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Cascading tipping in a coupled cryosphere-ocean model

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In the climate system, many different large-scale components have been identified as tipping elements, i.e., components that may pass a tipping point, with a substantial and definitive impact on earth and societies. These climate components do not stand on their own, but are dynamically coupled, which leads to the issue of cascading tipping. One important example of cascading involves the Greenland Ice Sheet (GIS), the West Antarctica Ice Sheet (WAIS) and the Atlantic Meridional Overturning Circulation (AMOC). While the destabilizing effect of a GIS decline on the AMOC is well established, the effect of a tipping WAIS is still unclear.

In this project, we aim at getting a better understanding of the global behaviour of this connected system, at a conceptual level. Accounting for the different nature of both ice sheets, we use two models including their most important feedbacks, namely, the marine ice sheet instability for the WAIS and the height-accumulation feedback for the GIS. The AMOC, depicted by the Rooth model, is coupled to both ice sheets through meltwater fluxes. Finally, we consider the Southern Ocean temperature as the main driver of the marine ice sheet instability.

With this conceptual interhemispheric model, we study the role of the AMOC as mediator of this potential cascading in hosing and/or climate change experiments, as well as the involved time scales. As a new result we find that, in this model, the stability of the AMOC depends on the ratio between the GIS and WAIS tipping rates, as well as their delay in time.