



Ph.D. position: Integrated analysis of the impact of extreme weather conditions and socio-economic factors on electricity demand and CO₂ emissions: a data-driven approach at national/regional scale

We are looking for a motivated candidate for a 3 years Ph.D. program at Laboratoire des Sciences du Climat et de l'Environnement (LSCE) in collaboration with ATOS. The Ph.D. candidate will be part of an integrated team with LSCE, AgroParisTech, and Atos.

The goal of the Ph.D. is to analyze large amounts of data in different countries and regions to produce a new understanding of the influence of extreme weather events and socio-economic factors on electricity demand and CO₂ and pollutant emissions. The candidate will develop statistical models incorporating climate data, demographic and socio-economic factors, and building-related variables, evaluate these models against observations, and use them for projections of the power demand based on ensembles from seasonal climate forecasts and long-term projections from climate models.

The expected research findings will help to develop tailored services for policymakers, energy system managers, and stakeholders in their pursuit of a more sustainable and resilient energy future.

The research will be performed at LSCE and funded by ATOS, a large data and services company with activities in many different regions. The successful candidate will be offered a permanent position at ATOS from the start of the Ph.D. contract.

Background:

This thesis aims to extend previous work on electricity demand modeling using data-driven models based on climate variables and human activities at the national/regional scale. The primary focus will be on investigating the impact of extreme weather events on electricity demand and the associated CO₂ and pollutants emissions. By analyzing historical data and climate change scenarios, the research will assess the magnitude of the impact and its implications for energy system management. Secondly, the study aims to incorporate new socio-economic data to enhance the accuracy of demand modeling by accounting for buildings characteristics and the demographic characteristics of the inhabitants.

Objective 1: Analysis of Extreme Weather Events on Electricity Demand

The first objective of this thesis is to analyze the influence of extreme weather days on electricity demand patterns. By considering variations in demand during these periods and understanding the responses of the energy system, we will assess the scale of impact and implications for energy system management. This analysis will be based on historical data as well as climate change scenarios to project future scenarios. Quantile regression models will be used for this analysis. The research will evaluate the potential impact of extreme weather on CO₂ emissions, identifying opportunities for improving energy efficiency and reducing environmental impact. The expected research findings will help establish an accurate and continuous monitoring system for CO₂ fluxes at an hourly resolution over France Metropolitan.

objective 2: Integration of Socio-Economic Factors into Electricity Demand Modeling

The second objective is to enhance the electricity demand modeling by integrating new socio-economic data. The daily power demand models previously developed already account for human activity's impact on demand with variables such as holidays, week-end and working days, etc. Different



variables, such as thermal insulation of buildings, construction dates, and demographic characteristics of inhabitants (such as social origin and age), will be considered to improve the models. Advanced machine learning and statistical modeling techniques will be employed to explore the relationships between these factors and electricity demand, with a specific focus on extreme weather days. The impact on CO₂ emissions will also be evaluated.

Required skills

- Highly skilled in programming (preferably in Python/R) and machine learning, with a strong ability to implement and optimize algorithms
- Having expertise in similar climatical/ecological applications is a plus
- Satisfactory level of English proficiency (written and oral)

Selection Criteria

- Master's degree in a field such as data science, remote sensing, signal processing, machine learning, or statistics.
- Autonomy, ability to work in a team, and time management skills.
- Experienced in multidisciplinary team-based activities with the ability to effectively communicate with colleagues and with staff from the partners of a project.

PhD. Director:

Philippe Ciais (LSCE)

PhD co-directors:

Léna Gurrriaran (Atos-France) and Yannig Goude (EDF)

Duration of the Ph.D.:

36 months

Funding:

The research is funded by ATOS under a CIFRE Ph.D. contract. The successful candidate will be offered a permanent position at ATOS and will work on the Ph.D. project for the first three years of his contract.

What Atos, LSCE and AgroParisTech can offer you

ATOS (www.atos.net)

Is a global leader in digital transformation with 105,000 employees and annual revenue of over € 11 billion. European number one in cybersecurity, cloud, and high-performance computing, the Group provides tailored end-to-end solutions for all industries in 71 countries. A pioneer in decarbonization services and products, Atos is committed to a secure and decarbonized digital for its clients. The purpose of Atos is to help design the future of the information space. Its expertise and services support



the development of knowledge, education and research in a multicultural approach and contribute to the development of scientific and technological excellence. Across the world, the Group enables its customers and employees, and members of societies at large to live, work and develop sustainably, in a safe and secure information space.

LSCE (<https://www.lsce.ipsl.fr>)

Is a world-class research laboratory established and a collaboration between CEA, CNRS, and the University of Versailles Saint-Quentin (UVSQ). It is part of the Institute Pierre Simon Laplace (IPSL). LSCE hosts approximately 300 researchers, engineers, and administrative staff, including many PhD and master's students. This project will provide the employee with the opportunity to work directly on advanced methods with researchers from the LSCE and other institutions.

AgroParisTech UMR MIA – Paris Saclay (<https://mia-ps.inrae.fr/>)

The UMR MIA Paris-Saclay, associated with AgroParisTech, INRAE, and the University of Paris Saclay, brings together statisticians and computer scientists specializing in statistical and computational modeling and learning for biology, ecology, the environment, agronomy, and agri-food. Their skills cover statistical inference methods (complex models, latent variable models, Bayesian inference, learning, model selection, etc.) and algorithmic methods (generalization, domain transfer, knowledge representation). The unit develops original statistical and computational methods. Its activities are underpinned by a sound grounding in the disciplines for which it is intended: ecology, environment, agri-food, molecular biology, and systems biology.

Starting date:

The position is available from July 2023 and will remain open until filled. The expected start of the PhD is January 2024.

Salary:

Competitive salary, full social and health benefits commensurate with work experience. A short contract before that starting time is possible.

How to apply:

Applicants should submit a complete application package by email to the contacts below. The application package should include (1) a curriculum vitae including, e.g., recent publications/projects, (2) a statement of motivation, (3) answers to the selection criteria above, (4) names, addresses, phone numbers, and email addresses of at least two references.

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