November 7, 2013

Example of estimation of probability rainfall

1. Outline of this page

◯ This document introduces the example of estimation of the probability rainfall per day.
◯ In this document, following probability distribution models are used:

1	Gumbel	Gumbel distribution	2 parameters
2	GEV	Generalized Extreme Value distribution	3 parameters
3	Weibull (Goda)	Weibull distribution (L-moments by GODA)	3 parameters
4	Weibull (LSM)	Weibull distribution (Least Square Method)	3 parameters
5	Weibull (MLM)	Weibull distribution (Maximum Likelihood Method)	3 parameters
6	SQRT-ET	SQRT exponential-type distribution of maximum	2 parameters
7	LP3	Log Pearson type III distribution	3 parameters
8	LN3 (Iwai)	Logarithmic Normal distribution (Iwai method: quantile)	3 parameters
9	LN3 (Moment)	Logarithmic Normal distribution (Moment method)	3 parameters
10	LN3 (Trial)	Logarithmic Normal distribution (Trial method)	3 parameters
11	Exponential	Exponential distribution	2 parameters
12	GPD	Generalized Pareto distribution	3 parameters

◯ Cunnane formula is used as a plotting position formula for an observed value plot.
◯ Input data is Anual Maximum Series data of the rainfall per day.
◯ Source data for input samples are following:

- Record of Maximum daily rainfall in Sapporo : http://iss.ndl.go.jp/books/R000000004-I4522177-00
- Record of Maximum daily rainfall in Maebashi : Webpage of Japan Meteorological Agency
- Record of Maximum daily rainfall in Kyoto : ISBN978-4-627-49631-6

(**Notice**)
Note that although Exponential distribution and GPD shall be aplied to the analysis using Peaks Over Threshold data, the same data as other methods are used for these calculation examples.

2. Results of parameter estimation

Sapporo (data: 1883-1997 [except 1888], 114years)

CDF	Estimated parameters				r
Gumbel	(*,a,b)	******	23.2287	54.6021	0.9910
GEV	(k,a,b)	-0.1204	20.5086	53.3511	0.9953
Weibull (Goda)	(k,a,c)	1.2653	41.0969	29.8365	0.9943
Weibull (LSM)	(k,a,c)	1.8362	53.5212	20.0000	0.9818
Weibull (MLM)	(k,a,c)	1.6878	54.0180	20.0000	0.9859
SQRT-ET	(a,b,*)	62.1595	0.6967	******	0.9953
LP3	(a,b,c)	0.0491	70.8151	0.6545	0.9958
LN3 (Iwai)	(a,m,s)	11.8395	3.8956	0.5190	0.9959
LN3 (moment)	(a,m,s)	1.6808	4.0990	0.4372	0.9949
LN3 (trial)	(a,m,s)	8.2000	3.9740	0.4875	0.9958
Exponential	(*,a,c)	******	32.2018	35.8079	0.9911
GPD	(k,a,c)	0.2019	42.6095	32.5574	0.9905

Maebashi (data: 1897-2010, 114years)

CDF	Estimated parameters				r
Gumbel	(*,a,b)	******	30.6850	78.4176	0.9587
GEV	(k,a,b)	-0.1811	25.1676	76.0772	0.9887
Weibull (Goda)	(k,a,c)	1.1211	48.0942	50.0044	0.9721
Weibull (LSM)	(k,a,c)	1.5103	59.8866	41.3000	0.9528
Weibull (MLM)	(k,a,c)	1.3833	60.3496	41.3000	0.9593
SQRT-ET	(a,b,*)	124.5701	0.6175	******	0.9799
LP3	(a,b,c)	0.1244	9.2123	3.3424	0.9872
LN3 (Iwai)	(a,m,s)	34.7338	3.9124	0.6483	0.9860
LN3 (moment)	(a,m,s)	37.0289	3.8600	0.6622	0.9866
LN3 (trial)	(a,m,s)	30.0000	4.0187	0.5909	0.9830
Exponential	(*,a,c)	******	42.5384	53.5906	0.9768
GPD	(k,a,c)	0.0979	48.9890	51.5083	0.9664

Kyoto (data: 1901-2008, 108years)

CDF	Estimated parameters				r
Gumbel	(*,a,b)	******	29.9941	89.3022	0.9710
GEV	(k,a,b)	-0.1593	25.2824	87.2494	0.9883
Weibull (Goda)	(k,a,c)	1.1704	49.1276	60.0933	0.9797
Weibull (LSM)	(k,a,c)	1.6323	63.0903	49.5000	0.9618
Weibull (MLM)	(k,a,c)	1.4936	63.5526	49.5000	0.9676
SQRT-ET	(a,b,*)	259.3959	0.6786	******	0.9849
LP3	(a,b,c)	0.1140	8.6225	3.6260	0.9877
LN3 (Iwai)	(a,m,s)	37.4759	4.0874	0.5426	0.9855
LN3 (moment)	(a,m,s)	38.5954	4.0606	0.5642	0.9864
LN3 (trial)	(a,m,s)	36.5000	4.1043	0.5433	0.9856
Exponential	(*,a,c)	******	41.5806	65.0342	0.9832
GPD	(k,a,c)	0.1348	50.3628	62.2327	0.9743

After this page, some estimation results by bootstrap method are shown as graphs.

Although 5000year probability rainfalls are shown in the graphs, it is not practical to estimate 5000years probability rainfall using original data during about 100years.

These are only for test executions of the Fortran program.

