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Temporal velocity changes after the 2014 northern Nagano earthquake, central Japan

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Since 2003, we have calculated daily fluctuation of seismic velocity for all over Japan by applying interferometry method to Hi-net continuous ambient noise records using vertical component. Several stations showed reduction of velocity after large earthquakes such as the 2004 Chuetsu earthquake, the 2008 Iwate-Miyagi earthquake and the 2011 Tohoku-Oki earthquake, and after magma intrusions like the seismic swarms at the eastern Izu peninsula. However, we still need to investigate velocity changes associated with the seismic or volcanic event, since we still have no idea why velocity reduction after these events occurs and whether the velocity reduction is generally observed or not. On 22 November 2014, a large earthquake of Mj6.7 occurred at the northern Nagano prefecture, which is located near the northern part of the Itoigawa-Shizuoka Tectonic Line (ISTL). In this study, we investigated the earthquake effect on the velocity structure by way of the interferometry method using Hi-net data.

Around the source area of the northern Nagano earthquake, there are typical six Hi-net stations and six easy Hi-net stations which are composed of only a three-component high-sensitivity and short-period velocity seismograph. Three of them, N.HBAH, N.HKKH, and N.OTNH are on the source region. Using ambient seismic noise of 1-3 Hz bandwidth, we calculated auto-correlation functions (ACFs) of vertical component applying a one-bit normalization correction. Since the relative delay of the ACFs for each lag time corresponds to the relative change of the velocity, the velocity fluctuation for each Hi-net station could be estimated by applying a stretching method to waveforms obtained before and after the earthquake.

The three stations on the source area showed 1 % to 3 % velocity reduction during the earthquake. In addition, N.IGWH at northward and N.MKGH at northeastward from the source area also decreased approximately 0.5 % and 1.5 %, respectively. We could not find clear correlation between the velocity reduction and values such as peak ground acceleration, peak ground velocity, site amplification effect, tilt record, and volumetric strain change by the estimated source fault. After the earthquake, the velocity has recovered approximately by 50% for 2 months except for N.OTNH.

Keywords: a large earthquake, seismic interferometry, auto correlation functions, velocity reductions, Hi-net