GeoSUN

PACIFIC POWER ASSOCIATION

solar and meteorological measurements

FEBRUARY 2023

CONSOLIDATED SITE MEASUREMENT REPORT

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1. Data Fields

Table 1: Nomenclature

Field	Instrument	Measurement
DHI (1)	Solar Sensor (Delta-T SPN1)	Diffused Horizontal Irradiation
DHI (SAT)	Satellite Derived (Solargis)	Diffused Horizontal Irradiation
GHI (1)	Thermopile Pyranometer (Hukseflux SR30-D1)	Global Horizontal Irradiation
GHI (2)	Thermopile Pyranometer (Hukseflux SR20-T2)	Global Horizontal Irradiation
GHI (SAT)	Satellite Derived (Solargis)	Global Horizontal Irradiation
GTI (Clean)	Silicon Irradiance Sensor (IMT Si-mV-85)	Global Tilted Irradiation (Cleaned)
GTI (Monthly)	Silicon Irradiance Sensor (IMT Si-mV-85)	Global Tilted Irradiation (Cleaned Monthly)
GTI (Soil)	Silicon Irradiance Sensor (IMT Si-mV-85)	Global Tilted Irradiation (Soiled)
Temp	Thermometer (Campbell Scientific model CS215)	Ambient Air Temperature
Temp (SAT)	Satellite Derived (Solargis)	Ambient Air Temperature
RH	Hygrometer (Campbell Scientific model CS215)	Relative Humidity
Rain	Rain Gauge (Texas Electronics TR-525I)	Rain
BP	Barometer (Vaisala PTB110)	Barometric Pressure
Wind Speed	Anemometer (RM Young 03002)	Wind Speed (measured at 3 m)
Wind Direction	Wind Vane (RM Young 03002)	Wind Direction (measured at 3 m)
Cleaning	Push Button	Button to be pressed on cleaning event
NaN	Numerical Value Not Available	Not a Number

2. Introduction

The World Bank initiated the Sustainable Energy Industry Development Project (SEIDP) to, amongst others, support the Pacific Power Association (PPA) in doing renewable energy resource assessments. The focus for this particular section of the project was to get high quality bankable wind as well as irradiance measurements supported by high quality meteorological measurements and to promote the awareness of the resource potential of wind and solar energy.

GeoSUN Africa executed the on-site measurement related aspects of the solar section of the project in Papua New Guinea, Federated States of Micronesia, Marshall Islands, Nauru, Palau, Vanuatu, Solomon Islands and Tuvalu. The assignment for GeoSUN Africa was as follows:

- An inception mission which involved visiting the proposed site locations and selecting the optimal location for the measurement equipment;
- Providing high quality measuring equipment for each site;
- Installation of measurement equipment;
- Hosting and providing two years of high quality, 'bankable' meteorological data relevant for solar resource assessment and project development;
- Ensuring maintenance, security, local cleaning/caretaking, and mitigation against extreme weather events and corrossion;
- Ensuring strong local involvement and capacity building;
- Decommissioning of all sites at the end of the measurement campaign.

This document acts as the Consolidated Site Measurement Report for the solar and meteorological measurements which follows the completion of the full two year measurement campaign, summarizing the measurement results and data quality.

3. Marshall Islands

3.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020	69	179
April 2020	68	154
May 2020	62	145
June 2020	47	165
July 2020	56	158
August 2020	55	176
September 2020	48	166
October 2020	62	145
November 2020	54	147
December 2020	54	133
January 2021	55	171
February 2021	56	172
Total (kWh/m²/year)	686	1912

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	67	153
April 2021	60	166
May 2021	68	136
June 2021	56	159
July 2021	58	173
August 2021	46	186
September 2021	50	157
October 2021	50	164
November 2021	57	124
December 2021	55	157
January 2022	54	180
February 2022	56	165
March 2022	73	156
Total (kWh/m²/year)	750	2078

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	19	30	25	20	18	31	37	31	15	4	2	5
6 pm	155	190	164	143	120	166	182	168	130	85	71	88
5 pm	359	397	344	298	268	320	348	354	297	251	228	251
4 pm	546	584	499	454	419	470	478	561	470	429	404	388
3 pm	692	750	616	600	532	618	631	703	627	592	544	534
2 pm	787	851	701	716	623	702	727	773	726	669	622	646
1 pm	802	853	733	743	632	737	725	787	755	726	632	690
12 pm	767	795	696	705	558	706	674	757	725	704	581	662
11 am	665	669	601	650	508	617	583	667	594	618	549	598
10 am	489	514	440	509	411	502	464	507	517	440	442	428
9 am	271	286	256	318	274	329	307	323	333	315	278	250
8 am	77	81	90	128	119	145	131	139	144	128	111	90
7 am	1	1	4	12	17	19	12	11	15	17	12	4

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	14	22	19	15	14	20	24	19	12	3	2	4
6 pm	74	95	88	79	76	75	87	69	64	49	46	53
5 pm	126	165	162	142	150	128	141	120	119	110	117	121
4 pm	163	212	219	199	217	174	194	169	158	181	180	166
3 pm	203	241	268	256	254	200	224	192	182	214	221	205
2 pm	203	228	280	284	276	218	223	185	191	225	244	211
1 pm	225	248	280	262	263	194	219	192	208	232	233	232
12 pm	228	243	288	263	244	177	217	201	205	235	232	234
11 am	199	216	253	243	220	186	191	179	175	209	220	192
10 am	161	177	189	192	188	151	156	147	152	172	177	163
9 am	106	114	124	128	132	116	103	100	109	118	127	113
8 am	42	43	52	63	64	66	58	52	59	61	61	49
7 am	1	1	3	8	11	12	8	7	9	11	9	3

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	28	28	28	28	28	27	28	28	28	28	28	28
10 pm	28	28	28	28	28	28	28	29	29	28	28	28
9 pm	28	28	28	28	28	28	28	29	29	28	28	28
8 pm	28	28	28	28	28	28	28	29	29	29	28	28
7 pm	28	28	28	28	28	28	29	29	29	29	28	28
6 pm	28	29	28	28	28	28	29	29	29	29	28	28
5 pm	29	29	28	29	29	29	29	30	29	30	29	28
4 pm	29	29	29	29	29	29	30	30	30	30	29	29
3 pm	29	29	29	29	29	29	30	30	30	30	29	29
2 pm	29	29	29	29	29	29	30	30	30	30	29	29
1 pm	29	29	29	29	29	29	30	30	30	30	29	29
12 pm	29	29	29	29	28	29	29	30	30	30	29	29
11 am	29	29	28	29	28	29	29	30	30	30	29	29
10 am	28	29	28	29	28	29	29	29	29	29	29	28
9 am	28	28	28	28	28	28	28	29	29	29	28	28
8 am	28	28	27	28	27	28	28	28	28	28	28	28
7 am	27	27	27	27	27	27	28	28	28	28	28	27
6 am	27	27	27	27	27	27	28	28	28	27	28	27
5 am	27	27	27	27	27	27	28	28	28	28	28	27
4 am	27	27	27	27	27	27	28	28	28	28	27	27
3 am	27	27	27	27	28	27	28	28	28	28	28	28
2 am	27	28	27	27	28	27	28	28	28	28	28	28
1 am	28	28	27	28	28	27	28	28	28	28	28	28
12 am	28	28	28	28	28	27	28	28	28	28	28	28

