Figure S1: Libya map

Table S1. Utilization of the satellite database for evaluating the potential of wind energy in various regions

Reference	Location/Country	Data source
[78]	Antarctic	ERA reanalysis and RACMO2/ANT
[79]	Iberian Peninsula	NASA's Sea Winds
[80]	Europe	ERA-Interim
[81]	Africa	VORTEX
[82]	India	NASA
[83]	Kribi/ Cameroon	NASA
[84]	European Coasts	ERA-Interim, ERA20C, and NCEP
[85]	Germany, Denmark, France, Sweden, and Bonneville.	MERRA-2 and ERA5
[86]	Portugal	NCEP-R2, ERA-Interim, NASA-MERRA and NCEP-CFSR
[87]	Republic of Djibouti	NCEP-CFSR and ERA5
[88]	Algeria	ERA-Interim
[89]	South Sudan	TerraClimate data
[90]	Cameroon	NASA satellite
[91]	Northern Hemisphere	ERA-Interim, JRA-55, CFS, and MERRA-2.
[92]	Colombia	ERA5 reanalyses
[93]	FINO3, Cabauw, Boulder, Ghoroghchi, Humansdorp, and Wallaby Creek	ERA5 reanalyses
[94]	Northern Cyprus	European Centre for Medium-Range Weather Forecasts
[95]	Global	ERA5 reanalyses
[96]	Algeria	ERA5 reanalyses

Table S2. Model performance rating based on RRMSE

Performance rating	Range of RRMSE
Excellent	$< 10\%$
Good	$10\% < RRMSE < 20\%$
Fair	$20\% < RRMSE < 30\%$
Poor	$> 30\%$

Table S3. Summary of reviewed studies on analyzing WSC at different locations (worldwide) using various distribution functions (DFs)

Reference	Region	DFs used
[101]	United Arab Emirates	Gamma, generalized extreme value, generalized Gamma, Kappa, Kernel density, 2-parameter Lognormal, 3-parameter Lognormal, Pearson type III, 2-parameter Weibull, 3-parameter Weibull and Gumbel
[102]	Northern Cyprus	2-parameter Weibull, Gamma, Lognormal, Logistic, Log-Logistic, Inverse Gaussian, Generalized Extreme Value, Nakagami, Normal and Rayleigh
[103]	Pakistan	2-parameter Weibull, Gamma, Lognormal, Logistic, Log-Logistic, Inverse Gaussian, Generalized Extreme Value, Nakagami, Normal and Rayleigh
[104]	East and southeast parts of Iran	Exponential, Weibull, Gamma, Lognormal, Inverse Gaussian, Log–Logistic, Generalized extreme value and Nakagami
[105]	Peninsular Malaysia	Weibull, Gamma and Inverse Gamma
[106]	Güzelyurt region in northern Cyprus	Beta, Burr, 4-parameter Burr, Cauchy, Dagum, 4-parameter Dagum, Erlang, 3-parameter Erlang, Exponential, 2-parameters Exponential, Gamma, 3-parameter Gamma , Generalized Extreme Value, Generalized Gamma, 4-parameter Generalized Gamma, Generalized Logistic, Generalized Pareto, Gumbel Max, Gumbel Min, Inverse Gaussian, 43-parameter Inverse Gaussian , Log-Gamma, Log-Logistic, 3-parameter Log-Logistic, 3-parameter Log-Pearson, Logistic, Lognormal, 3-parameter Lognormal, Nakagami, Normal, Pareto, 2-parameter Pareto, Rayleigh, 2-parameter Rayleigh, Wakeby, Weibull, and 3-parameter Weibull
[107]	Tamil Nadu, India	Exponential, gamma, generalised extreme value, inverse Gaussian, Kumaraswamy, log-logistic, lognormal, Nakagami, and Weibull
[108]	Red Sea State, Sudan	Beta, Burr, 4-parameter Burr, Cauchy, Dagum, 4-parameter Dagum, Erlang, 3-parameter Erlang, Exponential, 2-parameters Exponential, Gamma, 3-parameter Gamma , Generalized Extreme Value, Generalized Gamma, 4-parameter Generalized Gamma, Generalized Logistic, Generalized Pareto, Gumbel Max, Gumbel Min, Inverse Gaussian, 43-parameter Inverse Gaussian , Log-Gamma, Log-Logistic, 3-parameter Log-Logistic, 3-parameter Log-Pearson, Logistic, Lognormal, 3-parameter Lognormal, Nakagami, Normal, Pareto, 2-parameter Pareto, Rayleigh, 2-parameter Rayleigh, Wakeby, Weibull, and 3-parameter Weibull
[109]	Algeria	Weibull, Gamma, Inverse Gaussian, Log Normal, Gumbel, Generalized extreme value, Nakagami, and Generalized Logistic
[110]	Poland	2-parameter Weibull, and 3-parameter Weibull
[111]	Southern coasts of Iran	Weibull, Gamma, Lognormal, Generalized extreme value, Rayleigh and Inverse Gaussian
[112]	Lebanon	2-parameter Weibull, Gamma, Lognormal, Logistic, Log-Logistic, Inverse Gaussian, Generalized Extreme Value, Nakagami, Normal and Rayleigh
[113]	Northern Lebanon	2-parameter Weibull, Gamma, Lognormal, Logistic, Log-Logistic, Inverse Gaussian, Generalized Extreme Value, Nakagami, Normal and Rayleigh
[114]	New South Wales, Australia	Rayleigh, Weibull, Gamma, and Lognormal
[115]	Lebanon	Beta, Burr, 4-parameter Burr, Cauchy, Dagum, Pearson 5, Pareto 2, Pareto, 3-parameter Pearson 5, Pearson 6, 4-parameter Pearson 6, Reciprocal, 4-parameter Dagum, Erlang, 3-parameter Erlang, Exponential, 2-parameters Exponential, Gamma, 3-parameter Gamma , Generalized Extreme Value, Generalized Gamma, 4-parameter Generalized Gamma, Generalized Logistic, Generalized Pareto, Gumbel Max, Gumbel Min, Inverse Gaussian, 3-parameter Inverse Gaussian , Log-Gamma, Log-Logistic, 3-parameter Log-Logistic, 3-parameter Log-Pearson, Logistic, Lognormal, 3-parameter Lognormal, Nakagami, Normal, Pareto, 2-parameter Pareto, Rayleigh, 2-parameter Rayleigh, Wakeby, Weibull, and 3-parameter Weibull

Table S4. Distribution parameters for all models used based on daily measured data

	Model	Parameters	KS Statistic	Rank
January	W-3P	α=0.90202 β=1.5061 γ=1.9856	0.112	1
	BS	α=0.92529 β=1.1559 γ=1.8191	0.134	2
	K	$α_1$=0.72313 $α_2$=2.0247 a=1.9856 b=8.3624	0.135	3
	GEV	k=0.28759 σ=0.775 μ=2.718	0.158	4
	IG	λ=20.108 μ=3.4694	0.169	5
	G	α=5.7957 β=0.59862	0.174	6
	LL	α=4.4959 β=3.1473	0.175	7
	W	α=2.9968 β=3.764	0.194	8
	LN	σ=0.35959 μ=1.1738	0.201	9
	N	σ=1.4411 μ=3.4694	0.204	10
	Na	m=1.2256 Ω=14.047	0.209	11
	L	σ=0.79453 μ=3.4694	0.226	12
	R	σ=2.7682	0.232	13
February	K	$α_1$=0.96782 $α_2$=2.3675 a=1.998 b=7.1638	0.083	1
	W-3P	α=1.2016 β=1.5998 γ=1.9819	0.084	2
	GEV	k=0.11749 σ=0.86654 μ=2.8768	0.095	3
	LL	α=4.9855 β=3.2307	0.101	4
	BS	α=0.74069 β=1.4035 γ=1.6993	0.105	5
	IG	λ=28.793 μ=3.4901	0.112	6
	G	α=8.25 β=0.42304	0.118	7
	Na	m=1.9108 Ω=13.604	0.125	8
	LN	σ=0.32219 μ=1.1962	0.127	9
	W	α=3.4021 β=3.7789	0.131	10
	N	σ=1.2151 μ=3.4901	0.154	11
	L	σ=0.66991 μ=3.4901	0.172	12
	R	σ=2.7847	0.227	13
March	GEV	k=0.08641 σ=0.911 μ=3.207	0.083	1
	LL	α=5.5427 β=3.5587	0.083	2
	BS	α=0.5037 β=2.2021 γ=1.3358	0.084	3
	W-3P	α=1.4578 β=1.968 γ=2.0315	0.091	4
	LN	σ=0.30321 μ=1.2921	0.093	5
	IG	λ=35.446 μ=3.8175	0.099	6
	W	α=3.8255 β=4.0942	0.107	7
	K	$α_1$=0.96594 $α_2$=2.2277 a=2.0892 b=7.8007	0.116	8
	G	α=9.2852 β=0.41114	0.117	9
	Na	m=2.0189 Ω=16.092	0.131	10
	L	σ=0.69071 μ=3.8175	0.140	11
	N	σ=1.2528 μ=3.8175	0.155	12
	R	σ=3.0459	0.215	13

Table S4. Continued

	Model	Parameters	KS Statistic	Rank
April	GEV	k=-0.09812 σ=1.0965 μ=3.7969	0.101	1
	G	α=12.754 β=0.33967	0.106	2
	Na	m=3.2898 Ω=20.189	0.108	3
	W-3P	α=2.098 β=2.6821 γ=1.9575	0.109	4
	BS	α=0.27718 β=4.2204 γ=-0.0505	0.109	5
	LN	σ=0.2787 μ=1.4277	0.109	6
	IG	λ=55.249 μ=4.3321	0.111	7
	LL	α=5.7365 β=4.1001	0.113	8
	N	σ=1.2131 μ=4.3321	0.129	9
	W	α=4.0452 β=4.6801	0.130	10
	L	σ=0.66879 μ=4.3321	0.144	11
	K	α₁=0.84624 α₂=1.0777 a=2.2159 b=6.7994	0.155	12
	R	σ=3.4565	0.240	13
May	W	α=4.3227 β=3.6114	0.071	1
	IG	λ=37.36 μ=3.3913	0.081	2
	G	α=11.017 β=0.30784	0.091	3
	K	α₁=0.66376 α₂=1.5493 a=2.239 b=7.1381	0.093	4
	Na	m=2.2333 Ω=12.511	0.094	5
	L	σ=0.56332 μ=3.3913	0.095	6
	GEV	k=0.17937 σ=0.65015 μ=2.8772	0.119	7
	BS	α=0.80815 β=1.0228 γ=2.0318	0.150	8
	LL	α=6.3769 β=3.1901	0.160	9
	W-3P	α=1.0689 β=1.1833 γ=2.2359	0.168	10
	N	σ=1.0217 μ=3.3913	0.171	11
	R	σ=2.7059	0.185	12
	LN	σ=0.2679 μ=1.1831	0.198	13
June	LL	α=8.1103 β=3.1914	0.089	1
	GEV	k=-0.06857 σ=0.60534 μ=2.9981	0.102	2
	BS	α=0.25363 β=2.6301 γ=0.59421	0.105	3
	LN	σ=0.20471 μ=1.1756	0.114	4
	W-3P	α=1.9943 β=1.4825 γ=1.9933	0.114	5
	G	α=22.523 β=0.14691	0.127	6
	Na	m=5.4127 Ω=11.419	0.136	7
	W	α=5.6954 β=3.5058	0.141	8
	K	α₁=0.89491 α₂=1.4045 a=2.1447 b=5.133	0.150	9
	L	σ=0.3844 μ=3.3089	0.155	10
	N	σ=0.69722 μ=3.3089	0.155	11
	IG	λ=74.526 μ=3.3089	0.155	12
	R	σ=2.6401	0.281	13

