Supplement A. Example of intentionally biased bootstrapping (IBB) and block-wise modeling

In the current example, the simulation procedure for monthly precipitation is presented with the IBB temperature for Station 1 (Sokcho) in South Korea instead of weekly due to simplicity. Assume that the monthly precipitation is generated with the condition of +0.5℃ increase. The explained procedure in section 2.4 is applied each month, and the procedure of month 1 is mainly presented as follows.

(1) The observed monthly temperature and precipitation are obtained as in Table S1 and Table S2, respectively.

(2) From the observed data, the temperature data are increasingly ordered at each month as shown in Table S3.

(3) The monthly precipitation data in Table S2 are rearranged in the same order as the ordered temperature data in Table S3 for each month (see Table S4 for the rearranged monthly precipitation). For example, -3.4 is the smallest for month 1 in the first value of the ordered temperature in month 1, 1977 as shown in the second column of Table S3. Subsequently, the monthly precipitation of 20.2 in 1977 for month 1 (see Table S2) is arranged for the first value of the rearranged monthly precipitation as shown in the second column of Table S4.

(4) The weight order (r) is estimated with the Harmony Search algorithm to resample the monthly temperature data with a +5℃ increase and the objective function of Eq. (6) at each month. The estimated weight orders are presented below.

r	1	2	3	4	5	6	7	8	9	10	11	12
	0.53	0.45	0.61	0.77	0.8	0.65	0.46	0.62	1.34	0.85	0.65	0.53

(5) With the weight order, the probability that the data are subjected to be selected is estimated as $\frac{1}{\Psi_r} S_{i,n}^r$ for i=1,…, n.

In the fourth column of Table S5, the scaled weight $\frac{1}{\Psi_r} S_{i,n}^r$ is presented. For example, the first value is estimated as $(S_{i,n})^r/\Psi_r$=(1/33)^0.53/22.106=0.159 /22.106=0.007. The scaled weights are accumulated and shown in the fifth column of Table S5.

(6) Using the uniform random number as shown in the sixth column of Table S5, one of the 33 time indices is selected. For example, if the random number is 0.326 as in the first value of the sixth column, then time index 16 is selected because the accumulated scaled weights of the 15th and 16th orders (see the fifth column of Table S5) are 0.308 and 0.339, respectively. Note that a higher order between the two orders is always selected when the generated uniform random is between two accumulated scaled weights (here, 0.308 and 0.339).

(7) As shown in the eighth column of Table S5, the monthly precipitation of month 1 is sampled with the selected time index shown in the seventh column of Table S5. For example, the 16th order of the rearranged precipitation shown in Table S4 is 28.4 mm, and this value is selected for the first value in the eighth column of Table S5, which is the resampled monthly precipitation regarding the condition of the +0.5℃ increase in temperature.

(8) Steps (6)-(7) are repeated for all the months as in the sixth, seventh and eight columns of Table S5.

(9) Steps (6)-(8) are repeated until all 100 series are simulated.

