Effect of successive aftershocks for one-bit normalization on the seismic interferometry

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1. Introduction

One-bit normalization is a method of waveform processing and converts amplitudes of a waveform to ±1 depending on their signatures. As the method is possible to retrieve phase information independently of amplitude, it is used to minimize non-noise records such as earthquakes on the seismic interferometry, which uses correlation functions.

Fig. 1 (a) shows the temporal change of auto-correlation functions (ACFs) that we calculated from seismic noise observed at Daigo, Ibaraki prefecture, Japan. The result on each day was averaged by 60 ACFs which were calculated from 1-min waveforms filtered from 1 to 3 Hz and red phases indicate positive correlations. After the 2011 off the Pacific coast of Tohoku Earthquake (hereafter, the 2011 Tohoku Earthquake), we found the change of dominant frequency on ACFs and the broken coherence around the lag time of 5 s.

One possibility is that they were associated with successive aftershocks that occur randomly. We investigated the effect of aftershocks for the one-bit normalization on the seismic interferometry.

2. Analysis

We calculated ACFs from normalized waveforms and investigated effects on the stacking procedure. Stacking is a process of making signals amplified by averaging ACFs.

We used waveforms of Hi-net stations at Daigo and Juoh in Ibaraki prefecture, Japan. First, waveforms were filtered between 1 and 3 Hz and applied by one-bit normalization. We then calculated ACFs for 1-min waveforms at the two stations. We carried out the procedure for waveforms on the 1st and 15th days from February to May, 2011 at both stations and averaged over 1 hour, 3 hours, 5 hours, 10 hours, 24 hours, respectively.

3. Results and Discussions

Fig. 1(b) and (c) show examples of ACFs in Daigo averaged over 10 and 24 hours, respectively. The effect of aftershocks clearly seen around the lag time of 5 s in Fig.1(c) was less dominant in Fig. 1(b). In addition, coherent phases could be traced in Fig. 1(c), whereas it was hard in Fig. 1(b). This would be associated with the number of stacked ACFs.

Our results suggest that the stacking of ACFs calculated from waveforms with the one-bit normalization can dramatically reduce the effect of successive aftershocks.

Acknowledgments
We used Hi-net waveform data.

Keywords: Seismic interferometry, One-bit normalization, Successive aftershocks

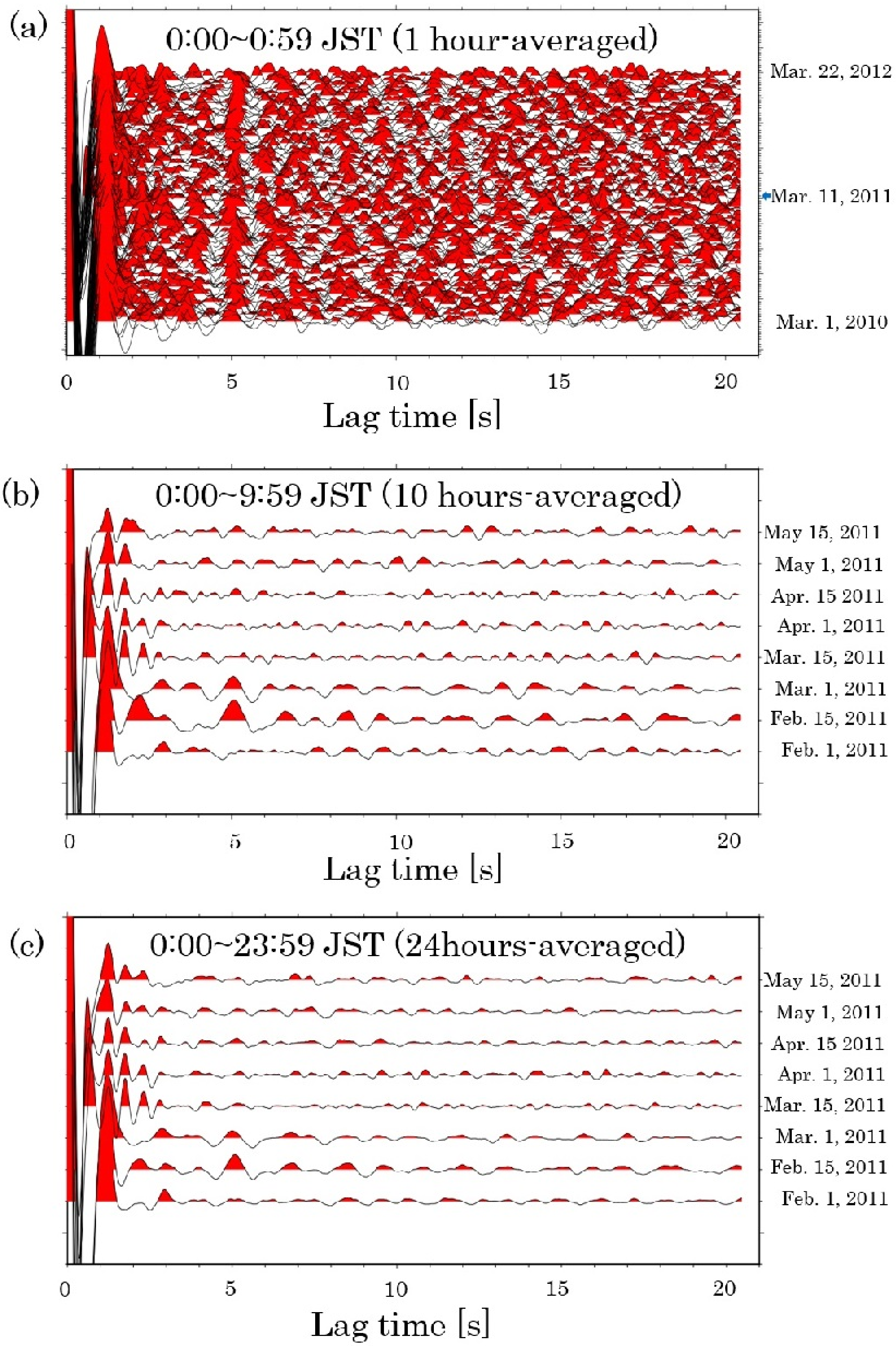

Fig. 1 (a) An example of averaged ACF at Daigo, Ibaraki prefecture, Japan. Individual ACFs were averaged by 60 one-min results. (b) ACFs averaged by 600 results. (c) ACFs averaged by 1440 results.