Movie Captions

- Movie 1

Evolution of the free surface geometry for the tidal cycle problem over the course of one week. The model setup and parameters are described in section 4.1. The reference upper surface elevation is h_0 =0.5 km. The colour scheme follows figures 1 and 3 in the main text. The ice-water surface is red, the bed is black, and the upper surface is blue. The minimum and maximum grounding line positions $x_\pm$ are noted by black triangles. The sea level ℓ is denoted by a dash-dotted green line and the flotation elevation h_f is denoted by a dashed purple line. Red points between x_- and x_+ are ice-water surfaces in the extended grounding zone that forms during sea level fall. For visualisation, 98% of the initial sea level and ice surface elevation have been subtracted from ℓ and h, respectively.

- Movie 2

Evolution of the water layer thickness $s - \beta -$ in the tidal problem for different mesh spacings Δx. Transients inherited from the initial geometry are absent after $t \approx 5$ days. The other numerical parameters are = 1 mm and $\Delta t = 1$ minute.

- Movie 3

Evolution of the water layer thickness $s - \beta -$ in the tidal problem for different timestep sizes Δt. Transients inherited from the initial geometry are absent after $t \approx 5$ days. The other numerical parameters are = 1 mm and $\Delta x = 50$ m.

- Movie 4

Evolution of the water layer thickness $s - \beta -$ in the tidal problem for different boundary geometry tolerance parameters , defined in section §3.4 of the main text. Transients inherited from the initial geometry are absent after $t \approx 5$ days. The other numerical parameters are $\Delta t = 1$ minute and $\Delta x = 50$ m.

- Movie 5

Evolution of the water layer thickness $s - \beta -$ for different sea level oscillation periods P, defined in section 4.1. The sea level oscillation amplitude is 1 metre for all examples. The ∼1 mm thick water layer that forms on the tidal timescale is absent at the longer oscillation periods. The numerical parameters are = 1 mm, $\Delta x = 50$ m and $\Delta t = P/500$.

- Movie 6

Evolution of free surface geometry for the subglacial lake problem over the course of two filling-draining cycles. The model setup and parameters are described in section 4.2. The reference upper surface elevation is $h_0 = 1$ km. The colour scheme follows figures 1 and 6 in the main text. The ice-water surface is red, the bed is black, and the upper surface is blue. The grounding line positions $x_\pm$ are noted by black triangles. For visualisation, 99% of the initial ice surface elevation has been subtracted from h.