Geophysical Research Abstracts
Vol. 17, EGU2015-7194, 2015
EGU General Assembly 2015

Volcanic Lightning: in nature and in the lab.

Corrado Cimarelli (1), Miguel A. Alatorre-Ibargüengoitia (2), Koki Aizawa (3), Ana I. Díaz Marina (2), Akihiko Yokoo (4), Ulrich Kueppers (1), Sebastian Mueller (5), Bettina Scheu (1), and Donald B. Dingwell (1)

(1) Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität München, Munich, Germany (cimarelli@min.uni-muenchen.de), (2) Centro de Investigación en Gestión de Riesgos y Cambio Climático, Universidad de Ciencias y Artes de Chiapas, Tuxtla Gutiérrez, Mexico,, (3) Institute of Seismology and Volcanology, Kyushu University, Kyushu, Japan, (4) Aso Volcanological Laboratory, Kyoto University, Kyoto, Japan, (5) Institute of Geological Sciences, Mainz University, Mainz, Germany

Ash-rich volcanic plumes that are responsible for injecting large quantities of aerosols into the atmosphere are often associated with intense electrical activity and the generation of volcanic lightning.
Although the hazard of volcanic lightning is mostly confined to the area proximal to the vent, monitoring electrical discharges associated with explosive eruptions can provide crucial information on the dynamics and structure of the plume as well as on the mass eruption rate and cargo of erupted fine ash.
Nevertheless, our understanding of volcanic lightning is still limited due to lacking of both i) systematic instrumental observation of electric activity in volcanic plumes and ii) the limited number of experimental investigations on the electrical properties of volcanic materials and the opportunity of replicating volcanic plume conditions in the lab.
We recently contributed to the understanding of both these aspects by performing multi-parametric observation of volcanic lightning at Sakurajima volcano in Japan and by achieving volcanic lightning in particle-laden jets generated in the lab.
At Sakurajima volcano we combined high-speed imaging with magnetotelluric and acoustic measurements of ash-rich plumes generating electrical discharges and compare our observation with maximum plume height measurement and atmospheric soundings. Our observations at Sakurajima allow the measurement of flash properties with respect to the plume evolution as well as magnetic and electric field variation and associated transferred current. In addition, weather-balloon soundings rule out the contribution of hydrometeors in the electrification of the plume.
We complement the field observation by performing rapid decompression experiments of well-constrained (composition and granulometry) ash samples and analogue materials (micrometric glass beads). The experiments have a similar character to the cannon-like vulcanian explosions observed at Sakurajima and show many similarities with the natural counterpart and, most importantly, they highlight how lightning is controlled by the dynamics of the rapidly expanding particle-laden jet. Two main conditions are required to generate lightning: 1) tribo-electrification of the particles and 2) clustering of the particles driven by the jet fluid dynamics. As observed in nature, the size of the flashes scales with the dimensions of the evolving jet and the presence of fine ash in the jet is key for the generation of electrical discharges.
We further invite discussions on cross-correlation of relevant monitoring and lab techniques and possible future developments of multi-parametric arrays relevant for volcanic lightning.