Modelling the instantaneous response of glaciers after ice shelf collapse

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In February 2002, satellite images from a remote location in Antarctica revealed how an immense volume of floating ice, up to 1km thick, suddenly collapsed. Over the course of a few weeks, 3,300km^2 of the Larsen B Ice Shelf shattered and drifted out into the open ocean, leaving behind a large number of neighbouring mountain glaciers now exposed to the ocean.

Prior to this dramatic event, these glaciers were held back by the ice

shelf, which controlled their speed. Once the ice shelf disintegrated, the glaciers lost their buttressing and accelerated almost instantaneously to up to 5 times their previous speed. Over the following years, many glaciers lost a large volume of ice to the ocean, accounting for a substantial part of Antarctica's contribution to present-day sea-level rise.

In this work, we were able for the first time to accurately reproduce this complex behaviour using computer simulations. Newly acquired satellite, airborne and shipborne data were assimilated into the code to accurately reproduce conditions prior to the collapse of the ice shelf. Computer algorithms were then used to simulate the response of the glaciers when the ice shelf was taken away.

Results could be compared to recently acquired satellite maps of changes in surface motion, covering all glaciers between 1995 and 2013, and a good match was obtained. This work provides an important first step in validating computer models that aim to predict glacier changes in response to the ongoing weakening of other ice shelves in Antarctica, and to improve our confidence in the associated estimates of sea-level rise.

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