Comparison of nonlinear wavelets observed by both infrasound and seismometers in polar regions

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Several characteristic waves detected by seismographs in Antarctic stations have been recognized as originating from the physical interaction between the solid-earth and the atmosphere - ocean - cryosphere system surrounding the Antarctic and may be used as a proxy for characterizing ocean wave climate. An infrasound sensor was installed at Syowa Station, Antarctica, in April 2008 during the IPY2007-2008. Continuous infrasound data for 2008-09 includes background signals - microbaroms- with a broad peak in the wave period between the values of 4 and 10 seconds. Signals with the same period are recorded by the broadband seismograph as microseisms. On the infrasound data, stationary signals are identified with harmonic overtones at a few Hz to lowermost human audible band, which we suggest is due to local effects such as sea-ice cracking and vibration. Microseism measurements are a useful proxy for characterizing ocean wave climate, complementing other oceanographic and geophysical data. In Antarctic stations, continuous monitoring by both broadband seismograph and infrasound contribute to the Federation of Digital Seismographic Networks, the Comprehensive Nuclear-Test-Ban Treaty in the high southern latitudes, and the Pan-Antarctic Observations System under the Scientific Committee on Antarctic Research. In particular, this presentation focuses on the characteristic harmonic tremors observed both by infrasound and seismic sensors at Syowa Station, Antarctica during the period from February to April 2015.

Keywords: infrasound, seismic waves, nonlinear wavelets, harmonic tremor, polar region

Detection of infrasound from the landslide and earthquakes in Taiwan –primary results

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After large earthquakes and tsunamis occur, infrasound emitted from the epicenters and tsunami source areas are often observed. Using triangulation method, identification of the sources are being attempted. Since such phenomena accompanying large motion of ground/sea surface often emit infrasound, landslide is also highly expected to emit the infrasound. In fact, people often reported some uncertain noise just after the landslide occurred. Although less scientific report of infrasound observation from the landslide has been done so far, we try to detect the infrasound emitted from the landslide. In order to achieve the purpose, we started observation of the infrasound in Taoyuan (23.1607°N, 120.7658°E) and Dabu (23.3005°N, 120.6296°E), Taiwan from July 2015. In this paper, we introduce our observation sites and primary results of power spectrum and landslides identification from the infrasound. Furthermore, the infrasound emitted accompanying the M6.4 Kaohsiung (Meinong), Taiwan earthquake (22.871°N, 120.668°E) occurred 33 km away from the Taoyuan observatory at 19:57:27 UTC on 5 February 2016 was observed. The results before and after the earthquake are also shown.

Keywords: infrasound, landslide, Taiwan, Kaohsiung earthquake

Locating snow avalanches by using of infrasound array data

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Infrasound observation measures the energy radiated by the snow avalanche in the atmosphere and is able to detect snow avalanches over large areas. The use of infrasound for snow avalanche monitoring has increased in the last decades, with significant improvements on snow avalanche dynamics research.
Our research team has conducted infrasound observation in the last 3 winter seasons in Tokamachi, Niigata. Firstly, we deployed an infrasound sensor in front of the specific slope between Jan. and April 2013 with visual observation by using a web camera and grasped infrasound signals characteristics generated by snow avalanches. And in the second season (2013-2014 winter season), we deployed two infrasound sensors with about 1 km distance and caught the distance attenuation characteristics of infrasound signals. In the last 2014-2015 winter season, we deployed 3 sensors with a triangular geometry spaced 1 to 2 km apart and tried to extract signals associated with snow avalanches from observed raw data automatically by using time domain processing. And for extracted signals, locations of snow avalanches were estimated by using cross-correlation method. 12 events were picked up and located. Estimated locations were in the area with many steep slopes. Infrasound array monitoring system with real time processing might deliver significant information on snow avalanche activity to us.

