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Transverse subglacial water flow beneath the surging Bering Glacier

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Surge-type glaciers, which periodically switch between slow and fast flow regimes, provide us a unique opportunity in understanding the mechanisms and stability of slow and fast ice flows. Numerous field observations and theoretical analyses have confirmed that the subglacial drainage system plays a critical role during glacier surges. The drainage switches from a channelized, low-pressure system to a distributed, high-pressure system, thus decouples ice from the glacier base and facilitates fast basal sliding. However, the spatial configuration of the distributed drainage system is inaccessible to most field methods, especially during surges. Here I apply seismic interferometry to ambient noise traveling across the surging Bering Glacier, Alaska, to monitor the subglacial drainage system. Using the permanent broadband stations on the sides of Bering Glacier, I derive an eleven-year long history of seismic structure across the glacier, covering its latest surge event from 2008 to 2011. I observe substantial frequency-dependent drops of Rayleigh and Love wavespeeds during the surge event, caused by changes of the basal conditions. Furthermore, the amplitudes of the speed changes for Rayleigh and Love waves require an anisotropic basal layer with the fast direction perpendicular to the ice flow. This is best explained as due to transverse subglacial water flow during surges, consistent with the linked-cavities model proposed by Kamb (1987).