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Constraining the electrification properties of weak volcanic plumes.

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Electrification of volcanic plumes is often observed by the occurrence of lightning discharges during vigorous explosive eruptions. It is generally agreed that electric charge is carried by the ash and that plume electrification depends on the way the ash is generated, ejected and subsequently processed in the plume. This conceptual model is built on the observation of lightning discharges produced by ash-rich, mid- to highly-explosive eruptions (Vulcanian to Plinian). Very little is known about the electrification of mild explosive eruptions (e.g. Strombolian style) where less ash and gas are erupted, leading to weaker plumes rising to a few hundred of meters only, and bearing a lower ash concentration. Studying these eruptions has a two-fold interest. First, they are very frequent, making the instrumentation set-up easier and allowing statistical analysis. Second, being at the lower end of the spectrum of explosivity, they represent the best opportunity to derive basic information about the charge distribution and charge carriers in volcanic plumes containing a range of proportions of gas and ash.
In this scope, we carried out a multi-parametric monitoring campaign at Stromboli volcano (Italy) during October 2017. The instrumental array at the ground was composed of a wideband radio receiver, a high-speed electrostatic sensor, a thermal imaging camera, a high-speed camera, and two infrasound sensors. With the exception of the high-speed camera, which was triggered manually at the occurrence of the explosions, the other instruments were recording continuously thus allowing correlations between the variation in explosive activity and the electrical signals recorded. Additionally, an airborne miniature sensing package measuring electrostatic charge, aerosol concentration and SO_2 concentration was deployed for the first time for in-situ measurement inside the volcanic plume.
Preliminary results show that ash is not the only charge carrier, since SO_2-rich and ash-poor portions of the plumes can also be substantially charged. Our results further extend the spectrum of electrical activity observations in relation to volcanic explosive activity and open a new scenario for the interpretation of the role of gas and solid aerosol in carrying electrostatic charges in the plume.