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A spectra classification methodology of infrared hyperspectral images to reach near real-time SO₂ emission flux estimation of Mount Etna plume

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Monitoring active volcanoes activity passes through the detection of fluctuations in degassing levels which may reflect changes in the magma supply rate and help inform a short-term forecast of on-going eruptions. Infrared hyperspectral imagers, which is an imaging technology still little used for volcanoes monitoring, have been deployed for various field campaigns on active volcanoes recently. For example, the Hyper-Cam LWIR (LongWave InfraRed) ranging between 850-1300 cm⁻¹ (7.7 - 11.8 μm) with a spectral resolution up to 0.25 cm⁻¹, provided high spectral resolution images from ground-based measurements of the Mount Etna (Sicily, Italy) plume during IMAGETNA campaign in June 2015. Processing the raw data and retrieving the infrared spectra with the LATMOS (Laboratoire Atmosphères Milieux Observations Spatiales) Atmospheric Retrieval Algorithm (LARA), a robust and a complete radiative transfer model, require a calculation time of ~7 days per image.

One of the main ways of risk mitigation effects of explosive eruptions is to get a fast and accurate quantification of SO₂ fluxes emitted by volcanoes. In this context, using the dataset acquired during IMAGETNA campaign at Mount Etna, a spectra classification methodology has been developed to drastically decrease the calculation time and reach near real-time retrievals of SO₂ slant column densities. The methodology is based on a network built on two layers of information from the extraction of spectral features in the O₃ and SO₂ emission bands. A training dataset of five SO₂ slant column densities images retrieved with the time-consuming pixel-by-pixel retrieval method allowed the creation of a library. The spectra classification makes it possible to process each hyperspectral image in less than 40 seconds. It opens the possibility to infer near real-time estimation of SO₂ emission fluxes from IR hyperspectral imager measurements.