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Generating precipitation ensembles for flood alert and risk management

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Floods represent one of the major natural disasters that are often responsible for fatalities and economic losses. Flood warning systems are needed to anticipate the arrival of severe events and mitigate their impacts. Flood alerts are particularly important for risk management and response in the nowcasting of flash floods. In this case, precipitation fields observed in real time play a crucial role and observational uncertainties must be taken into account. In this study, we investigate the potential of a framework which combines a geostatistical conditional simulation method that considers information from precipitation radar and rain gauges, and a distributed rainfall-runoff model to generate an ensemble of precipitation fields and produce probabilistic flood alert maps. We adapted the simulation method proposed by Leblois and Creutin (2013), based on the Turning Band Method (TBM) and a conditional simulation approach, to consider the temporal and spatial characteristics of radar data and rain gauge measurements altogether and generate precipitation ensembles. The AIGA system developed by Irstea and Météo-France for predicting flash floods in the French Mediterranean region (Javelle et al., 2014) was used to transform the generated precipitation ensembles into ensembles of discharge at the outlet of the studied catchments. Finally, discharge ensembles were translated into maps providing information on the probability of exceeding a given flood threshold. A total of 19 events that occurred between 2009 and 2013 in the Var region (southeastern France), a region prone to flash floods, was used to illustrate the approach. Results show that the proposed method is able to simulate an ensemble of realistic precipitation fields and capture peak flows of flash floods. This was shown to be particularly useful at ungauged catchments, where uncertainties on the evaluation of flood peaks are high. The results obtained also show that the approach developed can be used to improve risk management by enabling the display of probabilistic information on discharges exceeding critical thresholds over the study area. The proposed method could be a solution to merge radar and rain gauges information, while quantifying the observed precipitation uncertainties in flash flood nowcasting.

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