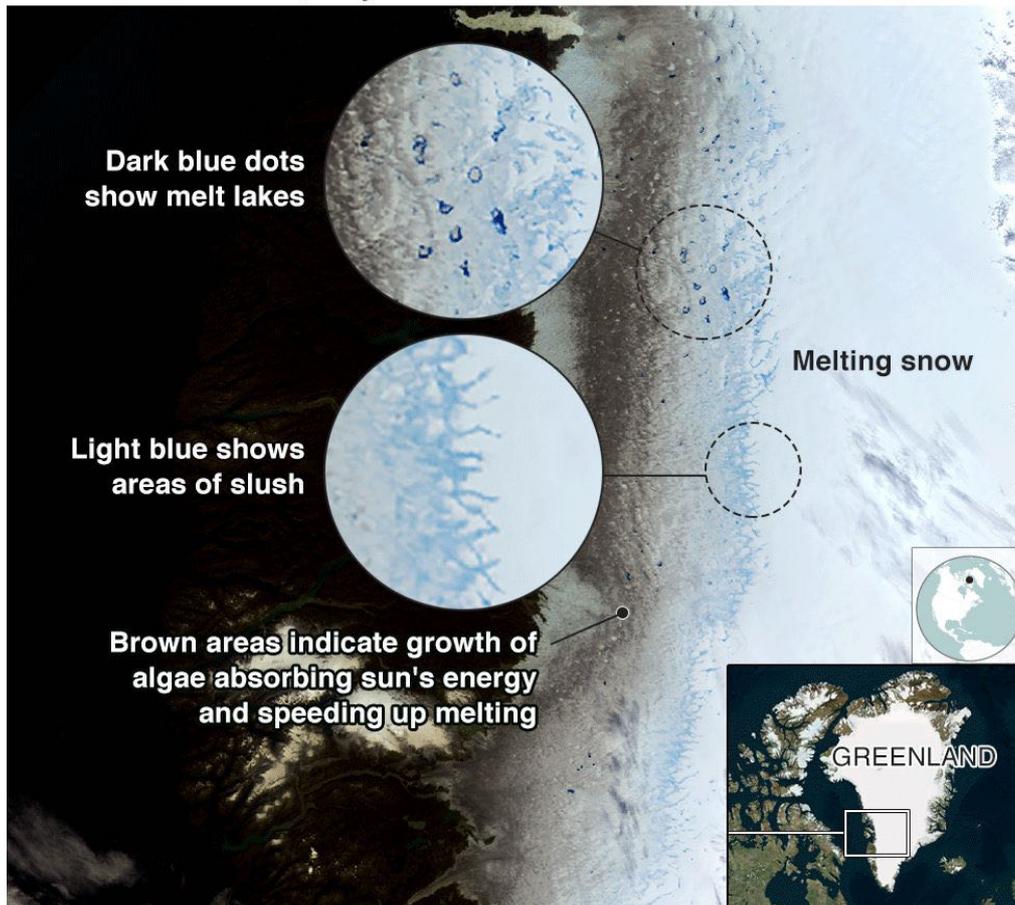
Algae growing on the Sermilik glacier

It used to be thought that this darkness was mainly caused by a mix of dust and pollution particles carried on the winds from distant power stations and industrial centres.

But since my last visit to Sermilik glacier, scientists have made an important breakthrough in understanding that a major cause of the darkening is in fact biological - algae, **microscopically small plants that are flourishing in the melting ice.**

Satellite images reveal how ice is melting

Southern Greenland, July 2019

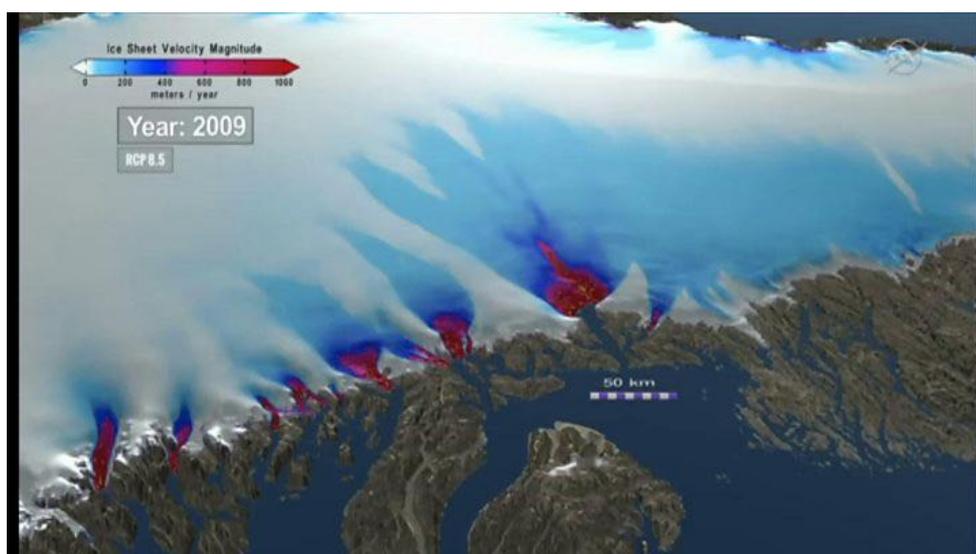


Source: Copernicus, 29 July 2019

By turning the surface grey, or black, from its usual bright white, the algae make it less reflective, so it absorbs more of the Sun's rays. This accelerates the warming and in turn leads to even more melting.

