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Uncertainties on mean areal precipitation: assessment and impact on streamflow simulations

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Abstract. This paper investigates the influence of mean areal rainfall estimation errors on a specific case study: the use of lumped conceptual rainfall-runoff models to simulate the flood hydrographs of three small to medium-sized catchments of the upper Loire river. This area (3200 km^2) is densely covered by an operational network of stream and rain gauges. It is frequently exposed to flash floods and the improvement of flood forecasting models is then a crucial concern. Particular attention has been drawn to the development of an error model for rainfall estimation consistent with data in order to produce realistic streamflow simulation uncertainty ranges. The proposed error model combines geostatistical tools based on kriging and an autoregressive model to account for temporal dependence of errors. It has been calibrated and partly validated for hourly mean areal precipitation rates. Simulated error scenarios were propagated into two calibrated rainfall-runoff models using Monte Carlo simulations. Three catchments with areas ranging from 60 to 3200 km^2 were tested to reveal any possible links between the sensitivity of the model outputs to rainfall estimation errors and the size of the catchment. The results show that a large part of the rainfall-runoff (RR) modelling errors can be explained by the uncertainties on rainfall estimates, especially in the case of smaller catchments. These errors are a major factor limiting accuracy and sharpness of rainfall-runoff simulations, and thus their operational use for flood forecasting.

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