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Supplement of

Uncertainty in nonstationary frequency analysis of South Korea's daily rainfall peak over threshold excesses associated with covariates

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Table S1. Parameter estimation of stationary GP distribution at other sites

Site	Parameter	PWM	MH
Ghangreung	α	30.4736	30.6887
	k	-0.2770	-0.2885
	nllh	1256.9933	1257.0521
Incheon	α	34.1123	35.2850
	k	-0.1391	-0.1294
	nllh	1112.4150	1112.4106
Chupuryeong	α	28.5773	27.6439
	k	-0.0319	-0.0836
	nllh	819.7220	819.7751
Pohang	α	28.4154	28.1192
	k	-0.1627	-0.1845
	nllh	859.2326	859.2515
Daegu	α	29.5569	28.6007
	k	-0.0310	-0.0850
	nllh	755.3478	755.5559
Jeonju	α	26.9367	27.8984
	k	-0.1330	-0.1234
	nllh	970.8081	970.7840
Ulsan	α	28.3941	28.3681
	k	-0.2111	-0.2362
	nllh	1171.6912	1171.7828
Ghangju	α	32.1973	30.5867
	k	-0.0325	-0.0930
	nllh	1238.0525	1237.7390
Mokpo	α	28.7419	27.6156
	k	-0.0736	-0.1334
	nllh	965.3405	965.4393
Yeosu	α	31.2253	32.0783
	k	-0.1524	-0.1435

	nllh	1453.0901	1453.0880
Juju	α	40.6917	42.0497
	k	-0.1403	-0.1348
	nllh	1174.6091	1174.5951

Table S2. Uncertainty of stationary and non-stationary frequency analysis

Site	Factor	Parameter	Stationary	Non-stationary	
				(DPT-based)	(SAT-based)
Ghangreung	m-factor	α_1	0.3875	0.3381	0.3791
		α_2		0.6456	0.6974
		α		0.3678	0.3689
		k		0.9696	0.8855
	h-factor	100-yr	1.0579	0.6762 (1.3801)	0.55849 (1.2638)
Seoul	m-factor	α_1	0.3407	0.7127	0.7076
		α_2		0.8588	0.9796
		α		0.3349	0.3021
		k		1.5613	0.8021
	h-factor	100-yr	0.7421	0.5331 (1.0273)	0.43832 (0.9335)
Incheon	m-factor	α_1	0.4087	0.7131	0.7591
		α_2		0.8758	1.1438
		α		0.3297	0.3886
		k		1.6575	1.6657
	h-factor	100-yr	0.8196	0.4713 (0.9679)	0.6093 (0.9677)
Chupungryeong	m-factor	α_1	0.3515	0.8080	0.8261
		α_2		1.3008	1.8752
		α		0.3499	0.3655
		k		2.0368	2.1806
	h-factor	100-yr	0.5200	0.4482 (0.8598)	0.54444 (0.8230)
Pohang	m-factor	α_1		0.8035	0.9505
		α_2		1.1251	1.6701

		α	0.4143	0.3579	0.4149
		k	1.4735	1.0175	1.2074
	h-factor	100-yr	0.7113	0.5227 (1.0389)	0.6169 (1.0144)
Daegu	m-factor	α_1	0.3832	0.8745	0.8512
		α_2		1.1773	2.0205
		α		0.3517	0.3718
		k		1.8217	1.8478
	h-factor	100-yr	0.4910	0.3437 (0.7596)	0.4207 (0.6998)
Jeonju	m-factor	α_1	0.3881	0.9989	0.9155
		α_2		1.1253	1.2628
		α		0.3779	0.3978
		k		1.7234	1.7513
	h-factor	100-yr	0.6043	0.5273 (0.9540)	0.5794 (0.9256)
Ulsan	m-factor	α_1	0.3878	0.7192	0.8763
		α_2		1.5050	1.7133
		α		0.3846	0.3947
		k		1.1898	1.1694
	h-factor	100-yr	1.0592	0.7304 (1.0903)	0.6912 (1.0305)
Gwangju	m-factor	α_1	0.3046	0.7866	0.7516
		α_2		1.2788	2.0357
		α		0.2947	0.3111
		k		1.8203	1.5323
	h-factor	100-yr	0.4093	0.4290 (0.7991)	0.4093 (0.6730)

