Supplementary Material - Daily identification of compound drought and heatwave across four seasons

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This supplementary material includes:

Table S1: The days per year and events number per year compared before after removing and merging

Table S2: Trend test of annual days for drought, heatwave, and CDHW events based on Mann Kendall statistic test for different cumulation periods and pre-identification thresholds.

Fig. S1: Mann Kendall statistic test at 0.05 level for daily mean temperature over 1901-2020 and 30-years moving window.

Fig. S2: Distribution of duration of droughts and heatwaves without removing and merging.

Fig. S3: Identification of drought, heatwave, and CDHW events (union, conditioned on drought, conditioned on heatwave, and intersection).

Table S1: The days per year and events number per year compared before after removing and merging

		Without removing and merging			After removing and merging		
	Scales	SPI_T=-0.5	SPI_T=-1	SPI_T=-1.5	SPI_T=-0.5	SPI_T=-1	SPI_T=-1.5
Drought	15	103.6, 11.0	56.8, 7.8	38.4, 5.9	37.8, 1.12	28.3, 1.13	21.2, 1.18
	30	111.6, 7.2	58.8, 5.2	36.9, 3.8	45.7, 0.65	33.6, 0.68	17.9, 0.55
	45	112.4, 6.1	57.8, 4.0	36.4, 2.9	59.8, 0.78	30.8, 0.60	18.7, 0.43
	60	114.7, 5.0	58.4, 3.3	35, 2.4	62.1, 0.58	28.9, 0.43	24.9, 0.39
	90	115.6, 3.8	60.6, 2.9	36.3, 2.1	67.2, 0.43	30.2, 0.25	23.6, 0.28
Heatwave	Scales	SHI_T=-0.5	SHI_T=1	SHI_T=1.5	SHI_T=-0.5	SHI_T=1	SHI_T=1.5
	3	123.1, 21.9	68.8, 16.4	42.9, 12.6	34.9, 1.83	19.2, 1.56	16.4, 1.88
	5	124.9, 16.5	68.3, 12.0	42.8, 9.0	40.6, 1.73	25.5, 1.83	16.4, 1.47
	7	125.1, 13.6	68.3, 9.8	43.4, 7.5	23.5, 0.49	29.9, 1.90	16.5, 1.09
	10	126, 11.1	68.6, 7.8	44.5, 6.1	41.12, 1.23	33.6, 1.76	18.6, 1.08
	15	127.6, 8.5	69.6, 6.2	44.8, 4.6	49.1, 1.03	33.6, 1.30	15.4, 0.58

Table S2: Trend test of annual days for drought, heatwave, and CDHW events based on Mann Kendall statistic test for different cumulation periods and pre-identification thresholds. Values larger than 1.96 mean significant positive trends at 0.05 level while values less than -1.96 means significant negative trends.

Start and end thresholds	Scales of drought	Scales of heatwave	Trend for drought	Trend for heatwave	Union	H|D	D|H	Intersection
SPI=-1(or SHI=1)	15	3	0.22	3.67	1.47	1.46	1.52	1.53
	30	5	1.33	3.59	1.70	1.67	1.55	1.50
	45	7	0.64	2.54	0.43	0.44	0.30	0.37
	60	10	-0.03	2.57	0.60	0.53	0.64	0.54
	90	15	0.02	2.74	0.33	0.33	0.31	0.28
SPI=-1.3(or SHI=1.3)	15	3	0.42	4.10	1.68	1.70	1.74	1.78
	30	5	0.56	3.88	0.47	0.47	0.44	0.42
	45	7	0.88	2.76	0.51	0.51	0.53	0.49
	60	10	0.30	3.31	0.74	0.76	0.62	0.66
	90	15	0.21	2.30	0.38	0.39	0.40	0.39

(a)

