No 'Tipping Point' for Sea Ice in Polar Bears' Future

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Polar bears may be threatened, but they aren't yet doomed.

While Arctic sea ice will continue to retreat under the glare of rising global temperatures, the ice is unlikely to collapse in spectacular fashion, causing hope that, with aggressive greenhouse gas emissions cuts and wildlife management, polar bears may retain viable habitat into the next century, a team of scientists reports in a paper to be published tomorrow in *Nature*.

Several years ago, government scientists projected that two-thirds of

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the world's polar bears would go extinct by midcentury under current emissions scenarios, a finding that ultimately prompted the George W. Bush administration to list the bear as threatened. Those estimates, though uncertain in their specifics, remain unchanged by the current work, said Steven Amstrup, senior scientist at Polar Bears International and former biologist for the U.S. Geological Survey, who co-authored both studies.

However, what seems increasingly unlikely is that the retreat of summer sea ice -- the base for bears' pursuit of seals, their highway system and their mating grounds -- could cascade out of control. Rather, its decline is entirely contingent on controlling human emissions of greenhouse gases, Amstrup said.

"Conserving polar bears largely seems to be a matter of containing temperature rise," he said.

The notion that no "tipping point" exists for Arctic ice decline has spread in climate science for several years, supported by deeper examination of the North's physics. Initially, the media exaggerated fears that the loss of ice, which naturally reflects light, would expose more heat-absorbing water to the sun, causing runaway decline. However, scientists now widely believe this feedback is balanced by a host of other phenomena, like increased flows of hot air from the tropics, improved ice formation efficiency under thinning conditions and the region's general cloudiness.

The sea ice episode should be a cautionary tale, wrote Dirk Notz, a climatologist at the Max Planck Institute for Meteorology, last year. Melting thresholds likely exist for land-bound glaciers in Greenland and Antarctica, he said, and scientists should not risk their credibility by conflating those claims with Arctic sea ice. Most prominently, NASA climatologist James Hansen has included Arctic ice in his list of possible tipping points, along with melting permafrost, glacier melt and ecosystem collapse.

Despite the growing scientific awareness that ice loss has an inch-by-inch relationship to rising temperatures, though, the public has largely been left with the message that prospects were grim for polar bears, no matter what steps were taken to limit global warming, Amstrup said. That message was hardly a call to action and, more importantly from a scientific view, lacked validity.

"If people and leaders feel there's nothing they can do, they will do nothing," he said.

'Messy literature'

The projections published by Amstrup should be taken with a grain of salt, independent scientists said. Most models incorporating sea ice fall short of predicting the actual loss seen in the Arctic over the past several decades, and systems like cloud cover are not well understood. Indeed, over the past few years a sometimes acrimonious debate has arisen as to whether existing ice models were unintentionally introducing errors to compensate for errors.

However, despite these gross differences, there's one thing nearly every model agrees on: that there is a gradual relationship between rising temperatures and ice loss, said Michael Winton, an Arctic modeler at the Geophysical Fluid Dynamics Lab at Princeton University.

Arctic sea ice is a "messy literature," Winton said. Substantial natural variability is needed to match even the most sensitive models, like the one used in the *Nature* study, to observed changes, he said. "The outstanding question is, 'Are the models sufficiently sensitive? Are we missing something?'"

Given these uncertainties, it has been perplexing to scientists that the public seized on "tipping point" scenarios for sea ice, the one area where there is large agreement. Those fears, which peaked in 2007, were likely exacerbated by the stark retreat in sea ice that year. The Arctic lost more than 1.6 million square kilometers of ice, an area larger than Alaska; by September, sea ice covered half the area it had during the early 1950s.

However, since that shocking decline, the ice has modestly expanded during the summer, perhaps the best evidence that Arctic ice won't drop off a cliff, said Eric DeWeaver, a co-author on the *Nature* paper and physical climatologist at the National Science Foundation.

The 2007 loss was "spectacular," he said, but "one would not expect to see it very often."

Scientists do expect that ice fluctuations will become increasingly steep and difficult to predict, largely thanks to the floes' declining girth. Simply put, the thinner ice is more susceptible to the weather.

Sweltering summers will cause large retreats in sea ice, while chilly years will cause equally large increases. (The mid-1990s saw a one-year ice advance almost as large as the 2007 loss.) The era of Arctic ice impassively gliding through these variations is over.

It's uncertain what physical process helps stabilize the warming seen from exposed water. One important effect is that as ice declines in thickness, it becomes more efficient at growing, a well-established truism. Cold air at the ice's surface causes heat to rise through the slab, all the way down to the ice-water interface, where more ice then forms. The efficiency of this exchange improves as the slab thins out, helping floes winnowed by summer temperatures grow back in the winter.