Table S4. Continued

	Model	Parameters	KS	
			Statistic	Rank
July	GEV	k=-0.27709 σ=0.65494 μ=2.7991	0.092	1
	W	α=5.3355 β=3.2365	0.097	2
	N	σ=0.64012 μ=3.0326	0.103	3
	K	α₁=0.87641 α₂=1.1263 a=1.9447 b=4.4331	0.106	4
	BS	α=0.05171 β=12.172 γ=-9.156	0.107	5
	Na	m=5.961 Ω=9.5929	0.108	6
	W-3P	α=2.3328 β=1.5427 γ=1.6668	0.111	7
	G	α=22.444 β=0.13512	0.113	8
	L	σ=0.35292 μ=3.0326	0.121	9
	LN	σ=0.21398 μ=1.087	0.122	10
	IG	λ=68.061 μ=3.0326	0.132	11
	LL	α=7.4585 β=2.927	0.142	12
	R	σ=2.4196	0.276	13
August	GEV	k=0.1618 σ=0.51417 μ=2.482	0.072	1
	LL	α=6.7455 β=2.7315	0.081	2
	BS	α=0.48017 β=1.4158 γ=1.297	0.085	3
	W-3P	α=1.5423 β=1.2879 γ=1.7178	0.105	4
	LN	σ=0.24797 μ=1.024	0.116	5
	IG	λ=38.017 μ=2.8759	0.120	6
	G	α=13.219 β=0.21755	0.137	7
	W	α=4.5767 β=3.071	0.140	8
	Na	m=2.7665 Ω=8.8761	0.146	9
	K	α₁=0.9692 α₂=1.8251 a=1.7586 b=5.0853	0.148	10
	L	σ=0.43609 μ=2.8759	0.163	11
	N	σ=0.79099 μ=2.8759	0.172	12
	R	σ=2.2946	0.273	13
September	LN	σ=0.16736 μ=1.0878	0.081	1
	BS	α=0.25927 β=1.9203 γ=1.0251	0.087	2
	GEV	k=-0.05567 σ=0.44379 μ=2.7771	0.093	3
	G	α=32.858 β=0.0916	0.095	4
	LL	α=9.9404 β=2.9306	0.097	5
	W	α=6.9148 β=3.1665	0.100	6
	W-3P	α=1.9687 β=1.1047 γ=2.0291	0.103	7
	Na	m=7.6731 Ω=9.3264	0.106	8
	L	σ=0.2895 μ=3.01	0.108	9
	N	σ=0.5251 μ=3.01	0.112	10
	IG	λ=98.902 μ=3.01	0.117	11
	K	α₁=0.83696 α₂=1.1156 a=2.1288 b=4.3199	0.181	12
	R	σ=2.4016	0.325	13

Table S4. Continued

	Model	Parameters	KS	
			Statistic	Rank
October	K	α_1=0.92564 α_2=2.3776 a=1.7988 b=4.4167	0.112	1
	W-3P	α=0.86194 β=0.65758 γ=1.7988	0.122	2
	LN	σ=0.22896 μ=0.88908	0.127	3
	GEV	k=0.10685 σ=0.44329 μ=2.192	0.131	4
	LL	α=7.0784 β=2.3917	0.134	5
	G	α=16.477 β=0.15172	0.134	6
	BS	α=0.96885 β=0.52661 γ=1.7212	0.136	7
	Na	m=3.7487 Ω=6.6165	0.145	8
	W	α=4.8018 β=2.6742	0.153	9
	N	σ=0.61586 μ=2.4999	0.165	10
	IG	λ=41.191 μ=2.4999	0.167	11
	L	σ=0.33954 μ=2.4999	0.176	12
	R	σ=1.9946	0.334	13
November	K	α_1=0.81574 α_2=1.6662 a=1.7568 b=7.3267	0.096	1
	W-3P	α=1.1934 β=1.9202 γ=1.7392	0.111	2
	Na	m=1.4941 Ω=14.63	0.121	3
	LL	α=4.1674 β=3.2088	0.126	4
	GEV	k=0.05569 σ=1.1051 μ=2.852	0.132	5
	BS	α=0.7786 β=1.6231 γ=1.4339	0.133	6
	G	α=6.1105 β=0.58164	0.139	7
	W	α=2.8848 β=3.863	0.140	8
	IG	λ=21.717 μ=3.5541	0.141	9
	LN	σ=0.38622 μ=1.1925	0.147	10
	N	σ=1.4378 μ=3.5541	0.158	11
	R	σ=2.8358	0.179	12
	L	σ=0.79269 μ=3.5541	0.180	13
December	GEV	k=-0.2544 σ=1.0578 μ=2.9325	0.100	1
	N	σ=1.0756 μ=3.3254	0.101	2
	Na	m=2.4818 Ω=12.178	0.113	3
	BS	α=0.15604 β=6.7169 γ=-3.4732	0.121	4
	W-3P	α=1.969 β=2.2715 γ=1.3074	0.122	5
	L	σ=0.59304 μ=3.3254	0.122	6
	G	α=9.5578 β=0.34793	0.126	7
	W	α=3.4291 β=3.5999	0.129	8
	LN	σ=0.33672 μ=1.1476	0.132	9
	IG	λ=31.784 μ=3.3254	0.140	10
	LL	α=4.7119 β=3.0787	0.147	11
	K	α_1=0.9587 α_2=1.8915 a=1.5952 b=6.6033	0.155	12
	R	σ=2.6533	0.196	13

Table S5. Distribution parameters for all models used based on daily CFSR data

	Model	Parameters	KS	
			Statistic	Rank
January	BS	α=0.77429 β=1.5107 γ=1.2535	0.09978	1
	W-3P	α=1.1529 β=1.7846 γ=1.5189	0.10105	2
	GEV	k=0.23663 σ=0.8718 μ=2.4504	0.11368	3
	IG	λ=15.228 μ=3.2168	0.12663	4
	LL	α=3.9886 β=2.8631	0.12799	5
	G	α=4.7339 β=0.67952	0.13648	6
	LN	σ=0.40641 μ=1.0803	0.15167	7
	W	α=2.6937 β=3.4938	0.15896	8
	N	σ=1.4785 μ=3.2168	0.18278	9
	R	σ=2.5666	0.18362	10
	Na	m=1.0477 Ω=12.463	0.18427	11
	K	α$_1$=0.90713 α$_2$=1.5087 a=1.53 b=6.9719	0.19963	12
	L	σ=0.81512 μ=3.2168	0.20207	13
February	GEV	k=0.07305 σ=0.65211 μ=2.7788	0.10501	1
	BS	α=0.4618 β=1.7039 γ=1.32	0.10787	2
	LL	α=6.4509 β=3.0414	0.11219	3
	W-3P	α=1.5511 β=1.4588 γ=1.8922	0.12152	4
	IG	λ=43.237 μ=3.2057	0.14167	5
	LN	σ=0.25424 μ=1.1317	0.14402	6
	G	α=13.487 β=0.23768	0.15866	7
	Na	m=3.0652 Ω=11.011	0.1645	8
	K	α$_1$=0.83388 α$_2$=1.2611 a=1.95 b=5.294	0.16928	9
	W	α=4.4366 β=3.4298	0.17266	10
	N	σ=0.87289 μ=3.2057	0.19489	11
	L	σ=0.48125 μ=3.2057	0.19712	12
	R	σ=2.5578	0.25878	13
March	LL	α=5.3484 β=3.5563	0.08953	1
	GEV	k=0.11356 σ=0.93426 μ=3.1969	0.09246	2
	BS	α=0.52545 β=2.2344 γ=1.3106	0.09252	3
	W	α=3.6949 β=4.1117	0.09495	4
	LN	σ=0.31954 μ=1.2952	0.10219	5
	W-3P	α=1.3898 β=2.0364 γ=1.9932	0.10779	6
	IG	λ=29.845 μ=3.8535	0.11469	7
	G	α=7.7448 β=0.49756	0.13259	8
	L	σ=0.76342 μ=3.8535	0.14714	9
	Na	m=1.4972 Ω=16.705	0.15843	10
	K	α$_1$=0.92059 α$_2$=3.0432 a=2.04 b=9.6596	0.16121	11
	N	σ=1.3847 μ=3.8535	0.1668	12
	R	σ=3.0747	0.20768	13

