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Characterizing the volcanic ash surface using laboratory experiments, analytical measurements and numerical models: case of Eyjafjallajökull eruption 2010

Gholam Ali Hoshyaripour (1), Michael Bruns (1), Jens Hartmann (2), Roland Hellmann (3), and Matthias Hort (2)
(1) Karlsruhe Institute of Technology, Germany, (2) University of Hamburg, Germany, (3) CNRS Université Grenoble Alpes, France

Volcanic ash is a common companion of volcanic activity that can significantly affect the biogeochemical cycles by releasing nutrients (e.g. iron and silica) and toxic material (e.g. fluorine). These effects are mainly induced by the surfaces of the volcanic ash particles where contact with the surrounding environments takes place, not only during atmospheric transport but also upon deposition in the hydrosphere and biosphere. Thus, ash surfaces carry invaluable information about the atmospheric processes (e.g. interactions with gases, clouds and aerosols), as well as the possible environmental impacts on soil and water (e.g. iron fertilization, fluorine contamination). Therefore, examining the ash particle surface is necessary for revealing the underlying atmospheric processes and to predict the impacts on the environment and climate system.

Here we combine laboratory, analytical and numerical methods to study the surface composition of ash erupted during Eyjafjallajökull eruption, Iceland, 2010. Ash samples were taken during the 3rd eruption phase in May 2010 at different distances from the vent. To determine the surface chemistry the samples are leached in the laboratory and also analyzed with X-ray Photoelectron Spectroscopy (XPS) before and after leaching. A numerical model was then used to simulate the atmospheric processing within the eruption plume and cloud. The chemical mechanism takes into account the gaseous and aqueous chemistry, as well as the gas-aerosol partitioning within a fully-coupled scheme. In other words, it is capable of modeling the changes in the gas, liquid and solid phase separately, as well as the interactions between phases. The preliminary results compare well with the properties of the ash samples that are experimentally measured. For example, the model satisfactorily reproduces the halogen and sulfur scavenging by ash as a function of residence time in the eruption cloud. It also captures mobilization of nutrients (e.g. Fe) in volcanic ash. By furthering our understanding of volcanic ash surfaces, this study lays the foundation for the future modeling and laboratory investigations dealing with the impact of ash on the environment and climate system.