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Towards an operational rainfall estimation and now-casting using weather radar and ground measurements

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Floodings in head catchments are connected with high damage potentials due to short lead times and rapid increases of the water level. Water management in such catchments requires precise operational forecasting of rainfall-runoff processes as well as corresponding control of reservoirs and retention basins. The OPAQUE project (Operationelle Abflussvorhersage in Quellgebieten – Operational runoff forecasting in head catchments) is concerned with the development of such an operational system for small head catchments in Germany. Study catchments include the Upper Danube, Upper Iller, the Golderbach and the Weißeritz.

An important aspect of the OPAQUE project is the improvement of real-time spatio-temporal rainfall estimation and the prediction of rainfall for the next 2-3 hours (now-casting). For this purpose, radar data (1˚ x 1 km azimuth and range) provided by the German Weather Service (2005) is combined with rain-gauge measurements on the ground. Both estimation of current rainfall and now-casting are based on procedures developed by Ehret (2002). Real-time rainfall estimation is achieved by the so-called "merging" of radar and rain-gauge measurements. The merging preserves the mean rainfall field estimated by rain-gauge observations but imprints the spatial variability of the radar image. In this project, we systematically analyse the deficits of the merging methodology for our particular study catchments. Envisaged improvements comprise e.g. the consideration of radar data subject to its quality and the establishment of robust procedures in the case of missing data (either ground or radar measurements).

The approach to "now-cast" precipitation fields based on radar data acknowledges the impossibility to accurately predict the rainfall situation in a radar image even for a few hours ahead. Instead, a stochastic approach can establish reference points over the range of possible developments. Our basic approach is to apply the so-called ‘Spectrum-corrected Markov chain” (SCM) procedure from Ehret (2002). First, a bi-variate auto-regressive process is used to forecast the image scale parameters (rainfall coverage and mean rainfall intensity). Then, the individual development of each pixel in the radar image is forecasted by using a Markov chain (which defines its system states by rainfall type, intensity and development over the last 30 minutes). Finally, the forecasted field is adjusted to the predicted coverage and mean rainfall intensity and shifted according to the prevailing advection vector. As we use a radar image composite for entire Germany, the advection vectors have to be considered as a function of space and time. Spatial rainfall data from the merging procedure will be employed for now-casting validation.

References:

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