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Evaluation of remote-sensing- and reanalysis-based precipitation products for agro-hydrological studies in the semi-arid tropics of Tamil Nadu

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Supplementary Tables and Figures

Table S1a. Geographic coordinates of the Meteorological ground stations

Geographic coordinates (°N,°E)			
Coimbatore	Madurai	Tiruchirapalli	Tuticorin
11.1869976,76.8228552	9.9585312,77.7565042	11.3384582,78.539969	9.3464424,78.0663815
11.0298278,76.8263478	9.8040348,77.62401	11.1891953,78.5362835	9.1953367,77.9152757
10.8831359,76.8228552	9.6471797,77.7588629	11.0307185,78.226701	9.1934939,78.0719097
10.4226101,76.8243661	9.9597106,77.9168974	11.0436178,78.383335	9.1898084,78.2248582
11.340301,76.9828428	9.8099316,77.9168974	11.019662,78.5391262	9.0387027,77.76417
11.1873525,76.9754718	9.6495384,77.9145386	11.041775,78.6947602	9.0350172,77.9115902
11.0288758,76.9773145	9.7993174,78.072573	11.034404,78.8384949	9.0350172,78.0719097
10.8796128,76.9883711	9.9561725,78.0725731	10.8888266,78.5381262	9.0258034,78.21933
10.7266643,76.9810001	9.8052142,78.0713938	10.8685563,78.6910747	8.880226,77.7604845
10.5774013,76.9791573	9.9585312,78.2306076	10.870399,78.8550797	8.8839115,77.913433
10.4207673,76.9865283	10.1059514,78.3803866	10.7248216,78.6855464	8.880226,78.0755952
10.2586051,76.9791573	9.9585312,78.385104	10.5718731,78.3796495	8.7328057,77.9171185
11.1855098,77.1339485		10.4170818,78.3814922	8.723592,78.0719097
11.0288758,77.1431623		10.721136,78.8513942	8.5798572,77.9097495
10.8796128,77.1394768		10.4189246,78.539969	8.5780145,78.0719097
10.7248216,77.1321058			8.4140095,77.913433
10.5847723,77.1339485			

(Source: Public Works Department, Government of Tamil Nadu)

Leave One Out Cross Validation (LOOCV) for linear interpolation

We performed a LOOCV analysis on the linear interpolated data to check for bias or uncertainty in the data. LOOCV was performed on linear interpolation based on assuming that the value of a station was unknown. The unknown station was estimated from the value of the neighbouring stations based on linear interpolation. The analysis was systematically carried out in Python. The results of the LOOCV analysis represent the mean RMSE at a monthly timescale, which includes both monsoon and non-monsoon months. The RMSE and %MAE of LOOCV analysis produced lower values, indicating minimal uncertainty due to the linear interpolation. Hence, we proceeded with linear interpolation of station data before grid-to-grid comparison.

Table S1b. LOOCV performance of Linear interpolation of precipitation at the monthly timescale

Study Region	Mean RMSE (mm)	Percent Mean Absolute Error (%)
Coimbatore	39.22	36
Madurai	52.50	30
Tiruchirappalli	39.93	29
Tuticorin	42.32	25

