Perspectives

Can CTBT infrasound technology assist civil aviation?

by Dr Hein Haak

In addition to their primary purpose of verifying compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT), the data of the verification technologies of the International Monitoring System (IMS) and the products of the International Data Centre (IDC) have the potential to provide a range of useful civil and scientific applications. For example, the IMS infrasound network can detect volcanic events, and possibly make a contribution to air safety.

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Today there are over 600 active volcanoes in the world. The Indonesian archipelago alone has over 100. Between 50 and 70 volcanoes are active during any given year and sometimes they can erupt violently. Recent examples include Mount Etna on Sicily in 2001, Montserrat in the Caribbean in 1995-1996, Pinatubo in the Philippines in 1991 and Mount St Helens in the United States in 1980. When volcanoes explode, tonnes of solid material can be thrown into the air. The lighter material is transported by winds, often in gigantic ash plumes.

EXPLOSION, MOUNT ETNA (ITALY), JULY 2001

Volcanic ash plumes can have a catastrophic effect on the jet engines of an airplane, causing them to malfunction or to stall completely. Volcanic ash melts at approximately 1100 ºC. The operating temperature of a jet engine is much higher – around 1400 ºC – which is why hot material fuses to parts of the jet engine. Since 1982, a 'flame out' caused by the ingestion of volcanic ash into a jet engine has happened four times. Airlines are keenly aware of the danger posed by volcanic ash, and have to be informed of any volcanic activity in the world. If volcanic activity is reported, airplanes must be rerouted. This safety measure has economic implications and can cause delays.

Efforts are underway currently to coordinate the reporting of volcanic activity around the world. The International Civil Aviation Organization (ICAO) of the United Nations, together with the World Meteorological Organization (WMO), the International Union of Geodesy and Geophysics (IUGG) and the World Organization of Volcano Observatories (WOVO), coordinate a programme called International Airways Volcanic Watch (IAVW). IAVW collects the data of ground-based measuring networks, satellite detection systems and in-flight air reports and it provides the necessary warnings to aircrafts.

How can infrasound help in the detection of volcanic eruptions? When a volcano explodes, it causes very low frequency infrasonic waves. These sound waves can propagate over thousands of kilometres. The explosions of Mt. Etna in July 2001, for example, were recorded in Europe at the IMS infrasound array IS 26 in Germany, in France near Flers and at an experimental infrasound array in the Netherlands at a distance of 1700 kilometres from Mt. Etna. The Dutch array recorded almost 1000 detections from Etna in less than a day. Infrasound arrays of the IMS network and also national institutions could, in principle, contribute significantly to the work of IAVW. The ICAO has already requested the CTBTO to study the possibilities of using the IMS infrasound network for the detection of volcanic events.

Courtesy of European Space Agency (ESA)

ASH PLUME CAUSED BY ERUPTION OF MOUNT ETNA (ITALY), 24 JULY 2001, 9:52 GMT

The detection and identification of nuclear explosions is not that much different from the detection of volcanic

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explosions. Volcanic explosions may occur in a series of quite small events, and they occur naturally at the surface of the earth. Other than this, there are strong similarities between the two types of explosive sources. Both also produce seismic and hydroacoustic signals which can be used in synergy with the infrasound measurements to detect explosions.

As well as locating infrasonic events it is also important that signals can be recognized and attributed to specific sources. Infrasound analysis is still in its infancy and the number of infrasound experts around the world is limited. At the moment, only a few phenomena are easily identified, such as the infrasound from interacting ocean waves, or infrasound that is caused by strong winds passing mountain ridges. With respect to explosive sources, identification is less certain. To distinguish between an exploding meteorite, a volcanic explosion or a nuclear explosion is still an unresolved problem. This problem becomes even more difficult to solve if the signals are small. In the learning phase of infrasound analysis other techniques are needed to make positive source identification.

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What does this mean for the detection capability of volcanic events by the IMS infrasound network? Further research and testing is needed to understand fully the potentials and limitations of monitoring volcanoes with infrasound. However, in synergy with IMS and IDC data from the seismic and hydroacoustic network, infrasound is likely to become a viable technology to detect and locate volcanic events. ■

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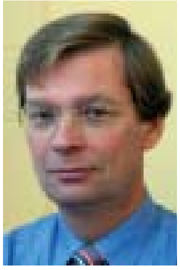
Biographical note



Hein Haak heads the Division of Seismology at the Royal Netherlands Meteorological Institute. In 1987 he joined the Group of Scientific Experts that laid out the scientific basis for the CTBT. As a seismologist, he became also interested in the related field of infrasound, also of prime importance to the CTBT. In the decisive final year of the CTBT negotiations in Geneva, he served on the team that assisted the Dutch chair leading the negotiations. Since 1997 he has supported the work of the CTBTO Preparatory Commission as a Friend of the Chair of Working Group B. ■

DETAIL OF AN INFRASOUND ARRAY