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Decomposing the rainfall control on flash flood hydrograph shape into spatial, temporal and storm motion components

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Space-time variability of rainfall, drainage network structure and local runoff generation properties, including land use/cover and geologic characteristics, shape the catchment response to storms. A way to describe the complexity of the interaction between these factors is to quantify their relative contribution on flood hydrograph shape. Quantifying the contribution of each factor is of great importance because this can identify which sources of variability are crucial for understanding and predicting catchment response. In this work we focus our analysis on the role of space-time variability of rainfall and drainage structure on flash flood hydrographs. An extended version of the concept of "spatial moments of catchment rainfall" which accounts for hillslope/channel velocity differentiation forms the basis of the analytical framework used in our analysis. The framework is used to quantify the contribution of each source of variability in flood response for eight extreme flash flood-inducing storms occurred in Europe in the period 2002 to 2008. The storms were selected from the HYDRATE project database, where high resolution radar rainfall data were integrated with post event surveys. The location of the events covers a range of climatic regions (Mediterranean, Alpine, Continental). Comparison between scenarios of uniform and variable (spatially) rainfall, showed that the effect of spatial variability of rainfall on mean runoff time is apparent only for basin scales > 100km2 . The difference in mean runoff time, relative to original rainfall, ranges from -5 to +10%. Corresponding investigation on the effect of rainfall spatial variability on variance of runoff time showed no apparent scale dependence and a relative difference of +/- 20%. Regarding the effect of drainage structure, an interesting result is that event-wise the importance of drainage network follows a well-defined scale dependence. Finally, examination on the relative importance of storm motion shows that its contribution is generally low (<10%) suggesting that storm velocity had a minor effect on the hydrograph shape for the cases examined.