Orientations of DONET2 seismometers estimated from seismic waveforms

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DONET (Dense Oceanfloor Network System for Earthquakes and Tsunamis) has been developed along the Nankai trough in order to issue earthquake and tsunami early warnings, monitor the crustal activities, determine the crustal structures, and reveal and monitor preparation processes of large megathrust earthquakes. DONET1 and DONET2 cover the Kumano fore-arc basin and the Muroto basin between off Shiono-misaki and off Muroto, respectively. All DONET2 stations have been installed by March 2016. Two new stations have been added to DONET1 to fill the gap between DONET 1 and 2 networks, off Shiono-misaki. Seismometer orientation is crucial for analyzing seismic waveforms. Nakano et al. (2012) obtained seismometer orientation of each DONET1 station. In this study, we estimated seismometer orientation of DONET2 stations and the new stations of DONET1. We also estimated the seismometer orientation at KMA03 in DONET1 because the seismometer package has replaced in December 2015.
We estimated the orientations of DONET seismometers by using the cross-correlation of long-period seismic waveforms with those at reference stations located in land (Shiomi et al., 2003). By using five F-net stations (KIS, KMT, NOK, ISI, and UMJ) installed at coastal area in the Kii Peninsula and the Shikoku Island as references, we estimated the direction of broad-band seismometer at each DONET station. We used data from 31 earthquakes that occurred between March 2015 and January 2017 in the world with magnitude larger than 7. The orientation of seismometer at F-net stations KIS and ISI are corrected by the angle of NS component shown in the web site.
We applied a Butterworth filter between 0.008 and 0.01 Hz for the waveforms. We rotated the horizontal components of waveforms at a DONET station and computed cross-correlation coefficient with NS and EW components at each F-net station. The angle that gives the maximum cross-correlation coefficient is the estimate of the seismometer orientation. We adopted the data with the sum of the correlation coefficients of the two components larger than 1.7. For robust estimations, we removed data with a deviation larger than 10 degree from the average, and computed the average again. The standard error for the orientations were between 1 and 2 degree.
We also estimated the seismometer orientations at DONET1 stations for comparison with those obtained by Nakano et al. (2012). The seismometer orientations differ by 4 degree at maximum at several stations. Number of data used for the estimations of such stations were relatively small compared to other stations in Nakano et al. (2016). This would be because that the analysis period was immediately after the construction of the network in the previous study.
We concern the same situation for estimations at DONET2 stations obtained in this study. Some stations were not buried after the installation and seismic noise in long-period components is larger, resulting in less number of data available. Increasing the number of data by using much number of events, as well as improving the data quality by burial of seismometer is important for increasing the accuracy of the estimations. Combination of estimations by using another method such as the orientation of P-wave first motion that was used in Nakano et al. (2012) also improves the accuracy.
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Keywords: Ocean-bottom seismometer, Nankai trough

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