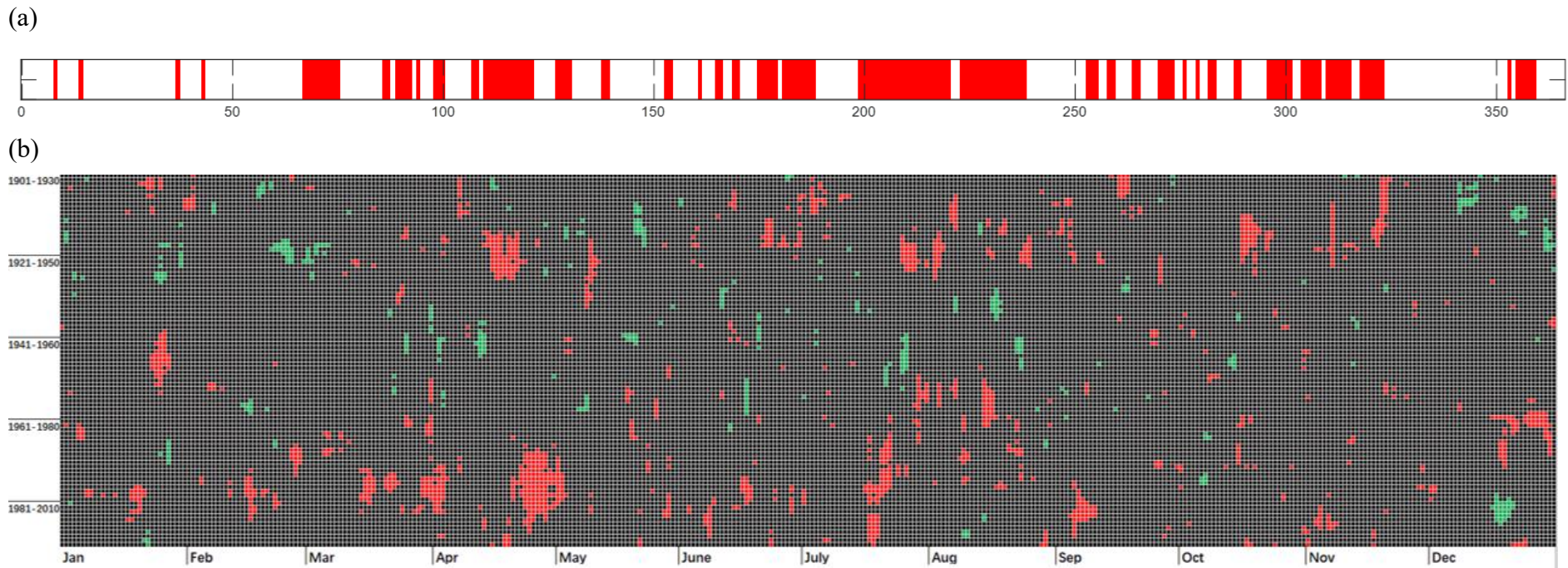
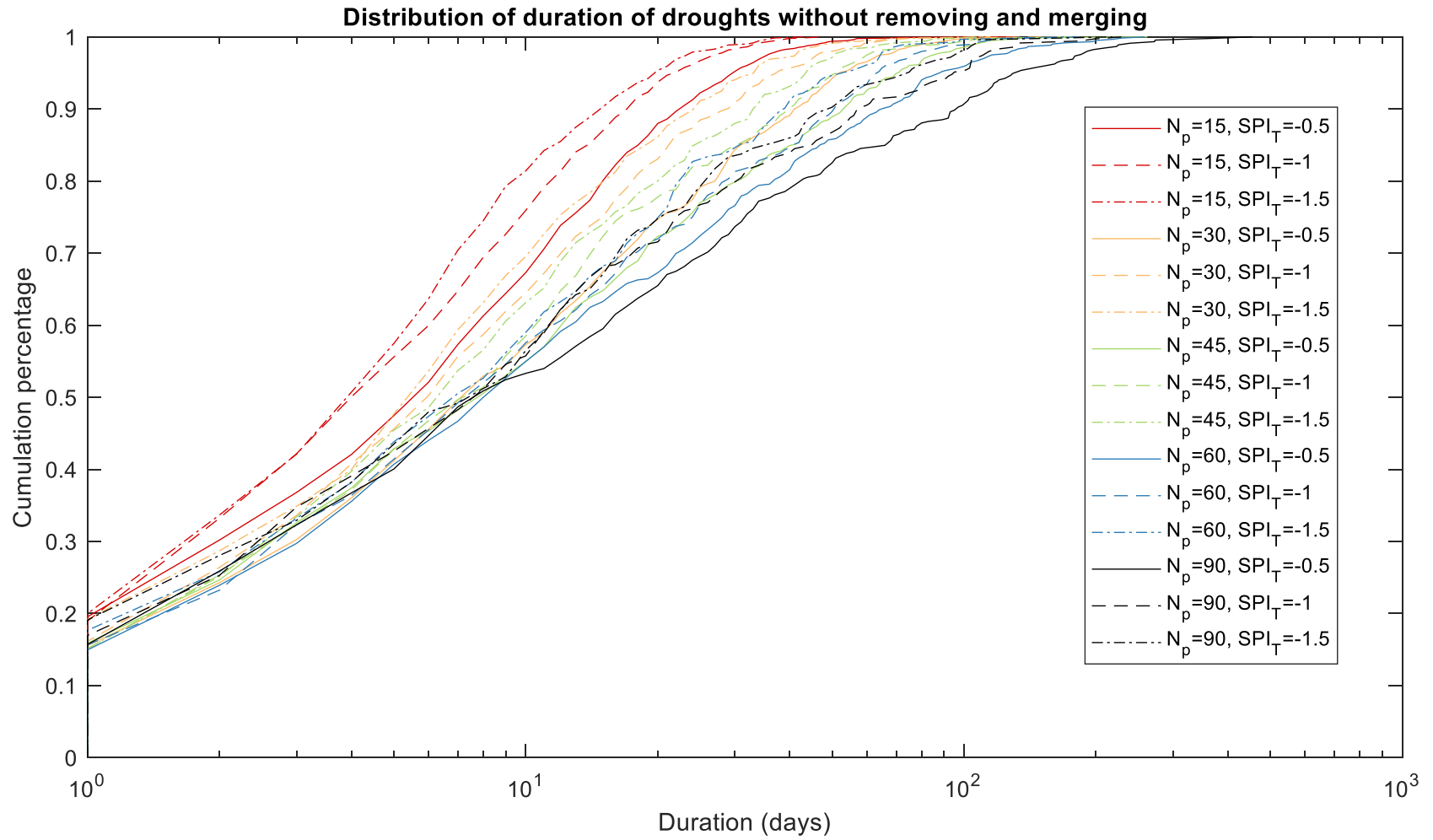