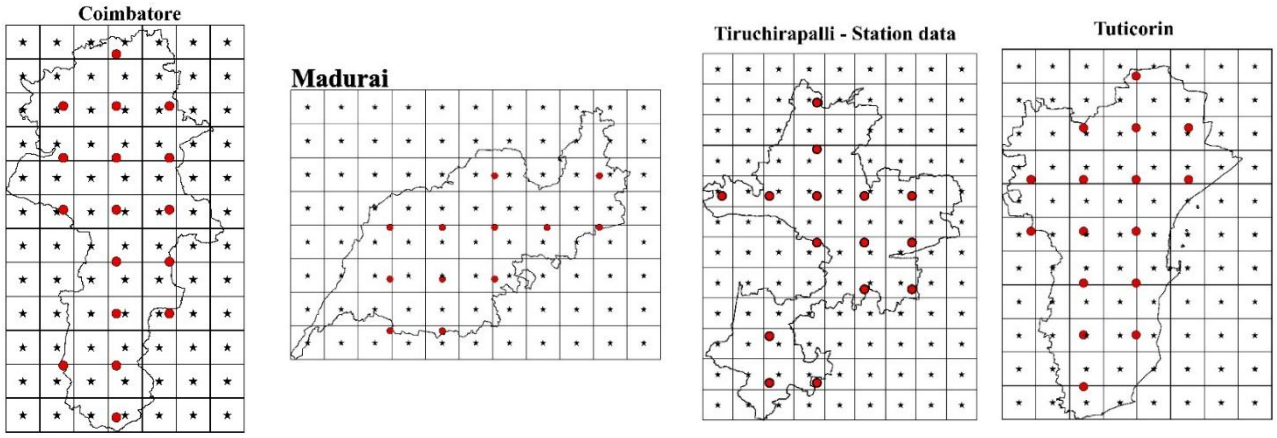

Figure S1: Linearly interpolated grids (0.1°) of the study regions along with the station data. In the figure above, red points denote the distribution of station datasets. The grids and the stars represent the linear interpolation. Only grids that are surrounded by at least one rain gauge station were included in the analysis to avoid uncertainties in the analysis.

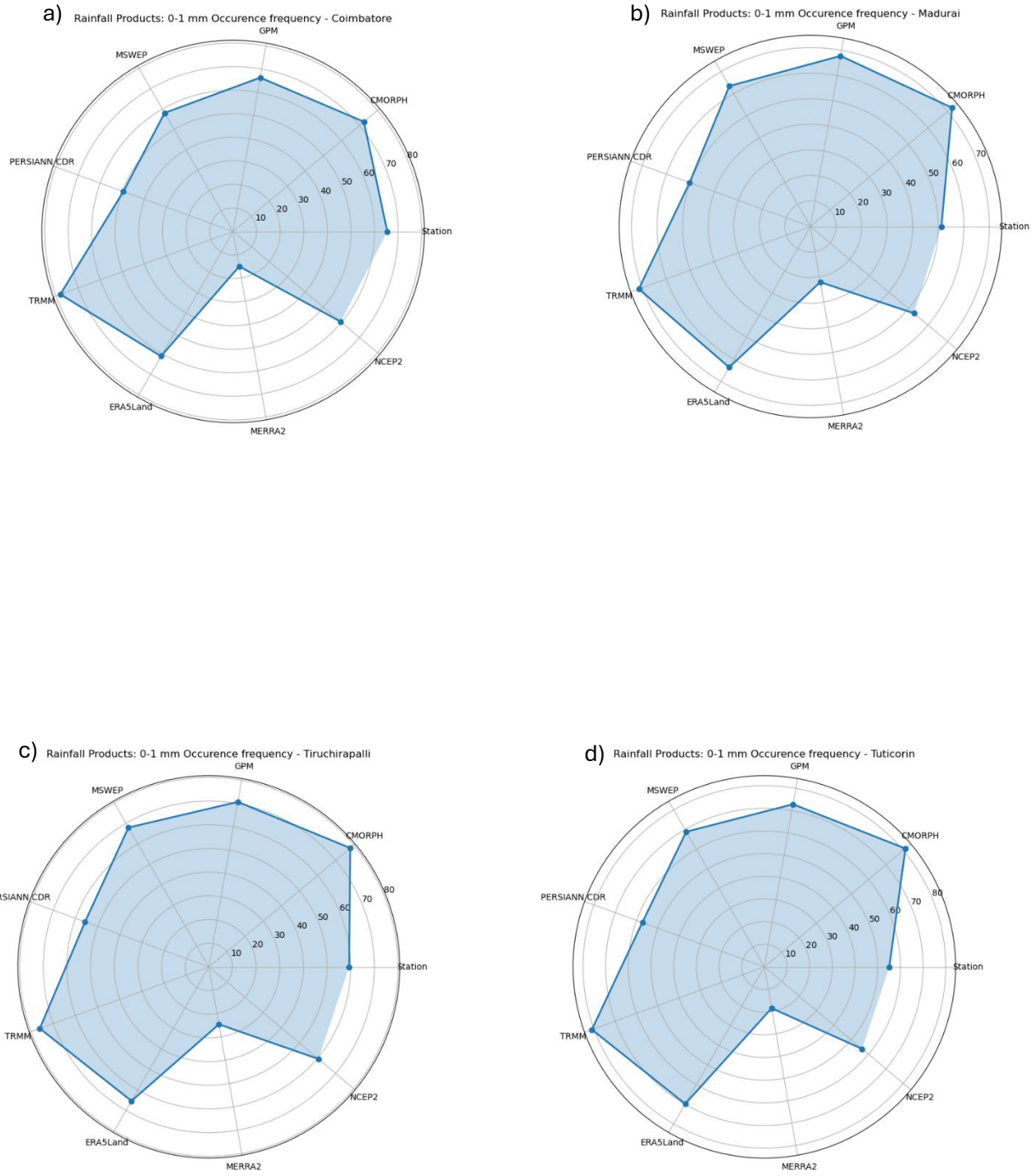

Figure S2 Occurrence frequency of precipitation (0-1 mm) for (a) Coimbatore, (b) Madurai, (c) Tiruchirapalli and (d) Tuticorin

