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Infrasound wavefield modeled by coupling conduit dynamics and topography by 3D-FDTD

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Infrasound signal on active volcanoes has become an important tool for monitoring and understanding the explosive source dynamics. Volcano infrasound is the direct measure of pressure oscillations near open-vent and it can provide important constraints on the intensity of the eruption as well as on the source parameters including the variations of volumetric flux and exit velocity.

At present, infrasonic signals recorded close to the volcano (<5 Km) have been used to model the acoustic source of volcanic explosions considering that at this distance the acoustic wavefield is relatively less affected by atmospheric structure. On the contrary, recent 2D finite-difference time-domain (FDTD) numerical modelling of infrasound propagation indicates a strong effect on the wavefield induced by the diffraction of the crater rim [Kim and Lees 2011] and by the near-source topography [Lacanna and Ripepe 2013]. However, the full three-dimensional interaction of acoustic source with conduit geometry and the topography of the volcano edifice have not been fully investigated. In order to evaluate these effects, we have developed a 3D-FDTD modelling to simulate infrasound propagation taking in account conduit dynamics and topography of the volcano.

In linear acoustics, the pressure perturbations in a duct propagates as a plane wave front, which become spherical outside the vent. The radiation impedance at the vent depends on the pressure wavelength and the vent radius. In addition, the diffraction and reflection of topography contaminate the acoustic wave field and have a strong effect in reducing the amplitude and changing the waveform of the infrasonic signal also at short (<2 km) distances.

Besides, the 3D numerical model allows to define in terms of Green's function the scattering effects on the acoustic wavefield caused by topography along the source-receiver path. Only by removing topographic effects from the infrasonic record and by considering the propagation inside the conduit we can quantify the source parameters with a strong impact on our understanding of the explosive dynamics.