Fig. S1: Mann Kendall statistic test at 0.05 level for daily mean temperature over 1901-1920 (a) and 30-years moving window(b). Red is for significant increasing trends; Green is for significant negative trends; White in (a) and black in (b) mean there is no clear trend. Over the whole time series, test results show 147 days over 365 days have a significant increasing trend and no day has a decreasing trend. For 30-years moving window, on average, only 5.59% periods have a clear trend: 4.38% is increasing and 1. 22% is decreasing. Results indicate it is easy and effective to handle nonstationary by regarding the "normal" condition as the past 30-years, instead of the whole period.

(a) Distribution of duration of droughts without removing and merging

(b) Distribution of duration of heatwaves without removing and merging

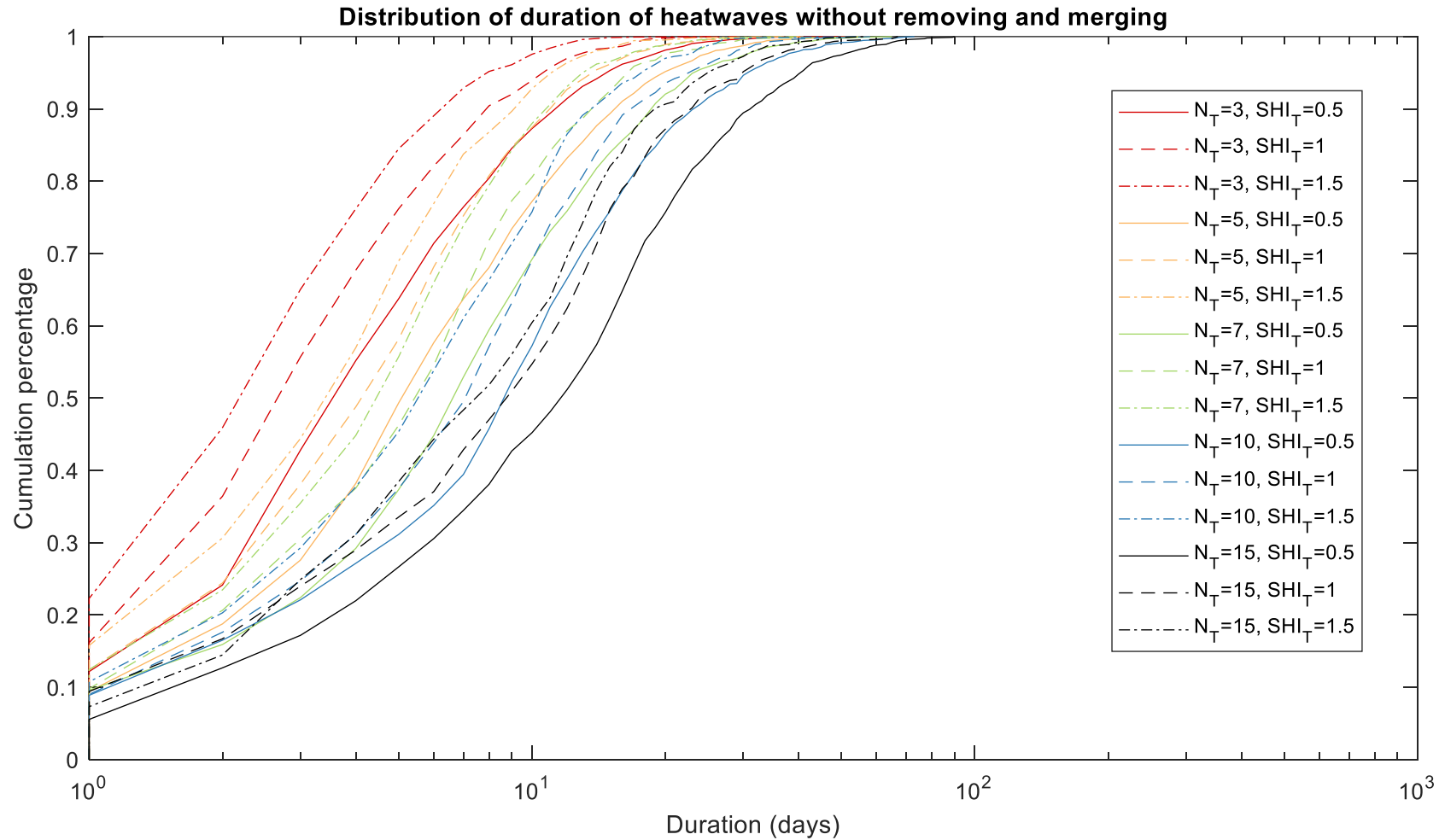
