19 September 2012 Last updated at 17:36 GMT

Record minimum for Arctic sea ice

By Paul Rincon Science editor, BBC News website

The late season decline is thought to indicate how thin the ice now is

Arctic sea ice has reached its minimum extent for the year, setting a record for the lowest summer cover since satellite data collection began.

The 2012 extent has fallen to 3.41 million sq km (1.32 million sq mi) - 50% lower than the 1979-2000 average.

Arctic sea ice has long been regarded as a sensitive indicator of changes in the climate.

Scientists who have been analysing the startling melt think it is part of a fundamental change.

"We are now in uncharted territory," said Mark Serreze, director of the National Snow and Ice Center (NSIDC) in Colorado, US.

"While we've long known that as the planet warms up, changes would be seen first and be most pronounced in the Arctic, few of us were prepared for how rapidly the changes would actually occur."

This year's minimum caps a summer of low ice extents in the Arctic. On 26 August, sea ice extent fell to 4.10 million sq km (1.58 million sq mi), breaking the previous record low set on 18 September 2007 of 4.17 million sq km (1.61 million sq mi).

On 4 September, it fell below four million sq km (1.54 million sq mi), another first in the 33-year satellite record.

"We know very little about the consequences of drastic sea ice reductions. Most model predictions have sea ice declining less fast"

Dr Poul Christoffersen University of Cambridge
"The strong late season decline is indicative of how thin the ice cover is," said NSIDC scientist Walt Meier.

"Ice has to be quite thin to continue melting away as the sun goes down and Fall approaches."

Scientists say they are observing fundamental changes in sea ice cover. The Arctic used to be dominated by multiyear ice, or ice that survived through several years.

Recently, the region is characterised by seasonal ice cover and large areas are now prone to completely melt away in summer.

The sea ice extent is defined as the total area covered by at least 15% of ice, and varies from year to year because of changeable weather.

However, ice extent has shown a dramatic overall decline over the past 30 years.

A 2011 study published in Nature journal, used proxies such as ice cores and lake sediments to reconstruct sea ice extent in the Arctic over the last 1,450 years.

The results suggest the duration and magnitude of the current decline in sea ice may be unprecedented over this period.

It's difficult to grasp the scale of this but picture about a dozen United Kingdoms lined up side by side: that's how much more sea ice has vanished beyond the average amount left at the end the summer over the past 30 years.

This is a bigger, faster, more dramatic melt than anyone would have imagined possible even a few years ago. The most striking impression during a visit to Svalbard earlier this month was the look of shock on the faces of the scientists.

The models have underestimated the rapidity of the processes at work. The polar winters will always see the ocean refreeze. But the prospect of change on a planetary scale looms closer: the Arctic ice cap, a permanent feature at the roof of the world throughout human history, becoming a seasonal, temporary one instead, and sooner rather than later.

Dr Julienne Stroeve, a research scientist with the NSIDC, is currently aboard a Greenpeace ship in Svalbard, Norway, that has just returned from a research expedition to assess the region's melt.

She said the new record suggested the Arctic "may have entered a new climate era, where a combination of thinner ice together with warmer air and ocean temperatures result in more ice loss each summer".

She continued: "The loss of summer sea ice has led to unusual warming of the Arctic atmosphere, that in turn impacts weather patterns in the Northern Hemisphere, that can result in

persistent extreme weather such as droughts, heat waves and flooding."

Dr Poul Christoffersen, from the University of Cambridge, told BBC News: "We know very little about the consequences of drastic sea ice reductions.

"Most model predictions have sea ice declining less fast. But the fact is that less sea ice means more heat going into the upper ocean and the lower atmosphere. There could be some large scale effects from this, such as shifting wind patterns, surface ocean currents and potentially the jet stream.

"The wet northern European summer of 2012 could very well have been influenced by the record low extent of sea ice in the Arctic."

If the current melting trend during summer months continues, there will be opportunities as well as challenges.

Some ships have already been cutting their journey times by sailing a previously impassable route north of Russia.

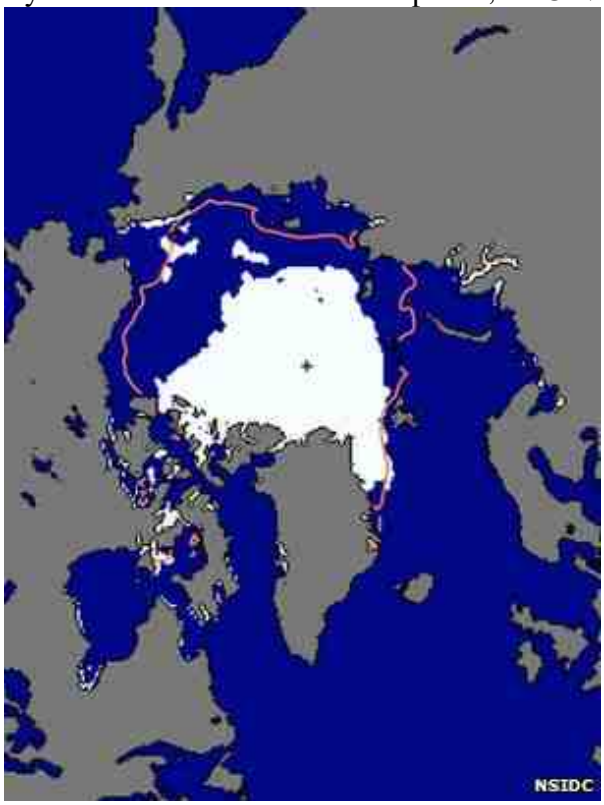
Oil, gas and mining firms are all planning to exploit rich resources thought to be held by the Arctic, although they are strongly opposed by environment campaigners.

