

EGU24-19466

EGU General Assembly 2024

© Author(s) 2024. This work is distributed under the Creative Commons Attribution 4.0 License.



## Combining scanning-DOAS and SO<sub>2</sub> camera observations leads to more robust volcanic SO<sub>2</sub> flux records.

**Giovanni Lo Bue Trisciuzzi**<sup>1</sup>, Alessandro Aiuppa<sup>1</sup>, Giuseppe Salerno<sup>3</sup>, Dario Delle Donne<sup>1,2</sup>, Marcello Bitetto<sup>1</sup>, Luciano Curcio<sup>1</sup>, Angelo Vitale<sup>1</sup>, Joao Pedro Nogueira Lages<sup>1</sup>, Francesco Maria Lo Forte<sup>1</sup>, Filippo Murè<sup>3</sup>, Roberto Maugeri<sup>3</sup>, and Paolo Principato<sup>3</sup>

<sup>1</sup>Dipartimento di Scienze della Terra e del Mare (DiSTeM), Università di Palermo

<sup>2</sup>INGV-Osservatorio Vesuviano, Napoli

<sup>3</sup>INGV-Osservatorio Etneo, Catania

The volcanic SO<sub>2</sub> flux is key indicator of magma influx into the shallower portions of magmatic plumbing systems, and as such is central to volcano monitoring. However, observations are challenged by a variety of technical and methodological caveats and limitations, requiring the use of a multiple-technique approach as a key to acquiring more robust SO<sub>2</sub> flux time-series. Here, we compare ~9 years (2014 to 2022) of SO<sub>2</sub> flux measurements at Stromboli obtained through (i) a near-vent SO<sub>2</sub> camera (UV1 system, managed by UNIPA) and (ii) a network of scanning-DOAS spectrometers (FLAME network, managed by INGV-OE). The UV1 system operates in close proximity to the summit craters (~500 m), while the FLAME network intercepts the volcanic plume from a greater distance (~2 km).

We find remarkable differences in the SO<sub>2</sub> flux time-series streamed by the two observational techniques, with the FLAME daily averages fluxes being up to ~200% higher than those seen by the SO<sub>2</sub> camera. By examining the individual components involved in the flux calculation, we find the SO<sub>2</sub> integrated column amounts (ICAs) to match one each other within a factor 30%. Hence, the large mismatch between the two SO<sub>2</sub> fluxes is primarily caused by large differences in the used plume speeds. By applying a simple dispersion model, we find the Stromboli's plume to exhibit a non-Gaussian dispersion behaviour, in which in-plume SO<sub>2</sub> concentrations are non-linearly diluted (upon atmospheric dispersion) as a function of wind intensity. In the "puffing" plume conditions our model suggests for Stromboli, use of wind speed as a proxy for real gas velocity may not be appropriate, as it can lead to a net overestimation of SO<sub>2</sub> fluxes when observed by distally operating scanning-DOAS. In contrast, SO<sub>2</sub> camera observations can provide more accurate plume transport results, but are challenged by radiative transfer issues in the optically opaque, proximal plume.

Ultimately, we propose a new SO<sub>2</sub> flux record for Stromboli that combines DOAS and SO<sub>2</sub> camera and takes advantage of the specific advantages of both techniques. Our combined SO<sub>2</sub> fluxes is obtained by combining the SO<sub>2</sub> camera-derived plume velocities (obtained from the optical flow algorithm applied to high-frequency UV camera images in near-vent conditions) with the FLAME-derived ICAs, recalculated at source conditions using an experimentally derived plume dilution

function. The resulting SO<sub>2</sub> flux exhibits a stronger correlation with volcanic activity than obtained using any of the two techniques alone. We emphasize that integrating near-vent measurements through UV cameras with distal scanning-DOAS measurements may significantly improve our understanding of volcano degassing dynamics and behaviour.