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Ash-Plume Dynamics, Mass Discharge Rate and Atmosphere Interaction by Infrasound and Thermal Imagery: the 2010 Eyjafjallajökull Eruption

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The long-lasting Eyjafjallajökull ash plume activity was recorded during 4-21 May 2010 using a 4-element small (100 m) infrasonic array located ∼7km from the volcano. The array measured pressure perturbations with frequencies ranging from 0.1-4 Hz down to 1-2 mHz (typical of acoustic-gravity waves) and was able to provide the time history of the excess pressure, suggesting that the explosive emission of gas drove the plume dynamics. The combination of infrasound measurements and thermal camera imagery allows the infrasound source to be constrained and the plume exit velocity(45-124 m/s) to be estimated based on the acoustic signal. Exit velocities are converted into mass eruption rates using additional constraints on vent radius and mixture density, resulting in a discharge rate ranging from 106 kg/s during the high explosive phase of May 4-6 to 105 kg/s during the final stage of the eruption. Finally, mass eruption rate is used to estimate plume heights using field-based relationships and 1D radially averaged simulations of plume rise with and without the influence of the local wind field and using a reconstructed granulometry. Obtained heights are in good agreement with independent measurements (IMO radar). We conclude that the use of infrasonic monitoring may lead to important understanding of the plume dynamics and real-time determination of eruption source parameters (e.g., mixture exit velocity and mass eruption rate). This could improve substantially the forecast of volcano-related hazards, with important implications for civil aviation safety.