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Looking for a correlation between infrasound and volcanic gas in strombolian explosions by using high resolution UV spectroscopy and thermal imagery

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According to the linear theory of sound, acoustic pressure propagating in a homogeneous atmosphere can be modelled in terms of the rate of change of a volumetric source. At open-vent volcanoes, this acoustic source process is commonly related to the explosive dynamics triggered by the rise, expansion and bursting of a gas slug at the magma free surface with the conduit. Just before an explosion, the magma surface will undergo deformation by the expanding gas slug. The deformation of the magma surface will then produce an equivalent displacement of the atmosphere, inducing a volumetric compression and generating an excess pressure that scales to the rate of volumetric change of the atmosphere displaced. Linear theory of sound thus predicts that pressure amplitude of infrasonic waves associated to volcanic explosions should be generated by the first time-derivative of the gas mass flux during the burst. In some cases a correlation between the first time-derivative and the SO_2 mass flux has been found. However no clear correlation has yet been established between infrasonic amplitude and total ejected gas mass; therefore, the origin of infrasound in volcanic systems remains matter of debate.

In the framework of the FP7-ERC BRIDGE Project,
we tested different possible hypotheses on the acoustic source model, by correlating infrasound with the total gas mass retrieved from high-resolution UV spectroscopy techniques (UV camera). Experiments were conducted at Stromboli volcano (Italy), where we also employed a thermal camera to measure the total fragments/gas mass. Both techniques allowed independent estimation of total mass flux of gas and fragments within the volcanic plume. During the experiments, explosions detected by the UV camera emitted between 2 and 55 kg SO_2, corresponding to SO_2 peak fluxes of 0.1-0.8 kg/s. SO_2 mass was converted into a total (maximum) erupted gas of 1310 kg, which is generating a peak pressure of $\sim$8 Pa recorded at $\sim$450 m from the source vent.

Mass fluxes derived by infrasound using different methods show weak correlation with the SO_2 mass measured by UV camera, and the total volume measured by thermal imagery. This correlation increases when acoustic energy is considered, supporting thus the idea that total mass is not the only parameter controlling infrasound amplitude and waveform. However, more experiments need to be done in order to better understand how infrasound is related to mass of the erupted gas and/or fragments. These include a synchronized acquisition of infrasound and gas flux using high frame rate UV and thermal imaging, allowing us to better investigate the first phase of volcanic explosions.