Keywords: Snow avalanche, Infrasound, Array observation

Comparison of seismic waveforms observed by microbarograph with broadband accelerometer

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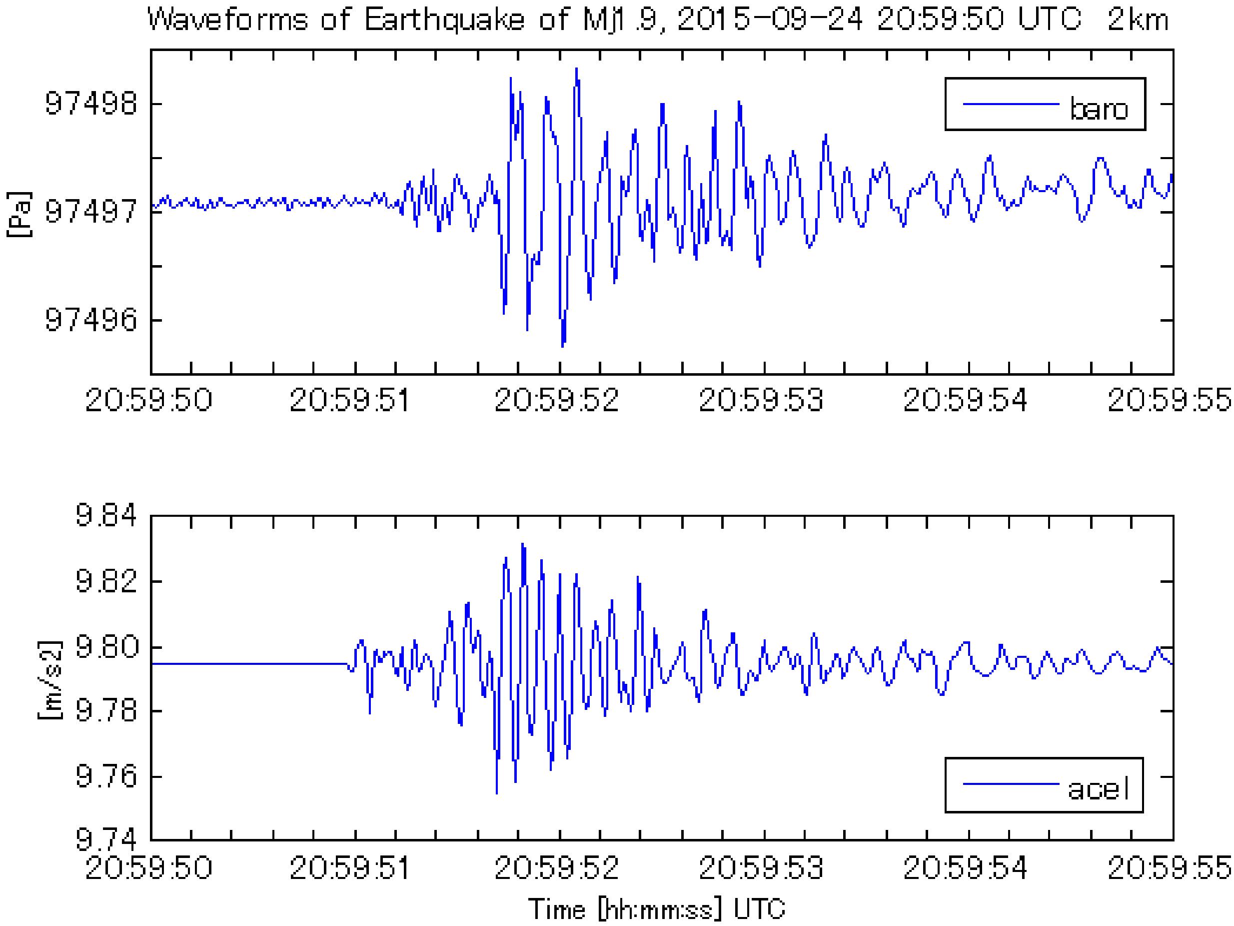
As already discussed in the papers, sensitive Microbarographs can detect seismic waves without going off the scale and supplemental measurements made with accelerometers.

Hakone volcanic activity increased from April 2015. To monitor Hakone volcanic activity, we started to measure seismic and pressure signals using a seismo-acoustic sensor that is a combination of a Broadband Accelerometer (Developed by Quartz Seismic Sensors, Inc., USA) and a Sensitive Microbarograph (Manufactured by Paroscientific, Inc., USA) in August. Both sensors use precise quartz crystal resonators to archive parts-per-billion resolution. The single axis accelerometer records the vertical component of ground accelerations.

