Estimation of seismic velocity changes in response to the earth tide: Noise correlation analysis at 13 active volcanoes in Japan

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Seismic velocity changes due to a large earthquake have received much attention in recent years to understand the mechanical properties of the shallow structure. Strong motion and stress changes due to crustal deformation are considered as mechanisms of seismic velocity changes, however it is necessary to estimate each contribution to understand the mechanism of velocity change quantitatively. Recently, Takano et al. [2014] and Hillers et al. [2015] estimated velocity changes due to the Earth tide by applying seismic interferometry method to ambient noises to investigate the seismic velocity changes only due to stress. However, there are only two studies, hence we estimate seismic velocity changes in response to the Earth tide using ambient noises recorded at 13 active volcanoes in Japan.
Vertical component of ambient noises recorded by Japan Meteorological Agency at 13 active volcanoes in Japan are analyzed: Tokachidake, Meakandake, Mt. Tarumae, Mt. Usu, Hokkaido-komagatake, Mt. Azuma, Mt. Bandai, Nasudake, Mt. Kusatsushirane, Mt. Ontake, Izuoshima, Miyakejima, Unzenfugendake. We analyzed continuous data for 2 years (2013-2014). For every possible pair combination of stations whose distances are within about 5km, we computed cross correlation functions (CCFs) at dilatational and contractional episodes, respectively. Each episode is defined by dividing observation period according to tidal strain amplitudes computed by GOTIC2 [Matsumoto et al., 2001]. CCFs are then stacked for the dilatational episode and the contractional one. By measuring the phase difference between dilatational CCFs and contractional CCFs, seismic velocity changes due to the Earth tide are estimated. Record sections of CCFs indicate that surface wave might be dominant in ambient noise.
Seismic velocity changes due to vertical component of the Earth tide averaged for all station pairs are estimated to be -0.02±0.02% at 0.5-1Hz, -0.01±0.01% at 1-2Hz, and -0.06±0.01% at 2-4Hz, respectively, while seismic velocity changes due to areal component are estimated to be 0.03±0.02% at 0.5-1Hz, 0.02±0.01% at 1-2Hz, and 0.06±0.01% at 2-4Hz, respectively. Negative values of velocity changes indicate seismic velocity is reduced during the dilatational episode in contrast to the contractional episode. Therefore, it appears that seismic velocity is reduced due to vertical dilatation. It is consistent with the result of Hillers *et al.* [2015]. However, Yamamura et al. [2003] and Takano et al. [2014] detected velocity reduction due to areal dilatation. The two studies analyzed P-wave, while this study and Hillers et al. [2015] analyzed Rayleigh waves. This suggests that the observed velocity changes may differ for the orientation of strain and type of seismic waves analyzed.

Keywords: seismic velocity change, seismic interferometry , earth tide