Table S1. Observed monthly temperature of station 1 (Sokcho) in South Korea

Temp	mon1	mon2	mon3	mon4	mon5	mon6	mon7	mon8	mon9	mon10	mon11	mon12
1976	-0.5	3.1	6.0	11.5	16.8	19.1	22.1	22.3	19.1	14.7	6.5	2.3
1977	-3.4	-0.1	4.9	10.8	15.5	18.0	23.9	22.9	20.3	16.7	8.4	4.8
1978	0.1	-0.9	5.7	12.2	17.0	20.5	24.6	25.1	20.1	14.7	9.5	4.3
1979	3.2	3.6	7.2	11.1	16.4	20.2	22.8	24.2	19.5	16.5	8.4	4.7
1980	-0.7	-0.3	5.5	9.8	17.8	21.5	21.0	20.8	19.1	13.5	10.3	-0.4
1981	-2.9	-0.1	4.3	11.7	14.7	17.2	23.8	23.2	18.7	14.5	5.8	3.0
1982	-0.9	0.7	6.0	10.9	16.4	19.7	22.9	24.2	19.9	15.9	9.1	2.6
1983	0.8	-0.5	4.1	12.0	16.4	17.4	21.3	24.4	20.7	14.7	8.3	1.9
1984	-2.9	-1.8	3.2	7.5	14.3	20.1	22.7	25.3	19.8	14.7	10.1	1.7
1985	-2.4	1.7	5.0	11.2	16.0	18.7	24.7	24.7	19.9	15.4	7.4	0.1
1986	-2.5	-2.0	3.2	10.3	15.1	16.9	19.5	22.9	18.5	12.6	7.7	4.2
1987	0.2	1.6	4.6	11.3	17.1	20.0	23.5	22.3	18.8	15.5	8.1	3.9
1988	1.1	-0.4	4.6	12.7	16.9	19.5	21.3	24.4	20.1	15.8	7.9	3.5
1989	1.5	2.7	5.9	12.4	16.5	17.9	21.0	22.7	19.4	14.4	8.0	3.5
1990	-1.4	2.6	6.9	10.5	16.1	19.2	21.4	24.7	19.3	15.1	11.1	3.1
1991	-0.6	0.0	4.1	10.7	15.3	21.0	23.3	21.7	19.9	14.4	8.6	4.0
1992	1.8	2.1	5.7	12.0	14.8	18.7	24.7	22.2	20.4	14.1	8.4	3.6
1993	0.2	2.5	5.7	11.0	15.2	17.1	19.7	21.3	20.2	14.2	9.8	2.6
1994	0.5	1.7	4.6	11.8	17.2	19.4	26.8	26.0	20.8	14.8	10.0	3.7
1995	0.1	2.1	5.2	11.5	15.8	17.7	23.9	25.4	19.4	15.6	8.4	1.1
1996	-0.4	0.1	4.0	11.2	14.2	18.0	22.0	23.0	20.2	14.5	7.4	3.8
1997	-0.4	2.0	7.0	12.7	16.2	19.8	24.2	24.7	18.4	14.3	9.5	3.0
1998	-0.1	2.8	8.6	13.4	17.0	18.4	21.6	23.1	21.1	16.8	8.9	4.6
1999	1.8	3.0	5.6	11.5	17.0	20.8	23.1	23.3	21.5	14.9	9.3	3.1
2000	-0.4	-0.1	6.8	11.2	14.2	19.2	24.8	24.0	18.6	14.4	7.7	3.2
2001	-2.3	1.2	5.6	12.2	17.3	20.1	23.4	22.4	19.9	15.9	8.7	1.4
2002	0.8	4.2	8.6	12.2	15.6	19.5	21.8	22.7	19.1	13.0	5.1	1.2
2003	-1.6	1.6	4.5	11.0	14.8	20.3	20.8	22.5	19.6	14.1	9.3	2.9
2004	0.5	3.6	6.9	12.7	16.6	20.8	23.8	23.1	20.1	14.8	10.6	4.2
2005	-0.1	-0.8	4.2	12.8	14.4	20.6	24.1	25.0	19.9	15.0	9.8	-1.5
2006	0.3	1.5	5.9	9.5	14.4	18.3	21.0	25.2	19.1	17.1	8.5	2.0
2007	0.8	4.1	6.6	11.7	17.1	20.3	22.0	25.0	20.6	15.2	8.4	3.5
2008	0.3	1.2	7.3	13.1	16.8	18.7	25.3	23.4	20.6	16.8	9.0	3.6

