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Measurement Campaign of Icelandic Volcanic Ash During its Arrival to Slovenia in April 2010

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The main eruption of the Eyjafjallajökull volcano starting on 14 April 2010 ejected 250 million cubic meters of tephra into the atmosphere, resulting in the spreading of volcanic ash over most parts of Europe. In Slovenia, a measuring campaign including ground in-situ measurements, lidar-based remote sensing and airborne in-situ measurements was performed before and during the predicted arrival of volcanic ash, aiming at determining the presence and characteristics of volcanic ash and its possible long-term effects on local weather and climate.

Based on the synoptic situation over Europe and especially above the neighboring countries, volcanic ash initially reached Slovenia at high altitudes (above 5 km a.s.l.) during the night of 17 April 2010, which was confirmed by the collected aerosol samples in ground in-situ measurements and satellite imaging. Continuous monitoring of air composition from 11 to 18 April revealed an increased concentration of PM10 and SO_2 on 17 and 18 April. Moreover, the presence of F- anions in the precipitation, which are usually below the detection limit, was established as well. Due to the streaming height of ash and local weather conditions (low clouds and precipitation), lidar-based remote sensing was not feasible.

The second arrival of Icelandic volcanic ash on 20 April 2010 occurred in clear weather conditions and was detected by both lidar-based remote sensing (in two lidar sites) and airborne in-situ measurements. The collected data revealed two or more elevated aerosol layers over Slovenia which could not be identified by satellite images due to lower concentrations and lower streaming altitudes than in the initial arrival. Atmospheric extinction profiles retrieved by two lidar systems (applying Klett method with preset lidar ratio of 55±5) show the same trends of the elevated aerosol layers. They also exhibit inverse proportionality of the extinction values to the transmitting wavelengths, implying that the both lidars were probing the atmospheric layer at the same altitude consisting of the same type and similar concentration of scatters at both sites. Temperature and humidity profiles from airborne measurements also show layering in the atmosphere, implying significant physical changes between different altitude ranges. Aerosol concentration profiles for six different aerosol dynamic equivalent diameters (0.3, 0.5, 1.0, 2.5, 5.0 and 10.0 μm) and the total particle matter provided distributions and absolute concentration values of particles in the atmosphere.

Subsequent chemical analysis of the samples from ground and airborne measurements in Slovenia confirmed - through a comparison of their EDS spectra to those of ash grains brought from Iceland - that a fraction of particles are volcanic ash from Eyjafjallajökull eruption. In a structural analysis they were found to be either single, angular-shaped particles, or agglomerates with sizes up to a few tens of microns. Airflow trajectories simulated by the ECMWF and the HYPLIST models can explain how the air masses containing volcanic ash came to Slovenia. Results show that the methodology applied can be used to reliably confirm the presence of volcanic ash layers in the atmosphere even at relatively low concentrations of ash content, and to monitor their altitude and the concentration of ash particles within the lidar detectable range.