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Tsunamis obey Snell's Law: Simulations and Real Data

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We study the effect of a wide continental shelf at the receiver end of a far-field tsunami, by using conventional seismic beaming techniques across arrays of receivers, in order to define a two-dimensional slowness vector expressing the phase velocity of the tsunami and its azimuth of passage over the array.

In the Pacific Ocean, we first target two wide shelves fronting the Alaska Panhandle and Central America, and simulate tsunamis based on recent events in Chile and Japan, across arrays of several hundred virtual gauges located both on the shelves and in the nearby abyssal plains.

In all cases, we recover phase velocities compatible with their values expected under the SWA (160-185 m/s in deep water and 30-40 m/s on the shelf), while the azimuths of arrival show severe refraction (of up to 55 degrees) between the two environments. The resulting ray parameters ($p = \sin i / v$) are found to vary by less than 20%, and thus to verify Snell's law, despite the grossly simplified model of a linear continental shelf break separating two homogeneous media.

We also apply this approach to real data recorded by ad hoc arrays of hydrophones operated as part of temporary OBS/OBH deployments during the past ten years in various coastal and abyssal areas of the Pacific Basin.