

Short-term rainfall characteristics dependence on the length of processed period

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1 Introduction

Characteristics of short-term rainfalls, especially their intensity and design values, are very important for the technical (e.g., sewage system) and hydrological practice. However, measurement and data processing of these characteristics are rather complicated. The rainfall intensity has been regularly measured in Czechia since 1898 with a few manual pluviographs. Automatic rain gauges started to replace them in the late 1990s. Nowadays, a large part of historical pluviographs records has been digitalized. Both the digitalized pluviographs records and the automatic rain gauge measurement provide rainfall series in temporal resolution of 1 minute. In our contribution, the dependence of short-term rainfalls characteristics to the length of processed period is analyzed in order to assess a possibility to use relatively short rainfall series (e.g., 20-year or shorter) for estimation of return levels. This information is important for assessing a possibility to use radar data (available since 2002) for improvement of information about spatial distribution of return levels by combining it with the estimates from longer station series.

2 Methods

Estimated return levels (RL) of short-term rainfalls (duration of 10–360 min) with regard to different lengths of processed period are studied at 20 selected stations.

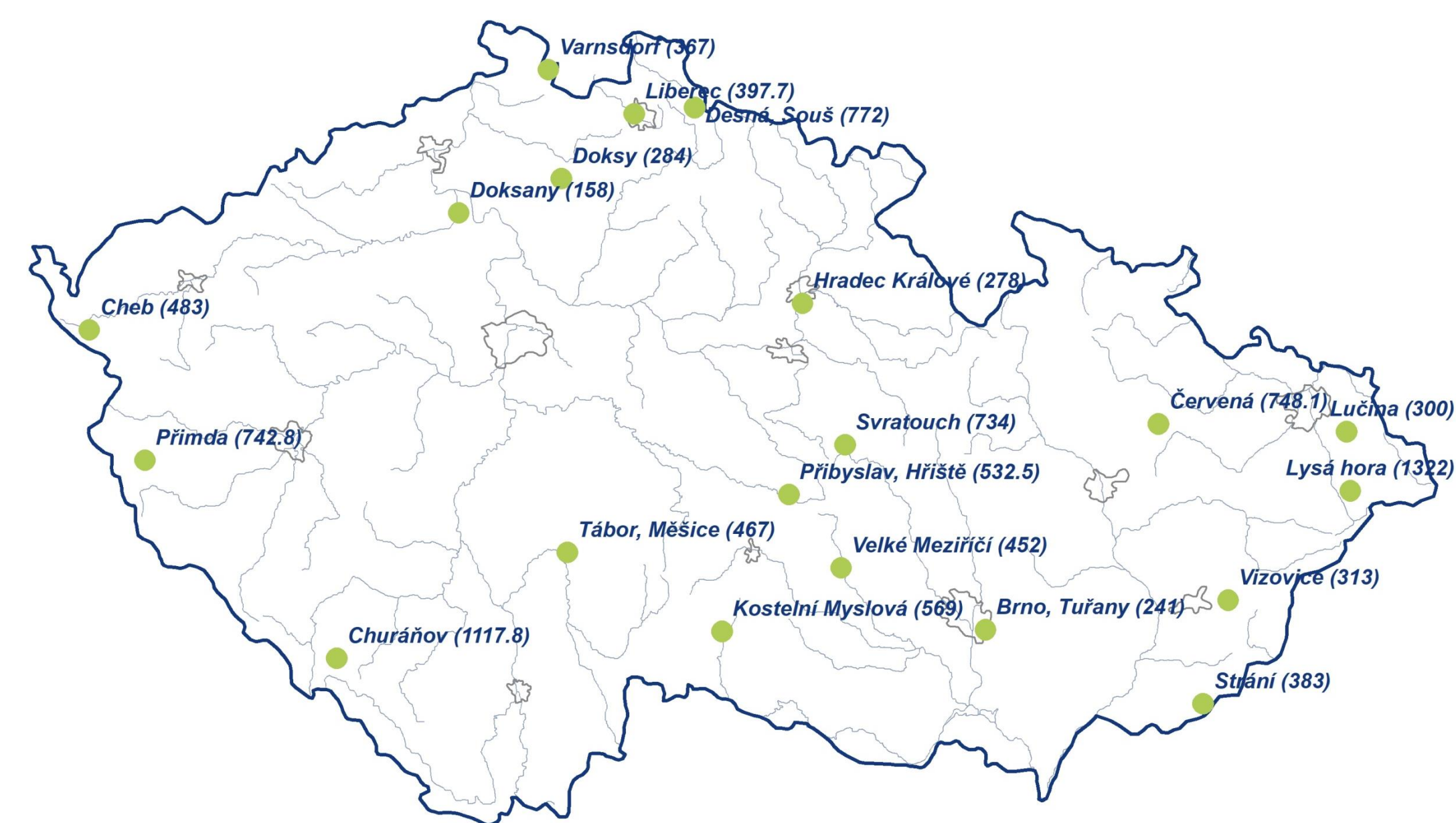


Fig. 1. Twenty stations with the series longer than 50 years from 1961–2020 (concerning joined digitalized pluviograph records and automatic rain gauge measurement) used in the analysis.

The RL of the short-term rainfalls were estimated by fitting General Extreme Value (GEV) distribution to annual maxima. The parameters of distribution were estimated using method of L-moments. A sampling technique with 5,000 samples was applied to determine the possible range of estimated RLs when shorter processed period than the longest available is used. Several different lengths of processed period, i.e. sample sizes of 10–50 annual maxima, were tested. The 5th and 95th percentiles of estimated return levels from the 5,000 samples were computed (for each sample size, rainfall duration and station). Then, they were compared to RLs estimated from the whole available series (“the best estimate”) in order to evaluate the range of deviation of RL estimate that is not exceeded with the probability of 90 % (“RL estimate deviation”). Below, the values of 5th and 95th percentiles are presented as deviation from “the best estimate” in percentage of “the best estimate”.