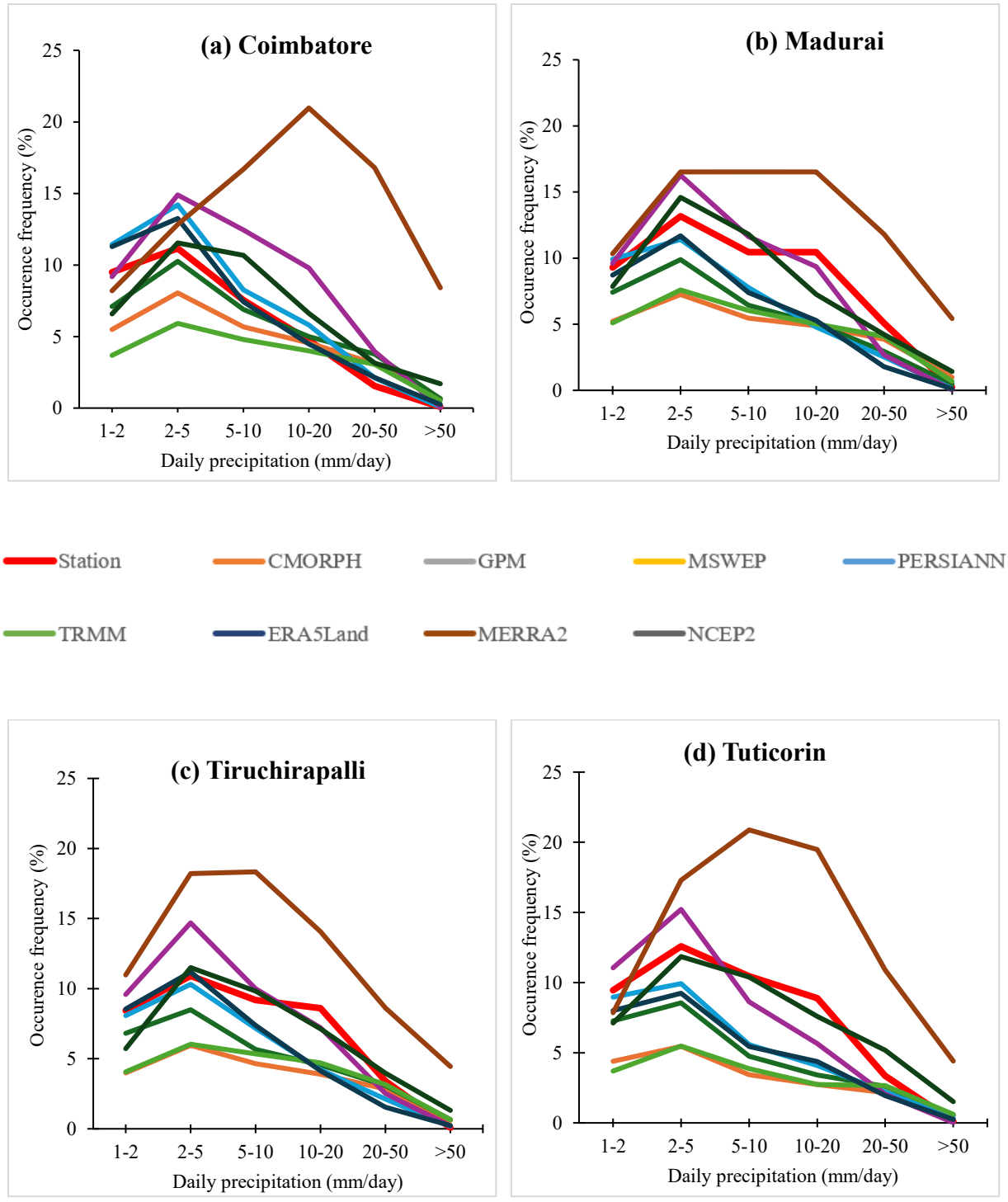

Figure S3 Occurrence frequency of precipitation (1-> 50 mm) for (a) Coimbatore, (b) Madurai, (c) Tiruchirapalli and (d) Tuticorin

