NUMERICAL MODEL INVESTIGATION OF CRANE GLACIER RESPONSE TO COLLAPSE OF LARSEN B ICE SHELF, ANTARCTIC PENINSULA'

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Several outlet glaciers in the Larsen B ice shelf embayment experienced sudden sped up and front retreat as a result of the ice shelf disintegration in March of 2002. Glaciers in the Larsen B embayment have responded different to ice shelf disintegration. Crane Glacier stands out among the fast responding glaciers for its dramatic increase in speed, from ~500 m/a to ~1500 m/a in its downstream reach, large surface lowering, and front retreat. Between March 2002 and early 2005, the glacier's calving front retreated by about 11.5 km to a location at which it has remained since that time. In order to investigate the physical processes that control the reaction of Crane Glacier to ice shelf disintegration, a flowline model has been developed. The model solves for the full momentum balance along the flowline using the finite element method and allows for basal sliding using a Budd type sliding relation. Model parameters are tuned to reproduce observation of surface velocity prior to ice shelf disintegration. Model can be applied diagnostically to examine instantaneous changes in boundary conditions.

The instantaneous model response of the glacier to ice shelf removal produces surface velocities and thinning rates that agree well with observations of the glacier immediately post collapse. When the front position is modified to represent the steady position reached in 2005, the model again produces velocities similar to those observed on the glacier. A typical tidewater calving criterion can be used to predict the steady position toward which the front retreated.

Ice shelf removal produces a small change in vertical shearing. This change in shearing is amplified by the basal sliding relation to produce a large velocity response. The pattern of glacier front retreat can be explained by a tidewater calving instability. These conclusions underscore the importance of basal sliding parameterizations in understanding observed changes in ice sheet outlet glaciers and modeling their future behavior. Correct representation of iceberg calving is also important.

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