

Figure S1: Conceptual illustration of the identification of CDHEs

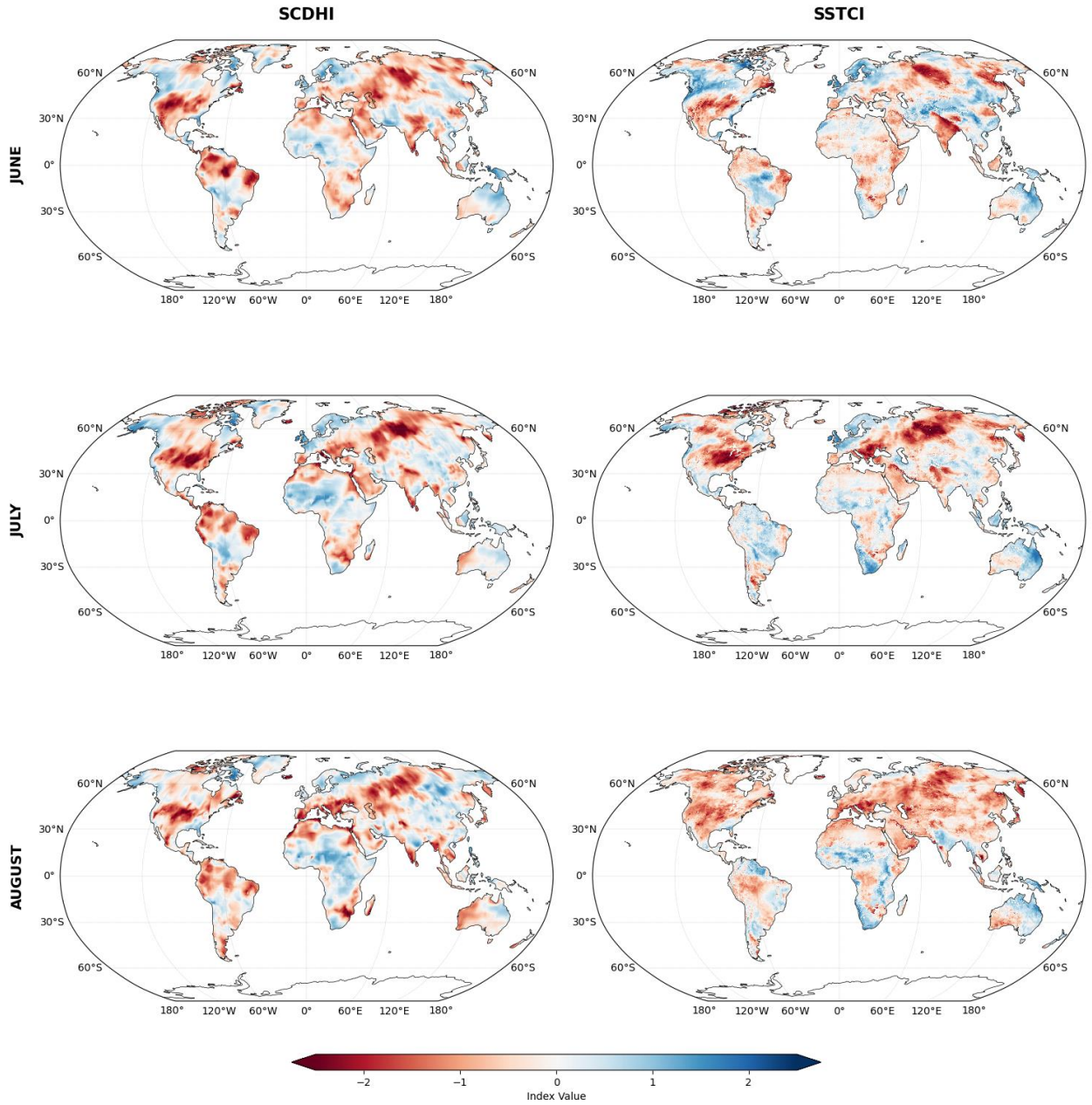


Figure S2: Spatial pattern comparison of standardized compound dry hot index(SCDHI) and standardized soil moisture temperature index (SSTCI) for summer 2012.