Paul.Rincon-INTERNET@bbc.co.uk

21 August 2012 Last updated at 10:55 GMT

Arctic sea ice set to hit record low

By Mark Kinver Environment reporter, BBC News



Arctic sea ice extent on 19 August 2012 (orange line shows the 1979-2000 median)

Arctic sea ice looks set to hit a record low by the end of the month, according to satellite data.

Scientists at the US National Snow and Ice Data Center said data showed that the sea ice extent was tracking below the previous record low, set in 2007.

Latest figures show that on 13 August ice extent was 483,000 sq km (186,000 sq miles) below the previous record low for the same date five years ago.

The ice is expected to continue melting until mid- to late September.

"A new daily record... would be likely by the end of August," the centre's lead scientist, Ted Scambos, told Reuters.

"Chances are it will cross the previous record while we are still in ice retreat."

'Rapid melt'

Sea ice extent refers to a measurement of the area of Arctic Ocean that contains at least some sea ice. Areas with less that 15% is considered by scientists to mark the ice edge.

In its latest summary, the centre said the average rate of ice loss since late June had been "rapid", with just over 100,000 sq km melting each day.

However, it added, the rate of loss doubled for a few days earlier this month during a major storm.

Responding to the latest update, Prof Seymour Laxon, professor of climate physics at University College London, said that he was not surprised that 2012 was set to deliver a record minimum.


The melt season is expected to continue until the second half of September
"We got very close to a record minimum last year," he told BBC News.

"The fact that Cryosat showed thinner ice last winter, it is not surprising to me that it looks like we will have a record minimum this year."

Cryosat is a radar spacecraft operated by the European Space Agency (Esa) that was launched in 2010 to monitor changes in the thickness and shape of polar ice.

Prof Laxon added that this year's projected record minimum could result in a change in projections of when the Arctic would be sea ice-free during summer months.

"The previous [Intergovernmental Panel on Climate Change] report (published in 2007) stated that the likely date for an ice-free Arctic in the summer - and definitions for this vary a bit - was 2100," he explained.

"When we had the 2007 minimum, that date was brought forward to 2030-2040.

"The fact that we look set to get another record ice minimum in such a short space of time means that the modellers may once again need to go and look at what their projections are telling them."

Arctic sea ice plays a key role in help keep polar regions cool and helps control the global climate system.

As the ice has a bright surface, it reflects about 80% of the sunlight that hits it back into space.

When the sea ice melts, it exposes more of the dark ocean surface, resulting in 90% of the sunlight being absorbed, which warms the Arctic ocean.

27 August 2012 Last updated at 20:11 GMT

Arctic sea ice reaches record low, Nasa says

By Roger Harrabin Environment analyst

The melt season is expected to continue until the second half of September

The Arctic has lost more sea ice this year than at any time since satellite records began in 1979, Nasa says.

Scientists involved in the calculations say it is part of a fundamental change.

What is more, sea ice normally reaches its low point in September so it is thought likely that this year's melt will continue to grow.

Nasa says the extent of sea ice was 1.58m sq miles (410m sq km) compared with a previous low of 1.61m sq miles (4.17m sq km) on 18 September 2007.

The sea ice cap grows during the cold Arctic winters and shrinks when temperatures climb again, but over the last three decades, satellites have observed a 13% decline per decade in the summertime minimum.

The thickness of the sea ice is also declining, so overall the ice volume has fallen far - although estimates vary about the actual figure.

Joey Comiso, senior research scientist at Nasa's Goddard Space Flight Center, said this year's ice retreat was caused by previous warm years reducing the amount of perennial ice - which is more resistant to melting. It's created a self-reinforcing trend.

"Unlike 2007, temperatures were not unusually warm in the Arctic this summer. [But] we are losing the thick component of the ice cover," he said. "And if you lose [that], the ice in the summer becomes very vulnerable."

'Inevitable death'
Walt Meier, from the National Snow and Ice Data Center that collaborates in the measurements, said: "In the context of what's happened in the last several years and throughout the satellite record, it's an indication that the Arctic sea ice cover is fundamentally changing."

"The summer ice volume is now only 30% of what it was in the 1980s"

Prof Peter Wadhams Cambridge University
Professor Peter Wadhams, from Cambridge University, told BBC News: "A number of scientists who have actually been working with sea ice measurement had predicted some years ago that the retreat would accelerate and that the summer Arctic would become ice-free by 2015 or 2016.

"I was one of those scientists - and of course bore my share of ridicule for daring to make such an alarmist prediction."

But Prof Wadhams said the prediction was now coming true, and the ice had become so thin that it would inevitably disappear.

"Measurements from submarines have shown that it has lost at least 40% of its thickness since the 1980s, and if you consider the shrinkage as well it means that the summer ice volume is now only 30% of what it was in the 1980s," he added.

"This means an inevitable death for the ice cover, because the summer retreat is now accelerated by the fact that the huge areas of open water already generated allow storms to generate big waves which break up the remaining ice and accelerate its melt.

"Implications are serious: the increased open water lowers the average albedo [reflectivity] of the planet, accelerating global warming; and we are also finding the open water causing seabed permafrost to melt, releasing large amounts of methane, a powerful greenhouse gas, to the atmosphere."

Threats and opportunities
Opinions vary on the date of the demise of summer sea ice, but the latest announcement will give support to those who err on the pessimistic side.


Greenpeace is strongly opposing attempts to exploit the Arctic

A recent paper from Reading University used statistical techniques and computers to estimate

that between 5-30% of the recent ice loss was due to Atlantic Multi-decadal Oscillation - a natural climate cycle repeating every 65-80 years. It's been in warm phase since the mid 1970s.

But the rest of the warming, the paper estimates, is caused by human activity - pollution and clearing of forests.

If the ice continues to disappear in summer there will be opportunities as well as threats.

Some ships are already saving time by sailing a previously impassable route north of Russia.