Who's trying to work out what's going on?

With the stakes so high for so many millions of people around the world, Greenland is the target of a major international research effort involving satellites, monitoring flights and expeditions on the ice itself.



Nasa visualisation of the melting Greenland ice sheet

The US space agency Nasa has for years run projects investigating exactly what's causing the ice to melt and what could happen to it in future.

Back in 2005, I reported on a Nasa-funded team that made an important discovery about the movement of the ice sheet.



Although the great mass of ice looks immobile, it's actually always inching down towards the coast and the team found that this movement doubles in speed in summer - as meltwater from the surface works its way to the bottom of the ice and helps it to slide along.



Another revelation is that the ice is not only being melted by the air, as the atmosphere heats up, but also by warmer water reaching underneath the fronts of the glaciers. One Nasa scientist describes the ice as being under a hair-dryer and at the same time also on a cooker. And Jason Box and his colleagues at GEUS run a network of sensors on the ice to record details of the height of the surface and its reflectivity, and how they're changing.



The hardest challenge for the scientific community is understanding enough of the mechanisms of the ice sheet to be able to offer reliable forecasts of sea level rise.

Dr Masashi Niwano, a researcher with the Japan Meteorological Agency, is just back from a field trip to gather data to try to validate his computer simulations of the ice.

"The ice sheet mass is decreasing - that is very certain. And these results affect global sea-level rise - that is also very certain," he said. "But maybe there are several physical processes that we don't understand, so developing future projections is very difficult."

What do the people of Greenland make of all this?

There are only 56,000 Greenlanders, and they live in communities perched on the narrow band of land at the edge of the ice sheet which, though close, is usually out of sight.



Inutislaq Ibsen, 18, Naja-Theresia Hoegh, 19, and Caroline Hartmann Hansen, 21, in Qaqortoq

In the village of Narsaq, Christian Mortensen tells me a glacier that was visible when he was younger has since retreated and that icebergs seem to "break more and more" into the waters.

Warmer conditions would allow more farming and, as we talk, cattle are grazing around us on pasture that's beside bright white chunks of ice bobbing in the sea.



But for some young Greenlanders, climate change is becoming a big concern, partly because of the impact of "their" ice on other areas of the planet.

Naja-Theresia Hoegh, who's just finished school, was inspired by the Swedish campaigner Greta Thunberg to lead a climate strike in her town of Qaqortoq, a pretty port of brightly painted houses.

She describes a boat trip to the edge of the ice sheet where she found it "astonishing and scary" that so much water could flow out.

"All of that is ending up in our waters, into the sea, and to the rest of the world and, if this continues, it will someday just cover a whole country," Ms Hoegh explained.

Her friend Caroline Hartmann Hansen also talked about her fears over the uncontrolled nature of the melting. "It's not our fault; it's everyone's," she said.



Can anything be done?

If the calculations of Jason Box and his colleagues are right, the ice sheet is already crossing a threshold into an era in which there may still be years with net gains of ice - like last year - but the new normal will see more big losses.



Even with a rapid move to cut emissions of warming gases - as outlined in the 2015 Paris climate agreement - Greenland could still see a growing rate of melting, though that could possibly be slowed.
So, as with the young Greenland climate campaigners, the scientists feel the need to take action of their own.
They have started a scheme to try to absorb some of the carbon dioxide emitted by the flights they take to conduct their research; Jason said he has been criticised for his high carbon footprint and "feels guilty about it".



Dr. Faezeh Nick plants tree saplings near Narsarsuaq

Close to the airport at Narsarsuaq, which connects them to the glaciers of southern Greenland, the researchers are planting 6,000 saplings of Siberian larch, a type of tree known to do well in conditions here. They admit that 10 of the trees would need to grow for 60 years to absorb the carbon produced by a return flight from London to San Francisco, but they say it's a start and that if the project later leads to a much larger forest, it might "make a dent" in climate change. Meanwhile, as memories of last month's polar heatwave fade, the scientists are leaving ahead of the winter nights, to try to hone their predictions for what the scarred and darkened ice sheet is likely to do next.