# Detailed S-wave velocity structure of sediment and crust off Sanriku, Japan by a new analysis method for distributed acoustic sensing data using a seafloor cable with seismic interferometry

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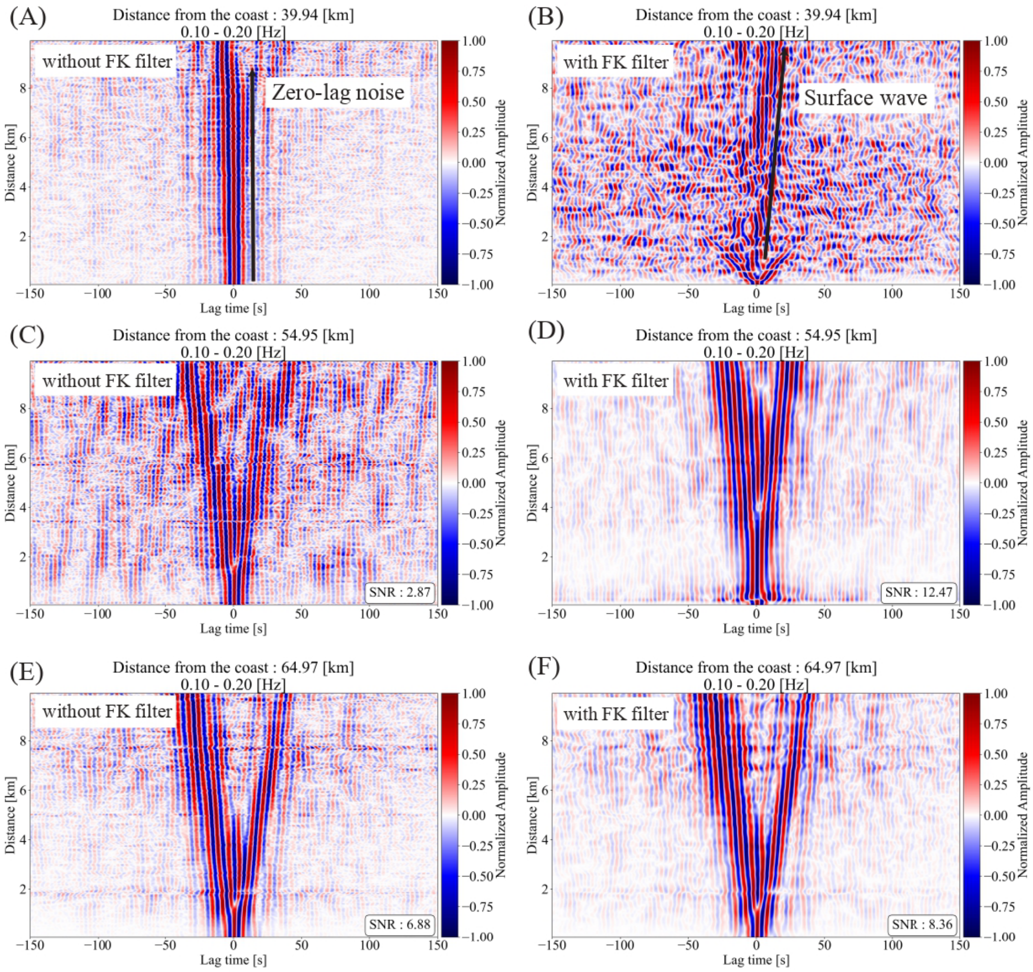
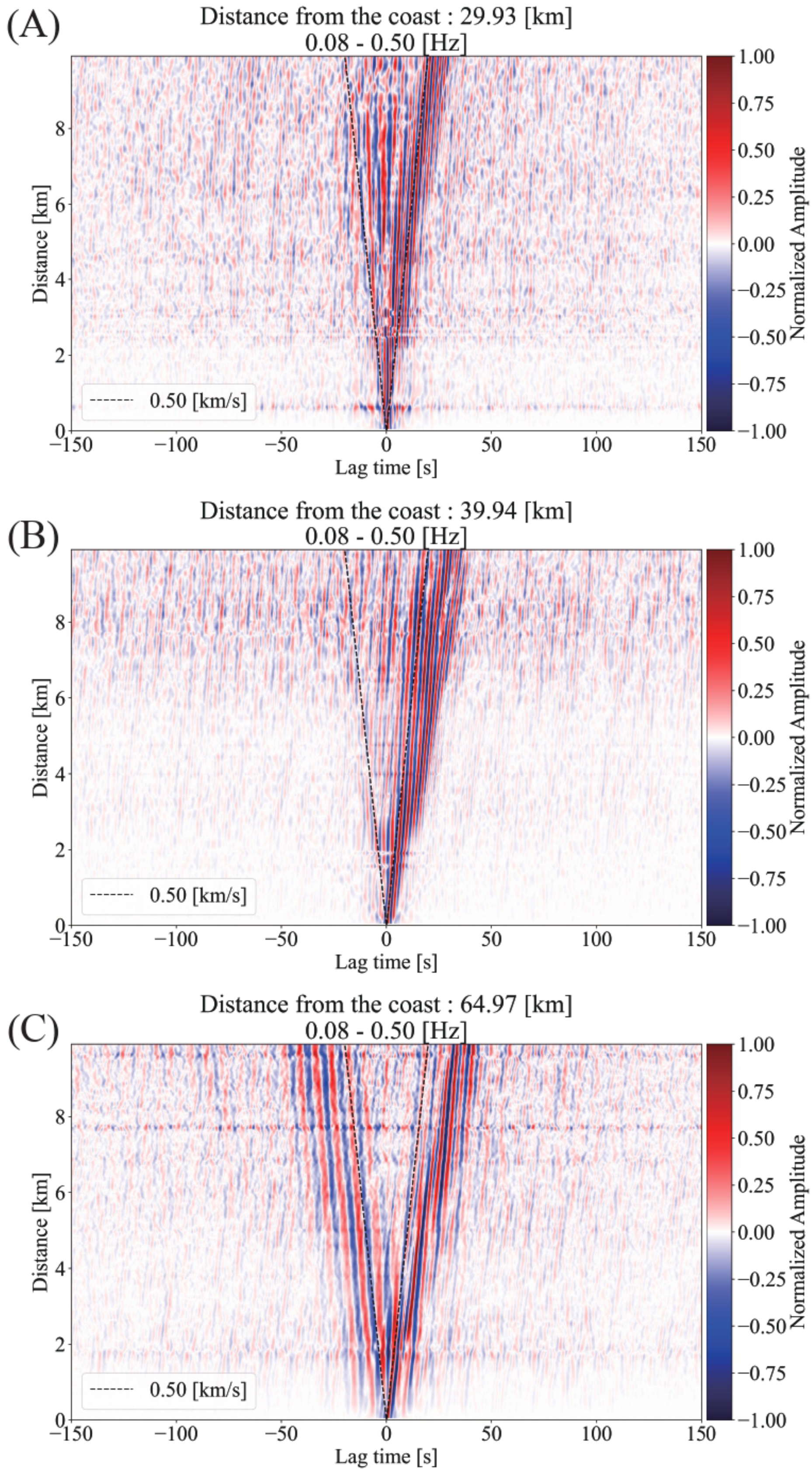



