Detection of long period acoustic waves in conjunction with Earth's background free oscillations

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It has long been considered that only large earthquakes excite free oscillations of the solid Earth. Recently, however, evidence was reported that they are excited as Earth's background free oscillations even on seismically quiet days [Nawa et al., 1998; Suda et al., 1998; Kobayashi and Nishida, 1998]. Statistical features of them and an annual variation of their amplitudes with a peak in July suggest that atmospheric disturbance is the most probable excitation source for this phenomenon [Nishida and Kobayashi, 1999; Nishida et al., 2000]. If the atmospheric excitation mechanism is efficient, atmospheric acoustic free oscillations must be also excited persistently. In fact there is evidence of resonance oscillations between seismic free oscillations and atmospheric acoustic free oscillations at periods around 230 and 270 s [Nishida et al., 2000]. The resonant amplitudes of the seismic records suggest the atmospheric excitation of the acoustic free oscillations but there is no direct observation of them. For detection of the long period acoustic waves, we installed a cross array of barometers in the University Forest in Chiba, Japan. The array has 28 micro-barometers employing quartz crystal resonator technology (Paroscientific Inc. 216B-250) with station spacing of about 500 m. We analyze 1-second continuous sampling records in a time period from March to December 2002. We calculated the wavenumber-frequency spectra of the barometric records in barometric quiet periods. The calculated spectra show a clear branch of acoustic waves at periods from 2 to 50 s with phase velocity around 350 m/s. We also calculated the frequency-slowness spectra, which show two different origins of these waves. (1) The calculated spectra at periods from 2 to 10 s show that these waves travel from SE to NW with the amplitudes around 0.1 Pa. These waves are termed microbaroms which are generated by ocean waves in coastal regions. (2) The spectra at periods from 10 to 50 s show that these waves travel from NW to SE with the amplitudes around 0.1 Pa. It has been reported that long-period acoustic waves are often associated with mountain regions but their origin is still unknown [Gossard and Hooke, 1975]. For detection of the expected acoustic free oscillations at periods around 230 and 270 s, we have to expand further the scale of the array.