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Influences of temporal rainfall radar and spatial rainfall-runoff model resolution on flood prediction

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The rainfall-runoff-model DROGen (Distributed RunOff Generation) was developed to simulate runoff generation processes during floods and flash floods generation with a very high spatial resolution for the whole state of Baden-Württemberg in Southwest Germany. The model connects available spatial geo information with detailed process understanding at the plot and hillslope scale and is not calibrated. The model was successfully validated in 8 meso-scale watersheds with different geology, soils, topography and land-use and the results were very satisfying. We believe that the high spatial resolution of $1*1m^2$ and a temporal resolution of 1 hour especially improved flow dynamics and the runoff concentration behaviour of the different runoff components. Some spatial information used by DROGen is available in very high resolution of $1*1m^2$ (e.g. DEM and degree of sealing of land surface). Other data are much more generalized (e.g. soil information at the scale of 1:200.000) or at a fixed temporal resolution of one hour (e.g. calibrated precipitation radar data of the German weather survey (RADOLAN)).
In order to find the adequate temporal and spatial resolution we investigated how the the spatial resolution of the geo data and the temporal resolution of the rainfall radar data effects the model result. Regarding the spatial resolution, we found, that the processes of runoff generation and runoff concentration are sensitive at different spatial scales. A decrease of spatial resolution from 1m to 25m lead to an implausible increase of the generation of saturation overland flow and to an accelerated concentration of subsurface flow, while Hortonian overland flow was almost not affected by the spatial resolution. For the model validation runs we realized that for short convective rain events a one hour resolution of the rainfall data might be not sufficient because of severe underestimation of peak intensities. We developed and tested a new method to estimate the temporal distribution of rain intensity in higher resolution by using only the information of the hourly radar data and an assumed temporal distribution of rainfall at each radar grid cell. The methods preserves the total rainfall amount at each cell and preserves the overall rainfall pattern and movement of precipitation cells. Generally, we could improve the prediction of the model for short convective events in particular for the peak discharge. The higher temporal resolution effects the runoff generation and depends strongly on soil characteristics. On soils with high infiltration capacity the increase of temporal resolution effects the generation of fast overland runoff. This effect decreases with decreasing infiltration capacity of soils. The analysis revealed that a variable temporal resolution is needed to model convective and advective rainfall events with the same model parameterization. A "correct" spatial resolution of the distributed model, however, depends strongly on the dominant runoff generation process in a watershed and is also different for runoff generation and runoff concentration.