Continuous-time calibration of the Z-R relationship for estimating rainfall fields from radar measurements

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The operational use of weather radar has become a widespread and useful tool for estimating rainfall fields as well as for now-casting applications. The radar-gauge adjustment is a commonly adopted technique which allows one to reduce bias and dispersion between radar rainfall estimates and the corresponding ground measurements provided by rain gauges. Nevertheless, rainfall fields estimated through radar data are known for being scarcely-reliable at reproducing a quantitative assessment of the total areal rainfall, though they provide an accurate qualitative description of the spatial evolution of the rainfall intensities throughout the event. Because of that, radar products still find scarce use into distributed hydrologic models.

The goal of this work is to identify a methodology for estimating rainfall fields based on a radar-gauge adjustment, in order to minimize the related error. The study region is located in the north-west of Italy, where ARPA Piemonte operates a C-band radar near the city of Turin. We consider 19 rainfall events between 2003 and 2006, with available measures of radar reflectivity and rainfall intensity from 20 rain gages with a 10 minutes temporal resolution. For each hourly time step, we estimate several Z-R relationships in the form of power laws, with parameters estimated on moving windows of different durations, between 1 and 24 hours.

Three further methods are then applied, based on power law relationships: (1) the one which is currently adopted at ARPA Piemonte, $Z = 300\ R^{1.5}$, (2) one which minimizes the squared sum of the residuals from all the available Z-R pairs, and finally (3) a method similar to (2) which evaluate a relationship for each rainfall event. We apply a cross-validation procedure in order to assess the error characteristics as a function of the calibration period.

Our results suggest that a 14% reduction of the standard error is obtained by recalibrating the power law parameters on all the available Z-R pairs. The use of Z-R relations calibrated on shorter durations allows one to achieve further substantial improvements, which we found to be about 27% for a calibration windows of three to five hours.