Geophysical Research Abstracts
Vol. 21, EGU2019-15414, 2019
EGU General Assembly 2019

New insights into degassing from Soufriere Hills Volcano, Montserrat and global estimates of volcanic CO_2 flux

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Soufriere Hills Volcano (SHV), Montserrat, last erupted in February 2010 and since then has exhibited continued unrest through magmatic degassing and inflation, resulting in a continued close vigilance and large areas of the island remaining under an exclusion zone. Tracking the flux and composition of gas emissions from Montserrat is therefore a key tool in tracking its evolution, either towards a new eruption or continued quiescence. In May 2017 we conducted an airborne survey of the gas plume produced by SHV using a novel tunable diode laser and ultraviolet LED based suite of instruments, measuring CO_2, SO_2, HCl and HF concentrations with 3 Hz frequency. We performed traverses through the centre of the plume as close as could be arranged at speeds of 60 knots, and detected SO_2 with concentrations up to 1 ppmv, HCl up to 0.3 ppm, negligible HF and volcanic CO_2 in excess of 6 ppmv above background. This allows us to compare our results with the previous published measurements of SO_2/HCl and CO_2/SO_2 conducted in and before 2008.

The rapid data acquisition allowed us to detect spatial heterogeneities in degassing from SHV which we believe are controlled by the thermal characteristics of the main conduit connecting a magma reservoir to the surface. We tentatively propose that current methodologies used to measure CO_2 fluxes from active volcanoes may systematically underestimate the actual CO_2 efflux by an order of magnitude, with significant implications for our current understanding of volatile cycles on Earth. We conclude that further high-speed measurements are needed on multiple degassing volcanoes, and that UAVs combined with high frequency gas sensors provide the ideal technical solution to achieve this.

We highlight that recent results from TROPOMI on the global emission of volcanic CO_2 indicate several hundred degassing sources, and we examine the implications of hydrothermal scrubbing on global estimates of the CO_2 released by these systems.