

Grounding-line change before and after ice-shelf collapse, Larsen Ice Shelves, Antarctic Peninsula

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Over the past century, the Antarctic Peninsula has experienced some of the most rapid atmospheric warming on Earth. Characterised by regional temperature increases of up to 0.43°C per decade between 1961-2000, this warming is believed to have facilitated the dramatic collapse of Larsen A and B Ice Shelves in 1995 and 2002 respectively. This atmospheric warming alongside intrusions of warm water along the western Peninsula has led to the cumulative retreat of over 90% of the neighbouring ice shelves fringing this region of Antarctica.

Whilst recent remote-sensing observations of accelerated frontal retreat, ice flow speed-up and surface thinning of the glaciers upstream of former Larsen A and B Ice Shelves have been attributed to the debutressing effect of ice-shelf loss, knowledge of the processes pre-conditioning ice-shelf collapse are less clearly understood. At present, there is a lack of information on the nature of grounding-line migration immediately prior to collapse at these sites; knowledge is critical to accurately forecasting the potential future destabilisation of other ice shelves, including e.g. the neighbouring Larsen C Ice Shelf.

Using grounding-line migration as a proxy indicator for pre- and post-collapse glaciological instability, this study has evaluated the relationship between ice dynamics and ice-shelf break-up for the glaciers and ice streams formerly and presently feeding into the Larsen A, B and C Ice Shelves. Changes in the position of the grounding-line were detected from medium resolution optical satellite imagery, using a novel technique recently applied to other regions of Antarctica. Pre-collapse, several areas of significant grounding-line retreat occurred along the ice masses draining into Larsen B Ice Shelf. Post collapse, substantial retreat continued where glaciers now met open water but notably also where a remnant of Larsen B Ice Shelf remains. Along the margin of Larsen C Ice Shelf, we observe more minor but notable grounding-line retreat throughout the observational period. These findings underscore the requirement for continued, close observation of the rapidly evolving Remnant Larsen B Ice Shelf and Larsen C Ice Shelf in the future. Such observations are required to monitor and forecast the future destabilisation of other Antarctic ice shelves, with a view to deriving more accurate ice-mass-loss and global sea-level rise contribution estimates.