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Ecosystem shifts under climate change - a multi-model analysis from ISI-MIP

Lila Warszawski (1), David Beerling (2), Douglas Clark (3), Andrew Friend (4), Akihito Ito (5), Ron Kahana (6), Rozenn Keribin (4), Axel Kleidon (7), Mark Lomas (2), Wolfgang Lucht (1), Kazuya Nishina (5), Sebastian Ostberg (1), Ryan Pavlick (7), Tim Tito Rademacher (4), and Sibyll Schaphoff (1)

(1) Potsdam Institute for Climate Impact Research, (2) Department of Animal and Plant Sciences, University of Sheffield, (3) Centre for Ecology and Hydrology, (4) Cambridge Centre for Climate Science, (5) Center for Global Environmental Research, National Institute for Environmental Studies Japan, (6) Met Office, Hadley Centre, (7) Max-Planck-Institut fuer Biogeochemie, Jena

Dramatic ecosystem shifts, relating to vegetation composition and water and carbon stocks and fluxes, are potential consequences of climate change in the twenty-first century. Shifting climatic conditions, resulting in changes in biogeochemical properties of the ecosystem, will render it difficult for endemic plant and animal species to continue to survive in their current habitat. The potential for major shifts in biomes globally will also have severe consequences for the humans who rely on vital ecosystem services. Here we employ a novel metric of ecosystem shift to quantify the magnitude and uncertainty in these shifts at different levels of global warming, based on the response of seven biogeochemical Earth models to different future climate scenarios, in the context of the Intersectoral Impact Model Intercomparison Project (ISI-MIP). Based on this ensemble, 15% of the Earth's land surface will experience severe ecosystem shifts at 2°C degrees of global warming above 1980-2010 levels. This figure rises monotonically with global mean temperature for all models included in this study, reaching a median value of 60% of the land surface in a 4°C warmer world. At both 2°C and 4°C of warming, the most pronounced shifts occur in south-eastern India and south-western China, large swathes of the northern lattitudes above 60°N, the Amazon region and sub-Saharan Africa. Where dynamic vegetation composition is modelled, these shifts correspond to significant reductions in the land surface of vunerable vegetation types. We show that global mean temperature is a robust predictor of ecosystem shifts, whilst the spread across impact models is the greatest contributor to uncertainty.