Table S5. Continued

	Model	Parameters	KS	
			Statistic	Rank
April	LL	α=6.0856 β=4.0961	0.07566	1
	GEV	k=0.08329 σ=0.93482 μ=3.7189	0.08181	2
	BS	α=0.56181 β=2.0146 γ=2.0086	0.09925	3
	LN	σ=0.27195 μ=1.4301	0.10748	4
	IG	λ=50.103 μ=4.342	0.11053	5
	W-3P	α=1.2555 β=1.7872 γ=2.6709	0.11066	6
	K	α$_1$=0.94661 α$_2$=1.9601 a=2.7 b=7.8513	0.12358	7
	G	α=11.539 β=0.37629	0.12857	8
	W	α=4.1719 β=4.6568	0.13342	9
	Na	m=2.5339 Ω=20.432	0.13901	10
	L	σ=0.70472 μ=4.342	0.15661	11
	N	σ=1.2782 μ=4.342	0.16562	12
	R	σ=3.4644	0.26191	13
May	LL	α=6.7261 β=3.6194	0.07951	1
	BS	α=0.41587 β=2.3048 γ=1.3272	0.08044	2
	GEV	k=0.05425 σ=0.79808 μ=3.3255	0.08345	3
	IG	λ=48.927 μ=3.8313	0.08497	4
	W-3P	α=1.6689 β=1.9063 γ=2.1277	0.08528	5
	LN	σ=0.258 μ=1.3088	0.08602	6
	G	α=12.77 β=0.30002	0.09677	7
	W	α=4.6923 β=4.0576	0.109	8
	N	σ=1.0721 μ=3.8313	0.11751	9
	L	σ=0.59109 μ=3.8313	0.11768	10
	Na	m=2.6604 Ω=15.791	0.13463	11
	K	α$_1$=0.90122 α$_2$=1.8632 a=2.21 b=7.4793	0.16483	12
	R	σ=3.0569	0.27023	13
June	GEV	k=-0.26005 σ=0.80477 μ=3.5648	0.09215	1
	W	α=5.4019 β=4.128	0.09504	2
	K	α$_1$=1.0324 α$_2$=0.93531 a=2.4895 b=5.21	0.10279	3
	BS	α=0.04888 β=15.925 γ=-12.084	0.1061	4
	N	σ=0.79186 μ=3.8607	0.10673	5
	Na	m=6.316 Ω=15.511	0.10682	6
	W-3P	α=2.5015 β=2.02 γ=2.071	0.10939	7
	G	α=23.77 β=0.16242	0.11508	8
	LN	σ=0.20749 μ=1.3298	0.12341	9
	IG	λ=91.768 μ=3.8607	0.12451	10
	L	σ=0.43657 μ=3.8607	0.12839	11
	LL	α=7.5959 β=3.7386	0.13722	12
	R	σ=3.0804	0.27871	13

Table S5. Continued

	Model	Parameters	KS	
			Statistic	Rank
July	GEV	k=-0.27295 σ=0.60819 μ=3.3851	0.08859	1
	K	α₁=1.0542 α₂=0.94101 a=2.4473 b=4.63	0.09055	2
	N	σ=0.59372 μ=3.6035	0.09884	3
	W	α=6.8115 β=3.8127	0.0989	4
	W-3P	α=2.8907 β=1.7093 γ=2.0829	0.10134	5
	IG	λ=132.75 μ=3.6035	0.10163	6
	BS	α=0.0208 β=28.031 γ=-24.433	0.1026	7
	Na	m=9.6385 Ω=13.327	0.10497	8
	G	α=36.838 β=0.09782	0.10768	9
	LN	σ=0.16556 μ=1.2684	0.11187	10
	L	σ=0.32734 μ=3.6035	0.11989	11
	LL	α=9.5749 β=3.5241	0.12196	12
	R	σ=2.8752	0.32152	13
August	GEV	k=0.08411 σ=0.49908 μ=3.1798	0.11145	1
	BS	α=0.45806 β=1.3378 γ=2.0347	0.11328	2
	W-3P	α=1.5593 β=1.141 γ=2.4862	0.11473	3
	LL	α=9.1032 β=3.4093	0.13667	4
	Na	m=6.1028 Ω=12.786	0.15499	5
	G	α=26.823 β=0.13097	0.15819	6
	LN	σ=0.18103 μ=1.2396	0.16065	7
	W	α=6.1983 β=3.7174	0.17417	8
	N	σ=0.67829 μ=3.5129	0.17782	9
	IG	λ=94.226 μ=3.5129	0.18434	10
	L	σ=0.37396 μ=3.5129	0.19672	11
	K	α₁=0.76014 α₂=0.78631 a=2.5218 b=5.11	0.25901	12
	R	σ=2.8029	0.33461	13
September	W	α=7.7231 β=3.7982	0.123	1
	Na	m=11.843 Ω=13.31	0.13417	2
	G	α=47.806 β=0.07556	0.13718	3
	N	σ=0.5224 μ=3.612	0.13988	4
	LN	σ=0.14102 μ=1.2743	0.14314	5
	GEV	k=-0.10967 σ=0.47534 μ=3.3846	0.14389	6
	LL	α=11.168 β=3.5439	0.15574	7
	IG	λ=172.68 μ=3.612	0.15586	8
	L	σ=0.28802 μ=3.612	0.16102	9
	K	α₁=0.79997 α₂=1.4545 a=2.92 b=4.8147	0.17102	10
	W-3P	α=1.1553 β=0.72939 γ=2.9145	0.20807	11
	BS	α=0.83169 β=0.60108 γ=2.7981	0.23514	12
	R	σ=2.882	0.40147	13

Table S5. Continued

	Model	Parameters	KS	
			Statistic	Rank
October	GEV	k=0.07287 σ=0.38587 μ=2.6071	0.10475	1
	BS	α=0.23039 β=2.1688 γ=0.63331	0.12082	2
	LN	σ=0.17684 μ=1.0347	0.12469	3
	LL	α=9.5823 β=2.7722	0.12993	4
	W	α=6.6061 β=3.0066	0.13281	5
	L	σ=0.29746 μ=2.8597	0.13992	6
	G	α=28.094 β=0.10179	0.14248	7
	K	α_1=2.3322 α_2=461.04 a=1.6662 b=20.331	0.14585	8
	W-3P	α=2.3244 β=1.3413 γ=1.6683	0.14635	9
	Na	m=6.1093 Ω=8.4595	0.15699	10
	N	σ=0.53953 μ=2.8597	0.16005	11
	IG	λ=80.339 μ=2.8597	0.1669	12
	R	σ=2.2817	0.37139	13
November	W-3P	α=0.86334 β=1.5457 γ=2.41	0.1063	1
	GEV	k=0.1675 σ=0.9692 μ=3.2466	0.11678	2
	IG	λ=28.159 μ=3.9967	0.1257	3
	LL	α=5.0922 β=3.6568	0.12752	4
	BS	α=0.99074 β=1.187 γ=2.2157	0.12901	5
	G	α=7.0457 β=0.56725	0.13675	6
	LN	σ=0.33339 μ=1.3265	0.15124	7
	W	α=3.4889 β=4.2632	0.1584	8
	N	σ=1.5057 μ=3.9967	0.17343	9
	L	σ=0.83013 μ=3.9967	0.1932	10
	K	α_1=0.51597 α_2=1.3361 a=2.41 b=10.662	0.20009	11
	Na	m=1.3868 Ω=18.165	0.20462	12
	R	σ=3.1889	0.24842	13
December	GEV	k=0.00317 σ=1.0482 μ=2.6459	0.10684	1
	W-3P	α=1.1852 β=1.7403 γ=1.6042	0.10898	2
	IG	λ=21.161 μ=3.2542	0.11221	3
	LN	σ=0.38295 μ=1.1065	0.11233	4
	LL	α=4.1242 β=2.9583	0.11633	5
	G	α=6.5027 β=0.50044	0.12035	6
	BS	α=0.73798 β=1.5709 γ=1.2511	0.12113	7
	W	α=2.8706 β=3.5659	0.12827	8
	Na	m=1.7278 Ω=12.166	0.13106	9
	N	σ=1.2761 μ=3.2542	0.16409	10
	L	σ=0.70357 μ=3.2542	0.17438	11
	R	σ=2.5965	0.17687	12
	K	α_1=0.8786 α_2=1.059 a=1.62 b=5.8324	0.19865	13

Table S6. Distribution parameters for all models used based on daily EAR5-Land data

	Model	Parameters	KS	
			Statistic	Rank
January	W-3P	α=0.84414 β=1.7457 γ=1.5913	0.0809	1
	GEV	k=0.2261 σ=1.1353 μ=2.5195	0.09346	2
	BS	α=1.1544 β=1.2165 γ=1.4469	0.09775	3
	IG	λ=11.982 μ=3.498	0.10245	4
	LL	α=3.3608 β=2.9924	0.10694	5
	LN	σ=0.4822 μ=1.1293	0.12267	6
	K	α₁=0.46857 α₂=1.2828 a=1.5913 b=9.9886	0.12384	7
	G	α=3.4254 β=1.0212	0.13603	8
	W	α=2.282 β=3.785	0.13663	9
	R	σ=2.791	0.15001	10
	N	σ=1.89 μ=3.498	0.17911	11
	L	σ=1.042 μ=3.498	0.19528	12
	Na	m=0.78867 Ω=15.693	0.20049	13
February	BS	α=0.52168 β=3.271 γ=-0.67318	0.08716	1
	W	α=1.6271 β=3.2996	0.08788	2
	LN	σ=0.68821 μ=0.90489	0.08934	3
	GEV	k=0.04743 σ=1.4675 μ=2.1246	0.09085	4
	G	α=2.6217 β=1.1609	0.09136	5
	LL	α=2.269 β=2.3776	0.09544	6
	W-3P	α=1.509 β=3.0744 γ=0.26707	0.09647	7
	IG	λ=7.9796 μ=3.0436	0.10641	8
	Na	m=0.7862 Ω=12.671	0.12343	9
	R	σ=2.4285	0.1335	10
	K	α₁=0.87895 α₂=1.275 a=0.3722 b=7.1619	0.14293	11
	N	σ=1.8798 μ=3.0436	0.17374	12
	L	σ=1.0364 μ=3.0436	0.17793	13
March	GEV	k=-0.26078 σ=1.7488 μ=3.0361	0.08386	1
	N	σ=1.7225 μ=3.6782	0.09716	2
	W-3P	α=2.3185 β=4.131 γ=0.02091	0.09801	3
	BS	α=0.05368 β=31.553 γ=-27.92	0.10105	4
	R	σ=2.9348	0.1092	5
	Na	m=1.5504 Ω=16.401	0.11483	6
	G	α=4.5598 β=0.80666	0.1153	7
	L	σ=0.94968 μ=3.6782	0.11585	8
	W	α=1.9614 β=4.1048	0.11994	9
	K	α₁=0.99996 α₂=0.99875 a=0.781 b=6.9971	0.13534	10
	IG	λ=16.772 μ=3.6782	0.14203	11
	LN	σ=0.56959 μ=1.1648	0.15005	12
	LL	α=2.675 β=3.123	0.17129	13