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	81	80	84	85	87	85	85	82	81	82	84	83
10 pm	81	80	83	85	86	84	84	82	80	81	84	83
9 pm	81	80	83	85	86	84	83	81	80	80	84	83
8 pm	80	79	83	84	86	84	83	80	79	80	83	83
7 pm	79	79	82	83	85	83	82	80	79	79	82	83
6 pm	78	77	81	82	84	82	80	78	78	77	81	81
5 pm	77	77	80	81	83	80	79	76	77	76	79	80
4 pm	75	76	79	80	82	79	78	75	75	75	78	80
3 pm	75	75	79	79	82	79	78	76	75	75	77	79
2 pm	74	75	79	79	82	79	78	76	76	76	79	79
1 pm	74	76	80	79	82	79	79	77	76	76	79	79
12 pm	75	76	79	80	84	79	80	77	77	76	80	78
11 am	75	77	81	80	84	80	80	79	78	76	80	79
10 am	77	77	82	82	85	81	82	81	78	78	81	81
9 am	78	78	82	84	86	82	83	82	80	79	82	82
8 am	79	80	84	85	87	84	85	83	82	81	83	83
7 am	80	80	84	87	88	85	86	85	84	83	84	84
6 am	80	80	84	87	87	85	86	85	84	83	84	84
5 am	80	81	85	87	87	85	86	84	84	83	84	83
4 am	80	81	85	87	86	85	86	84	84	83	84	84
3 am	80	81	84	87	86	85	86	84	83	83	84	83
2 am	80	81	84	86	86	86	86	84	82	83	84	83
1 am	80	81	84	86	87	85	85	84	82	83	84	83
12 am	81	81	84	86	87	86	85	83	81	82	84	83

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	15.8	14.2	21.6	32.0	55.0	30.2	52.0	3.6	16.8	25.4	12.8	19.0
10 pm	6.6	2.4	26.2	39.4	53.6	41.4	24.4	12.0	8.6	26.4	31.2	22.2
9 pm	16.8	2.6	29.0	41.0	63.2	6.6	50.4	9.4	23.2	40.8	56.0	8.2
8 pm	37.6	16.0	20.8	11.4	34.6	10.6	16.8	37.2	32.4	18.2	69.2	17.4
7 pm	5.6	6.0	20.4	18.2	42.0	20.4	28.2	20.4	8.2	37.6	3.8	42.2
6 pm	14.8	5.6	26.0	15.2	69.6	23.2	27.8	50.4	12.8	29.8	20.8	27.2
5 pm	36.2	30.6	18.8	58.2	20.2	40.8	7.6	23.2	33.4	14.0	28.6	27.4
4 pm	27.0	24.0	31.8	32.6	19.2	27.8	20.6	22.4	18.4	17.4	42.4	19.8
3 pm	9.6	17.6	52.4	10.6	32.6	37.4	26.0	13.4	25.8	18.2	17.2	35.8
2 pm	26.2	31.2	33.4	1.4	28.0	16.0	34.4	47.0	70.2	14.6	17.8	54.8
1 pm	31.6	31.2	48.4	18.0	24.4	15.8	13.4	23.2	63.2	64.4	46.2	31.8
12 pm	22.8	25.6	29.8	17.2	26.8	18.0	27.0	45.4	29.4	32.2	26.0	50.8
11 am	12.2	18.4	45.2	10.2	49.0	12.8	15.4	15.0	54.2	28.0	20.4	18.6
10 am	13.0	11.6	48.8	9.6	52.8	19.8	13.0	22.2	35.4	46.4	42.6	2.4
9 am	10.6	2.2	28.8	18.2	73.4	14.4	37.6	43.8	12.4	31.8	27.4	28.4
8 am	11.6	13.0	10.8	11.6	57.2	27.2	16.6	9.6	12.6	46.8	21.0	54.4
7 am	10.8	22.8	23.6	22.0	63.6	22.2	39.0	13.4	34.6	30.8	39.2	24.6
6 am	5.2	5.0	14.6	16.2	45.8	37.8	12.6	21.2	31.0	68.8	41.8	27.4
5 am	19.4	14.8	20.8	47.6	58.2	16.8	14.2	9.4	35.2	50.0	42.8	9.4
4 am	13.2	8.6	31.2	50.6	58.2	25.2	43.0	4.2	23.6	44.0	19.0	34.0
3 am	4.6	7.0	67.0	29.8	34.2	12.0	37.6	5.0	15.0	75.8	14.8	23.4
2 am	10.6	5.0	51.6	20.2	20.0	6.4	44.0	3.0	30.6	88.2	22.0	10.4
1 am	3.6	26.6	24.4	26.4	26.6	18.0	45.0	1.8	16.8	55.0	89.6	9.6
12 am	16.8	18.2	11.4	23.8	39.8	25.4	12.8	20.4	10.8	43.0	31.4	7.6

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,011	1,011	1,010	1,006	1,006	1,012	1,011	1,012	1,012	1,012	1,012	1,011
10 pm	1,011	1,011	1,010	1,006	1,006	1,012	1,011	1,012	1,012	1,012	1,012	1,011
9 pm	1,011	1,011	1,009	1,005	1,006	1,012	1,011	1,012	1,012	1,011	1,011	1,011
8 pm	1,010	1,010	1,009	1,005	1,005	1,011	1,010	1,011	1,011	1,011	1,011	1,010
7 pm	1,010	1,009	1,008	1,004	1,004	1,011	1,010	1,011	1,010	1,010	1,010	1,009
6 pm	1,009	1,009	1,008	1,004	1,004	1,010	1,009	1,010	1,010	1,010	1,010	1,009
5 pm	1,009	1,008	1,007	1,003	1,004	1,010	1,009	1,010	1,010	1,009	1,009	1,009
4 pm	1,009	1,008	1,007	1,003	1,004	1,010	1,009	1,010	1,010	1,009	1,009	1,008
3 pm	1,009	1,009	1,008	1,004	1,004	1,010	1,010	1,010	1,010	1,009	1,009	1,009
2 pm	1,010	1,010	1,009	1,004	1,005	1,011	1,010	1,011	1,010	1,010	1,010	1,009
1 pm	1,011	1,010	1,010	1,005	1,005	1,012	1,011	1,012	1,011	1,011	1,011	1,010
12 pm	1,011	1,011	1,010	1,006	1,006	1,012	1,011	1,012	1,012	1,012	1,012	1,011
11 am	1,012	1,012	1,011	1,006	1,006	1,013	1,012	1,012	1,012	1,012	1,012	1,011
10 am	1,012	1,012	1,011	1,006	1,006	1,012	1,012	1,013	1,013	1,012	1,012	1,012
9 am	1,012	1,011	1,010	1,006	1,006	1,012	1,011	1,012	1,012	1,012	1,012	1,011
8 am	1,011	1,011	1,010	1,005	1,006	1,012	1,011	1,012	1,012	1,011	1,011	1,011
7 am	1,010	1,010	1,009	1,005	1,005	1,011	1,010	1,011	1,011	1,011	1,011	1,010
6 am	1,010	1,010	1,008	1,004	1,004	1,010	1,010	1,011	1,010	1,010	1,010	1,010
5 am	1,010	1,009	1,008	1,004	1,004	1,010	1,010	1,011	1,010	1,010	1,010	1,009
4 am	1,009	1,009	1,008	1,004	1,004	1,010	1,010	1,010	1,010	1,010	1,010	1,009
3 am	1,010	1,010	1,009	1,004	1,004	1,010	1,010	1,011	1,010	1,010	1,010	1,009
2 am	1,010	1,010	1,009	1,005	1,005	1,011	1,010	1,011	1,011	1,010	1,011	1,010
1 am	1,011	1,011	1,010	1,006	1,005	1,012	1,011	1,012	1,011	1,011	1,011	1,011
12 am	1,011	1,011	1,010	1,006	1,006	1,012	1,011	1,012	1,012	1,011	1,012	1,011