Table S2. Observed monthly precipitation of station 1 (Sokcho) in South Korea

Precip	1	2	3	4	5	6	7	8	9	10	11	12
1976	0.1	208.3	43.7	52.6	10.3	76.2	89.1	602.7	68.3	67.2	45.1	102.6
1977	20.2	25.0	55.7	238.3	33.2	68.0	174.7	100.3	120.8	67.1	159.1	49.6
1978	112.9	81.4	85.2	32.2	22.5	266.9	172.1	232.5	99.4	284.3	54.1	158.8
1979	142.3	58.7	88.2	126.0	117.0	289.1	181.0	206.0	43.9	52.3	0.0	8.6
1980	43.0	6.0	89.8	147.7	22.9	79.4	271.3	208.3	114.0	16.3	8.5	15.3
1981	16.8	18.1	63.6	81.4	151.7	74.7	333.5	177.8	405.7	10.3	81.2	1.5
1982	45.9	48.2	39.8	45.7	137.8	44.2	163.1	392.9	6.9	23.3	146.7	5.5
1983	19.6	9.7	85.4	62.2	33.9	125.7	300.4	246.3	148.6	111.8	21.9	31.0
1984	18.3	31.5	6.8	85.1	68.2	96.7	289.9	371.8	650.8	6.7	73.0	42.9
1985	1.6	38.7	42.6	62.5	162.0	54.3	60.3	293.7	180.7	216.7	39.2	31.8
1986	58.3	25.4	28.6	60.4	23.1	110.5	180.7	474.6	188.0	169.2	10.8	49.0
1987	14.4	95.0	63.5	48.5	95.3	123.9	207.3	383.8	55.9	63.5	130.9	8.9
1988	4.5	52.7	38.0	14.7	50.9	75.6	202.1	84.2	308.5	56.2	39.8	0.7
1989	165.9	65.3	121.7	6.2	66.8	109.9	221.2	277.7	156.4	163.0	123.0	103.0
1990	81.9	170.6	86.8	120.4	79.8	236.6	262.8	110.5	596.4	90.6	143.6	31.7
1991	18.2	25.3	48.6	36.7	77.5	15.2	250.7	148.2	129.4	18.4	14.6	225.9
1992	86.1	45.2	75.6	108.7	130.9	63.3	161.0	403.7	256.3	122.2	38.2	65.2
1993	79.0	89.4	37.7	95.8	111.3	192.3	286.1	329.4	46.4	16.0	106.4	15.5
1994	71.7	43.4	4.2	25.3	94.8	69.3	86.6	236.9	37.8	280.1	143.2	15.9
1995	11.0	45.0	110.4	27.3	18.1	107.0	176.6	441.7	142.7	6.4	8.8	2.5
1996	23.5	114.2	75.1	64.9	20.2	356.5	189.4	200.0	42.0	77.7	66.0	20.1
1997	59.9	34.4	43.6	45.4	355.6	113.0	73.3	60.3	322.4	39.7	153.9	101.0
1998	47.6	69.0	12.6	101.2	67.2	199.0	550.6	376.5	175.0	81.9	65.6	51.5
1999	1.1	4.2	55.8	158.5	167.6	78.8	152.1	515.2	431.4	76.6	78.3	2.4
2000	90.2	8.4	8.7	23.4	71.0	175.7	109.2	440.3	347.2	7.0	58.3	5.8
2001	37.6	64.4	24.0	14.1	7.2	126.6	233.3	56.9	311.5	234.9	36.7	20.2
2002	87.1	0.6	14.1	58.5	78.2	66.5	301.4	531.1	226.0	42.8	4.0	140.0
2003	34.7	63.0	56.8	136.1	113.0	132.1	258.0	349.2	425.4	51.6	278.2	1.8
2004	25.0	26.7	1.8	104.4	46.7	99.7	554.0	460.3	200.1	16.9	39.5	12.2
2005	28.4	52.4	102.5	47.9	122.7	151.2	185.2	246.9	263.9	114.9	38.4	0.4
2006	34.5	18.3	9.3	90.2	141.7	129.0	545.0	109.3	112.4	285.5	84.0	47.4
2007	23.3	7.2	112.6	27.4	102.1	52.3	212.8	206.8	397.8	87.3	33.9	1.2
2008	66.6	0.6	103.9	13.5	70.0	91.3	361.6	343.1	129.9	73.5	78.5	78.0

Table S3. Increasingly ordered monthly temperature of Station 1 (Sokcho) in South Korea

