Geophysical Research Abstracts
Vol. 14, EGU2012-10373, 2012
EGU General Assembly 2012

Stochastic modeling of high resolution space-time precipitation fields

A. Paschalis, P. Molnar, S. Fatichi, and P. Burlando
Institute of Environmental Engineering, ETH Zürich, Switzerland

Representing the fine scale structure of precipitation fields both in space and time (∼1km and ∼5min) is a crucial issue in hydrology. Good examples are the prediction of runoff and drainage in urban settings or of flash floods in small mountainous river basins. In these (and many other) cases there is strong evidence that the small scale variability of rainfall significantly affects the runoff response and needs to be properly accounted for.

One option is to simulate high resolution precipitation fields by numerical weather prediction models. Although these are based on physical process understanding, many precipitation formation processes still need to be parameterized, and the models are computationally demanding and not fully suitable for use in a Monte Carlo framework. Another alternative is that of stochastic processes which have been successfully used in operational hydrology for decades. Although there is a vast literature concerning the stochastic representation of precipitation in time, the lack of high-resolution space-time data so far has been a major restriction on developing and evaluating the performance of spatio-temporal stochastic models. In this respect, remote sensing techniques, and especially weather radars, have been very promising for the investigation of the spatio-temporal structure of precipitation fields, especially for mountainous areas which are generally not covered well by rain gauges.

In this study, we evaluate the performance of three space-time stochastic rainfall models both for point and areal statistics for an Alpine area. The investigated models are (i) a Poisson cluster model as introduced by Cowpertwait (2002 Water Resour. Res.) which simulates precipitation fields as a superposition of circular rain cells; (ii) a stochastic model based on the 2D spectral structure of rainfall fields (Bell, 1987 Water Resour. Res.; Clothier and Pegram, 2001 J. Hydrol.); and (iii) a model which reconstructs the full space-time covariance function of precipitation (DeMichele and Bernardara, 2005 Atmos. Res.). The dataset we use for model calibration/validation is the "best" ground estimate of precipitation intensity derived from the operational weather radars of the Swiss Federal Office of Meteorology and Climatology (MeteoSwiss). We use a 7 year dataset (2004-2010) with temporal resolution 5 min and spatial resolution 2 km in order to calibrate the stochastic models (ii) and (iii). Model (i) relies on ground observations only. Our case study is an area of 128 km × 128 km centered on the radar of Monte Lema (southwest Switzerland – northern Italy), where the performance of the radar product has been successfully tested. Since precipitation in this area can be both stratiform and convective, and subject to orographic forcing, we can validate the applicability of the studied models for different types of precipitation events. The results show that in general point process models fail to adequately represent the spatial variability of rainfall but perform well as multisite precipitation models (typically for time scales beyond 1h). On the other hand the other two models perform well in representing the complete spatiotemporal variability of rainfall but suffer due to the inherent measurement problems associated with quantification of precipitation intensities using remote weather radars.