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Estimated CO_2, SO_2 and H2S emission to the atmosphere from the 2011 El Hierro submarine eruption (Canary Islands) on the basis of helicopter gas surveys

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An accurate estimation of SO_2 emission rates is an important issue to elucidate the activity of volcanoes, moreover the monitoring of its temporal evolution might help to predict a possible eruption and thus, save the loss of human's lives in cities nearby volcanoes. In the lasts years new instruments have been developed and improved, in order to be more portable, cheaper and lighter. The miniDOAS consist of a small spectrometer with a lens for collecting scattered UV light, and are controlled/powered via USB with a laptop. Recently, new technical developments have allowed monitoring the emission of other gas species such as CO_2, H2S, etc from volcanic plumes by means of portable multisensor system. With both devices we were able to evaluate the SO_2 emission rates and the molar ratios of major volcanic gas components, respectively. Multiplying the observed SO_2 emission rate times the observed (gas)i/SO_2 mass ratios (CO_2/SO_2 and H2S/SO_2) allowed us to estimate other volatiles emission rates. Between November 11, 2011, and January 16, 2012, and as a consequence of the submarine volcanic eruption started on October 10, 2011, south off shore El Hierro, Canary Islands, a regularly monitoring of the volcanic plume from the submarine volcano has been performed with remote sensors, always depending of helicopter availability. The instruments are mounted aboard on a helicopter belonged to the Helicopter Unit of Spanish Civil Guard. The SO_2 flux measured during this period showed a maximum SO_2 emission of 109 ± 19 t/d on November 6, just two days before the occurrence of a intense bubbling at the sea surface on November 8, producing a water, gas and ash column of about 15 meters over the sea surface. That day, CO_2 and H2S emission also reached the maximum measured, with 5400 t/d and 3.6 t/d, respectively. Since then, SO_2, CO_2 and H2S emission rates have declined to values close to detection limit ($\sim$ 2 t/d for SO_2). These results report the first SO_2 emission rates measured ever from a submarine volcanic eruption and are rather smaller than those measured from volcanic plumes of subaerial volcanoes. This can be explained due to the high solubility of sulphur species like SO_2 and H2S in water which act as a chemical trap due to neutralization reactions. Only small amounts of these gases escape to the atmosphere when the volcanic gas flux is big enough to avoid all the reactive gas species dissolve in the sea water. Vertical profiles of pH carried out close to the submarine eruptive site by the oceanographic vessels "Profesor Ignacio Lozano" and "Ramón Margalef" have shown a remarkable decreasing of pH, results of this neutralization process.