
Supplementary Materials:

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This supplementary information file includes:

- ERA5 Precipitation data difference between adjusted and unadjusted time zone to local time (Figure S1)
- Scatterplot of precipitation including extreme precipitation from observations and corresponding ERA5 grid points for each station for each month and year (Figures S2 and S3)
- Seasonal time series of extreme precipitation in the ERA5 data and observation (Figures S4–S7, Tables S1–S4)
- Seasonal variations of convective and large-scale precipitation contribute to the extreme precipitation (Figure S8)

Nighttime in ERA5 represents 12:00–24:00 UTC (corresponding to 20:00–08:00 Beijing Time) and daytime in ERA5 represents 0:00–12:00 UTC (corresponding to 08:00–20:00 Beijing Time). For example, the precipitation data for 1 February 2005 were accumulated from 20:00 on 31 January to 20:00 on 1 February Beijing Time (corresponding to 12:00 on 31 January to 12:00 on 1 February UTC), rather than simply using 0:00 to 24:00 on 1 February UTC. The time-zone-adjusted ERA5 precipitation time series can effectively improve the evaluation accuracy with surface observations (Figure S1). Errors caused by unadjusted time zone mainly occur at nighttime.

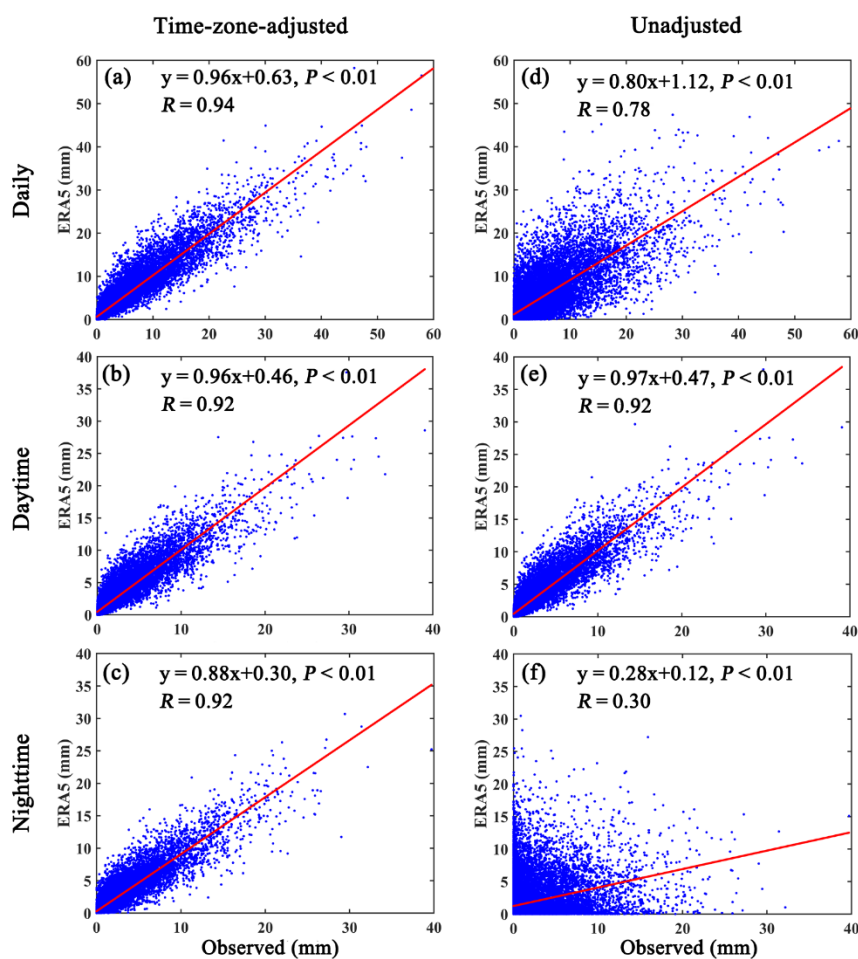


Figure S1. Scatter plots of time-zone-adjusted (a–c) and unadjusted (d–f) ERA5 precipitation against the surface observations at the daily, daytime, and nighttime scales during 1961–2018. The 185 meteorological stations and their corresponding ERA5 grid points were compared in this study.