Busan	m-factor	α_1	0.3278	0.5463	0.6363
		α_2		0.8700	1.0570
		α		0.2920	0.3319
		k		1.5717	1.6513
	h-factor	100-yr	0.7595	0.4771 (1.0274)	0.4390 (0.9273)
Mokpo	m-factor	α_1	0.3841	0.7528	0.5806
		α_2		2.4953	2.7306
		α		0.3823	0.3953
		k		1.8768	1.5854
	h-factor	100-yr	0.7428	0.5121 (0.7114)	0.4494 (0.5628)
Yeosu	m-factor	α_1	0.3424	0.6458	0.7046
		α_2		0.7659	0.9428
		α		0.2979	0.3191
		k		1.7258	1.8294
	h-factor	100-yr	0.6175	0.4021 (1.1322)	0.4556 (1.0251)
Jeju	m-factor	α_1	0.3938	0.6135	0.7120
		α_2		0.6645	0.8296
		α		0.3234	0.3344
		k		1.8819	1.5639
	h-factor	100-yr	0.9153	0.4480 (1.1041)	0.4986 (1.1215)

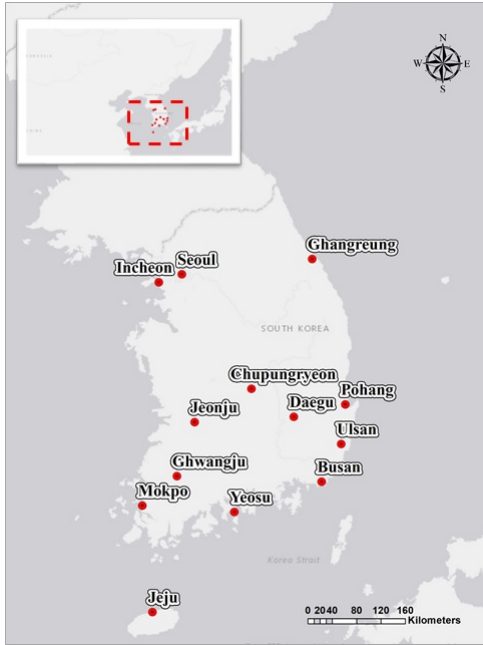


Figure S1. Location of study sites.

