EGU21-8915
https://doi.org/10.5194/egusphere-egu21-8915
EGU General Assembly 2021

Modelling the source of glacial earthquakes

Pauline Bonnet[1,2,3], Vladislav Yastrebov[2], Anne Mangeney[1,4,5], Olivier Castelnau[3], Alban Leroyer[6], Patrick Queutey[6], Martin Rueckamp[7], Eleonore Stutzmann[1], Jean-Paul Montagner[1], and Amandine Sergeant[8]

[1]Institut de Physique du Globe de Paris, Seismology, Université de Paris, France (pbonnet@ipgp.fr)
[2]MINES ParisTech, PSL University, Centre des Matériaux, CNRS UMR 7633, Evry, France
[3]Laboratoire Procédés et Ingénierie en Mécanique et Matériaux, CNRS, ENSAM, CNAM, Paris, France
[4]Université Paris-Diderot 7, Sorbonne Paris Cité, UFR STEP, Paris, France
[5]Inria, Laboratoire J.-L. Lions, ANGE team, CEREMA, CNRS, Paris, France
[6]Laboratoire LHEEA, METHRIC Team, UMR CNRS n°6598, Centrale Nantes, France
[7]Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany
[8]Aix Marseille Univ, CNRS, Centrale Marseille, LMA, France

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. Ice loss in Greenland is distributed approximately equally between loss in land by surface melting and loss at the front of marine-terminating glaciers that is modulated by dynamic processes. Dynamic mass loss includes both submarine melting and iceberg calving. 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 fine-tune the parameters of these hydrodynamic effects on an iceberg capsizing in free ocean with the help of reference direct numerical simulations of fluid-structure interactions involving full resolution of Navier-Stokes equations. We simulate the response of a visco-elastic near-grounded glacier to the capsize of an iceberg close to the terminus. We assess 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. The surface displacements simulated with our model are then compared with measured displacements for well documented events.