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Quantification of the effects of measurement precision on precipitation scaling estimators

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Since the introduction of the multifractal formalism in hydrological studies, many studies have been carried out to identify generalities in the scaling behaviour of temporal precipitation. Most of these studies approached departures from scaling as a feature which captures some physical (scaling) limits of the precipitation process in space and/or time. Unfortunately little attention has been given to other factors that can possibly affect the reliability of scaling estimators (e.g. Harris et al., 1997, Nonlinear Processes in Geophysics).

In this study we show the influence of measurement precision on the most widely used scaling estimators. We do this by comparing two different common precipitation measurement devices: a tipping-bucket raingauge and an electronic weighing gauge from a mountain location in the Swiss Alps. The tipping-bucket raingauge is operated at a 10-min temporal resolution with depth precision 0.1 mm, while the weighing gauge is operated at a 1-min temporal resolution and has much higher depth precision. Our results show that data quantization (time and volume) by the tipping-bucket mechanism leads to severe bias in the scaling estimators especially for periods of low rainfall intensities in the winter season when most precipitation falls in solid form. By Monte Carlo simulation we also numerically approximate the bias introduced by the tipping-bucket mechanism as a function of the time resolution and depth precision of the tip.

We also find that the tipping-bucket records may fail to identify transition scaling regimes that exist in time scales between minutes-hours and which can be detected by high resolution weighing gauges. This has important consequences for the identification of the scaling behaviour in temporal precipitation from different measurement sensors.