Spatiotemporal distribution of fin whale signals in northeast Japan

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We investigated spatiotemporal distributions of whale signals observed by ocean-bottom seismometers of S-net (Seafloor observation network for earthquakes and tsunamis along the Japan Trench) deployed in and around the source area of the 2011 Tohoku earthquake.

We used velocity waveform data from 2017 to 2019. We found characteristic signals with the spectral peak in narrow frequency bands of 14-25 Hz that are different with typical bands of seismic waves and T-phases. The signals have a short duration of about 1 second and are repeatedly found at regular intervals of several tens of seconds. These features are consistent with those of acoustic signals from fin whales as shown in hydroacoustic and seismic observation data by previous studies (e.g., Watkins et al., 1987; Sciacca et al., 2015). We thus assume that the characteristic signals observed at S-net stations are ones associated with fin whale activities.

We developed a detection system that automatically picks the signals of the activities from continuous seismic data. Most of the signals detected by this system are found at stations off Kushiro and Aomori areas from early fall to spring months. The signals are also detected at stations deployed in the outer rise area. In summer months, however, these are not clearly found at all stations. Our results also show that the migration of the signals among the stations from the northeast to southwest direction is found during winter. From analyzing the three-year data, these features are repeatedly seen every year. Considering whale sighting survey results that fin whales are abundant in high latitude areas during warm months and low latitude areas during cold months (e.g., Edwards et al., 2015), such spatial and seasonal variations of the detected signals shown in this study probably associate with the migratory behavior of fin whales. At some stations, we also find the rotation motion in horizontal components during several minutes or hours, which would be also caused by the migration around a station.

We suppose that integrated scientific studies across marine ecology to geophysics using S-net data could contribute to developing our understandings of various signal sources observed in ocean-bottom areas and of ecological behavior of marine mammals.

Keywords: ocean-bottom observation, S-net, fin whale

