Greenland sets melt records in 2015 consistent with 'Arctic amplification'

June 9 2016

Study recorded record melts in Greenland. Credit: Professor Edward Hanna of the University of Sheffield

Following record-high temperatures and melting records that affected northwest Greenland in summer 2015, a new study has provided the first

evidence linking melting in Greenland to the anticipated effects of a phenomenon known as Arctic amplification.

Arctic amplification is the faster warming of the Arctic compared to the rest of the Northern Hemisphere as sea ice disappears.

It is fuelled by a feedback loop: rising global temperatures are melting Arctic sea ice, leaving dark open water that absorbs more solar radiation which in turn warms the Arctic even more.

Arctic amplification is well documented, but its effects on the atmosphere are more widely debated.

One hypothesis suggests that the shrinking temperature difference between the Arctic and the mid-latitudes will lead to a slowing of the jet stream, which circles the northern latitudes and normally keeps frigid polar air sharply separated from warmer air further south.

Slower winds could create wilder swings of the jet stream, allowing warm, moist air to penetrate further north.

The new study, published in *Nature Communications* and conducted by researchers from the University of Sheffield and Columbia University's Lamont-Doherty Earth Observatory, among several other institutes, shows that those anticipated effects occurred over northern Greenland during the summer of 2015, including a northern swing of the jet stream that reached latitudes never before recorded in Greenland at that time of year.

Edward Hanna, Professor in Climate Change in the Department of Geography, University of Sheffield, said: "Our results show the effects of a strongly warming Arctic and disturbed atmospheric jet stream on causing a record melt of the far northern reaches of the Greenland Ice

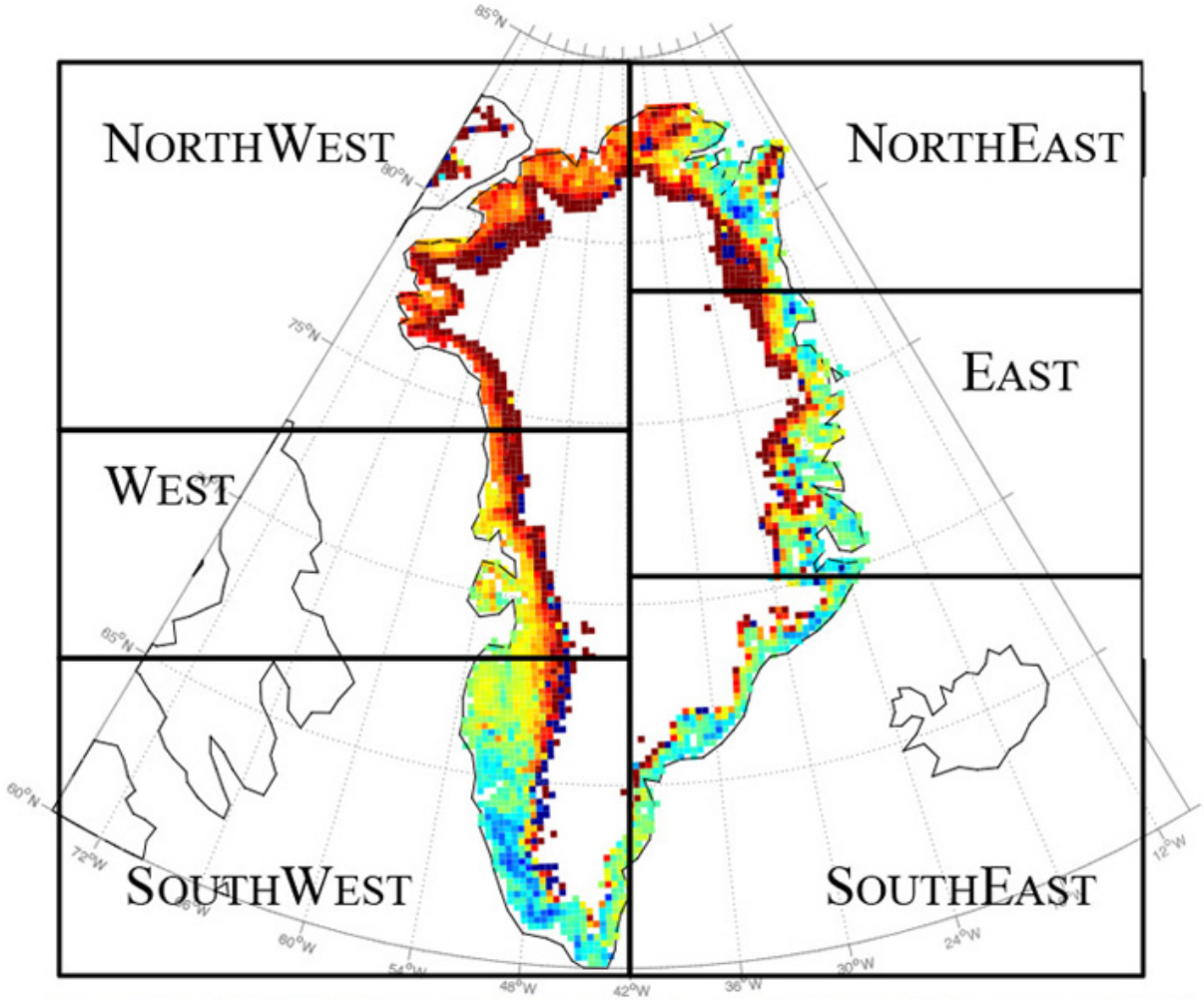
Sheet last summer.