Table S6. Continued

	Model	Parameters	KS	
			Statistic	Rank
April	GEV	k=-0.21405 σ=1.8531 μ=3.3462	0.08221	1
	R	σ=3.26	0.08764	2
	W	α=2.1263 β=4.545	0.09069	3
	N	σ=1.8711 μ=4.0858	0.09293	4
	BS	α=0.18648 β=9.8424 γ=-5.9277	0.09839	5
	W-3P	α=1.7399 β=3.5805 γ=0.88487	0.10377	6
	G	α=4.7684 β=0.85686	0.10658	7
	Na	m=1.5566 Ω=20.078	0.10837	8
	L	σ=1.0316 μ=4.0858	0.11273	9
	LN	σ=0.5212 μ=1.286	0.13145	10
	IG	λ=19.483 μ=4.0858	0.13299	11
	LL	α=2.9457 β=3.5335	0.14226	12
	K	α$_1$=1.0519 α$_2$=0.87051 a=1.2214 b=7.1935	0.17945	13
May	IG	λ=6.0826 μ=2.3815	0.08864	1
	BS	α=0.4285 β=3.118 γ=-1.0227	0.09851	2
	GEV	k=0.08781 σ=1.0785 μ=1.657	0.10056	3
	G	α=2.5541 β=0.93241	0.10799	4
	R	σ=1.9002	0.10888	5
	W-3P	α=1.5859 β=2.5378 γ=0.10162	0.11453	6
	W	α=1.5417 β=2.6114	0.14083	7
	Na	m=0.65626 Ω=7.8204	0.1424	8
	N	σ=1.4901 μ=2.3815	0.15207	9
	LN	σ=0.72778 μ=0.65035	0.15222	10
	L	σ=0.82156 μ=2.3815	0.15301	11
	LL	α=2.1254 β=1.8443	0.17713	12
	K	α$_1$=0.79551 α$_2$=1.4606 a=0.2067 b=6.4303	0.19321	13
June	W-3P	α=5.1821 β=5.8551 γ=-2.4675	0.12466	1
	GEV	k=-0.48521 σ=1.3049 μ=2.6135	0.1257	2
	L	σ=0.67479 μ=2.9205	0.13886	3
	Na	m=2.0908 Ω=9.9776	0.14379	4
	BS	α=0.00557 β=216.07 γ=-213.15	0.14555	5
	N	σ=1.2239 μ=2.9205	0.14611	6
	K	α$_1$=1.0 α$_2$=1.0 a=0.18318 b=5.3948	0.19342	7
	G	α=5.694 β=0.51292	0.20109	8
	R	σ=2.3303	0.20279	9
	W	α=1.4787 β=3.4935	0.20528	10
	IG	λ=16.63 μ=2.9205	0.22403	11
	LN	σ=0.69024 μ=0.91546	0.25637	12
	LL	α=1.9317 β=2.4325	0.25979	13

Table S6. Continued

	Model	Parameters	KS Statistic	Rank
July	GEV	k=-0.51533 σ=1.3934 μ=2.4295	0.09208	1
	W-3P	α=10.552 β=11.195 γ=-7.9252	0.11724	2
	N	σ=1.2513 μ=2.7356	0.13377	3
	K	α₁=1.0366 α₂=0.96532 a=0.19364 b=4.7509	0.13427	4
	BS	α=0.00577 β=213.77 γ=-211.03	0.13547	5
	R	σ=2.1827	0.15379	6
	L	σ=0.6899 μ=2.7356	0.15481	7
	Na	m=1.9762 Ω=8.9987	0.15844	8
	W	α=1.4133 β=3.2448	0.18012	9
	G	α=4.7791 β=0.5724	0.1855	10
	LN	σ=0.74159 μ=0.82218	0.19577	11
	LL	α=1.8562 β=2.2203	0.19592	12
	IG	λ=13.074 μ=2.7356	0.21021	13
August	GEV	k=0.04487 σ=0.88589 μ=1.755	0.10764	1
	BS	α=0.25624 β=4.305 γ=-2.1389	0.11783	2
	G	α=3.8091 β=0.60576	0.11862	3
	IG	λ=8.7891 μ=2.3074	0.11862	4
	W-3P	α=2.0732 β=2.6149 γ=-0.01285	0.13456	5
	R	σ=1.841	0.14205	6
	Na	m=0.91837 Ω=6.6767	0.16371	7
	N	σ=1.1823 μ=2.3074	0.16708	8
	LN	σ=0.62898 μ=0.68145	0.16952	9
	L	σ=0.65181 μ=2.3074	0.1706	10
	W	α=1.7073 β=2.6182	0.18267	11
	LL	α=2.3347 β=1.9125	0.20672	12
	K	α₁=0.90914 α₂=1.3155 a=0.2353 b=5.384	0.22511	13
September	L	σ=0.59703 μ=2.4296	0.11336	1
	GEV	k=-0.20157 σ=1.0293 μ=2.0096	0.12936	2
	Na	m=1.4102 Ω=7.0366	0.1348	3
	N	σ=1.0829 μ=2.4296	0.13543	4
	BS	α=0.22056 β=4.7559 γ=-2.442	0.1455	5
	R	σ=1.9386	0.14571	6
	W-3P	α=1.9332 β=2.2435 γ=0.43675	0.14688	7
	W	α=2.2863 β=2.6704	0.15022	8
	G	α=5.034 β=0.48264	0.15953	9
	K	α₁=0.95792 α₂=1.5563 a=0.651 b=5.343	0.1695	10
	LN	σ=0.49511 μ=0.77735	0.18192	11
	IG	λ=12.231 μ=2.4296	0.18509	12
	LL	α=3.1453 β=2.113	0.20042	13

Table S6. Continued

	Model	Parameters	KS	
			Statistic	Rank
October	Na	m=0.73469 Ω=4.8973	0.11274	1
	W-3P	α=1.2289 β=1.6135 γ=0.3587	0.11274	2
	G	α=2.4183 β=0.77335	0.11619	3
	BS	α=0.73203 β=1.407 γ=0.08448	0.11637	4
	LL	α=2.4275 β=1.4722	0.11831	5
	LN	σ=0.65277 μ=0.42116	0.12112	6
	GEV	k=0.11061 σ=0.8625 μ=1.2671	0.12173	7
	K	α₁=0.81476 α₂=1.3361 a=0.3759 b=4.464	0.12576	8
	IG	λ=4.5227 μ=1.8702	0.1296	9
	W	α=1.704 β=2.0166	0.13498	10
	R	σ=1.4922	0.15409	11
	N	σ=1.2026 μ=1.8702	0.15615	12
	L	σ=0.66304 μ=1.8702	0.17541	13
November	GEV	k=-0.05553 σ=1.6227 μ=2.5424	0.11846	1
	R	σ=2.7082	0.12684	2
	Na	m=0.98815 Ω=14.908	0.12797	3
	W	α=1.8553 β=3.7048	0.13068	4
	G	α=3.2878 β=1.0324	0.13379	5
	K	α₁=0.64662 α₂=1.1943 a=0.9047 b=7.8598	0.13873	6
	N	σ=1.8719 μ=3.3942	0.14459	7
	W-3P	α=1.2125 β=2.6893 γ=0.85179	0.14602	8
	BS	α=0.5621 β=3.1389 γ=-0.24308	0.14942	9
	LN	σ=0.60454 μ=1.0554	0.15218	10
	IG	λ=11.159 μ=3.3942	0.16108	11
	LL	α=2.5939 β=2.7763	0.16393	12
	L	σ=1.032 μ=3.3942	0.16722	13
December	GEV	k=-0.29354 σ=1.6149 μ=2.2786	0.12665	1
	K	α₁=0.9389 α₂=1.2242 a=0.2378 b=6.2697	0.1287	2
	N	σ=1.5762 μ=2.8371	0.13194	3
	BS	α=0.06212 β=24.952 γ=-22.163	0.14468	4
	L	σ=0.86898 μ=2.8371	0.14572	5
	Na	m=1.2392 Ω=10.453	0.16705	6
	W-3P	α=2.0524 β=3.4222 γ=-0.19503	0.16773	7
	R	σ=2.2637	0.17319	8
	W	α=1.4596 β=3.1762	0.17941	9
	G	α=3.2402 β=0.87562	0.19936	10
	LN	σ=0.75588 μ=0.82195	0.21799	11
	LL	α=1.964 β=2.1997	0.22045	12
	IG	λ=9.1928 μ=2.8371	0.22905	13

Table S7. Distribution parameters for all models used based whole year data

Dataset	Distribution	Parameters	KS Statistic	KS Rank
Actual	BS	α=0.50946 β=1.9468 γ=1.1394	0.02503	1
	GEV	k=0.08386 σ=0.79969 μ=2.8054	0.02985	2
	LL	α=5.6662 β=3.168	0.04975	3
	IG	λ=29.684 μ=3.3389	0.05447	4
	W-3p	α=1.6454 β=1.963 γ=1.5886	0.05638	5
	K	α$_1$=1.6409 α$_2$=367.59 a=1.589 b=73.473	0.05642	6
	LN	σ=0.31103 μ=1.1554	0.05689	7
	G	α=8.8901 β=0.37558	0.07497	8
	Na	m=1.8568 Ω=12.399	0.10279	9
	N	σ=1.1198 μ=3.3389	0.11962	10
	L	σ=0.6174 μ=3.3389	0.1224	11
	W	α=3.8277 β=3.6777	0.12296	12
	R	σ=2.6641	0.19858	13
CFSR	GEV	k=0.00871 σ=0.86024 μ=3.091	0.03288	1
	BS	α=0.34431 β=2.9879 γ=0.43004	0.03535	2
	IG	λ=37.081 μ=3.595	0.03843	3
	LN	σ=0.29518 μ=1.2352	0.04449	4
	W-3p	α=1.9663 β=2.3666 γ=1.4984	0.04709	5
	K	α$_1$=1.9662 α$_2$=1282.2 a=1.4991 b=91.499	0.04729	6
	LL	α=6.0581 β=3.43	0.04855	7
	G	α=10.314 β=0.34855	0.05394	8
	N	σ=1.1194 μ=3.595	0.09095	9
	Na	m=2.0887 Ω=14.174	0.0952	10
	L	σ=0.61715 μ=3.595	0.10542	11
	W	α=4.1566 β=3.935	0.10596	12
	R	σ=2.8684	0.20356	13
ERA5-Land	K	α$_1$=1.6581 α$_2$=10.333 a=0.1129 b=13.588	0.03434	1
	W	α=1.8484 β=3.2875	0.03602	2
	Na	m=0.87482 Ω=11.27	0.03699	3
	W-3p	α=1.79 β=3.2037 γ=0.07678	0.03809	4
	GEV	k=-0.04175 σ=1.3759 μ=2.1885	0.0426	5
	BS	α=0.37104 β=4.2118 γ=-1.5739	0.05152	6
	G	α=3.1696 β=0.92374	0.05473	7
	R	σ=2.3361	0.05523	8
	IG	λ=9.2804 μ=2.9279	0.0829	9
	N	σ=1.6446 μ=2.9279	0.08358	10
	LN	σ=0.6781 μ=0.88463	0.09755	11
	L	σ=0.9067 μ=2.9279	0.10349	12
	LL	α=2.5464 β=2.4138	0.10553	13

