Latest technologies applied in infrasound

By Dr Henry E. Bass, Dr Milton Garces, Dr Michael Hedlin and Robert Woodward

The International Monitoring System (IMS) and the International Data Centre were designed to be fully capable of monitoring compliance with the Treaty. New research and improved communication technologies continuously refine the detection capabilities of the IMS. This column introduces some of the latest developments in verification science.

The International Monitoring System (IMS) infrasound network of 60 stations uses sensors (microbarometers) which are able to detect micropressure variations in the atmosphere. These variations are generated by the propagation of very low-frequency acoustic waves produced by natural and man-made events. The detection of infrasonic signals is limited by background noise in the recorded data which is primarily caused by local winds. A better understanding of the noise characteristics at infrasound stations is crucial for the improvement of the processing capabilities of infrasound data.

Research at the United States Universities of Mississippi, California San Diego and Hawaii is focusing on a detailed analysis of the relationship between wind and pressure noise as a function of frequency, wind characteristics (e.g. speed, turbulence, spectral slope, etc.) and environmental conditions. It utilizes data from meteorological sensors which are co-located with one of the microbarometers used at IMS infrasound stations. The observed wind-pressure relationships (as a function of time) may lead to improved signal processing algorithms which dynamically adapt to changing wind conditions.

In this context two new wind noise filtering systems are being tested. Both systems rely on the different spatial distribution scales of signals and noise: Wind noise is incoherent beyond distances of tens of meters, while infrasonic signals can be coherent over distances in excess of 100 meters The two systems aim to increase the amplitudes of coherent signal and decrease the amplitudes of incoherent noise by summing or integrating the pressure field across distances beyond the coherence limit of noise. The first filtering system uses fiber optic cables to integrate the pressure field along a line. The second system comprises a grid of sensors, each independently sampling the infrasonic pressure field. Noise reduction is achieved by integrating the recordings adaptively from all sensors to cancel out noise optimally.

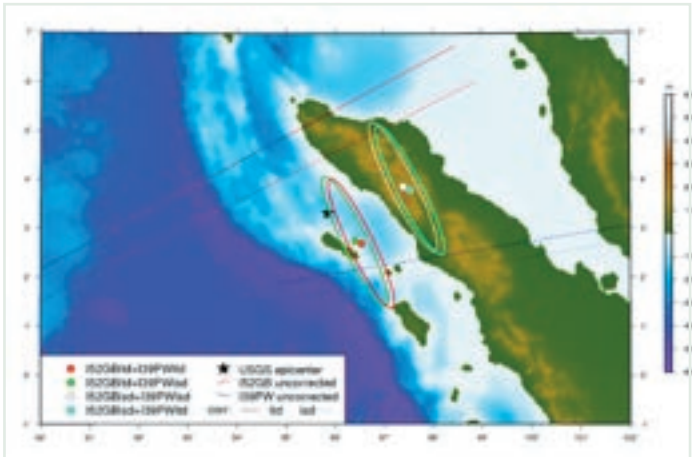

FIGURE 1 SHOWS THAT WITH THE HELP OF INFRASOUND DATA TWO LOCATIONS FOR THE SOURCE WHICH GENERATED THE BIG TSUNAMI OF 26 DECEMBER 2004 COULD BE IDENTIFIED: ONE IS NEAR THE EPICENTER/TSUNAMI SOURCE AND THE OTHER ONE NEAR THE HIGHEST MOUNTAINS IN ACEH, WHICH POSSIBLY GENERATED WITH THEIR SHAKING INFRASONIC WAVES. THE SOURCE LOCATIONS ARE RETRIEVED BY USING DIFFERENT INFRASOUND ARRIVALS FROM THE SOURCE TO IMS INFRASOUND STATIONS IN PALAU (IS39) AND DIEGO GARCIA (IS52)

Infrasonic signals loose their impulsive character as they propagate for thousands of kilometers. A typical infrasonic signal from a distant source appears to emerge gradually from the background sound field, and can sometimes be buried in the ambient noise. However, as infrasound waves propagate across an array, they produce distinctive patterns in space and time that can be recognized with specialized digital signal processing algorithms. The Progressive Multi-

continued on next page

Biographical note

Dr Henry E. Bass, Dr Milton Garces, Dr Michael Hedlin and Robert Woodward are experts in atmospheric and physical acoustics, molecular energy transfer in gases, seismology and nuclear monitoring.

Dr Bass, who coordinated the article with the other researchers, is the leader of the Multi-University US CTBT Infrasound Team. He is professor of physics and serves since 1992 as the Director of the National Centre for Physical Acoustics at the University of Mississippi.

Dr Garces is the Scientific Director at the Infrasound Laboratory of the University of Hawaii at Manoa and operates IMS infrasound stations IS59, IS52 and IS39.

Dr Hedlin is research geophysicist and senior lecturer at the Laboratory for Atmospheric Acoustics at the University of California, San Diego and operates infrasound stations IS56 and IS57.

Bob Woodward works as the Systems Integration Manager of the Science Applications International Cooperation which was a lead contractor in the creation of the full-scale prototype of the International Data Centre. ■