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Mapping glacier structure in inaccessible areas from turning seismic sources into a dense seismic array

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Understanding glaciers structural heterogeneity is crucial for assessing their fate. Yet, places where structure changes are strong are often inaccessible for direct instrumentation, such as in crevasses fields. To overcome this limitation, we introduce an innovative technique that transforms seismic sources, here generated by crevasses, into virtual receivers using source-to-receiver spatial reciprocity. We demonstrate that phase interference patterns between well-localized seismic events can be leveraged to retrieve phase velocity maps using seismic Michelson interferometry. The obtained phase velocity exhibit sensitivity to changes in glacier structure, offering valuable insights into the origins of mechanical properties changes, with spatial resolution surpassing traditional methods by a factor of four. In particular, we observe sharp variations in phase velocity related to strongly-damaged subsurface areas and indicative of a complex 3-D medium. Applying this method more systematically and in other contexts will enhance our understanding of the structure of glaciers and other seismogenic environments.