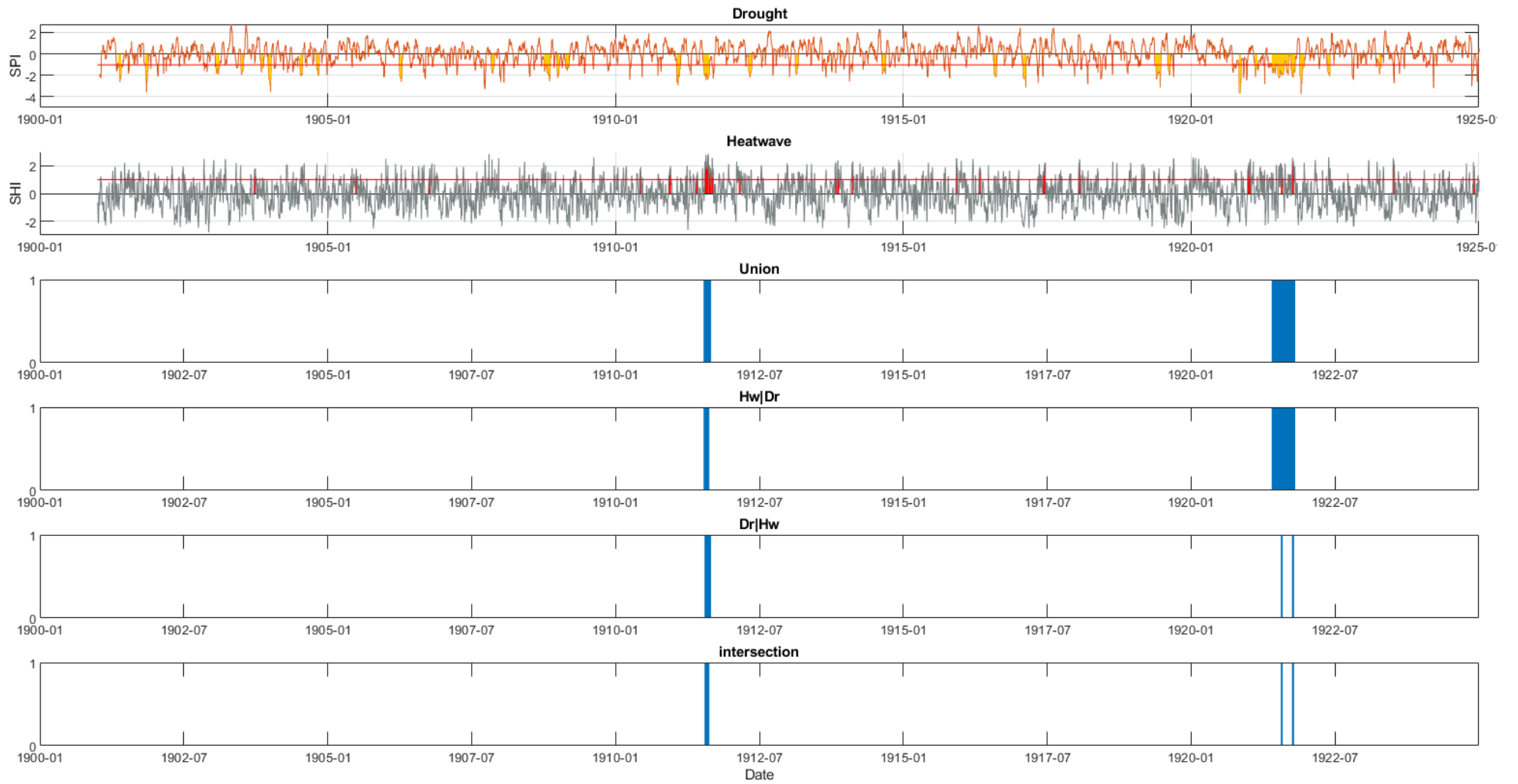
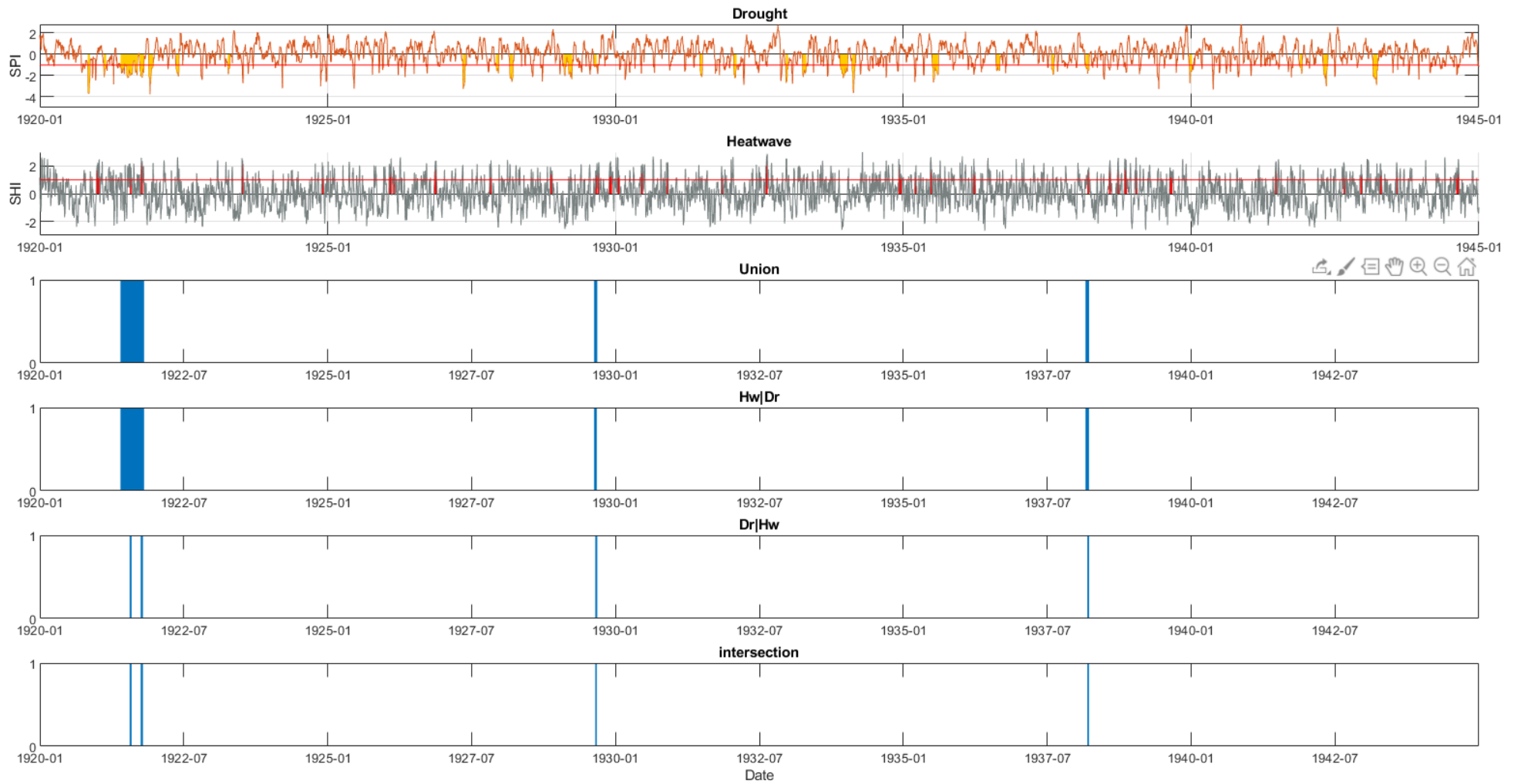
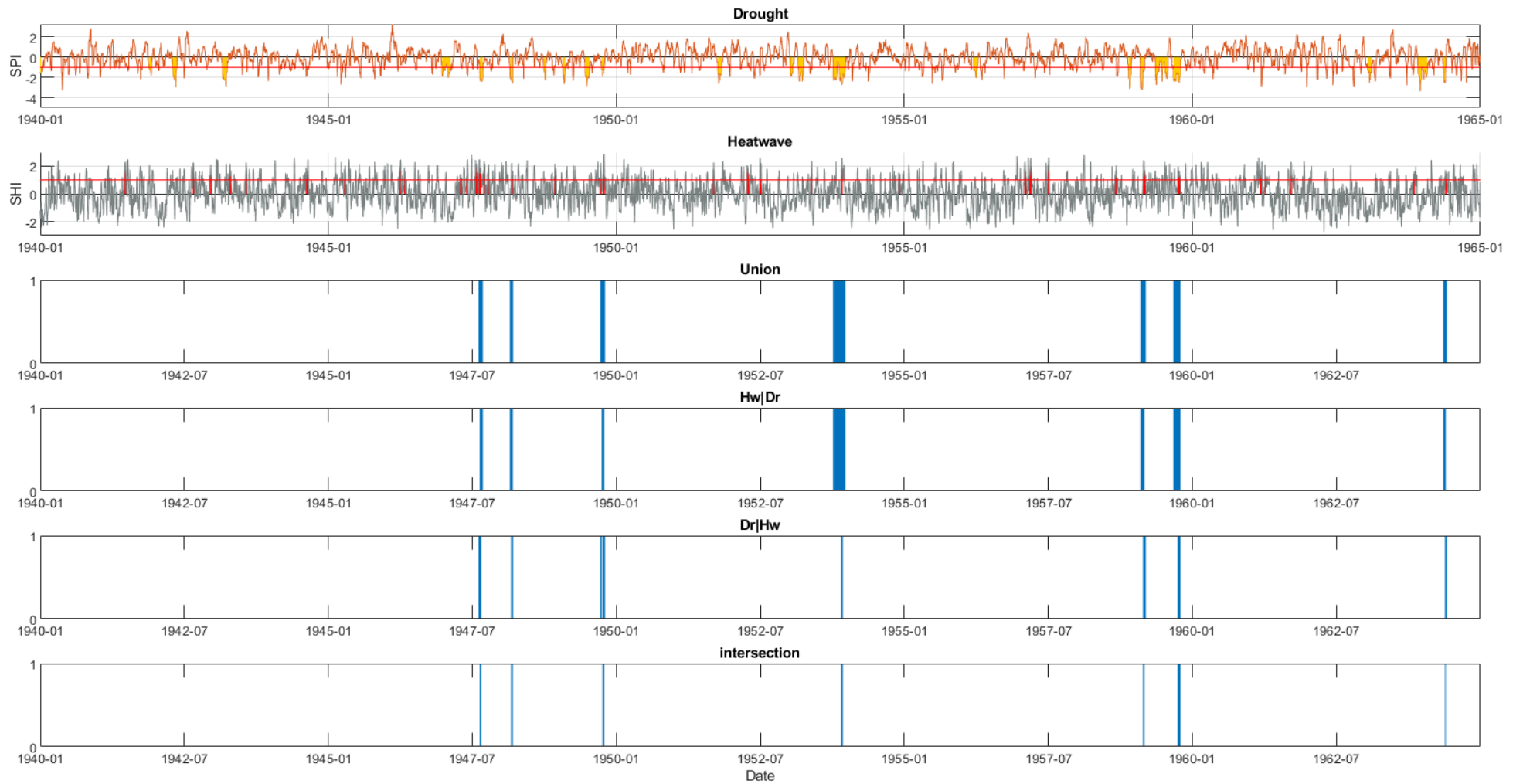
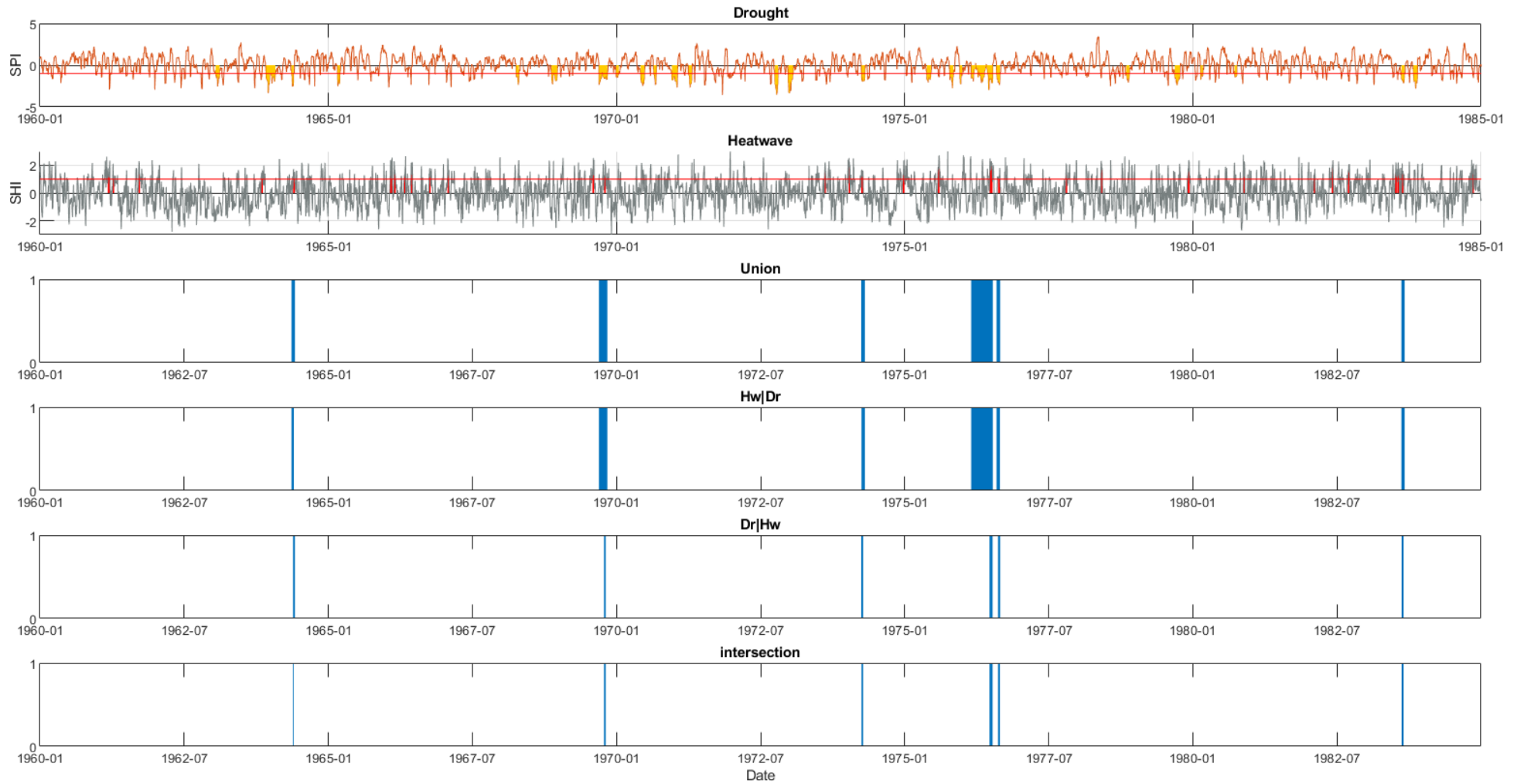
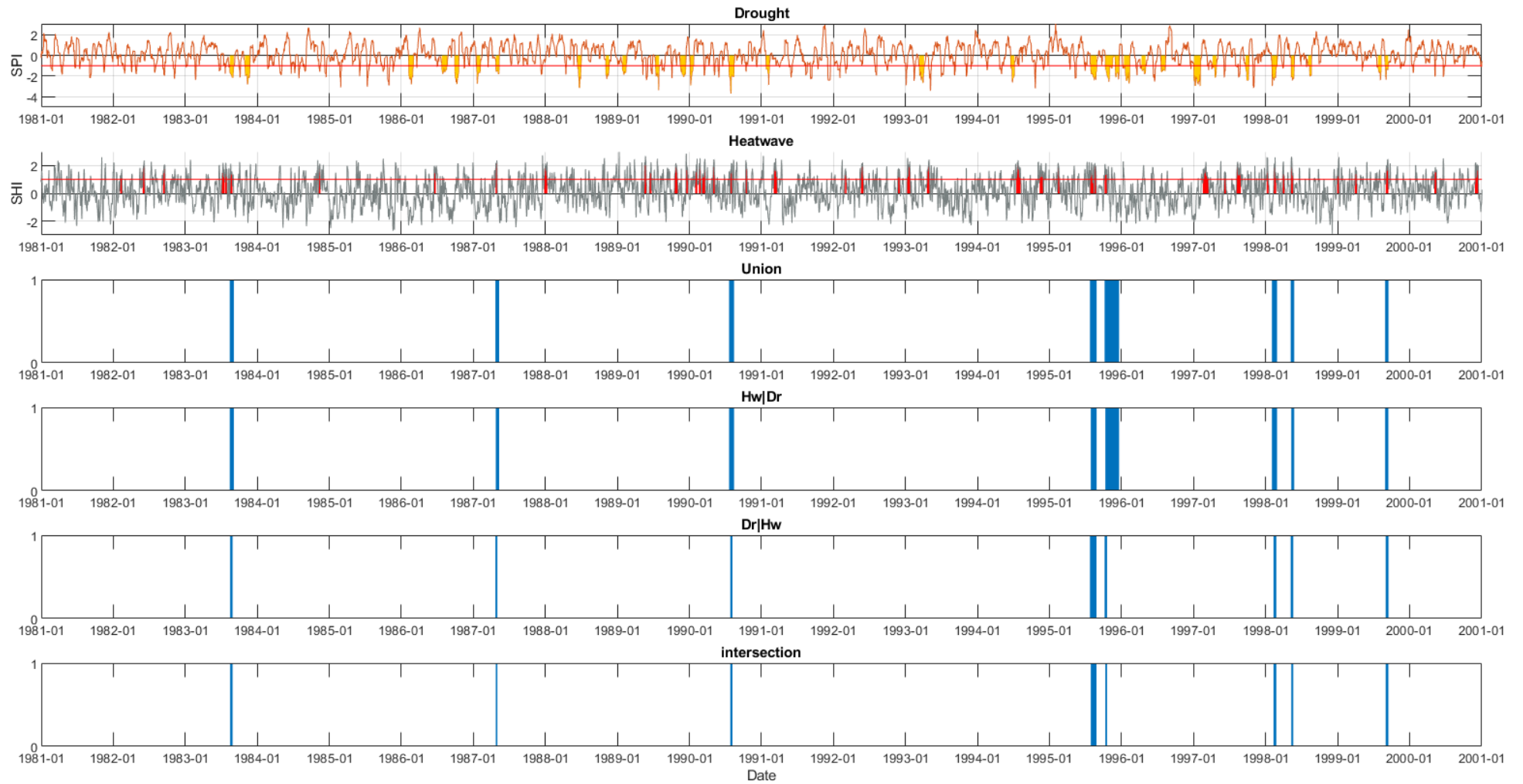



