# BODYWAVE ARRIVALS FROM SEISMIC NOISE

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## ABSTRACT

Array analysis of seismic noise has the potential to be very useful in improving body-wave tomography of Earth structure, just as noise cross-correlation methods have recently proven successful in surface-wave tomography. Beamforming of seismic noise recorded in southern California reveals P-wave arrivals from distant storms in open oceans. In this case, the noise can be processed using cross-correlation among different station pairs and optimal P-wave relative arrival times can be estimated using the same approach traditionally used to analyze earthquake arrival times.

Using three storms in the Gulf of Mexico, the Western Pacific (near Japan), and the South Pacific (near Fiji) respectively, we demonstrate that travel-time anomalies can be obtained from P waves generated by a distant storm, and that they are similar to those obtained from using an earthquake close to the storm. Our results suggest using oceanic storms as additional seismic sources for resolving P-wave travel-time anomalies.

Nonlinear wave-wave interactions generate double-frequency (DF) microseisms, which include both surface waves (mainly Rayleigh-type) and compressional (*P*) waves. Although it is unclear whether DF surface waves generated in deep oceans are observed on land, we show that DF *P* waves of both pelagic and coastal sources, generated by Super Typhoon Ioke far offshore, are detected by beamforming of land-based seismic array data. Two distinct spectral bands associated with different *P*-wave source locations are observed. The short-period DF band (~ 0.16–0.35 Hz) is dominated by *P* waves generated in the deep ocean by local wind seas under the storm. In contrast, *P* waves in the long-period DF band (~ 0.1–0.15 Hz) are weaker and generated closer to the coast of Japan from swell interactions. The accurate identification of DF *P*-wave microseism source areas is necessary to monitor ocean wave-wave interactions due to tropical cyclones and to image Earth structure using ambient noise.