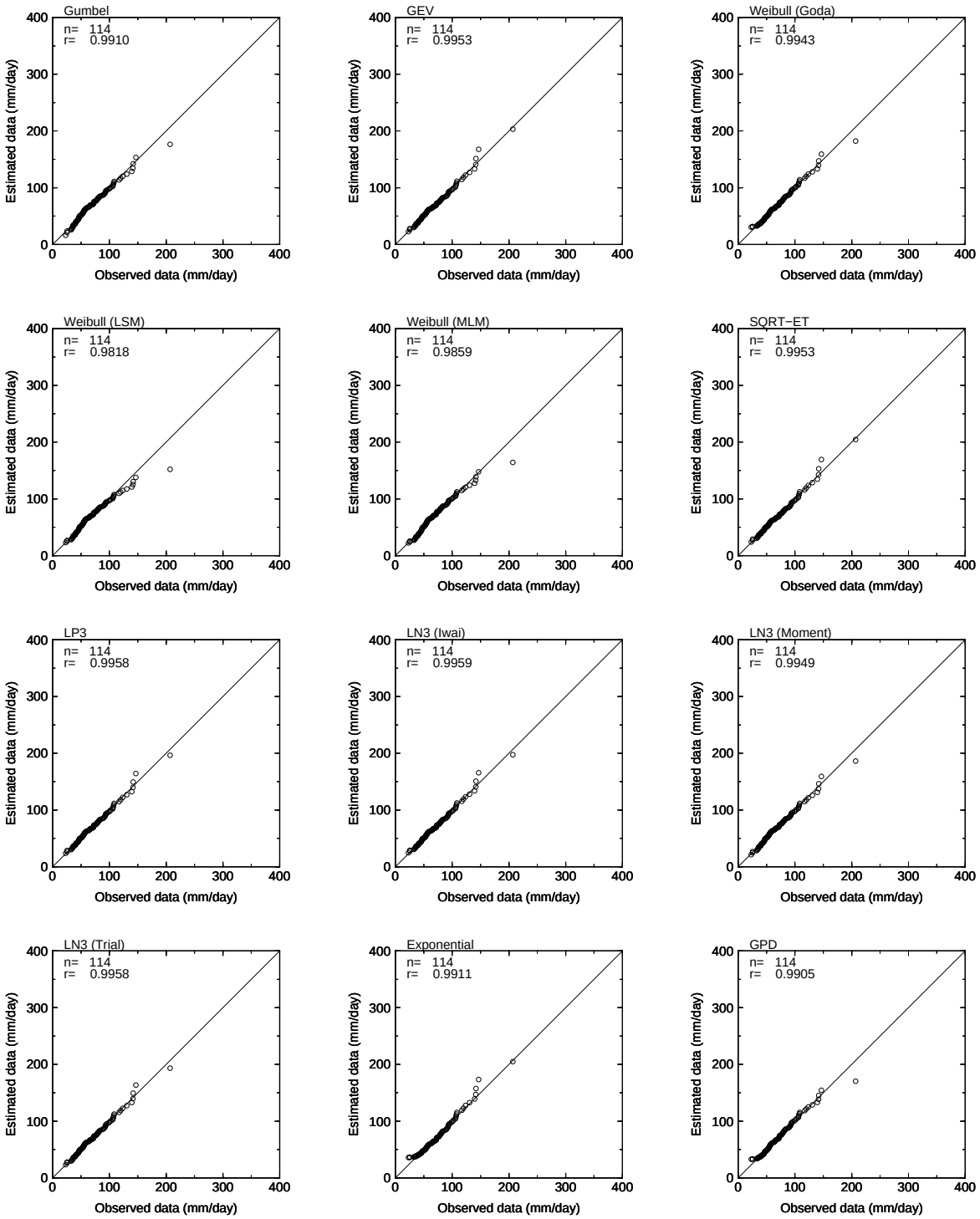


Fig.1 Q-Q plot (Sapporo)

