# Workshop: Cascading tipping in the Earth system

The workshop "Cascading tipping in the Earth system” is organized by [Niklas Boers](https://www.pik-potsdam.de/members/boers" \t "_blank), Technical University of Munich and Potsdam Institute for Climate Impact Research, [Anna von der Heydt](https://www.uu.nl/staff/ASvonderHeydt), Utrecht University and [Denis-Didier Rousseau](http://www.environnement.ens.fr/membres/les-anciens-du-ceres/rousseau-denis-didier/), CNRS-University of Montpellier. It will take place as an online event under the EU Horizon 2020 funded project "[TiPES – Tipping Points in the Earth System](https://www.tipes.dk/" \t "_blank)". Also, non-TiPES members are invited to participate.

**Please register here to attend:**

>>>>>>>> <https://indico.nbi.ku.dk/event/1696/>

**Aim and Scope**

In the climate system, many different large-scale components have been identified as tipping elements, i.e., sub-systems that may undergo abrupt transitions, with a potentially large impact on environment, economy and society. Individual tipping elements have been studied in varying level of detail in the past, while in particular thresholds for tipping remain uncertain for most tipping elements. Moreover, these climate subsystems do not stand on their own but are dynamically coupled to other parts of the climate system, potentially leading to tipping cascades with modified thresholds and impacts. In this workshop we will discuss the potential for tipping cascades in the climate system and other dynamical systems and review how such cascades can be treated theoretically.

**When?**

December 3rd, 2021, 2-5 pm CET

**Where?**

Zoom: <https://ucph-ku.zoom.us/j/66902667512?pwd=SmRUYW1rYkttL1ZkTkRnSXJRcUJ2UT09>

Meeting ID: 669 0266 7512

Passcode: 558427

**Programme**

14:00 Introduction

14:05-14:45 Keynote lecture: Victor Brovkin - Past abrupt changes, tipping points and cascading impacts in the Earth system

14:45-15:10 Victor Couplet - Cascade of tipping points : investigating the Hothouse narrative with dynamical systems

15:10 – 15:35 Jen Creaser - Tipping cascades and synchrony

15:35 – 16:00 Nico Wunderling - Risk for tipping cascades under global warming in a conceptual model for interacting climate tipping elements

16:00 – 17:00 Discussion

**Abstracts**

1. **Past abrupt changes, tipping points and cascading impacts in the Earth system**. Victor Brovkin, MPI-Meteorology Hamburg, Germany

The geological record shows that abrupt changes in the Earth system can occur on timescales short enough to challenge the capacity of human societies to adapt to environmental pressures. In many cases, abrupt changes arise from slow changes in one component of the Earth system that eventually pass a critical threshold, or tipping point, after which impacts cascade through coupled climate-ecological-social systems. Abrupt changes are rare events and their chance to occur increases with the length of observations. The geological record provides the only long-term information we have on the conditions and processes that can drive physical, ecological, and social systems into new states or organizational structures, which may be irreversible within human time frames. [In this study by Future Earth AIMES and PAGES projects](https://doi.org/10.1038/s41561-021-00790-5), well-documented abrupt changes of the past 30 thousand years are used to illustrate how their impacts cascade through the Earth System. We review useful indicators of upcoming abrupt changes, or early warning signals, and provide a perspective on the contributions of paleoclimate science to the understanding of abrupt changes in the Earth system.

1. **Investigating the hothouse narrative with dynamical systems.** Victor Coupet, Université Catholique de Louvain, Belgium

The 'hothouse narrative' states that Earth's climate may possibly undergo, in the foreseeable future, a cascade of tipping points, which would precipitate our planetary environment into a highly challenging state for humanity. The general objective of my research is to investigate this scenario with dynamical systems. In my talk, I will first present a toy model of interacting tipping elements. This framework will allow us to specify our research questions: Given a continuous family of emission scenarios, are there discontinuities in the family of responses, as suggested by the 'hothouse narrative' ? How realistic is this given knowledge provided by climate simulations and paleo-climate evidence? Second I would like to take the opportunity to discuss some problems I've encountered and how we can develop further the study of tipping cascades in low complexity climate models.

1. **Tipping cascades and synchrony.** Jen Creaser**,** Peter Ashwin**,** Krasimira Tsaneva-Atanasova**,** Department of Mathematics, University of Exeter, Exeter, UK.

Noise-induced tipping has been identified as an important mechanism of change in a variety of physical and biological systems. However, relatively little is known about how tipping cascades across networks of interconnected systems are affected by changes in node dynamics, coupling strength and synchronization. Here, we consider a general model of coupled bi-stable oscillators. Using numerical and theoretical techniques we explore the interplay between synchronization and noise-induced tipping from a non-oscillatory (quiescent) state to an oscillatory (active) state. We consider motifs where the presence of coupling introduces dependence between tipping elements. In particular, we find and investigate examples of three node symmetric networks where sequences of noise-induced tipping (domino effect) are associated with various types of partial synchrony during the sequence

1. **Risk for tipping cascades under global warming in a conceptual model for interacting climate tipping elements**. Nico Wunderling, PIK, Potsdam, Germany

Tipping elements are nonlinear subsystems of the Earth that have the potential to abruptly shift to another state if environmental change occurs close to a critical threshold, which would have large consequences for human societies and ecosystems worldwide. With progressing global warming, there is an increased risk that one or several climate tipping elements might cross such a critical threshold. Here, we study a subset of four tipping elements and their interactions in a conceptual and easily extendable framework: the Greenland Ice Sheet, the West Antarctic Ice Sheet, the Atlantic Meridional Overturning Circulation (AMOC) and the Amazon rainforest. In a large-scale Monte-Carlo simulation, we explicitly quantify the risk and uncertainty for the emergence of tipping under global warming in equilibrium experiments. Thereby, we find that (i) the risk for tipping events and cascades increases strongly between 1–3 °C of global warming, and (ii) additional internal temperature feedbacks of the tipping elements can slightly increase the risk of triggering tipping events.