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Climate feedbacks caused by cryosphere tipping elements

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Several tipping elements are known to exist in the climate system (Lenton et al., 2008). Some of them might be at risk of transgressing into a qualitatively different state within a global warming of 1.5°C to 2°C compared to pre-industrial levels (Schellnhuber et al., 2016). Among these are crucial components of the cryosphere: the West Antarctic Ice Sheet, the Greenland Ice Sheet as well as the Arctic summer sea ice and mountain glaciers. Their disintegration could possibly lead to severe changes in the climate system itself, through positive feedbacks such as the ice albedo feedback which act back on temperature.

For the quantification of feedbacks we use the CLIMBER-2 model (Pethoukov et al., 2000, Ganopolski et al., 2001), an Earth-system model of intermediate complexity on a coarse spatial resolution, that includes an atmosphere, ocean and sea ice model as well as a dynamic vegetation model and the global carbon cycle. With conceptual calculations, backed up by CLIMBER-2 simulations, we here assess the effect of tipping of (some or all of) the cryo-elements on global mean temperature. Furthermore, we separate the total model response into contributions from the different fast climate feedbacks including the albedo, water vapor, clouds and lapse rate feedbacks.