Supplementary Materials

Table S1. Observation stations of National Tibetan Plateau Data Center used in this study

ID	Time range	Time step	References	DOI
N1	2009-2017	Daily	Zhao, 2018	10.11888/AtmosphericPhysics.tpe.62.db.CSTR:18406.11.Atmospheric Physics.tpe.62.db
N2	2007-2017	Daily	Luo, 2018	10.11888/AtmosphericPhysics.tpe.68.db.CSTR:18406.11.Atmospheric Physics.tpe.68.db
N3	2011	Daily	Chen et al.; 2015; Chen et al.; 2014;	10.3972/heihe.110.2013.db.CSTR:18406.11.heihe.110.2013.db
N4	2007-2015	Daily	Hu et al.; 2015;Liu et al.; 2018; Li et al.;	10.3972/water973.0279.db.CSTR:18406.11.water973.0279.db
N5	2015-2017	Daily	Zhang, 2018	10.11888/Meteoro.tpdc.270086.CSTR:18406.11.Meteoro.tpdc.270086
N6	2003-2016	Daily	Wang, 2018	10.11888/AtmosEnviron.tpe.00000045.file.CSTR:18406.11.AtmosEnviron.tpe.00000045.file
N7	2008-2018	Daily	Zhao, 2021	10.11888/Meteoro.tpdc.271606.CSTR:18406.11.Meteoro.tpdc.271606
N8	2006-2010	Daily	He, 2014	10.3972/heihe.073.2014.db.CSTR:18406.11.heihe.073.2014.db
N9	2006-2010	Daily	Gao, 2018	10.11888/AtmosphericPhysics.tpe.5.db.CSTR:18406.11.AtmosphericPhysics.tpe.5.db
N10	2014-2018	Daily	Qin, 2018	10.11888/Glacio.tpdc.270004.CSTR:18406.11.Glacio.tpdc.270004
N11	2014-2018	Daily	Chen, 2019; Chen et al.; 2016	10.11888/Meteoro.tpdc.270460.CSTR:18406.11.Meteoro.tpdc.270460
N12	2005-2008	Daily	Wang, 2018	10.11888/Ecology.tpe.13.db.CSTR:18406.11.Ecology.tpe.13.db
N13-18	2004-2018	Daily	Zhao et al.; 2021; Zhao et al.; 2021;	10.11888/Geocry.tpdc.271107.CSTR:18406.11.Geocry.tpdc.271107
N19	2005-2009	Daily	Zhao, 2018	10.11888/AtmosphericPhysics.tpe.74.db.CSTR:18406.11.Atmospheric Physics.tpe.74.db
N20	2014-2018	Daily	Zhao, 2018	10.11888/Meteoro.tpdc.270084.CSTR:18406.11.Meteoro.tpdc.270084
N21	2006-2017	Daily	Luo, 2019	10.11888/AtmosphericPhysics.tpe.249395.db.CSTR:18406.11.AtmosphericPhysics.tpe.249395.db
N22	2005-2012	Daily	Luo, 2019	10.11888/AtmosphericPhysics.tpe.249395.db.CSTR:18406.11.AtmosphericPhysics.tpe.249396.db
N23	2012-2015	Daily	Zhang, 2018	10.11888/Meteoro.tpdc.270548.CSTR:18406.11.Meteoro.tpdc.270548
N24-29	2012-2017	Daily	Zhang, 2018	10.11888/Meteoro.tpdc.270005.CSTR:18406.11.Meteoro.tpdc.270005
N30	2005-2008	Daily	Luo and Liu, 2018	10.11888/Ecology.tpe.249285.db.CSTR:18406.11.Ecology.tpe.249285.db