Table S8. Distribution parameters for all models used based monthly data

Dataset	Distribution	Parameters	KS	
			Statistic	Rank
Actual	L	σ=0.2589 μ=3.3423	0.13947	1
	Na	m=12.497 Ω=11.373	0.15203	2
	BS	α=0.09231 β=4.8422 γ=-1.5205	0.15529	3
	GEV	k=-0.21261 σ=0.45317 μ=3.1609	0.15689	4
	G	α=50.656 β=0.06598	0.15694	5
	W-P3	α=2.6918 β=1.2705 γ=2.2108	0.15768	6
	N	σ=0.46959 μ=3.3423	0.15929	7
	LN	σ=0.135 μ=1.1976	0.16379	8
	IG	λ=169.31 μ=3.3423	0.16422	9
	W	α=8.4225 β=3.4298	0.18915	10
	LL	α=11.566 β=3.2322	0.23401	11
	K	α₁=0.72888 α₂=0.69014 a=2.4999 b=4.3651	0.30852	12
	R	σ=2.6667	0.35761	13
CFSR	GEV	k=-0.31896 σ=0.43414 μ=3.4525	0.11694	1
	N	σ=0.41238 μ=3.5957	0.13276	2
	W-P3	α=3.1881 β=1.262 γ=2.467	0.13924	3
	Na	m=19.454 Ω=13.085	0.13967	4
	IG	λ=273.37 μ=3.5957	0.14108	5
	G	α=76.028 β=0.04729	0.14151	6
	BS	α=0.01136 β=34.807 γ=-31.214	0.14268	7
	LN	σ=0.11131 μ=1.2736	0.15075	8
	L	σ=0.22735 μ=3.5957	0.15478	9
	W	α=9.6138 β=3.6983	0.17117	10
	LL	α=13.258 β=3.511	0.17752	11
	K	α₁=0.833 α₂=0.80741 a=2.8599 b=4.3602	0.19793	12
	R	σ=2.8689	0.39156	13
ERA5-Land	GEV	k=-0.17972 σ=0.63363 μ=2.6632	0.098	1
	G	α=20.756 β=0.14125	0.10856	2
	Na	m=5.3871 Ω=8.9752	0.10982	3
	W-P3	α=2.3936 β=1.5504 γ=1.5581	0.11066	4
	N	σ=0.64352 μ=2.9318	0.11575	5
	LN	σ=0.21474 μ=1.053	0.11779	6
	BS	α=0.12436 β=4.9364 γ=-2.0427	0.11977	7
	IG	λ=60.853 μ=2.9318	0.13768	8
	L	σ=0.35479 μ=2.9318	0.13796	9
	W	α=4.9216 β=3.0718	0.13822	10
	LL	α=6.8686 β=2.7753	0.14194	11
	K	α₁=0.94537 α₂=1.1486 a=1.8702 b=4.0934	0.15933	12
	R	σ=2.3393	0.30188	13

Table S9. Statistical estimators of the daily solar radiation in W/m² using various datasets for Az-Zāwiyah

| Month	Dataset	Mean	SD	CV	Min.	Max.	S	K	Month	Dataset	Mean	SD	CV	Min.	Max.	S	K
Jan	Measured	118.86	30.40	25.57	56.15	174.43	-0.22	0.76	Jul	Measured	324.16	11.25	3.47	274.90	334.96	-3.05	12.05
	CFSR	124.16	38.21	30.78	35.50	173.25	-0.88	0.56		CFSR	325.62	4.94	1.52	315.25	333.50	-0.58	-0.35
	ERA5	121.51	30.89	25.42	60.00	173.84	-0.30	0.70		ERA5	324.89	6.77	2.08	301.82	332.48	-1.51	3.04
	ERA5-Land	118.58	31.75	26.77	45.75	177.54	-0.21	0.67		ERA5-Land	320.89	12.39	3.86	266.42	332.95	-3.06	12.27
	MERRA-2	137.13	29.10	21.22	64.17	187.93	-0.43	-0.12		MERRA-2	335.91	8.28	2.47	316.69	350.44	-0.59	-0.17
Feb	Measured	159.56	33.82	21.19	70.21	213.43	-0.78	-0.07	Aug	Measured	288.80	11.24	3.89	265.16	308.67	0.08	-0.62
	CFSR	163.50	54.80	33.55	18.80	214.00	-1.44	0.14		CFSR	299.29	17.51	5.85	279.75	378.00	3.05	13.59
	ERA5	161.51	40.53	25.10	57.11	213.71	-1.12	-0.37		ERA5	294.04	11.50	3.91	273.83	330.46	0.94	1.87
	ERA5-Land	160.81	35.49	22.07	68.85	215.59	-0.91	-0.40		ERA5-Land	285.78	11.47	4.01	262.54	305.67	0.00	-0.73
	MERRA-2	176.32	30.69	17.40	107.51	224.60	-0.58	-0.21		MERRA-2	303.44	11.53	3.80	275.86	322.11	-0.68	0.16
Mar	Measured	224.03	47.78	21.33	38.37	271.69	-2.11	0.94	Sep	Measured	246.99	25.68	10.40	188.19	274.33	-0.86	-0.55
	CFSR	222.95	55.11	24.72	38.25	274.25	-1.87	2.75		CFSR	251.14	22.98	9.15	191.00	276.50	-1.18	0.66
	ERA5	223.49	48.62	21.75	38.31	272.97	-2.08	-0.79		ERA5	249.07	23.46	9.42	199.68	275.41	-0.79	-0.76
	ERA5-Land	225.28	48.47	21.52	39.13	274.08	-2.07	-0.92		ERA5-Land	245.40	25.88	10.54	184.73	272.32	-0.83	-0.56
	MERRA-2	216.66	50.22	23.18	59.17	284.61	-1.11	1.78		MERRA-2	252.16	25.13	9.97	195.02	282.11	-0.90	-0.19
Apr	Measured	279.15	28.93	10.37	201.91	313.28	-1.48	-0.83	Oct	Measured	186.26	19.51	10.47	153.70	216.08	-0.24	-1.07
	CFSR	267.1	58.2	21.79	16	315.5	-3.21	0.70		CFSR	203.04	15.28	7.52	168.00	227.25	-0.18	-0.43
	ERA5	273.15	35.88	13.14	161.88	313.89	-1.9	-1.23		ERA5	194.65	15.88	8.16	166.73	218.90	0.02	-1.02
	ERA5-Land	278.31	30.94	11.12	191.45	313.54	-1.54	-1.09		ERA5-Land	185.23	19.69	10.63	150.63	215.02	-0.31	-1.07
	MERRA-2	262.74	49.35	18.78	153.76	331.28	-0.48	-0.84		MERRA-2	206.97	17.66	8.53	165.01	238.35	-0.43	0.26
May	Measured	300.38	30.95	10.30	186.38	333.31	-2.04	1.84	Nov	Measured	144.92	26.96	18.60	59.86	177.68	-1.71	3.84
	CFSR	309.60	51.19	16.53	52.00	345.50	-4.53	2.21		CFSR	150.43	36.29	24.12	4.25	182.50	-2.94	9.83
	ERA5	304.99	39.28	12.88	119.19	339.41	-3.74	1.62		ERA5	147.68	29.89	20.24	32.06	180.09	-2.40	7.37
	ERA5-Land	299.55	29.35	9.80	195.59	331.05	-1.98	0.79		ERA5-Land	144.98	26.50	18.28	67.78	177.27	-1.41	2.39
	MERRA-2	312.79	40.78	13.04	204.18	358.78	-1.39	1.36		MERRA-2	160.30	27.50	17.15	73.34	192.10	-1.71	3.40
Jun	Measured	327.83	10.82	3.30	293.11	343.39	-1.79	4.45	Dec	Measured	123.69	13.93	11.26	91.59	140.46	-1.12	0.14
	CFSR	329.77	11.62	3.52	273.25	342.25	-4.13	20.52		CFSR	133.02	12.04	9.05	89.25	144.75	-2.26	5.44
	ERA5	328.80	10.43	3.17	285.15	342.20	-2.69	10.43		ERA5	128.35	12.23	9.53	90.42	141.86	-1.61	2.19
	ERA5-Land	325.95	10.81	3.32	286.33	341.87	-2.01	6.00		ERA5-Land	126.75	15.90	12.55	86.39	143.06	-1.28	0.48
	MERRA-2	339.85	15.65	4.61	284.61	360.86	-1.67	4.40		MERRA-2	130.98	16.48	12.58	59.59	154.18	-2.96	11.60
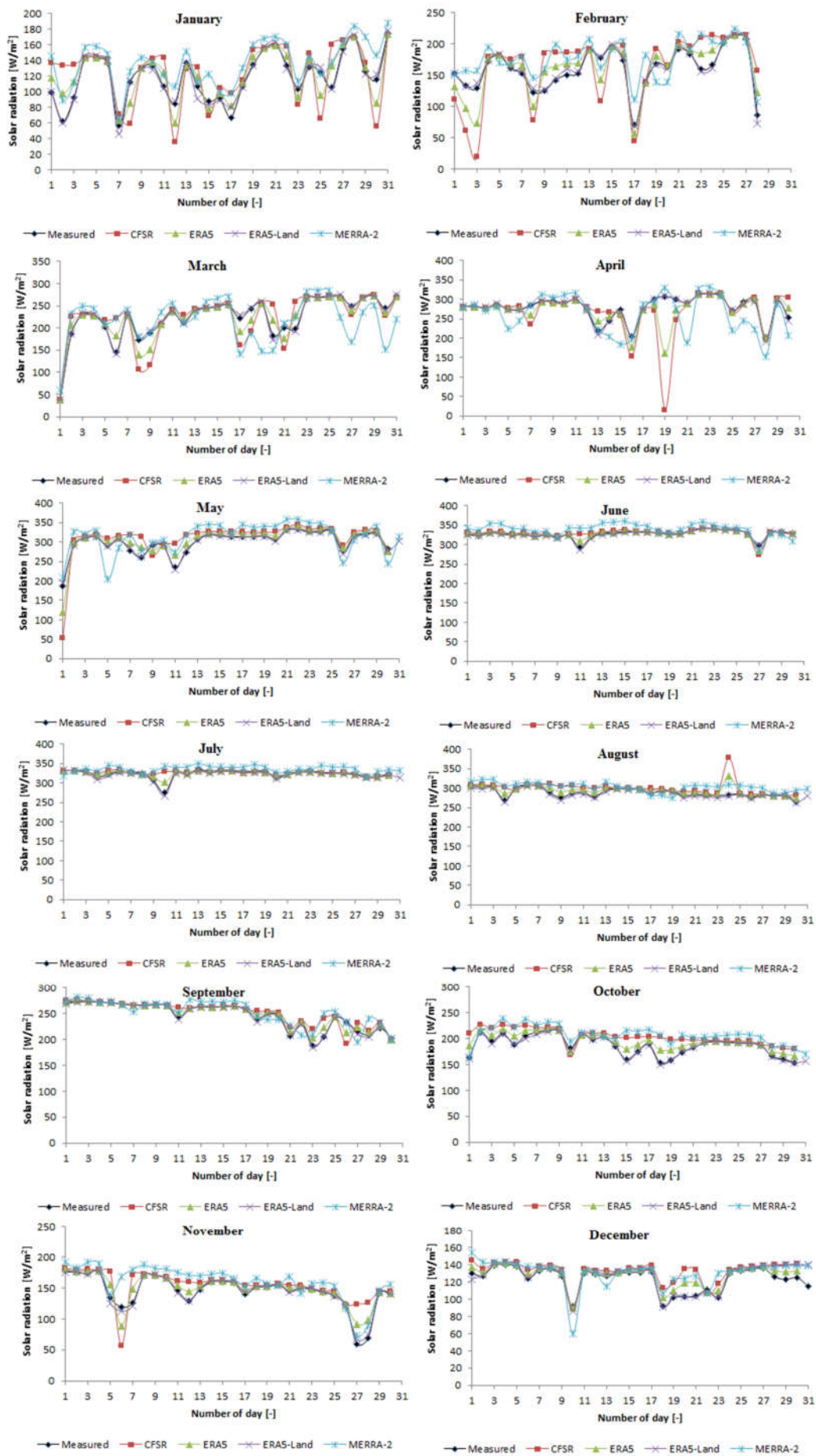
Figure S2. Average daily solar radiation for Az-Zāwiyah during 2022

