Tipping cascades, future Earth system trajectories and the prospect of a hothouse: insights from the SURFER model

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A tipping cascade is a series of tipping events in the Earth system where transitions in one subsystem can trigger further transitions in other subsystems. A concern for the future is that such a cascade could lock the Earth system in a pathway towards a so-called hothouse state. We investigate this possibility with SURFER, a reduced complexity model with a process-based carbon cycle that can reliably predict CO₂ concentrations, global mean temperatures, sea-level rise, and many ocean acidification metrics on timescales from decades to millions of years. We have incorporated in the model a network of interacting tipping elements and their feedback on the climate through albedo changes and additional greenhouse gas emissions. This has allowed for a systematic investigation of the effects of a family of realistic emission scenarios on the future trajectories of the Earth system. Our results show that a permanent shift to a hothouse state within the next few centuries is implausible. On longer time scales, however, tipping cascades can lead to enduring additional warming and particularly sea level rise.