Summery of the Dissertation:

Fractal Modeling of Rainfall: Downscaling in Time and Space for Hydrological Applications

22-Aug-2001

1 Synopsis

The author argues that the multifractal scaling theory can adequately explain the variability of rainfall in time and space. A number of analyses of rainfall data is presented to support this argument. To supplement the available data to find out the limits of temporal scaling, a rainfall measuring experiment has been carried out. Based on those results two complete multifractal modeling schemes one in time, and the other in space, are presented. Each of these are validated using rainfall data of Japan.

2 Contributions to the original knowledge

- Multifractal theory had rarely been used to analyze rainfall of Asia. For the first time, the Japanese rainfall data was modeled using multifractals. These applications involved the temporal analysis of gauge based data, spatial analysis of gauge-interpolated hourly and daily data and a comparison of radar based spatial rainfall with gauge-interpolated data. These produced an insight in to the scaling properties of Japanese rainfall in space and time.
- An improved modeling approach to use (existing) *Universal multifractal model* to analyze temporal rainfall has been proposed. This approach could overcome some of the problems associated with the exceedance-probability based formulation of the above model. Especially, the new approach is useful in situations where only a limited range of scales are available for model fitting.
- A complete modeling scheme to produce synthetic hourly rainfall series from daily observations, using the above multifractal approach together with a multiplicative cascade type model, has been proposed. Extensive statistical comparison with hourly observed data, shows that these synthetic rainfall series resemble observed rainfall from many important aspects. The validation included comparisons of: intensity quantiles, distribution of dry periods, autocorrelations, statistics of rainfall events and extreme value distributions including event magnitudes at various return periods.

- Using the data gathered from a high precision rainfall measurement experiment, it has been shown that the scaling properties of temporal rainfall extends from a several days to about 5min scale.
- Spatial Multifractal models are statistically homogeneous in space. Hence, they can not represent the long-term spatial heterogeneity observed in spatial rainfall. The author has proposed a new model to incorporate long-term spatial heterogeneity in to multifractal modeling. A modeling framework based on this proposal has been set up with the aid of a multifractal model (β-log normal model)and a two dimensional cascading scheme. Application to the central part of the *Honshu* island demonstrated that this model can represent rainfall intensities in space accurately, taking the spatial-heterogeneity in rainfall in to account.