Figure S1: Effectiveness of frequency-wave number (FK) filter for calculation of CCFs. The CCFs with FK filter ((B), (D) and (F)) are compared those without FK filter ((A), (C) and (D)). The CCFs at distances of 39.94 km, 54.95 km, and 64.97 km are shown in pairs of (A) and (B), (C) and (D), and (E) and (F), respectively. Each trace was filtered from 0.1 Hz to 0.2 Hz and was normalized by its amplitude. Seismic signals propagating with an apparent velocity range from 0.35 km/s to 4.0 km/s were selected by FK filtering. For the estimation of signal-to-noise ratio calculated by root mean square amplitude ratio between surface wave and noise data for the last 50s, the method of Bensen et al. (2007) was used. DAS instrument generally has a coherent noise has at the same timing in all stations (zero-lag noise) and the coherent noise interfere analyses for surfaces waves. We can remove the zero-lag noise by using FK filter due to difference of apparent velocity. Applying FK filter to DAS data before calculating CCFs effectively enhances surface waves in DAS records.



(A)
Distance from the coast : 29.93 [km]
0.08 - 0.50 [Hz]
Distance [km]
Lag time [s]
0.50 [km/s]
Normalized Amplitude
(B)
Distance from the coast : 39.94 [km]
0.08 - 0.50 [Hz]
Distance [km]
Lag time [s]
0.50 [km/s]
Normalized Amplitude
(C)
Distance from the coast : 64.97 [km]
0.08 - 0.50 [Hz]
Distance [km]
Lag time [s]
0.50 [km/s]
Normalized Amplitude

Figure S2: Calculated cross correlation functions (CCFs) with a frequency-wave number filter at the frequency range between 0.08 and 0.50 Hz. Each trace was normalized by its amplitude. (A), (B), and (C) denote CCFs at distances of 29.93, 39.94, and 64.97 km from the coast, respectively. The dashed lines indicate an apparent velocity of 0.5 km/s. Note that the seismic waves propagating with velocities of approximately 0.5 km/s are recognized in the CCFs. The group velocities of about 0.5 km/s were much slower than the surface waves in land for an identical period range. The surface wave propagating with a low velocity is estimated to correspond to a special type of Rayleigh wave or Scholte wave.

