Researchers shed new light on supraglacial lake drainage

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Helicopter view of a supraglacial lake over West Greenland. Credit: Dr. Marco Tedesco.

bodies of water that collect on the surface of the Greenland ice sheet – lubricate the bottom of the sheet when they drain, causing it to flow faster. Differences in how the lakes drain can impact glacial movement's speed and direction, researchers from The City College of New York (CCNY), University of Cambridge and Los Alamos National Laboratory report in *Environmental Research Letters*.

"Knowledge of the draining mechanisms allows us to improve our understanding of how surface melting can impact sea-level rise, not only through the direct contribution of meltwater from the surface, but also through the indirect contribution on the mass loss through ice dynamics," says Dr. Marco Tedesco, the principal investigator and lead author.

Dr. Tedesco is an associate professor in CCNY's Department of Earth and Atmospheric Sciences at CCNY and is currently serving as temporary program director for the National Science Foundation's Polar Cyberinfrastructure Program. The research described in the paper was funded before Dr. Tedesco accepted the position at NSF.

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Over the past decade, surface melting in Greenland has increased considerably.

Previous research already suggested that the water injected from the rapid draining of the supraglacial lakes controlled sliding of ice over the bed beneath it. However, there was no evidence of the impact of the slow draining mechanism, which the paper identified.

Professor Tedesco and colleagues documented that supraglacial lakes have two different drainage mechanisms that cause them to empty rapidly or slowly. The findings are based on analysis of data collected in 2011 from five GPS stations the team installed around two supraglacial lakes in the Paakistoq region of West Greenland.

The smaller of the two lakes, Lake Half Moon, overflowed its banks and drained from the side to reach a moulin. It took approximately 45 hours to empty. The larger lake, Lake Ponting, drained through a crack in the ice beneath it and was voided in around two hours.

"At first, a crack in the ice beneath the lake may be small, but it deepens as water enters it because the pressure of the water overcomes the compressive action of the ice, which is trying to close the crack," Professor Tedesco explains. "When the crack reaches the bed beneath the glacier, which could be 1,000 meters or more below the surface, the lake empties rapidly, like a bathtub after its plug is pulled."

Drainage from both lakes accelerated glacial movement. However, water from Lake Ponting caused the glacier to move faster and further. While the slower drainage from Lake Half Moon caused the glacial pace to increase from baseline values of 90 – 100 meters per year to a maximum of around 420 meters a year, glacial movement in the area affected by Lake Ponting reached maximum velocities of 1,500 – 1,600 meters per year, nearly four times greater.

The drainage of the two lakes impacted the glacier's trajectory differently, as well. The emptying of Lake Half Moon via the moulin did not change the direction of glacial movement. However, when Lake Ponting drained a slight southerly shift in the glacier's direction was detected.

"Because the different draining mechanisms affect ice velocity, they could also affect the amount of ice lost through calving of glaciers, which results in icebergs," Professor Tedesco points out. "Because what happens on a glacier's surface impacts what is going on below, researchers are trying to look at glaciers as a system instead of independent components," he adds.

"The surface is like the skin of a tissue and the subglacial and englacial channels that develop because of the surface water act like arteries or veins that redistribute this water internally."

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