Earthquake of Mj1.9 occurred at a depth of 2km in Hakone volcano area at 20:59:50 UTC on the 24th of September 2015, and its seismic signal was observed by both the microbarograph and accelerometer. The distance between the epicenter and the observation site is approximately 2.4 km. The microbarograph recorded similar waveforms to that of the accelerometer.

In this presentation, we discuss the similarities and differences of the seismic signals observed by the microbarograph and accelerometer.

Keywords: Sensitive Microbarograph, Broadband Accelerometer, seismic response


Waveforms of Earthquake of Mj1.9, 2015-09-24 20:59:50 UTC 2km
baro
97498
97497
97496
[Pa]
20:59:50
20:59:51
20:59:52
20:59:53
20:59:54
20:59:55
9.84
9.82
9.80
9.78
9.76
9.74
[m/s2]
acel
Time [hh:mm:ss] UTC

Relationship Between Amplitudes of Infrasound and Ionospheric TEC Disturbances by Vulcanian Volcanic Explosions

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We will compare infrasound records and TEC (Total Electron Content; number of electrons integrated along the GNSS line-of-sight) perturbations caused by the 2015 Kuchinoerabujima volcano eruption, and will evaluate the usefulness of the volcanic explosion scale inferred from TEC perturbations. Infrasound from a vulcanian volcanic eruption shakes ionospheric electrons at altitude of ~300 km. Heki (2006, GRL) investigated ionospheric disturbances by the 2004 September eruption of the Asama volcano using the GNSS-TEC method. We will compare such TEC changes with infrasound records, and study their quantitative relationship.
We compare amplitudes of changes of slant-TEC and infrasound (JMA volcanic activity reports) of five recent cases of vulcanian eruptions in Japan (the 2004 Asama, the 2009 Sakurajima, the 2011 Shinmoe (twice), the 2015 Kuchinoerabujima). The correlation coefficient was 0.5. We normalized the STEC change amplitude with the local vertical-TEC value inferred from GIM (Global ionospheric maps), and call it “F-scale”.
To confirm the usefulness of this scale, we checked the frequency spectra of infrasound records of the 2015 Kuchinoerabujima eruption. Generally speaking, infrasound by volcanic explosions is considered to have a peak around the period of 2-3 sec (Sakai et al., 2000, Kenshin-jiho [in Japanese]). However components with frequencies higher than ~0.1 mHz attenuate before it reach the ionosphere (Blanc, 1984, Ann. Geophys). Hence, it would be important to know such infrasound frequency spectrum to compare records of the two sensors (TEC and infrasound).
Information on infrasound recorded in volcanic eruptions is available in the JMA volcanic activity reports and Coordinating Committee for Prediction of Volcanic Eruptions reports. According to these documents, two JMA microphones (ACO TYPE7144, TYPE3348) and two NIED barometers (Vaisala PTB100) are installed in the Kuchinoerabujima. The JMA stations are located 2.3 km NE (>62.2 Pa) and 2.8 km NW (13.9 Pa) from the crater and the NIED barometers are located 1.7 km SE (350 Pa) and 1.5 km SW (280 Pa). The JMA microphone is sensitive to frequency band of 0.1-100 Hz, while the sampling interval of the NIED barometers is 1 sec.
We also try to improve observations of TEC oscillations, e.g. by converting slant TEC to vertical TEC and by correcting for the geometric attenuation caused by the propagation distance.

Keywords: GNSS, GPS, Volcano, Ionosphere, Earthquake

Power spectral density distribution of micro-barometric variation around the transition region between acoustic mode and internal mode gravity waves

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The vertical acoustic resonance between ground and upper atmosphere having period around 200 -280 seconds has been observed during Earthquakes, volcanic eruptions, tornadoes, etc. (Kanamori and Mori, 1992; Iyemori et al., 2005; Saito et al., 2011; Nishioka et al., 2013) These periods are shorter than the Brunt-Väisälä period and close to the acoustic cutoff period. On the other hand, more slow variation around 10 minutes to 20 minutes are often observed during stormy weather, and they may belong to the internal gravity waves. In this paper, we show statistically the power spectral density distribution of micro-barometric variations near the transition region around 5 -10 minutes.

Keywords: Micro-barometric variation, acoustic gravity waves, internal gravity waves, power spectral density

