Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

SSS24-05 Room:303 Time:May 20 10:00-10:15

Time-lapse changes in velocity and anisotropy after the 2011 Tohoku earthquake estimated by seismic interferometry

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Seismologists have estimated time-lapse changes in subsurface velocities and anisotropy caused by the 2011 Tohoku earthquake for two years. Seismic interferometry is recognized as a powerful tool to monitor the velocities and anisotropy, and applied to earthquake records and ambient-noise data recorded by KiK-net, Hi-net, and other seismometers. We apply seismic interferometry to KiK-net data and estimate mean values of near-surface shear-wave velocities in the periods of January 1–March 10 and March 12–May 26 in 2011. We detect about a 5% reduction in the velocity after the Tohoku earthquake. The area of the velocity reduction is about 1,200 km wide, which is much wider than earlier studies reporting velocity reductions after larger earthquakes. The reduction partly recovers with time. We can also estimate the azimuthal anisotropy by detecting shear-wave splitting after applying seismic interferometry. Estimating mean values over the same periods as the velocity, we find the strength of anisotropy increased in most parts of northeastern Japan, but fast shear-wave polarization directions in the near surface did not significantly change. The changes in anisotropy and velocity are generally correlated, especially in the northeastern Honshu (the main island in Japan).

Keywords: seismic interferometry, Tohoku earthquake, time lapse, shear-wave velocity, shear-wave splitting, KiK-net