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Ice-Shelf Rippling From Temporally Varying Melt and Ice Flow

ANDREW WELLS, CHRIS MACMACKIN, University of Oxford — The Antarctic and Greenland ice sheets often discharge into the ocean through floating ice shelves. Ice-shelf geometry is controlled by the coupling of a viscous ice flow with basal melt driven by buoyant meltwater plumes rising through the warm and salty ocean along the sloping ice-shelf base. Motivated by recent observations of the spatial patterns of ice-shelf thickness, we assess the response of an ice shelf to a range of temporally-periodic forcing conditions. We model the depth-integrated viscous extensional flow of an ice shelf downstream of the grounding line, where the grounded ice transitions to the floating shelf. Melting is determined from a meltwater plume model with imposed subglacial discharge. We use a linear perturbation analysis to explore the sensitivity of the ice shelf geometry to periodic variation of the freshwater source flux for the meltwater plume, ice flux across the grounding line, and coupled variation of ice flux and grounding line position. Such periodic variation leads to propagating ripple-like features on the ice shelf base, with greatest sensitivity to varying ice influx with coincident grounding line motion. We analyse the mechanisms controlling ripple amplitude, and discuss potential implications for formation of ice-shelf basal terraces.

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