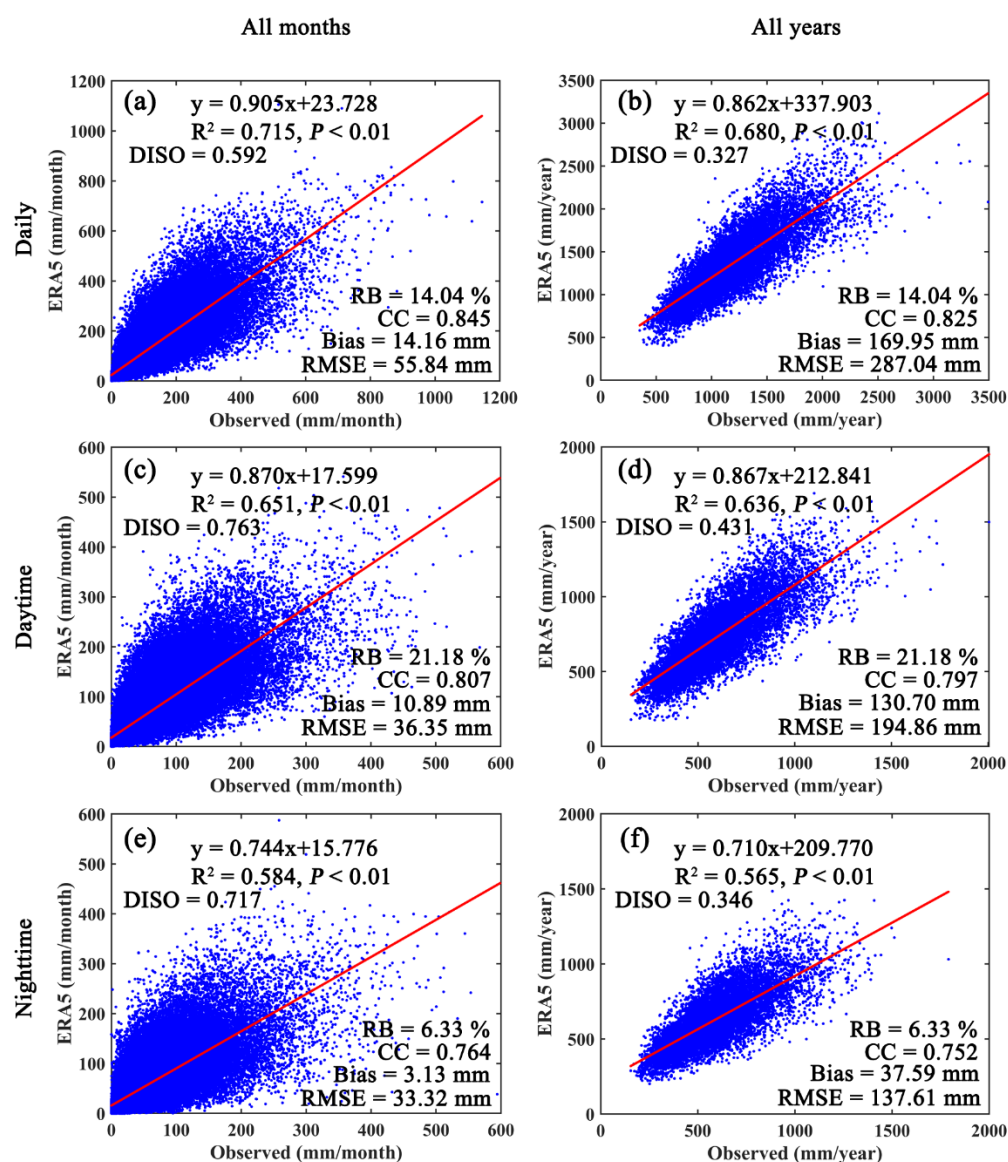


Figure S2. Scatterplot of daily (a, b), daytime (c, d), and nighttime (e, f) precipitation from observational stations and their corresponding ERA5 grid points for each station for each month or year in the YRD during 1961–2018. The left (right) column represents all months (all years) values and red solid lines denote linear regression lines. The matching points at the monthly and annual scales are 128760 and 10730, respectively (185 stations * 696 months/station and 185 stations * 12 years/station).

