Greenland and Antarctic ice sheet melting, rate unknown

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The Greenland and Antarctica ice sheets are melting, but the amounts that will melt and the time it will take are still unknown, according to Richard Alley, Evan Pugh professor of geosciences, Penn State.

In the past, the Greenland ice sheet has grown when its surroundings cooled, shrunk when its surroundings warmed and even disappeared completely when the temperatures became warm enough. If the ice sheet on Greenland melts, sea level will rise about 23 feet, which will inundate portions of nearly all continental shores. However, Antarctica, containing much more water, could add up to another 190 feet to sea level.

"We do not think that we will lose all, or even most, of Antarctica's ice sheet," said Alley. "But important losses may have already started and could raise sea level as much or more than melting of Greenland's ice over hundreds or thousands of years," Alley told attendees today (Feb 16) at the annual meeting of the American Association for the Advancement of Science.

Warming is expected to cause more precipitation on Greenland and Antarctica, adding snow. Previously, many scientists suggested that this would offset increasing melting. However, recent studies show that the ice sheets on both Greenland and in Antarctica are melting faster than the snow is replacing the mass.

A number of things can contribute to the increased rate of melting in Greenland and Antarctica. Large lakes of water on the ice in Greenland

pose a problem. This water, by wedging open a crack or crevasse in the ice, quickly flows through to the bottom, melting the bottom of the ice sheet and causing it to move more rapidly toward the ocean. Observers have seen lakes on the Greenland ice sheet drain at the speed of Niagara Falls.

All ice sheets spread due to their large mass, but friction from the rocks beneath slows the ice's motion. Water beneath the ice allows the ice to move more rapidly.

"Right now, the center of the Greenland ice sheet is frozen to the rocks," says Alley. "If the melt water moves inland as the world warms and gets to the bottom, it will thaw the bottom and unstick the ice from the rocks."

Another contributor to the melting ice sheets is the warming of the ocean. When ice shelves -- ice still connected to the ice sheet but floating over water -- melt, they also cause the ice sheet to flow faster. In Greenland, the Jakobshavn ice shelf has retreated more than 5 miles since 1992. Rocks and cliffs on the sides of fiords or inlets slow the seaward movement of the ice shelves. If these shelves break up and melt, the ice streams behind them move more rapidly.

Ice shelf failures have also occurred on Antarctica where, for example, most of the Larsen B ice shelf disintegrated in March of 2002 and increased the rate of ice stream flow eight times.

"Water temperature is more important than air temperature in melting the ice shelves," says Alley. "However, both contribute."

Warmer oceans, caused by general global warming or local events can trigger more breakups of ice shelves and faster flow of ice streams in Antarctica. In Greenland, sustained increase in temperatures of only a

few degrees will remove the ice.

Alley believes he knows the direction to go to gain a better understanding of the ice sheets, how they work and the effect they have on climate change. Although those who study ice sheets have long modeled ice sheet behavior, simulations of the whole earth system typically have not included ice sheets along with the atmosphere, oceans and clouds, in their models. Past atmospheric modelers usually treated the ice sheets simply as white mountains.

"They are not white mountains and they need to be modeled," said Alley. "We need to have them in the models to figure out how the system works."

Alley notes that a collaboration of government and academic scientists created the atmospheric and ocean models, but collaborations to model the ice are only just being developed.

Source: Penn State