Post-doctorate position

General information
Offer title: researcher (M/F) on the study of the evolution of organic carbon in a context of climate change: improvement of emissions and chemistry in 0D models
Reference: LISA UMR7583
Number of positions: 1
Workplace: Créteil, France
Date of publication: : 18/10/2024
Type of contract: Fixed-term research contract
Contract period: one year renewable (total possible 24 months)
Expected date of employment: early 2025
Proportion of work: full-time
Remuneration: 3 081,33 euros à 4 291,70 euros bruts monthly according to experience
Desired level of education: PhD
Experience required: Indifferent
Section(s) CN: Earth system: surface envelopes

To consult the offer and submit a candidacy
https://emploi.cnrs.fr/Offres/CDD/UMR7583-GENTUA-077/Default.aspx

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Missions
Organic compounds in the atmosphere have an impact on air quality and climate. However, quantifying these impacts remains a delicate task, given the uncertainties associated to the speciation and emission fluxes of primary organic compounds, as well as to the reactivity and mass transfer of secondary organic compounds. These uncertainties are particularly acute during the summer months, when climate change brings extreme weather conditions and high levels of photochemical pollution.

The aim of this post-doctoral project is to improve the representation of organic carbon evolution in air quality models in summer under a context of climate change.

During the summer of 2022, characterized by several heatwave periods that can be used as an analogue for a future climate, highly detailed observations of atmospheric chemical composition were carried out simultaneously in different types of environments in France: background sites as part of the EMEP campaign (European Monitoring and Evaluation Programme - https://projects.nilu.no/ccc/tfmm/EIMPsummer2022/EIMP2022_index.html), as well as urban (Paris), suburban (SIRTA (Site Instrumental de Recherche par Télédétection Atmosphérique - Institut Pierre Simon Laplace) - https://sirta.ipsl.fr) and forest (Rambouillet forest) sites as part of the ACROSS (Atmospheric ChemistRy of the Suburban foreSt - https://across.cnrs.fr) campaign. These detailed observations are strong constraints for evaluating and improving our understanding of the processes incorporated in the models.

However, a direct comparison between air quality model simulations and detailed measurements is tricky. Indeed, in these models, the thousands of organic compounds present in the atmosphere are aggregated into a hundred or so model species, right from the emission stage, resulting in a significant loss of information on the speciation of individual organic compounds, and on their physico-chemical properties. Evaluating and improving the representation of processes in air quality models (3D) thus requires an essential intermediate step of comparing detailed observations with explicit modeling, which can only be solved in a box model (0D).

As part of this post-doc, highly detailed chemical simulations in 0D, and 3D simulations with the CHIMERE air quality model (https://www.lmd.polytechnique.fr/chimere) will be carried out jointly. Explicit simulations of organic carbon evolution will be carried out in a box model configured to represent the different measurement sites of summer 2022. This model will use the same input data in terms of emissions and meteorology as the CHIMERE model. The 0D model will use a highly detailed chemical mechanism created using the GECKO-A chemical mechanism generator (https://geckoa.lisa.u-pec.fr). Comparisons between the explicit model and measurements will allow to assess the emission fluxes and speciation of biogenic and anthropogenic organic compounds, as well as the chemistry of secondary species, and to propose improvements for integration into CHIMERE. Next, reduced gaseous and particulate chemical mechanisms, as used in CHIMERE, will be integrated into the box model and compared to explicit simulations, used here as a reference, to identify the reduced mechanism the most reliable. Simulations of the summer of 2022 will then be carried out with this improved CHIMERE, and model/measurement comparisons will enable us to assess the model's ability to represent the formation of secondary pollutants (ozone and particles) in a proxy of future climate. The sensitivity of the formation of these pollutants to anthropogenic and biogenic sources, as well as to the often canicular meteorological conditions (high temperature, low humidity) during summer 2022 will be analyzed.

Activities

- carry out a state-of-the-art study on the representation of organic carbon evolution in models;
- develop 0D scenarios to represent the measurement sites of the ACROSS and EMEP campaigns;
- carry out explicit 0D simulations for the various measurement sites;
- select and format the measurements of interest from the ACROSS and EMEP campaigns, in particular VOC's;
- make explicit model/detailed measurements comparisons and evaluate the model;
- identify the origin of observed discrepancies (anthropogenic/biogenic emissions, chemistry…) and suggest improvements;
- run 0D simulations with reduced mechanisms for the various measurement sites;
- make comparisons between reduced mechanisms/explicit model/detailed measurements;
- select the most reliable reduced mechanism to represent the formation of secondary pollutants (ozone, particulates);
- run CHIMERE simulations for the summer of 2022, following these improvements;
- carry out model/measurement comparisons and evaluate the model;
- analyze the contribution of anthropogenic and biogenic sources to the formation of secondary pollutants (ozone, particulates) and the dependence on meteorological conditions (presence of heat waves with drought effects);
- present results at ECLAT project meetings;
- promote work at international conferences and write scientific articles.

Skills

PhD in atmospheric sciences, environmental sciences, chemistry or related disciplines
Experience in chemical modeling, ideally of atmospheric chemical composition

Excellent knowledge of scientific programming (R, Python, Fortran…)
Expertise in Linux environment
Rigor, autonomy and scientific curiosity
Initiative, synthesis and critical analysis skills
Good teamwork skills
Writing and verbal skills in English

Work Context

The post-doctorate will be located at LISA (Laboratoire Interuniversitaire des Systèmes Atmosphériques - http://www.lisa.u-pec.fr), in the Modeling group. The work will be carried out as part of the ECLAT project (Tirer les leçons de l'Eté 2022 : quelle qualité de l'air dans un CLImAT futur?), funded by ADEME and led by Matthias Beekmann (DR CNRS/LISA, e-mail Matthias.Beekmann@lisa.ipsl.fr). The post-doctorate will benefit from LISA's strong expertise in 0D modeling and explicit chemical mechanisms, with contributions to the supervision team from Marie Camredon (MCF UPEC/LISA, e-mail Marie.Camredon@lisa.ipsl.fr), Richard Valorso (IR CNRS/LISA co-developer of GECKO-A) and Bernard Aumont (PR UPEC/LISA). He/she will also benefit from the expertise in 3D modeling and reduced mechanisms of Matthias Beekmann, as well as Guillaume Siour (IR CNRS/LISA) and Arineh Cholakian (IE CNRS/LMD), both co-developers of CHIMERE. This postdoctoral position will also involve collaboration with the experimental teams that took part in the ACROSS campaign: the members of LISA's MEREIA group and all the partners in the ÉCLAT project, a highly complementary consortium that includes, in addition to the LISA teams, INERIS, LMD, LSCE, LCE and IMT-nord Europe teams.

Additional information

LISA (Laboratoire Interuniversitaire des Systèmes Atmosphériques), UMR CNRS 7583, is a joint research unit of Université Paris-Est Créteil, Université Paris Cité and CNRS. It is part of the Observatoire des Sciences de l'Univers EFLUVE and the IPSL research federation. Its main research themes focus on understanding the functioning of terrestrial and planetary atmospheres, and the impacts of human activities on atmospheric composition. The methods used are based on real-atmosphere observations, experimental laboratory simulation and numerical modeling.