Using dense array seismology to observe glacier dynamics: the RESOLVE-Argentière project

Florent Gimbert*[1], Philippe Roux[2], Ugo Nanni[3], Agnès Helmstetter[2], Stéphane Garambois[2], and Mickael Langlais[2]

[1]CNRS, IGE, Univ. Grenoble Alpes, Grenoble – Institut des Geosciences de l'Environnement – France
[2]CNRS, ISTerre, Univ. Grenoble Alpes, Grenoble – Institut des Sciences de la Terre Grenoble-Alpes – France
[3]CNRS, IGE, Univ. Grenoble Alpes, Grenoble, France – Institut des Geosciences de l'Environnement – France

Abstract

Glacier dynamics controls the advection of ice towards warmer areas with faster melt, and thus glacier response to climate change. Although certain key processes at play in glacier dynamics are relatively well understood (e.g. ice viscous flow), yet others such as glacier fracturing, glacier basal sliding and englacial or subglacial hydrology remain poorly known mainly as a result of lacking observations. Here we present an innovative field instrumentation strategy that evaluates glacier seismic motion with unprecedently unprecedented high temporal and spatial definition resolutions in order to unravel the specifics of those poorly known, highly intermittent and spatially heterogeneous processes. Field instrumentation was conducted on the Argentière Glacier (Mont Blanc, France) during the early melt season (month of May 2018) and consisted in a quite unique set of instruments including an array of about 100 three-component seismic sensors evenly spaced 40-m from each other (covering an area of about 0.5x0.5 km2 in the ablation zone), about 12 sensors placed in and below the glacier thanks to boreholes and subglacial tunnels drilled into bedrock, respectively, as well as a succession of complementary observations of glacier bed geometry (using ground penetrating radar), subglacial water pressure (using pressure sensors in boreholes) and glacier surface velocities (using GPS and ground radar interferometry). Analysis of seismic waveforms shows that impulsive and continuous sources coexist and are respectively caused by ice fracturing and by the flow of water. Preliminary analysis of the wavefield suggests that these different sources may be located spatially located, and that their properties such as icequake magnitude and subglacial conduit size estimated. Our seismic observations nicely add to the other complementary observations, and their combined analysis should allow yielding new insights into our understanding of glacier dynamics in a near future.

*Speaker