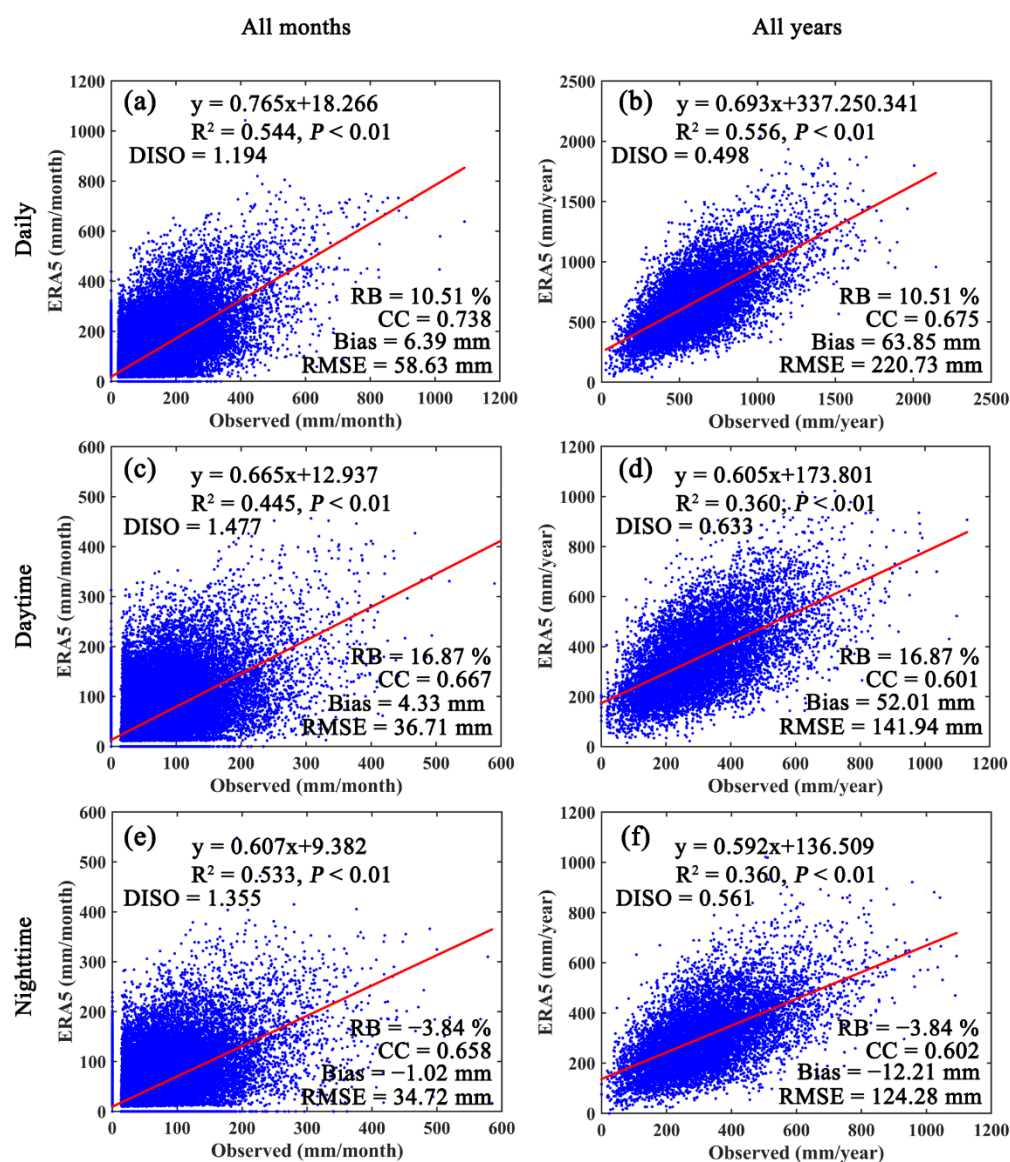


Figure S3. Same as Figure S2, but for extreme precipitation.