N31	2007-2014	Daily	Yang, 2018	10.11888/AtmosPhys.tpe.249477.db.CSTR:18406.11.AtmosPhys.tpe.249477.db
N32	2007-2014	Daily	Yang, 2018	10.11888/AtmosPhys.tpe.249477.db.CSTR:18406.11.AtmosPhys.tpe.249477.db
N33	2005-2016	Daily	Ma, 2018; Ma et al.; 2011; Ma et al.;	10.11888/AtmosEnviron.tpe.0000014.file.CSTR:18406.11.AtmosEnviron.tpe.0000014.file
N34	2019-2020	Hourly	Niu, 2021	10.11888/Meteoro.tpdc.271282.CSTR:18406.11.Meteoro.tpdc.271282
N35	2020	Hourly	Hou, 2022	10.11888/Atmos.tpdc.272018.CSTR:18406.11.Atmos.tpdc.272018
N36	2007-2009	Hourly	Ma et al.; 2015; Xu et al.; 2015	10.3972/water973.0289.db.CSTR:18406.11.water973.0289.db
N37	2018	Hourly	Zhao and Zhang, 2019	10.11888/Geogra.tpdc.270165.CSTR:18406.11.Geogra.tpdc.270165
N38	2018	Hourly	Zhao and Zhang, 2021	10.11888/Meteoro.tpdc.271379.CSTR:18406.11.Meteoro.tpdc.271379
N39 -43	2016-2019	Hourly	Yang, 2020	10.11888/Meteoro.tpdc.270319.CSTR:18406.11.Meteoro.tpdc.270319 10.11888/Meteoro.tpdc.270319.CSTR:18406.11.Meteoro.tpdc.270319 10.11888/Meteoro.tpdc.270319.CSTR:18406.11.Meteoro.tpdc.270319 10.11888/Meteoro.tpdc.270319.CSTR:18406.11.Meteoro.tpdc.270319 10.11888/Meteoro.tpdc.270319.CSTR:18406.11.Meteoro.tpdc.270319
N44	2021	Hourly	Li, 2022; Li et al.; 2018; Li et al.; 2016	10.11888/Atmos.tpdc.272685.CSTR:18406.11.Atmos.tpdc.272685
N45	2020-2021	Hourly	Li, 2021; Li et al.; 2018; Li et al.; 2016	10.11888/Meteoro.tpdc.271382.CSTR:18406.11.Meteoro.tpdc.271382
N46 -70	2017-2020	Hourly	Chen et al.; 2022; Zhan et al.; 2022	10.11888/Atmos.tpdc.272983.CSTR:18406.11.Atmos.tpdc.272983
N71	2016	Hourly	Yang, 2018; Yang et al.; 2017	10.11888/AtmosPhys.tpe.249475.db.CSTR:18406.11.AtmosPhys.tpe.249475.db
N72	2016			

Table S2. Performance of each SPPs in detecting precipitation occurrence during different periods

