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Numerical modelling of iceberg calving and implications in generated seimic waves

Amandine Sergeant (1), Vladislav Yastrebov (2), Anne Mangeney (1), Olivier Castelnau (3), Jean-Paul Montagner (1), and Eléonore Stutzmann (1)

(1) IPGP, Seismology, Paris, France (amandine.sboy@gmail.com), (2) Centre des Materiaux, Mines ParisTech, PSL Research University, France, (3) Procedes et Ingenierie en Mecanique et Materiaux, Arts Métiers ParisTech, France.

Glacial earthquakes is a class of seismic events of magnitude up to 5, occurring primarily in Greenland, in the margins of large marine-terminated glaciers with near-grounded termini. They are caused by calving of cubickilometer scale unstable icebergs which penetrate the full-glacier thickness and, driven by the buoyancy forces, capsize against the calving front. These phenomena produce seismic energy including surface waves for 2 min, with dominant energy between 10-150 s of period whose seismogenic source is compatible with the contact force exerted on the terminus by the iceberg while it capsizes. During the capsize of the iceberg which can last typically for 5 min, the normal force applied to the calving front causes a reverse motion of the elastically compressed glacier terminus within a 500 m radius area. Once the contact is released, a terminus rebound is measured and the glacier terminus flows for few hours. To simulate capsize events, we use a finite element model with special boundary conditions to model fluid-structure interaction (fluid pressure depending on depth, pressure and skin drags). A 2D plane strain formulation in linear elasticity is used. Contact and frictional forces are measured on the terminus and compared with laboratory experiments. We show the influence of geometric factors on the force history, amplitude and duration at the laboratory and field scales. Finally, the force inverted from seismic data is used to constrain the model and invert geometric and physical parameters as the iceberg dimensions, the local water depth, the calving front orientation or the ice-bedrock friction.