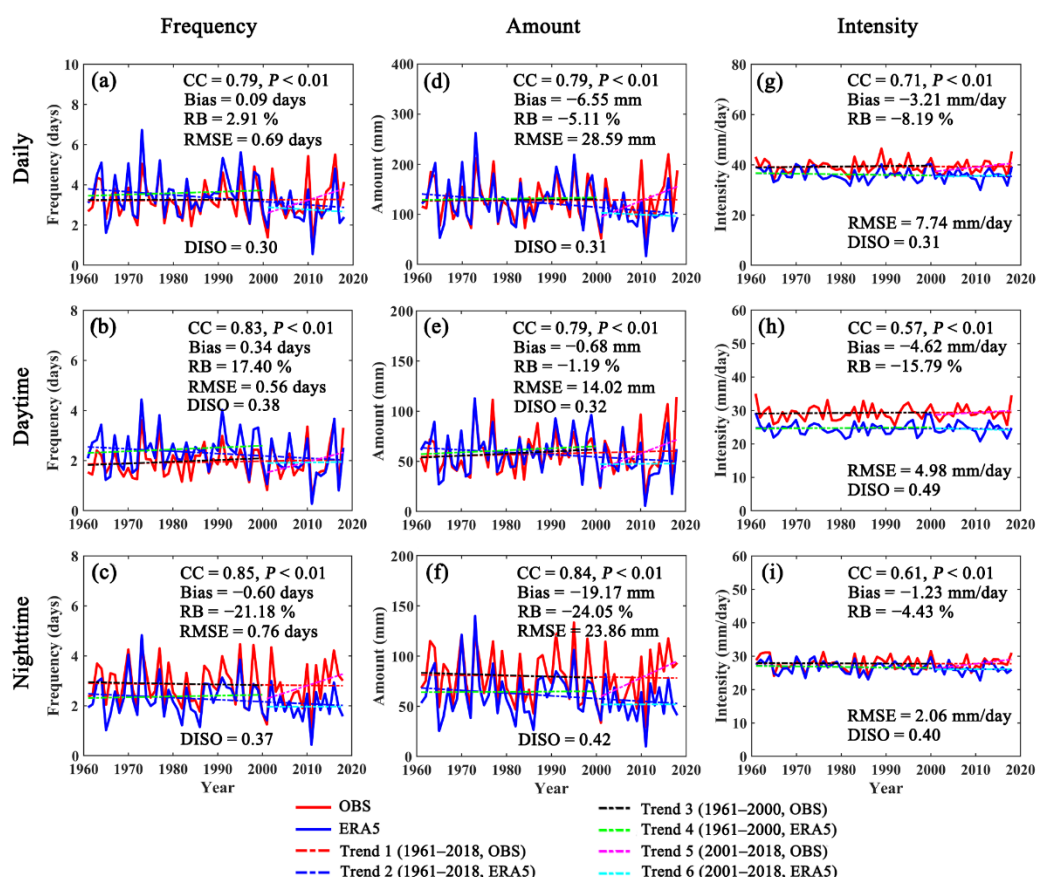


Figure S4. Times series of the spring extreme precipitation frequency (a–c), amount (d–f), and intensity (g–i) in the observational stations (red) and their corresponding ERA5 grid points (blue) re-analysis data at the daily, daytime, and nighttime scales (left, middle, and right columns, respectively).

Table S1. Trends of spring extreme precipitation frequency, amount, and intensity from observational stations and their corresponding ERA5 grid points, respectively, at the daily, daytime, and nighttime scales.

Time scale	Period	Frequency (days/decade)		Amount (mm/decade)		Intensity mm/day/decade	
		OBS	ERA5	OBS	ERA5	OBS	ERA5
Daily	1961–2018	0.01	-0.16*	0.39	-6.72*	0.04	-0.21
	1961–2000	0.01	0.07	0.56	1.22	0.20	-0.26
	2001–2018	0.71	-0.13	35.45	-3.93	1.87	0.31
Daytime	1961–2018	0.03	-0.09	1.00	-2.34	0.06	-0.05
	1961–2000	0.07	0.07	2.07	2.01	0.08	0.10
	2001–2018	0.47	0.03	17.11	0.45	0.76	-0.32
Nighttime	1961–2018	-0.02	-0.08	-0.56	-2.72	-0.01	-0.21
	1961–2000	-0.03	0.03	-1.30	0.22	-0.05	-0.16
	2001–2018	0.58	0.00	20.76*	0.10	1.60**	0.06

Note: *, **, and *** represent significance at 0.1, 0.05, and 0.01 level, respectively.