Oil, gas and mining firms are jostling to exploit the Arctic - although they're being strongly opposed by environmentalists. Greenpeace has been protesting at drilling by the Russian giant Gazprom.

Among the many threats, the warming is bad for Arctic wildlife. Thanks to the influence of sea ice on the jet stream the changes could affect weather in the UK.

The changes - if they happen - could unlock frozen deposits of methane which would further overheat the planet.

Warmer seas could lead to more melting of Greenland's ice cap which would contribute to raising sea levels and changing the salinity of the sea, which in turn could alter ocean currents that help govern our climate.

Arctic ice low heralds end of 3-million-year cover

- 29 August 2012 by **Catherine Brahic**
- Magazine issue 2880. **Subscribe and save**
- For similar stories, visit the **Climate Change** Topic Guide

The consequences of what is arguably the greatest environmental change in human history will extend far beyond the North Pole

Editorial: "Arctic melt, smash and grab ahead"

IT IS smaller, patchier and thinner than ever - and rotten in parts. The extent of the Arctic ice cap has hit a record low, and the consequences of what is arguably the greatest environmental change in human history will extend far beyond the North Pole.

For at least 3 million years, and most likely 13 million, says Louis Fortier of the University of Laval in Quebec City, Canada, the Arctic Ocean has been covered by a thick, floating ice cap, the breadth of which fluctuates with the seasons and currents. Each summer, the cap shrinks to an annual minimum in mid-September before growing out again, fuelled by plummeting winter temperatures and long nights.

Climate change has had more of an impact here than anywhere else on Earth. Air temperatures are rising twice as fast as the global average, and models predict that the region could see temperatures rise by between 6 °C and 14 °C by 2100, depending on how fast the sea ice disappears. Nobody believes the world's northern ice cap could survive such scorching

summers.

Constant, real-time monitoring made it evident last week that this would be a landmark year, even worse than 2007, when the summer thaw opened the North-West Passage for the first time in living memory. On 27 August, the daily update from the US National Snow and Ice Data Center (NSIDC) reported that the ice pack had shrunk to 4.1 million square kilometres (see diagram). That is 70,000 km^2 smaller than the 2007 low, and there are several weeks to go before the ice starts growing back as winter approaches. (To see an interactive diagram showing the summer ice extent for every year from 1979 to 2011, see our interactive map.)

Less ice in the Arctic means more light enters the ocean beneath, fuelling more life (see "What ice-free summers will mean for Arctic life"), but it also means warmer surface waters and more energy released into the atmosphere. That energy drives cyclones, which generate mammoth waves capable of ripping into the ice pack, degrading it further. The consequences are not good for this highly specialised environment, and the knock-on effects for the rest of us could be severe.

Even the NSIDC's figures for ice coverage, from satellite data, could be overestimations, as satellite images cannot distinguish between pack ice and slushy, "rotten" ice (*Geophysical Research Letters*, doi.org/dht5wr).

Measurements of ice thickness are also worrying. From 1979 to 2000, the average volume of Arctic ice in September was 12,000 cubic kilometres. This year, it is less than 3000 cubic kilometres. "In plain words," says Fortier, "we are three-quarters of the way to a summertime ice-free Arctic Ocean, with all the climatic, geopolitical, environmental and economic consequences."

Several factors are to blame. Warm spring temperatures didn't help, then on 5 August a major cyclone crossed into the Arctic Circle. Such events used to be rare, but are now more frequent, stronger and last longer than before, says Ziangdong Zhang at the University of Alaska Fairbanks (*Journal of Climate*, doi.org/d2d6n6).

These storms carry heat from the lower latitudes, and stir up the highly stratified Arctic Ocean waters, bringing warm bottom-waters up to the surface, where they help further melting of the floating ice. More dramatic is the storms' direct physical influence. With the Arctic water no longer protected by thick multiyear ice, near-hurricane-force winds shove it around, forming powerful waves capable of shredding any ice floes they encounter.

Dave Barber and Matthew Asplin at the University of Manitoba in Winnipeg, Canada, witnessed this in September 2009 aboard an ice-breaker called Amundsen. They were near an ice floe 10 kilometres across and up to 10 metres thick in places. "We were about to put a team down on the ice when all of a sudden I saw a wave enter the ice pack," Barber recalls. "The entire floe rose up on top of the wave trains, and as it came down on the other side, it split. As I watched, it broke into small pieces 100 metres across."

Smaller pieces melt faster, so the researchers believe cyclones are an important positive feedback mechanism, further reducing the pack ice (*Journal of Geophysical Research - Oceans*, doi.org/h7m).

Zhang points out that cyclones also carry clouds, which boost downward radiation. He says the August cyclone probably contributed to this year's low. Bill Chapman at the University of

Illinois at Urbana-Champaign agrees. "Sea-ice area decreased rapidly during the period of the storm," he says, "but it was decreasing rapidly already during the height of this melt season."

The upheaval will not be confined to the Arctic Circle. The atmospheric-temperature gradient between the hot tropics and the cold poles powers much of our planet's weather and water cycles. It drives the jet stream, for instance, which pushes global weather systems, it fuels the winds that power ocean currents, and it distributes moisture around the planet.

What's more, the accelerating melt of Arctic ice is injecting a layer of freshwater into the surface of the North Atlantic and Baffin Bay, off the coast of Greenland, says Fortier. This may be slowing the circulation in the Atlantic, which pushes water all through the world's oceans.

The long-term trends are damning. The latest climate models predict that by around 2050 the Arctic will be completely ice-free during the summers (*Geophysical Research Letters*, doi.org/h7q). When that happens, the Arctic routine, stable for millions of years, will be flipped on its head. "The changes under way in the Arctic," concludes Barber, "are the most significant, in scale and rate, that we have seen in the history of human civilisation."