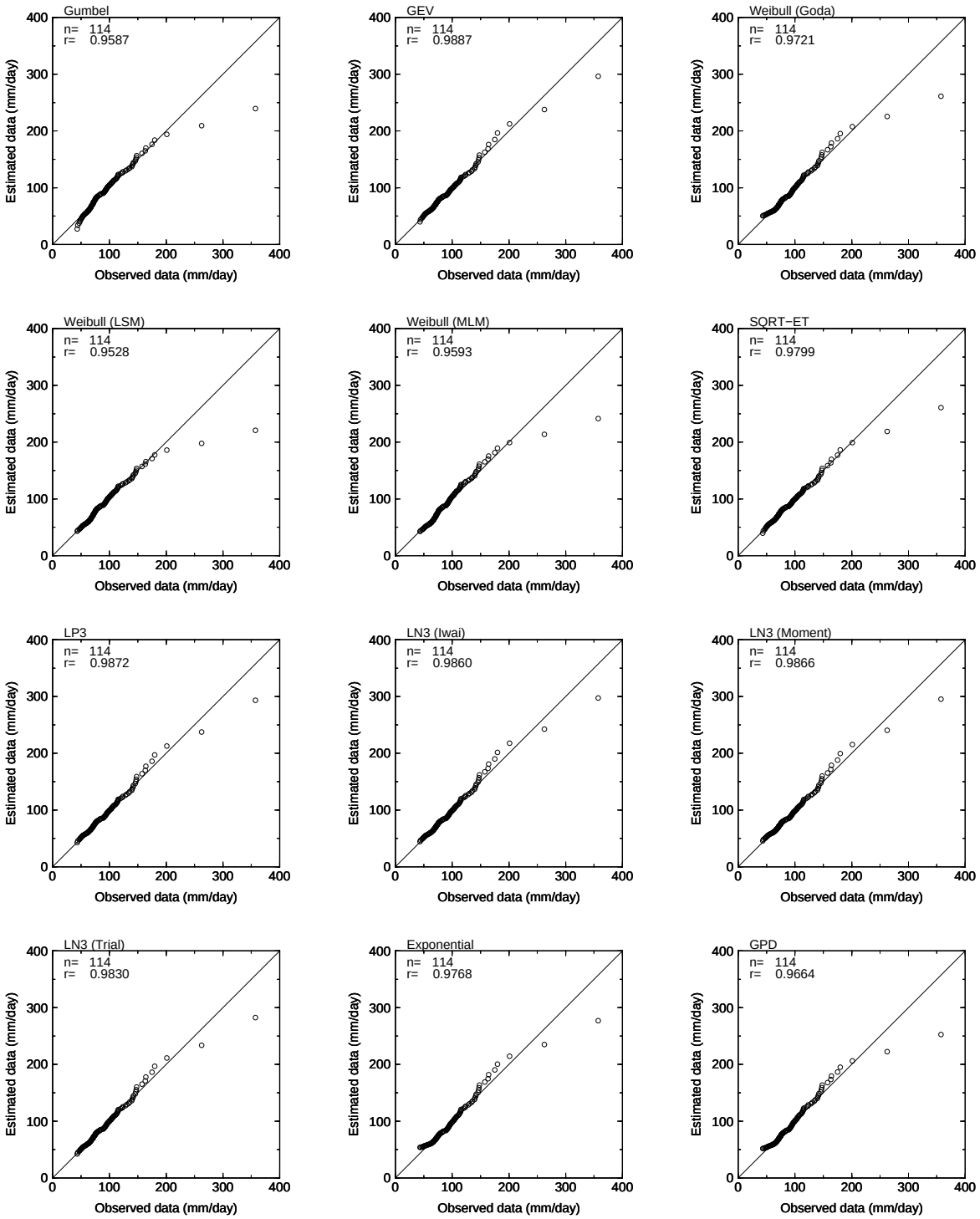


Fig.2 Q-Q plot (Maebashi)

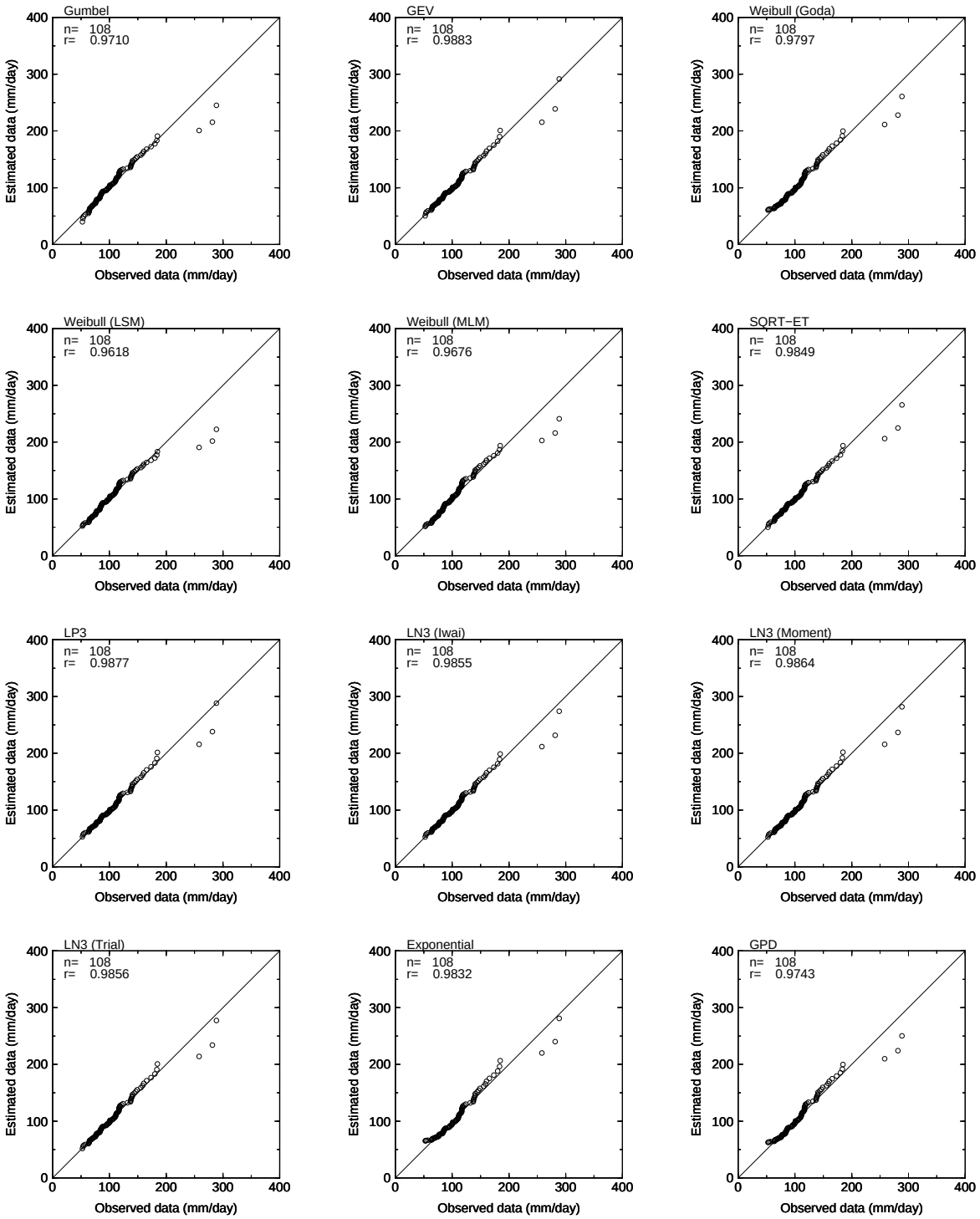
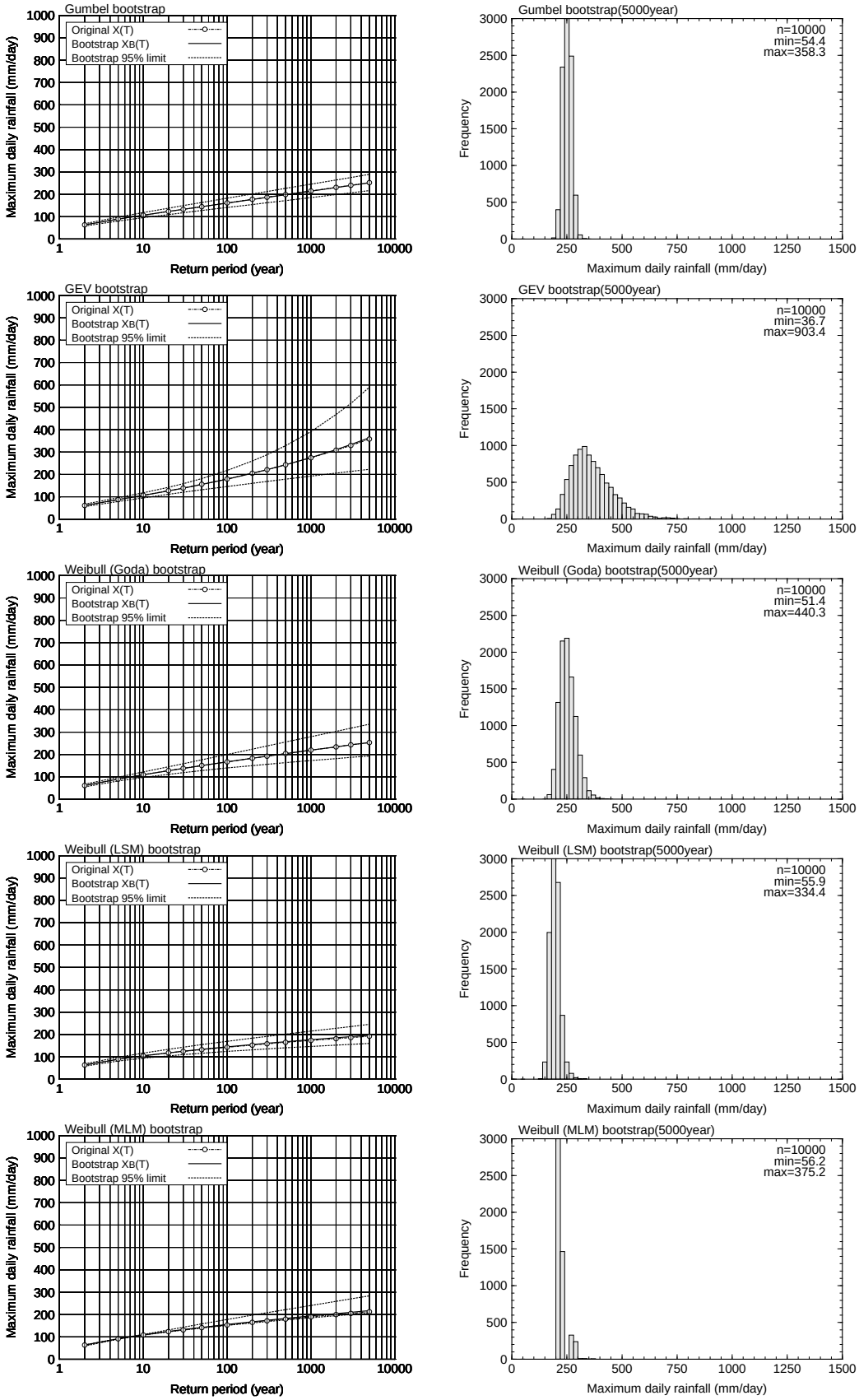


