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On the influence of rain gauge performance on extreme events statistics: the case of weighing gauges

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Measurement accuracy requirements for rainfall intensity gauges under operational use are becoming tighter after the recent Field Intercomparison of Rainfall Intensity Gauges promoted by WMO (the World Meteorological Organisation) demonstrated the achievable accuracy of a number of commercially available instruments (Vuerich et al., 2009). Various measuring principles had been involved in the WMO intercomparison exercise and extensively tested, first under controlled laboratory conditions (see Lanza and Stagi, 2009) and then at a field test site in the period 2007-2009 (see Lanza and Vuerich, 2009).
This notwithstanding, the effects of inaccurate rainfall data on the information derived from rain records is yet not much documented in the literature. La Barbera et al. (2002) investigated the propagation of measurement errors into the most common statistics of rainfall extremes and found that systematic mechanical errors of tipping-bucket rain gauges may lead to biases, e.g. in the assessment of the return period T (or the related non-exceedance probability) of short-duration/high intensity events, quantified as 100% for T = 100 years. In that work an equivalent sample size is also defined in order to quantify the equivalent number of correct data that would be needed to achieve the same statistical uncertainty introduced by the influence of errors on inaccurate records.
The present paper aims at extending the investigation to include rainfall intensity gauges based on a different measuring principle, and the attention is focused here on the weighing type gauges. The OTT Pluvio2 weighing gauge (WG) and the GEONOR T-200 vibrating-wire precipitation gauge are investigated in this work since they demonstrated very good performance under previous constant flow rate laboratory calibration efforts (Lanza et al., 2005). One of the most significant results of the last WMO Field Intercomparison of Rainfall Intensity Gauges is the evidence that the dynamic response seem to impact quite heavily on the accuracy of WG measurements under real world/time varying rainfall conditions (see Vuerich et al., 2009).
A laboratory dynamic rainfall generation system has been arranged and validated in order to simulate a number of precipitation events with variable time steps reference intensities. Such artificial events were generated basing on real world rainfall intensity (RI) records so that the statistical structure of the time series is preserved. Considerations about the performance of the Pluvio2 and T-200 rain gauges under non-steady precipitation and the biasing factors influencing the two different measuring principles are reported. In particular, the effect of the natural variability of rainfall intensity on the response time (time constant) of the two WGs has been closely addressed.

In the present work, the influence of the WG RI measurements accuracy on the relative extreme events statistics is analyzed comparing the original intensity-duration-frequency (IDF) curves with those obtained after laboratory testing. Moreover the common contingency of a change in the measurements accuracy of a RI time series is also considered by studying experimentally the effect of the replacement of a traditional tipping bucket with a weighing gauge on the consistency of the recorded precipitation.

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