What ice-free summers will mean for Arctic life

- 30 August 2012 by **Catherine Brahic** and **Sara Reardon**
- Magazine issue 2880. **Subscribe and save**
- For similar stories, visit the **Climate Change** Topic Guide

A transformation not seen in 3 million years spells big changes for the unique ecosystem of the extreme north

Editorial: "Arctic melt, smash and grab ahead"

"WE ARE witnessing the early stages of the transformation of the Arctic," says Louis Fortier of Laval University in Quebec City, Canada. For millennia, the top of the planet has been the preserve of specialist organisms, from fish with antifreeze running through their veins to bears capable of fasting for months. That's all changing. An increasingly ice-free Arctic is opening a new frontier for life on Earth.

There are some windows into this warmer future: natural open-water hotspots that have always been present in the Arctic. Called polynyas, they are found in places where wind patterns and natural upwellings of warm water prevent ice from forming. The archetypal polynya is the North Water in northern Baffin Bay, says Fortier, "perhaps the most productive ecosystem beyond the Arctic Circle where marine mammals - including large whales - and humans have congregated for centuries".

Relatively few creatures have evolved to survive at Arctic temperatures, so the fate of entire food chains can pivot on a few species. Shift things slightly in time, space or volume and everything can tip.

Timing is a particular concern. Climate change means the sun is reaching into Arctic waters earlier. Ice that only formed the previous winter lets light through more readily than a 10-metre-thick floe that has been building for several years. This means the annual cycle of life can kick

off earlier, creating a problem for large species like whales, whose migrations have evolved to coincide with the historical onset of spring.

In the Amundsen Gulf of north-west Canada, nutrient upwellings have become a recurrent feature since 2002, boosting local biodiversity, says Fortier. In June 2008, the nutrients triggered a phytoplankton bloom. In just three weeks, local primary productivity shot up to more than twice the annual amount. In the Beaufort Sea to the north of Alaska, the biomass of ice algae - which cling to the underside of ice floes and occupy the lowest link of the food chain - was more than three times that reported in 35 years of seasonal observations (*Climatic Change*, doi.org/h7n).

Algal blooms are just the beginning. They feed tiny zooplankton, which provide vital energy supplies for organisms higher up the food chain - the polar bears that eat the seals, which eat the fish. Less ice, says George Hunt of the University of Washington in Seattle, could cause a cascade of changes to these food chains.

Some of the transformations have already taken place and appear to be here to stay. Connie Lovejoy, also at Laval University, took water samples from the Beaufort Sea between 2003 and 2010, and used DNA analysis to see what algae, plankton and bacteria it contained. The species composition was constant between 2003 and 2006, but in 2007, when summer ice cover was abnormally low, photosynthetic organisms suddenly seemed to take over. Although the following years saw more summer ice cover, the community never reverted to its initial make-up (*PLoS One*, doi.org/cfrj9n).

Elsewhere, species are moving in from further south. The polar cod once dominated the Hudson Bay and Beaufort Sea, but capelin and sand lance are now making appearances. Pacific salmon are also moving into the Arctic Basin, says Fortier. For now, the local polar cod and Arctic charr seem unaffected. But that could change if further warming brings in more competitive generalists, which can thrive in a wide range of environments. They might be able to outcompete the wildlife that has taken millennia to adapt to the unique conditions of the Arctic.

In the short run, the top of the world looks set to bloom, at least in parts. Some will profit: industrial fisheries are already keen to move in. But at what cost? Fortier hesitantly predicts that Pacific plankton and fish will dominate by 2050 and many marine mammals and birds could be gone entirely by the end of the century.

"It might take decades until we observe the final 'new state'," says Rolf Gradinger of the University of Alaska Fairbanks. "But once a tipping point has been reached, there might be no way back - although we'll see oscillations around a new centre."

For more on the Arctic's record low in ice coverage, see "Arctic ice low heralds end of 3-million-year cover"

Future not all bad for bears

Thin ice could be good news for some species, at least initially. It's a habitat in which seals thrive. "They want to slip up on an ice floe and slip back in," says Peter Boveng of the National Marine Mammal Laboratory in Seattle. Thin ice that formed the previous winter also crumples more easily than thick multi-year floes, forming ridges and gaps that offer breathing holes.

That makes this first-year ice attractive to the animal at the top of the Arctic food chain: the polar bear. Some areas have seen an increase in *Ursus maritimus*, says David Barber of the University of Manitoba in Winnipeg, Canada. Polar bears typically move to thicker ice during the autumn but can move onto land to den as well.

In the short run, then, some polar bear populations could benefit from thinner ice. Others won't. Melissa McKinney and Robert Letcher of Environment Canada in Ottawa studied polar bears near Hudson Bay and found they ate different seal species in years when the sea ice broke up early. That could be a problem: some species live in water with high levels of PCBs, flame retardants and other toxic chemicals from fertiliser runoff. The contaminants move up the food chain, but the consequences are unclear as yet.

Although the changes might bring benefits in the short term, the long-term picture is very different. Seals could lose breeding ground if the ice pulls away from the shore before they can give birth, for example. And more open water means polar bears need to spend more time swimming than they can afford. As the open-water season lengthens, so will their fasting time. Other species from further south - such as brown bears - may stand a better chance.

5 September 2012 Last updated at 18:20 GMT

Arctic ice melt 'like adding 20 years of CO2 emissions'

By Susan Watts Newsnight Science editor, BBC News

The sea ice extent at 26 August (white) is markedly different from the 1979-2000 average (orange line)

Continue reading the main story

Related Stories

- Ice mission produces first map

Loss of Arctic ice is effectively doubling mankind's contribution to global warming, ice scientist Professor Peter Wadhams has told BBC Newsnight.

White ice reflects more sunlight than open water, acting like a parasol.

Melting of white Arctic ice, currently at its lowest level in recent history, is causing more absorption.

