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Time variation of transfer functions obtained by ACROSS signal transmitted from Morimachi

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We have analyzed temporal variation of transfer functions obtained by seismic ACROSS signals transmitted from Morimachi station and detected at Hi-net stations .We found the presence of two types of variation in travel time: (1) smooth seasonal variation and (2) sharp variations well correlated with precipitation nearby (Yoshida et al., 2008). Since the detected travel time variations appear to be related to meteorological factors, they might be attributed to the change of the material properties in the shallow layers. Therefore, it is demanded to remove the influence of meteorological factors on the shallow layers, in order to realize the active monitoring of the deeper seismogenic structures.
We used the seismograms of low-frequency transmission signal (frequency range: 3.5 - 7.5 Hz) during 2 years and 9 months (from 2006/12/26 to 2009/08/14). Seismograms obtained at N.MRIH (distance: 2.9km) and N.KGWH (distance: 8.4km) were used in this analysis. Continuous waveform is segmented into every 400 sec and stacked for 1 day to calculate a set of 6 components of transfer function tensor. The travel time analysis is made on the two time windows of 1 second duration; one for S phase and another for the later part of S phase. The travel time delay from a reference trace was calculated by means of the phase delay in frequency domain.
The detail characteristics of temporal variation of travel time are dependent on the tensor components, time windows and also on the observation sites. However, we recognized the two common characteristics: (1) a smooth annual variation with larger travel time in summer with ~5 msec and (2) an abrupt delay of travel time by several msec and its recovery with a time constant of about one week after the precipitation recorded at the nearby AMeDAS stations. Additionally, we recognized that the sensitivity of travel time delay responding to precipitation is significantly large in summer than in winter. This suggests the presence of non-linear mechanism of travel time response by the precipitation.
We try to explain the relation between the travel time variation and meteorological parameters. Whereas the correlation between the variations of travel time and surface temperature is good, simple causal relation of temperature to the travel time is not justified because of the delay of temperature variation behind the travel time.
Tank model (Sugawara, 1972) was applied to explain the travel time delay response against the daily precipitation. Daily precipitation of Tenryu and Mikura was used as an input, and no significant difference in results was found between them. The model parameters are determined by trial and error by assuming that the water level of the final tank in the model, is linearly proportional to the travel time difference so as to fit with the data of about 1 year in 2007. The General features of temporal variation in travel time well explained by a single tank model. This model also fit with the temporal variation up to 2009, and it suggests the validity of selected parameters for tank model.
Large earthquake with the magnitude of 6.5 occurred in Suruga bay almost at the end of analyzed period (August 11, 2009). Coseismic delay of travel time by several msec was detected in Htt-component at N.MRIH, located at Morimachi (seismic intensity = 4). This variation might be caused by the ground shaking by this earthquake.

The temporal variation of travel time is strongly affected by the precipitation. Since .it can be well represented by a tank model, it would be possible to remove the meteorological effects on the seismic wave propagation to realize the seismic monitoring of the deep zone in the lithosphere.

Acknowledgement
We used Hi-net and JMA AMeDAS data in this analysis.

Keywords: ACROSS, temporal variation, tank model, precipitation