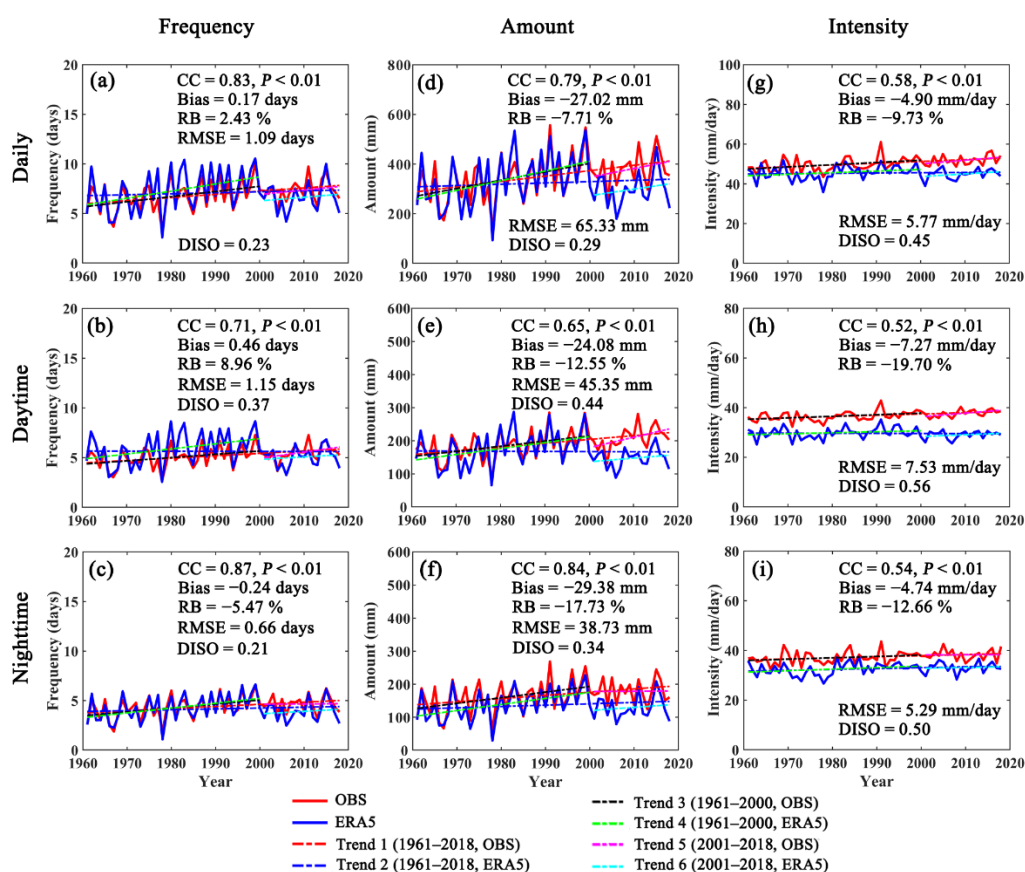


Figure S5. Same as figure S4, but in summer.

Table S2. Trends of summer extreme precipitation frequency, amount, and intensity from observational stations and their corresponding ERA5 grid points, respectively, at the daily, daytime, and nighttime scales.

Time scale	Period	Frequency (days/decade)		Amount (mm/decade)		Intensity mm/day/decade	
		OBS	ERA5	OBS	ERA5	OBS	ERA5
Daily	1961–2018	0.32**	0.10	21.74**	5.29	0.90**	0.15
	1961–2000	0.52**	0.72**	33.64**	39.05**	1.14**	0.82*
	2001–2018	0.44	0.37	35.57	26.47	1.83	1.38
Daytime	1961–2018	0.24**	-0.01	11.51**	-0.49	0.51**	-0.03
	1961–2000	0.33**	0.52**	15.60**	17.90**	0.64**	0.41
	2001–2018	0.63*	0.26	31.34**	11.12	1.46**	0.72
Nighttime	1961–2018	0.22**	0.09	9.74**	4.09	0.45**	0.35*
	1961–2000	0.40**	0.49**	16.98**	18.41**	0.55	0.62*
	2001–2018	0.03	0.26	0.82	9.65	0.04	0.33

Note: *, **, and *** represent significance at 0.1, 0.05, and 0.01 level, respectively.

