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Ice load-bedrock uplift feedback leads to self-sustained oscillations in the Greenland Ice Sheet on long time scales

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The Greenland ice sheet loses substantial amounts of mass, due to accelerating outlet glaciers and longer melting periods. Different positive feedback mechanisms, as the melt-elevation feedback and the ice-albedo feedback, introduce a non-linear evolution and may further accelerate mass loss. Negative feedbacks, such as the feedback between receding ice load and subsequent bedrock uplift, might counteract the accelerating positive feedbacks on long timescales. Roughly, the bedrock uplift amounts to 1/3 of the change in the ice sheet thickness on a timescale of millennia.

To explore the interplay of those feedbacks, we use simulations of the Greenland Ice Sheet with the Parallel Ice Sheet Model (PISM) including an Elastic Lithosphere Relaxing Asthenosphere (ELRA) model in an idealized warming scenario. In particular, we observe that depending on the temperature anomaly (and thus the retreat time) and the asthenosphere viscosity, three distinct responses of the ice sheet are possible:

- The full or partial retreat of the ice sheet.
- The full or partial recovery of the ice sheet after an initial retreat.
- Large-scale self-sustained oscillations of the volume of the ice sheet on multi-millennial timescales.

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