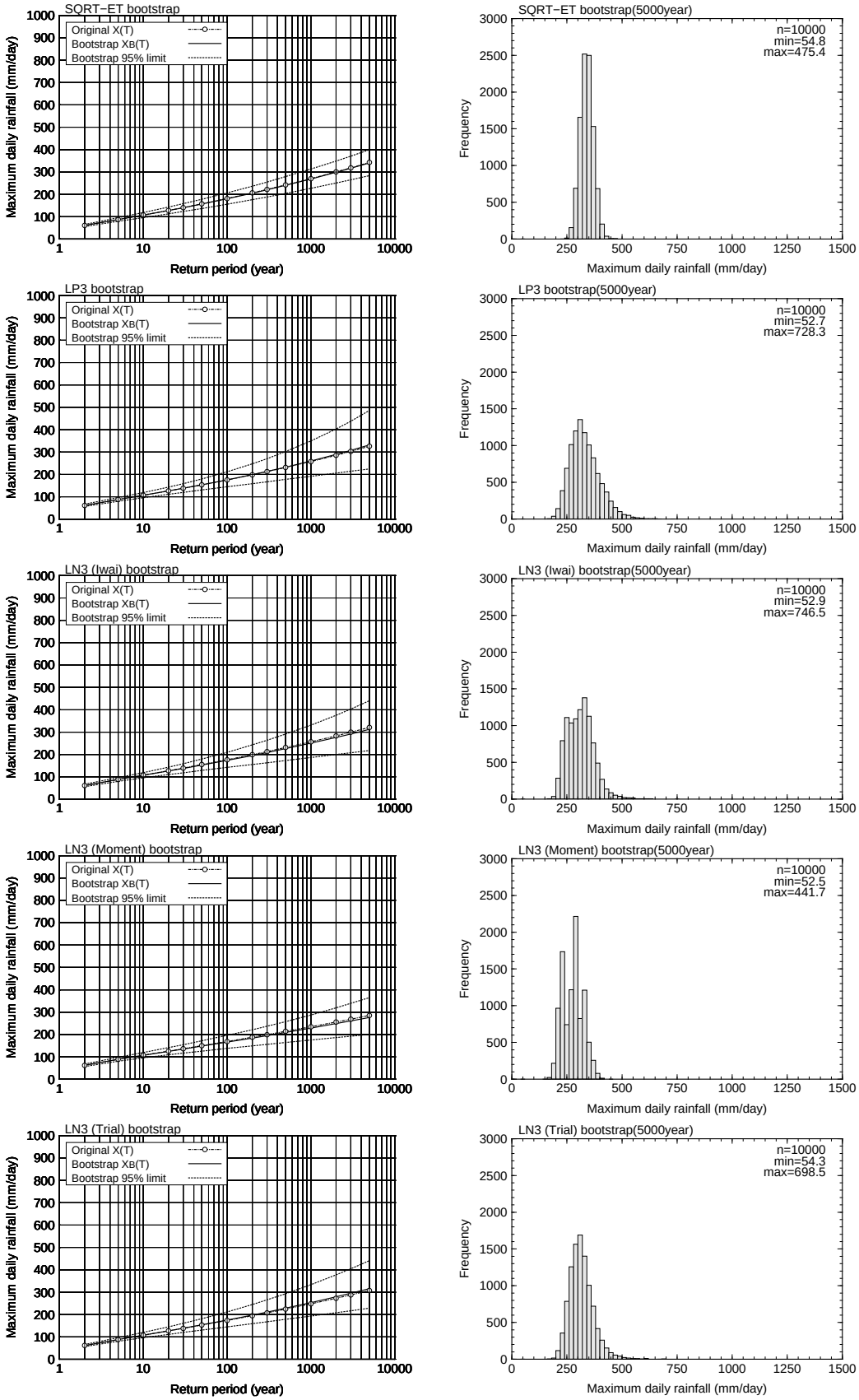
Fig.3 Q-Q plot (Kyoto)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

