Using IMS hydrophone data for detecting submarine volcanic activity: Insights from Monowai, 26°S Kermadec Arc

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Only little is known on active volcanism in the ocean. As eruptions are attenuated by seawater and fallout does not regularly reach the sea surface, eruption rates and mechanisms are poorly understood. Estimations on the number of active volcanoes across the modern seas range from hundreds to thousands, but only very few active sites are known. Monowai is a submarine volcanic centre in the northern Kermadec Arc, Southwest Pacific Ocean. During May 2011, it erupted over a period of five days, with explosive activity directly linked to the generation of seismoacoustic tertiary waves ('T-phases'), recorded at three broadband seismic stations in the region.

We show, using windowed cross-correlation and time-difference-of-arrival techniques, that T-phases associated with this eruption are detected as far as Ascension Island, South Atlantic Ocean, where two bottom-moored hydrophone arrays are operated as part of the International Monitoring System (IMS) of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO). We observe a high incidence of T-phase arrivals during the time of the eruption, with the angle of arrival stabilizing at the geodesic azimuth between the IMS arrays and Monowai. T-phases from the volcanic centre must therefore have propagated through the Sound Fixing And Ranging (SOFAR) channel in the South Pacific and South Atlantic Oceans and over a total geodesic range of approximately 15,800 km, one of the longest source-receiver distances of any naturally occurring underwater signal ever observed.

Our findings, which are consistent with observations at regional broadband stations and two dimensional, long-range, parabolic equation modelling, highlight the exceptional capabilities of the hydroacoustic waveform component of the IMS for remotely detecting episodes of submarine volcanic activity. Using Monowai and the hydrophone arrays at Ascension Island as a natural laboratory, we investigate the long-term eruptive record of a submarine volcano from IMS data made available through the virtual Data Exploitation Centre (vDEC). We also discuss how our results may aid in identifying further episodes of volcanic activity, both at Monowai and elsewhere, in archived hydroacoustic data and within the automated IMS processing stream in the future.