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Volcanic plume charging at Stromboli volcano

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Volcanic plumes are known to charge electrically, producing some of the most spectacular displays of lightning on the planet. Lightning activity within volcanic plumes can be sensed remotely by lightning detection networks but such techniques can only be fully exploited if the charging mechanisms in volcanic plumes are well understood. Although the exact details of plume charging processes may vary from one eruption to another, it is generally accepted that the presence of ash is required to generate electrification substantial enough to produce discharges. This work focuses on plume charging processes at Stromboli volcano, which produces regular small eruptions, which are generally mildly explosive and ash-poor (<10^5 kg per explosion), therefore not expected to become electrified via the charging mechanisms typically associated with the generation and interaction of volcanic ash.

Here we present results from a multi instrument measurement campaign to Stromboli volcano, Italy during October 2017. Observational techniques deployed included a wideband radio receiver, high speed electrostatic sensor, high speed cameras, thermal imaging cameras and infrasound sensors. Of particular novelty was the deployment of a newly developed miniature sensing package for the in-situ measurement of volcanic ash properties (VOLCLAB). This comprised both optical and gravimetric sensors as well as a wide range electrometer for charge measurements. This was deployed as a network of surface sensors and also for airborne plume sampling from free and tethered balloon platforms. Observations from SO_2 and water vapour rich plumes above the Stromboli craters are presented here using a combination of the above sensors. These demonstrate that even in the absence of ash, volcanic plumes can still be substantially charged, most likely related to charge transport by SO_2 ions.