Observation of microseisms generated by wind wave on seafloor

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Recently microseisms, which have been considered as unnecessary noise in seismological observation, draw a great deal of attention as new signal sources which can be utilized for subsurface structure survey and so on. They are observed not only as ground motion but also as low frequency acoustic ambient noise of less than several Hz on seafloor.

The microseisms are basically supposed to be generated by the pressure fluctuation associated with atmosphere-ocean interaction, the nonlinear interference between ocean waves on sea surface and the conversion to the ground motion on the seafloor followed by the propagation to the shore. However, the mechanism of microseism generation is not necessarily clarified. For more detailed understanding, the observation in the ocean where the microseisms are supposed to be generated is important.

Meanwhile, real-time long-term deep seafloor observations, both with hydrophones and with seismometers at the same time and at the same site, are carried out by cabled observatories which were deployed off Hatsushima Island in Sagami Bay and off Kushiro-Tokachi in Hokkaido.

The main factors of the pressure fluctuation at the frequency band corresponding to microseisms are wind waves on the sea surface and the associated low frequency swells which were propagated to the surrounding area.

The major factors which affect the spectrum of the wind wave are wind speed and fetch on the sea surface. Besides, it also undergoes influences by the seafloor topography and the geography of the coast.

Although the frequency responses of the hydrophones, ITC-1010A, used at the observatories are not necessarily stable at low frequency, the spectral amplitude peaks are observed to appear under strong wind such as typhoons at frequency between 0.1 Hz and several Hz that corresponds to the frequency of microseisms. This time, the observed spectral changes of both acoustic and seismic data was investigated along with the meteorological data of Japan Meteorological Agency stations on shore and with NOWPHAS wave height data of Port and Airport Research Institute obtained at neighboring harbors.

In Sagami Bay, an amplitude peak at about 1 Hz almost always appears in the spectrum of the acoustic data, but it does not appear in that of seismic data. Also, a peak of the same frequency (1 Hz) does not appear in the hydrophone data of off Kushiro-Tokachi observatory. At both observatories, under the strong wind associated with typhoons and low atmospheric pressures, the increase of the spectral amplitude accompanied by the decrease of the peak frequency appears in the spectra of both acoustic and seismic data. These fluctuations correlate well with both the increase of the significant wave height and the decrease of significant wave frequency observed by the NOWPHAS wave height meter. These phenomena suggest the development process of the wind wave and the generation of microseisms. In addition, the spectra in Sagami Bay are characterized by an amplitude peak at about 0.3 Hz which is excited by the developed wind wave. On the other hand, the spectra of off Kushiro-Tokachi observatory are characterized by an amplitude peak at lower frequency, about 0.15 Hz in the lowest case observed so far. These differences also suggest the influence of topography and fetch.