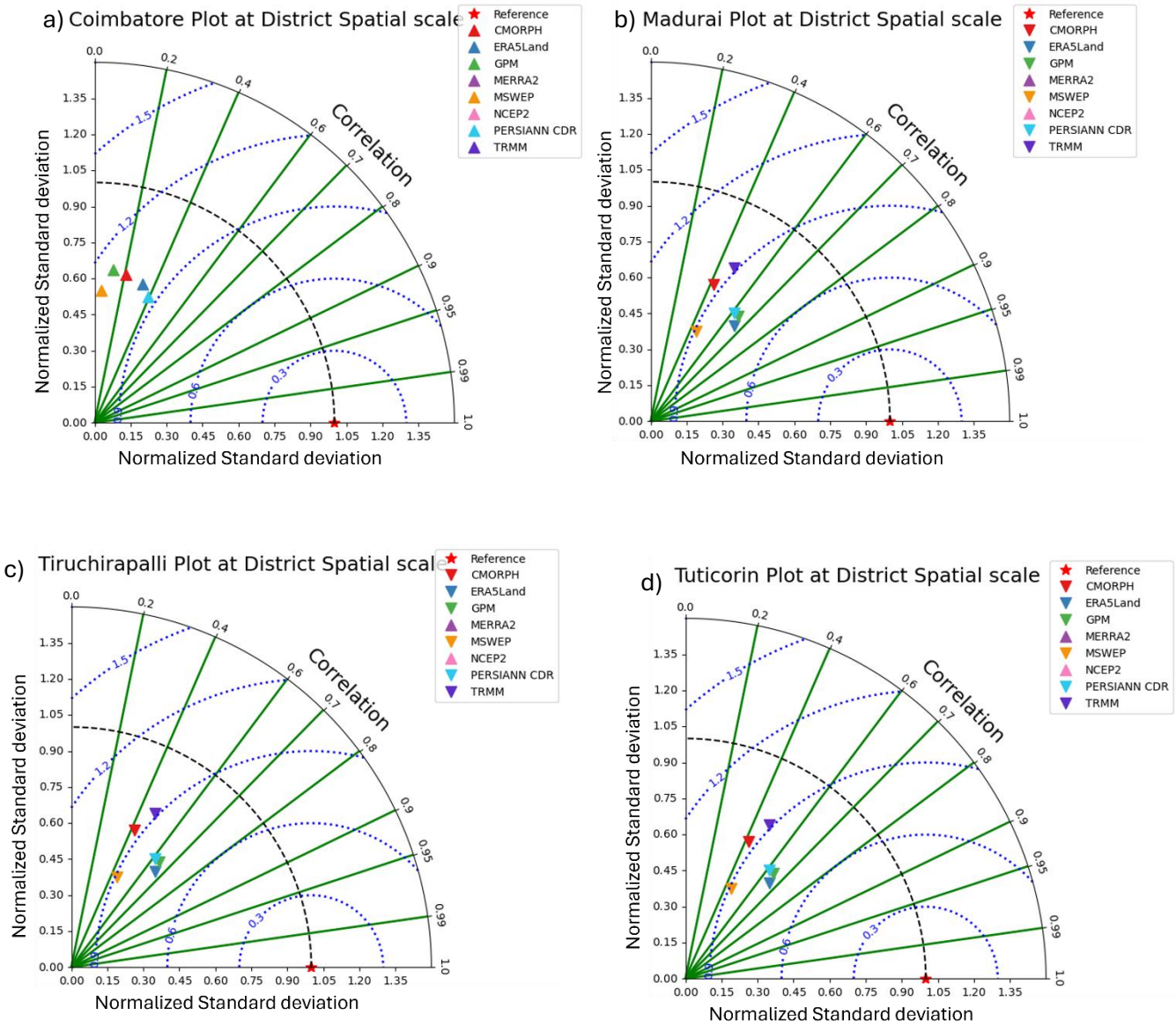

Figure S4 Taylor diagram depicting the agreement between station data and precipitation products at a yearly district scale

