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A new metric to assess the sensitivity of flood response modelling to spatial aggregation of rainfall

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The paper aims to investigate the influence exerted by the representation of the space-time rainfall patterns on the hydrologic response to determine the conditions and the scales for which the use of basin-averaged rainfall play a significant role on flood response error. Different flood and flash flood events from the *HYDRATE* project (hydrate.tesaf.unipd.it) archive are examined. This affords analysis of disparate spatial scales and climate/topographic conditions throughout Europe. High resolution, quality controlled radar rainfall fields and a distributed hydrologic model are used to evaluate the sensitivity of flood response to spatial aggregation of rainfall.
The influence of rainfall spatial aggregation is examined by using the *Spatial Moments of Catchment Rainfall (SMCR)*, which provide a description of overall spatial rainfall organisation, as a function of the rainfall field $R(u)$ value at position u and of the flow distance $d(u)$ between the position u and the catchment outlet measured along the river network. The analytical framework proposed by Woods and Sivapalan (1999) to identify the control exerted by the spatial variability of rainfall on catchment response provides a rationale for the SMCR. The $zero$-th order spatial moment yields the average catchment rainfall, the first moment the location of the center of the mass of catchment rainfall, and the second moment relates to the spreading of the rainfall field about its mean position.
The results confirm the suitability of the metric based on the SMCR to describe the sensitivity of the flood response to rainfall spatial aggregation, particularly for small and medium size catchments (up to 1000 km^2). It is shown that, for catchments of similar size and for rainfall events displaying similar spatial variability, the sensitivity of the flood response is emphasized when there is a significant and systematic variation of rainfall with the flow distance. Typical physical mechanisms leading to this situation are the focusing processes, particularly active during flash flood events, and the orographic enhancement of precipitation.

Woods, R. and M. Sivapalan (1999) A synthesis of space-time variability in storm response: Rainfall, runoff generation, and routing, Water Resources Research, 35(8), 2469-2485.