Greenland's fastest glacier reaches record speeds

EGU press release on research published in The Cryosphere

Jakobshavn Isbræ (Jakobshavn Glacier) is moving ice from the Greenland ice sheet into the ocean at a speed that appears to be the fastest ever recorded. Researchers from the University of Washington and the German Space Agency (DLR) measured the dramatic speeds of the fast-flowing glacier in 2012 and 2013. The results are published in The Cryosphere, an open access journal of the European Geosciences Union (EGU).

"We are now seeing summer speeds more than 4 times what they were in the 1990s on a glacier which at that time was believed to be one of the fastest, if not the fastest, glacier in Greenland," says Ian Joughin, a researcher at the Polar Science Center, University of Washington and lead-author of the study.

Iceberg from Jakobshavn Isbræ (Credit: Ian Joughin, PSC/APL/UW)

Iceberg-choked Jakobshavn fjord (Credit: Ian Joughin, PSC/APL/UW)

In the summer of 2012 the glacier reached a record speed of more than 17 kilometres per year, or over 46 metres per day. These flow rates are unprecedented: they appear to be the fastest ever recorded for any glacier or ice stream in Greenland or Antarctica, the researchers say.

They note that summer speeds are temporary, with the glacier flowing more slowly over the winter months. But they add that even the annually averaged speedup over the past couple of years is nearly 3 times what it was in the 1990s.

This speedup of Jakobshavn Isbræ means that the glacier is adding more and more ice to the ocean, contributing to sea-level rise. "We know that from 2000 to 2010 this glacier alone increased sea level by about 1 mm. With the additional speed it likely will contribute a bit more than this over the next decade," explains Joughin.

Jakobshavn Isbræ, which is widely believed to be the glacier that produced the large iceberg that sank the Titanic in 1912, drains the Greenland ice sheet into a deep ocean fjord on the coast of the island. At its calving front, where the glacier effectively ends as it breaks off into icebergs, some of the ice melts while the rest is pushed out, floating into the ocean. Both of these processes contribute about the same amount to sea-level rise from Greenland.

As the Arctic region warms, Greenland glaciers such as Jakobshavn Isbræ have been thinning and calving icebergs further and further inland. This means that, even though the glacier is flowing towards the coast and carrying more ice into the ocean, its calving front is actually retreating. In 2012 and 2013, the front retreated more than a kilometre further inland than in previous summers, the scientists write in the new The Cryosphere study.

In the case of Jakobshavn Isbræ, the thinning and retreat coincides with an increase in speed. The calving front of the glacier is now located in a deeper area of the fjord, where the underlying rock bed is about 1300 metres below sea level, which the scientists say explains the record speeds it has achieved. "As the glacier's calving front retreats into deeper regions, it loses ice – the ice in front that is holding back the flow – causing it to speed up," Joughin clarifies.

The team used satellite data to measure the speed of the glacier as part of US National Science Foundation (NSF) and NASA studies. "We used computers to compare pairs of images acquired by the German Space Agency's (DLR) TerraSAR-X satellites. As the glacier moves we can track changes between images to produce maps of the ice flow velocity," says Joughin.

The researchers believe Jakobshavn Isbræ is in an unstable state, meaning it will continue to retreat further inland in the future. By the end of this century, its calving front could retreat as far back as the head of the fjord through which the glacier flows, about 50 km upstream from where it is today.

This press release was originally published on the EGU website

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Ancient forests stabilised Earth's CO_2 and climate

EGU press release on research published in Biogeosciences

UK researchers have identified a biological mechanism that could explain how the Earth's atmospheric carbon dioxide and climate were stabilised over the past 24 million years. When CO_2 levels became too low for plants to grow properly, forests appear to have kept the climate in check by slowing down the removal of carbon dioxide from the atmosphere. The results are now published in Biogeosciences, an open access journal of the European Geosciences Union (EGU).

