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PHD THESIS OFFER

Characterization of the AhR biological activity induced by primary and secondary emissions from residential wood heating combining in vitro/in vivo bio-analytical approach and chemical analyses (WOODSOA-AhR)

Type of contract: PhD Fixed-term (2024-2027)

Location: Verneuil-en-Halatte (60, France) - accessible by public transport 40 minutes north of Paris

Access: Private and free shuttle between Creil station and INERIS

Teleworking: Up to 100 days/year

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CONTEXT

Ineris (National Institute for the Industrial Environment and Risks) employs around 500 people and serves as a national reference body under the supervision of the French Ministry of the Environment. Its primary mission is to conduct studies and research aimed at preventing risks that economic activities pose to the safety of people and property.

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PHD OBJECTIVES

Residential wood heating significantly contributes to fine particle ($PM_{2.5}$) concentrations observed in ambient air, especially during the winter. This source emits also large quantities of organic species of different volatilities which are transformed in the atmosphere through physical and (photo-)chemical processes into secondary organic aerosols (SOA) contributing significantly to fine PM concentrations.

The current understanding of the SOA formation processes from these emissions, or from precursor molecules, as well as their physicochemical properties, is still limited, particularly for nighttime chemical processes (involving the NO_3 radical) or processes under marine influence involving halogen radicals. The toxic potential of these primary or secondary particles and the associated chemical compounds are also unknown. Toxic compounds such as polycyclic

aromatic hydrocarbons (PAHs) and their nitrated or oxygenated derivatives (nitro- and oxy-PAHs) are known to be associated with this type of particles. However, their chemical analysis does not account for all emitted PAH-like compounds, especially biologically active compounds, nor does it account for mixture effects.

Methods based on specific biological effects of a toxic mode of action (e.g., activation of the aryl hydrocarbon receptor (AhR) by PAH or dioxin-like compounds) using *in vitro* (cell models) or *in vivo* (whole organisms) assays can address these issues and are complementary to chemical analyses.

In this context, the main objectives of this PhD thesis are to:

- Study and characterize the formation of SOA from precursors typically emitted by biomass burning (e.g., PAHs and phenolic compounds) under marine influence (involving Cl radicals).
- Quantify and compare, using cellular bioassays, the AhR biological activities (PAH- and dioxin-like) of gaseous and particulate, primary and secondary (aged) emissions from residential wood heating, and SOA formed from PAHs and phenols, under different combustion conditions (excess/lack of air, fuel, log or pellet appliances, etc.) and oxidation simulating daytime, nighttime, and marine influence atmospheric processes (involving OH, NO_3, and Cl radicals).
- Evaluate the biological effects (e.g., embryonic development, AhR activity, endocrine disruption, cardiac activity alteration) on a model organism (zebrafish embryos, *Danio rerio*) of organic compounds associated with PM and determine a threshold *in vitro* activity value beyond which there is a danger to the organism.
- Compare and study potential links between the detailed chemical characterization of gaseous and particulate phases and the *in vitro/in vivo* biological responses to identify the most active chemical species towards the molecular targets studied in cell models and zebrafish embryos.

PROFILE

Master's degree in Environmental chemistry, Analytical Chemistry, Environmental Ecotoxicology, or Environmental Toxicology.

Experience/Skills

- Strong interest in experimental and laboratory work.
- Knowledge in atmospheric chemistry/air quality would be a plus.
- Knowledge in data analysis and statistical processing (e.g., R, Igor Pro).
- Autonomy, scientific rigor, adaptability, teamwork, open-mindedness, analytical skills, and writing abilities.
- Good oral and written English skills.

MISCELLANEOUS

- Thesis Location: 100% INERIS
- Desired start date: October - December 2024

PhD directors: Alexandre Albinet (INERIS) and Barbara D'Anna (LCE - University Aix Marseille)
Supervision: Alexandre Albinet, Abd El Rahman El Mais and François Brion (INERIS)

Application procedure:

The application must include: a CV, the grades obtained in the M2, a letter describing your motivation and your interest in working on the proposed subject and possibly, one or more letters of recommendation from your current or past teachers and/or supervisors.

- Salary: €2105 gross/month
- 18 RTT + 31 CP annual leave
- Flexible hours
- Staff canteen
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