	SPPs / Periods	CMO	GPM	MS	PER	CHI	GaM	GaN	PDI	PCS	PDR
POD	Jan	0.19	<u>0.05</u>	**0.77**	0.69	0.39	0.17	0.15	0.40	0.74	0.61
	Feb	0.31	<u>0.08</u>	**0.80**	0.71	0.46	0.19	0.20	0.51	0.75	0.68
	Mar	0.47	<u>0.16</u>	**0.84**	0.75	0.49	0.36	0.33	0.69	0.79	0.75
	Apr	0.64	<u>0.27</u>	**0.88**	0.75	0.44	0.54	0.51	0.81	0.76	0.82
	May	0.68	0.41	**0.94**	0.61	<u>0.26</u>	0.65	0.61	0.83	0.59	0.80
	Jun	0.69	0.53	**0.97**	0.51	<u>0.30</u>	0.71	0.68	0.80	0.50	0.76
	Jul	0.79	0.69	**0.98**	0.61	<u>0.44</u>	0.77	0.74	0.84	0.60	0.83
	Aug	0.80	0.66	**0.98**	0.60	<u>0.42</u>	0.77	0.74	0.82	0.59	0.82
	Sep	0.71	0.52	**0.97**	0.47	<u>0.30</u>	0.62	0.63	0.78	0.46	0.76
	Oct	0.60	0.41	**0.89**	0.45	<u>0.21</u>	0.44	0.46	0.73	0.48	0.67
	Nov	0.42	0.20	**0.78**	0.55	0.28	<u>0.19</u>	0.25	0.62	0.60	0.63
	Dec	0.24	<u>0.07</u>	**0.69**	0.58	0.32	0.14	0.14	0.41	0.63	0.47
	Warm	0.77	0.62	**0.98**	0.57	<u>0.38</u>	0.74	0.71	0.83	0.56	0.81
	Cold	0.33	<u>0.11</u>	**0.78**	0.69	0.45	0.27	0.24	0.54	0.75	0.67
	Annual	0.70	0.53	**0.96**	0.61	<u>0.38</u>	0.64	0.62	0.79	0.60	0.79
FAR	Jan	0.23	**0.01**	0.24	0.42	0.14	0.10	0.08	0.20	<u>0.44</u>	0.34
	Feb	0.36	**0.03**	0.30	0.50	0.21	0.12	0.10	0.30	<u>0.52</u>	0.42
	Mar	0.44	**0.06**	0.36	0.54	0.26	0.23	0.20	0.46	0.56	<u>0.57</u>
	Apr	0.54	**0.12**	0.47	0.51	0.21	0.34	0.30	0.54	0.49	<u>0.59</u>
	May	0.53	0.12	0.56	0.36	**0.11**	0.44	0.39	0.55	0.34	<u>0.59</u>
	Jun	0.43	0.19	<u>0.71</u>	0.24	**0.12**	0.45	0.38	0.50	0.25	0.52
	Jul	0.42	0.30	<u>0.77</u>	0.30	**0.19**	0.44	0.36	0.50	0.30	0.57
	Aug	0.43	0.24	<u>0.77</u>	0.25	**0.15**	0.43	0.35	0.44	0.25	0.51
	Sep	0.37	0.15	<u>0.67</u>	0.16	**0.09**	0.34	0.28	0.37	0.15	0.39
	Oct	0.46	0.13	<u>0.48</u>	0.18	**0.06**	0.19	0.20	0.33	0.19	0.33
	Nov	<u>0.40</u>	**0.05**	0.27	0.25	0.06	0.10	0.13	0.27	0.26	0.28
	Dec	0.28	**0.02**	0.19	0.29	0.09	0.06	0.07	0.15	<u>0.30</u>	0.22
	Cold	0.40	0.21	<u>0.72</u>	0.22	**0.13**	0.40	0.33	0.43	0.22	0.48
	Warm	0.32	**0.03**	0.27	0.43	0.17	0.12	0.11	0.26	<u>0.44</u>	0.37
	Annual	0.38	**0.12**	<u>0.47</u>	0.34	0.14	0.26	0.23	0.37	0.33	0.44
FPR	Jan	0.83	0.66	**0.63**	0.76	0.71	<u>0.87</u>	0.80	0.79	0.80	0.79
	Feb	<u>0.82</u>	**0.56**	0.62	0.74	0.68	0.78	0.72	0.75	0.75	0.75
	Mar	<u>0.72</u>	**0.44**	0.54	0.68	0.62	0.66	0.65	0.67	0.68	0.69
	Apr	<u>0.59</u>	**0.35**	0.46	0.57	0.50	0.56	0.52	0.56	0.55	0.57
	May	0.46	**0.26**	0.38	0.43	0.37	<u>0.47</u>	0.41	0.45	0.42	0.46
	Jun	0.32	**0.23**	0.34	0.31	0.26	<u>0.37</u>	0.30	0.35	0.31	0.36
	Jul	0.22	0.18	0.27	0.21	**0.17**	<u>0.29</u>	0.21	0.24	0.21	0.27
	Aug	0.25	**0.20**	0.31	0.23	0.20	<u>0.32</u>	0.24	0.27	0.23	0.30
	Sep	0.35	**0.24**	0.38	0.31	0.28	<u>0.44</u>	0.33	0.35	0.30	0.36
	Oct	0.62	**0.46**	0.53	0.53	0.46	<u>0.64</u>	0.53	0.55	0.52	0.56
	Nov	0.81	**0.66**	0.66	0.74	0.66	<u>0.84</u>	0.79	0.77	0.77	0.78