"As CO_2 concentrations in the atmosphere fall, the Earth loses its greenhouse effect, which can lead to glacial conditions," explains lead-author Joe Quirk from the University of Sheffield. "Over the last 24 million years, the geologic conditions were such that atmospheric CO_2 could have fallen to very low levels – but it did not drop below a minimum concentration of about 180 to 200 parts per million. Why?"

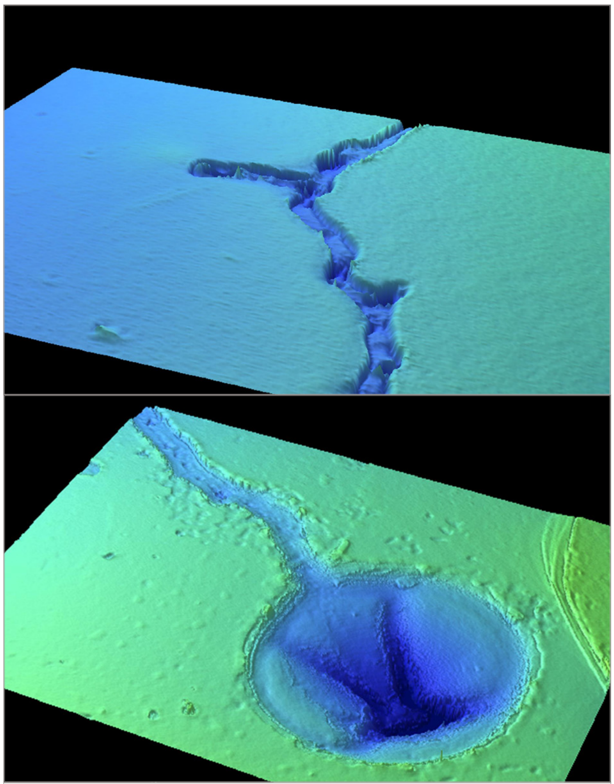
Before fossil fuels, natural processes kept atmospheric carbon dioxide in check. Volcanic eruptions, for example, release CO_2, while weathering on the continents removes it from the atmosphere over millions of years. Weathering is the breakdown of minerals within rocks and soils, many of which include silicates. Silicate minerals weather in contact with carbonic acid (rain and atmospheric CO_2) in a process that removes carbon dioxide from the atmosphere. Further, the products of these reactions are transported to the oceans in rivers where they ultimately form carbonate rocks like limestone that lock away carbon on the seafloor for millions of years, preventing it from forming carbon dioxide in the atmosphere.

Forests increase weathering rates because trees, and the fungi associated with their roots, break down rocks and minerals in the soil to get nutrients for growth. The Sheffield team found that when the CO_2 concentration was low – at about 200 parts per million (ppm) – trees and fungi were far less effective at breaking down silicate minerals, which could have reduced the rate of CO_2 removal from the atmosphere.

"We recreated past environmental conditions by growing trees at low, present-day and high levels of CO_2 in controlled-environment growth chambers," says Quirk. "We used high-resolution digital imaging techniques to map the surfaces of mineral grains and assess how they were broken down and weathered by the fungi associated with the roots of the trees."

As reported in Biogeosciences, the researchers found that low atmospheric CO_2 acts as a 'carbon starvation' brake. When the concentration of carbon dioxide falls from 1500 ppm to 200 ppm, weathering rates drop by a third, diminishing the capacity of forests to remove CO_2 from the atmosphere.

The weathering rates by trees and fungi drop because low CO_2 reduces plants' ability to perform photosynthesis, meaning less



Mineral weathering by fungi (Credit: Joe Quirk)

carbon-energy is supplied to the roots and their fungi. This, in turn, means there is less nutrient uptake from minerals in the soil, which slows down weathering rates over millions of years.