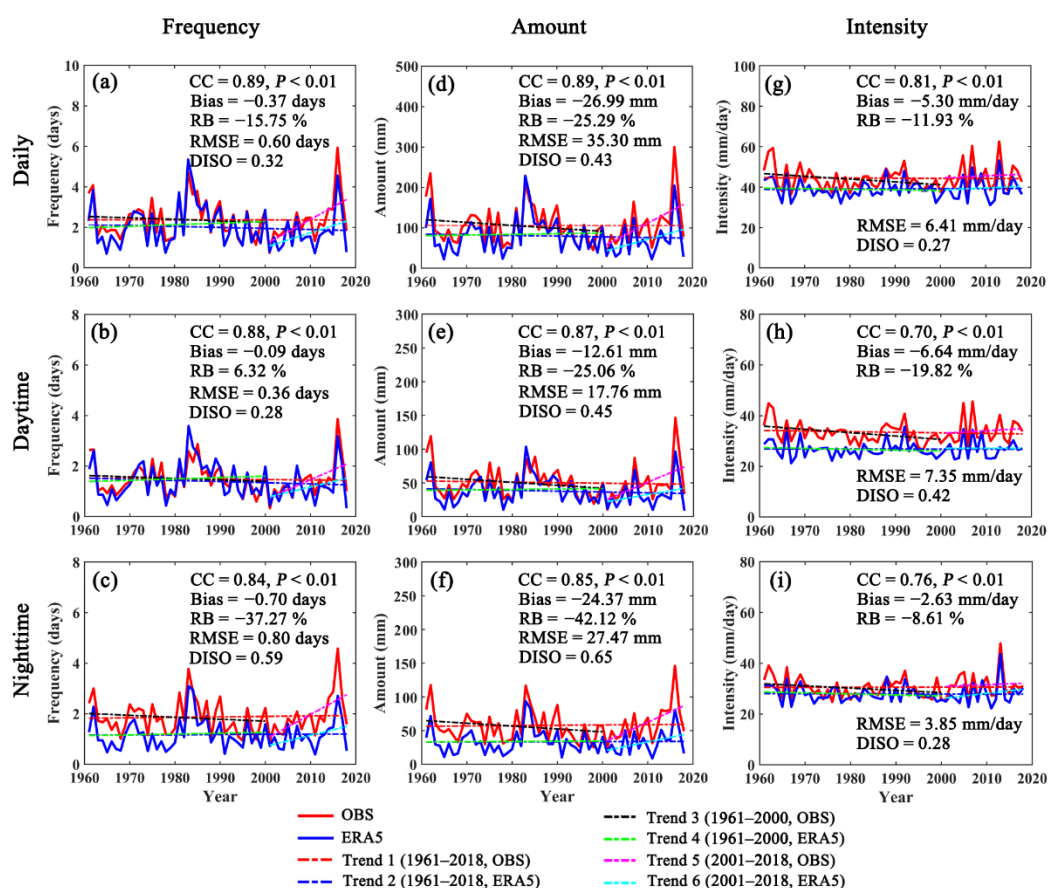


Figure S6. Same as figure S4, but in autumn.

Table S3. Trends of autumn extreme precipitation frequency, amount, and intensity from observational stations and their corresponding ERA5 grid points, respectively, at the daily, daytime, and nighttime scales.

Time scale	Period	Frequency (days/decade)		Amount (mm/decade)		Intensity mm/day/decade	
		OBS	ERA5	OBS	ERA5	OBS	ERA5
Daily	1961–2018	0.00	-0.05	-0.15	-1.68	-0.08	0.08
	1961–2000	-0.07	0.08	-7.36	1.68	-1.41*	-0.29
	2001–2018	1.24***	0.72*	58.51**	30.98	1.04	0.99
Daytime	1961–2018	-0.02	-0.05	-0.79	-1.24	-0.24	-0.02
	1961–2000	-0.06	0.06	-4.43	0.64	-1.34**	-0.34
	2001–2018	0.78**	0.43	28.22**	11.60	1.00	0.01
Nighttime	1961–2018	0.02	0.01	0.51	0.18	0.03	-0.04
	1961–2000	-0.08	0.03	-4.25	0.25	-0.89*	-0.40
	2001–2018	0.98***	0.44*	30.55**	13.66	0.72	2.01

Note: *, **, and *** represent significance at 0.1, 0.05, and 0.01 level, respectively.