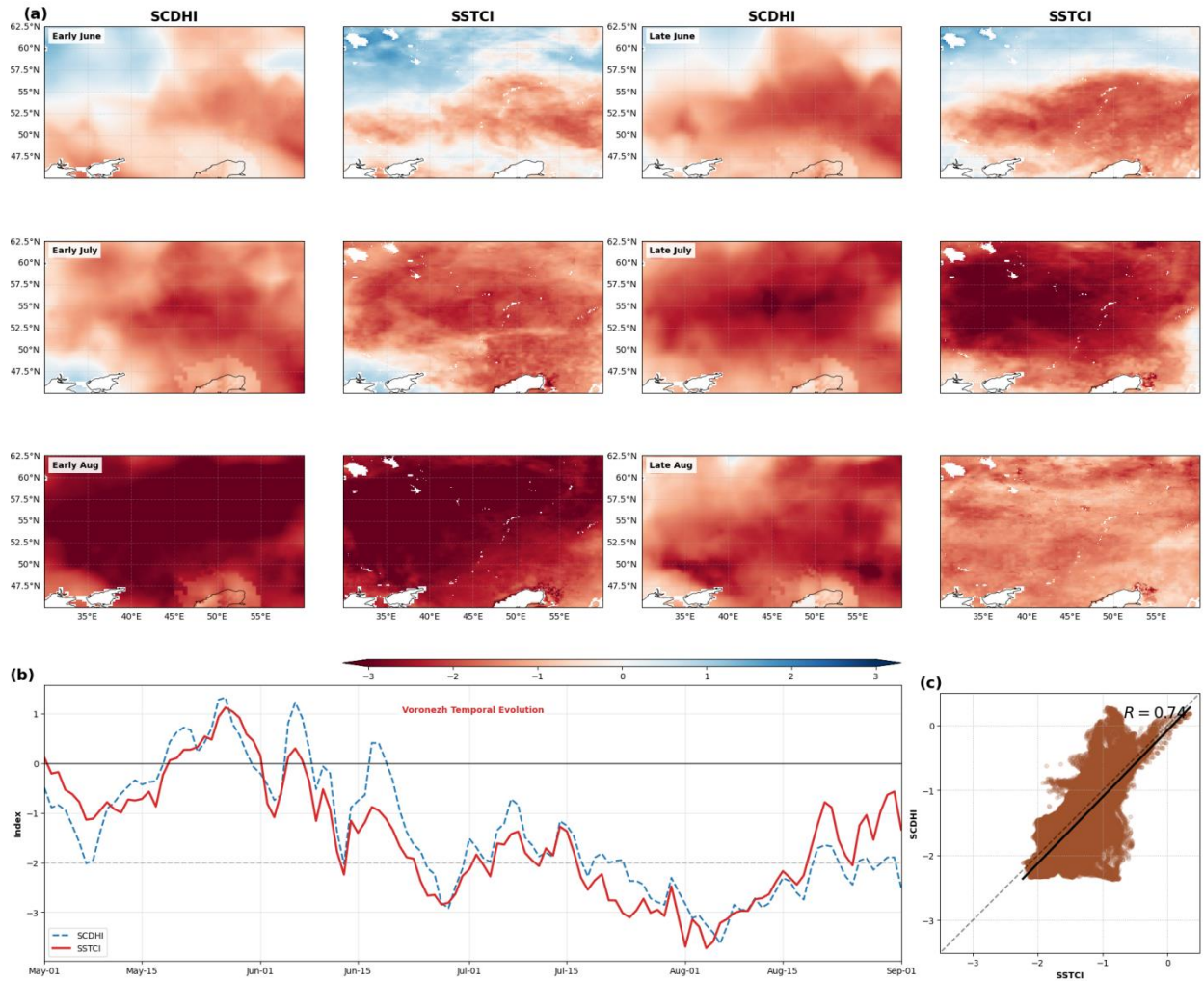


Figure S3: Spatiotemporal analysis of the 2010 Western Russia CDHE event. (a) 15-day mean evolution of SCDHI and SSTCI (June–August) (b) Daily time series for Voronezh (May–September) showing tight coupling between SSTCI and SCDHI (c) JJA spatial correlation across the Western Russia domain (45–65N°,30–60E°). The robust positive relationship ($R = 0.74$) confirms the indices' agreement during extreme conditions.

