



Modelling the source of glacial earthquakes: numerical modelling of the response of a tide-water glacier to the capsize of an instable iceberg

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One current concern in Climate Sciences is the estimation of the annual amount of ice lost by glaciers and the corresponding rate of sea level rise. Greenland ice sheet contribution is significant with about 30% to the global ice mass losses. The processes that control ablation at tidewater glacier termini, glacier retreat and calving are complex, setting the limits to the estimation of dynamic mass loss and the relation to glacier dynamics. It involves interactions between bedrock – glacier – icebergs – ice-mélange – water – atmosphere. Moreover, the capsize of cubic kilometer scale icebergs close to a glacier front can destabilize the glacier, generate tsunami waves, and induce mixing of the water column which can impact both the local fauna and flora.

We aim to improve the physical understanding of the response of glacier front to the force of a capsizing iceberg against the terminus. For this, we use a mechanical model of iceberg capsize against the mobile glacier interacting with the solid earth through a frictional contact and we constrain it with measured surface displacements and seismic waves that are recorded at teleseismic distances. Our strategy is to construct a solid dynamics model, using a finite element solver, involving a deformable glacier, basal contact and friction, and simplified iceberg-water interactions. We simulate the response of a visco-elastic near-grounded glacier to the capsize of an iceberg close to the terminus. The influence of the glacier geometry, the type of capsize, the ice properties and the basal friction on the glacier dynamic and the observed surface displacements are assessed. The surface displacements simulated with our model are then compared with measured displacements for well documented events. We show the surface and basal displacements of the glacier are significantly different in the case of a top-out and a bottom-out (the two possible rotations) iceberg capsize. This suggests different basal forces in both types of

capsize, and thus probably a different signature in the seismic waves generated at the basal surface during capsize. To reproduce the vertical displacements of the glacier, our results suggest a higher hydrodynamic force on the glacier tongue than suggested in previous studies.