Potential civil and scientific applications

Monitoring volcanic eruptions with the IMS infrasound network

The International Monitoring System uses seismic, hydroacoustic, infrasound and radionuclide technologies to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty. These technologies, together with the data and the products of the International Data Centre, have potential civil and scientific applications which may benefit States and the scientific community.

VOLCANIC ACTIVITY AT TAVURVUR VOLCANO, PAPUA NEW GUINEA, 2001. THE VOLCANO HAD A MAJOR ERUPTION IN 1994.

Nearly ten years ago, none of the 60 infrasound stations belonging to the International Monitoring System (IMS) network existed. Since then, a significant effort has been made to establish the infrasound network. Quite a few of these stations are located in some of the most remote areas of the globe. To build them, logistical and engineering challenges needed to be mastered. The first infrasound station was installed in 1999 and the data flow to Vienna commenced in May 1999. Currently, 36 stations are in operation, 33 of them have been certified.

The fact that 60% of the IMS infrasound network is operational has contributed to trigger again the interest around the world for infrasound, a science that reached the peak of interest during the Fifties and since then lost progressively its importance.

EXPLOSIVE ERUPTION AT SOUFRIÈRE HILLS VOLCANO, MONTSERRAT, WEST INDIES, 1995

Besides its mandate, to monitor the potential occurrence of nuclear tests and verify compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT) together with the other verification technologies, the IMS infrasound network has the potential to provide a significant contribution to the monitoring of volcanic eruptions around the world.

Volcanic hazard represents a serious threat towards human settlements located in the vicinity of a volcano. A significant number of casualties and serious damage to cities, villages and the environment has been caused by erupting volcanoes such as Pinatubo in the Philippines (1991), Soufrière Hills in Monserrat, West Indies (1995 and 2004), Tavurvur and Manam in Papua New Guinea (1994 and 2005), and Mount St. Helens in Washington State, United States (1980, 2005).

Can the IMS infrasound network help reduce volcanic hazard?

Since the majority of the energy of a volcanic eruption is released in the atmosphere, the infrasound technology can be a very useful tool for monitoring volcanic activity. The infrasound waves generated by a volcanic eruption can have a wide frequency content and can be recorded not only by infrasound stations close to the volcano, but also from distant ones (hundreds or thousands of kilometers far from the source). The range of detection of a volcanic eruption depends on the yield of the eruption and on the wind conditions in the lower and upper atmosphere.

In recent years, the PTS has registered a significant number of detections of volcanic eruptions by one or more stations of the IMS infrasound network. As shown in Figure 1, IS56 in Newport, United States, clearly detected the eruption of Mount St. Helens which occurred on 9 March 2005 at 01:25 Universal Time (UT).

The information available on volcanic eruptions, in particular the beginning of an outbreak, is often very limited. There are several reasons to that: at times, the local weather conditions do not permit a clear

view of the volcano from the satellites. In other cases, a local monitoring network is not available to record an increase of seismic and/or gas emission activity in the neighborhood of the volcano.

The presence of an infrasound station relatively close to the volcano can be extremely useful to monitor the start of an eruption and can be used both as a unique monitoring tool in case other monitoring systems are not available (or cannot be used), and as a complementary tool to other, already existing, monitoring systems.

Volcanic eruptions can also be extremely dangerous for civil aviation. The ash cloud produced by a sudden eruption can block an aircraft engine. So far several such incidents have occurred, but loss of human lives could be avoided thanks to the excellent performance of the pilots.

Can the IMS infrasound network contribute to air safety?

The monitoring of volcanic activity can significantly help civil aviation to mitigate the risk of future accidents. In fact, any warning system capable of distributing promptly updated bulletins of volcanic activity can help pilots to avoid entering an ash plume intersecting the route of their aircrafts. In this respect, the contribution of infrasound technology could play a relevant role in monitoring volcanic activity and trigger a warning system whenever, as previously mentioned, other monitoring systems (like satellite imagery, seismic or gas emission stations), are either not available or cannot be used. An integration of the existing monitoring tools supporting civil aviation with information coming from the IMS infrasound network might play an important role for the future of air safety.

