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Remote monitoring of volcanic eruptions using the International Monitoring System infrasound network

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The deployment of local networks of infrasound sensors at volcanoes is becoming a common practice both for monitoring and research purposes. However, such low frequency waves (<20 Hz) have the capability to propagate over distances of thousands of kilometres within the atmosphere, and present an opportunity to continuously monitor remote volcanic eruptions and constrain eruptive characteristics on a global scale. Many volcanoes in remote locations are not monitored individually but can still pose a threat, especially to aviation. The growing International Monitoring System (IMS) network of infrasound stations provides an opportunity to monitor these remote volcanoes. Currently comprising of 43 arrays, the network has been installed for the purpose of verifying the Comprehensive Nuclear Test Ban Treaty, and is designed to achieve global coverage for surface explosions equivalent to a few hundred tonnes of chemical explosive.

In recent years some work has been published on the detection of specific volcanic eruptions at IMS infrasound stations. In contrast this work aims to create a catalogue of volcanic eruptions that have been detected at IMS stations, with the aim of assessing the capability of the IMS network for use in global volcano monitoring. After a preliminary study conducted in 2009 which showed promising results, the methodology has been refined and the catalogue enlarged. It now comprises around 100 eruptive events at 40 volcanoes from the period 2004 – 2009.

In such a large study, propagation effects and noise levels vary between stations and volcanoes, while eruption details are often poorly characterised. Despite these problems, trends in how signal characteristics relate to eruption characteristics are emerging from the data. Results include close to 150 individual detections of volcanic events at IMS infrasound stations. These range from Strombolian activity at Mount Erebus (Antarctica) recorded at a range of 25 km distance, to the Plinian eruption of Manam Volcano (Papua New Guinea) recorded at ranges of over 10,000 km distance. Larger eruptions are found to be detectable at greater distances, for example eruptions involving plume heights of eight kilometres and greater are typically detectable at distances of at least 2000 km. The observed signal frequencies for different eruptions vary widely, from less than 0.01 Hz to greater than 5 Hz. In general lower frequencies were found to be generated by larger eruptions. The large data set allows the spreading of acoustic energy during propagation to be investigated, and presents an opportunity to explore the relationship between acoustic power or amplitude, and eruption magnitude.

These observations add weight to the idea that a global network of infrasound stations may be used to remotely monitor volcanoes. Importantly, in addition to simply detecting an event it may also be possible to infer approximate eruption magnitude based on the characteristics of the observed infrasonic waveforms.