Geophysical Research Abstracts
Vol. 21, EGU2019-11422-1, 2019
EGU General Assembly 2019

Electrical activity of volcanic plumes: recent advances and perspectives.

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Volcanic plumes, as thunderstorm clouds, generate intense electrical activity and associated lightning discharges, which make them readily detectable at safe distance. While techniques in thunderstorm lightning detection and now-casting have progressed enormously reaching a high level of sophistication, volcanic lightning detection, although being a rapidly evolving field, can still be considered in its infancy. This delay is mainly due to the lack of systematic instrumental observations and the limited number of laboratory experimental investigations, which still hamper a thorough understanding of volcanic lightning and electrification of volcanic plumes in general.
Recent years have seen an increasing amount of report of volcanic lightning at erupting volcanoes (Stromboli 2003 and 2007, Eyjafjallajökull 2010, Puyehue 2011, Kirishima 2011, Etna 2013 and 2015, Sinabung 2014, Villarrica 2015, Calbuco 2015, Colima 2015, 2016 and 2017, Pavlov 2016, Bogoslof 2017, Ambae 2018, Fuego 2018, Krakatau 2019, to quote some), several of which have been detected by worldwide thunderstorm lightning detection networks. However, intrinsic differences make the direct comparison between volcanic plumes and thunderclouds inadequate. In this respect, dedicated methods of investigation of volcanic plume's electrical activity need to be put in place to fully grasp the underlying basic mechanisms.
We are contributing to this effort following a twofold approach by using multi-parametric observation of the electrical activity at target volcanoes, and by experimentally reproducing lightning discharges in particle-laden jets in the laboratory. In this presentation, latest advancements in the study of volcanic lightning and plume charging will be discussed in light of observational and experimental results. Particular emphasis will be put on: the discrimination between thunderstorm and volcanic lightning discharges, the competition between "internal" (volcanic) and "external" (atmospheric) factors in plume electrification, the near-vent volcanic jet dynamics and the benefit and limitations of different detection techniques. Finally, the presentation will conclude with a discussion on the future perspectives of volcanic lightning and plume charging as a monitoring tool for active volcanoes.