Infrasound of sustained volcanic eruptions, a laboratory and field study

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Volcanic plumes represent a significant hazard both near to and at distance from source. Unfortunately, high temporal resolution monitoring, especially in the case of more remote systems, is often lacking. Due to their turbulent nature, these plumes are a substantial source of sub 10 Hz sound; meaning infrasonic methodology has the potential to fill the monitoring void. Recent studies of volcano infrasound have drawn upon research from the aero-acoustics industry, fitting the large scale jet noise spectrum (LSS) to that observed during column generating eruption events (Matoza et al 2011). However, due to the differences between volcanic plumes and the pure gas jets, from which the aero-acoustics spectra are created, further laboratory studies are required to investigate the true source of the volcanic signals.

In the absence of industrial standard anechoic chambers, and indeed in terms of the field application of experimental findings, successful source localisation methods are paramount. Adaptive beamforming, as opposed to the commonly used delay and sum methodology, offers a means to achieve the required spatial resolution of the generated sound field.

In a set of experiments at the University of Bristol, an omni-directional microphone array was used to demonstrate the ability of the adaptive method. The acoustic signatures of a series of subsonic jets were recorded using the GFAL 36 and 48 element GFAL Acoustic Camera arrays and subsequently analsyed using both GFAL and in house built software. The experiments were housed in a purpose built test structure lined with 10cm pyramid foam. A flow settling chamber and baffle box, upstream of the test section, were used to prevent the transmission of rig noise to the recorded signals. A synchronous PIV dataset was also obtained enabling visualisation of the jet structure. The level of PIV seeding was varied to enable assessment of the effect of particulate matter upon the acoustic signature. Furthermore a range of different nozzle shapes have been test to better reproduce the fully turbulent conditions of volcanic jets.

In addition to the laboratory dataset, the beamforming methodology has been applied in the field setting at Santiaguito volcano, Guatemala. A 4 element infrasound array consisting of a 1 Chaparral Physics Model 25Vx and 3 Hyperion Technology IFS-3114 Infrasound Sensors with an inter-element spacing of 100 m was installed at the Santiaguito Volcano Observatory 6 km from the vent and used to retrieve dominant source locations and powers.

The adaptive methods employed here offer the potential to remove dominate acoustic sources, which preliminary findings show to be related to the nozzle/vent exit. Such source removal has the potential to reveal any weaker flow related sources which may be present.

REFERENCES: Matoza,R., et al (2009) Geophysical Research Letters Vol, 36 L08303.