Polarization evidence for the occurrence of shallow tremors in the Japan Trench subduction zone

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In the Japan Trench subduction zone, northeast Japan, the coincidental occurrences of the tremors with the slow slip events (SSEs) have been identified by using the ocean bottom seismometer (OBS) records (Ito et al., 2013; Ito et al., 2015). However, since the previous detection was based on the amplitude changes of ambient noise levels at few stations near the trench axis, the locations and source mechanisms of tremors are still uncertain. Here we investigate the polarization of OBS data to validate and deduce further source information of shallow tremors beneath the Japan Trench subduction zone.
Following the method proposed by Jurkevicks (1988), we calculate the average particle motion polarization for every 10-minute time window on the basis of the three-component covariance matrix of ground motion. Three principal axes of the best-fit ellipsoid to the particle motion correspond to the eigenvectors of the matrix in the least squares sense. The polarization azimuth is given by the direction of first eigenvector and the degree of linearity is given by the ratio among three eigenvalues. We analyze the continuous velocity seismograms for 5 months from November 2010 to March 2011 recorded at 17 short-period OBS network stations deployed in the Japan Trench axis area off Miyagi, northeast Japan.
We obtain several long sequences of high linearity and nearly constant polarization azimuths associated with tremors from the records of at least three stations near the trench. Three major sequences correspond to the tremor sequences reported in Ito et al. (2015). The stable and nearly constant azimuths in these sequences indicate the similarities of focal mechanisms and epicenters of tremors. The dominant polarization azimuth shows the angle of about 130 degrees, which may suggest shear slips in the subduction direction of the Pacific plate. Furthermore, the azimuths slightly change toward the timing of the largest foreshock of the 2011 Tohoku-Oki earthquake, which possibly indicates the migration of tremor sources.
We further apply the method to three different frequency bands (0.5-2 Hz, 2-8 Hz, 10-20 Hz) of OBS data to examine frequency characteristics. While the results from three bands show quite different background polarization azimuths, the specific polarization patterns associated with the SSE are only shown at the frequency of 2-8 Hz, which also supports the occurrences of tremors.

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