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Surface meltwater causes large and rapid accelerations of Antarctic Peninsula outlet glaciers

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Surface meltwater is widespread across the Antarctic Ice Sheet. While much recent research has focused on understanding the impact meltwater has on ice shelves, where its presence can act as a catalyst for rapid ice shelf break up, the effect of meltwater on grounded ice dynamics in Antarctica remains unknown. Using high-resolution ice velocity data derived from Sentinel 1 imagery we identify previously unobserved large (up to 100% greater than the annual mean), sudden, and synchronous accelerations in ice flow at 5 glaciers across the Antarctic Peninsula, which occur during modelled periods of surface melt. Coincident optical satellite imagery demonstrates that although much of the surface meltwater refreezes, some water appears to access the bed through crevasses and surface lake drainage. Several characteristics of the ice accelerations are consistent with the enhancement of basal motion by surface-derived meltwater reaching the ice bed. Firstly, speed-up events are often followed by short-lived reductions in ice velocity to pre-event values, and secondly, their relative magnitude is greater in regions of observed surface melt, immediately downstream of surface lake drainage events and after prolonged periods of no-or-little melt. Our data suggest that following arrival at the ice bed, meltwater is efficiently evacuated, limiting the duration of speed-up events to less than 6 days (the temporal resolution of our data). Although Antarctic Peninsula speed-up events are currently short-lived, we anticipate that predicted longer and more intense melt-seasons may lead to a shift in ice-dynamics in the region.