Mon /Ord.	1	2	3	4	5	6	7	8	9	10	11	12
1	-3.4	-2	3.22	7.48	14.2	16.9	19.5	20.8	18.4	12.6	5.07	-1.5
2	-2.9	-1.8	3.23	9.53	14.2	17.1	19.7	21.3	18.5	13	5.83	-0.4
3	-2.9	-0.9	3.97	9.83	14.3	17.2	20.8	21.7	18.6	13.5	6.52	0.08
4	-2.5	-0.8	4.09	10.3	14.4	17.4	21	22.2	18.7	14.1	7.38	1.07
5	-2.4	-0.5	4.15	10.5	14.4	17.7	21	22.3	18.8	14.1	7.4	1.17
6	-2.3	-0.4	4.18	10.7	14.7	17.9	21	22.3	19.1	14.2	7.72	1.39
7	-1.6	-0.3	4.25	10.8	14.8	18.0	21.3	22.4	19.1	14.3	7.73	1.71
8	-1.4	-0.1	4.53	10.9	14.8	18.0	21.3	22.5	19.1	14.4	7.94	1.94
9	-0.9	-0.1	4.62	11	15.1	18.3	21.4	22.7	19.1	14.4	8.04	2.01
10	-0.7	-0.1	4.62	11	15.2	18.4	21.6	22.7	19.3	14.4	8.14	2.25
11	-0.6	0.03	4.63	11.1	15.3	18.7	21.8	22.9	19.4	14.5	8.31	2.59
12	-0.5	0.1	4.92	11.2	15.5	18.7	22.0	22.9	19.4	14.5	8.36	2.61
13	-0.4	0.73	5.0	11.2	15.6	18.7	22.0	23.0	19.5	14.7	8.36	2.92
14	-0.4	1.2	5.23	11.2	15.8	19.1	22.1	23.1	19.6	14.7	8.42	2.97
15	-0.4	1.22	5.53	11.3	16	19.2	22.7	23.1	19.8	14.7	8.44	2.99
16	-0.1	1.48	5.57	11.5	16.1	19.2	22.8	23.2	19.9	14.7	8.44	3.09
17	-0.1	1.58	5.62	11.5	16.2	19.4	22.9	23.3	19.9	14.8	8.5	3.1
18	0.09	1.64	5.66	11.5	16.4	19.5	23.1	23.4	19.9	14.8	8.59	3.25
19	0.1	1.68	5.68	11.7	16.4	19.5	23.3	24.0	19.9	14.9	8.72	3.5
20	0.17	1.75	5.72	11.7	16.4	19.7	23.4	24.2	19.9	15.0	8.91	3.51
21	0.23	2.04	5.87	11.8	16.5	19.8	23.5	24.2	20.1	15.1	9.04	3.54
22	0.28	2.14	5.94	12.0	16.6	20.0	23.8	24.4	20.1	15.2	9.13	3.56
23	0.31	2.14	6.02	12.0	16.8	20.1	23.8	24.4	20.1	15.4	9.26	3.6
24	0.46	2.54	6.05	12.2	16.8	20.1	23.9	24.7	20.2	15.5	9.3	3.67
25	0.5	2.56	6.57	12.2	16.9	20.2	23.9	24.7	20.2	15.6	9.48	3.81
26	0.76	2.74	6.84	12.2	17.0	20.3	24.1	24.7	20.3	15.8	9.48	3.87
27	0.8	2.76	6.86	12.4	17.0	20.3	24.2	25.0	20.4	15.9	9.78	3.99
28	0.85	3.03	6.89	12.7	17.0	20.5	24.6	25.0	20.6	15.9	9.8	4.2
29	1.14	3.08	7.01	12.7	17.1	20.6	24.7	25.1	20.6	16.5	10.0	4.23
30	1.48	3.56	7.23	12.7	17.1	20.8	24.7	25.2	20.7	16.7	10.1	4.33
31	1.79	3.57	7.26	12.8	17.2	20.8	24.8	25.3	20.8	16.8	10.3	4.6
32	1.8	4.06	8.55	13.1	17.3	21.0	25.3	25.4	21.1	16.8	10.6	4.7
33	3.21	4.18	8.59	13.4	17.8	21.5	26.8	26.0	21.5	17.1	11.1	4.84

Table S4. Rearranged monthly precipitation with the same order of the temperature data in Table S3 of Station 1 (Sokcho) in South Korea

