DAS and Ice: How Distributed Acoustic Sensing Pushes the Boundaries of Cryoseismology

The earth's cryosphere includes some of the most dynamic and fastest changing environments of our planet. Iceberg calving, glacier surges, and the sudden disintegration of ice sheets manifest on one hand the inherent dynamic character of large ice masses, on the other hand how sensitive the cryosphere reacts on the earth's rapidly warming climate. Measuring ground unrest with seismometers on or close to the ice has become the method of choice to sense fast glaciological processes and cryoseismological observations have led to paradigm changes in glaciology as for example in the understanding of glacier basal sliding.

However, instrumenting the cryosphere with traditional seismometers is difficult due to its harsh, hostile, remote and inaccessible nature as well as the sheer size of glaciers, ice streams and ice sheets. Therefore, field instrumentation has been punctually both in space and time, impeding to understand the big picture of dynamic cryospheric processes and the connection to environmental forcings.

Here, I will present how Distributed Acoustic Sensing (DAS) is changing this limitation and currently transforming cryoseismological field investigations. In 2019, the first DAS experiment on an alpine glacier opened the door for sensing the cryoseismological wavefield in an unprecedented way and unveiled the huge potential of this new technology for studying dynamic processes in glaciated terrain over large spatial scales. In contrast to traditional seismic instrumentation, the simplicity and toughness of fiber optic cables allows for long-term installations in difficult and potentially dangerous glaciated terrain, while the interrogators can be operated at a safer and more accessible location. This unique characteristic of DAS will finally make it possible to sense the seismic wavefield at locations that are critical for the evolution of the earth's cryosphere in a warming climate but have been impossible to instrument with seismometers in the past such as kilometer wide calving fronts and ice streams with hundreds of kilometers extent.