Fig. S2: Distribution of duration of droughts(a) and heatwaves(b) without removing and merging. N_P and N_T are cumulation periods of droughts and heatwaves, respectively. SPI_T and SHI_T are pre-identification thresholds of droughts and heatwaves, respectively. We can find that the too short durations occupy a large percentile without removing and merging, which could disturb the extreme analysis.

(a) Identification results over the period 1901-1920

(b) Identification results over the period 1921-1940

(c) Identification results over the period 1941-1960

(d) Identification results over the period 1961-1980

(e) Identification results over the period 1981-2000

(f) Identification results over the period 2001-2020

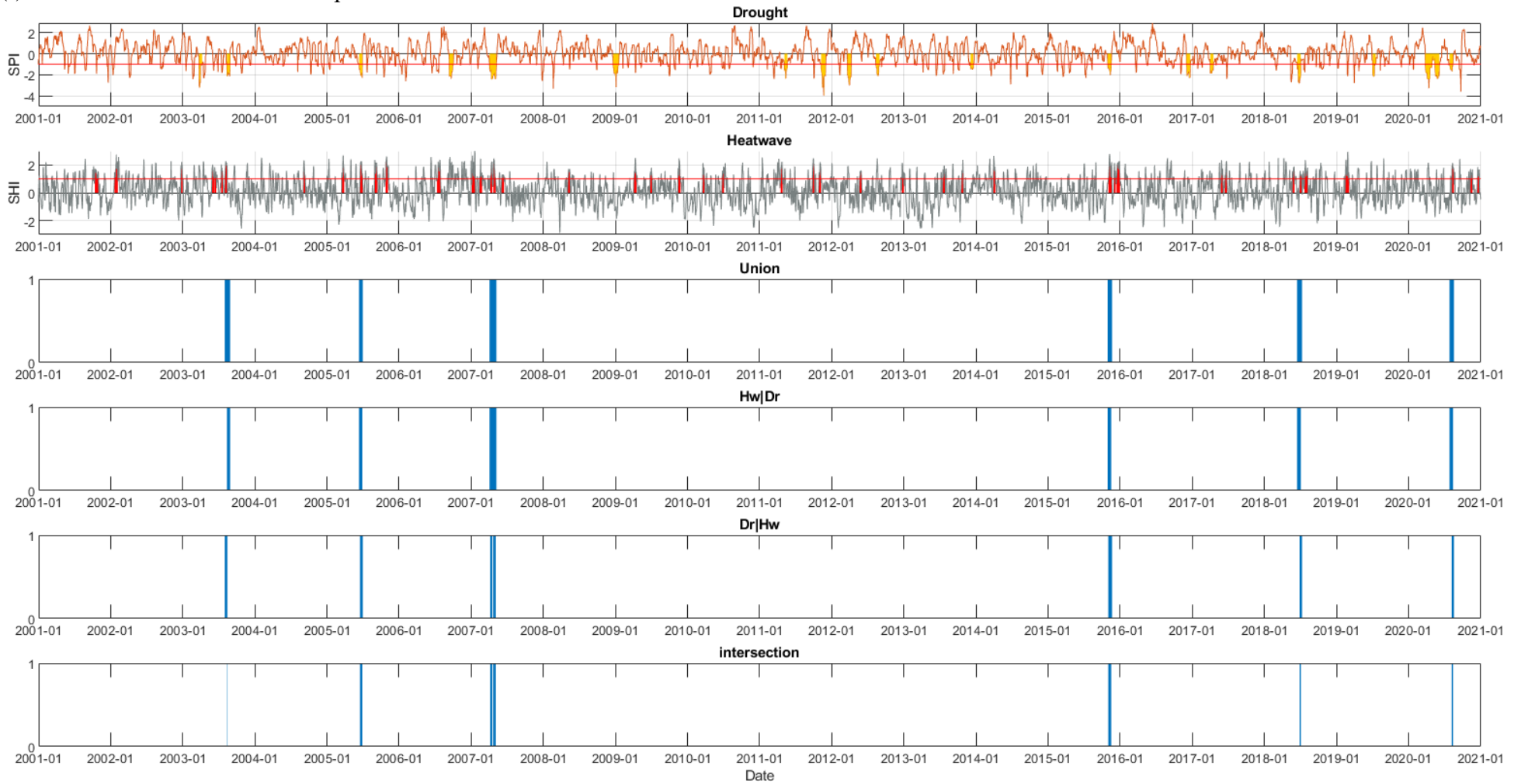



Fig. S3: Identification of drought, heatwave, and CDHW events (union, conditioned on drought, conditioned on heatwave, and intersection). SPI is with 15-days scale and pre identification threshold equals -1; SHI is with 3-days scale and pre identification threshold equals 1.