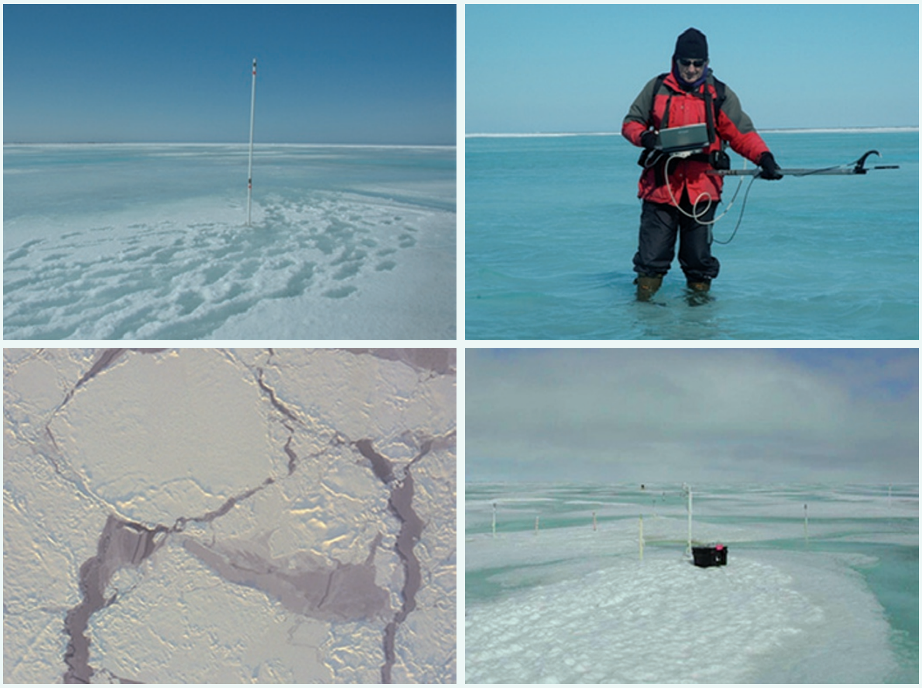
SNAPSHOT

Arctic ice turns to the dark side

It is well known that the minimum summer Arctic sea-ice cover has shrunk by about a third since 1979, at an average rate of more than 10% per decade. Less well appreciated is the fact that the proportion of thick, old ice that lasts from one year to the next is shrinking even faster, at about 15% per decade (*J. Clim.* **25,** 1176–1193; 2012). In the mid-1980s, about 75% of Arctic spring ice was 'multiyear', but by 2001 that had plummeted to 45% (*Geophys. Res. Lett.* **38,** L13502; 2011).



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The age of the ice makes a difference to the albedo, or the amount of sunlight reflected by the surface throughout the year. 'Seasonal' ice, which grows in the late autumn and melts in the early summer of each year, tends to accumulate only a thin layer of about 5 cm of snowpack in the spring. Multiyear ice, however, gathers about 20–30 cm of snow in late August and September, before the seasonal ice has had a chance to form. This means that the snow on seasonal ice melts more quickly in the early summer, revealing ice and melt ponds that soak up more sunlight than highly reflective snow. Seasonal ice also tends to be smoother than multiyear ice, as the latter accumulates bumps and ridges from year after year of melting and refreezing. So the melt ponds spread out more on seasonal ice than they do on multiyear ice. "You get a period of about a week where pretty much the entire surface is flooded," says Don Perovich of the US Army Cold Regions Research and Engineering Laboratory in Hanover, New Hampshire.

Although these effects have been relatively well understood in theory, they have not been well quantified in the field. Sea-ice albedo is often measured from satellites, which do not take much data during the summer melt, when their view is blocked by clouds. That used to be sufficient. "In the old days there was a lot more multiyear ice; that's what people were interested in and what people studied," says Perovich. Now, though, he says the community is trying to understand the seasonal-ice cycle better.

Perovich and his colleague Christopher Polashenski, also of the Cold Regions Research and Engineering Laboratory, spent four years taking daily measurements of the albedo of seasonal ice during May and June, about a kilometre offshore of Barrow, Alaska. "We'd get there when the Sun came up for the season, and stay as long as we could go out onto the ice," says Perovich. Eventually the melt ponds would become so pervasive that it would be impossible to navigate out through the maze of water to their equipment. "If you fall in, it's not a big deal so long as you have a good way out," he says. "At one point or another you get wet. If no one saw, you shrug it off and pretend it never happened." Standing around in freezing temperatures with wet feet is "what makes it fun to do," laughs Perovich.

Their data show that the albedo of both multiyear and seasonal ice starts at about 0.85 when it is covered with dry snow in early May. When ponds form in June, the albedo of seasonal ice drops to 0.3, whereas that of multiyear ice stays at about 0.5. By the time open water is seen in August, the area previously covered by seasonal ice has dropped to less than 0.1, whereas multiyear ice is still at 0.4. (The researchers added in data from previous ship studies for the time periods when the ice was too thin for them to safely venture out.) Over the course of the entire season, nearly 40% more energy enters an ocean system with seasonal sea-ice cover than one with multiyear ice, they conclude in a recently published study (*Geophys. Res. Lett.* **39,** L08501; 2012).

Previous work has shown that young ice can take different forms, which again affects the albedo (*Eos* **10,** 81–82; 2009). When patches of open water are small and surrounded by ice packs, as has been common in the past in the Arctic, the water is protected from wind-whipped waves. In such calm conditions, young ice forms in unbroken sheets called nilas. But when there is more open water and more waves, ice crystals tend to form into round 'pancakes' of thin ice a metre or two in diameter, with dark water in between. Perovich says they have a 'mini Arctic' in their lab — a pool some 20 m by 7 m and 2 m deep — in which they can study such thin-ice effects.

Such data are being collected in an attempt to improve models of ice disappearance and temperature rise in the Arctic. "That's a big area of interest now," says Perovich.

NICOLA JONES