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RESEARCH HIGHLIGHTS

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Arctic summer sea ice loss may not 'tip' over the edge

The disappearance of Arctic summer sea ice may not show a tipping point after all, according to researchers from Harvard University and Yale University, US. The pair used bifurcation analysis to look at the phenomenon.

Summer sea ice in the Arctic has been retreating rapidly in recent years, with September 2007 seeing a record minimum ice extent. Some predictions are for summer sea ice cover to disappear as early as 2013 while other models suggest the 2030s. As the ice disappears the darker ocean below absorbs more radiation from the sun, exacerbating warming in what is know as the ice-albedo feedback effect.

"On first glance, it makes sense that the positive ice-albedo feedback might turn into a runaway process during this transition, causing there to be a point beyond which the Arctic Ocean undergoes an irreversible transition to a seasonally ice-free state," said Ian Eisenman of Harvard University. "At the start of this project, I expected that our model would produce this result. Indeed, this viewpoint has been prevalent in the scientific community for quite some time."

Sea ice

Tipping points are commonly thought of as a critical threshold beyond which a system cannot be returned to its original state. As well as Arctic sea ice, the Greenland and West Antarctic ice sheets, Amazon rainforest, boreal forest, El Nino and West African monsoon and Atlantic thermohaline circulation are all systems that may exhibit tipping points.

But Eisenman and colleague John Wettlaufer of Yale University found that the thermodynamics of sea ice made the situation reversible, providing that there was sufficient ice around during the rest of the year. In their model, the ice-albedo feedback accelerated the rate of sea ice loss but did not cause a tipping point in the transition between an ocean containing sea ice all year round and a seasonally ice-free state.

"When the climate is further warmed and the ocean becomes ice-free throughout the entire year, however, our results suggest that a tipping point may occur," said Eisenman. "In this scenario, there would be sea ice in the Arctic Ocean during some fraction of the year, and then a small additional warming would cause the sea ice to disappear in an irreversible process during a relatively short period."

According to Eisenman, sea ice is very difficult to represent accurately in climate models, and the spread in predicted sea ice retreat between different models is considerably larger than the spread in predicted global mean surface temperature. "An aim of my research is to help constrain the future evolution of Arctic sea ice," he said. "In my current work I am analyzing satellite observations of Arctic sea ice during recent decades and state-of-the-art global climate model simulations."

The researchers reported their work in **PNAS**.