Investigations of sensor orientation and a possibility of detecting crustal deformation based on accelerometer records of S-net

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Seafloor Observation Network for Earthquakes and Tsunamis along the Japan Trench (S-net) of National Research Institute for Earth Science and Disaster Resilience (NIED) will greatly improve our knowledge of subsurface structure beneath offshore region along Japan trench and understanding of regular and slow earthquakes on the subducting plate boundary. We estimated the orientations of S-net sensors that are fundamental information for further data analysis and investigated the possibility of detecting crustal deformation based on accelerometer records.

We determined three parameters of sensor orientations: tilt angle of the long axis of a cable, rotation angle around the long axis, azimuth of the long axis. We estimated the tilt and rotation angles by assuming the DC components of accelerometers record the gravitational acceleration. The tilt and rotation angles slightly vary within the range of 0.01-0.1 degree during the period from 2016 to 2018 except for coseismic steps of rotation angles larger than 1 degree due to the M6.4 off Sanriku earthquake (August 20, 2016) and M7.4 off Fukushima earthquake (November 20, 2016). The long-axis azimuths are estimated by particle motions of long-period Rayleigh waves. We used the accelerometer records in 30-100 s of 7-14 teleseismic earthquakes with Mw 7.0-8.2. The azimuths are constrained in the range of 5-10 degrees. After correcting waveforms based on the estimated sensor orientation, we found coherent waveforms within the whole S-net stations and separation of Rayleigh and Love waves in radial and transverse components.

The capability of the DC components of accelerometers implies a possibility to detect crustal deformation from accelerometer records. We made time series of tilt and rotation angle with the sampling rate of one hour. During the period without offsets partly due to earthquakes, the root-mean-square (RMS) amplitudes of tilt and rotation angles are about 2 micro radians at most stations. The buried stations shallower than 1500 m show smaller variations and RMS amplitudes are about 0.2 micro radians. Some buried stations show tidal response with amplitude of about 1 micro radians. Since the maximum tilt change of land stations by a slow slip event (SSE) near the Boso Peninsula is about 1 micro radians, it might be possible to detect crustal deformation due to similar SSEs based on the accelerometer records.

Acknowledgement: We used continuous records of S-net managed by NIED. We thank NIED for providing the data.

Keywords: S-net, Sensor orientation, Crustal deformation, Slow slip, Tilt observation

