Rainfall, volatility and roughness: an intriguing story across scales

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Abstract

Joint work with Marc Hoffmann (CEREMADE, Université Paris Dauphine - PSL) Résumé : Hydrologists have long modelled rainfall with discrete or continuous time models based on point processes. In a first part, we show that most of the desired phenomenological properties of rainfall models are captured by Hawkes processes. Viewing this approach as a microscopic modelling, we zoom out in a second part our data to build a macroscopic model of aggregated rainfall. On several macroscopic data sets, we empirically establish that rainfall behaves like a rough fractional process with Hurst parameter close to 0.1; we further rigorously analyze the compatibility of this modelling across time scales, implying a heavy-tailed behavior for the accompanying microscopic Hawkes model. As a consequence, an unexpected analogy of the theory of rough volatility of Gatheral and Rosenbaum seems to emerge for rainfall modelling. We further discuss these findings from a statistical point of view, in particular how they advocate for the need of better tools for analyzing nonstationary data.

Keywords: Rainfall, Point process, Hawkes process, Fractionnal brownian motion, volatility

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