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PhD student position at Aix-Marseille University

Advisor / co-advisor : MONOD Anne / ROBERT-PEILLARD Fabien
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Institution : LCE, Laboratoire de Chimie de l'Environnement UMR7376 (http://lce.univ-amu.fr)

The Environmental Chemistry Unit of CNRS and Aix-Marseille University (France) seeks for a highly motivated PhD student to study cloud processes in an arid region of Austral Africa

The Environmental chemistry lab has an experience of more than 20 years in chemistry of the atmosphere and chemistry of surface waters, aerosol, cloud and VOC characterization, and processes. It handles state-of-the art analytical devices, it holds the LC-MS-ORBITRAP instrument of the national IMAGINE² platform and it is the University principal investigator of the mobile MASSALYA platform. http://lce.univ-amu.fr/

Work description

Aerosol-cloud interactions and their impacts on ecosystems of the Namib arid region

Cloud processes are currently one of the largest uncertainties for radiative budgets and climate projections, as well as for transformations and transport of pollutants and nutrients. Thorough cloud and fog characterization is thus necessary to robustly improve climate models. Southern Africa is pointed as one of the world's climate change hotspots. Namibia is characterized by some of the most extreme climate regimes ranging from the cold Benguela Current to the hyper-arid coastal deserts of the Namib region. Here, fog and low clouds are typical features, affecting the coast and inland where they provide a higher contribution to the total water volume than rainfall. They act as a medium and vector for supplying and regulating the flow of critical limiting resources—water, nutrients, and light—to such sensitive ecosystems. However, the understanding of the microphysical and chemical mechanisms ruling its formation, composition, and its ability to solubilize aerosol nutrients and distribute them over a wider region is still not well understood. Several previous studies have shown the unique character of the region in terms of atmospheric chemistry, aerosols, fogs and clouds (Formenti *et al.*, 2019; Gottlieb *et al.,* 2019 ; Klopper *et al.*, 2020). It is thus highly urgent to study the specific microphysics

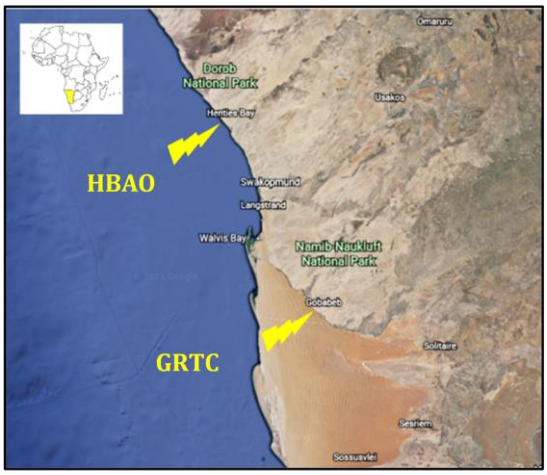

Fig. 1 Namibia sampling sites

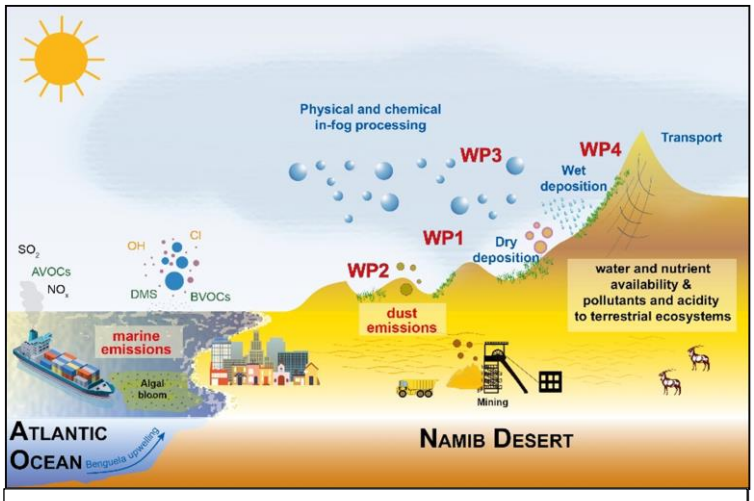

Fig.2 Scheme of emissions transport and deposition of chemicals

and chemistry processes of cloud and fog formation, their chemical composition, and their ability to solubilize nutrients and pollutants present in cloud condensation nuclei, and finally their ability to disseminate nutrients and pollutants on a wide region over the Namib.

The objectives of the PhD thesis are to thoroughly characterize physics and chemistry of the aerosols and cloud/fog droplets on the Namib coast and the inland arid area. It aims at understanding the role of aerosols on the development of fogs and clouds, its chemical composition, and its influence on local biogeochemistry and ecosystems. It will contribute to an international interdisciplinary and collaborative project, aimed at closing existing knowledge gaps and providing, for the first time, knowledge of the distribution and input of fog-related nutrients and their fate on endemic species in arid ecosystems such as Namibia, important for climatic predictions and the health of the environment.