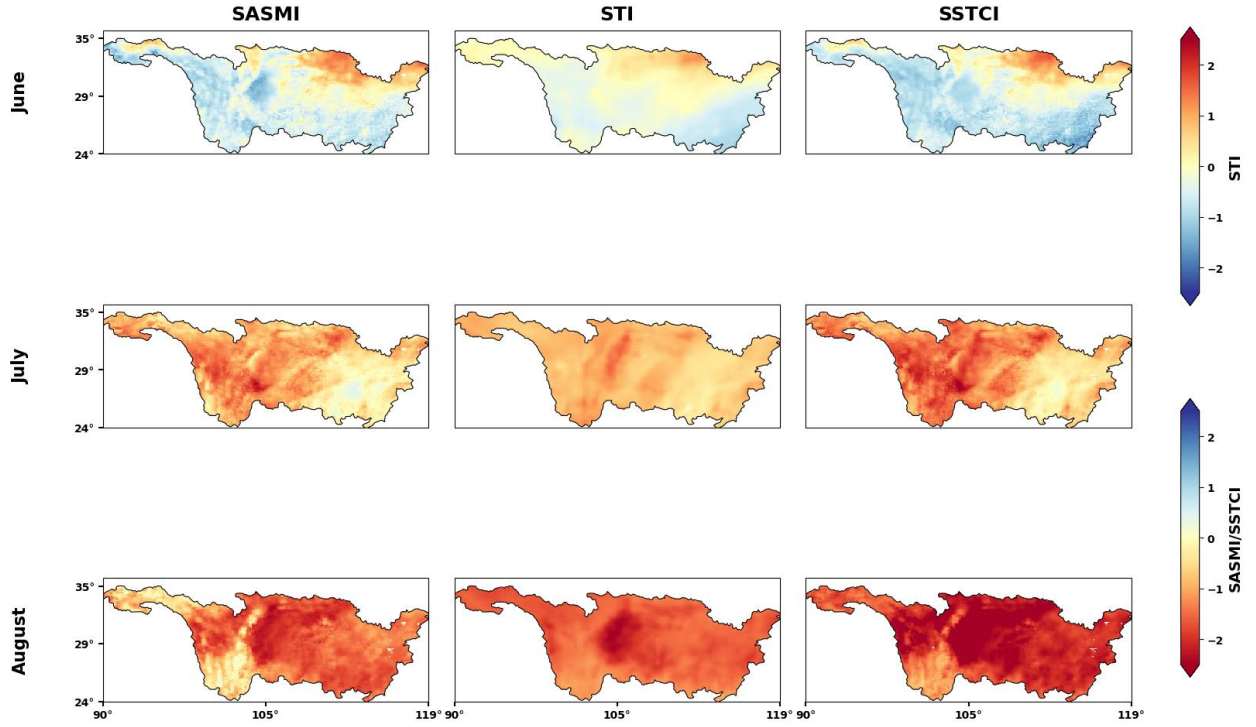


Figure S4: Monthly Evolution of the CDHE 2022 event over the Yangtze River basin

Table S1: Categories of compound dry and hot conditions thresholds based on SSTCI

Category	SSTCI Threshold
Abnormal	-0.80, -0.50
Light	-1.30, -0.80
Moderate	-1.60, -1.30
Heavy	-2.0, -1.60
Extreme	≤ -2

Table S2: Selected latitude and longitude range for the Global Radar plots

Region	Years	Lon Min	Lon Max	Lat Min	Lat Max
Northern Italy (Po Basin)	2022	7.5°E	13.2°E	44.4°N	46.4°N
Southwest US (Mogollon Rim)	2021	112.3°W	108.9°W	33.5°N	35.8°N
Pantanal (Brazil)	2020	58.5°W	55.0°W	20.5°S	16.5°S
South Africa (central–northern interior)	2015–2016	20.0°E	30.5°E	28.5°S	22.0°S
Northeast Australia	2019	142.0°E	151.0°E	22.0°S	12.0°S
Yangtze River Basin (YRB)	2022	103.0°E	123.0°E	25.0°N	35.0°N