"The study is closely linked to ongoing work conducted at the University of Sheffield which analyses the connection between Arctic climate change and extreme weather events across the densely-populated northern hemisphere mid-latitudes."

Professor Marco Tedesco, Research Professor at Columbia University's Lamont-Doherty Earth Observatory and adjunct scientist at NASA Goddard Institute for Space Studies is the lead author of the study.

"How much and where Greenland melts can change depending on how things change elsewhere on Earth," he said.

"If loss of sea ice is driving changes in the jet stream, the jet stream is changing Greenland, and this, in turn, has an impact on the Arctic system as well as the climate. It's a system, it is strongly interconnected and we have to approach it as such."



Changes in runoff from the Greenland ice sheet during July 2016 compared to the 1981-2010 mean. Redder colors indicate more runoff. Credit: Tedesco *et al.*, *Nature Communications, 2016*

The Greenland ice sheet, Earth's second largest after Antarctica, holds enough ice that, if it were to melt entirely, it would raise average global sea level by about seven meters. Understanding the drivers of melting is critical to understanding how quickly and by how much sea level will rise in the future and how Greenland's freshwater runoff will affect ocean circulation and ecology.

Northwest Greenland's summer of melt started in June 2015, when a high-pressure ridge squeezed off from the jet stream, the study shows. It moved westward over Greenland until it sat over the Arctic Ocean and affected weather across the island through mid-July.

That high-pressure system, called a cut-off high, brought clear skies and warmed northern Greenland, helping set records for surface temperature and meltwater runoff in the northwest, the study shows. With less summer snow falling and melting underway, northern Greenland's albedo, or reflectivity, also decreased. A less-reflective surface absorbs more solar energy, which feeds more melting, as Tedesco illustrated in a study earlier this year on the darkening of Greenland.

Northern Greenland also set an unusual July record for wind: the winds blew east to west on average, rather than the usual west to east; only two other years on record show easterly winds on average in July, both slower. At the same time, the jet stream's northernmost ridge swung farther north than ever recorded for that month, passing 76 degrees North latitude, nearly two degrees further north than the previous July record, set in 2009, the authors write.

The same atmospheric pattern had a different impact on southern Greenland, where new melting records have been set over the past decade. The south saw more snow during summer of 2015 and less melting than previous years.

The authors stop short of confirming Arctic amplification as the cause of the warming, but they say the results fit the anticipated effects of Arctic amplification described by Jennifer Francis of Rutgers University and Stephan Vavrus of the University of Wisconsin in a 2012 paper.

Recent studies exploring the potential effects of Arctic amplification have showed that high-pressure blocks connected to northward swings of

the jet stream have become more common near Greenland.

Professor Hanna also released a study in May using the Greenland Blocking Index to measure the strength of stationary high-pressure systems over the past 165 years and found that seven of the top 11 systems had occurred since 2007.

"The significant increase in Greenland high-pressure blocking that has occurred in the last 20 to 30 years is clearly related to recent record warming over the region, as well as jet-stream changes," he said.

"This makes it more likely than not that within the next five to 10 years we will witness further record Greenland melt events like in 2012 and 2015."

Whether the patterns seen in 2015 will continue in the future remains to be seen. This spring, Arctic sea ice set another record low for its maximum extent for the year.

"Greenland also experienced early season melt in early April of this year comparable to April 2012. Record setting melt occurred later that summer, but it is too early to tell whether the same will hold true in 2016," said co-author Thomas Mote of the University of Georgia.

"The conditions we saw in the past aren't necessarily the conditions of the future," Tedesco said. "If humans change the forcing, we are going into uncharted territory."

More information: M. Tedesco et al, Arctic cut-off high drives the poleward shift of a new Greenland melting record, *Nature Communications* (2016). DOI: 10.1038/ncomms11723

Provided by University of Sheffield