Calibration experiment for infrasound sensors by a space chamber

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Infrasound monitoring is important for atmospheric study and disaster prevention for destructive geophysical events such as volcanic eruptions, thunderstorms, landslides, tsunamis, etc. We have been developed a kind of infrasound sensor in our laboratory since 2007, then most recently, a combined type infrasound sensor was successfully developed, collaborating with a company of *RESONA ALES* in 2015. At a time of infrasound sensor construction, precise calibration with simulated infrasonic waves is significant for evaluation. Here we introduce a method of calibrating infrasonic waves with precise pressure amplitude and frequency with using a space chamber in laboratory. The space chamber is usually used at a scene of testing rocket-borne instruments and satellites in extremely severe rarefied environment before the launch with using multiple vacuum pumps to create space environment in laboratory. However, we use the chamber as an extremely rigid volume without having any surrounded surface change during the calibrating experiments. The infrasound is understood as pressure waves in the atmosphere, thus the same kind of waves can be simulated if we inject a fixed small volume into the fixed amount of atmospheric volume enveloped by the rigid chamber. The simulated pressure level can easily be calculated by using a ration between the injected small volumes per the large amount of enveloped space. A small space chamber in Kochi University of technology (KUT) with 240 litter volume was used for this kind of calibration with a small syringe with giving $1/10^8$ of the 240 litter per a fixed time constant. The syringe can be accurately controlled by a motor-driven push-pull motion mechanics with a long time period up to 1000 s. Therefore, sinusoidal pressure waves with a pressure level of 0.001 Pa as well as extremely slow frequency of 0.001 Hz was realized for calibration. By using such facilities in KUT, precise calibration with the developed infrasound sensor as well as any other infrasound sensors, microphones, and barometers can be realized. In this paper, calibrating datasets for various types of sensors will be shown.

Keywords: Infrasound, Calibration, Space chamber

Development of automatic detection software for N-type waveform events of infrasound

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1.Background
The lower frequency sonic wave less than 20 Hz is called as infrasound. The infrasound has a long distance propagation characteristics because of its weak attenuation feature in the atmosphere, therefore it is considered as the future technique for disaster prevention for volcanic eruptions and tsunamis, for example It has been studied on the infrasound in Yamamoto lab. in Kochi University of Technology since 2005, with developing direction-finding technique for incoming waves. Applying the direction-finding technique into the observation system, the source area of infrasound waves was fixed with multiple-site array observation of infrasound (Komatsu, 2012). However, the automatic detection of the N-type waveform events in the case of encountering explosive natural phenomena such as the eruptions of the volcano or thunders is essential to make the realtime observation of the infrasound for disaster prevention.
2. Purpose
The purpose of this study is to develop automatic detection software for N-type waveform infrasound events as well as to inspect the precision of the software for the real datasets of N-type waveform events.
3. Developed software
This software outputs the event detection time and number of counts by inputting five parameters including the trigger to detect the events with drawing spectrogram.The N-type waveform event shows broad spectrum in wide frequency range without any specific peak periods. Thus, the software divides long-time observational data into short-time blocks then performs FFT (Fast Fourier Transform) sequentially and calculates mean parameter of the spectrum strength in whole frequency range in the spectrum in order to detect a point (time) of enhancing as N-type waveform events.
4. Evaluation
Using observed infrasound data for firework events by Komatsu (2012), 11 events were confirmed by human viewing. We inspect the software with adding a kind of pseudonoise on these data gradually and tried to find out detection points of the N-type events with changing trigger parameter so that the number of the detection becomes 11. Thus, we evaluated the software with respect to the volume of noise included in the real infrasound data.
5. Consideration by the inspection result
It was recognized that the software could detect half of the N type wave form events even if the SNR was less than 1 from a result of the inspection. The software could detect a part of N-type events that had difficulty in confirmation by the human viewing.
6. Conclusion
We conclude that the purpose was confirmed successfully because the software can detect the N-type events from the noisy dataset
Reference:
Komatsu,Takayasu, Construction of multi-site arrayed-sensor system for infrasound observation and estimation of sound source coordinates, Special research report at graduated school of Kochi University of Technology, 2012.

Keywords: infrasound, N-type waveform event, automatic detection

The current status of the infrasound observation network for improving the tsunami warning system

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Sensitive microbarographs in and around Japan recorded unequivocal signals associated with the 2011 Off the Pacific Coast of Tohoku, Japan earthquake (Mw = 9.0).
We identify them as atmospheric boundary waves excited by the uplift and subsidence of the ocean surface (tsunami generation), on the basis of the waveform characteristics as well as similarity with the data from ocean-bottom pressure gauges.
It is noted that the atmospheric boundary waves, once excited, travel in the atmosphere significantly faster than the tsunami waves in the ocean. In addition, they retain the original shape of the tsunami, because they are little dispersive. Establishment of a network of infrasound observation along the coast line facing the subduction zone would improve the tsunami warning system, because it would provide information on the tsunami source.
In order to achieve this conception, we have developed a prototype system of the infrasound observation network and started to observe the atmospheric pressure changes associated with tsunami generation by deploying of three infrasound observation sites in Ofunato city of Tohoku region on July 2013. In addition we caused expansion of this network by newly deploying of infrasound observation sites in Mie prefecture of Tokai region on Jun 2015.
Now, based on the findings of the observation, we are discussing what the observation network should be, where and how a prototype system would be deployed.
In this presentation, we would introduce our discussing.

[References]

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