INSTITUT POLYTECHNIQUE DE PARIS

RESEARCH DAY

Researcher Biographies and Project Abstracts

Symposium
"Climate and Meteorology"

December, 1st
1.30 pm to 3.30
Lecture hall Thévenin

Chaired by
Catherine Lepers, Professor at SAMOVAR, a laboratory of Télécom SudParis

INSTITUT POLYTECHNIQUE DE PARIS | l'X École Polytechnique | ENSTA | École Nationale des Ponts et Chaussées | ENSAE | Telecom Paris | Telecom SudParis

Marc Bocquet holds a Ph.D. from École Polytechnique and has an Habilitation delivered by Sorbonne University. He was a postdoctoral fellow at the University of Warwick and then at the University of Oxford. He is currently deputy director of CEREA, a laboratory of École nationale des ponts et chaussées and EDF R&D, and a professor at École nationale des ponts et chaussées, Institut Polytechnique de Paris. He works on data assimilation, inverse problems and statistical learning applied to the geosciences. He develops mathematical methods to better estimate the state of the atmosphere, of the ocean and the climate, as well as their constituents, using massive observations and complex models. He has published 120 papers and two books. He is associate editor of several peer-reviewed journals in the geosciences, and a Distinguished Research Fellow of the world's most renowned weather forecasting centre, the European Centre for Medium-Range Weather Forecasts (ECMWF).

The AI revolution in numerical weather prediction: surrogate models and data assimilation

Since 2022, the introduction of deep learning techniques for numerical prediction in the geosciences has abruptly and radically transformed the state of both science and technology in the field. Experimental evidence has shown that the most complex numerical models used in leading meteorological forecasting centres can advantageously be replaced by much faster deep neural networks.

However, these statistical surrogate models are trained on meteorological reanalyses—that is, long, high-resolution reconstructions of the state of the atmosphere, obtained at great computational cost through traditional models, Earth observations, and data assimilation techniques that combine the two.

To move beyond this first wave of the AI revolution, it is therefore necessary to train surrogate models not on reanalyses, but directly on observations. This implies implicitly learning not only the dynamics of the atmosphere, but also the assimilation process that enables these observations to be processed.

I will discuss these profound ongoing changes in the field, focusing in particular on the contribution of generative AI to the development of surrogate models and the learning of optimal data assimilation methods.

I will illustrate these points with examples from the geosciences, particularly in meteorology, sea-ice modelling (especially in the Arctic), and climate science.

INSTITUT POLYTECHNIQUE DE PARIS | École Polytechnique | ENSTA | École nationale des Ponts et Chaussées | ENSAE | Telecom Paris | Telecom SudParis

Aglaé Jézéquel is a climate scientist working at IPSL in Paris (LMD-ENS). In her research, she combines climate science around weather and climate extremes and their attribution to climate change with a strong interest in social science, including both science and technology studies and more generally social inequities. This leads her to work on questions such as how useful event attribution might really (not) be for stakeholders and climate justice, as well as combinations of weather and climate data analysis (event attribution and extreme events projections) with data and approaches from human geography.

Heatwaves in a changing climate: from hazards to impacts

Heatwaves have become more frequent and more intense under the influence of climate change, resulting in increased impacts on human health, infrastructure and economic activities. However, meteorological characteristics do not always inform properly on the actual human and material impacts resulting from heatwaves. In other terms, heatwaves with a high intensity in the climatological sense may not be equivalently as intense in terms of impacts. I will first present an empirical investigation of the link between the meteorological characteristics of European heatwaves and their impacts, as listed in the EM-DAT disaster database. This study includes an exploration of an ensemble of heatwave indices, including a subset of indices combining meteorological and demographic data. The second part of the talk will be dedicated to a focus on inequities in exposure to heatwaves at a city level. Urban areas are commonly hotter than rural counterparts. Research suggests that marginalized groups are more exposed than the general population to environmental hazards. Inequalities of exposure to urban heat island putting higher heat stress on persons of color and people living below the poverty line have been shown for an ensemble of U.S. Cities. Less is known about these inequalities of exposure in Europe. The combination of data on urban heat island effect from the Urbclim urban climate model for 10 French cities with demographic data (density, age, income level, types of households) highlights that neighborhoods with households with lower income and a higher density of children below the age of 10 have a higher exposition to heatwaves than the rest of the population.

Olivier Lopez is currently Professor in actuarial sciences at Ensae. His research topics cover applications of statistics to the evaluation of risks in insurance, with a particular focus on machine learning and their use in anticipating the impact of emerging risks (climate, cyber, health...). He is the principal investigator of the Excellence Research Chaire CARE (Chair for the Insurability of Emerging Risks) between Allianz France - Ensae IP Paris - Fondation du Risque. As a member of the board of the French actuarial association, he is in charge of AI topics in the evolution of the profession, and involved in the AI and sustainability working groups of the European and International Actuarial Associations.

Parametric insurance: challenges and opportunities to reduce the climate insurance protection gap

Insurance protection gap questions the ability to absorb the financial burden of natural disasters, which are supposed to increase in frequency and/or severity with climate change. It is essentially related to the inability of insurance to deploy an efficient economic model due to the extreme volatility of the loss, and to the failure of risk pooling. Parametric (or index-based) insurance refers to a type of products which often promoted as promising weapon against insurance gaps. The idea is to simplify the compensation process, by automatizing it, thanks to the use of a parameter (or index) that can be computed soon after the event, and which is supposed to be highly correlated with the effective loss encountered by the victim. The idea is to reduce the costs of expertise, to speed up the recovery, and to respond efficiently to the needs of victims in areas that are difficult to access. Conceiving an appropriate index is then very much related with the data available after the incident, with the particular attention to reduce as much as possible the « basis risk » (difference between the true loss and the compensation), and with the constraint to design a economically viable insurance product. This talk will present the methodological challenges and recent advances in the development of parametric insurance.

Loic Landrieu is a senior computer vision scientist at IMAGINE (ENPC/LIGM) and an associate researcher at IGN–LASTIG. His research focuses on computer vision for environmental monitoring. Active in both CV/ML and remote sensing communities, he has served as Area Chair for CVPR, ECCV, 3DV, and IGARSS. He co-chairs ISPRS and IEEE GRSS Working Groups on Earth Observation, was Program Chair of the ISPRS Congress 2022, and co-organizes the CVPR EarthVision workshop 2021-2025 and the EurIPS 2025 Advances in Representation Learning for Earth Observation workshop, and other events fostering collaboration between computer vision and Earth observation research.

Learning Environmental Representations for Scalable, Long-Term, Tree-Level Forest Monitoring

Estimating forest biomass and canopy height is essential for understanding ecosystem dynamics, yet current approaches rely on costly and unscalable field studies or airborne LiDAR surveys. Satellite imagery, by contrast, is abundant and inexpensive. In this talk, I present recent advances in learning to predict canopy height directly from imagery. I will introduce Open-Canopy, an open-access benchmark pairing very-high-resolution satellite images with LiDAR-derived canopy height, enabling systematic model evaluation and comparison. Building on this foundation, we trained a robust model using SPOT imagery and applied it across France over a decade at 1.5 m resolution—uncovering a detailed, time-resolved view of forest disturbances and recovery.

Follow us on social media

http://www.ip-paris.fr/en/news/ip-paris-research-day-2025