Group Velocity of Rayleigh Waves Revealed from the Cross-Correlation Analysis of Ambient Seismic Noise

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1. Introduction

Cross-correlation function of ambient seismic noise observed at two stations well represents the Green function in the inhomogeneous earth medium [e.g., *Shapiro and Campillo*, 2004; *Snieder*, 2004]. Following this fact, we can retrieve seismic waves' propagation characteristics between station pairs without using active seismic sources. In this study, we practice the cross-correlation analysis of ambient seismic noise observed in Tohoku and Kanto area.

2. Data and Method

Three-component velocity records of ambient seismic noise recorded at F-net stations during 59 days, January and February in 2005, are analyzed. Applying forth-degree band-pass filters (2-4s, 4-8s, 8-16s) to records registered at two stations, we calculate cross-correlation functions of one-bit signal pair for every time window of 360s in length. We calculate the ensemble average of cross-correlation functions for the whole term of our analysis and estimate the group velocity from the envelope of obtained Green function.

3. Retrieved Rayleigh Waves

Clear wavelets appear for 8-16s band in the averaged cross-correlation functions between the vertical components observed at TYS and other stations (Figure 1). The group velocity of these wavelets is about 3km/s. Focusing on the cross-correlation functions near the maximum amplitudes, the phase of the cross-correlation calculated for two vertical components is delayed for 90 degree from that for vertical and radial components (Figure 2 (a) (b)). The particle orbit shows retrograde motion (Figure 2 (c)), so that the wavelets are identified as Rayleigh waves.

4. Spatial Distribution for Group Velocity

Figure 3 shows the spatial distribution of Rayleight waves' group velocities for 8-16s band in Tohoku and Kanto area. Generally Tohoku area shows higher group velocity than Kanto area. This result reflects the fact that the shallow structure of the Kanto plain consists of soft sediment layers.

5. Conclusion and Outlook

We have succeeded in retrieving clear Rayleigh waves from the cross-correlation analysis of ambient seismic noise. These Rayleigh waves are constructed only from ambient seismic noise. This strongly suggests that our method is very effective for estimating seismic waves' velocity even in a wide area where the seismicity is low. As a future study, we plan to analyze Hi-net seismograms throughout Japan to reveal the inhomogeneous velocity structure by using surface wave tomography technique.

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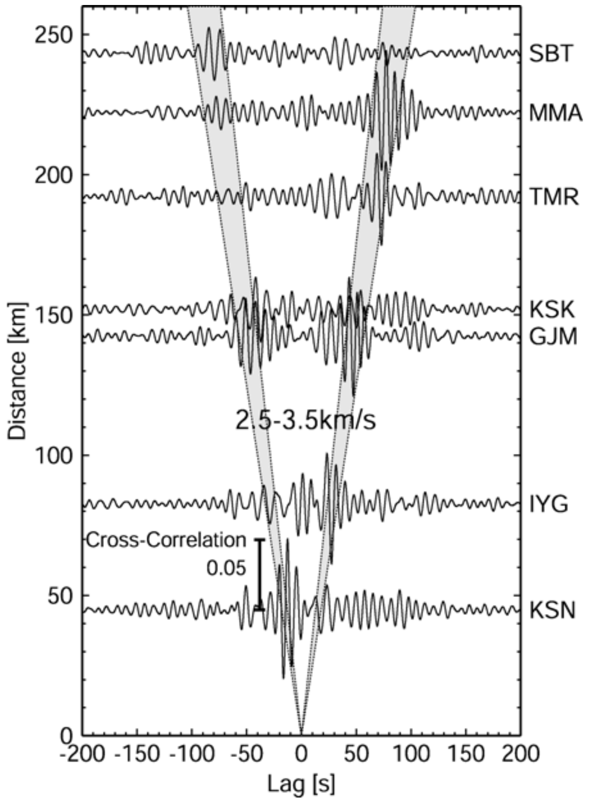

Figure 1. Averaged cross-correlation functions for 8-16s band between vertical component traces observed at TYS and other stations. Gray mesh shows group velocity for 2.5-3.5km/s.

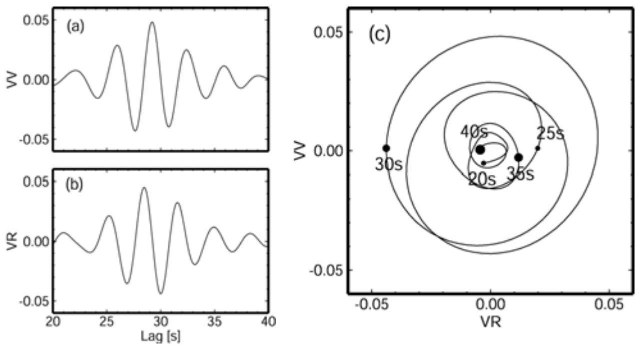

Figure 2. Averaged cross-correlation functions for 2-4s band between traces observed at IYG and TYS: (a) both vertical components; (b) vertical and radial components. (c) Particle orbit of this wavelet.

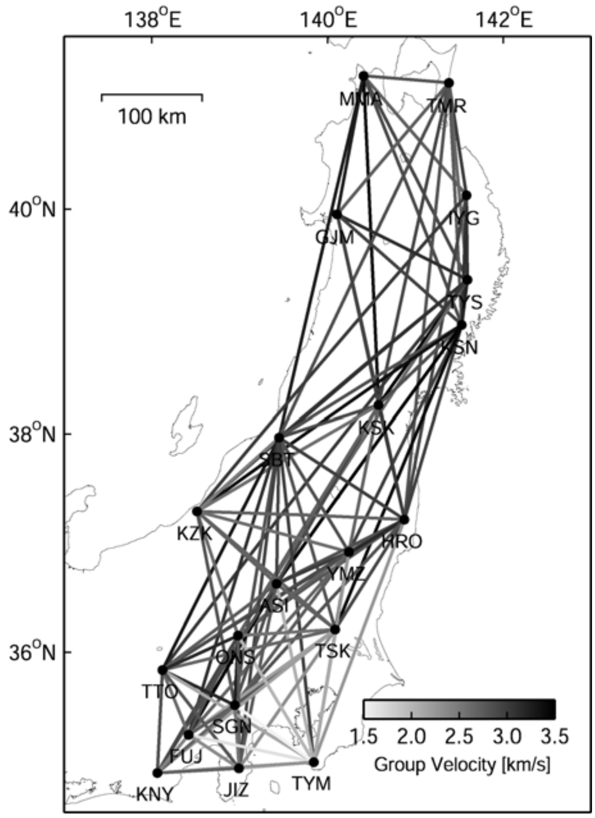

Figure 3. Spatial distribution of Rayleigh wave's group velocity in Tohoku and Kanto area. Gray scale shows estimated group velocity of the path between two stations.