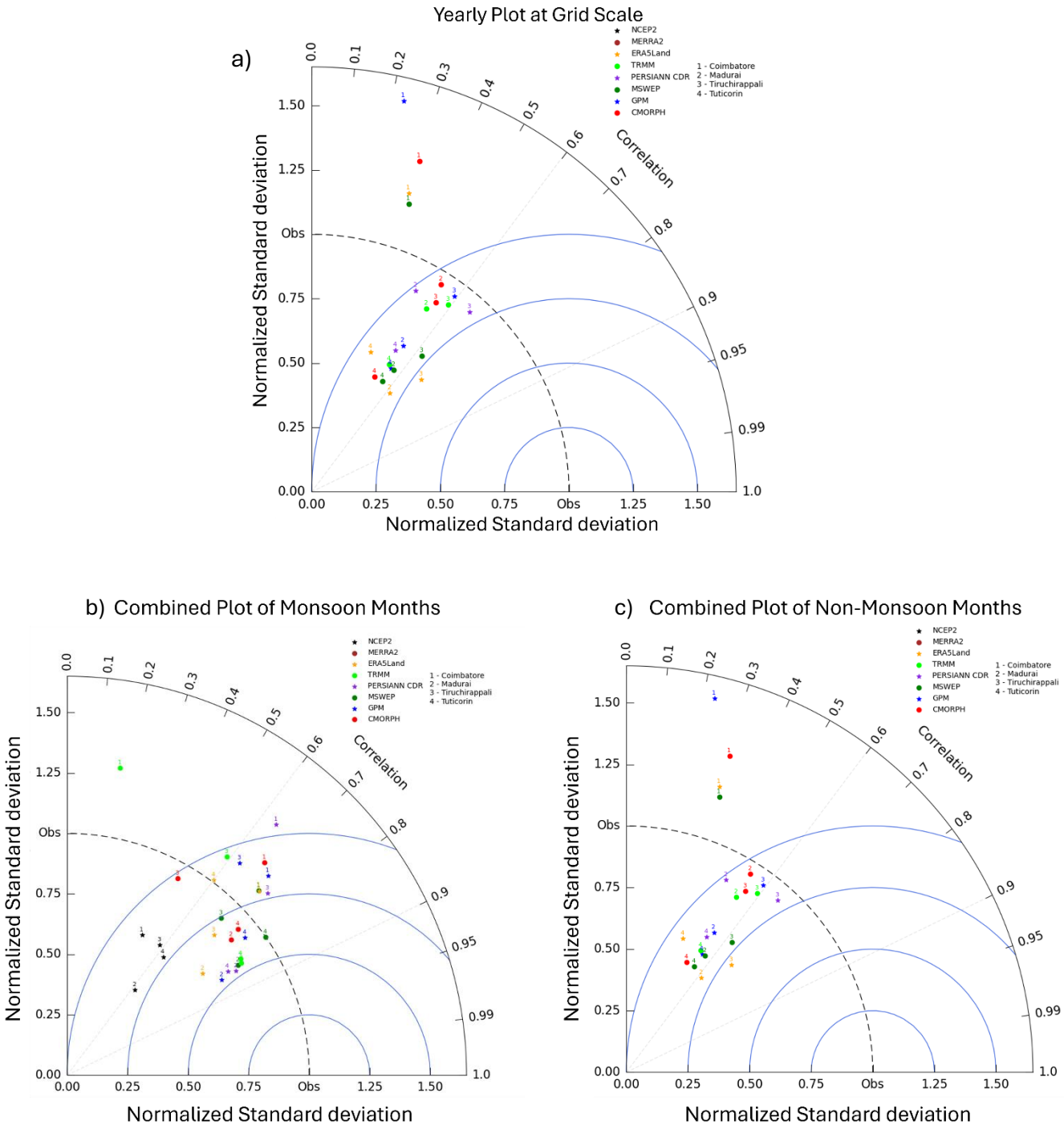

Figure S5 Combined Taylor diagram depicting the agreement between station data and precipitation products at a) yearly grid scale b) monsoon months c) non-monsoon months

Table S2. Daily precipitation characteristics of Coimbatore, Madurai, Tiruchirapalli and Tuticorin