Table S3. Summary of historical CDHE events identified for an example pixel (**28.9°N, 108.9°E**)

Number	Duration	Total severity	Intensity	Start Year	Start Month	Start Day	End Year	End Month	End Day
1	17	41.87	2.46	1963	2	19	1963	3	7
2	6	13.91	2.32	1965	5	28	1965	6	2
3	3	6.43	2.14	1966	1	8	1966	1	10
4	3	7.85	2.62	1966	1	30	1966	2	1
5	4	8.32	2.08	1966	10	1	1966	10	4
6	5	12.39	2.48	1973	2	22	1973	2	26
7	16	40.21	2.51	1974	1	7	1974	1	22
8	4	9.59	2.40	1978	3	10	1978	3	13
9	3	6.38	2.13	1978	7	13	1978	7	15
10	3	9.01	3.00	1979	1	19	1979	1	21
11	3	7.14	2.38	1981	5	19	1981	5	21
12	3	7.67	2.56	1981	7	7	1981	7	9
13	3	7.35	2.45	1987	1	9	1987	1	11
14	11	29.01	2.64	1988	11	17	1988	11	27
15	3	6.89	2.30	1992	1	27	1992	1	29
16	12	26.19	2.18	1992	8	3	1992	8	14
17	3	7.89	2.63	1993	1	4	1993	1	6
18	3	7.68	2.56	1997	2	5	1997	2	7
19	4	9.00	2.25	1999	2	12	1999	2	15
20	4	8.48	2.12	2000	4	1	2000	4	4
21	3	6.36	2.12	2001	5	14	2001	5	16

22	9	20.76	2.31	2001	5	18	2001	5	26
23	3	7.69	2.56	2001	12	13	2001	12	15
24	4	8.62	2.16	2002	6	12	2002	6	15
25	3	7.53	2.51	2004	12	14	2004	12	16
26	4	9.06	2.26	2005	7	5	2005	7	8
27	3	6.61	2.20	2005	8	12	2005	8	14
28	3	6.65	2.22	2005	9	19	2005	9	21
29	6	14.63	2.44	2006	8	30	2006	9	4
30	4	9.57	2.39	2006	9	25	2006	9	28
31	3	6.54	2.18	2007	10	5	2007	10	7
32	3	6.91	2.30	2008	9	21	2008	9	23
33	3	7.14	2.38	2008	12	1	2008	12	3
34	17	45.81	2.69	2008	12	9	2008	12	25
35	3	6.69	2.23	2009	8	26	2009	8	28
36	4	9.10	2.28	2009	9	5	2009	9	8
37	3	6.60	2.20	2011	8	16	2011	8	18
38	3	7.05	2.35	2011	8	20	2011	8	22
39	10	23.18	2.32	2011	8	29	2011	9	7
40	4	9.42	2.35	2013	3	6	2013	3	9
41	22	58.22	2.65	2013	7	28	2013	8	18
42	5	12.76	2.55	2013	10	10	2013	10	14
43	5	10.93	2.19	2014	1	23	2014	1	27
44	6	14.35	2.39	2014	1	29	2014	2	3
45	5	10.90	2.18	2015	1	21	2015	1	25
46	8	18.41	2.30	2015	10	19	2015	10	26
47	3	6.53	2.18	2016	9	24	2016	9	26
48	3	6.27	2.09	2017	11	8	2017	11	10
49	9	20.67	2.30	2019	8	20	2019	8	28
50	7	17.86	2.55	2019	9	29	2019	10	5
51	3	6.85	2.28	2019	10	9	2019	10	11
52	5	13.13	2.63	2021	10	1	2021	10	5
53	6	15.98	2.66	2022	7	12	2022	7	17
54	41	112.71	2.75	2022	8	11	2022	9	20
55	6	15.37	2.56	2022	9	29	2022	10	4
56	15	35.58	2.37	2022	10	14	2022	10	28
57	5	10.98	2.20	2022	10	30	2022	11	3
58	4	10.63	2.66	2022	11	9	2022	11	12
59	3	6.45	2.15	2023	9	9	2023	9	11
60	4	9.05	2.26	2023	12	6	2023	12	9