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Evolution of supraglacial lakes on Shackleton Ice Shelf, East Antarctica

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Supraglacial lakes (SGLs) enhance surface melting and their development and subsequent drainage can flex and fracture ice shelves, leading to their disintegration. However, the seasonal evolution of SGLs and their potential influence on ice shelf stability in East Antarctica remains poorly understood, despite a number of potentially vulnerable ice shelves. Using optical satellite imagery, climate reanalysis data and surface melt predicted by a regional climate model, we provide the first multi-year analysis (1974-2019) of seasonal SGL evolution on Shackleton Ice Shelf in Queen Mary Land, which is Antarctica's northernmost remaining ice shelf. We mapped >43,000 lakes on the ice shelf and >5,000 lakes on grounded ice over the 45-year analysis period, some of which developed up to 12 km inland from the grounding line. Lakes clustered around the ice shelf grounding zone are strongly linked to the presence of blue ice and exposed rock, associated with an albedo-lowering melt-enhancing feedback. Lakes either drain supraglacially, refreeze at the end of the melt season, or shrink in-situ. Furthermore, we observe some relatively rapid (≤ 7 days) lake drainage events and infer that some lakes may be draining by hydrofracture. Our observations suggest that enhanced surface meltwater could increase the vulnerability of East Antarctic ice shelves already preconditioned for hydrofracture, namely those experiencing high surface melt rates, firn air depletion, and extensional stress regimes with minimum topographic confinement. Our results could be used to constrain simulations of current melt conditions on the ice shelf and to investigate the impact of increased surface melting on future ice shelf stability.