		Coimbatore				Madurai				Tiruchirapalli				Tuticorin			
Scale	**Product**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**
Grid	**CMORPH**	3.62	0.36	0.58	1.59	5.21	0.47	-1.12	1.17	4.19	0.42	-0.97	1.21	3.88	0.55	-1.66	1.05
	GPM-IMERG	3.87	0.38	1.00	1.70	4.67	0.53	-1.60	1.05	4.19	0.47	-0.55	1.21	3.99	0.60	-1.26	1.08
	MSWEP	2.96	0.55	0.39	1.30	4.09	0.61	-1.85	0.91	3.45	0.56	-1.15	0.99	3.23	0.66	-0.99	0.87
	PERSIANN CDR	4.25	0.56	0.37	1.87	4.52	0.62	-1.95	1.01	3.91	0.57	-1.17	1.13	3.62	0.63	-1.21	0.98
	TRMM	3.49	0.30	0.20	1.53	5.09	0.50	-1.26	1.14	4.27	0.44	-0.67	1.23	3.96	0.58	-1.53	1.07
	ERA5-Land	2.86	0.57	0.35	1.26	3.86	0.63	-2.04	0.86	3.24	0.59	-1.19	0.93	3.57	0.61	-1.43	0.96
	MERRA2	18.95	0.13	18.29	8.32	13.02	0.25	10.87	2.91	11.19	0.18	9.38	3.22	11.89	0.23	10.49	3.21
	NCEP2	5.40	0.13	2.59	2.37	6.44	0.28	0.45	1.44	5.50	0.26	1.06	1.59	6.16	0.30	1.48	1.66
District	**CMORPH**	3.39	0.39	0.58	1.49	5.12	0.48	-1.12	1.15	4.11	0.43	-0.97	1.18	3.69	0.59	-1.66	1.00
	GPM-IMERG	3.55	0.41	1.00	1.56	4.56	0.55	-1.60	1.02	4.08	0.48	-0.55	1.18	3.62	0.64	-1.26	0.98
	MSWEP	2.70	0.59	0.39	1.18	4.00	0.63	-1.85	0.89	3.36	0.57	-1.15	0.97	3.19	0.66	-0.99	0.86
	PERSIANN CDR	4.04	0.59	-0.17	1.77	4.44	0.64	-1.95	0.99	3.81	0.58	-1.17	1.10	3.38	0.66	-1.21	0.91
	TRMM	0.17	0.37	1.43	0.07	4.99	0.52	-1.26	1.12	4.17	0.45	-0.67	1.20	3.74	0.61	-1.53	1.01
	ERA5-Land	0.06	0.59	-0.73	0.03	3.79	0.65	-2.04	0.85	3.15	0.60	-1.19	0.91	3.28	0.66	-1.43	0.89
	MERRA2	18.70	0.14	18.29	8.21	12.93	0.25	10.87	2.90	11.09	0.17	9.38	3.20	11.62	0.23	10.49	3.14
	NCEP2	5.22	0.13	2.59	2.29	6.40	0.29	0.45	1.43	5.43	0.26	1.06	1.57	6.00	0.29	1.48	1.62

Table S3. Monthly precipitation characteristics of Coimbatore, Madurai, Tiruchirapalli and Tuticorin