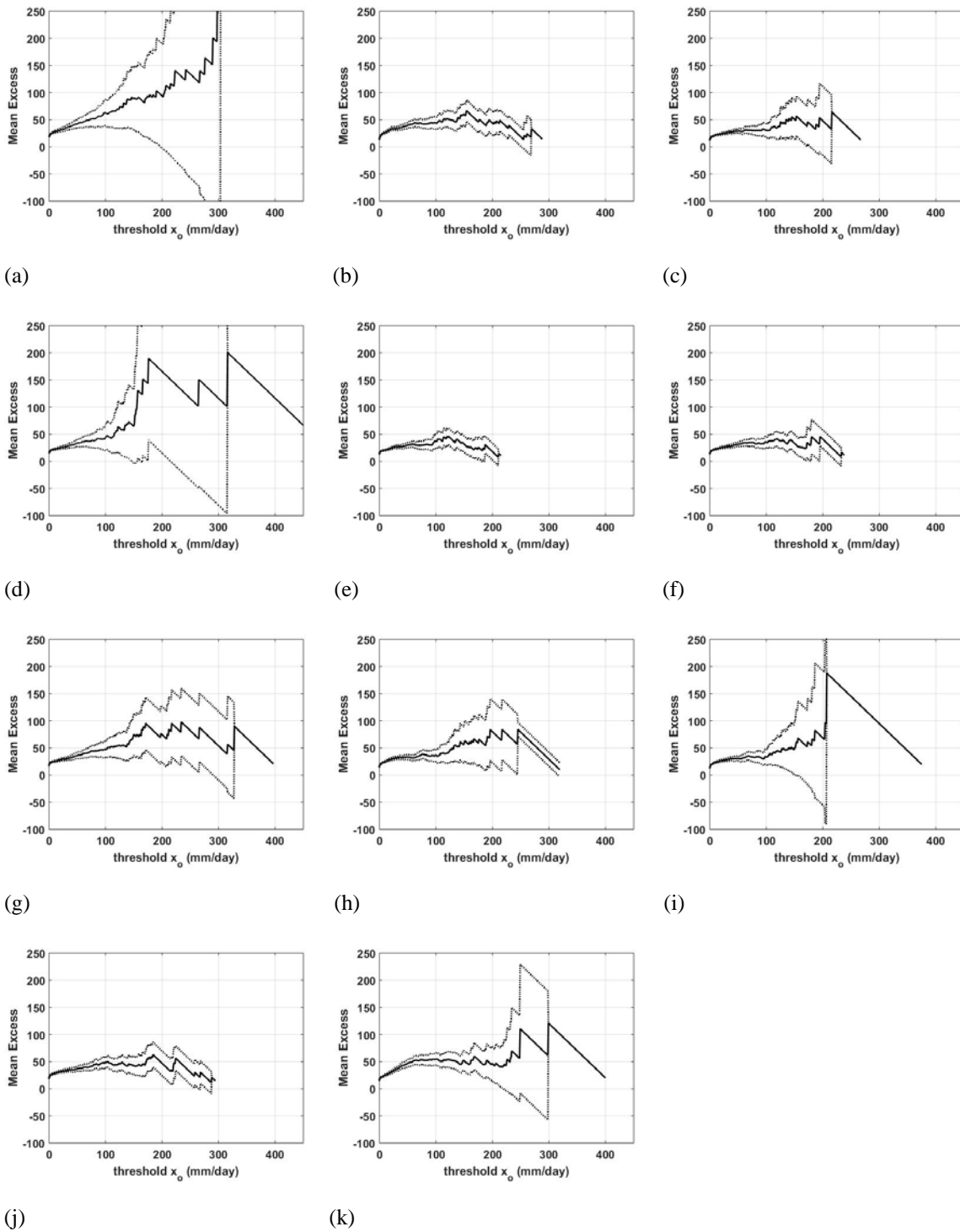


Figure S2. Mean residual life plot at (a) Ghangreung, (b) Incheon, (c) Chupungryeong, (d) Pohang, (e) Daegu, (f) Jeonju, (g) Ulsan, (h) Gwangju, (i) Mokpo, (j) Yeosu and (k) Jeju sites.

