Composition and evolution of volcanic aerosol following three eruptions 2008 - 2010

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Introduction

Major volcanic eruptions inject gases and particles deep into the atmosphere. Measurements of atmospheric aerosols by the CARIBIC (Civil Aircraft for Regular Investigation of the atmosphere Based on an Instrument Container) platform following the Kasatochi (Alaska), Sarychev (Russia) and Eyjafjallajökull (Iceland) eruptions in the period 2008-2010 (all with VEI4) are presented. After the eruption of Kasatochi, analyses of the stratospheric aerosol composition showed enhanced concentrations of sulfur and carbon for several months. On the other hand the ash component, which could clearly be seen in a sample seven days after the eruption, was not detected a month later (Martinsson et al., 2009). To further investigate the composition of the volcanic aerosol three flights trough the volcanic plume of the Eyjafjallajökull eruption were performed. The CARIBIC platform operates on a Lufthansa passenger aircraft usually on inter-continental flights, measuring the atmospheric composition in the UT/LS at 8-12 km altitude once per month (Brenninkmeijer et al., 2007). Instruments on the platform perform aerosol sampling for chemical characterization and particle number concentration measurements. The CARIBIC data set also includes meteorological information and measurements for mixing ratios of a large number of trace gases.

Methods

Specific flights bringing the CARIBIC platform through the volcanic ash cloud from the Eyjafjallajökull eruption were carried out on April 20, May 16 and May 19, 2010. Aerosol samples were collected by an impaction technique with a cut off diameter of 2 µm (Nguyen et al., 2006) and analyzed by quantitative multi-elemental analysis by PIXE (Particle-Induced X-ray Emission) to obtain concentrations of elements with atomic number larger than 13. Also PESA (Particle Elastic Scattering Analysis) was used to obtain elemental concentrations for hydrogen, carbon, nitrogen and oxygen (Nguyen and Martinsson, 2007).

Results and Conclusions

Three samples taken during the special flights to study the Eyjafjallajökull eruption contained unusually high concentrations of elements pointing to crustal origin. The composition of these samples was compared to ash from a fall out sample (Sigmundsson et al., 2010). The ratio of detected elements to iron in both sample types shows good agreement for most of the elements for all three aerosol samples (Fig.1). The deviation in content of potassium (K) and Zirconium (Zr) could be caused by fractioning in concentration between different sizes of aerosol due to degassing of these elements from the magma followed by condensation onto aerosol particles. The composition is compared to earlier stratospheric samples influenced by the Kasatochi and Sarychev eruptions, and the evolution in time of the volcanic influence on aerosol after eruptions is investigated.

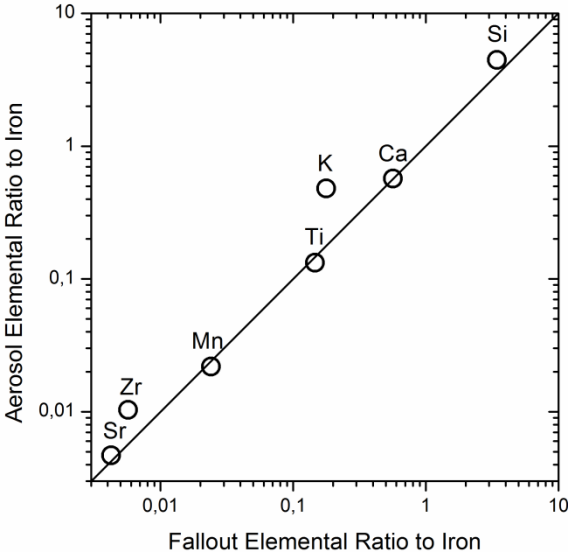

Figure 1. Geometric mean of elemental ratio to iron in aerosol samples collected by the CARIBIC platform vs. fall out sample (SRG 5a, Sigmundsson et al., 2010). The solid line indicates equal ratio.

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