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Effects of the raingauge network density on the quality of rainfall fields estimated blending radar and raingauge data in real-time

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Most of proposed techniques to combine radar and raingauge measurements aim to join the quantitative skill of raingauges with the good spatial description observed by the radar rainfall fields into an enhanced rainfall field. During last years we have developed a methodology to blend rain gauges and radar data in real time using a fully automatic definition of spatial correlation models and Kriging estimators (see e.g. Velasco et al., 2004; Velasco-Forero et al., 2003). This methodology is able to deal with anisotropy and temporal variations of the spatial structure and to define automatically two dimensional correlation maps at any time step avoiding the need to fit theoretical models of variograms.

This paper is focused in showing the consequences on the quality of the blended rainfall fields due to changes in density of the raingauge network used in the estimation. The raingauge network densities analyzed were 1 gauge every 130, 160, 280 and 650 km^2. Three geostatistical techniques were evaluated in this paper: Ordinary Kriging [OK], Kriging with external drift [KED], and Collocated Cokriging [ColCOK]. Performances of rainfall estimations of those techniques were assessed analyzing cross-validations estimations and raingauge observations of all time steps using Nash-Sutcliffe efficiency. The variations in the Nash-Sutcliffe efficiency were evaluated using 100 sub-samples for each density for raingauges. Six different rainfall

events occurred in a region of 10000 km^2 around Barcelona (Spain) were used as case studies. A total of 193 hourly time steps were analyzed in this paper.

The results show that when the number of raingauges decreases, the accuracy of all estimation techniques also decreases, but in different ways for each geostatistical technique. Rainfall estimations using techniques that take advice of radar values (e.g., KED and ColCOK) result in higher Nash-Sutcliffe efficiency values, even when a small number of raingauges are used. With the lowest number of raingauges, the quality of OK estimations is considerably lower than with the highest raingauge densities and even it is worse than radar performance. This is because with low raingauge densities, the point measurements (at raingauges) do not reflect the true aerial rainfall accurately, particularly in rainfall events with low spatial continuity such as convective ones. However, if correlation maps computed from radar fields instead from raingauge data are used with OK estimator, previous results were outperformed. Those results seem to confirm the hypothesis that radar rainfall fields are preferable to raingauge data for computing the spatial variability model of the reference rainfall, particularly when the density of the raingauge network is low.