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Gridded hourly real-time precipitation by geostatistical radar-gauge combination: A systematic application in Switzerland

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There is an increasing demand for gridded precipitation analyses of high spatial and temporal resolution. For many applications, such as hydrological flood forecasting, these precipitation grids should be available in real-time. In several studies geostatistical interpolation methods (kriging) have been proposed to combine the complementary strengths of the two main precipitation sensors: radar (high spatial resolution) and rain gauges (high local accuracy). Many of these studies demonstrate that there is considerable improvement by the combination compared to single sensor analyses as well as compared to less sophisticated combination methods. These improvements were, so far, primarily reported for the daily time-scale and for selected precipitation events. However, specific challenges arise if these methods are applied systematically for the hourly time-scale. The sparsity of data (large majority of the gauges is dry in most hours) calls for particular solutions with respect to parameter estimation. And the assumptions of classical geostatistics (stationarity, Gaussian distribution) are usually not met by hourly precipitation data.

Two popular geostatistical combination methods, kriging with external drift (KED) and ordinary kriging of radar errors (OKRE) are systematically applied over an entire year (2008) in Switzerland. The radar data is a composite from three C-band radars using a constant Z-R relationship and advanced post-processing. For the gauge data, a network of 75 automatic stations is employed, resulting in a typical inter-gauge distance of 25 km. A trans-Gaussian framework is proposed to improve the compliance with model assumptions. To tackle the challenge of parameter estimation in hours with less than 10 wet gauges, a parametric approach with climatological variogram parameters and a previously suggested non-parametric approach are compared. Leave-one-out cross-validation is performed and several error measures are calculated to analyze and compare the methods with respect to bias, mean error, wet-dry-delineation and intense precipitation.

Both combination methods show considerable improvements compared to single sensor estimates. This improvement is found for hours with sufficient wet gauges to estimate all the parameters, but also for the challenging hours, when climatological parameters need to be applied. The comparison between the two methods shows a better performance for KED in terms of overall bias and mean error, and a better performance for OKRE in terms of wet-dry-delineation and intense precipitation. The non-parametric approach and the parametric approach with climatological parameters show fairly comparable results in the examined framework.