Mon /Ord.	1	2	3	4	5	6	7	8	9	10	11	12
1	20.2	25.4	6.8	85.1	20.2	110.5	180.7	208.3	322.4	169.2	4.0	0.4
2	18.3	31.5	28.6	90.2	71.0	192.3	286.1	329.4	188.0	42.8	81.2	15.3
3	16.8	81.4	75.1	147.7	68.2	74.7	258.0	148.2	347.2	16.3	45.1	31.8
4	58.3	52.4	48.6	60.4	122.7	125.7	271.3	403.7	405.7	51.6	39.2	2.5
5	1.6	9.7	85.4	120.4	141.7	107.0	221.2	383.8	55.9	122.2	66.0	140.0
6	37.6	52.7	102.5	36.7	151.7	109.9	545.0	602.7	112.4	16.0	10.8	20.2
7	34.7	6.0	63.6	238.3	113.0	356.5	202.1	56.9	226.0	39.7	58.3	42.9
8	81.9	25.0	56.8	45.7	130.9	68.0	300.4	349.2	68.3	7.0	39.8	31.0
9	45.9	8.4	4.2	136.1	23.1	129.0	262.8	277.7	114.0	18.4	123.0	47.4
10	43.0	18.1	38.0	95.8	111.3	199.0	550.6	531.1	596.4	163.0	130.9	102.6
11	18.2	25.3	63.5	126.0	77.5	54.3	301.4	474.6	156.4	77.7	21.9	5.5
12	0.1	114.2	55.7	62.5	33.2	63.3	189.4	100.3	142.7	10.3	0.0	15.5
13	23.5	48.2	42.6	64.9	78.2	91.3	212.8	200.0	43.9	6.7	8.8	1.8
14	90.2	64.4	110.4	23.4	18.1	76.2	89.1	376.5	425.4	284.3	33.9	1.5
15	59.9	0.6	89.8	48.5	162.0	175.7	289.9	460.3	650.8	111.8	38.2	101.0
16	28.4	18.3	24.0	158.5	79.8	236.6	181.0	177.8	6.9	67.2	159.1	31.7
17	47.6	63.0	55.8	52.6	355.6	69.3	163.1	515.2	180.7	280.1	84.0	2.4
18	112.9	95.0	85.2	27.3	33.9	75.6	152.1	343.1	129.4	16.9	14.6	5.8
19	11.0	38.7	75.6	81.4	117.0	66.5	250.7	440.3	311.5	76.6	36.7	0.7
20	79.0	43.4	37.7	27.4	137.8	44.2	233.3	392.9	263.9	114.9	65.6	1.2
21	14.4	34.4	121.7	25.3	66.8	113.0	207.3	206.0	308.5	90.6	78.5	103.0
22	66.6	45.2	9.3	108.7	46.7	123.9	333.5	84.2	200.1	87.3	146.7	65.2
23	34.5	45.0	43.7	62.2	70.0	126.6	554.0	246.3	99.4	216.7	278.2	78.0
24	71.7	89.4	39.8	32.2	10.3	96.7	174.7	60.3	46.4	63.5	78.3	15.9
25	25.0	170.6	112.6	58.5	50.9	289.1	176.6	110.5	42.0	6.4	54.1	20.1
26	23.3	65.3	8.7	14.1	22.5	132.1	185.2	293.7	120.8	56.2	153.9	8.9
27	87.1	69.0	1.8	6.2	67.2	52.3	73.3	206.8	256.3	23.3	106.4	225.9
28	19.6	4.2	86.8	45.4	167.6	266.9	172.1	246.9	129.9	234.9	38.4	49.0
29	4.5	208.3	43.6	104.4	95.3	151.2	161.0	232.5	397.8	52.3	143.2	12.2
30	165.9	58.7	88.2	14.7	102.1	78.8	60.3	109.3	148.6	67.1	73.0	158.8
31	86.1	26.7	103.9	47.9	94.8	99.7	109.2	371.8	37.8	73.5	8.5	51.5
32	1.1	7.2	12.6	13.5	7.2	15.2	361.6	441.7	175.0	81.9	39.5	8.6
33	142.3	0.6	14.1	101.2	22.9	79.4	86.6	236.9	431.4	285.5	143.6	49.6

Table S5. Estimated selection probability for IBB and its related information for resampling monthly precipitation in month 1 of Station 1 (Sokcho) in South Korea. Here, r=0.53.