Prof Wadhams calculates that this increased absorption of the sun's rays is "the equivalent of about 20 years of additional CO2 being added by man".

The Cambridge University expert says that the Arctic ice cap is "heading for oblivion".

In 1980, the Arctic ice in summer made up some 2% of the Earth's surface. But since then the ice has roughly halved in area, and the volume of ice has dropped to just a quarter of what it was.

"The volume of ice in the summer is only a quarter of what it was 30 years ago and that's really the prelude to this final collapse," Prof Wadhams said.

The polar ice cap acts as a giant parasol, reflecting sunlight back into the atmosphere in what is known as the albedo effect.

But white ice and snow reflect far more of the sun's energy than the open water that is replacing

it as the ice melts.

Instead of being reflected away from the Earth, this energy is absorbed, and contributes to warming.

Parts of the Arctic Ocean are now as warm in summer as the North Sea is in winter, Prof Wadhams said.

UK weather effect
The melting ice could have knock-on effects in the UK. Adam Scaife, from the Met Office Hadley Centre told Newsnight it could help explain this year's miserable wet summer, by altering the course of the jet stream.

"Some studies suggest that there is increased risk of wet, low pressure summers over the UK as the ice melts."

There may be effect for our winters too: "Winter weather could become more easterly cold and snowy as the ice declines," Mr Scaife said.

Opinions vary on the date of the demise of summer sea ice. The Met Office says it is not expecting the Arctic to be completely ice-free in summer until after 2030.

7 September 2012 Last updated at 06:18 GMT

Arctic ice melting at 'amazing' speed, scientists find

By David Shukman Science Editor, BBC News, in Svalbard

David Shukman visits the Ny-Alesund research base in Svalbard

Continue reading the main story

Related Stories

- So remote, it could pass for Mars

- Ice loss 'like 20 years of CO2'
- Arctic sea ice melts to record low Watch

Scientists in the Arctic are warning that this summer's record-breaking melt is part of an accelerating trend with profound implications.

Norwegian researchers report that the sea ice is becoming significantly thinner and more vulnerable.

Last month, the annual thaw of the region's floating ice reached the lowest level since satellite monitoring began, more than 30 years ago.

It is thought the scale of the decline may even affect Europe's weather.

The melt is set to continue for at least another week - the peak is usually reached in mid-September - while temperatures here remain above freezing.

'Unprecedented'

The Norwegian Polar Institute (NPI) is at the forefront of Arctic research and its international director, Kim Holmen, told the BBC that the speed of the melting was faster than expected.

"It is a greater change than we could even imagine 20 years ago, even 10 years ago," Dr Holmen said.

"And it has taken us by surprise and we must adjust our understanding of the system and we must adjust our science and we must adjust our feelings for the nature around us."

The institute has been deploying its icebreaker, Lance, to research conditions between Svalbard and Greenland - the main route through which ice flows out of the Arctic Ocean.

During a visit to the port, one of the scientists involved, Dr Edmond Hansen, told me he was "amazed" at the size and speed of this year's melt.

"As a scientist, I know that this is unprecedented in at least as much as 1,500 years. It is truly amazing - it is a huge dramatic change in the system," Dr Hansen said.

"This is not some short-lived phenomenon - this is an ongoing trend. You lose more and more ice and it is accelerating - you can just look at the graphs, the observations, and you can see what's happening."

Thinner ice

I interviewed Dr Hansen while the Lance was docked at Norway's Arctic research station at Ny-Alesund on Svalbard.

Key data on the ice comes from satellites but also from measurements made by a range of different techniques - a mix of old and new technology harnessed to help answer the key environmental questions of our age.

David Shukman explains the positive feedback caused by melting polar ice

The Norwegians send teams out on to the floating ice to drill holes into it and extract cores to determine the ice's origin.

And since the early 90s they have installed specialist buoys, tethered to the seabed, which use sonar to provide a near-constant stream of data about the ice above.

An electro-magnetic device known as an EM-Bird has also been flown, suspended beneath a helicopter, in long sweeps over the ice.

The torpedo-shaped instrument gathers data about the difference between the level of the seawater beneath the ice and the surface of the ice itself.

By flying transects over the ice, a picture of its thickness emerges. The latest data is still being processed but one of the institute's sea ice specialists, Dr Sebastian Gerland, said that though conditions vary year by year a pattern is clear.

"In the region where we work we can see a general trend to thinner ice - in the Fram Strait and at some coastal stations."

Where the ice vanishes entirely, the surface loses its usual highly reflective whiteness - which sends most solar radiation back into space - and is replaced by darker waters instead which absorb more heat.

According to Dr Gerland, additional warming can take place even if ice remains in a far thinner state.

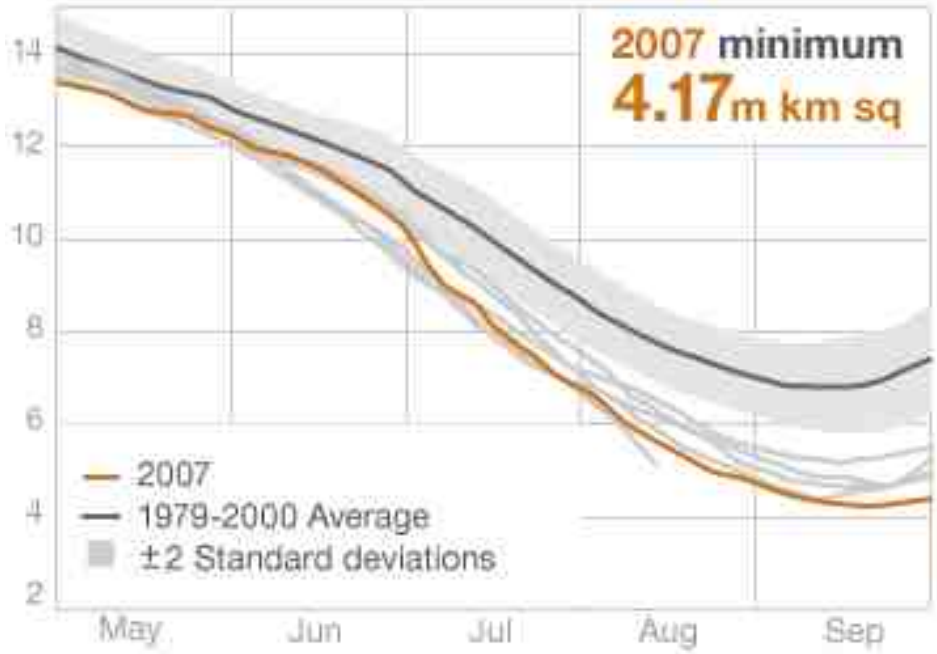
"It means there is more light penetrating through the ice - that depends to a high degree on the snow cover but once it has melted the light can get through," Dr Gerland said.

