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On the variability of Hershfield-type rainfall sampling adjustment factors

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All precipitation records, even those from “continuous gages,” are actually discrete, as rainfall depths are aggregated over fixed or “clock” measurement periods typically ranging from 10 to 60 minutes. This invariably introduces negative biases when estimating rainfall extremes over short durations, in the order of the totalization period. Starting with Hershfield’s work in the 1950’s, rainfall sampling adjustment factors (SAFs) have been used in order to convert fixed (“clock”) - time maxima into continuous (“sliding”) maxima. A problem in the literature though, is that there is no clear agreement on the definition of, and basic procedures for determining rainfall SAFs; more surprisingly, nobody has systematically looked at the different sources of variability in SAFs.

We analized 34-yr long rainfall records at 52 stations distributed over Switzerland (41,300 km2), with data every 10 min. All records are concurrent, and were collected with the same instrument model and methodology. Independent storms were identified and assigned to fixed, warm or cold seasons, as well as to convective or non-convective events (based on co-occurrence of lightning). For a range of durations ($\geq$20 min), we extracted the “true” maxima from our “continuous” (10 min) data, as well as for data totalized over a range of different periods, for eight different combinations of season and storm type, using all possible ways of totalizing. We then applied partial duration analysis to obtain rainfall depth-duration-frequency (DDF) values at each station, for each totalization period, way of totalizing, and season/storm type. SAFs were subsequently computed as the ratios between DDF values obtained for fixed and continuous time windows.

There is ample variability in SAFs within each station, due to the different ways in which the data can be temporally aggregated, as well as across stations. For example, the Hershfield factor - the 1-h to 60-min SAF - has a mean value of 1.12, but ranges from 1.04 to 1.22. Both season of the year and storm type have strong effects on rainfall SAFs. We did not find any obvious spatial pattern for SAFs.