

# **Precipitation modelling using doubly stochastic point process models at fine time-scale**

**N I Ramesh,**

University of Greenwich  
School of Computing and Mathematical Sciences  
University of Greenwich  
Old Royal Naval College  
Park Row  
London SE10 9LS, UK

**C Onof**

Department of Civil and Environmental Engineering  
Imperial College London  
London SW7 2AZ, UK

**D Xie**

Ecole Nationale des Ponts et Chaussées  
6 - 8 Avenue Blaise Pascal  
Cité Descartes  
77455 Champs-sur-Marne  
Marne la Vallée cedex 2, France

This paper explores the use of a class of stochastic point process models, based on doubly stochastic Poisson processes, in the modelling of rainfall. We examine the application of this class of models, a neglected alternative to the widely-known Poisson cluster models, in the analysis of fine time-scale rainfall using tipping-bucket raingauge tip times. These models are used to analyse data from a single and multiple sites to study the temporal and spatial variability of precipitation at fine time-scales.

The arrival pattern of raingauge bucket tip times is viewed as a Poisson process whose rate of occurrence varies according to an unobserved finite state irreducible Markov chain. Since the likelihood function can be expressed in a tractable form, the models are fitted with maximum likelihood methods, thus enabling a more straightforward estimation of parameter uncertainty than for Poisson-cluster models. One of the advantages of this modelling approach is that it allows us to fit various sub-models of interest for the data, and also to test hypotheses on model parameters. As the tip-times from raingauges are modelled directly, this approach overcomes the usual need to convert tip-times into rainfall depths.

We study precipitation patterns at a network of gauges in the South-West of England (HYREX data) using univariate models and the extension of these models to a multivariate framework is examined. The multivariate version of our proposed model can provide the basis for a proper spatial-temporal model for which the parameters are well identified using maximum likelihood estimation. Results on fitting 3-state and 4-state models are presented. A small scale simulation study is carried out to compare some of the rainfall characteristics of accumulated rainfall.