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International Master 2 Atmospheric Environment: Research Training 2018-2019

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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 SO_2 within volcanic plumes

Volcanic sulfur dioxide (SO_2) gas emissions represent a crucial indicator of the subsurface volcanic activity, which is widely used today for volcano monitoring and hazard assessment purposes. Volcanic SO_2 is also important regarding atmospherical studies as it strongly impacts air quality as well as climate following its conversion to radiatively-active sulfate aerosols.

Although SO_2 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 SO_2 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 SO_2 emissions. This is all the more critical than the concentration and flux of all other volcanic gas species are generally measured relatively to SO_2. Consequently, the error made on the budget of volcanic SO_2 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 SO_2 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 SO_2 UV and IR data collected on Etna volcano (Italy). If time permited, we will run a formal information content analysis to quantify the information present in SO_2 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 SO_2 and particle contents in the near future.

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