Table S10. Distribution parameters for all models used based on monthly EAR5-Land dataset

Location	Model	Parameters	KS Statistic	Rank
Aljmail	GEV	k=-0.22487 σ=1.664 μ=4.0918	0.08722	1
	N	σ=1.628 μ=4.7433	0.1037	2
	G	α=8.4894 β=0.55873	0.11359	3
	W-3P	α=1.7986 β=3.1128 γ=1.967	0.1152	4
	Na	m=2.4439 Ω=24.929	0.11681	5
	W	α=2.9293 β=5.056	0.11707	6
	BS	α=0.14192 β=10.965 γ=-6.3319	0.11753	7
	LN	σ=0.3517 μ=1.498	0.11761	8
	K	α₁=0.99175 α₂=1.0139 a=2.37 b=7.6054	0.1201	9
	L	σ=0.89754 μ=4.7433	0.1209	10
	IG	λ=40.268 μ=4.7433	0.12871	11
	LL	α=4.0618 β=4.2632	0.1621	12
	R	σ=3.7846	0.17805	13
Az-Zāwiyah	GEV	k=-0.29787 σ=1.7401 μ=4.5921	0.09377	1
	N	σ=1.6367 μ=5.1892	0.11149	2
	BS	α=0.01924 β=81.178 γ=-76.003	0.12333	3
	G	α=10.052 β=0.51625	0.1255	4
	W-3P	α=2.207 β=3.6639 γ=1.9459	0.12628	5
	L	σ=0.90238 μ=5.1892	0.12779	6
	Na	m=2.934 Ω=29.383	0.12872	7
	W	α=3.1346 β=5.5431	0.14006	8
	LN	σ=0.32555 μ=1.5964	0.14477	9
	IG	λ=52.16 μ=5.1892	0.14499	10
	LL	α=4.3283 β=4.7264	0.18322	11
	R	σ=4.1404	0.1941	12
	K	α₁=1.0238 α₂=0.3597 a=1.9907 b=7.94	0.43362	13
Castelverde	GEV	k=-0.1245 σ=1.538 μ=4.1401	0.08148	1
	K	α₁=0.89492 α₂=1.2586 a=2.58 b=7.9476	0.08926	2
	Na	m=2.4241 Ω=25.993	0.09453	3
	N	σ=1.6172 μ=4.8575	0.09751	4
	G	α=9.0218 β=0.53842	0.10108	5
	W-3P	α=1.567 β=2.766 γ=2.3602	0.10384	6
	BS	α=0.32441 β=4.7113 γ=-0.10186	0.11051	7
	LN	σ=0.3292 μ=1.5278	0.11188	8
	L	σ=0.89161 μ=4.8575	0.11254	9
	IG	λ=43.823 μ=4.8575	0.11391	10
	W	α=3.2028 β=5.1308	0.12409	11
	LL	α=4.4761 β=4.3897	0.13315	12
	R	σ=3.8757	0.19874	13

Table S10. Continued

Location	Model	Parameters	KS Statistic	Rank
Msallatah	GEV	k=-0.02114 σ=1.3792 μ=4.4255	0.08888	1
	Na	m=2.6284 Ω=29.306	0.09473	2
	G	α=10.588 β=0.4905	0.09762	3
	W-3P	α=1.3239 β=2.3672 γ=3.0	0.10437	4
	IG	λ=54.986 μ=5.1933	0.1081	5
	K	α₁=0.81367 α₂=1.4305 a=3.09 b=8.6792	0.11157	6
	BS	α=0.49763 β=2.9466 γ=1.8808	0.11608	7
	LN	σ=0.2916 μ=1.6048	0.1187	8
	N	σ=1.596 μ=5.1933	0.11911	9
	L	σ=0.87994 μ=5.1933	0.12397	10
	LL	α=5.2549 β=4.7457	0.12944	11
	W	α=3.7235 β=5.4272	0.13	12
	R	σ=4.1437	0.24274	13
Sabratah	GEV	k=-0.2391 σ=1.6829 μ=4.2042	0.0896	1
	N	σ=1.6326 μ=4.8467	0.10627	2
	K	α₁=0.87633 α₂=1.2223 a=2.46 b=8.0008	0.10981	3
	G	α=8.8128 β=0.54996	0.11654	4
	W-3P	α=1.8312 β=3.1657 γ=2.0264	0.119	5
	W	α=2.9762 β=5.1686	0.11942	6
	BS	α=0.11454 β=13.633 γ=-8.8761	0.11971	7
	Na	m=2.5437 Ω=25.934	0.12042	8
	LN	σ=0.34539 μ=1.5216	0.12061	9
	L	σ=0.90011 μ=4.8467	0.12318	10
	IG	λ=42.713 μ=4.8467	0.13143	11
	LL	α=4.1247 β=4.3698	0.16428	12
	R	σ=3.8671	0.18318	13

Table S11. Distribution parameters for all models used based on monthly CFSR dataset

Location	Model	Parameters	KS	
			Statistic	Rank
Aljmail	GEV	k=-0.43468 σ=1.3836 μ=4.4744	0.08478	1
	W-3P	α=4.4936 β=4.9881 γ=0.2979	0.10131	2
	N	σ=1.2343 μ=4.8375	0.1132	3
	BS	α=0.00869 β=136.16 γ=-131.33	0.11617	4
	L	σ=0.68048 μ=4.8375	0.11726	5
	IG	λ=74.31 μ=4.8375	0.12292	6
	Na	m=4.5061 Ω=24.798	0.12933	7
	G	α=15.361 β=0.31492	0.1467	8
	W	α=3.8017 β=5.1593	0.15218	9
	LN	σ=0.2661 μ=1.5431	0.16115	10
	K	α₁=1.091 α₂=0.79379 a=2.7016 b=6.78	0.17559	11
	LL	α=5.1993 β=4.5239	0.19676	12
	R	σ=3.8598	0.21846	13
Az-Zāwiyah	GEV	k=-0.36819 σ=1.3752 μ=4.4338	0.07427	1
	N	σ=1.2507 μ=4.8467	0.0925	2
	BS	α=0.00836 β=142.56 γ=-137.72	0.10369	3
	W-3P	α=3.2786 β=3.861 γ=1.3947	0.10467	4
	Na	m=4.3073 Ω=24.924	0.1072	5
	L	σ=0.68953 μ=4.8467	0.11349	6
	G	α=15.018 β=0.32273	0.12504	7
	IG	λ=72.786 μ=4.8467	0.12849	8
	W	α=3.8487 β=5.1595	0.13434	9
	LN	σ=0.26462 μ=1.545	0.14062	10
	LL	α=5.3054 β=4.5313	0.17779	11
	R	σ=3.8671	0.23059	12
	K	α₁=1.1565 α₂=0.64533 a=2.7837 b=6.81	0.24596	13
Castelverde	Na	m=4.6708 Ω=26.102	0.08109	1
	G	α=17.578 β=0.28335	0.08514	2
	BS	α=0.0965 β=11.767 γ=-6.8405	0.08666	3
	W-3P	α=2.2495 β=2.7111 γ=2.5799	0.08711	4
	GEV	k=-0.22492 σ=1.2101 μ=4.507	0.0879	5
	L	σ=0.65497 μ=4.9808	0.093	6
	N	σ=1.188 μ=4.9808	0.09679	7
	LN	σ=0.2358 μ=1.5785	0.09806	8
	IG	λ=87.555 μ=4.9808	0.10312	9
	W	α=4.4574 β=5.2411	0.11194	10
	LL	α=6.2064 β=4.6853	0.14928	11
	R	σ=3.9741	0.26521	12
	K	α₁=1.1622 α₂=0.54715 a=3.1133 b=7.05	0.36915	13

Table S11. Continued

Location	Model	Parameters	KS Statistic	Rank
Msallatah	W-3P	α=1.603 β=1.9524 γ=3.7333	0.12004	1
	BS	α=0.36174 β=2.9042 γ=2.3957	0.12205	2
	GEV	k=-0.03342 σ=0.98563 μ=4.9527	0.12876	3
	LL	α=7.9504 β=5.2148	0.13637	4
	W	α=5.6043 β=5.701	0.13747	5
	LN	σ=0.19446 μ=1.6839	0.15388	6
	G	α=23.453 β=0.23409	0.16389	7
	K	$α_1$=0.82515 $α_2$=1.392 a=3.89 b=7.9561	0.16786	8
	Na	m=5.6909 Ω=31.318	0.17069	9
	N	σ=1.1336 μ=5.49	0.19129	10
	IG	λ=128.76 μ=5.49	0.19144	11
	L	σ=0.62501 μ=5.49	0.19464	12
	R	σ=4.3804	0.32586	13
Sabratah	GEV	k=-0.25204 σ=1.2222 μ=4.7891	0.08291	1
	N	σ=1.1796 μ=5.245	0.08624	2
	Na	m=5.2652 Ω=28.786	0.08908	3
	BS	α=0.06012 β=18.775 γ=-13.563	0.09714	4
	W-3P	α=2.3751 β=2.8111 γ=2.7554	0.09881	5
	G	α=19.77 β=0.26531	0.10142	6
	L	σ=0.65037 μ=5.245	0.10519	7
	LN	σ=0.22241 μ=1.6331	0.11457	8
	IG	λ=103.69 μ=5.245	0.11624	9
	W	α=4.7166 β=5.5135	0.11829	10
	K	$α_1$=0.92003 $α_2$=1.2175 a=3.37 b=7.2899	0.15235	11
	LL	α=6.5608 β=4.9593	0.16351	12
	R	σ=4.1849	0.27692	13