"The last 24 million years saw significant mountain building in the Andes and Himalayas, which increased the amount of silicate rocks and minerals on the land that could be weathered over time. This increased weathering of silicate rocks in certain parts of the world is likely to have caused global CO_2 levels to fall," Quirk explains. But the concentration of CO_2 never fell below 180–200 ppm because trees and fungi broke down minerals at low rates at those concentrations of atmospheric carbon dioxide.

"It is important that we understand the processes that affect and regulate climates of the past and our study makes an important step forward in understanding how Earth's complex plant life has regulated and modified the climate we know on Earth today," concludes Quirk.

This press release was originally published on the EGU website.

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Europe to suffer from more severe and persistent droughts

EGU press release on research published in Hydrology and Earth System Sciences

As Europe is battered by storms, new research reminds us of the other side of the coin. By the end of this century, droughts in Europe are expected to be more frequent and intense due to climate change and increased water use. These results, by researchers from the European Commission's Joint Research Centre (JRC) and the University of Kassel in Germany, are published in Hydrology and Earth System Sciences, an open access journal of the European Geosciences Union (EGU).

"Our research shows that many river basins, especially in southern parts of Europe, are likely to become more prone to periods of reduced water supply due to climate change," says Giovanni Forzieri, a researcher in climate risk management at the JRC and lead author of the study. "An increasing demand for water, following a growing population and intensive use of water for irrigation and industry, will result in even stronger reductions in river flow levels."

Drought is a major natural disaster that can have considerable impacts on society, the environment and the economy. In Europe alone, the cost of drought over the past three decades has amounted to over 100 billion euros. In this study, the researchers wanted to find out if and where in Europe increasing temperatures and intensive water consumption could make future droughts more severe and long-lasting.

To do this, they analysed climate and hydrological models under different scenarios. "Scenarios are narratives of possible evolutions – up to 2100 in this study – of our society that we use to quantify future greenhouse gas emissions and water consumption by different sectors," explains Luc Feyen, a hydrologist at JRC and co-author of the paper. "Climate and water-use models then translate the greenhouse gas concentrations and water requirement into future climate and water consumption projections."

The scientists then used these projected conditions to drive a hydrological model that mimics the distribution and flow of water on Earth. By running this model until 2100 for all river basins in Europe, they could evaluate how drought conditions may change in magnitude and severity over the 21st century.

The research shows that southern parts of Europe will be the most affected. Stream and river minimum flow levels may be lowered by up to 40% and periods of water deficiency may increase up to 80% due to climate change alone in the Iberian Peninsula, south of France, Italy and the Balkans.

Higher temperatures not only result in more water being evaporated from soils, trees and bodies of water, but will also lead to more frequent and prolonged dry spells, reducing water supply and worsening droughts. The emission scenario used in the study predicts that average global temperature will increase by up to 3.4°C by 2100, relative to the period 1961–1990. But the authors warn that the warming projected for Europe, particularly its southern regions, is even stronger. "Over the Iberian Peninsula, for example, summer mean temperature is projected to increase by up to 5°C by the end of this century," says Feyen.

In addition to climate warming, intensive water use will further aggravate drought conditions by 10–30% in southern Europe, as well as in the west and centre of the continent, and in some parts of the UK.

"The results of this study emphasise the urgency of sustainable water resource management that is able to adapt to these potential changes in the hydrological system to minimise the negative socio-economic and environmental impacts," Forzieri concludes.

This press release was originally published on the EGU website

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Dry river bed in a peat upland in Northern England (Credit: Catherine Moody, distributed via imaggeo.egu.eu)

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Geoengineering approaches to reduce climate change unlikely to succeed

