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Estimating Crustal Velocity Structure in Alaska from Acoustic-to- Seismic Coupling from the 2022 Hunga, Tonga Eruption

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The 2022 climactic eruption of the Hunga volcano in the Kingdom of Tonga generated broadband acoustic waves observed over 10,000 kilometers away on pressure and seismic sensors in Alaska. The arrival of high-amplitude acoustic energy at a regional network of colocated sensors provides a unique opportunity to examine acoustic-to-seismic coupling and use these observations to estimate crustal elastic parameters. We compute coherence between pressure and vertical seismic channels and identify three bands of strong coupling centered on 1.0, 0.03, and 0.007 Hz. We exploit the fact that coupling ratios in these bands are sensitive to bulk elastic parameters to depths of 0.03, 1.7, and 7.2 kilometers to estimate shear-wave velocities. Our results generally agree with existing velocity models for Alaska, exhibiting the remarkable ability of an acoustic wave to probe crustal depths of over 7 kilometers. We compare results at two stations to estimates obtained using the 2013 Chelyabinsk bolide as a source and obtain velocities to within a percent, indicating estimates are robust. We note that coupling on horizontal components is more complex and often disagrees with theory.
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