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Estimating volumes of capsizing iceberg : mechanical modelling of capsize constrained by seismic signals

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One main concern in climate science is to reduce uncertainties on sea level predictions. In particular, these uncertainties depend on the quantification of the mass balance of polar ice caps including Greenland ice sheet. Iceberg calving at Greenland tide water glaciers accounts for up to half of ice losses at glacier termini. Glacier-height thin icebergs are unstable and their capsize exerts a force on the glacier front which generates a seismic wave recorded at stations at teleseismic distances (GLISN network on Greenland).

The force of the iceberg on the glacier depends on the volume of the iceberg and the whole dynamic of the capsizing iceberg (Sergeant et al. GRL 2016). The global aim of this work is to retrieve information of the capsize dynamic based on seismic data to infer the volume and other characteristics of the icebergs. Iceberg capsize dynamics depends on complex phenomena: iceberg-water interactions, iceberg-glacier friction, glacier-sea floor friction, elasto-viscoplastic deformation of ice; and only little field data is available. Solving directly fluid flow, solid motion, and contact equations even in two dimensions is very costly and can hardly be used to generate catalogues and to solve inverse problem. Therefore, a simplified mechanical model of a capsizing iceberg in water has been developed based on few assumptions. The proposed model, named SAFIM (semi-analytical floating iceberg model) accounts for sea hydrodynamics only through hydrostatic pressure, pressure drag, and added mass, and it has been validated based on a separate state-of-the-art Computational Fluid Dynamics code which can handle free surface and arbitrary iceberg configurations. In SAFIM model, the pressure drag presents a very important effect to take into consideration in accurate modelling of the dynamic of the capsizing iceberg. The SAFIM model is used to invert seismic signals and to estimate the dimensions of capsizing icebergs for few well-documented events.