Table S12. Wind turbine characteristics

SunSurfs WT3 Vertical Axis Wind Turbine		Endurance Wind Power	
Type of wind turbine	Vertical axis	Type of wind turbine	Horizontal axis
Rated power [kW]	50	Rated power [kW]	50
Startup wind speed [m/s]	1.8	Cut-in wind speed [m/s]	3.5
Rated wind speed [m/s]	10	Rated wind speed [m/s]	10
Survival wind speed [m/s]	28	Cut-out wind speed [m/s]	25
Rated rotating speed [rpm]	40	Survival wind speed [m/s]	52.5
Diameter [m]	18	Diameter [m]	19.2
Tower height [m]	14	Hub height [m]	43
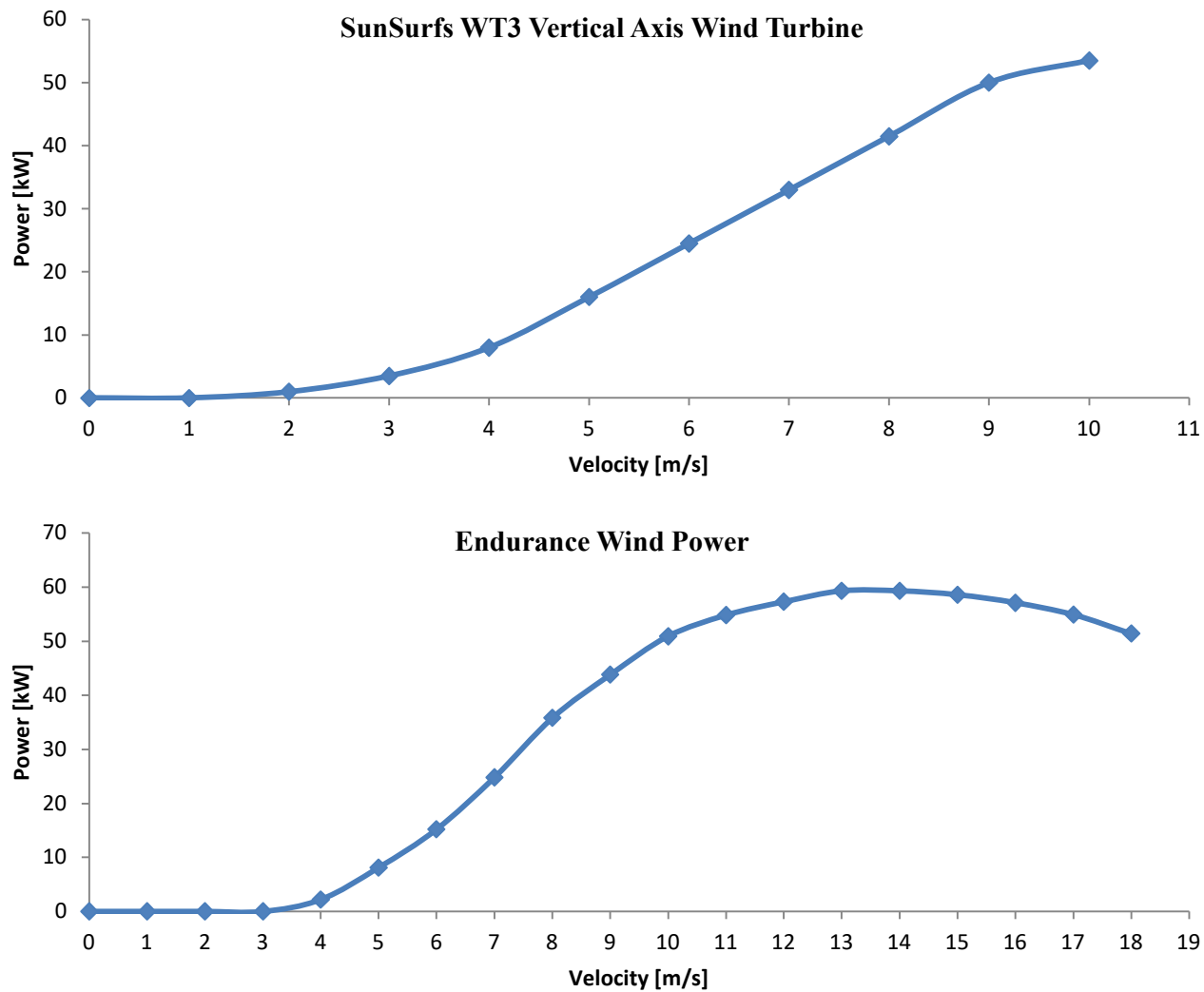
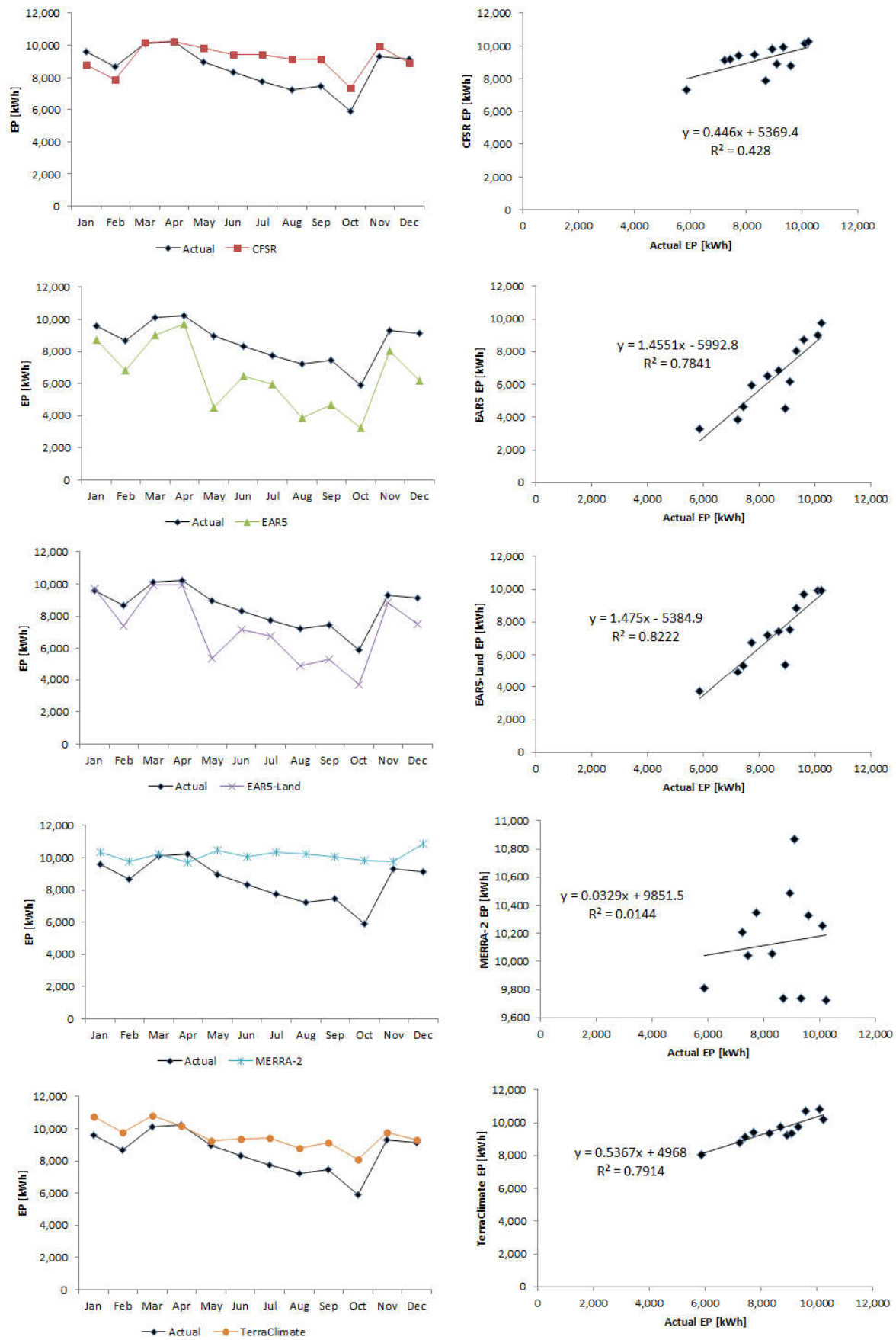**Figure S3.** Characteristic machine power curves

