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The fate of Greenland Ice Sheet supraglacial lakes in a warm and cool year

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Supraglacial lakes form on the surface of the Greenland Ice Sheet during the summer months and can directly impact ice sheet mass balance by removing mass via drainage and runoff or indirectly impact mass balance by influencing ice sheet dynamics. Here, we utilize the growing inventory of optical and microwave satellite imagery to automatically determine the fate of Greenland-wide supraglacial lakes during 2018 and 2019, a cool and warm melt season respectively. We use a machine learning time series classification approach to categorize lakes into four different categories: lakes that 1) refreeze, 2) rapidly drain, 3) slowly drain, and 4) become buried lakes at the end of the melt season. We find that during the warmer 2019, not only was the number of lake drainage events higher than in 2018, but also the proportion of lakes that drained was greater. By investigating mean lake depths for these four categories, we show that drained lakes were, on average, 22% deeper than lakes that refroze or became buried lakes. Interestingly, drained lakes had approximately the same maximum depth in 2018 and 2019; however, lakes that did not drain were 29% deeper in 2018, a cooler year. Our unique two-year dataset describing the fate of every Greenland supraglacial lake provides novel insight into lake drainage and refreeze in a relatively warm and cool year, which may be increasingly relevant in a warming climate.