A study of the dependence of the ratio between rainfall amounts measured using fixed and unrestricted intervals on the characteristic rainfall pattern of a place

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Correction of Maximum Rainfall:

Historically, most rainfall has been measured daily at a fixed time. However, precipitation in unrestricted 24 hours is a more useful information in order to study maximum rainfall. In consequence, several studies recommend the adjustment of rainfall measured at fixed intervals (Hershfield, 1961; Weiss, 1964; Dwyer and Reed, 1995; Van Montfort, 1997; Asquith, 1998; Young-McEnroe, 2003), usually through a multiplicative factor.

Methodology and Data:

In the present study, empirical correction factors are derived for rainfall measured in 24 hours and up to 21 days at several locations in Catalonia. The empirical factor is the ratio between rainfall at unrestricted intervals and rain amounts obtained at fixed time intervals for the same episode and duration. This study has been carried out for Catalonia using a selection of 131 automatic weather stations (AWS) from the database of the Meteorological Service of Catalonia (IMC). This rainfall data is recorded at time intervals of one hour or higher temporal resolution and the first available date is from 1988. The temporal period of the study is 1988-2016 and selected series have a minimum of 15 years of data (118 stations) or have been selected due to its location at high altitude (13 stations).

Correction factors for daily measures taken at fixed time intervals starting at 8 a.m. are inferior than factors obtained for measures taken at fixed time intervals that start at 4 p.m. This means that rain episodes would be more often split if measures were taken at 4 p.m. leading to a ratio of true maxima in 24 hours versus fixed interval of 1 day larger than if the fixed interval started at 8 a.m. Indeed, as fig[2](a) shows, at nearly every locations it often rains less around 8 a.m. than the amount collected by a constant rain, whereas at 4 p.m. most locations (see fig[2](b)) present a higher fraction of rain around that time.

Conclusions:

- Correction factors depending on sampling intervals obtained in this study are slightly lower than those deduced by Weiss (1964) and they agree even better with the factors calculated by other authors (Huff-Angel, 1992; Young-McEnroe, 2003).
- The study has shown that different starting time of the fixed sampling interval need different correction factors, being 8 a.m. a good time to take daily measures as it corresponds to an hour with a small fraction of rain and, thus, needs less correction.
- Seasonal calculation of empirical correction factors shows that a higher correction value is needed in spring whereas an extremely lower one is needed in summer. This agrees with the climatic pattern of rainfall in the region where summer rain episodes are usually in a time of the day where they would not be split by a daily measure taken at a fixed time in the morning; spring, however, brings often episodes that are less influenced by the daily cycle, i.e., less dependent on the time of the day and more probably split by measures taken in the morning. In Autumn and Winter the correction factor is closer to the average value, nonetheless, spatial patterns arise.
- Empirical results showing a spatial and temporal (regarding annual cycle) variability of the ratio between true rainfall in 24 hours and rain amounts at sampling intervals suggest the need to apply different corrections depending on location and season. Moreover, a minimum for the correction factor has been found depending on altitude: for locations at greater height than 1000 m (a.s.l.) a minimum factor of 1.114 should be applied whereas at heights over 2000 m (a.s.l.) the minimum factor is 1.132.

References:


Figures:

- Fig[1]: comparison between empirical factor (dots) and theoretical formula of Weiss and Young-McEnroe, depending on the considered duration (N is the number of fixed intervals in the desired duration).
- Fig[2]: empirical correction factors for measures taken at fixed time 8 a.m. (4 p.m. on the right) are displayed depending on the fraction of rain collected from 7:30 to 8:30 (15:30 to 16:30 on the right). The horizontal line at 1.129 indicates the averaged empirical correction factor for measures at 8 a.m., which is comparable to the factor obtained by other authors for fixed intervals of 1 day. The vertical line at 0.04 represents the fraction of rain that would be collected during 1 hour of the rain were uniform over time (i.e.: 1/24).
- Fig[3]: correction factors depending on height above sea level. A line enclosing minimum values shows that at higher altitudes an increasing minimum correction is needed.
- Fig[4]: spatial distribution of empirical correction factor obtained for fixed intervals of sampling time starting at 8 a.m. and averaging monthly depending on season.
- Fig[5]: empirical correction factor depending on the season, averaged over all locations in Catalonia where the study has been carried out. Results show how a higher correction is needed in spring whereas in summer the needed correction is under the average.