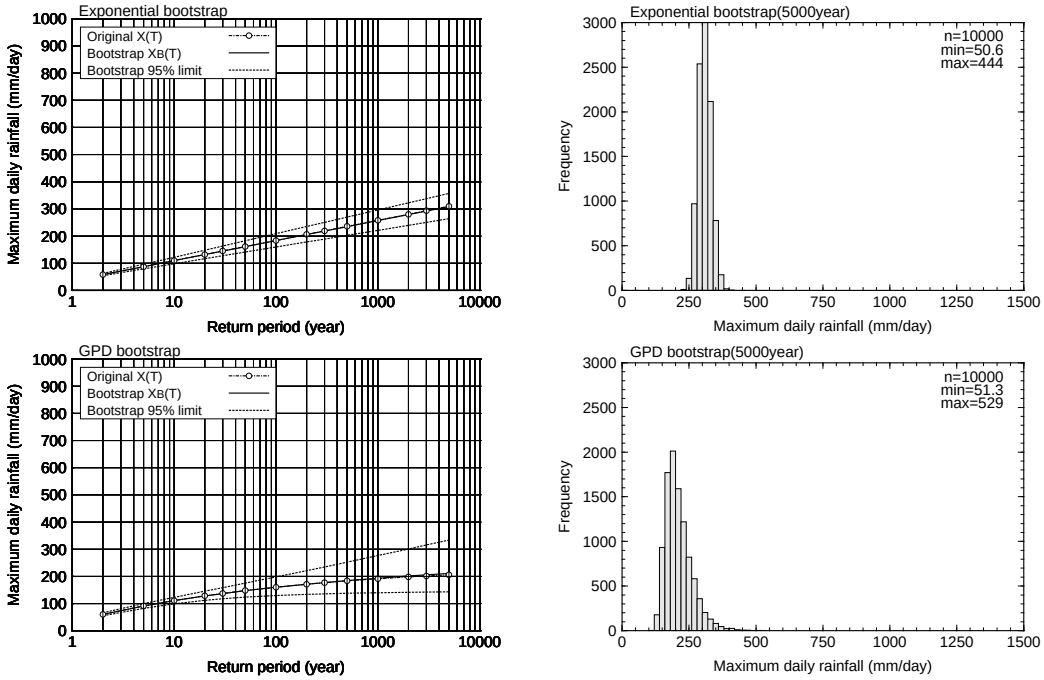
Fig.4 Results of Bootstrap estimation (Sapporo: 1)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

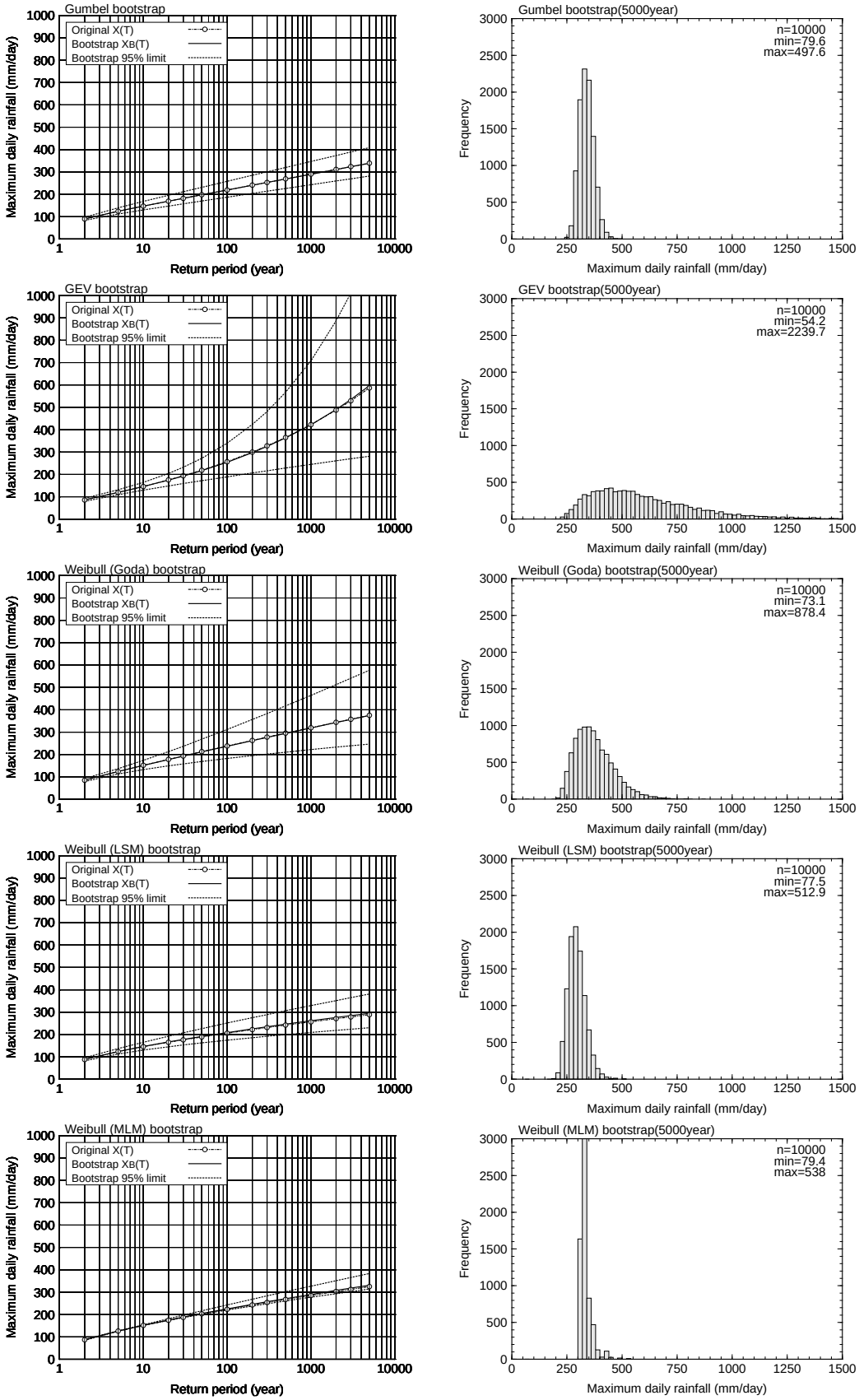
Fig.5 Results of Bootstrap estimation (Sapporo: 2)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