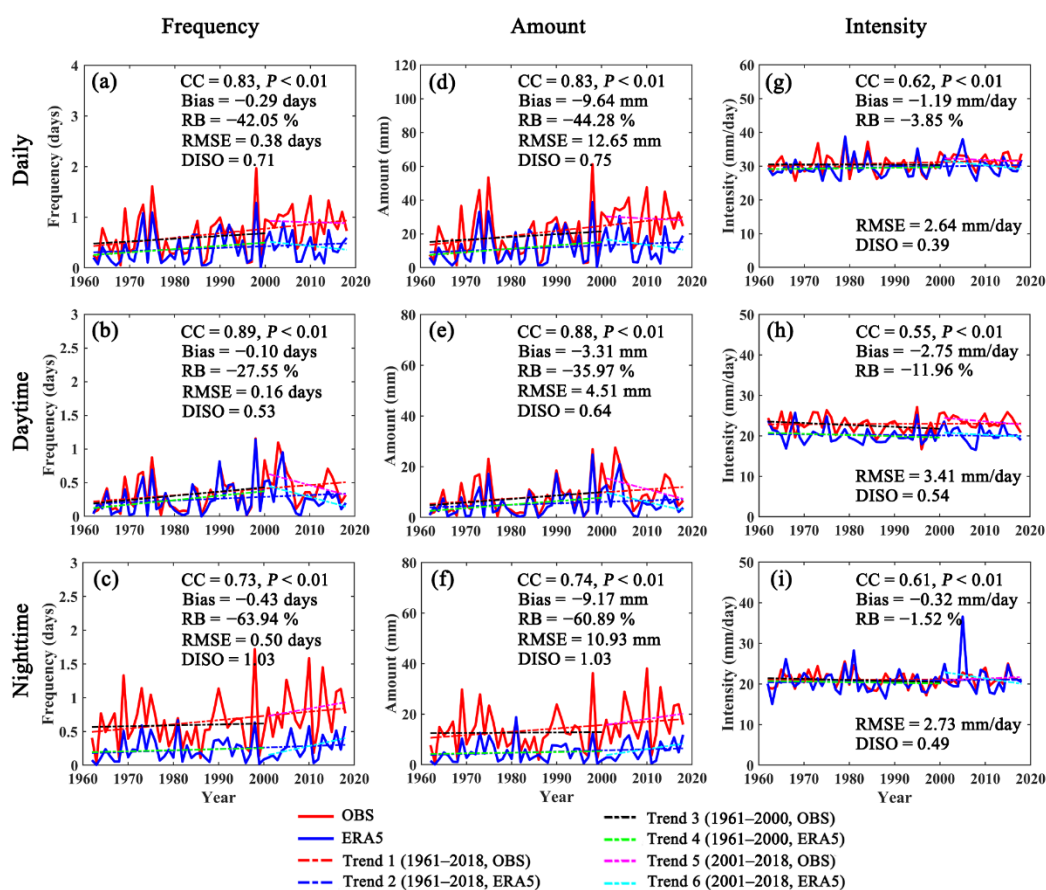


Figure S7. Same as figure S4, but in winter.

Table S4. Trends of winter extreme precipitation frequency, amount, and intensity from observational stations and their corresponding ERA5 grid points, respectively, at the daily, daytime, and nighttime scales.

Time scale	Period	Frequency (days/decade)		Amount (mm/decade)		Intensity mm/day/decade	
		OBS	ERA5	OBS	ERA5	OBS	ERA5
Daily	1961–2018	0.09**	0.03	2.95**	1.06	0.30	0.22
	1961–2000	0.05	0.06	1.63	2.02	-0.02	0.15
	2001–2018	-0.02	-0.09	-1.36	-3.56	-0.49	-1.42
Daytime	1961–2018	0.05**	0.03	1.20**	0.57	0.04	-0.09
	1961–2000	0.06	0.07*	1.37	1.37*	-0.47	-0.31
	2001–2018	-0.18	-0.18*	-4.76*	-4.12*	-0.96	-0.56
Nighttime	1961–2018	0.06**	0.02	1.32**	0.46	0.02	0.13
	1961–2000	0.01	0.02	0.11	0.27	-0.26	-0.16
	2001–2018	0.12	0.15*	2.58	2.63	0.42	-1.68

Note: *, **, and *** represent significance at 0.1, 0.05, and 0.01 level, respectively.

