Geophysical Research Abstracts
Vol. 12, EGU2010-12177, 2010
EGU General Assembly 2010

Which rainfall spatial information for flash flood response modelling? A numerical investigation based on data from the Carpathian range, Romania

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In this work, we introduce a spatial rainfall organisation metric to clarify the dependence existing between spatial rainfall distribution, basin morphology and runoff response. The metric provides a description of overall spatial rainfall organisation, in terms of concentration and dispersion statistics, as a function of the travel time measured along the river network. The statistics are based on the observation that runoff routing through branched channel networks imposes an effective averaging of spatial rainfall excess at equal travel time, in spite of the inherent spatial variability. High resolution radar rainfall fields and a distributed hydrologic model are employed to examine how effective are these statistics in describing the degree of spatial rainfall organisation which is important for runoff modelling, and in quantifying the effects of neglecting the spatial rainfall variability on flood modelling. The investigation focuses on three extreme flash flood events occurred on the Carpathian Range (Romania) in the period 2005-2007. The size of the study catchments ranges between 36 to 167 km2. The analysis reported here shows that neglecting the spatial rainfall variability results in a considerable loss of simulation Nash-Sutcliffe (NS) efficiency in almost 30% of the cases (NS less than 0.8), with NS less than 0.6 in one of the cases. This provides a significant documentation of the influence of the spatial rainfall variability on runoff modeling for catchment size less than 160 km2. Moreover, it is shown that these rainfall statistics, used in combination, are able to isolate and describe the features of rainfall spatial variability which have significant impact on runoff simulation. Overall, this implies that rainfall organization measured along the river network by using the travel time coordinate may be a significant property of rainfall spatial variability when considering flood response modelling.