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The response of the Larsen C Ice Shelf to changes in ice-shelf buttressing

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The future viability of the Larsen C Ice Shelf (LCIS) has been called into question following the collapse of its more northerly, neighbouring ice shelves on the Antarctic Peninsula, and the calving of the A68 iceberg in July 2017. Initially, using the ice-flow model Úa, we conduct time-independent experiments and find that the vast majority of the buttressing capacity of the LCIS is generated in the regions of the ice shelf just downstream of the grounding line. We also find that the Bawden and Gipps Ice Rises provide a negligible proportion of the total buttressing capacity of the ice shelf, as determined by modelled instantaneous changes in grounding line flux (GLF) in response to their removal.

We then conduct time-dependent experiments to examine the transient evolution of the LCIS and its tributary glaciers to changes in ice-shelf buttressing. We present, for the first time, simulations of the transient response of the system to the loss of basal contact at the Bawden and Gipps Ice Rises. We find that the instantaneous increase in ice-shelf velocities is sustained throughout the 100-year model run, with associated dynamic thinning of the ice shelf on the order of tens of metres during this period. However, we find that the impact on the grounded ice dynamics, GLF and ice volume above flotation (VAF) is limited.

Through idealised calving experiments we show that the instantaneous response in GLF to a reduction in ice-shelf buttressing decays rapidly in the first few years following the calving event. We also find an increasing, but non-linear, relationship between the reduction in ice-shelf buttressing and the loss of VAF after 100 years, largely controlled by the bedrock topography of the tributary glaciers. With our model setup, using the BedMachine Antarctica v2 ice thickness and bedrock topography data, we find that the dynamic mass loss 100 years after the complete collapse of the LCIS is ~0.6 mm SLE.