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Quantifying the Evolution of Supraglacial Lakes on Larsen B Ice Shelf in the Two Decades Preceding its Collapse, Using Spaceborne Optical and SAR Data

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Supraglacial lakes have been implicated in the disintegration of Larsen B Ice Shelf due to their ability to cause hydrofracture and thus structural weakening. Despite this, a detailed quantitative analysis of lake evolution in the decades prior to shelf failure has yet to be undertaken, largely due to a data gap in the optical (Landsat) record spanning most of the 1990s. Here, we combine the available optical satellite imagery with SAR data to produce the first multi-decadal analysis of lake evolution on Larsen B prior to its collapse. 13,850 lake occurrences were mapped over eight images between 1988 and 2002. We found that there is a high degree of inter-annual variability in lake area and number, which can be correlated with variability in climate. We also reveal a southerly spreading of the lake populated area at a rate of around 3 km a year between 1979 and 1997 which we correlate with depletion of the firn pack atop the shelf. Lake depth is calculated by applying a radiative transfer model to the Landsat imagery. We find that lakes get deeper year-on-year in a pattern which is statistically independent of changing melt amounts. This suggests that lakes on Antarctic ice shelves deepen either by melting out at their base or as a result of successive fill-drain cycles as opposed to climate forcing. The collapse of Larsen B Ice Shelf was the last catastrophic shelf disintegration event; therefore, it is vital to attempt to understand the mechanisms contributing to its failure. Such knowledge can then support more informed predictions of the future of Larsen C and other Antarctic ice shelves.