

EGU24-7633, updated on 25 Mar 2025

<https://doi.org/10.5194/egusphere-egu24-7633>

EGU General Assembly 2024

© Author(s) 2025. This work is distributed under the Creative Commons Attribution 4.0 License.



## Achieving net zero greenhouse gas emissions critical to limit climate tipping risks

**Annika (Ernest) Högner**<sup>1,2,3</sup>, Tessa Möller<sup>3,4,5</sup>, Carl-Friedrich Schleussner<sup>4,5,6</sup>, Samuel Bien<sup>1,2,3</sup>, Niklas H. Kitzmann<sup>1,3</sup>, Robin D. Lamboll<sup>7</sup>, Joeri Rogelj<sup>5,7,8</sup>, Jonathan F. Donges<sup>3,9,10</sup>, Johan Rockström<sup>2,3,9</sup>, and Nico Wunderling<sup>3,9,10</sup>

<sup>1</sup>Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany

<sup>2</sup>Institute of Environmental Science and Geography, University of Potsdam, Potsdam, Germany

<sup>3</sup>Potsdam Institute for Climate Impact Research (PIK), Member of the Leibniz Association, Potsdam, Germany

<sup>4</sup>Climate Analytics, Berlin, Germany

<sup>5</sup>Energy, Climate and Environment Program, International Institute for Applied Systems Analysis, Laxenburg, Austria

<sup>6</sup>Geography Department & IRI THESys, Humboldt University of Berlin, Berlin, Germany

<sup>7</sup>Grantham Institute for Climate Change and the Environment, Imperial College London, London, UK

<sup>8</sup>Centre for Environmental Policy, Imperial College London, London, UK

<sup>9</sup>Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden

<sup>10</sup>High Meadows Environmental Institute, Princeton University, Princeton, NJ, USA

**Under current emission trajectories, at least temporarily overshooting the Paris global warming limit of 1.5 °C above pre-industrial levels is a distinct possibility. Permanently exceeding this limit would substantially increase the risks of triggering several climate tipping elements with associated high-end impacts on human societies and the Earth system. It is essential to assess this risk under emission pathways that temporarily overshoot 1.5 °C. Here, we investigate the tipping risks associated with a number of policy-relevant future emission scenarios, using a stylised Earth system model that comprises four interconnected core tipping elements. Assessing tipping risks in the year 2300, we find a non-linear increase for overshoots that exceed 1.8 °C peak temperature or persist above 1.5 °C beyond the end of the 21st century. Scenarios following current policies or pledges lead to high tipping risk of 30% (median) and more, with uncertainty from climate sensitivity and carbon-cycle feedbacks translating to large uncertainties in tipping risk (45% and more) for these scenarios. Further, we show that on multi-century timescales achieving and maintaining at least net-zero greenhouse gas emissions is paramount to minimise tipping risks. Our results underscore that stringent emission reductions in the current decade in line with the Paris Agreement 1.5 °C limit are critical for planetary stability.**