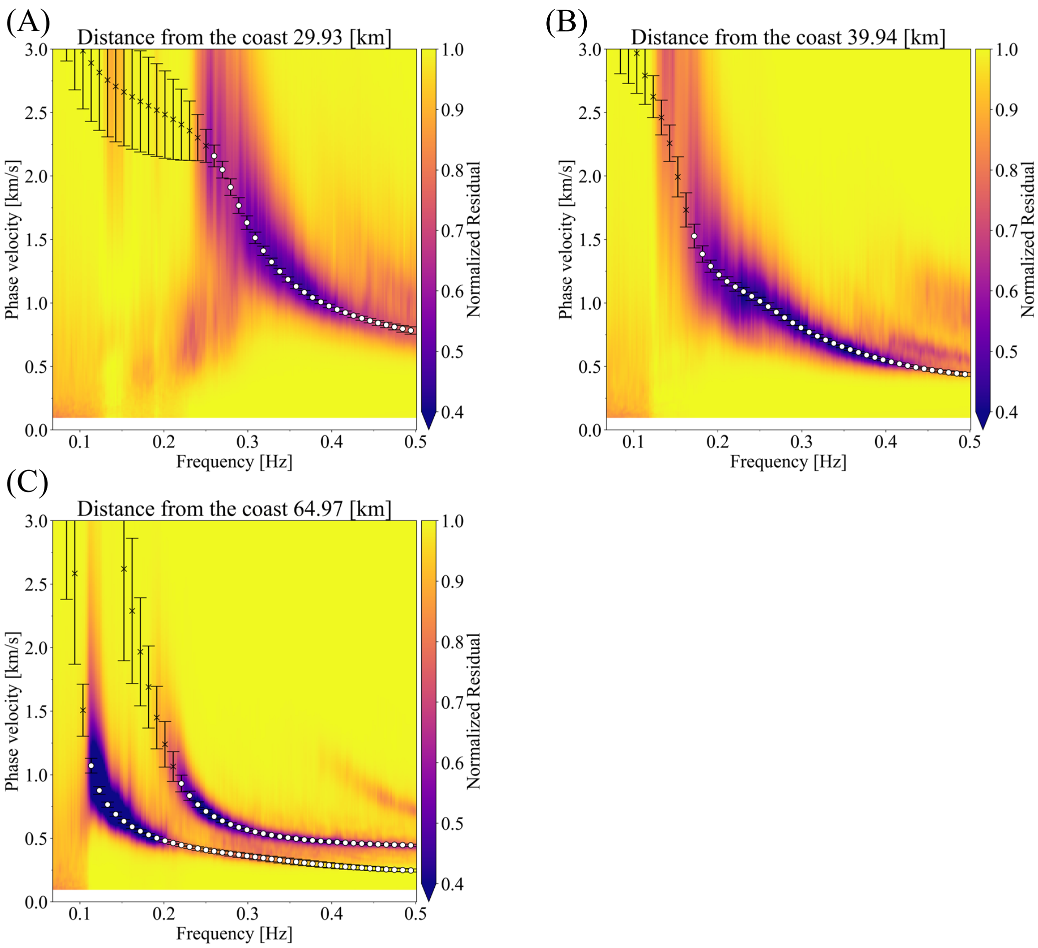



Figure S3: Normalized residuals and estimation of phase velocities in the subarrays from the coast of 29.93 (A), 39.94 (B), and 64.97 (C). Bars indicate phase-velocity uncertainties, which were estimated by a bootstrap method. The estimated phase velocities with errors less than 0.1 km/s are indicated by white circles. Although the fundamental Rayleigh wave was dominant near the coast, both fundamental (0.5–0.1 Hz) and 1st higher mode (0.5–0.2 Hz) Rayleigh waves appeared far from the coast. The faster phase velocities were observed in areas closer to the coast.

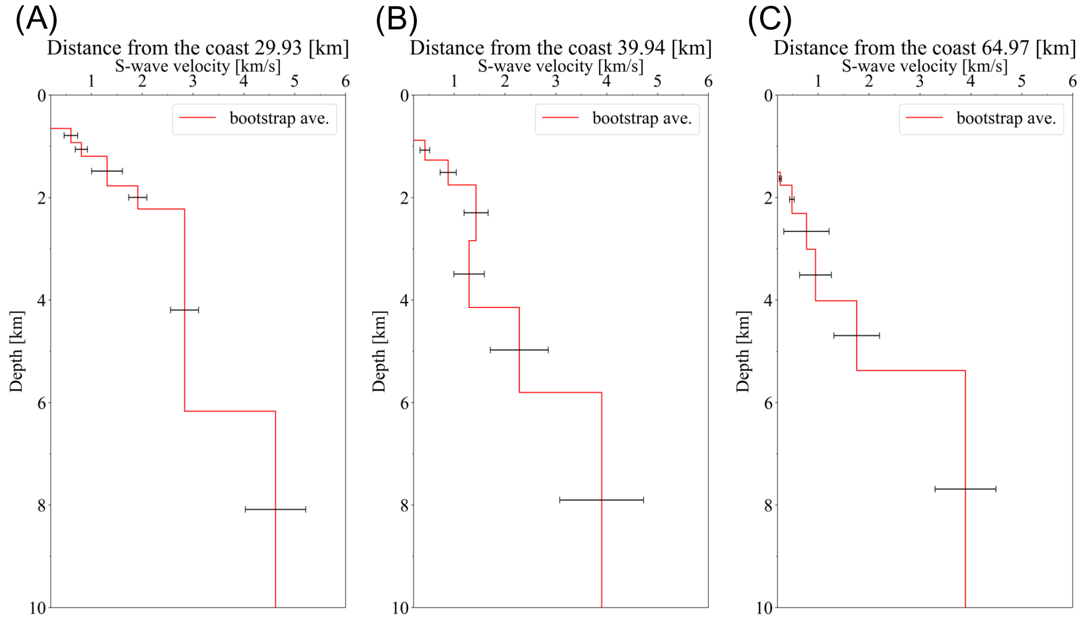



Figure S4: The obtained *Vs* structures at subarrays centered at distances at 29.93 km (A), 39.94 km (B), and 64.97 km (C) from the coast. The errors were estimated by the bootstrap method. *Vs* and thickness in each layer are set to be model parameters and minimized values of the misfit function between observed and synthetic dispersion curves in Equation 6.