i	$S_{i,n}$	$(S_{i,n})^r$	$(S_{i,n})^r/\Psi_r$	Acc. $(S_{i,n})^r/\Psi_r$	RAND #	Sel. Index	Sel. Precip
1	0.030	0.159	0.007	0.007	0.326	16	28.4
2	0.061	0.229	0.010	0.018	0.231	13	23.5
3	0.091	0.284	0.013	0.030	0.627	25	25.0
4	0.121	0.330	0.015	0.045	0.330	16	28.4
5	0.152	0.371	0.017	0.062	0.379	18	112.9
6	0.182	0.408	0.018	0.081	0.705	27	87.1
7	0.212	0.443	0.020	0.101	0.624	25	25.0
8	0.242	0.475	0.021	0.122	0.543	22	66.6
9	0.273	0.505	0.023	0.145	0.606	24	71.7
10	0.303	0.534	0.024	0.169	0.690	26	23.3
11	0.333	0.562	0.025	0.195	0.860	30	165.9
12	0.364	0.588	0.027	0.221	0.927	32	1.1
13	0.394	0.613	0.028	0.249	0.370	17	47.6
14	0.424	0.637	0.029	0.278	0.386	18	112.9
15	0.455	0.661	0.030	0.308	0.142	9	45.9
16	0.485	0.684	0.031	0.339	0.894	31	86.1
17	0.515	0.706	0.032	0.371	0.345	17	47.6
18	0.545	0.727	0.033	0.403	0.314	16	28.4
19	0.576	0.748	0.034	0.437	0.891	31	86.1
20	0.606	0.769	0.035	0.472	0.829	30	165.9
21	0.636	0.789	0.036	0.508	0.519	22	66.6
22	0.667	0.808	0.037	0.544	0.020	3	16.8
23	0.697	0.827	0.037	0.582	0.155	10	43.0
24	0.727	0.846	0.038	0.620	0.613	24	41.7
25	0.758	0.864	0.039	0.659	0.832	30	165.9
26	0.788	0.882	0.040	0.699	0.111	8	81.9
27	0.818	0.900	0.041	0.740	0.178	11	18.2
28	0.848	0.917	0.041	0.781	0.788	29	4.5
29	0.879	0.934	0.042	0.823	0.456	20	79
30	0.909	0.951	0.043	0.866	0.878	31	86.1
31	0.939	0.968	0.044	0.910	0.820	29	4.5
32	0.970	0.984	0.045	0.955	0.957	33	142.3
33	1.000	1.000	0.045	1.00	0.037	4	58.3
	Sum (Ψr)	22.106					

Remark: (1) The first column presents the order of the 33 years.
(2) The second column is $S_{i,n}$=i/n, e.g., i/n=1/33=0.3 for the first value.
(3) The third column is $(S_{i,n})^r$=(i/n)^r, e.g., (i/n)^0.53=(1/33)^0.53=0.159 for the first value.
(4) The fourth column presents the scaled weight $(S_{i,n})^r/\Psi_r$=(i/n)^r/sum((i/n)^r), e.g.,

$(S_{i,n})^r/\Psi_r$=0.159 /22.106=0.007 for the first value.
(5) The fifth column presents the accumulation of the scaled weight. Note that the last value (i.e., 33rd) must be 1.0 because it is the accumulated probability, similar to the discrete cumulative distribution function (CDF).
(6) The sixth column presents a generated uniform random number between 0 and 1, U~Unif[0,1] for i=1,…,33. Note that in this case, the simulation length is equal to the recorded length.
(7) The seventh column shows the selected time index using the generated uniform random number and the accumulated scaled weights in the fifth column. For example, if the random number is 0.326 as in the first value of the sixth column, then time index 16 is selected because the 15th and 16th accumulated scaled weights are 0.308 and 0.339, respectively. Note that the higher time index 16 is selected with this procedure.
(8) The eighth column shows the selected monthly precipitation of month 1 with the selected time index shown in the seventh column. For example, the 16th order of the rearranged precipitation shown in Table S4 is 28.4 mm and is selected for the first value of the simulated value in the eighth column.