Climate impacts arising from Arctic sea ice retreat

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The recent rapid retreat of Arctic sea ice is now leading to the possibility of complete loss during the summer months and severe loss of area during winter months as well. Such an increase in open water area at high latitudes is having major effects on varied aspects of the global climate via positive feedback mechanisms. The rapidity of change applies to ice thickness as well as to area, and we begin by surveying what is known of ice thickness decline and hence the decline of total ice volume in the Arctic.

We go on to consider the global feedback effects of volume decrease in ice They include (1) an albedo feedback – as sea ice and snow on land retreat, the average albedo of the Earth is reduced, with a forcing effect equivalent to adding 50% to our emissions of CO2; (2) a sea level feedback – the retreating sea ice creates a warmer atmosphere around Greenland in summer, speeding its melt rate and thus increasing the rate of global sea level rise, with larger-scale ice sheet dislocations likely in both Greenland and Antarctica; (3) a methane feedback – increasing quantities of methane are being emitted from the continental shelves of the Arctic Ocean, and this could accelerate to create a methane pulse with major climate implications; (4) a weather feedback – extreme weather changes seem to be related to the ice retreat and these threaten global food supply; (5) a weakening of the Atlantic thermohaline circulation due to a loss of sea ice from the Greenland Sea, which will reduce the warming rate of western Europe while increasing that of the tropical Atlantic.

We estimate the magnitudes of these five feedbacks and their total impact on the global climate system, and end by urging the need for geoengineering and/or direct air capture as the only feasible ways of holding back warming. Some of these methods, like marine cloud brightening, have specific targeting value for regenerating Arctic sea ice.