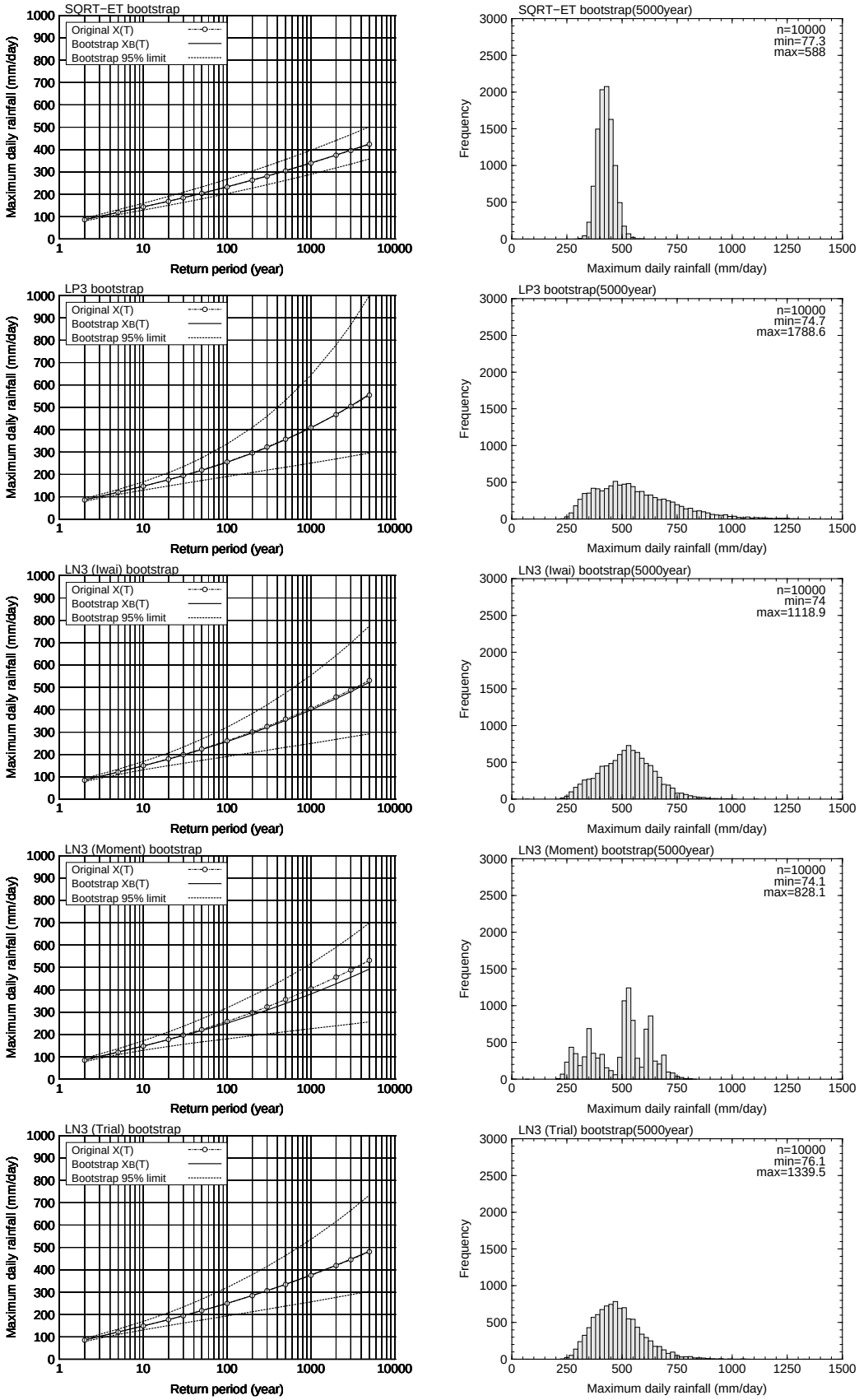
Fig.6 Results of Bootstrap estimation (Sapporo: 3)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