"If the ice is thinner there is more light penetrating and that light can heat the water."

Continue reading the main story

The Arctic summer melt, 2007-2012

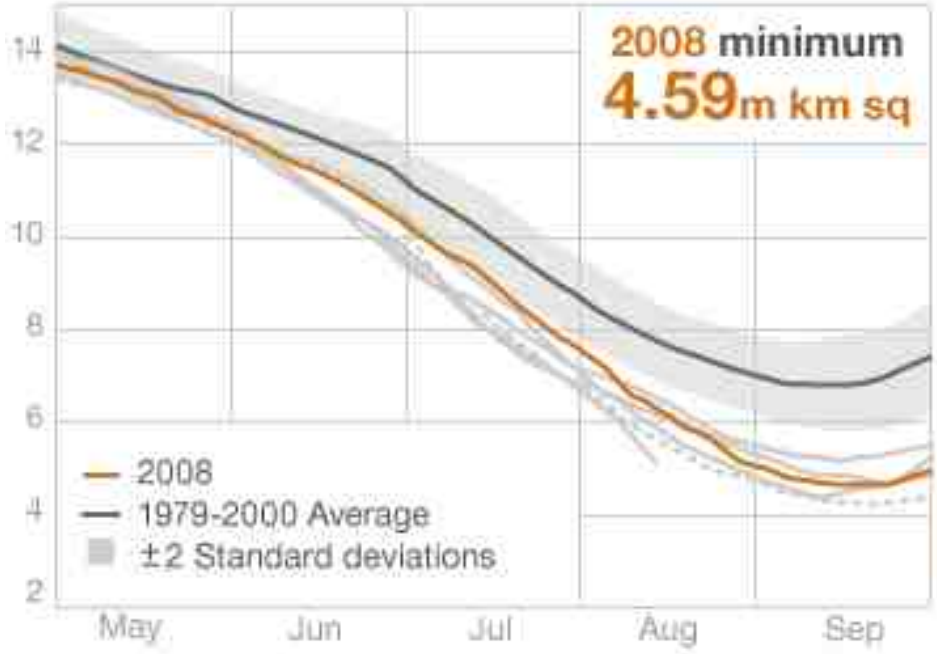
Sea ice extent, millions of kilometres squared



Source: National Snow and Ice Data Center, Boulder, Colorado

The Arctic summer melt, 2007-2012

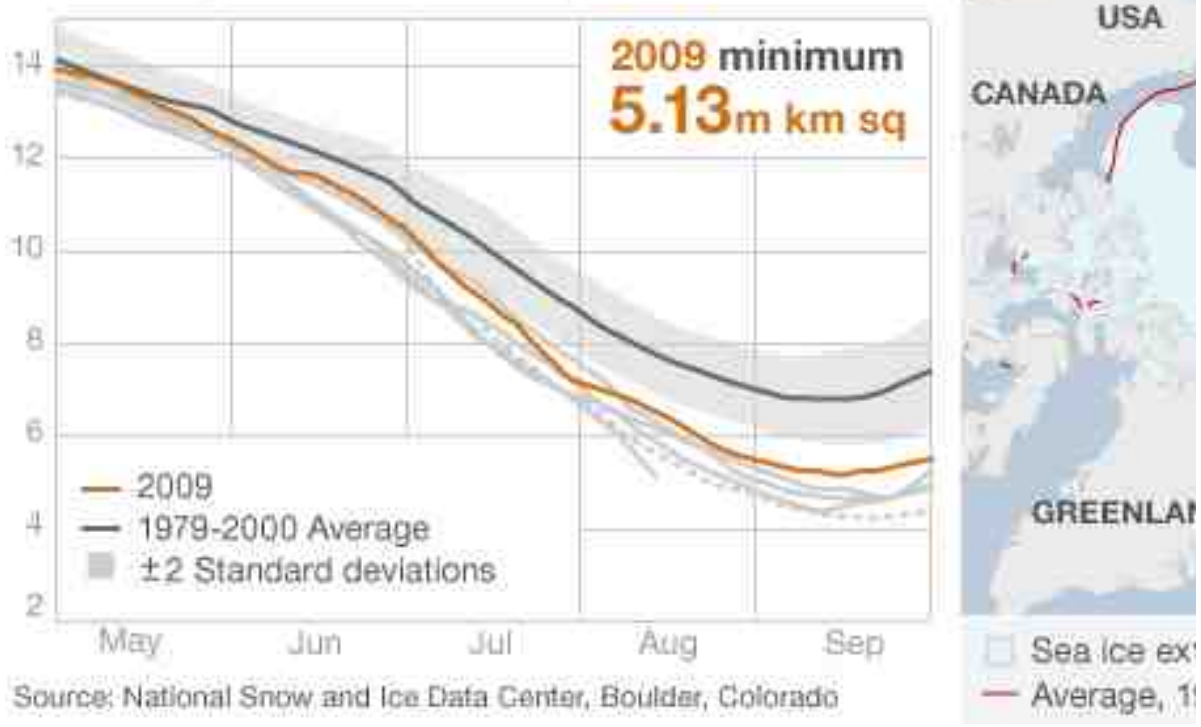
Sea ice extent, millions of kilometres squared