To tackle these aims, the PhD study will consist into three complementary steps:

1/ Data reanalysis

The large previous campaign AEROCLO-sA situated on the Namib coast in August-September 2017 (Formenti *et al*., 2019) has generated a very large set of data, which is currently under valorization. This part of the PhD thesis will study the fog chemical and microphysics data and relate them to the aerosol data. This work will highlight the missing data needed for a more complete description and understanding of cloud and fog formation and their impacts on the local ecosystems. It will thus be used for the preparation of the future campaigns.

2/ Developments of analytical and technical setups

New physical and chemical measurements: new methods of characterization of the organic fraction of the aerosol and the fog droplets will be deployed to answer unresolved questions such as the nature and the origin of the organic fraction, and its role on Cloud Condensation Nuclei (CCN) (Sellegri *et al.*, 2021). To do so, i) new methods of non-target analysis will be developed and deployed on the Namibian samples using the high-resolution mass spectrometer (ORBITRAP) recently acquired by the LCE on the national IMAGINE² platform. Complementary quantitative determinations will also be done on specific compounds using liquid chromatography coupled to the instrument; ii) to investigate the role of surface tension on the CCN activity, new methods for quantification of surfactants and their related surface tension will be tested in the laboratory and deployed on the Namibian aerosol and droplet samples.

New cloud/fog droplets collection techniques: the new technique deployed by the LCE research activities to collect cloud droplets samples from ULAs (Ultra-Light Aircraft flights – see Chazette *et al*., 2021) will be calibrated and finalized. For fog collection, the existing collectors will be automatized to get sequenced sampling and on-line measurements of global parameters such as pH and conductivity.

3/ Participation to two field campaigns in Namibia

The above-mentioned setup work will be completed and deployed during the field campaigns of the international AEROFOG project. The latter is based on simultaneous detailed measurements of aerosol, deposition and fog chemistry, and microphysics during two intensive field campaigns in the austral winter and summer at coastal and desert sampling Namibian sites, maximizing the fog occurrences while differentiating their compositions. The PhD work will consist in deploying the fog and cloud droplet collectors and analyses the samples during and after the campaigns. The data will then be treated and interpreted in collaboration with the international AEROFOG consortium.

As a result of its participation to an interdisciplinary and collaborative effort, the PhD work will contribute to close existing knowledge gaps and provide, for the first time, knowledge of the distribution and input of fog-related nutrients and their fate on endemic species in arid ecosystems such as Namibia, important for climatic predictions and the health of the environment.

References:

Chazette *et al*. Experimental investigation of the stable water isotope distribution in an Alpine lake environment (L-WAIVE). Atmos. Chem. Phys., 21, 10911-10937, 2021.

Formenti *et al*., The Aerosols, Radiation and Clouds in Southern Africa Field Campaign in Namibia: Overview, Illustrative Observations, and Way Forward. Bull. Amer. Meteor. Soc., 100, 1277–1298, 2019

Gottlieb *et al*. The contribution of fog to water and nutrient supply to Arthraerua leubnitziae in the central Namib Desert, Namibia. Journal of Arid Environments 161, 35-46, 2019

Klopper *et al*., Chemical composition and source apportionment of atmospheric aerosols on the Namibian coast. Atmos. Chem. Phys., 20, 1–23, 2020

Sellegri *et al.* Surface ocean microbiota determine cloud precursors. Scientific Report 11, 281, 2021.

We offer

Location: The position will be located at Marseille, France, at LCE, in the downtown university campus (St Charles).

Salary: between 24 and 26 k€ / year through a doctoral contract funded by the Aix-Marseille university from the national pool of allocations of the research and teaching ministry

Research funding program: The research activities will be funded by 3 different national and international projects funded national programs (CNRS-INSU and ANR). These projects are collaborative studies involving other French instituts (IRCE-LYON, IGE-Grenoble, LaMP-Clermont-Ferrand, LISA-Paris) and international instituts (TROPOS-Germany, KIT-Germany, GRTC - Gobabeb Research and Training Center, Gobabeb, Namibia, UNAM-University of Namibia, Henties Bay.

