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Tipping points and tipping cascades in the climate system: How do we know whether 2 degrees is too much?

In the climate system a number of tipping elements have been identified - these are subsystems that could potentially undergo a transition towards a different state and thereby induce a rather abrupt and dramatic change in a region of the planet. Examples of tipping elements are the Atlantic Ocean circulation or the Greenland ice sheet. More recently, it has been suggested that different tipping elements can influence each other; where an abrupt transition in one region affects another region, initiating a 'tipping cascade'.

At the same time the Earth is warming due to anthropogenic greenhouse gas emissions. The Equilibrium Climate Sensitivity (ECS) is widely used as a measure for possible future global warming. It has been determined from a wide range of climate models, observations and palaeoclimate records, however, it still remains relatively unconstrained. In particular, large values of warming as a consequence of atmospheric greenhouse gas increase cannot be excluded, with some of the most recent state-of-the-art climate models supporting (much) more warming than previous generations of climate models. Moreover, some of the (cascades of) climate tipping elements may affect global mean temperature, while the ECS only predicts the linear response to greenhouse gas forcing.

In this talk I will review various tipping elements and their potential interaction in the climate system. I will further focus on the question how the climate systems response (e.g. ECS) behaves when the system is close to a tipping point.