	Dec	0.84	0.75	**0.67**	0.77	0.79	_0.89_	0.88	0.83	0.85	0.84
	Cold	0.27	**0.20**	0.32	0.25	0.21	_0.34_	0.25	0.29	0.25	0.31
	Warm	_0.77_	**0.56**	0.59	0.73	0.67	0.74	0.73	0.74	0.75	0.75
	Annual	_0.49_	**0.25**	0.40	0.45	0.39	0.43	0.36	0.43	0.47	0.47
CSI	Jan	0.08	_0.04_	**0.32**	0.16	0.16	0.07	0.08	0.14	0.17	0.17
	Feb	0.11	_0.06_	**0.35**	0.19	0.19	0.10	0.12	0.19	0.20	0.21
	Mar	0.21	_0.14_	**0.43**	0.25	0.23	0.19	0.19	0.28	0.27	0.28
	Apr	0.34	_0.23_	**0.50**	0.35	0.27	0.34	0.34	0.39	0.37	0.39
	May	0.44	0.35	**0.60**	0.40	_0.22_	0.42	0.43	0.49	0.39	0.46
	Jun	0.53	0.45	**0.65**	0.41	_0.26_	0.51	0.54	0.57	0.41	0.53
	Jul	0.65	0.59	**0.72**	0.52	_0.40_	0.59	0.63	0.66	0.51	0.64
	Aug	0.63	0.56	**0.68**	0.49	_0.38_	0.56	0.60	0.62	0.49	0.60
	Sep	0.51	0.44	**0.61**	0.38	_0.26_	0.43	0.49	0.55	0.38	0.52
	Oct	0.30	0.29	**0.45**	0.27	_0.16_	0.25	0.31	0.37	0.28	0.33
	Nov	0.13	0.12	**0.29**	0.15	0.15	_0.08_	0.11	0.18	0.17	0.18
	Dec	0.08	_0.04_	**0.24**	0.12	0.12	0.05	0.05	0.11	0.12	0.12
	Cold	0.60	0.53	**0.67**	0.47	_0.34_	0.54	0.58	0.61	0.47	0.59
	Warm	0.14	_0.09_	**0.35**	0.20	0.19	0.13	0.13	0.21	0.20	0.22
	Annual	0.44	0.44	**0.58**	0.37	_0.29_	0.44	0.46	0.48	0.37	0.46
Accuracy	Jan	0.67	0.81	0.75	_0.55_	0.80	**0.83**	0.83	0.76	0.58	0.66
	Feb	0.59	0.79	0.73	_0.52_	0.73	**0.79**	0.78	0.69	0.52	0.61
	Mar	0.58	**0.76**	0.74	_0.51_	0.67	0.69	0.70	0.60	0.51	0.54
	Apr	0.59	0.70	**0.71**	0.57	0.64	0.68	0.69	0.60	0.58	_0.56_
	May	0.62	0.67	**0.72**	0.62	_0.59_	0.67	0.67	0.64	0.62	_0.59_
	Jun	0.69	0.67	**0.72**	0.63	_0.55_	0.69	0.71	0.69	0.62	0.64
	Jul	0.73	0.71	**0.76**	0.67	_0.59_	0.71	0.73	0.74	0.65	0.72
	Aug	0.73	0.70	**0.73**	0.66	_0.60_	0.70	0.72	0.72	0.66	0.70
	Sep	0.70	0.69	0.70	0.67	_0.59_	0.69	**0.71**	**0.71**	0.66	0.69
	Oct	_0.59_	0.74	0.69	0.70	0.72	**0.77**	0.74	0.69	0.71	0.67
	Nov	_0.58_	0.80	0.74	0.68	**0.85**	0.84	0.80	0.72	0.72	0.71
	Dec	0.65	0.82	0.76	_0.63_	0.86	**0.88**	0.86	0.81	0.69	0.76
	Warm	0.71	0.69	**0.73**	0.66	_0.58_	0.70	0.72	0.72	0.65	0.69
	Cold	0.62	**0.79**	0.74	_0.56_	0.77	**0.79**	**0.79**	0.72	0.58	0.64
	Annual	0.67	**0.75**	0.74	_0.63_	0.67	0.74	0.74	0.70	0.63	0.66

Note: The underline means the worst performance, while bold font represents the best performance.