Constituents of the autocorrelation function in seismic interferometry in Oita Pref., Japan

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1. Introduction

Auto-correlation functions (ACFs) of ambient noise, which can be interpreted as a seismic wavefield or Green's function for the collocated source and receiver, is a powerful tool for searching temporal change of crustal structure. In this study, we investigate the cause of the velocity reduction at Oita prefecture in 2007 associated with the earthquake swarm activities which was originally reported by Maeda et al. (2008) .

2. Earthquake swarm activities in Oita, Japan, in 2007

Earthquake swarm activity had started from 6 June 2007 at mid Oita prefecture, in NE Kyushu, Japan. High-activity lasts about 6 days. Earthquake sources are located Beppu Bay to northern portion of Yufuin fault system, having depth of about 10km. Fine-scale relocation by using precise measurement of relative traveltime by waveform cross correlation technique shows that the swarm earthquake activity migrates from NNE to WSW direction with increasing time. Four months later, small-size earthquakes are re-activated on the shallower portion along the extended line of the swarm migration at 30 October.

3. Seismic interferometery analysis

We calculated ACFs of noise at OITA2 station that is located very close to the epicenters of earthquake swarm, operated by Japan Meteorological Agency. At first, one-day continuous trace of vertical component is divided into 24 of one-hour segments. Then, filtered trace at the frequency band of 1-3 Hz is used to calculate autocorrelation by one-bit correlation technique [*Campillo and Paul*, 2003]. By taking ensemble average of ACFs among 24 hours, the one-day ACF is estimated. Following to the above method, one-day ACFs are calculated from January 2006 to March 2008. From the ACFs in 2006 in which there are no swarms, we confirmed the stability of the ACFs in this frequency range. We found that there is prominent phase delay for the lag times of 7 s and 10 s from the mid of June 2007, when earthquake swarm had started. We note that the delay is not uniformly increases with increasing lag time. For example, there is no delay around 8s in lag time, whereas there are clear delays at lag times before and after that time. The second delay at around 10 s in lag time was generally larger than that at around 7s. The estimated phase delay was up to 0.2 s, and this phase delay remains about four months after the termination of the earthquake swarm activities with decreasing the amount of phase delay. However, in 30 October, sudden phase delay is observed again, accompanying the second earthquake swarm activity. Additionally, we found that the polarization direction of there two delay in horizontal component ACF was almost perpendicular to each other.

4. Discussion

We found the delay and recovery of phase in ACFs with the long-time duration. This observation suggests that there is a velocity change and its recovery associated with the earthquake swarm. ACF could also be changed by seasonal and/or rainfall changes. However, phase delay observed in this case does not match rainy season. Two separated delayed wave packets of the ACF and their polarization can be systematically interpreted that they are backscattered P- and S-waves from the inhomogeneities around the source region of the swarm. Difference in lag time between these two packets also well agrees with this interpretation.

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We used the continuous seismic trace recorded by JMA station.