3D Lattice-Boltzmann strategies: New insights into Volcanic Jet Dynamics and Infrasound

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Recent studies highlighted the great potential of infrasound measurements for real time detection of volcanic plume source parameters. This is especially relevant in the case of bent over plumes, where the relation between mass eruption rate and plume height is made more complex by the interaction with the surrounding wind field and classical formulation do not apply. Pressure variation detected through acoustic data could be used to determine the exit velocity of the gas jet, which can be related to mass eruption rate, based on the geometric constrain of the vent and the mixture density. However, a source theory for volcanic infrasound is far from being complete. Woulff and McGetchin (1976), based on Lighthill's classical source model theory, proposed that small-scale volcanic jet turbulence may produce infrasound waves as quadrupole or dipole-type source when boundaries or solid particles are present. More recently, Matoza et al. (2009) on the base of the spectral shape infer large-scale turbulence to explain the infrasonic signal generated by large explosive eruptions at Mount St. Helens (USA) and Tungurahua (Ecuador). Even if the gas-thrust region of large Vulcanian and Plinian eruptions is made up by a turbulent free-shear-jet flow the application of the classical source models is challenged by sound radiation pattern measurements.

A better knowledge of the link between the acoustic radiation and actual volcanic fluid dynamics processes is required. New insigths in this subject could be given by the study of realistic areoacustics numerical simulation of a volcanic jet. Lattice Boltzmann strategies provide the opportunity to devolop an accurate, computationally fast, 3D physical model for a volcanic jet and wave propagation. Our work mainly focuses on developing and validating such numerical model to determine when and how classic model source theory can be applied to explain volcanic infrasound data. Here we present the first test results for our model.