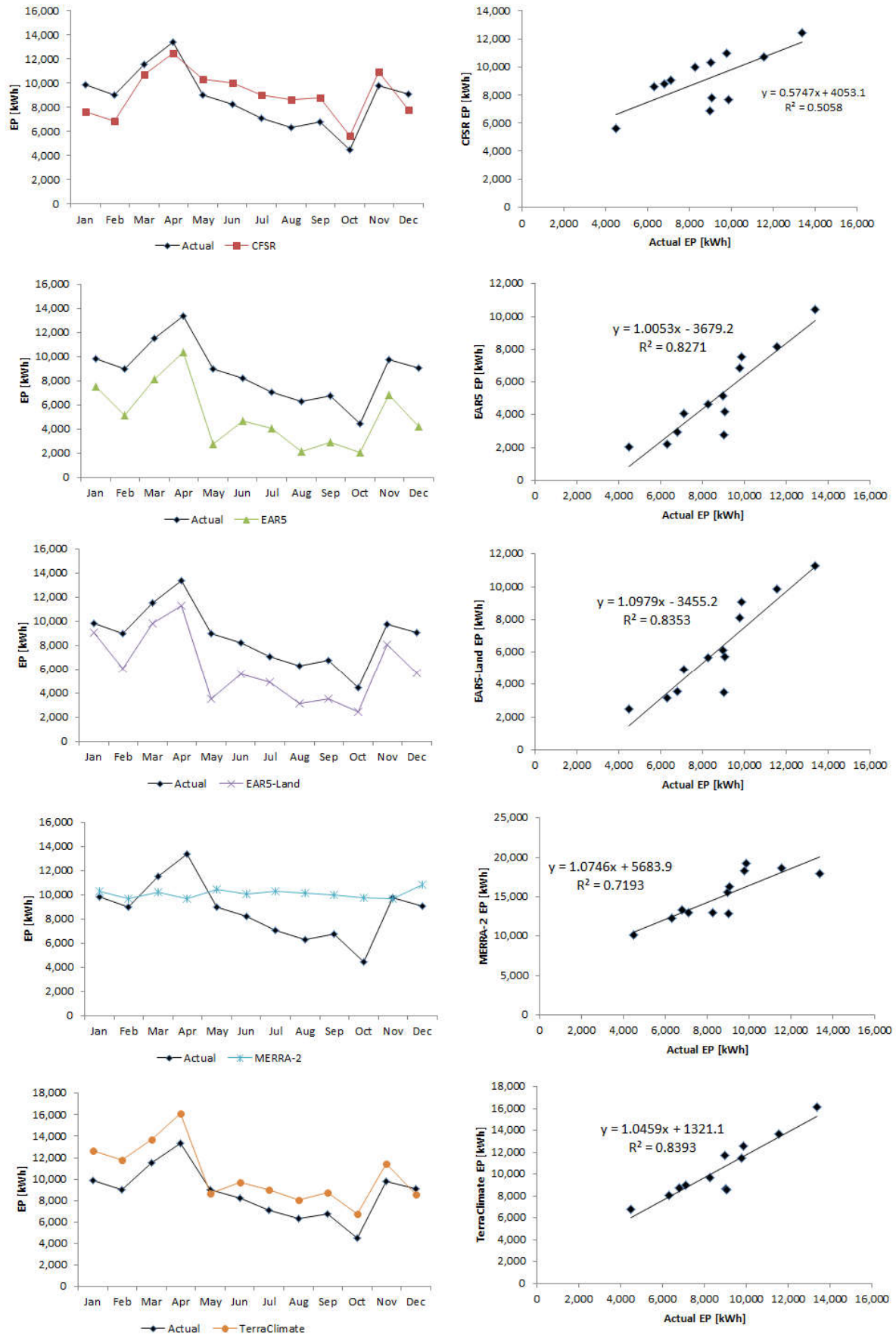**Figure S4.** Monthly variation of EP using VAWT

Figure S5. Monthly variation of EP using HAWT
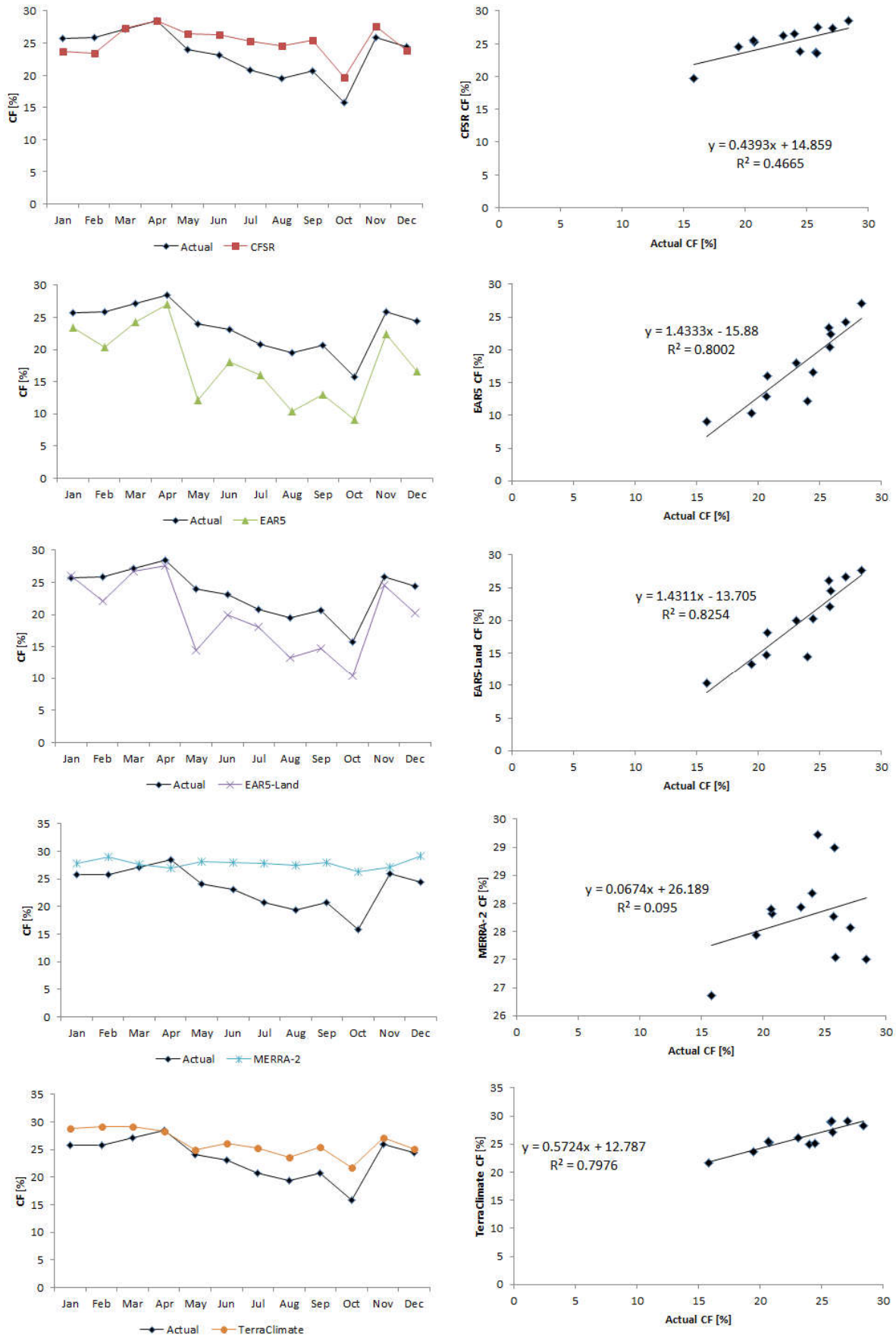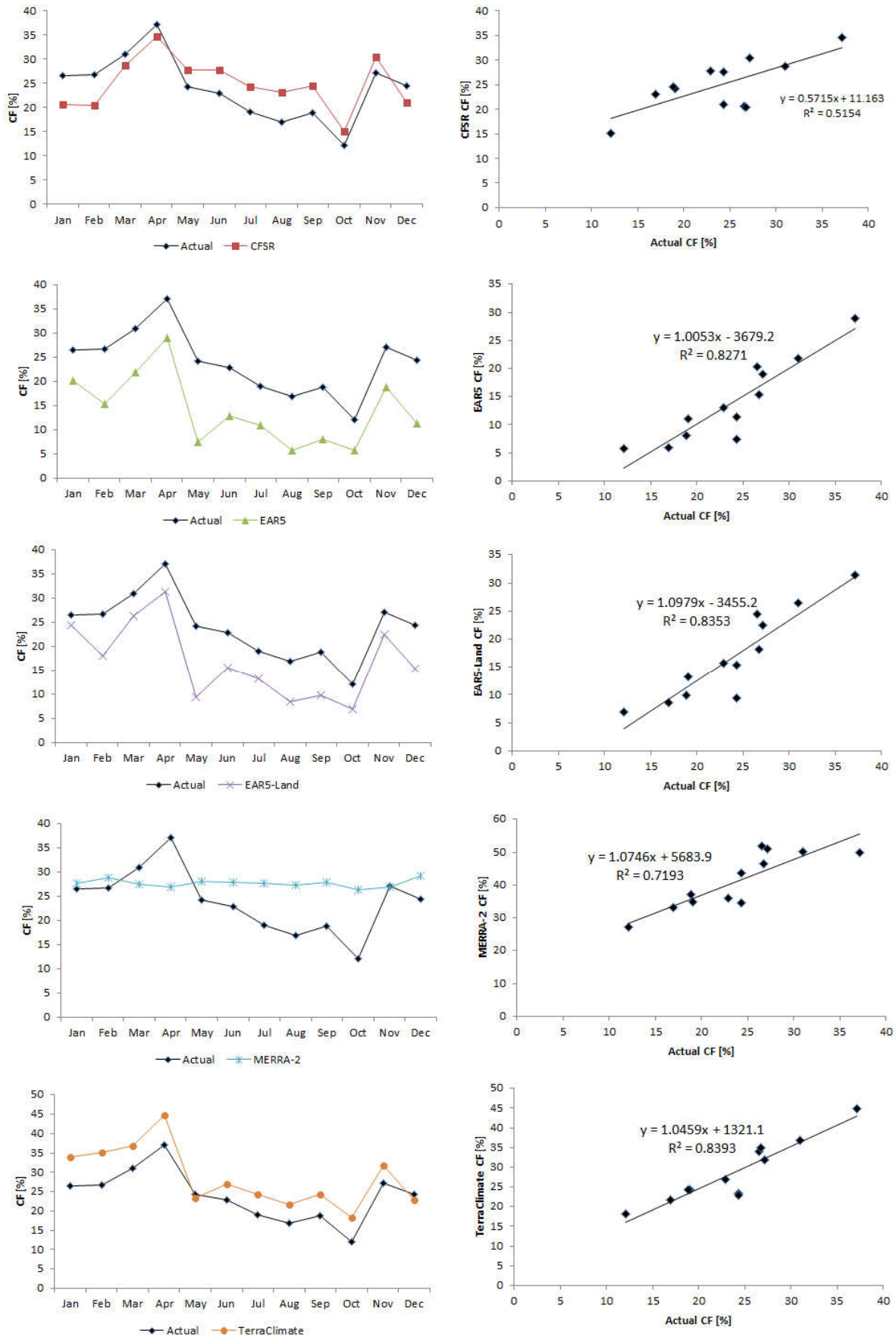
Figure S6. Monthly variation of CF using VAWT

Figure S7. Monthly variation of CF using HAWT

Table S13. Specification of selected PV panel

Item	Specification	
Manufacturer	JinKO solar	
Model	JKM545M-72HL4-V	
	STC	NOCT
Maximum Power (P_{max}) [W]	545	405
The voltage at Maximum Power (Vmp) [V]	40.8	38.25
Current at Maximum Power (Impp) [A]	13.36	10.60
Open Circuit Voltage (Voc) [V]	49.52	46.74
Short Circuit Current (Isc) [A]	13.94	11.26
Operating Temperature Range [℃]	-40℃~+85℃	
Temperature Coefficient of P_{max} [%/℃]	-0.35%/℃	
Temperature Coefficient of Voc [%/℃]	-0.28%/℃	
Temperature Coefficient of Isc [%/℃]	0.048%/℃	
Nominal operating cell temperature (NOCT)	45±2℃	
Cost [USD/W]	0.37	