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Search for seismic velocity changes due to the 2009-2010 Bungo-Channel slow slip event with seismic interferometry

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Recently, seismic velocity structures and their temporal changes have been investigated with seismic interferometry, where green function waveforms propagating between two stations are constructed by producing ambient noise correlations of waveform data observed at two stations. Rivet et al. (2010) have reported a possible velocity change of 0.3 % due to the 2006 slow slip event in Guerrero, Mexico. Inspired by their study, we try to detect the possible velocity change due to the 2009-2010 Bungo-Channel slow slip event occurring in southwest Japan with seismic interferometry.

We analyze continuous vertical waveform data obtained at 28 Hi-net stations operated by NIED in the Shikoku region, southwest Japan. Applying band-pass filtering of 0.1-0.5Hz, we first produce 1-day stacked cross-correlation functions (CCFs) for each pair of stations following the running-absolute-mean normalization method (Bensen et al.,2007) to enhance the ambient noise portions. Each 1-day CCF has a similar waveform but the amplitude is changing. Therefore, we produce 1-month stacked CCFs. Stacked CCFs during the whole period for respective pairs show a prominent Rayleigh wave packet propagating with the group velocity of 2.5 km/s. Then, we produce a cross-correlation function between the corresponding phase portions for the 1-month stacked CCF and for the reference CCF, and examine the temporal changes in the arrival time of the phase in 1-month CCF for each station pair.

Even if CCFs are relatively stable in time, say CCFs for stations N.OOTH and N.MISH, they have asymmetry in the CCF delay time, and the phases of Rayleigh wave portion appear in the positive and the negative delay times depending on the season. As previous studies pointed out, this seems to be caused by the temporal change in the distribution or the strength of noise sources. We compare the CCFs for the western and the eastern Shikoku station pairs with those for the northern and the southern ones. The CCFs for the western and the eastern ones show the arrival time seasonal changes of 1 %, and the larger delays appear in winter than in summer if the reference stations are take to be the western ones. Such seasonal delay changes, however, cannot be seen in CCFs for the northern and the southern station pairs. Furthermore, differently from seasonal changes, in some northern and southern station pairs, the CCFs show rapid delays of arrival times amounting to 0.3-0.5 % around January in 2010. The paths between these station pairs sample the region where the 2009-2010 Bungo-Channel slow slip occurs. And the amount of arrival time delays, namely, the reduction of seismic velocity, is comparable to those reported in previous studies. Therefore, the changes in delay times might be related to the slow slip event, though we need further to examine the details in the changes, to distinguish the seasonal changes and to investigate CCFs in some different frequency bands.

In this paper, in addition to the data at the stations in Shikoku, we analyze the data recorded at the Hi-net stations in Ooita and Miyazaki prefectures, the Kyushu region, which give us the CCFs for station pairs whose paths are crossing the Bungo-Channel and well sampling the source region of the slow slip event.

Keywords: Seismic interferometry, ambient noise, cross-correlation, Bungo-Channel slow slip event