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Depth variability of the crustal response to the Mw 9.0, 2011 Tohoku-oki earthquake from noise-based seismic monitoring

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Many studies apply noise-based seismic monitoring to track the physical property changes in the shallow upper crust. However, little information about the rheology of the lower crust has been discussed or observed with noise-based monitoring. To understand how stress changes in the deep crust, we benefit from the dense array of Hi-net tiltmeter instruments to measure seismic velocity changes at long period above 5s. We apply the doublet and inversion method to 190 tiltmeter stations up to 90 km apart in two period ranges 8 – 30s and 15 – 50s in northeastern Honshu from 2008 to 2012. The results first prove the feasibility of using tiltmeter data to track seismic velocity changes at long period. Combined with the results from Hi-net short period seismometers, we observe that spatial distribution of postseismic velocity changes in 1 – 7s is in agreement with the 2011 Tohoku-oki earthquake-induced shaking distribution, while the long period shows a different pattern. The amplitudes of coseismic velocity changes diminish at long period. Postseismic deformation gets more complicated concerning the long period and is delayed in time in the response compared to the short period. This is the sign for postseismic viscoelastic behavior. To understand this phenomenon, we model velocity changes based on surface waves sensitivity kernel. The optimal model helps to clarify the rheology of the crust as well as the seismic cycle regarding seismic velocity changes at various depths.