EGU press release on research published in Earth System Dynamics

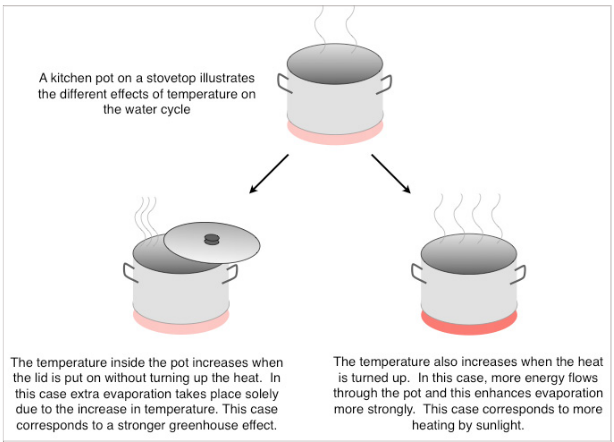
Reducing the amount of sunlight reaching the planet's surface by geoengineering may not undo climate change after all. Two German researchers used a simple energy balance analysis to explain how the Earth's water cycle responds differently to heating by sunlight than it does to warming due to a stronger atmospheric greenhouse effect. Further, they show that this difference implies that reflecting sunlight to reduce temperatures may have unwanted effects on the Earth's rainfall patterns. The results are now published in Earth System Dynamics, an open access journal of the European Geosciences Union (EGU).

Global warming alters the Earth's water cycle since more water evaporates to the air as temperatures increase. Increased evaporation can dry out some regions while, at the same time, result in more rain falling in other areas due to the excess moisture in the atmosphere. The more water evaporates per degree of warming, the stronger the influence of increasing temperature on the water cycle. But the new study shows the water cycle does not react the same way to different types of warming.

Axel Kleidon and Maik Renner of the Max Planck Institute for Biogeochemistry in Jena, Germany, used a simple energy balance model to determine how sensitive the water cycle is to an increase in surface temperature due to a stronger greenhouse effect and to an increase in solar radiation. They predicted the response of the water cycle for the two cases and found that, in the former, evaporation increases by 2% per degree of warming while in the latter this number reaches 3%. This prediction confirmed results of much more complex climate models.

"These different responses to surface heating are easy to explain," says Kleidon, who uses a pot on the kitchen stove as an analogy. "The temperature in the pot is increased by putting on a lid or by turning up the heat – but these two cases differ by how much energy flows through the pot," he says. A stronger greenhouse effect puts a thicker 'lid' over the Earth's surface but, if there is no additional sunlight (if we don't turn up the heat on the stove), extra evaporation takes place solely due to the increase in temperature. Turning up the heat by increasing solar radiation, on the other hand, enhances the energy flow through the Earth's surface because of the need to balance the greater energy input with stronger cooling fluxes from the surface. As a result, there is more evaporation and a stronger effect on the water cycle.

In the new Earth System Dynamics study the authors also show how these findings can have profound consequences for geoengineering. Many geoengineering approaches aim to reduce global warming by reducing the amount of sunlight reaching the Earth's surface (or, in the pot analogy, reduce the heat from the stove). But when Kleidon and Renner applied their results to such a geoengineering scenario, they found out that simultaneous changes in the water cycle and the atmosphere cannot be compensated for at the same time. Therefore, reflecting sunlight by geoengineering is unlikely to restore the planet's original climate.



A stronger greenhouse effect puts a thicker 'lid' over the Earth's surface but, if there is no additional sunlight (if we don't turn up the heat on the stove), extra evaporation takes place solely due to the increase in temperature. Turning up the heat by increasing solar radiation, on the other hand, enhances the energy flow through the Earth's surface because of the need to balance the greater energy input with stronger cooling fluxes from the surface. As a result, there is more evaporation and a stronger effect on the water cycle. (Credit: Max Planck Institute for Biogeochemistry)

"It's like putting a lid on the pot and turning down the heat at the same time," explains Kleidon. "While in the kitchen you can reduce your energy bill by doing so, in the Earth system this slows down the water cycle with wide-ranging potential consequences," he says.