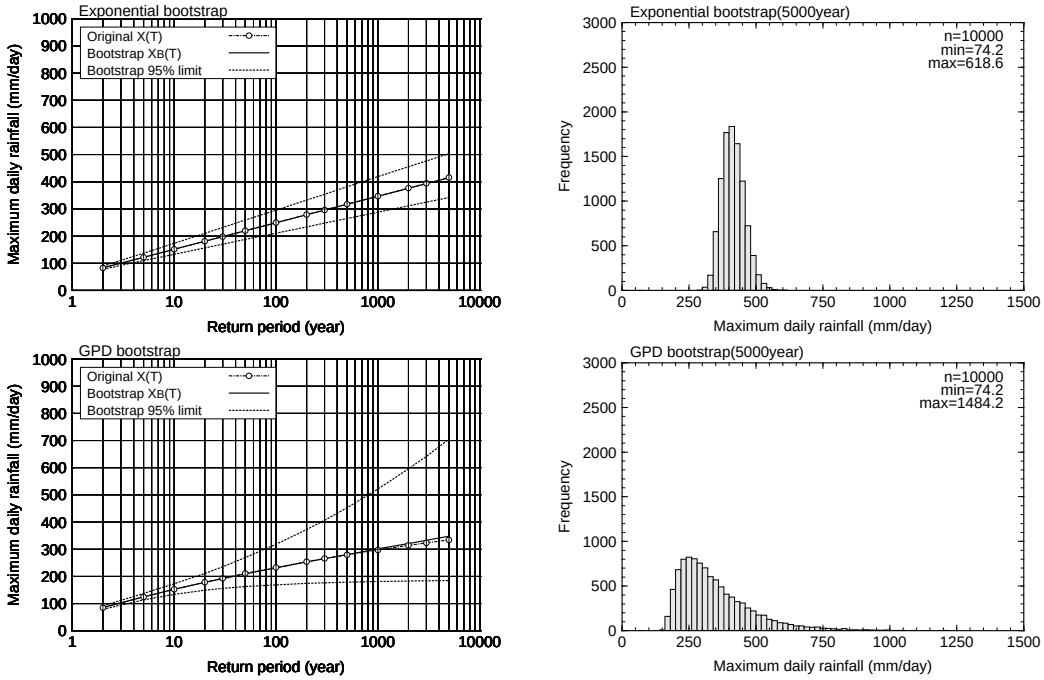
Fig.7 Results of Bootstrap estimation (Maebashi: 1)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

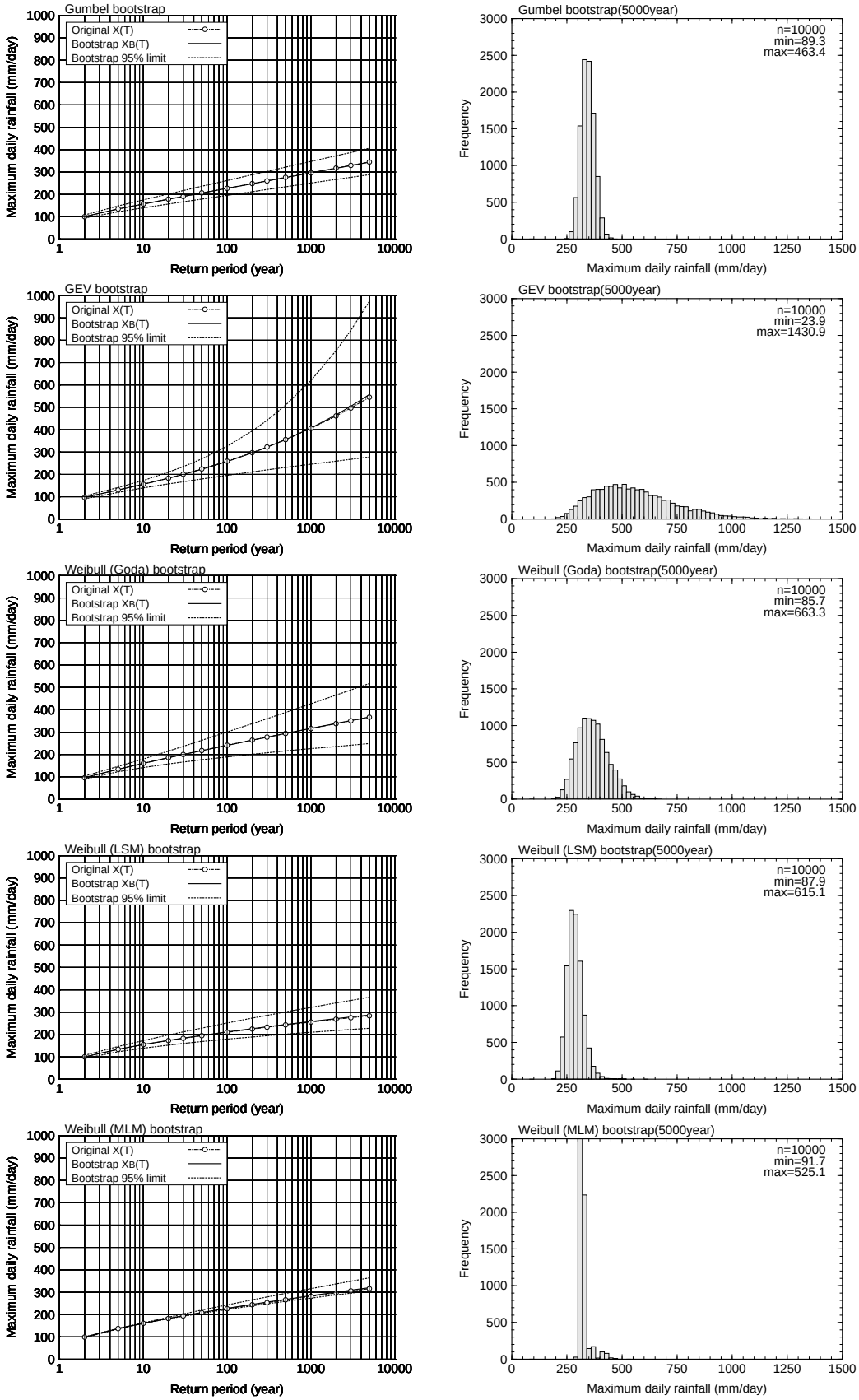
Fig.8 Results of Bootstrap estimation (Maebashi: 2)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

