ParisTech

École des Ponts ParisTech

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Mathematics and their applications

Subfield: Applied Physics, Geosciences, Data Science, Environment Science

Title: Multiscale short-term forecasts of geophysical fields based on remotely-sensed big data

ParisTech School: Ecole des Ponts ParisTech

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Research group/Lab: Hydrology Meteorology and Complexity lab (HM&Co)

Lab location: École des Ponts ParisTech, 6 et 8 avenue Blaise Pascal – Champs-sur-Marne – 77455 Marne- la-Vallée cedex 2, France

(Lab/Advisor website): *https://hmco.enpc.fr/*

Short description of possible research topics for a PhD:
We are witnessing a rapid deployment, in particular around large cities, of various recent remote sensing technologies, such as lidars and polarimetric radars, which provide more and more data (wind, precipitation, pollutants) with increasing resolutions. To take full advantage of these technologies and data, qualitatively new short-term forecasts ("nowcasts") must be developed.
It is proposed to develop stochastic nowcasts based on cascading multifractal processes which are much faster than classical deterministic forecasting methods while being closer to the multiscale and nonlinear physics of the processes involved, as well as their intrinsic limit of predictability. The 2024 Olympic Games (Paris) will be an important case of experimentation.

Required background of the student:
Stochastic processes; data science; informatics. A first part of the thesis will be devoted to update knowledge in those domains.

A list of 5 (max.) representative publications of the group:

1. Lovejoy, S. and Schertzer, D. (2013), The Weather and Climate: Emergent Laws and Multifractal Cascades. Cambridge U.K.: Cambridge University Press. pp. 491
2. Marsan, D., Schertzer, D. & Lovejoy, S. (1996), Causal space-time multifractal processes: Predictability and forecasting of rain fields. *J. Geophys. Res.* 101, 26,333-26,346
3. Paz, I., Tchiguirinskaia, I & Schertzer, D. (2020), Rain gauge networks' limitations and the implications to hydrological modelling highlighted with a X-band radar. Journal of Hydrology, 583, 124615
4. Schertzer, D. & Tchiguirinskaia, I. (2017), An Introduction to Multifractals and Scale Symmetry Groups, in Fractals: Concepts and Applications in Geosciences. Ghanbarian, B. and Hunt, A. (eds) CRC Press, 1-28
5. Schertzer, D. & Tchiguirinskaia, I. (2020), A century of turbulent cascades and the emergence of multifractal operators. *Earth Sp. Sci.* 7, e2019EA000608