The interest for infrasound technology restarted just in 1996, at the time of the adoption of the Comprehensive Nuclear-Test-Ban Treaty. Since then, several studies have been carried out or are still ongoing regarding the potential applications of this technology. It will be a great achievement if the IMS infrasound network will, in the future, be able to mitigate the risk of loss of lives due to volcanic eruptions. ■

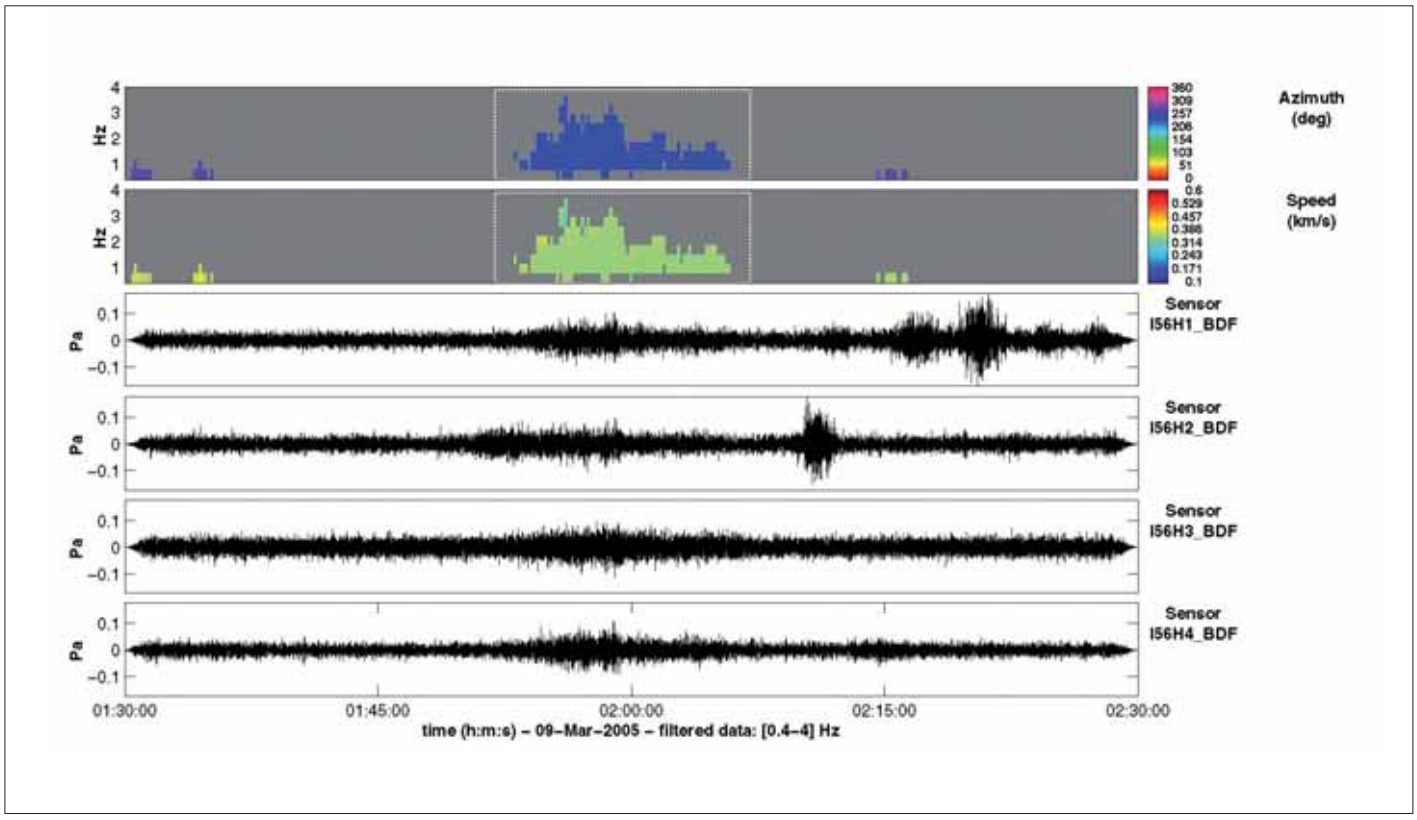

FIGURE 1. IS56 DETECTING THE VOLCANIC ERUPTION AT MOUNT ST. HELENS ON 9 MARCH 2005. THE LOWER WINDOW SHOWS THE ANALYZED DATA WHICH HAS BEEN FILTERED BETWEEN 0.4 AND 4HZ. THE NEXT WINDOW DEPICTS, USING A COLOR SCALE, THE SPEED OF THE INCOMING WAVES. THE SPEED VALUE FITS WELL WITH THE EXPECTED SPEED FOR INFRASOUND WAVES. THE UPPER WINDOW SHOWS, USING A COLOR SCALE, THE DIRECTION (IN DEGREES) FROM WHICH THE SIGNAL REACHED THE INFRASOUND STATION: THE DIRECTION FITS VERY WELL WITH THE POSITION OF THE VOLCANO WITH RESPECT TO THE STATION.