Climate tipping risks under policy-relevant overshoot temperature pathways

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The risk of triggering multiple climate tipping points if global warming levels were to exceed 1.5°C has been heavily discussed in recent literature. Current climate policies are projected to result in 2.7°C warming above pre-industrial levels by the end of this century and will thereby at least temporarily overshoot the Paris Agreement temperature goal.

Here, we assess the risk of triggering climate tipping points under overshoot pathways derived from emission pathways and their uncertainties from the PROVIDE ensemble using PyCascades, a stylised network model of four interacting tipping elements including the Greenland Ice Sheet, the West Antarctic Ice Sheet, the Atlantic Meridional Overturning Circulation, and the Amazon Rainforest.

We show that up until 2300, when overshoots are limited to 2°C, the upper range of the Paris Agreement goal, the median risk of triggering at least one element would be less than 5%, although some critical thresholds may have been crossed temporarily. However, the risk of triggering at least one tipping element increases significantly for scenarios that peak above the Paris Agreement temperature range. For instance, we find a median tipping risk in 2300 of 46% for an emission scenario following current policies. Even if temperatures would stabilize at 1.5°C after having peaked at temperatures projected under current policies, the long-term median tipping risks would approach three-quarters.

To limit tipping risks beyond centennial scales, we find that it is crucial to constrain any temperature overshoot to 2°C of global warming and to stabilize global temperatures at 1.0°C or below in the long-term.