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

Dmitry Yumashev (1), Chris Hope (2), Kevin Schaefer (3), Kathrin Riemann-Kampe (4), Fernando Fernando Iglesias-Suarez (5), Elchin Jafarov (6), Eleanor Burke (7), Paul Young (1), Yasin Elshorbany (8), and Gail Whiteman (1)

(1) Pentland Centre for Sustainability in Business, Lancaster University, United Kingdom (d.yumashev@lancaster.ac.uk), (2) Judge Business School, University of Cambridge, Cambridge, UK, (3) National Snow and Ice Data Centre, Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, Colorado, USA, (4) Alfred-Wegener-Institut, Helmholtz Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany, (5) Instituto de Química Física Rocasolano, Consejo Superior de Investigaciones Científicas, Madrid, Spain, (6) Computational Earth Science, Earth and Environmental Sciences EES-16, Los Alamos National Laboratory, New Mexico, USA, (7) UK Met Office, Exeter, UK, (8) University of South Florida, St. Petersburg, Florida, USA

Arctic feedbacks accelerate climate change and could jeopardise mitigation efforts. A release of carbon to the atmosphere from thawing permafrost results in a positive feedback. Similarly, the loss of sea ice and land snow increases solar absorption in high latitudes, creating a positive albedo feedback. A constant albedo feedback and zero permafrost feedback have been the legacy values used in nearly all climate policy studies. However, observations and models show that both feedbacks are nonlinear with the permafrost feedback being the stronger of the two. Here we use novel dynamic emulators of complex physical models in the integrated assessment model PAGE-ICE to estimate the impacts of including these nonlinear Arctic feedbacks on the global climate and economy under a range of scenarios consistent with the Paris Agreement. In most scenarios the combination of the two nonlinear feedbacks causes extra warming globally compared with their legacy values. The permafrost carbon feedback is increasingly positive in warmer climates while the albedo feedback is either similar to or weaker than the legacy values. The combination of these two factors increases the mean discounted economic effect of climate change by 4.1% ($25trillion) under the 1.5°C scenario, 5.6% ($34trillion) under the 2°C scenario, 4.8% ($67trillion) under levels of mitigation consistent with the current national pledges. Our findings support the need for more proactive mitigation measures to keep global temperature rise below 2°C.