There are other possibilities, too. The Arctic gets about half of its heat from the lower latitudes, not the sun, and as temperatures rise there is less vacancy for tropical air to inch north, Winton said. Also, there are simple facts like the persistent clouds that ring the Arctic and lack of sunlight during the ice's natural minimum that could neutralize declining reflectivity.

The lack of a physical threshold for ice loss also does not eliminate a biological threshold for polar bear decline, though. Animals seek to retain their populations until stress forces them into collapse, and while the bears are well-adapted to annual ice fluctuations, the overall retreat will cause stress across the Arctic's 19 different subpopulations, each of which will respond differently, Amstrup said.

"We expect to see 19 different responses as sea ice changes," he said.

Uncertainties about rate of ice loss

Amstrup's *Nature* study used one global climate model, developed by the National Center for Atmospheric Research, to test how sea ice would behave under various scenarios, including the type of global, rigorous effort that scientists have long said would be needed to curb climate change. Under those scenarios, combined with conservation, many polar bear populations could persist, they found.

Even polar bears already under stress from ice loss, like those living in the western Hudson Bay, could possibly survive given active mitigation, Amstrup said. Under current emission scenarios, any additional warming is likely to damage the Hudson Bay bears most seriously, he added.

Estimates of the world's polar bear population are sketchy at best, and combined with the climate model's uncertainty, Amstrup and his team did not attempt to gauge the numbers that could survive under reduced emissions. They did estimate, however, that at current emission rates, the bears would lose half their optimal habitat by 2050; under mitigation scenarios, only 20 percent was lost.

These figures were generated through network models based on the bears' ecology, and ultimately represent an educated guess, which is often the best climate science can do, especially in the Arctic. Modeling sea ice decline is notoriously difficult, and there remains wide disagreement in the models on how quickly the Arctic will retreat under warmer temperatures. Several models project a complete loss of summertime ice before the century's end, while others chart a modest 15 percent decline.

"How good are these models for making sea ice projections?" said Ian Eisenman, a researcher at the California Institute of Technology and the University of Washington. "I think in general, predicting future sea ice retreat has proven to be an extremely difficult problem."

However, these uncertainties all are about the rate of loss -- not the question of loss -- and models are falling short of predicting the actual retreat seen since the 1970s, when accurate satellite data begins, not overestimating it, Princeton's Winton said.

Still, as Winton shows in a **paper** (pdf) to be published in the *Journal of Climate*, five out of six models he examined have temperature sensitivities that would be labelled "unlikely" under existing international standards.

"Although most models are not strictly ruled out by the analysis here, substantial natural variability is necessary to reconcile even the most sensitive model with observations," he wrote, adding that it is "useful to explore the possibility that the models are not sufficiently sensitive."

A particularly scathing critic of existing models has been John Wettlaufer, a geophysicist and ice expert at Yale University. In 2007, he published a **paper** arguing that models used by the Intergovernmental Panel on Climate Change's fourth assessment had deep errors in their simulations of cloud cover -- a chronically difficult subject -- which they tuned out by tweaking parameters like ice reflectivity. In other words, he wrote, errors were being introduced to compensate for errors.

The models have not improved much in the past three years, he added in a letter.

"They are limited," he said, "by an imperfect incorporation of the understood physics that we know governs the system ... in addition to an intransigent issue plaguing systems for which we have a 'perfect' understanding of the physics; sensitive dependence to initial conditions."

The term "tipping point" has been so overworked to be devoid of meaning, he added. "In my experience 'tipping point' has been so vaguely used and thrown around that the term leads to more confusion than clarity," he said.

Models disagree

Only four models used by the last Intergovernmental Panel on Climate Change had physics incorporating ice thermodynamics, added Cecilia Bitz, an ice physicist at the University of Washington. One of those models, which she helped develop, was from the National Center for Atmospheric Research. It has proved to be one of the models closest to matching what's been seen in the Arctic, and while it can be improved, results generated through it should be taken seriously, she said.

"I don't think models are perfect, but this is just one issue where I would be cautious assuming models don't keep up," Bitz said. Indeed, the sensitivity of the model's ice to temperatures prompted Amstrup to use it in the *Nature* paper.

Most obviously, the model disagreement makes clear that much work needs to be done understanding ice formation.

Eisenman has developed a **theoretical model** (pdf) showing that the continents ringing the land-free Arctic are blocking ice formation. ("It gets all muddled up by continental geography," he said.) Removing North America, Eurasia and Greenland would show that winter ice is also retreating. And it would help solve disagreement with Antarctic ice formation, where there has not yet been any noticeable decline.

But while models may need to improve, basic physics show that the Arctic ice will decline, scientists said. Polar bears may the most visible and, at least abstractly, lovable creatures harmed, but there are many other species, like the ringed seal, that are at risk.

"I hope the public can appreciate the many other species that are potentially threatened," Bitz said.

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