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Array observation of strong motion for the precise estimation of current wavefield

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We conduct a research for the next generation of earthquake early warning based on the concept of Hoshiba (2013), where we will predict ground motion without estimating hypocentral information. Recently, Hoshiba and Aoki (2015) presented examples of ground motion prediction with observed records based on this concept.

For estimating current wavefield, Hoshiba and Aoki (2015) uses only amplitude at each station. It is expected that some more information about current wavefield such as propagation direction and apparent velocity leads to more accurate estimation of current wavefield. Array observation is one of the powerful tools to observe propagation direction and apparent velocity, so that we started array observation at the premises of our institute.

Our array network are consisted by six CV-374 type strong motion seismometers. Sampling frequency is 500 Hz. Except one station buried under the ground, five stations are fastened to the floor of each building. The size of array network is about 300 m.

We applied semblance analysis (Neidell and Tarner, 1971) to the records of the earthquake at Northern Nagano Pref. (2014/11/22, M6.7) using 1 s time window in several frequency ranges. At the time ranges of direct P wave arrival and P coda waves, semblance value of UD component is high even in a high frequency range. Backazimuth, however, is slightly southward than the expected arrival direction. Apparent velocity is also higher than the expected velocity, which means that the low velocity layer under the array may affect the backazimuth and apparent velocity. At the time range of direct S wave arrival, semblance value is relatively high for frequency under 4 Hz of horizontal component, although the backazimuth and apparent velocity at that time is not stable compared with those of direct P waves. Backazimuth and apparent velocity becomes unstable at the time range of S coda waves in spite of high semblance value.

To estimate the velocity structure under the array, we conducted seismic interferometry (e.g. Nagaoka et al., 2012) using continuous records. Dispersion relation of phase velocity of Rayleigh waves from 400 to 300 m/s for 1 to 4.5 Hz, which means the existence of low velocity layer under the array. We will further estimate the velocity structure under the array with other information.

Rapid calculation is needed in semblance analysis for the purpose of earthquake early warning. We will work on the development of effective calculation considering the velocity structure, as well as the parallel computation.

Keywords: Array observation, Earthquake early warning, efficient calculation