EGU2020-12220
https://doi.org/10.5194/egusphere-egu2020-12220
EGU General Assembly 2020

Exploiting the characteristics of volcanic lightning for volcano monitoring

Sonja Behnke[1], Harald Edens[2], Seda Senay[3], Diana Swanson[1], Alexa Van Eaton[4], David Schneider[5], Masato Iguchi[6], and Daisuke Miki[6]

[1]Los Alamos National Laboratory, Los Alamos, United States of America (sbehnke@lanl.gov)
[2]Langmuir Laboratory, New Mexico Institute of Mining and Technology, Socorro, United States
[3]Department of Electrical Engineering, New Mexico Institute of Mining and Technology, Socorro, United States
[4]Cascades Volcano Observatory, United States Geological Survey, Vancouver, United States
[5]Alaska Volcano Observatory, United States Geological Survey, Anchorage, United States
[6]Sakurajima Volcano Research Center, Disaster Prevention Research Institute Kyoto University, Kagoshima, Japan

Volcanic lightning measurements are gaining momentum in the volcano monitoring community as a tool to identify when an ash producing eruption has occurred. As a volcanic plume develops from an ash-laden jet to a convective plume, the electrical discharges also evolve, ranging from small “vent discharges” (a few meters in length) and near-vent lightning (tens of meters to kilometers in length) to thunderstorm-like plume lightning (tens of kilometers in length). Currently, volcanic lightning monitoring capabilities for volcano observatories are mainly limited to using long-range lightning sensor networks, which do not detect the full gamut of volcanic lightning due to the networks’ detection efficiency and the radio frequency band that they use (very low frequency or low frequency). This biases the sensors towards detecting only the larger volcanic lightning discharges that occur at later stages in plume development, which can result in detection delays of minutes to tens of minutes from the onset of eruption. In addition to the latency, there is no way to know if the lightning picked up by long range networks is from a volcanic or meteorological source without some other additional source measurement. Both the latency and the source ambiguity could be reduced by using lightning sensors at close range that can detect the very small vent discharges associated with volcanic explosions. Vent discharges occur within the gas thrust region in a plume, starting simultaneously with the onset of an eruption and persisting continually for seconds or tens of seconds, depending on the duration of an eruption. They produce a distinctive ‘continual radio frequency’ signal, of which there is no analogous signature in meteorological lightning. Thus, the characteristics of the radio frequency signature of vent discharges could be exploited to innovate a new sensor design that is both low power and transmits information (i.e., a useful derived data product) at rates low enough to be used at remote volcanoes where volcano monitoring is often sparse. To meet this goal, a new experiment at Sakurajima Volcano in Japan is underway to learn more about the physical characteristics and signal characteristics of vent discharges. We use broadband very high frequency sensors to record time series measurements of the vent discharges and other volcanic lightning discharges that occur from explosions of the Minamidake crater of Sakurajima. These measurements reveal new

information about vent discharges, such as their duration and spectral features, that can be used to help identify when explosive eruptions are occurring.