Source: National Snow and Ice Data Center, Boulder, Colorado

The Arctic summer melt, 2007-2012

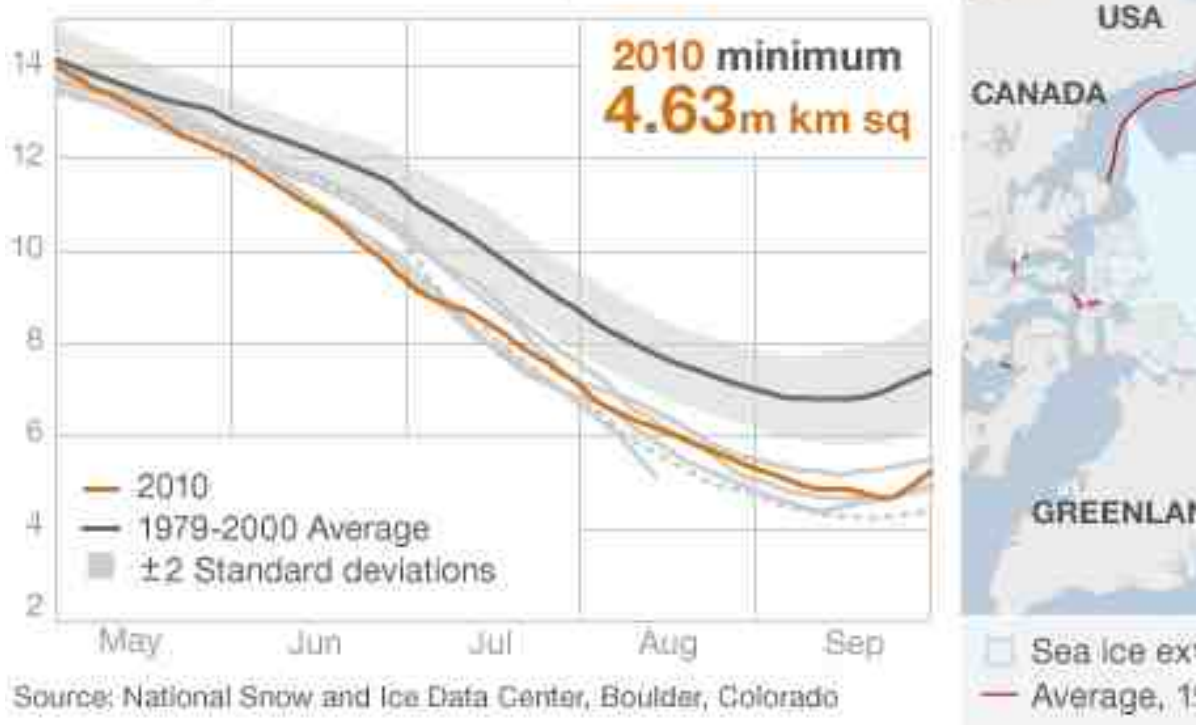
Sea ice extent, millions of kilometres squared



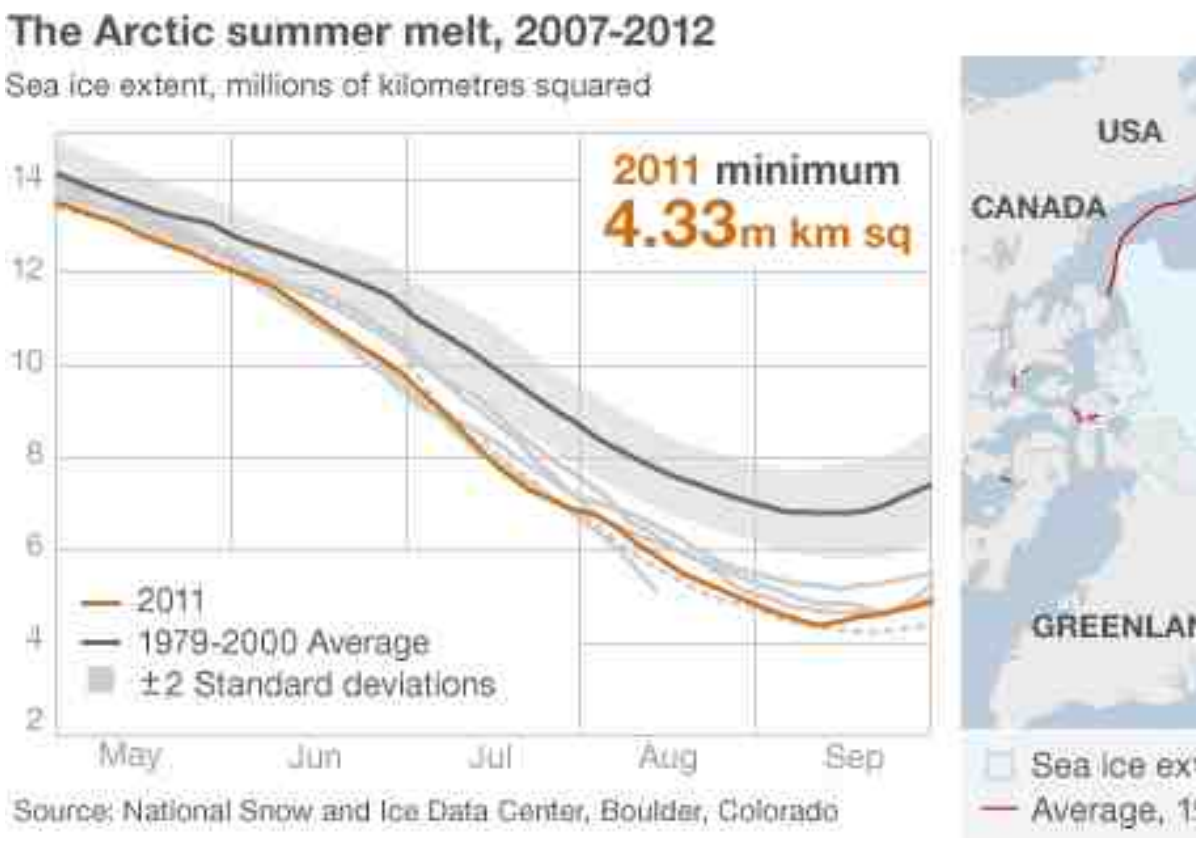
Source: National Snow and Ice Data Center, Boulder, Colorado