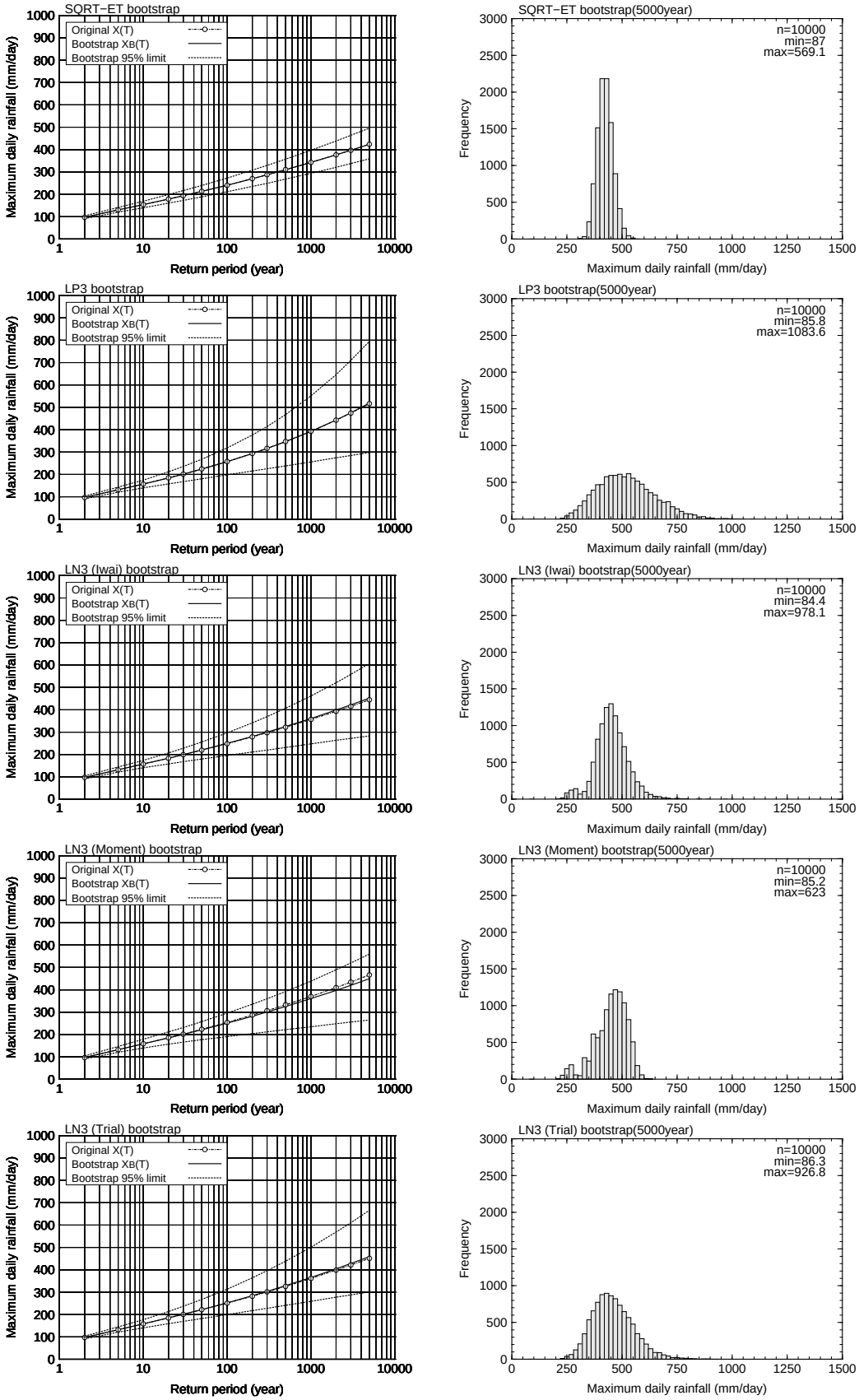
Fig.9 Results of Bootstrap estimation (Maebashi: 3)



Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

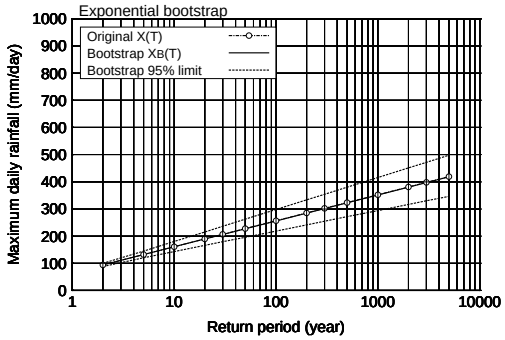
Fig.10 Results of Bootstrap estimation (Kyoto: 1)

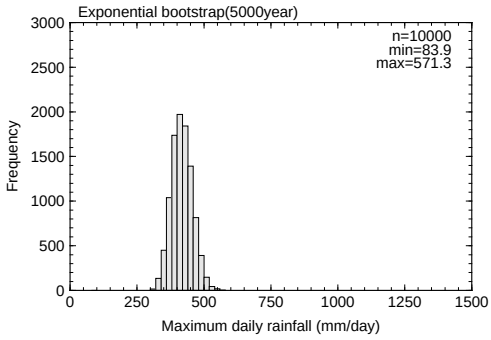


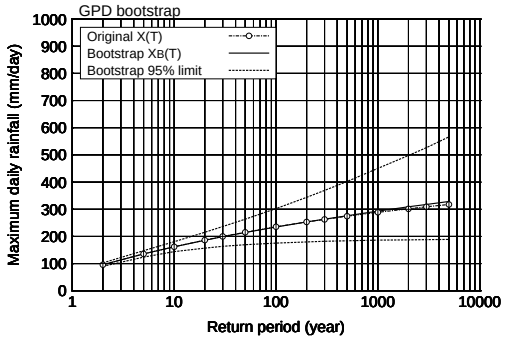
Bootstrap confidence interval (95%)

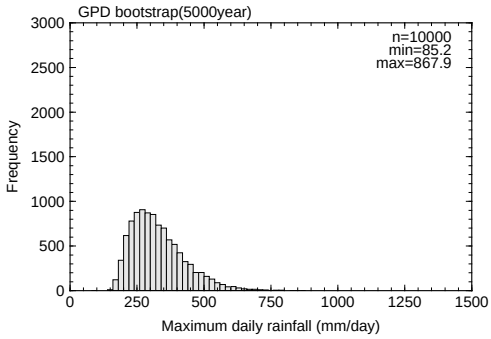
Histogram of bootstrap point estimate for 5000years

Fig.11 Results of Bootstrap estimation (Kyoto: 2)









Bootstrap confidence interval (95%)

Histogram of bootstrap point estimate for 5000years

Fig.12 Results of Bootstrap estimation (Kyoto: 3)