

International Master 2 Atmospheric Environment: Research Training 2017-2018

Laboratory: Laboratoire d'Optique Atmosphérique (LOA)

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CaPPA Work Package: **WP-2** (Aerosol microphysical, chemical and optical properties from fundamental heterogeneous processes to remote sensing) & **WP-3** (Aerosol observations: instrumentation and intensive field campaigns- Monitoring from networks and satellites)

Impact of volcanic particles on the remote sensing of SO₂ within volcanic plumes

Volcanic sulfur dioxide (SO₂) gas emissions represent a crucial indicator of the subsurface volcanic activity, which is widely used today for volcano monitoring and hazard assessment purposes. Volcanic SO₂ is also important regarding atmospheric studies as it strongly impacts air quality as well as climate following its conversion to radiatively-active sulfate aerosols.

Although SO₂ represents the volcanic gas species the most commonly measured from various ground- and space-based techniques, recent studies (e.g. Boichu et al., 2015) show that the standard retrieval methods of SO₂ can be significantly affected by the co-existence of particles within the volcanic cloud. The impact of these particles is never corrected for, which may induce substantial errors on the estimated budget of volcanic SO₂ emissions. This is all the more critical than the concentration and flux of all other volcanic gas species are generally measured relatively to SO₂. Consequently, the error made on the budget of volcanic SO₂ impacts more broadly the total budget of volcanic degassing.

To tackle this issue, we propose in this Master internship to study how the various types of particles found in volcanic plumes (water liquid droplets formed from the condensation of volcanic water vapour, sulfur-rich aerosols, ash and ice crystals) modify the radiative transfer through the volcanic cloud and impact the retrieval of SO₂ abundance. To do so, we propose to use state-of-the-art radiative transfer code called LIDORT (Spurr et al., 2008) coupled with a Line-by-line code from Dubuisson et al. (1996) to simulate the high spectral resolution spectroscopic measurements that sample volcanic plumes in the infrared (IR) and ultraviolet (UV) regions. We will first model the impact of various types of particles on the simulated spectrum depending on their concentration, size and temperature. Based on this sensitivity analysis, we will interpret a set of SO₂ UV and IR data collected on Etna volcano (Italy). If time permitted, we will run a formal information content analysis to quantify the information present in SO₂ plume measurements as a function of the microphysical characteristics (e.g. size, concentration) of the various types of co-existent volcanic particles. This work will pave the way toward a complete and accurate inverse modeling of volcanic plume SO₂ and particle contents in the near future.

Key words: Volcanic gas and aerosol emissions; radiative transfer modelling; information content