		Coimbatore				Madurai				Tiruchirapalli				Tuticorin			
Scale	**Product**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**	**MAE**	**IOA**	**BIAS**	**%MAE**
Grid	**CMORPH**	53.79	0.72	17.60	0.78	66.47	0.79	-34.17	0.49	55.51	0.77	-29.57	0.527	60.42	0.79	-50.57	0.54
	GPM-IMERG	61.88	0.67	30.57	0.90	65.64	0.80	-48.76	0.48	51.08	0.83	-16.67	0.485	55.31	0.83	-38.41	0.49
	MSWEP	45.99	0.83	8.71	0.67	67.68	0.79	-58.34	0.50	50.99	0.82	-36.54	0.484	47.07	0.86	-32.02	0.42
	PERSIANN CDR	84.50	0.54	54.51	1.23	68.06	0.79	-25.84	0.50	43.51	0.87	-7.32	0.413	50.59	0.83	-29.84	0.45
	TRMM	80.84	0.30	0.20	1.18	63.63	0.82	-38.29	0.47	51.99	0.82	-20.43	0.494	57.74	0.82	-46.41	0.51
	ERA5-Land	43.63	0.78	5.70	0.63	69.98	0.78	-62.09	0.52	49.01	0.83	-36.16	0.465	62.03	0.77	-43.45	0.55
	MERRA2	68.78	0.16	556.73	1.00	333.84	0.42	330.96	2.47	17383.95	0.34	285.37	165	319.79	0.37	319.31	2.85
	NCEP2	121.22	0.13	78.79	1.76	131.16	0.30	13.65	0.97	103.07	0.40	32.27	0.979	114.70	0.38	45.12	1.02
District	**CMORPH**	47.69	0.77	17.60	0.69	65.44	0.79	-34.17	0.48	53.66	0.78	-29.57	0.509	57.18	0.82	-50.57	0.51
	GPM-IMERG	54.81	0.71	30.57	0.80	64.83	0.81	-48.76	0.48	48.52	0.84	-16.67	0.461	51.76	0.85	-38.41	0.46
	MSWEP	38.43	0.83	8.71	0.56	67.00	0.80	-58.34	0.49	49.13	0.83	-36.54	0.466	46.72	0.86	-32.02	0.42
	PERSIANN CDR	78.23	0.54	54.51	1.14	67.76	0.80	-25.84	0.50	41.04	0.89	-7.32	0.39	44.03	0.86	-29.84	0.39
	TRMM	2.28	0.30	25.22	0.03	62.88	0.83	-38.29	0.46	50.09	0.83	-20.43	0.476	4947.30	0.84	-46.41	44.10
	ERA5-Land	35.84	0.84	5.70	0.52	69.45	0.78	-62.09	0.51	47.53	0.84	-36.16	0.451	55.56	0.82	-43.45	0.50
	MERRA2	556.66	0.15	556.73	8.09	333.68	0.42	330.96	2.46	287.05	0.34	285.37	2.725	319.43	0.37	319.31	2.85
	NCEP2	117.64	0.12	78.79	1.71	130.84	0.30	13.67	0.97	102.69	0.40	32.27	0.975	113.03	0.37	45.12	1.01

Table S4. Yearly precipitation characteristics of Coimbatore, Madurai, Tiruchirapalli and Tuticorin

		Coimbatore			**Madurai**			**Tiruchirapalli**			**Tuticorin**		
Scale	**Product**	**MAE**	**IOA**	**%MAE**	**MAE**	**IOA**	**%MAE**	**MAE**	**IOA**	**%MAE**	**MAE**	**IOA**	**%MAE**
Grid	**CMORPH**	344.76	0.47	0.41	433.69	0.52	0.27	382.18	0.49	0.30	625.21	0.44	0.46
	GPM-IMERG	454.90	0.44	0.55	585.09	0.50	0.36	230.68	0.72	0.18	461.92	0.55	0.34
	MSWEP	317.51	0.41	0.38	700.10	0.44	0.43	438.44	0.51	0.35	384.15	0.56	0.28
	PERSIANN CDR	670.97	0.44	0.81	330.26	0.60	0.20	174.31	0.80	0.14	379.93	0.50	0.28
	TRMM	860.22	0.07	1.04	462.26	0.54	0.28	266.01	0.65	0.21	558.37	0.48	0.41
	ERA5-Land	278.73	0.57	0.34	745.05	0.25	0.46	434.31	0.57	0.34	521.35	0.41	0.39
	MERRA2	6680.71	0.07	8.04	3971.54	0.12	2.44	3424.42	0.12	2.70	3831.64	0.13	2.83
	NCEP2	976.94	0.26	1.18	471.97	0.07	0.29	446.51	0.32	0.35	640.77	0.25	0.47
District	**CMORPH**	9.69	0.53	0.28	61.43	0.52	0.26	45.75	0.49	0.29	51.83	0.44	0.46
	GPM-IMERG	15.95	0.40	0.46	83.60	0.51	0.36	25.64	0.74	0.16	38.42	0.54	0.34
	MSWEP	12.50	0.58	0.36	100.03	0.45	0.43	54.80	0.51	0.35	192.15	0.57	1.71
	PERSIANN CDR	27.25	0.31	0.79	45.61	0.61	0.20	17.66	0.85	0.11	29.85	0.56	0.26
	TRMM	6.53	0.57	0.19	65.67	0.54	0.28	30.63	0.67	0.19	46.43	0.49	0.41
	ERA5-Land	9.72	0.80	0.28	106.46	0.46	0.46	54.21	0.58	0.34	43.44	0.51	0.39
	MERRA2	278.36	0.04	8.04	567.34	0.12	2.43	428.06	0.11	2.70	319.30	0.11	2.83
	NCEP2	39.40	0.12	1.14	66.67	0.07	0.29	54.81	0.31	0.35	53.25	0.20	0.47