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	6.2	6.7	6.1	5.5	6.4	4.8	4.3	3.4	4.0	3.1	5.0	5.5
10 pm	6.1	6.9	6.2	5.5	6.3	4.6	4.4	3.3	3.8	3.3	4.9	5.7
9 pm	6.1	6.9	5.9	5.6	6.3	4.5	4.5	3.5	3.7	3.2	5.1	5.8
8 pm	6.1	6.9	5.8	5.4	6.0	4.5	4.5	3.5	3.9	3.1	5.1	5.7
7 pm	6.0	6.6	5.9	5.5	6.2	4.7	4.6	3.4	4.2	3.3	4.9	5.5
6 pm	6.1	6.7	6.0	5.5	6.2	4.8	4.7	3.6	4.0	3.4	4.8	5.6
5 pm	6.2	6.7	6.1	5.3	6.3	5.0	4.9	3.7	4.0	3.5	4.9	5.9
4 pm	6.3	6.7	6.2	5.3	6.3	4.9	5.0	3.8	4.1	3.4	5.1	5.6
3 pm	6.3	6.6	6.3	5.4	6.6	5.0	5.1	3.7	4.3	3.6	5.3	5.6
2 pm	6.5	6.9	6.6	5.5	6.8	4.9	5.1	3.6	4.3	3.3	5.4	5.8
1 pm	6.5	7.0	6.7	5.7	6.7	5.0	4.8	3.7	4.2	3.6	5.4	5.9
12 pm	6.6	7.0	6.5	5.7	6.5	4.9	4.8	3.8	4.2	3.5	5.6	5.9
11 am	6.5	7.0	6.4	5.9	6.4	4.9	4.9	3.8	4.2	3.5	5.7	5.7
10 am	6.5	6.9	6.5	5.8	6.7	4.9	5.0	3.8	4.1	3.6	5.6	5.6
9 am	6.5	6.8	6.4	5.9	6.4	4.8	4.7	3.7	4.0	3.4	5.5	5.7
8 am	6.1	6.6	6.0	5.4	6.3	4.7	4.4	3.2	3.8	3.3	5.3	5.5
7 am	6.1	6.4	5.7	5.4	6.1	4.4	4.2	3.1	3.6	3.2	5.2	5.2
6 am	6.0	6.5	5.9	5.2	6.1	4.4	4.2	3.1	3.7	3.2	5.1	5.3
5 am	6.0	6.6	6.0	5.2	6.2	4.5	4.2	3.0	3.7	3.2	5.1	5.2
4 am	6.1	6.7	5.8	5.4	6.3	4.5	4.3	3.1	3.5	3.3	5.0	5.3
3 am	6.2	6.5	5.8	5.2	6.3	4.6	4.3	3.2	3.6	3.3	4.9	5.3
2 am	6.0	6.7	5.7	5.1	6.2	4.6	4.2	3.3	3.6	3.4	4.9	5.3
1 am	6.1	6.6	5.9	5.2	6.3	4.7	4.3	3.4	3.7	3.2	4.8	5.6
12 am	6.2	6.6	6.0	5.4	6.3	4.8	4.4	3.6	3.9	3.3	4.8	5.6

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	E	E	E	E	E	E	E	E	E	E	E	E
10 pm	E	E	E	E	E	E	E	E	E	E	E	E
9 pm	E	E	E	E	E	E	E	E	E	E	E	E
8 pm	E	E	E	E	E	E	E	E	E	E	E	E
7 pm	E	E	E	E	E	E	E	E	SE E	SE	E	E
6 pm	E	E	E	E	E	E	E	E	E	SE E	E	E
5 pm	E	E	E	E	E	E	E	E	SE	SE	E	E
4 pm	E	E	E	E	E	E	E	E	SE	SE	E	E
3 pm	E	E	E	E	E	E	E	E	SE	SE	E	E
2 pm	E	E	E	E	E	E	E	E	E	SE	E	E
1 pm	E	E	E	E	E	E	E	SE E	E	SE	E	E
12 pm	E	E	E	E	E	E	E	E	SE	SE	E	E
11 am	E	E	E	E	E	E	E	E	SE	SE	E	E
10 am	E	E	E	E	E	E	E	E	SE	SE	E	E
9 am	E	E	E	E	E	E	E	E	E	SE	E	E
8 am	E	E	NE	E	E	E	E	E	E	SE	E	E
7 am	E	E	E	E	E	E	E	E	E	SE	E	E
6 am	E	E	E	E	E	E	E	E	E	E	E	E
5 am	E	E	E	E	E	E	E	E	E	E	E	E
4 am	E	E	E	E	E	E	E	E	E	SE	E	E
3 am	E	E	E	E	E	E	E	E	E	SE E	E	E
2 am	E	E	E	E	E	E	E	E	E	E	E	E
1 am	E	E	E	E	E	E	E	E	E	E	E	E
12 am	E	E	E	E	E	E	E	E	E	E	E	E

