SORBONNE UNIVERSITÉ

Sorbonne Université/China Scholarship Council program 2021

Thesis proposal

Title of the research project: Using small sensors to characterize volcanic and urban pollution plumes in the atmosphere

Keywords: atmospheric chemistry, atmospheric physics, engineering

Joint supervision: yes (Tjarda ROBERTS)

Joint PhD (cotutelle): yes (name/surname) /no

Thesis supervisor: Slimane BEKKI.

Email address of the thesis supervisor: slimane@latmos.ipsl.fr

Institution: Sorbonne Universite

Doctoral school (N°+name): ED 129 Sciences de l'environnement d'Ile de France

Research laboratory: LATMOS

Address of the laboratory: LATMOS/IPSL, Sorbonne Université
4, place Jussieu
75252 Paris Cedex 05, France

Name of the laboratory director: Francois RAVETTA

Email address of the laboratory director: direction@latmos.ipsl.fr

Subject description (2 pages max):

1) Study context

Small sensors are a novel approach to measure gases and particles in the atmosphere. Their low cost, portability and low power requirements bring new measurement possibilities to atmospheric science. In our recent and ongoing research projects we are deploying small sensors at the remote summit of a volcanoes such as Mt Etna, Italy to characterise the gas (e.g. SO2, H2S, HCl) and size-resolved particle composition of the emissions-plume. We have also deployed small sensor

instruments in Fairbanks, Alaska, to better characterise the gas and particle composition during severe air quality episodes, including CO, NO, NO2, ozone and PM2.5. And we have also made small sensor measurements on moving platforms to probe the atmospheric chemical and meteorological properties in the horizontal and vertical dimensions i.e. spatial mapping of air pollution by small sensor. As well as these volcanic and urban Arctic applications, in our future projects we also plan to deploy small sensors to characterise fire emissions. Successful application of small sensors to atmospheric science requires that the sensors are well-characterised, particularly in such "extreme environments". The PhD student will undertake a detailed analysis of small-sensor datasets recently obtained in Fairbanks, Alaska, and at volcanoes, and participate to future field-campaigns using small sensors to measure gas and particle pollution. The small sensors will be characterised by making cross-comparisons to other instruments over a range of atmospheric conditions. The datasets will then be used to asses emissions composition and pollution exposure, and trace chemical and physical transformations of the gases and particles within the plumes. The observations will be analysed and interpreted through modelling of emissions sources and plume chemistry, in the context of the LATMOS TROPO group's chemistry-transport modelling activities. This work will contribute to two large-scale projects: the national ANR project VOLC-HAL-CLIM (Volcanic Halogens: from Deep Earth to Atmospheric Impacts, https://scanr.enseignementsup-recherche.gouv.fr/project /ANR-18-CE01-0018) devoted to the study of volcanic plumes, and the international program ALPACA (https://alpaca.community.uaf.edu/) devoted to the study of Arctic urban pollution and its climate impacts. Within the framework of these 2 projects, the PhD will address key questions on processes governing the formation and evolution of volcanic and Arctic urban pollution plumes, notably oxidation, heterogeneous chemistry, and secondary aerosol formation.

2) Details of the proposal

Using small sensors to characterize volcanic and urban pollution plumes in the atmosphere

- Rational:

Small sensors are a novel approach to measure gases and particles in the atmosphere. Their low cost, portability and low power requirements bring new measurement possibilities to atmospheric science. In our recent and ongoing research projects we are deploying small sensors at the remote summit of a volcanoes such as Mt Etna, Italy to characterise the gas (e.g. SO2, H2S, HCl) and size-resolved particle composition of the emissions-plume. We have also deployed small sensor instruments in Fairbanks, Alaska, to better characterise the gas and particle composition during severe air quality episodes, including CO, NO, NO2, ozone and PM2.5. And we have also made small sensor measurements on moving platforms to probe the atmospheric chemical and

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- Objectives
The main objectives of the PhD project will be, first, to estimate volcanic and Arctic urban emissions composition and pollution exposure, and, second, to improve our understanding of chemical and physical transformations of the gases and particles within the relevant plumes, with a focus on oxidation and secondary aerosol formation.

- Method
Spatial mapping of volcanic and urban pollution plumes using small sensors.
Data analysis and numerical modelling of plume physico-chemistry

- Expected results
Assessments of emissions composition and pollution exposure
Analysis of chemical and physical transformations of gases and particles within the plumes.

3) References

Roberts, T. J., et al. (2018). The primary volcanic aerosol emission from Mt Etna: Size-resolved particles with SO2 and role in plume reactive halogen chemistry. Geochimica et Cosmochimica Acta, 222,74–93. https://doi.org/10.1016/j.gca.2017.09.040

4°) Profile of the Applicant (skills/diploma…)

Master 2 in Physics, Chemistry, or Engineering

Contacts:

Thesis supervisor

Dr. Slimane Bekki (LATMOS, Paris) /

Email address of the thesis supervisor: slimane@latmos.ipsl.fr.