# Application of universal multifractals framework in estimating a scale invariant power law relation between kinetic energy and intensity of rainfall

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**Abstract**

There is not much agreement on mathematical relationship between kinetic energy (KE) and rainfall rate (R) due to large variety in methods used for measurement of drop size distribution (DSD) and their variability as per geographic location and rain data type. Here we aim to develop a scale invariant relation using the framework of universal multifractls (UM), which enables characterization and simulations of geophysical fields that exhibit extreme spatio-temporal variability. In this study, rainfall data collected using three optical disdrometers in Paris over the period of 4 years, in two different locations, are used. The disdrometers (one Campbell Scientific PWS100 and two OTT Parsivel2 instruments) are operated by the Hydrology, Meteorology, and Complexity laboratory of École des Ponts ParisTech. Disdrometer data provides information on rainfall microphysics, R and KE at different resolutions by directly measuring size and velocity of drops falling in a sampling area of few tens of cm. UM framework enables analysis and simulation of a high variability across scales with only three scale invariant parameters. Using UM a power law relation was developed which has been found to be valid not only at the scale of consideration, but across scales. Such scale invariant relation between KE and R helps in modeling of soil erosion and pollutant detachment as well as leading edge erosion of wind turbine blades through impact of rain drops.

**Keywords:** rainfall intensity, rainfall kinetic energy, disdrometer, multi fractal, scale invariant

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