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Variability in Rainfall and Kinetic Energy across scales of measurement: evaluation using disdrometers in Paris region

Jerry Jose[1], Auguste Gires[1], Daniel Schertzer[1], Yelva Roustan[2], Anne Ruas[3], and Ioulia Tchiguirinskaia[1]

[1]HM&Co, École des Ponts, UPE, Champs-sur-Marne, France
[2]CEREA, Joint Laboratory École des Ponts ParisTech and EDF R&D, UPE, Champs-sur-Marne, France
[3]LISIS/ IFSTTAR, Université de Marne-la-Vallée, 5 Boulevard Descartes, 77420 Champs-sur-Marne, France

To calculate the effect of rainfall in detaching particles and initiating soil erosion, it is important to represent relationship between recorded drop size distributions (DSD) and fall velocity across various scales of measurement. Commonly used relationships between kinetic energy (KE) and rainfall rate (R) exhibit strong dependence on the temporal resolution at which analysis is carried out. Here we aim at developing a scale invariant relationship relying on the framework of Universal Multifractals (UM), which has been widely used to analyze and characterize geophysical fields that exhibit extreme variability over measurement scales.

Rainfall data is collected using three optical disdrometers working on different underlying technologies (one Campbell Scientific PWS100 and two OTT Parsivel2 instruments) and operated by Hydrology, Meteorology, and Complexity laboratory of École des Ponts ParisTech in the Paris area (France). They provide access to the size and velocity of drops falling through sampling areas of few tens of cm^2. Such data enables estimation of rainfall microphysics, R and KE at various resolutions. The temporal variation of this geophysical data over wide range of scales is then characterized in the UM framework. A power law relation has been developed for describing the dependence of KE on R. The developed equation using scale invariant features of UM are valid not only at a single scale, but also across scales. The amount of uncertainty is further characterized by comparing actual data with simulated rainfall data from Sense-City climate chamber.

Keywords: rainfall intensity; rainfall kinetic energy; disdrometer; multi fractal; scale invariant