3 Results

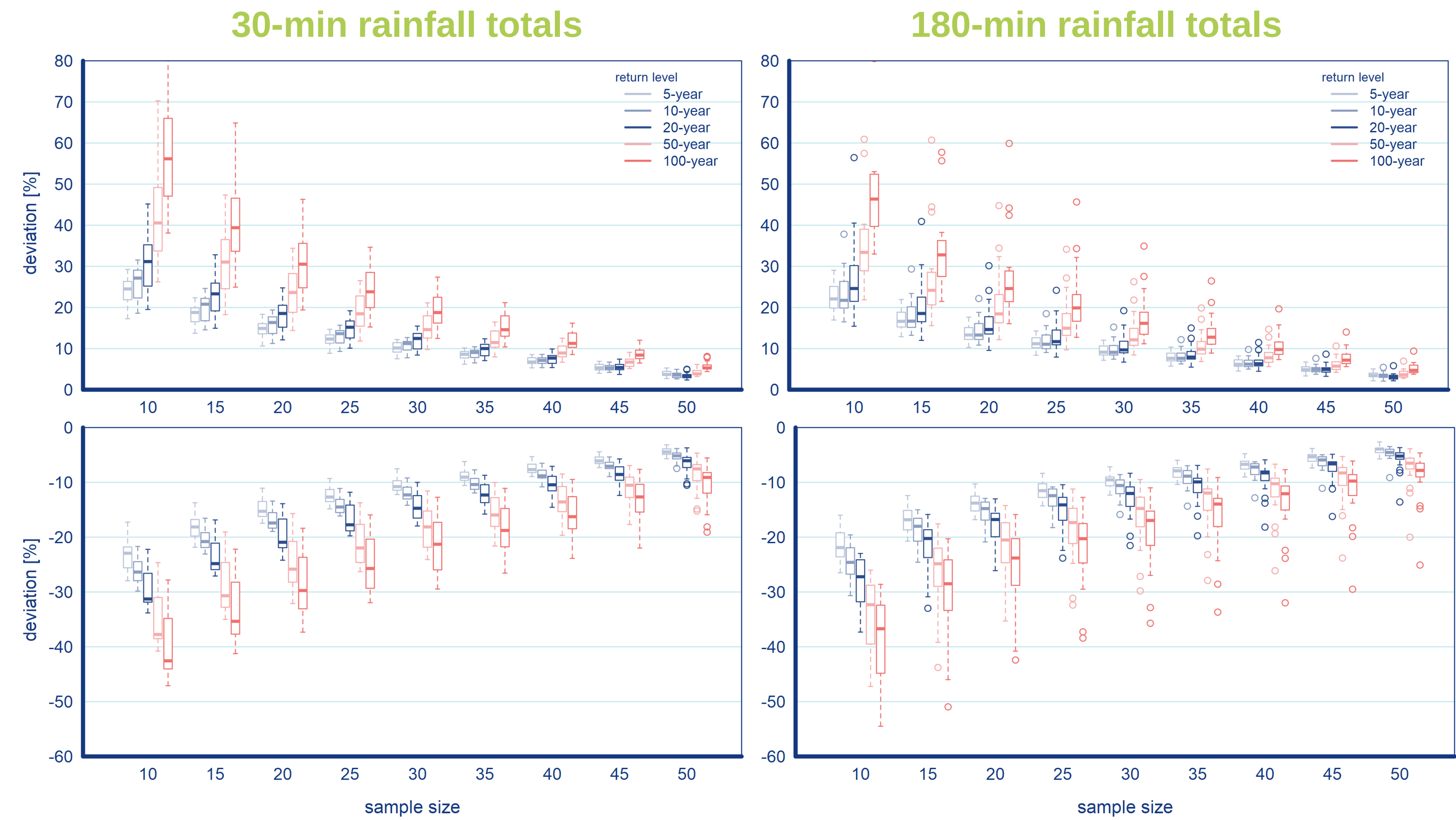


Fig. 2. Boxplots for 5th and 95th percentiles of the estimated return levels from sampling technique (as percentage deviation) calculated from 20 selected stations for 30-min and 180-min rainfall totals. Outlying values are defined as values above 1,5 multiple of the interquartile range above 75th percentile.

Sample size dependence

The increasing “RL estimate deviation” with decreasing sample size is well obvious. The 100-year RL estimates calculated from the smallest sample sizes can strongly differ from the “best estimate”. The “100-year RL estimate deviation” is in most cases (different stations and rainfall durations) greater than 40 % for sample size of 10, 30 % for sample size of 15, 25 % for sample size of 20, 20 % for sample size of 25. For larger sample sizes the “100-year RL estimate deviation” is in most cases smaller than 20 % for sample sizes ≥ 30 . For sample sizes ≥ 45 it is mostly up to 10 %.

Return period dependence

The increasing “RL estimate deviation” with increasing return period is also well obvious especially for small sample sizes.

Table 1. The 5th and 95th percentiles of the estimated return levels from sampling technique (as percentage deviation). The median values (over 20 selected stations and different durations) are given.

		sample size											sample size								
		10	15	20	25	30	35	40	45	50			10	15	20	25	30	35	40	45	50
