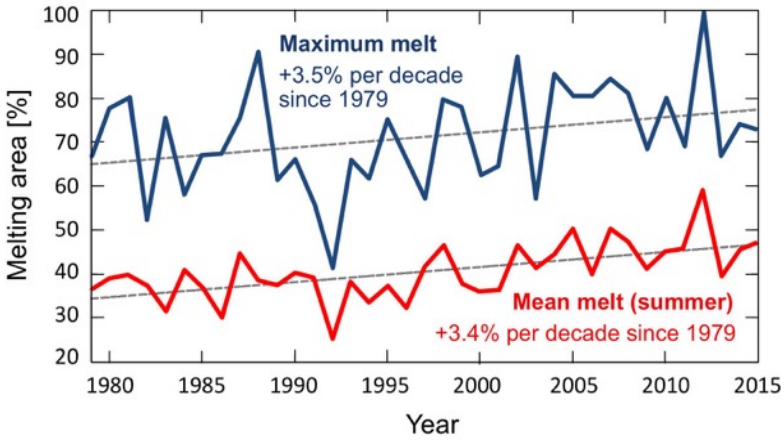
Disappearing Sea Ice Fuels Greenland Melt

THE ISSUE. Greenland's ice sheet is melting at an accelerating pace, augmenting sea-level rise and altering ocean currents and weather patterns in the Atlantic and beyond.

WHY IT MATTERS. In only a few decades, half of the summertime Arctic sea ice has disappeared, an area equal to that of the United States east of the Mississippi. During the same period, increasingly large areas of Greenland's ice sheet have experienced increased surface melting during summer, adding several hundred billion tons of meltwater to the ocean.[1] When land ice melts, it contributes directly to sea-level rise, a growing threat for coastal cities and communities worldwide. We know that human-induced global warming is the main driver of sea-ice loss. Current research suggests that disappearing sea ice is contributing to accelerated Greenland melt.[2]

STATE OF THE SCIENCE. In a typical year before 2000, about 30-40% of Greenland's surface experienced melt (see figure). Since 2000, the area has steadily increased, with new records set in 2007, 2010, then in 2012 jumping to an astonishing 97%. In the summer of 2015, the melt was again extensive, but it occurred mainly in far northern regions rather than the more typical southern areas.[3] This year, both sea ice and Greenland surface melting are on a pace to rival the records set in 2012.

A key culprit in causing these extreme Greenland melt seasons is a prolonged north-flowing wind pattern that brings warm, moist air over the ice sheet. These wind patterns are usually associated with an atmospheric "blocking high," in which upper-level winds spin off an eddy, a separated loop of circulating air. As the name suggests, these blocks tend to remain in place for days to weeks, preventing weather systems from progressing eastward as they normally would. By creating a persistent pattern, what begins as unusual weather becomes an extreme event.



Maximum and mean area of Greenland that experienced surface melt, 1979-2015 (Courtesy: M. Tedesco/LDEO-Columbia Univ.).

New research suggests that atmospheric blocks are occurring more often, especially in the Atlantic region in summer.[4] While the causes of this trend are still under investigation, sea-ice loss appears to be a crucial factor.[5] In years of substantially reduced sea ice, the resulting surface warming favors larger northward swings in the upper-level winds that can lead to blocking and northward transport of heat and moisture that enhance melt on Greenland's surface. If blocking events continue to increase, so should the extent and duration of melt.

Blocking is not only an issue for Greenland, it is also known to cause persistent weather conditions on both sides of the North Atlantic. Prolonged dry periods can lead to drought, and incessant storms can lead to flooding. Both of these types of extreme events have occurred more often in recent decades.[6,7]

Increased runoff from Greenland has additional significant consequences. A large area of unusually fresh ocean water has formed southeast of Greenland in the past few years, and recent studies have linked it to the extra Greenland runoff as well as to increased freshwater from the Arctic Ocean due to more rapid springtime snowmelt on land.[8] Fresher water is less dense, thus it resists mixing with the underlying ocean. Through this reduced mixing, the freshening is believed to be slowing the major current system of the Atlantic as well as creating a pronounced cool area to the south of Iceland. This "Cool Blob" of ocean temperatures may be affecting the strength and location of the Atlantic storm track, creating unusual conditions in Europe (e.g., more frequent storms and flooding).

WHERE THE SCIENCE IS HEADED. The climate system is a complicated web of interconnected forces and consequences. The links in the chain described above are consistent with basic laws of physics and with our understanding of the climate system, but the rapidly changing Arctic will undoubtedly present new puzzles and surprises. The effects of an increasingly ice-diminished Arctic Ocean, and far earlier snowmelt in the northern hemisphere, are bound to be substantial – huge areas of the north that used to remain white for most of the year are now dark ocean or dark land for far longer, changing the Earth's energy balance in a profound way. Runoff from Greenland is now at a scale where, among other things, impacts on ocean circulation are likely and may already be occurring as noted above. Research is focusing on better observing, understanding, and predicting the effects of ice loss and unprecedented rates of Arctic warming on the United States and beyond.

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