Figure 9: Dominant hourly Wind Direction

3.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

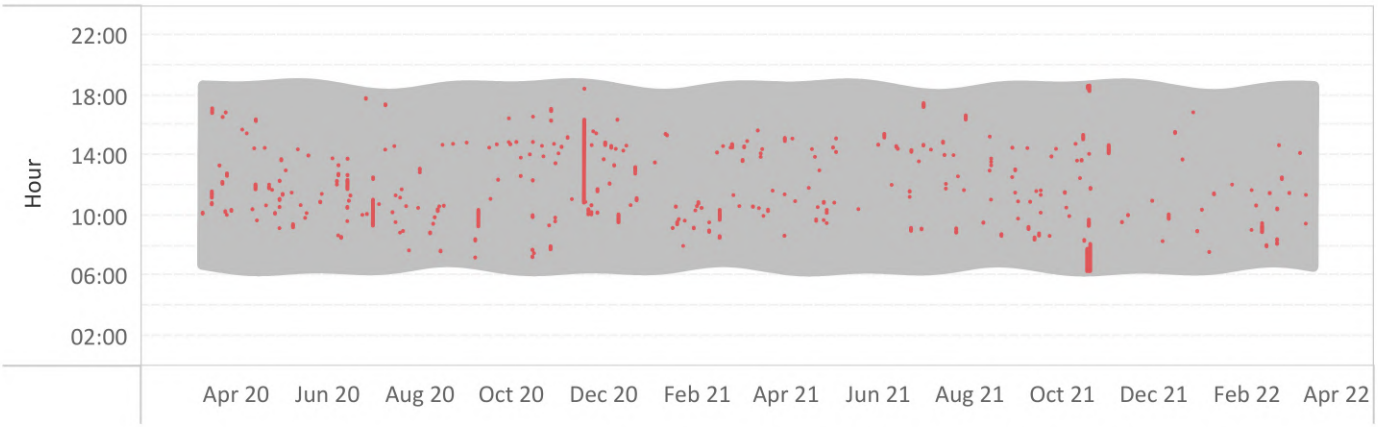

Figure 10: Quality control for GHI (1)

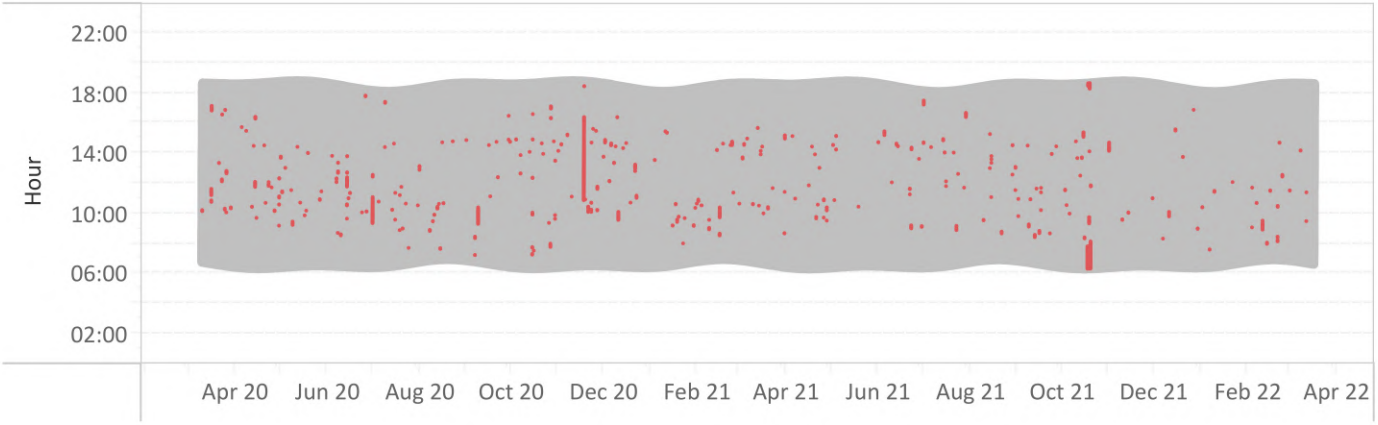

Figure 11: Quality control for GHI (2)

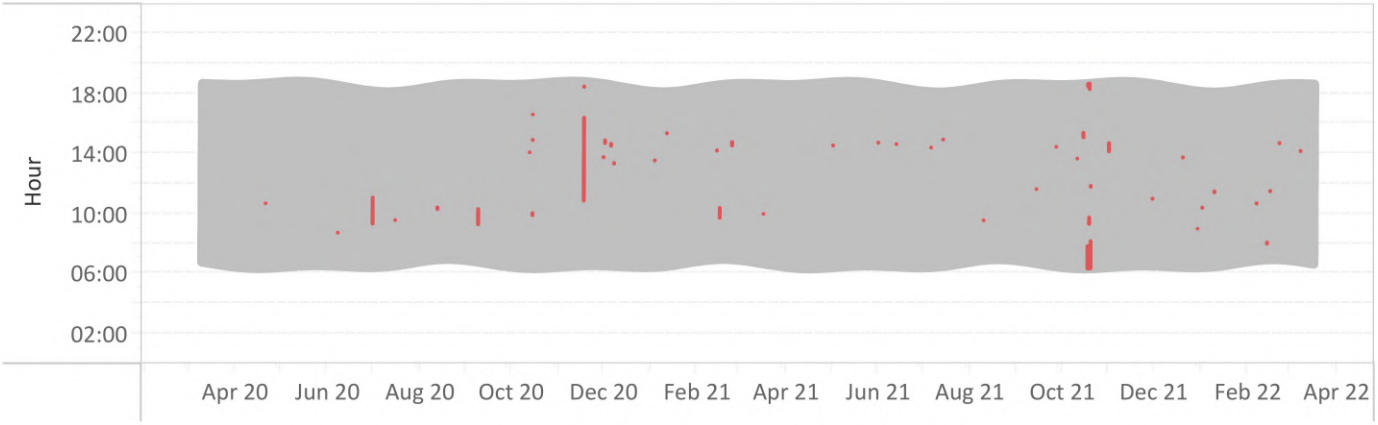

Figure 12: Quality control for DHI (1)