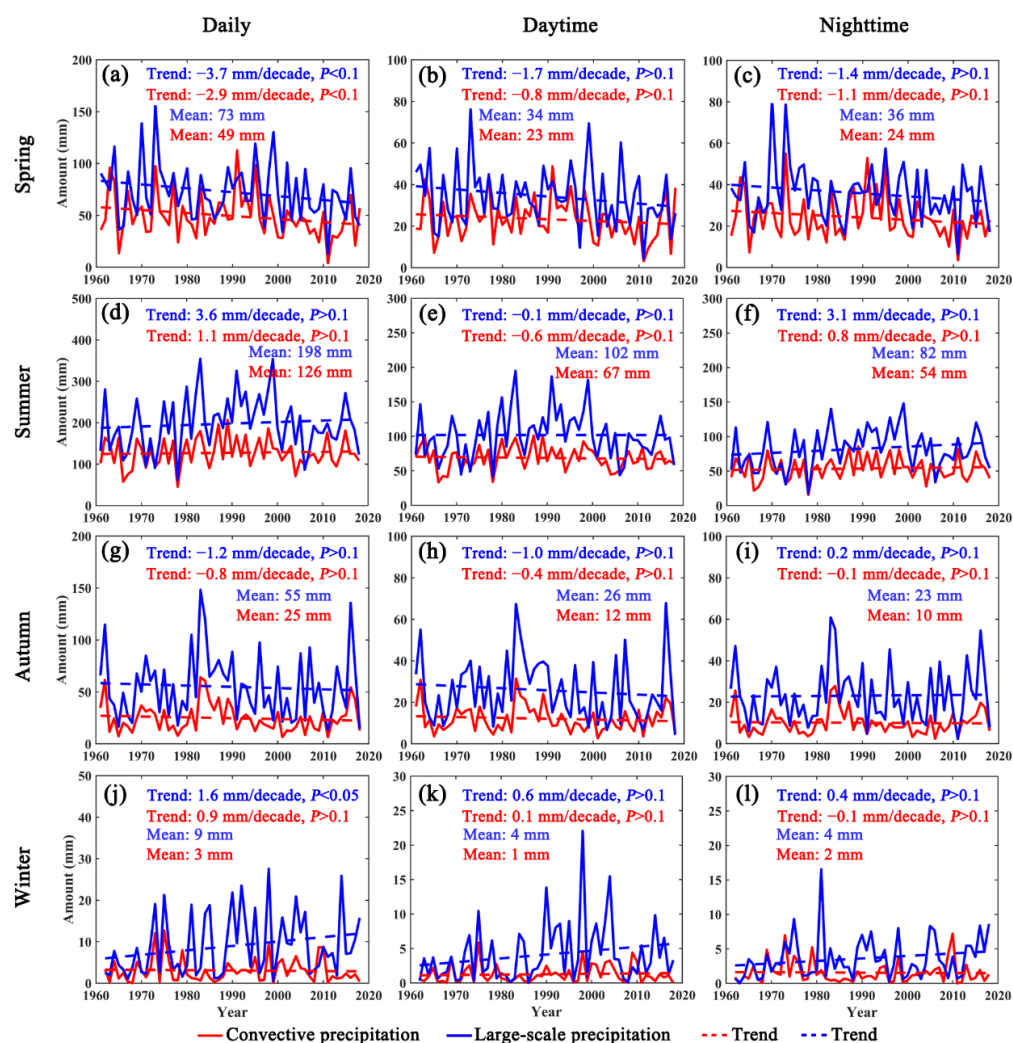


Figure S8. Seasonal variations of convective and large-scale precipitation contributed to extreme precipitation at the daily, daytime, and nighttime scales in the YRD during 1961–2018.