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Termination behaviour of supraglacial lakes on the Greenland Ice Sheet.

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The behaviour of supraglacial lakes on the Greenland Ice Sheet, specifically with regard to their drainage through hydrofracturing to the ice sheet base, has received a great deal of recent attention. However, a previous study has shown that this mode of drainage accounts for only 13% of the lakes on the Greenland Ice Sheet. No published work to date has studied what happens to those lakes that do not drain suddenly, and little is known about what differences exist between those lakes which drain suddenly and those which do not.

To learn more about the fate of those lakes that do not drain rapidly, we followed the evolution of 2600 supraglacial lakes over the five year period 2005-2009 using 3704 MODIS images. Lakes were studied in all areas of the ice sheet where they grow large enough to be observed using MODIS data (250 m pixels). From the MODIS images lake extent was classified and area was extracted giving a dataset of lake area over time. We used these data along with inferred melt from the MODIS Land Surface Temperature data product and qualitative observations from the imagery to discover how each lake disappeared from the ice sheet each year.

Here we present three different modes by which lakes can disappear from the ice sheet, which have strongly contrasting effects on glacial dynamics and ice sheet water budget. Firstly, 13% of all lakes drained suddenly, probably to the bed. We observed groups of lakes draining suddenly in the same day in apparently linked events suggesting a common trigger mechanism for drainage. Secondly, some lakes drained more slowly over several days (34% of lakes in our dataset). We interpret this to be the result of supraglacial drainage, probably through incision of the exit channel. Finally, 46% of lakes survived to the end of the melt season and froze over. We suggest hypotheses from our findings as to what factors control whether or not sudden lake drainage to the bed occurs. Our results show that care must be taken when interpreting remotely sensed observations of lake drainage, as lakes that drained supraglacially can be misinterpreted as having drained to the bed if the temporal resolution is too coarse.