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Study of the distributed hydrologic response of the Claduègne catchment (Ardèche), prone to flash floods, using dense networks of rain and water level gauges

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Flash floods are amongst the most important natural hazards in Europe, particularly in the Mediterranean region creating economical damage and life risk. This study investigates the factors that control the hydrological response in a set of 13 catchments, partially nested and ranging from 0.17 to 42 km^2, located in Ardèche, a Mediterranean region prone to flash floods. The period of interest is 2012-2015. The Claduègne catchment (42 km^2), which contains the other 12 catchments, is part of the OHMCV observatory and the OZCAR research infrastructure. This catchment can be separated into two distinctively different parts with a basaltic plateau in the upstream part and sedimentary rock in the downstream part (each about 50%). The sub-catchments are distributed over these two parts and different land use forms (forest, cultivated soils and grasslands). For most of the sub-catchments, no discharge rating curve exists, so the focus of the analysis mainly lies on the time component of the hydrological response as well as on descriptors of the rainfall-runoff event and catchment properties. Several characteristic times were calculated for each catchment based on a set of 49 to 158 events depending on the catchment and various statistical methods were applied in order to estimate the importance of different factors on the hydrological response on two levels: (A) inter-comparison of the catchments with regards to their properties and averaged event characteristics. (B) comparison of the storm events for each catchment considered separately with regards to the rain characteristics, initial degree of wetness and seasonality.
A simple estimate of lag time was shown to be able to characterize the dynamics of each catchment and provide an estimate of time of concentration, if calculated for a selection of impulsive events. A relationship between catchment size and parsimonious time step to describe rainfall forcing was also established. Besides the catchment's size, we found the geology to be an important factor influencing the catchments' response, with the catchments in the sedimentary part reacting faster.
On the catchment-level, a strong seasonal variation of event characteristics was found. The most intense, shortest events take place in autumn, while the events in spring are particularly long and slow. Two sub-catchments have singular behaviors. One was shown to react much faster and one much slower than expected. This suggests additional in-situ investigations in order to understand the hydrological processes.