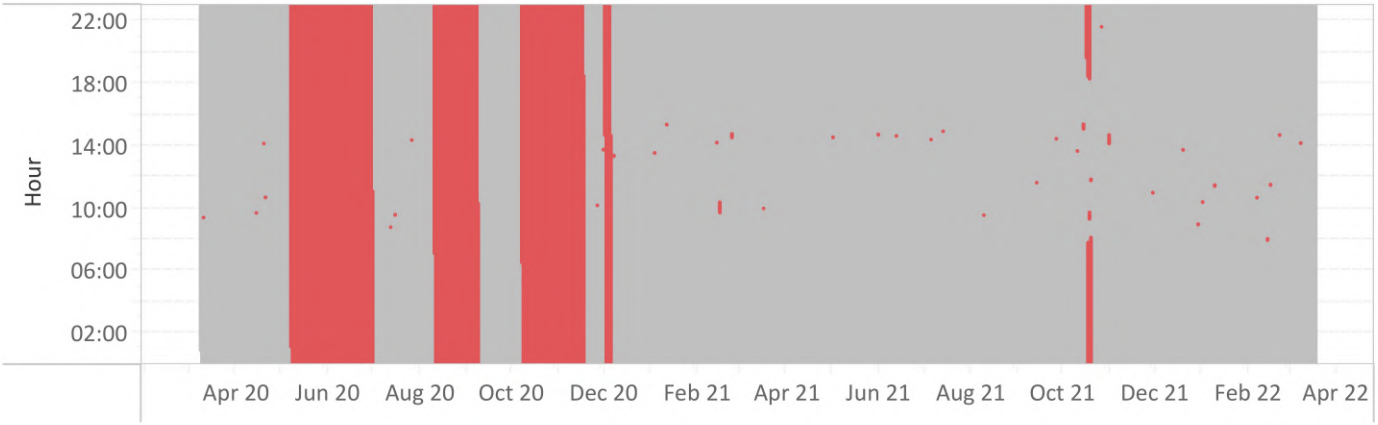

Figure 13: Quality Control for Temp

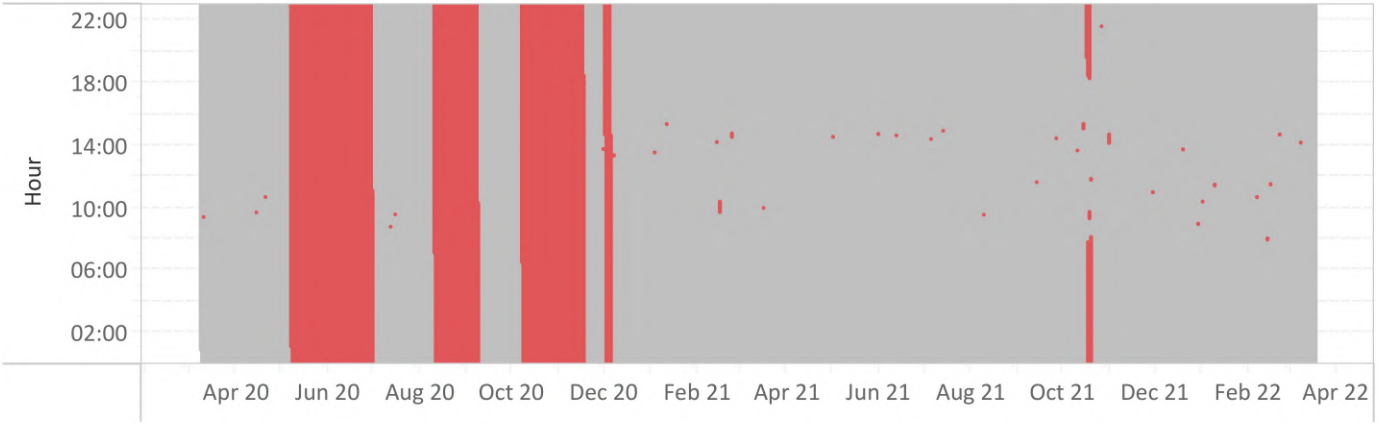

Figure 14: Quality Control for RH

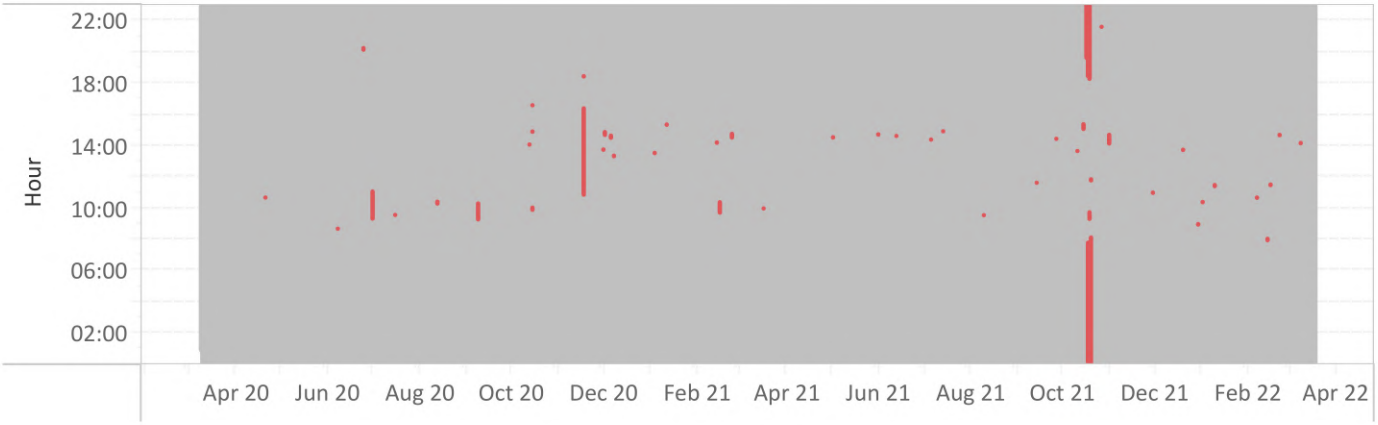

Figure 15: Quality Control for Rain

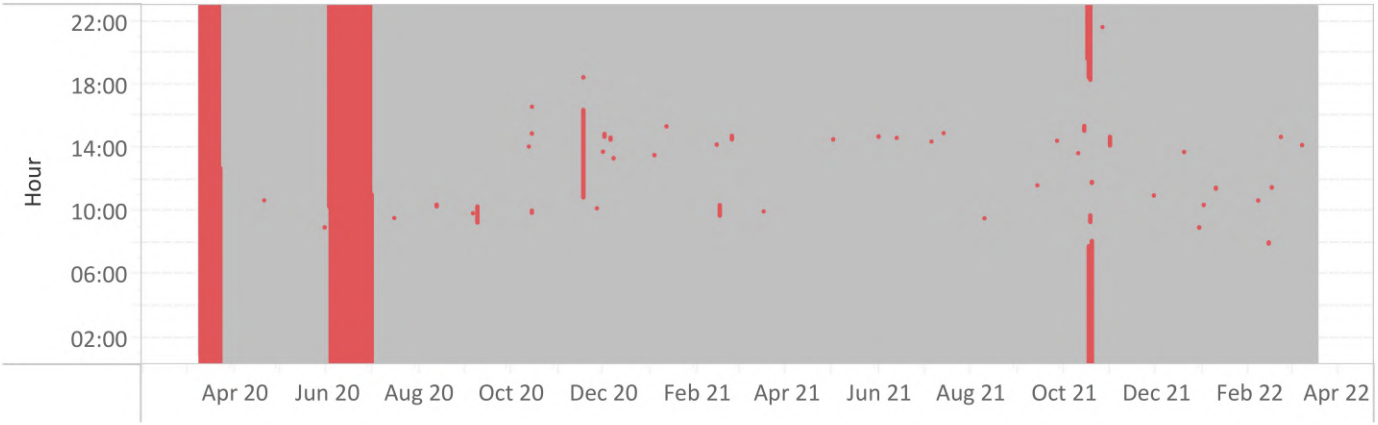

Figure 16: Quality Control for BP