Kleidon and Renner's insight comes from looking at the processes that heat and cool the Earth's surface and how they change when the surface warms. Evaporation from the surface plays a key role, but the researchers also took into account how the evaporated water is transported into the atmosphere. They combined simple energy balance considerations with a physical assumption for the way water vapour is transported, and separated the contributions of surface heating from solar radiation and from increased greenhouse gases in the atmosphere to obtain the two sensitivities. One of the referees for the paper commented: "it is a stunning result that such a simple analysis yields the same results as the climate models."

This press release, based on materials provided by the Max Planck Institute for Biogeochemistry, was originally published on the EGU website

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Using moving cars to measure rainfall

EGU press release on research published in Hydrology and Earth System Sciences

Drivers on a rainy day regulate the speed of their windshield wipers according to rain intensity: faster in heavy rain and slower in light rain. This simple observation has inspired researchers from the University of Hanover in Germany to come up with 'RainCars', an initiative that aims to use GPS-equipped moving cars as devices to measure rainfall. The most recent results of the project are now published in Hydrology and Earth System Sciences, an open access journal of the European Geosciences Union (EGU).

Rainfall can be very variable across different parts of a region such as Northern Germany. Conventional rain gauges are accurate, but are often distributed too sparsely to capture much of this variation. Having good information about precipitation is important for flood prediction and prevention, for example.

"If moving cars could be used to measure rainfall the network density could be improved dramatically," explains project-leader Uwe Haberlandt, who says the idea for RainCars emerged during a brainstorming session between geoinformatics researchers and hydrologists. With over 40 million cars in Germany alone, and with traffic increasing worldwide, the multi-disciplinary team might be onto a winner.

Now, with a lab equipped with a rain simulator, the researchers have been able to put their idea to the test. They placed cars with different wiper systems under the rain machine, which uses a sprinkler irrigation system with adjustable nozzles to simulate light to heavy rain, to find out exactly how wiper speed relates to rainfall intensity.

In one set of experiments, an individual in the car adjusted the wiper speed manually, depending on the windscreen visibility. "The experiments have shown that the front visibility is a good indicator for rainfall intensity," says Ehsan Rabiei, Haberlandt's collaborator and the paper's lead author. But the measurements could depend on the person adjusting the wiper speed so may not be very reliable.

In another set of experiments, the team used the rain machine to test optical sensors that are installed in many modern cars to automate wipers. The sensors use a system of infrared laser beams that detect when drops of rain accumulate on the surface of the device. Each sensor reading corresponds to a specific amount of water, with more frequent readings corresponding to more intense rainfall.

"The optical sensors measure the rain on the windshield in a more direct and continuous manner so, currently, they would be the better choice for rain sensors in cars," says Haberlandt.

The team could also test the effects of car movement on the measurements by placing the sensors on a rotating device, which simulates car speed, under the rain simulator. By knowing how the readings are affected by car speed, they can correct for this effect when using moving cars to measure rainfall.

A car tested under a rain simulator. An individual in the car adjusts the wiper speed manually depending on the windscreen visibility. The visibility is related to the intensity of the rain. This is set by the rain simulator, a machine that uses a sprinkler irrigation system with adjustable nozzles to simulate light to heavy rain. (Credit: www.ikg.uni-hannover.de, Daniel Fitzner)

But speed is not all that can alter the rain measurements, as Rabiei explains. "Our experiments so far were carried out in an ideal and controlled environment. In nature there are external effects like wind, spray from other cars or shielding trees that can affect the readings, and rainfall characteristics are different from the rain simulator."

However, Haberlandt clarifies, "the value of using moving cars to measure rainfall is not about a higher accuracy of rainfall measurements but about a much higher number of measurement points." In a Hydrology and Earth System Sciences study published in 2010, two of the team members showed that a high number of less accurate rain gauges gives more reliable rainfall readings than a low number of very accurate devices.

The researchers are already working on field experiments using cars to measure real rainfall in and around the city of Hanover. "There are some volunteers, a taxi company and a car company involved in the field experiments. We certainly would like to have some more people engaged."

