NATURE | NEWS

Witnessing a glacier's race to the sea

Video of retreating Alaskan ice is helping to quantify glacial contribution to sea-level rise.

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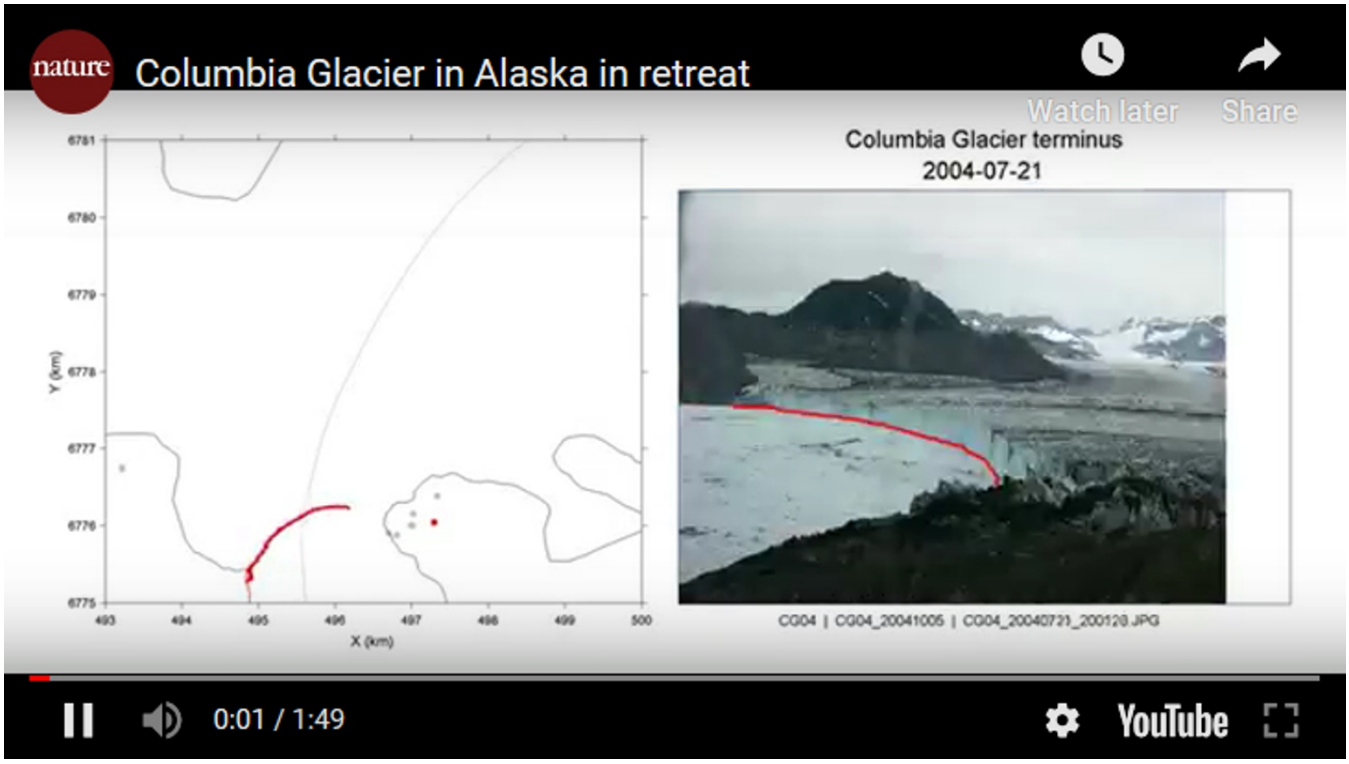

A seven-year photographic record of the Columbia Glacier in Prince William Sound on Alaska's south central Pacific coast has been made into a striking time-lapse video that documents the glacier's rapid ice discharge, and is helping researchers to understand how tidewater glaciers contribute to sea-level rise.

The video — assembled by the glaciologist William Pfeffer from the University of Colorado Boulder — shows large chunks of ice splitting off from the terminus of the main glacier and flowing out to sea. The glacier began to retreat rapidly in the early 1980s after being relatively stationary for well over a century. By spilling some 150 cubic kilometres of ice into the ocean, the glacier's terminus has retreated by roughly 20 kilometres.

Pfeffer began taking regular photos of the glacier's terminus in 2004. He has now assembled hundreds of images into a movie to animate glacier flow, which he presented at the International Polar Year 2012 scientific meeting in Montreal, Canada, on 25 April.

Slippery slope

For a typical mountain glacier, the ice flows faster as it gets thicker and steeper. But the dynamics of glaciers that advance into coastal waters are different: as ice is pushed into the ocean, it thins and becomes buoyant, lifting the weight off its bottom face and reducing friction with the ground below.

"Think of yourself in a pool. As you walk into the water, it gets deeper and deeper, so more of your weight is being carried by the buoyancy forces of the water, so your feet start to lose contact with the bottom of the pool. If that's the only thing that is keeping you from sliding forward, then as the water gets deeper, you're going to slip forward more easily," says Pfeffer.

The glacier became ungrounded in 2007. This was the first time scientists could directly observe the transitions between the floating and grounded states in a temperate tidewater glacier.

Pfeffer compared the thickness of the ice at the terminus of the glacier with the depth of the water, he found that the glacier became

unstable when the ratio dipped below four-thirds. He hopes that by studying the glacier, he will be able to estimate when other tidewater glaciers will become unstable, start to shed ice and contribute to sea-level rise.

Glaciers' potential to affect sea-level rise as Earth warms is underappreciated, says Pfeffer. If the Antarctic ice sheet melted it would raise global sea levels by 60 metres. “But that doesn’t really matter on the human time scale,” says Pfeffer. In the near term a more immediate concern is what is happening with the world’s glaciers and ice caps which — excluding those in Greenland and Antarctica — lost 148 gigatonnes per year between January 2003 and December 2010[1]. “Seventy-six percent of the glacial mass of sea-level rise is coming from Arctic North America,” says Martin Sharp, a glaciologist at the University of Alberta in Edmonton. “The Arctic is now the largest contributor to sea-level rise outside of the two largest ice sheets.”

“These glaciers are melting fast," says Pfeffer. "They’re small buckets with very large holes in them.”

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References

1. Jacob, T., Wahr, J., Pfeffer, W. T. & Swenson, S. *Nature.* **482**, 514–518 (2012).