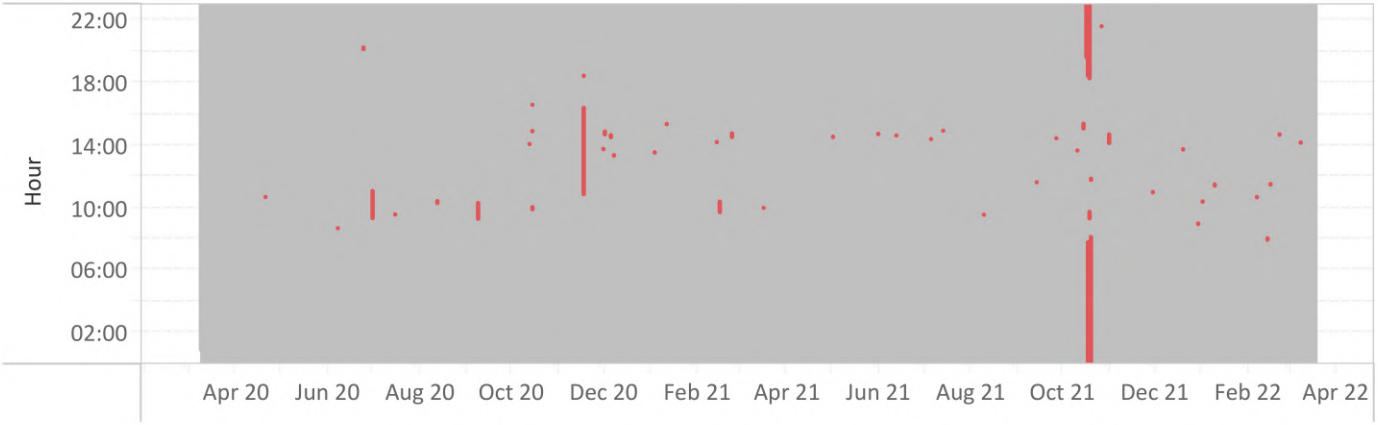

Figure 17: Quality Control for Wind Direction

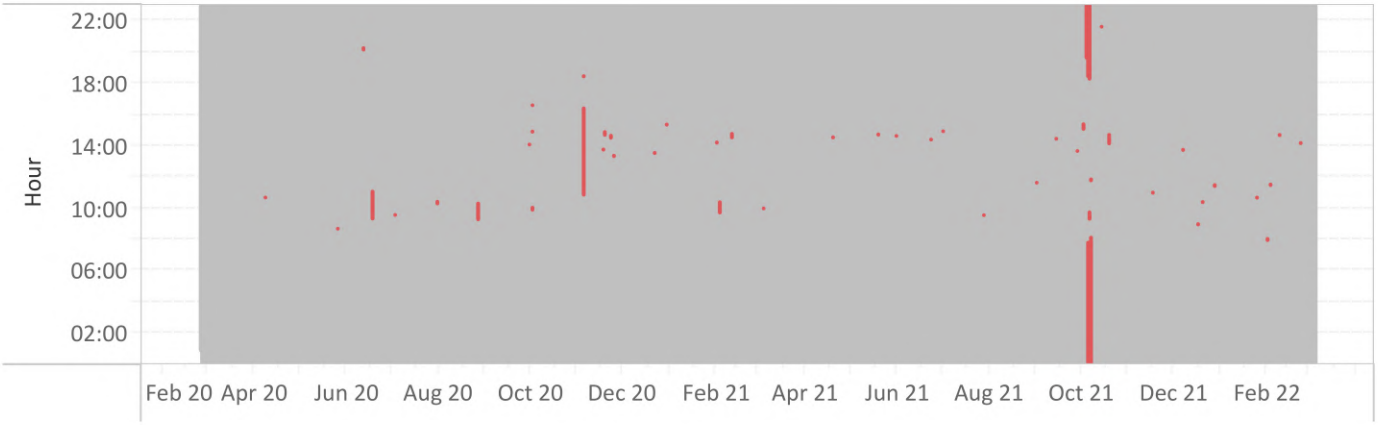

Figure 18: Quality Control for Wind Speed

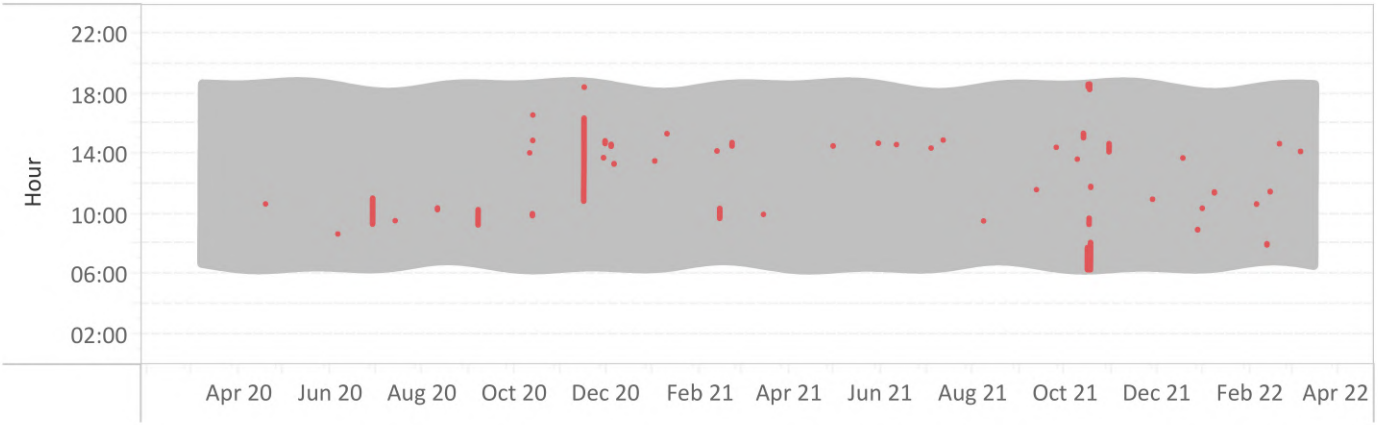

Figure 19: Quality control for soiling measurement (monthly cleaned)

