In-situ characterisation of aerosol and gases (SO 2 , HCl, ozone) in Mt Etna volcano plume

Tjarda Roberts, Damien Vignelles, Gaetano Giudice, Marco Liuzzo, Alessandro Aiuppa, Michel Chartier, Benoit Coute, Thibaut Lurton, Jean-Baptiste Renard

Geophysical Research Abstracts
Vol. 16, EGU2014-10638-3, 2014
EGU General Assembly 2014

In-situ characterisation of aerosol and gases (SO_2, HCl, ozone) in Mt Etna volcano plume

Tjarda Roberts (1), Damien Vignelles (1), Gaetano Giudice (2), Marco Liuzzo (2), Alessandro Aiuppa (3), Michel Chartier (1), Benoit Coute (1), Thibaut Lurton (1), and Jean-Baptiste Renard (1)

(1) LPC2E, Orleans, France, (2) INGV, Palermo, Italy, (3) University of Palermo, Italy

We present findings from a measurement campaign that deployed a range of in-situ real-time atmospheric measurement techniques to characterise aerosols and gases in Mt Etna plume in October 2013. The LOAC (Light Optical Aerosol Counter) instrument for size-resolved particle measurements was deployed alongside two Multi-Gas instruments (measuring SO_2, H2S, HCl, CO_2) and an ozone sensor. Measurements were performed at the summit craters (in cloudy- and non-cloudy conditions) and in grounding downwind plume on the volcano flank.

These high frequency measurements (acid gases: 1 to 0.1 Hz, aerosol: 0.1 Hz) provide a detailed in-situ dataset for time-resolved plume characterisation and volcano monitoring. The LOAC measurement of sized-resolved aerosol (over a 0.2 to 50 μm particle diameter range) alongside SO_2 (10's ppbv to 10's ppmv) provides a valuable dataset for determining the volcanic aerosol volume and surface area to SO_2 ratios. These parameters are presently poorly defined but are important for atmospheric models of the reactive halogen chemistry that occurs on volcanic aerosol surfaces to convert volcanic HBr into reactive bromine, including BrO. The LOAC's patented optical design can also provide insights into particle properties.

The two Multi-Gas SO_2 time-series show good agreement, detecting co-varying plume fluctuations in the downwind plume, which also correlate with the LOAC total aerosol volume time-series. An estimate of HCl/SO_2 in Etna emissions was made by Multi-Gas electrochemical sensor, using a novel design to limit absorption/desorption effects and low-noise electronics for improved resolution. The detection of volcanic HCl by electrochemical sensor brings new possibilities for Multi-Gas monitoring of volcanic halogen emissions. Electrochemical sensor response times are not instantaneous, particularly for sticky gases such as HCl (T90 $\sim$min), but also even for "fast" response (T90 $\sim$ 10 to 30 s) sensors such as SO_2 and H2S. However, in a volcanic plume environment, Multi-Gas instruments are exposed to very rapidly fluctuating gas concentrations due to turbulent plume eddies. The combination of these effects can introduce measurement errors, emphasizing a need for sensor response modelling approaches for accurate determination of gas ratios from Multi-Gas instruments.

Measurement of ozone in volcanic plume is of interest to quantify the atmospheric impact of rapid reactive halogen chemistry cycles that occur in the dispersing plume, depleting ozone. The UV-based ozone sensor we deployed exhibited a positive cross-sensitivity to SO_2 (as expected) that dominated the signal in strong plume. In the dilute (few ppmv SO_2) grounding plume, near-ambient ozone concentrations were observed. However the instrument was also occasionally subject to an interference (under evaluation, but potentially from mercury). Nevertheless, the data provide some constraints on BrO-mediated ozone loss in near-source volcanic plumes, towards improved initialisation of atmospheric chemistry models that aim to simulate this process.