PhD advisor : Anne MONOD, full professor at the Aix-Marseille University (https://lce.univ-amu.fr/fr/users/monod-anne)

5 major publications (including PhD students and post-docs supervised by A. Monod)**:**

- Formenti, P., B. D'Anna, C. Flamant, M. Mallet, S.J. Piketh, K. Schepanski, F. Waquet, F. Auriol, G. Brogniez, F. Burnet, J. Chaboureau, A. Chauvigné, P. Chazette, C. Denjean, K. Desboeufs, J. Doussin, N. Elguindi, S. Feuerstein, M. Gaetani, C. Giorio, D. Klopper, M.D. Mallet, P. Nabat, **A. Monod**, F. Solmon, A. Namwoonde, C. Chikwililwa, R. Mushi, E.J. Welton, and B. Holben. The Aerosols, Radiation and Clouds in Southern Africa Field Campaign in Namibia: Overview, Illustrative Observations, and Way Forward. Bull. Amer. Meteor. Soc., 100, 1277–1298, 2019
- Giorio C., Brégonzio-Rozier L., Cazaunau M., Temime-Roussel B., DeWitt H.L., Gratien A., Michoud V., Pangui E., Ravier S., Zielinski A.T., Tapparo A., Vermeylen R., Claeys M., Voisin D., Kalberer M., Doussin J.F., **Monod A**. Cloud processing of secondary organic aerosol from isoprene and methacrolein photooxidation. *J. Phys. Chem. A*, 121 (40), 7641–7654, 2017
- González-Sánchez, J. M., Brun, N., Wu, J., Morin, J., Temime-Rousell, B., Ravier, S., Mouchel-Vallon, C., Clément, J.-L. and **Monod, A**.: On the importance of atmospheric loss of organic nitrates by aqueous-phase OH-oxidation, Atmos. Chem. Phys., 21, 4915–4937, 2021
- Chazette, P., Flamant, C., Sodemann, H., Totems, J., **Monod, A.**, Dieudonne, E., Baron, A., Seidl, A., Steen-Larsen, H. C., Doira, P., Durand, A., Ravier, S. Experimental investigation of the stable water isotope distribution in an Alpine lake environment (L-WAIVE). Atmos. Chem. Phys., 21, 10911-10937. DOI.org/10.5194/acp-21-10911-2021
- Wu J., Brun N., González-Sánchez J.M, R'Mili B., Temime Roussel B., Ravier S., Clément J.L., **Monod A.** Substantial organic impurities at the surface of synthetic ammonium sulfate particles. Atmos. Meas. Tech. Discuss., 2021. doi.org/10.5194/amt-2021-327

PhD co-advisor : Fabien ROBERT-PEILLARD, assistant professor at the Aix-Marseille University (https://lce.univ-amu.fr/fr/users/robert-peillard-fabien)

5 major publications (including PhD students and post-docs supervised by F. ROBERT-PEILLARD)**:**

- **Robert-Peillard, F**.; El Mountassir, E.M.; Bonne, D.; Humbel, S.; Boudenne, J.L.; Coulomb, B., Determination of dissolved nickel in natural waters using a rapid microplate fluorescence assay method, *Spectrochim. Acta A -M* **2022**, 121170.
- Coulomb, B; **Robert-Peillard, F**; Gam, NB; Sadok, S; Boudenne, JL, Multisyringe Flow Injection Analysis of Tropomyosin Allergens in Shellfish Samples, *Molecules* **2021**, *26*, 5809.
- Singh, S., Coulomb, B., Boudenne, J.L., Bonne, D., Dumur, F., Simon, B., **Robert-Peillard, F**., Sub-ppb mercury detection in real environmental samples with an improved Rhodamine-based detection system, *Talanta* **2021**, *224*.
- Chehab, R., Coulomb, B., Boudenne, J.L., **Robert-Peillard, F**., Development of an automated system for the analysis of inorganic chloramines in swimming pools via multi-syringe chromatography and photometric detection with ABTS, *Talanta* **2020**, *207*, 120322.
- Mattio, E., Ollivier, N., **Robert-Peillard, F**., Di Rocco, R., Branger, C., Margaillan, A., Brach-Papa, C., Knoery, J., Bonne, D., Boudenne, J.L., Coulomb, B., Modified 3D-printed device for mercury determination in waters, *Anal. Chim. Acta* **2019**, *1082*, 78-85.

Doctoral school

Environmental Sciences school at Aix-Marseille University, France (https://ecole-doctorale-251.univ-amu.fr/en)

Requirements for the applicant

A master's degree in **chemical physics, analytical chemistry, environmental chemistry**, or a related discipline, obtained with a **minimum grade of 14/20** is required. Solid knowledge in analytical chemistry is required, as well as a taste for exploratory research and field observations. Independence, drive and collaboration are important and will be encouraged to develop the candidate's career.

To apply, please submit an application *via* email to **anne.monod@univ-amu.fr** and **before May 31st, 2023** with:

1/ a cover letter describing your **research interests**,
2/ a CV, detailing :

- the obtained **grades and ranking in Master** (each semester),
- the research **experience**
- names and institutes of **previous advisors and co-advisors**

3/ date of availability
4/ some reference persons