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The flight of Arcadia: spatial CO_2/SO_2 variations in a cross section above the Nord East crater of Etna volcano

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The CO_2/SO_2 ratio in volcanic plumes of open conduit volcanoes can provide useful information about the magma depth inside a conduit and the possible occurrence of an eruptive event. Moreover, the same CO_2 measurement when combined with a SO_2 flux measurement, commonly carried out at many volcanoes nowadays, is used to contribute to an improved estimate of global volcanic CO_2 budget. Today worldwide at 13 volcanoes automated in-situ instruments (known as Multi-GAS stations) are applied to continuously determine CO_2/SO_2 ratios and to use this signal as additional parameter for volcanic monitoring. Usually these instruments carry out measurements of half an hour 4 – 6 times/day and thus provide continuous CO_2/SO_2 values and their variability. The stations are located at crater rims in a position that according to the prevailing winds is invested by the plume. Obviously, although the stations are carefully positioned, it is inevitable that other sources than the plume itself, e.g. soil degassing and surrounding fumaroles, contribute and will be measured as well, covering the 'real' values.
Between July and September 2014 experiments were carried out on the North East crater (NEC) of Mount Etna, installing a self-made cable car that crossed the crater from one side to the other. The basket, called "Arcadia", was equipped with an automated standard Multi-GAS station and a GPS, which acquired at high frequency (0.5 Hz) the following parameters : CO_2, SO_2, H2S, Rh, T, P and geo-coordinates. The choice of NEC of the volcano Etna was based on its accessibility, the relative small diameter (about 230 m) and the presence of a relatively constant and rather concentrated plume. Actually, NEC belongs also to the monitoring network EtnaPlume (managed by the INGV of Palermo).
The aim of these experiments was to observe variations of each parameter, in particular the fluctuation of the CO_2/SO_2 ratio within the plume, moving from the edge to the center of the crater. The gained results give a first possibility to understand if common measurements carried out at the edge of a crater are subject to over- or underestimation and about the order of derivations caused by other sources than the plume. A preliminary analysis results in a lower CO_2/SO_2 ratio in the central part of the crater versus the more peripheral one. The deviation between the average CO_2/SO_2 ratio and the center of the plume ranges from a minimum of 58% up to a maximum of 74%. An increased CO_2/SO_2 emission could be caused by the influence of soil and/or fumarolic degassing at the crater rim. This interpretation leads us to the conclusion that measurements by fixed installed stations might overestimate the CO_2/SO_2 ratio compared to values originating from the "pure" plume. Further on, it means that variations of up to 74 % (in our experiment) don't necessarily correlate with volcanic activity changes.