

Studies add to concern about climate tipping

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Two model studies document the probability of climate tipping in Earth subsystems. The findings support the urgency of restricting CO₂ emissions as abrupt climate changes might be less predictable and more widespread in the climate system than anticipated. The work is part of the European TiPES project, coordinated by the University of

Copenhagen, Denmark but was conducted by Professor Michael Ghil, Ecole Normale Supérieure, Paris, France and coauthors from The Royal Meteorological Institute of Belgium and Parthenope University of Naples, Italy.

Tipping could be imminent

It is often assumed [climate change](#) will proceed gradually as we increase the amounts of CO₂ in the atmosphere. Over the last 15 years, however, it has become increasingly clear that the Earth's climate system or subsystems thereof—such as sea ice cover, monsoon systems, and [ocean currents](#)—might shift abruptly and with little warning as CO₂ levels go up. This is known as climate tipping.

Two studies from the European TiPES project now add to the evidence that tipping could be imminent and might be more widespread in the climate system than usually anticipated.

El Niño tips weather-system

In the first study, the authors show in a coupled ocean-atmosphere model how the mid-latitude wind systems over Europe and North America has a probability to tip between different types of behavior (or different regimes, as climate scientists say) depending on the strength of an El Niño. In other words, the climate phenomenon El Niño—during which heat builds up in the surface layers of the eastern tropical Pacific Ocean—determines whether the mid-latitude wind system in the U.S.A. will be more or less likely to shift abruptly between one regime and another.

Such probabilistic climate tipping complicates prediction, which is generally based on the assumption that climate systems change gradually

in a more predictable manner. The findings, - co-authored with Stéphane Vannitsem and Jonathan Demaeyer from the Royal Meteorological Institute of Belgium and published in *Journal of Advances in Modeling Earth Systems*, thus explain why the patterns of precipitation and temperature during and after an El Niño have been difficult to predict with accuracy up till now.

Tipping the Gulf Stream

The other result concerns rate-induced tipping. This kind of climate tipping takes place not because a certain threshold level is reached, like a CO₂ level in the atmosphere, but rather because the rate of change is too fast for the system to evolve gradually.

The study—co-authored with Stefano Pierini from the Parthenope University of Naples and published in *Scientific Reports*, finds rate-induced tipping in a simplified model of the wind-driven ocean circulation for the first time. In this model study, the Gulf Stream—which distributes heat to the North Atlantic and plays an important role in keeping the temperatures in Western Europe relatively mild—tips between regimes when CO₂ is introduced at a rapid rate into the model.

A real risk

Such a result is highly relevant as levels of CO₂ in the atmosphere currently go up at an unprecedented rate. If the Gulf Stream eventually tips in this rate-induced manner, Western Europe could experience rather abrupt changes to its climate.

"These results indicate that climate tipping is an imminent risk in the Earth System. Even the safe operating space of 1.5 or 2.0 degrees above

present generally assumed by the IPCC might not be all that safe. According to the precautionary principle, we must consider abrupt and irreversible changes to the [climate system](#) as a real risk—at least until we understand these phenomena better," says Professor Michael Ghil.

The TiPES project is an EU Horizon 2020 interdisciplinary [climate](#) science project on tipping points in the Earth system. Eighteen partner institutions work together in more than 10 countries. TiPES is coordinated and led by The Niels Bohr Institute at the University of Copenhagen, Denmark and the Potsdam Institute for Climate Impact Research, Germany.

More information: Stefano Pierini et al, Tipping points induced by parameter drift in an excitable ocean model, *Scientific Reports* (2021). [DOI: 10.1038/s41598-021-90138-1](https://doi.org/10.1038/s41598-021-90138-1)

Provided by University of Copenhagen

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