Thesis Subject: Chemical heterogeneity of atmospheric particles in urbanised and industrialised environments during pollution events: towards a better knowledge of nearby and remote sources controlling pollution peaks in the "Hauts de France" Region.

Abstract: Many studies demonstrate the harmful character of atmospheric pollution for human health, specially due to atmospheric aerosols. If fine particle emissions in France decreased for more than 60% between 1990 and 2015 (- 265 103 tons: SECTEN CITEPA Report April 2017, available at : http://www.citepa.org/fr/air-et-climat/polluants/poussieres-en-suspension#PM2_5), the World Health Organization (WHO) predicts that 92% of French people are always exposed to excessive $PM_{2.5}$ concentrations, especially during urban pollution events.

These fine particles are in part due to direct emissions in the atmosphere, but are also made of secondary pollutants, coming notably from gases condensation. The part of secondary aerosols in the atmospheric particulate matter load has been underestimated for a long time, but some recent studies showed that secondary inorganic aerosols (SIA) account for more than 77% of $PM_{2.5}$ concentrations during pollution events (Huang et al., 2014). During atmospheric transport, these particles are exposed to aggregation or condensation phenomena at their surface, to dissolution/precipitation processes in rain or cloud waters or to chemical reactions with ambient gases. These "aging processes" depend on of particles lifetime, weather conditions and also on the particles chemical environment. For instance, the presence of biogenic VOCs is against the formation of ammonium nitrate (Aksoyoglu et al., 2017).

High-performance analytical tools are needed for a better knowledge of these complex mechanisms, to obtain a detailed chemical characterisation at the individual particle scale. Due to our previous works, especially using cryo-scanning electron microscopy (cryo-SEM-EDX), the aerosol mixing state can be now quantified, taking into account the overall chemical diversity of the aerosol mass, as well as the chemical diversity at the individual particle scale, including SIA as ammonium sulphate.

These cryo-SEM-EX analytical developments will continue during this PhD, to reduce the beam damage of the finest and most volatile particles during the X-ray emission spectrum acquisition. That will lead to new insights in the evolution of $PM_{2.5}$ chemical composition and mass concentration during pollution events, particularly during summer time (high temperatures and intense photochemistry) or during sea breeze events. Ultimately, the goal will be to explain the aerosol mixing state evolution during pollution peaks.

References:

High secondary aerosol contribution to particulate pollution during haze events in China. R.-J. Huang et al., Nature 514(2014), pp. 218-222.

Secondary inorganic aerosols in Europe: sources and the significant influence of biogenic VOC emissions, especially on ammonium nitrate. S. Aksoyoglu et al., Atmos. Chem. Phys. 17 (2017), pp. 7757–7773.

Keywords: Atmospheric dust, urban and industrial pollution, chemical and physical characterization, electron microscopy

Thesis supervision: K. Deboudt, Assistant Professor (HDR) and P. Flament, Professor

Host laboratory: Laboratoire de Physico-Chimie de l'Atmosphère (LPCA - EA 4493), Université du Littoral Côte d'Opale, Dunkerque.

Doctoral School: Ecole Doctorale 104, Sciences de la Matière, du Rayonnement et de l'Environnement.

Deadline for application: March 20th 2018

Thesis starting date: October 1st 2018

To apply: Please send an email to karine.deboudt@univ-littoral.fr and pascal.flament@univ-littoral.fr with a short CV.