# Detecting temporal changes in shallow subsurface structures by using K-NET data

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The Kyoshin network (K-NET) of the National Research Institute for Earth Science and Disaster Prevention (NIED) has been recording strong ground motions for about 20 years since its construction in June 1996. K-NET data have been used to understand many subjects such as physics of earthquakes, seismic hazard caused by strong ground motion, and resultant earthquake disasters. In this presentation, I will show that K-NET data can be used to detect seismic velocity changes in shallow subsurface structures. Borehole data such as KiK-net are more suitable for the purpose, but the number of data is still limited. Hence, I proposed a method to use auto-correlation function of coda waves from local earthquakes recorded at K-NET (Nakahara, 2015). I applied this method to the 2011 Tohoku-Oki earthquake.
I used K-NET stations in the Pacific side of Northern Honshu (from Aomori to Chiba). At each station, two horizontal component records from earthquakes of M smaller than 7.0 which occurred at depths of 20-60km off Pacific region in 2010 and 2011 were used. In the frequency range of 1-20Hz, normalized auto correlation function of the record was calculated for a 10.24 s-long coda waves starting from the 1.5 times the direct S-wave travel time. I repeated such calculations 20 times by sliding time windows by 1 s. Normalized auto correlation functions were stacked with respect to different time windows. Aligning the stacked normalized auto correlation functions along time, I found changes in arrival times of phases in the auto correlation functions. Focusing on shallow depths, I dealt with phases in lag times of less than 1s. The results show that temporal variations occurred at some stations. Especially, clear phase delays were found at stations along the coast in Iwate and Ibaraki. And this change was associated with the mainshock. These delays recovered in a few month at some stations. However, these delays continued for a few years at other stations. This result may have an important implication for earthquake hazard estimation for large earthquakes that take place consecutively in a short time. Amounts of phase delays were in the order of 10% on average with the maximum of 30-50%. This method has an accuracy of about a few percent, which is much larger than methods using earthquake doublets. Hence this method might be applicable to detect larger changes. In spite of these disadvantages, this method is still attractive because it can be applied to records on the surface without boreholes.
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