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Evaluation of radar-based rainfall estimation by cross validation and runoff simulation

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Heavy rainfall events in mountaineous head catchments are particularly hazardous due to high runoff coefficients and a fast runoff concentration. Flood forecasting for such - typically meso-gamma scale - catchments requires both a precise precipitation forecast and a reliable estimate of rain which has already fallen before or during a major precipitation event. Since the network density of operational rain gauges is typically low, weather radar is indispensable to attain the required spatial information at this scale. But even after being adjusted by ground based gauge measurements, radar-based rainfall estimates usually are subject to a wide range of errors.

The objective of this study is to evaluate an adjustment procedure which merges radar and rain gauge measurements into a robust spatial rainfall estimate. This evaluation is based on two different approaches, namely cross validation and rainfall-runoff simulation. Both validation approaches are to be critically examined: While cross validation is straightforward and easy to interpret, it is limited by the network density of operationally available rain gauges and the errors of the gauge measurement itself. Runoff simulation, on the other hand, provides a means to relate a spatial rainfall estimate to the integral catchment response. However, it is subject to a wide range of model errors, process interactions, as well as time lag and calibration effects. In this study, we investigate under which conditions the two approaches are adequate to evaluate the quality of rainfall estimates and how they could complement one another in order to identify weaknesses in the adjustment procedure.

Our study area is the catchment of the Weisseritz River, a tributary to the Elbe River

near Dresden (Germany). Radar data are provided as national hourly composites by the German Weather Service (2005) at 1x1 km resolution from 2004 to 2007. These radar data are adjusted by hourly rain gauge measurements using a geostatistical method originally proposed by Ehret (2002): The basic procedure is to first estimate the mean precipitation field from rain-gauge observations by using Ordinary Kriging, and to subsequently imprint the spatial variability of the radar image. For rainfall-runoff simulations the LARSIM model (Large Area Runoff Simulation Model; Bremicker, 2000) is used.

The quality of our rainfall estimation procedure will be evaluated by applying the two different validation strategies to a couple of benchmark methods. These benchmarks include classical point based estimation procedures (such as IDW and Ordinary Kriging), unadjusted radar rainfall measurements, but also simple standard procedures for the adjustment of radar rainfall by gauges measurements.

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