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Climate policy implications of nonlinear decline of Arctic land permafrost and sea ice

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Arctic feedbacks will accelerate climate change and could jeopardise mitigation efforts. The permafrost carbon feedback releases carbon to the atmosphere from thawing permafrost and the sea ice albedo feedback increases solar absorption in the Arctic Ocean. A constant positive albedo feedback and zero permafrost feedback have been used in nearly all climate policy studies to date, while observations and models show that the permafrost feedback is significant and that both feedbacks are nonlinear. Using novel dynamic emulators in the integrated assessment model PAGE-ICE, we investigate nonlinear interactions of the two feedbacks with the climate and economy under a range of climate scenarios consistent with the Paris Agreement. The permafrost feedback interacts with the land and ocean carbon uptake processes, and the albedo feedback evolves through a sequence of nonlinear transitions associated with the loss of Arctic sea ice in different months of the year. The US's withdrawal from the current national pledges could increase the total discounted economic impact of the two Arctic feedbacks until 2300 by $25 trillion, reaching nearly $120 trillion, while meeting the 1.5°C and 2°C targets will reduce the impact by an order of magnitude.