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The dynamics of Larsen B ice shelf: insights from numerical modelling constrained by satellite observations

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This study investigates the dynamical controls and changes of the pre-collapse Larsen B ice-shelf (LBIS), by using a combination of numerical modelling and data assimilation. Shelf velocities derived from satellite interferometry are used to constrain an ice-shelf model by using a data assimilation technique based on the control method. Ice rheology and flow at the inland shelf boundary are simultaneously optimized to get a flow field that is consistent with observed flow. Application to the LBIS using two velocity data sets from 1995 and 1999 reveals a robust pattern of rheological weakening in narrow shear zones, mostly along margins. This suggests that such weak zones play a major role in the control of the flow of LBIS. The above data assimilation experiments together with additional perturbation modelling experiments further suggest that the observed acceleration from 1995 to 1999 can not solely be explained by the retreat of the shelf front but relies on a further significant rheological weakening of the already weak shear zones within the LBIS. Minor tributary acceleration is found to be an effect rather than a cause of the shelf acceleration. An application of the data assimilation tool to Pine Island ice-shelf further supports the conclusion that for smaller ice shelves similar as the LBIS, such weak shear margins play a crucial role in controlling their dynamics and are the key to understand changes in the future.