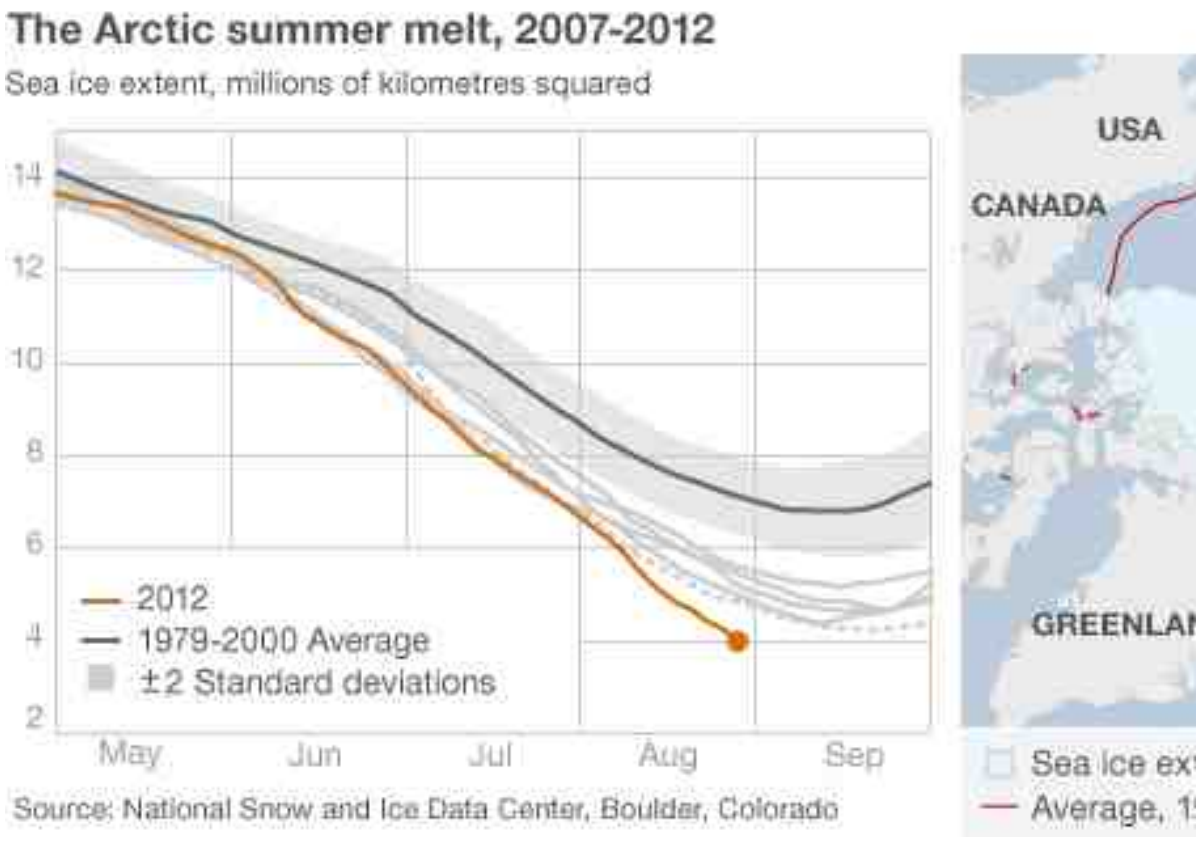
The Arctic summer melt, 2007-2012

Sea ice extent, millions of kilometres squared



Source: National Snow and Ice Data Center, Boulder, Colorado





Continue reading the main story

The most cautious forecasts say that the Arctic might become ice-free in the summer by the 2080s or 2090s. But recently many estimates for that scenario have been brought forward.

Early research investigating the implications suggests that a massive reduction in sea ice is likely to have an impact on the path of the jet stream, the high-altitude wind that guides weather systems, including storms.

The course and speed of the jet stream is governed by the difference in temperature between the Tropics and the Arctic, so a change on the scale being observed now could be felt across Europe and beyond.

Alan Thorpe of the European Weather Centre explains the link between melting ice in the Arctic and the UK's poor summer

Kim Holmen of the NPI explained how the connection might work.

"When the Arctic is ice free, it is not white any more and it will absorb more sunlight and that change will influence wind systems and where the precipitation comes.

"For northern Europe it could mean much more precipitation, while southern Europe will become drier so there are large scale shifts across the entire continent."

That assessment is mirrored by work at the European Centre for Medium-Range Weather Forecasting, based in the British town of Reading.

The centre's director-general, Alan Thorpe, said the link between the Arctic melt and European weather was complicated but it is now the subject of research.

"Where Arctic sea ice is reducing in summer - and if we have warmer than average sea surface temperatures in the north-west Atlantic - these twin factors together lead to storms being steered over the UK in summer which is not the normal situation and leads to our poorer summers."

But the research is in its earliest stages. For science, the Arctic itself is hard to decipher. The effects of its rapid melt are even tougher.