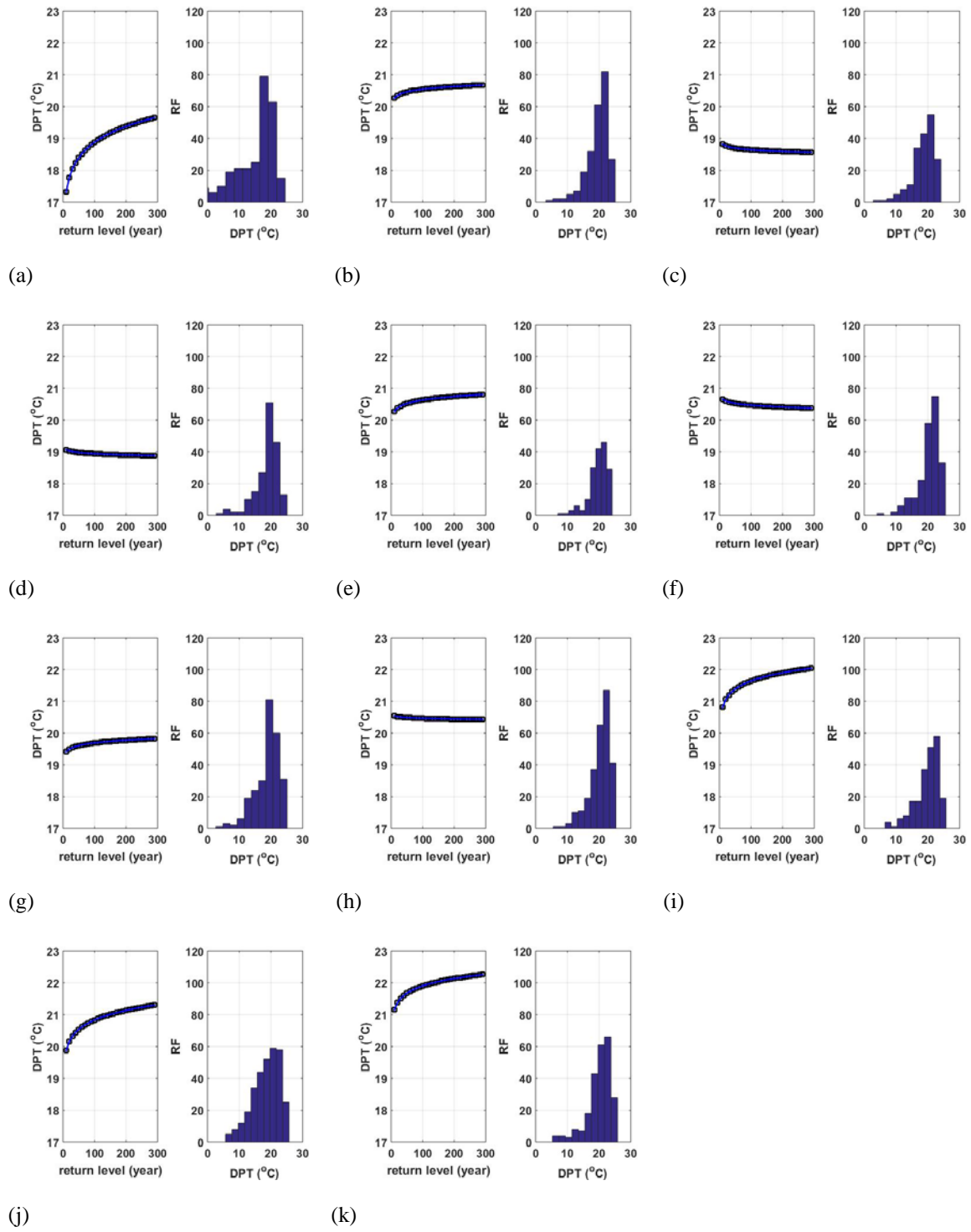
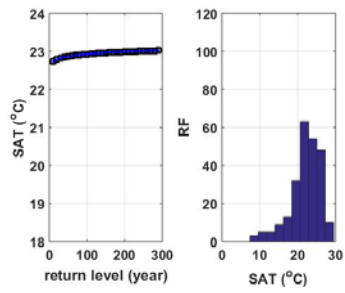


Figure S3. Selection of reference dew-point temperature for estimating rainfall quantiles at (a) Ghangreung, (b) Incheon, (c) Chupungryeong, (d) Pohang, (e) Daegu, (f) Jeonju, (g) Ulsan, (h) Gwangju, (i) Mokpo, (j) Yeosu and (k) Jeju sites. In this figure, 'RF' refers to the empirical relative frequency of DPT on the day of POT excess.



(m)

Figure S4. Selection of reference surface air temperature for estimating rainfall quantiles at (a) Ghangreung, (b) Seoul, (c) Incheon, (d) Chupungryeong, (e) Pohang, (f) Daegu, (g) Jeonju, (h) Ulsan, (i) Gwangju, (j) Busan, (k) Mokpo, (l) Yeosu and (m) Jeju sites. In this figure, 'RF' refers to the empirical relative frequency of SAT on the day of POT excess.