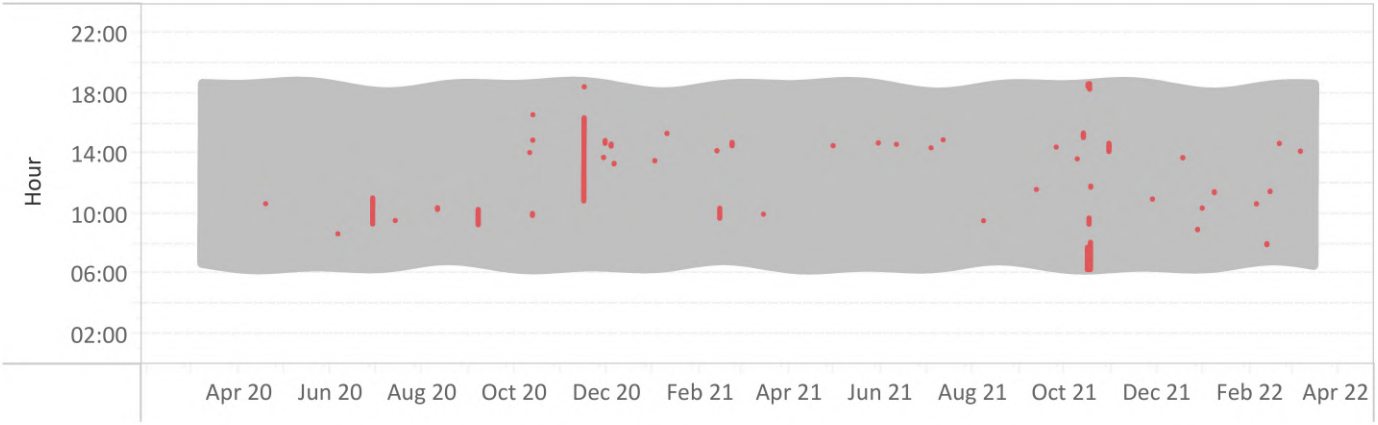

Figure 20: Quality control for soiling measurement (continuous soiling)

