

# #1: Simulating Tipping Points with Earth System Models

According to Intergovernmental Panel on Climate Change (IPCC), tipping points are critical thresholds that, when exceeded, can lead to significant and potentially irreversible changes in the climate system.

Global warming poses an increasing risk of tipping for several important Earth system phenomena including continental ice sheets, marine ecosystems, permafrost, vegetation dynamics and wildfires, and the overall carbon cycle. Tipping of Earth system elements may result in severe, even catastrophic consequences for ecosystems, biodiversity and society.

## Action

Current understanding of tipping points is based largely on models that do not fully represent the range of processes, interactions and feedbacks across the full Earth system. That's why, to understand the risks, impact, and (ir)reversibility of potential tipping events, TipESM will simulate tipping points in the Earth system using the most advanced Earth System Models and dedicated experiments.

## Why Earth System Models?

Earth System Models simulate the interactions of the atmosphere, ocean, land, ice, and biosphere to estimate the future state of the climate. As they increase in their process realism, Earth System Models can also include the impacts of human decision-making in the simulations. Consequently, Earth System Models can provide critical information on water availability, drought, climate and temperature extremes, ice sheets and sea levels, and land-use change.

For example, in using Earth System Models we can induce a (hypothetical) collapse of ocean circulation in the North Atlantic by applying different scenarios of freshwater or salt inputs. This will enable an analysis of the impact of these changes on marine biogeochemistry, ocean and land carbon uptake, and further impacts on climate, society and ecosystems.

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## The results of simulations with Earth System Models in TipESM will help us understand:

- The risk of exceeding different climate tipping points in relation to global warming
  - Processes causing tipping events
  - The reversibility of climate tipping points
  - The potential for cascading impacts of one tipping point to other parts of the Earth system
  - The impact of climate tipping events on human and ecological systems
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# TipESM - Exploring Tipping Points and Their Impacts Using Earth System Models

TipESM brings together scientists from a range of disciplines to deliver a step change in our understanding of climate tipping points in the Earth system, including their impact on ecosystems and society, combined with a set of early warning indicators and safe future emission pathways that minimise the risk of exceeding such tipping points.

## Expected impacts of TipESM

The key objectives of the project are to:

- Advance knowledge and solutions in Earth system science, pathways to climate neutrality, climate change adaptation, climate services, social science for climate action and understanding of climate-ecosystem interactions
- Contribute substantially to key international assessments (Intergovernmental Panel on Climate Change, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, and the European Environment Agency)
- Increase the transparency, robustness, trustworthiness and practical usability of the knowledge base on climate and Earth system change for use by policymakers, practitioners, other stakeholders and citizens
- Strengthen the European Research Area with increased knowledge of the risks of crossing climate tipping points

## Project partners and associated partners

- Danish Meteorological Institute
- Swedish Meteorological and Hydrological Institute
- The French National Centre for Scientific Research (and their affiliated entities)
- The Royal Netherlands Meteorological Institute
- University of Bergen
- The Potsdam Institute for Climate Impact Research
- Barcelona Institute for Global Health
- University of Leeds
- Met Office UK
- University of Reading
- University of Liverpool
- University of Bern
- Swiss Federal Institute for Forest, Snow and Landscape Research



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