return period	5-year	-22	-17	-14	-12	-10	-8	-7	-5	-4	return period	5-year	23	17	14	11	9	8	6	5	3
	10-year	-25	-19	-16	-13	-11	-9	-8	-6	-5		10-year	24	18	15	12	10	8	6	5	3
	20-year	-28	-22	-18	-15	-13	-11	-9	-8	-6		20-year	28	21	17	13	11	9	7	5	3
	50-year	-34	-27	-22	-19	-16	-14	-12	-10	-7		50-year	37	27	21	17	13	11	8	6	4
	100-year	-39	-31	-26	-22	-19	-17	-14	-11	-9		100-year	51	35	27	22	17	14	11	8	5

Rainfall duration dependence

The “RL estimate error” seems to be slightly decreasing with increasing rainfall duration in case of all assessed return periods (not shown). This dependence is noticeable especially for small sample sizes.

4 Conclusion

- The dependence of estimated return levels of short-term rainfalls on the length of processed period were studied using sampling technique.
- The increasing “RL estimate deviation” with decreasing sample size is well obvious. The “RL estimate deviation” also strongly depends on estimated return period and slightly on rainfall duration.
- For sample size of 20 (e.g., the length of radar data series) the estimated “100-year RL estimate deviation” exceeded 25 % in most cases, i.e. the 100-year RL estimate can be 25 % higher/lower than “the best estimate” with the probability of 10 %. In case of “10-year RL estimate deviation” it is about 15 %.
- The “RL estimate deviation” considerably varies with an assessed return period, rainfall duration and station and it is difficult to make unequivocal conclusion.

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