Tipping Behavior in the Climate System

February 2, 2024

When critical conditions on global mean surface temperature are exceeded, climate subsystems may undergo relatively rapid transitions, so-called tipping behavior, compared to the change in their forcing. Based on paleoclimate evidence several of such subsystems, so-called tipping elements, have been identified. Examples are the Atlantic Ocean circulation, the polar ice sheets, and the Amazon rainforest. In this course, an introduction into tipping phenomena will be given focusing on (i) the basis in (stochastic) dynamical systems theory, (ii) conceptual models of tipping elements and (iii) applications to specific cases.

1 Practical information

Contact: The coordinator of the course is Henk Dijkstra (h.a.dijkstra@uu.nl).

Website: https://www.unitn.it/dricam/1113/tipping-behavior-climate-system

Venue: Mo: 5/2 + 12/2, We: 7/2 + 14/2 Fr: 9/2 + 16/2

Grading: The final grade will be composed of the result on the (individual) written exam.

2 Tentative Schedule:

Date	10:00-10:45	11:00-11:45	12:00-12:45
Mo 5-2	General Intro Tipping Behavior (TB) Lenton et al., Section 0 + 1.1	Dynamical Systems + Bifurcation induced TB Strogatz, Chapters P1 + P2	Exercises
We 7-2	Oceans Lenton et al., Section 1.4	Noise induced TB Dijkstra, Chapter 10	Exercises
Fr. 9-2	Cryosphere Lenton et al., Section 1.2	Early Warning Signals of TB Lenton, Section 0 + Dijkstra, Chapter 5	Exercises
Mo 12-2	Atmosphere Lenton et al., Section 1.4	Overshoot + Rate induced TB Lenton, Section 1.6	Exercises
We 14-2	Climate Impact of TB Lenton et al., Section 1.5	Cascading TB Lenton, Section 1.5	Exercises + Question Time
Fr 16-2	Exam	Exam	Exam

3 Reading Material

1. T. M. Lenton et al. (eds), 2023, The Global Tipping Points Report 2023. University of Exeter, Exeter, UK.
2. Strogatz, S, 2015, Nonlinear Dynamics and Chaos, Westview Press, USA.
3. Dijkstra, H.A., 2013, Nonlinear Climate Dynamics, Cambridge University Press, UK.

4 Exercises:

Reading material, notes, slides and code will be provided on GitHub at https://github.com/hadijkstra/Tipping-Behavior-in-the-Climate-System.