This press release was originally published on the EGU website

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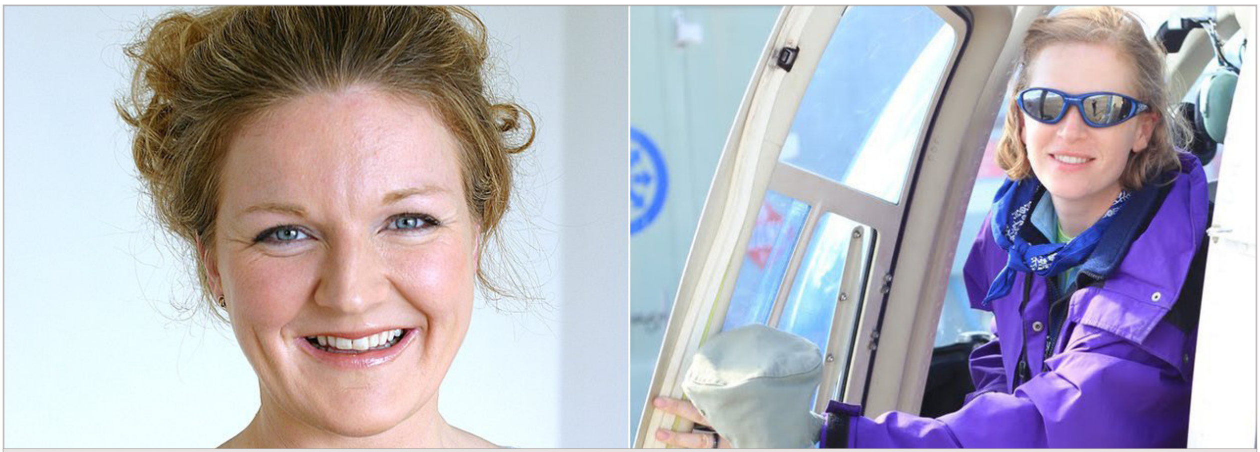
Sybille Hildebrandt and Chelsea Wald awarded EGU Science Journalism Fellowship



Sybille Hildebrandt and Chelsea Wald (Credit: right – Ben Shaw)

The European Geosciences Union (EGU) has named journalists Sybille Hildebrandt and Chelsea Wald as the winners of its 2014 Science Journalism Fellowship for projects on palaeontology, geochemistry and the origin of animal life, and on soil sciences and forensics, respectively. Hildebrandt will receive €3,500 to join a research team travelling to the Canadian Rockies, and Wald €1,500 to cover expenses related to a trip to Scotland.

Sybille Hildebrandt's proposal focuses on the recent discovery of a fossil mine near the Burgess Shale that has an abundance of early animal fossils that can provide important clues to solve the mystery of the origin of animal life. She will be accompanying a Danish team on a summer field trip to the mine where researchers will study the fossils and harvest geochemical samples.

Chelsea Wald proposes to report on a story that shows how soil science techniques can help in solving crimes. She will be travelling to Scotland where she will follow soil scientist Lorna Dawson of the James Hutton Institute in Aberdeen and colleagues as they test new methods at a mock crime scene.

Hildebrandt is a freelance journalist and press consultant based in Copenhagen, Denmark. She previously worked as a journalist for the Danish science website Videnskab.dk and as an editor at the popular science magazine Science Illustrated. Wald is a freelance science, health and environment writer based in Vienna, Austria. Her stories have appeared in Science, New Scientist, and Nautilus, among other renowned publications.

This press release was originally published on the EGU website

More information

The EGU Science Journalism Fellowship is an annual competition open to professional journalists wishing to report on ongoing research in the Earth, planetary and space sciences. The winning proposals receive up to €5K to cover expenses related to their projects. This support is intended to allow the fellows to follow geoscientists on location and to develop an in-depth understanding of their questions, approaches, findings and motivation.