3.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

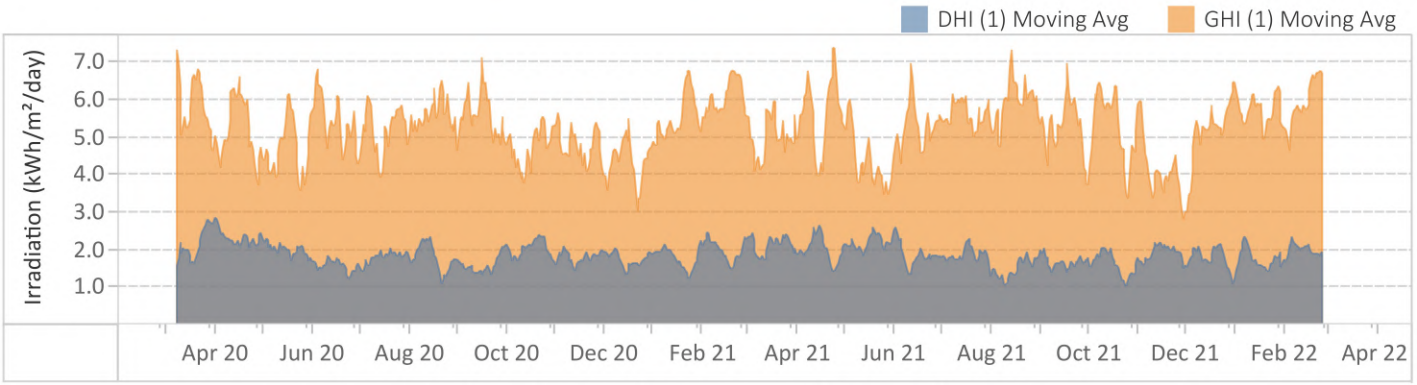

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

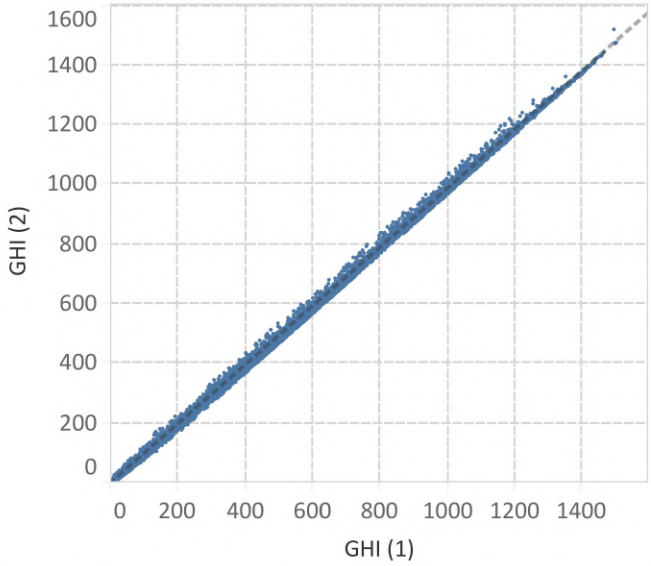

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

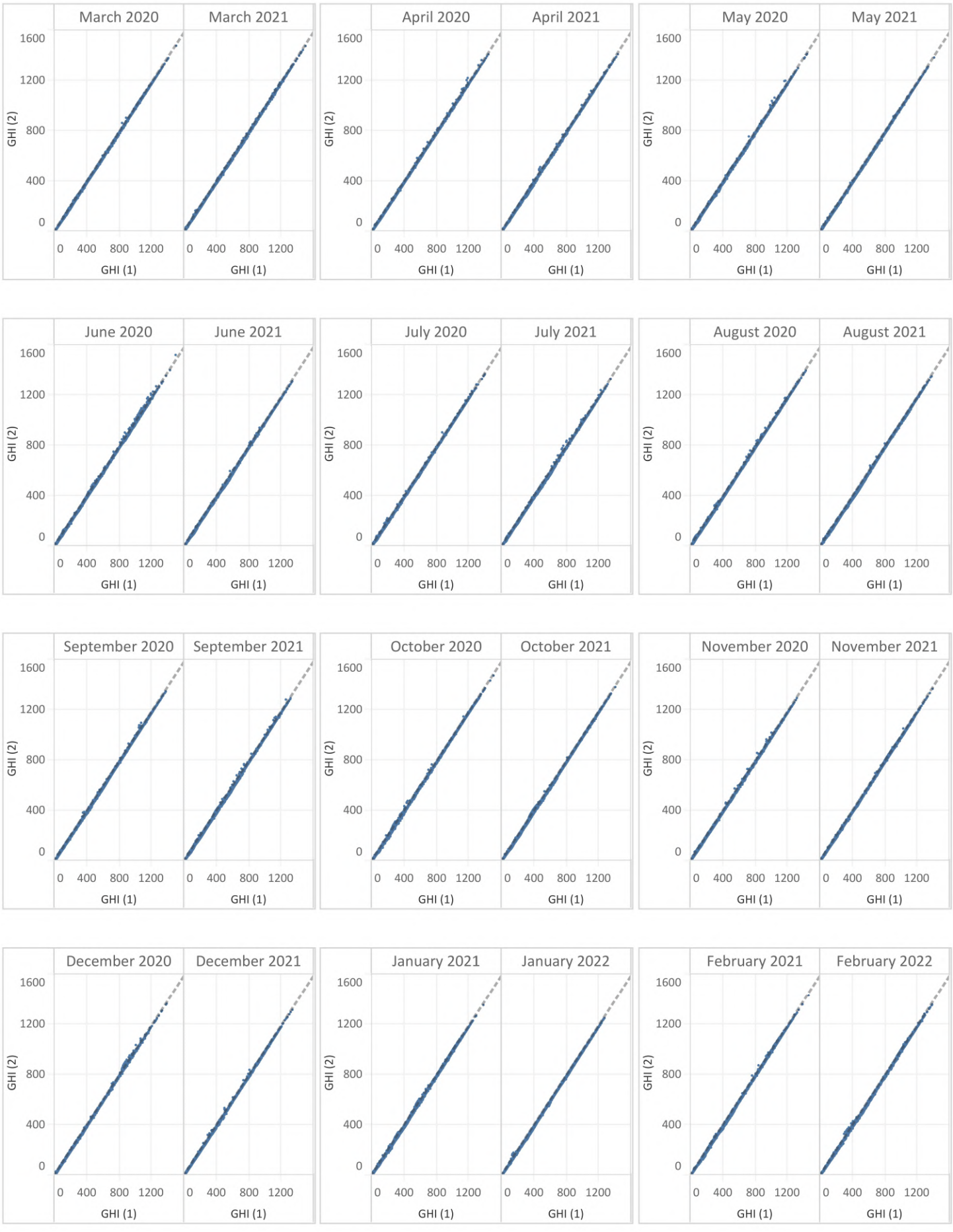

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

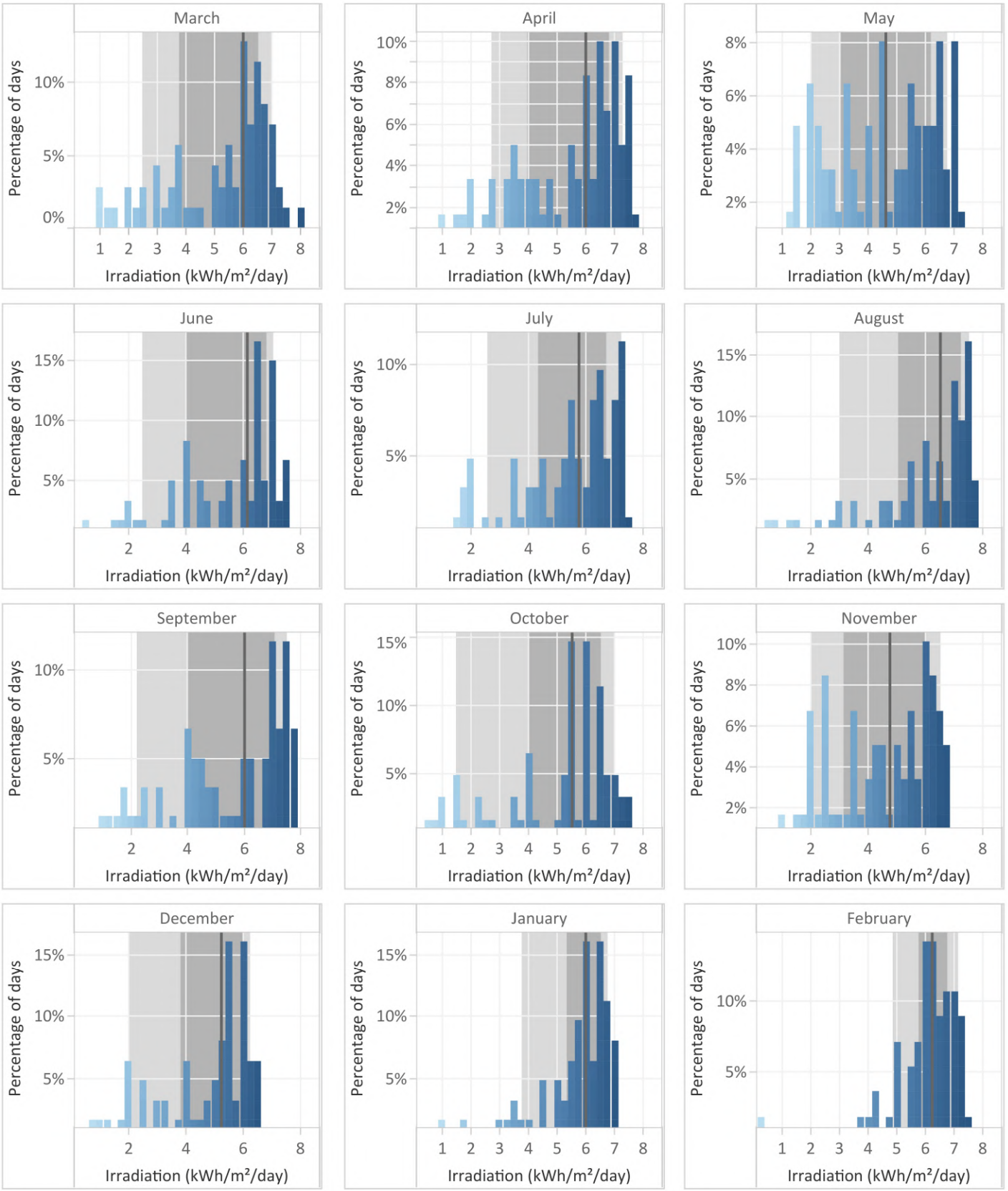

Figure 24: Daily summary of GHI (1)

3.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

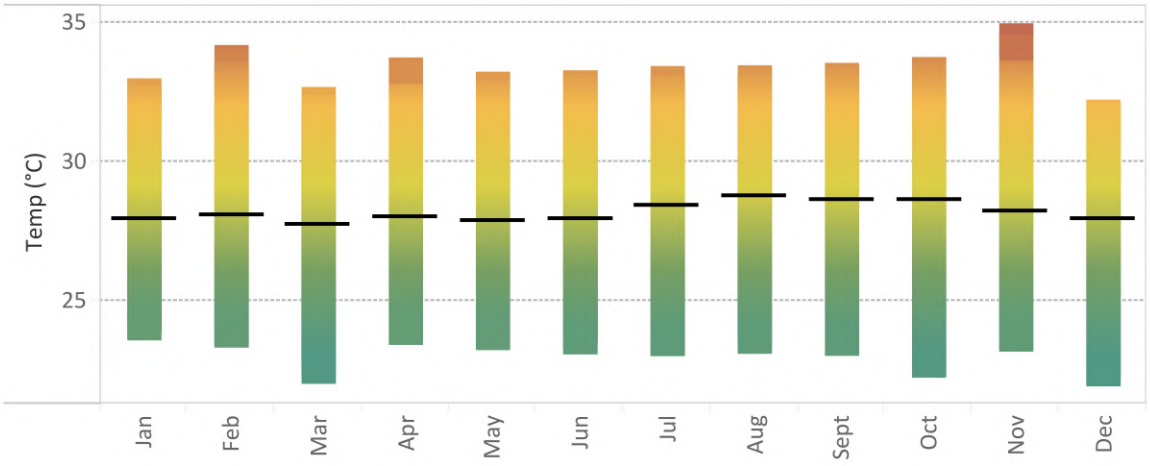

Figure 25: Monthly average, maximum and minimum temperature

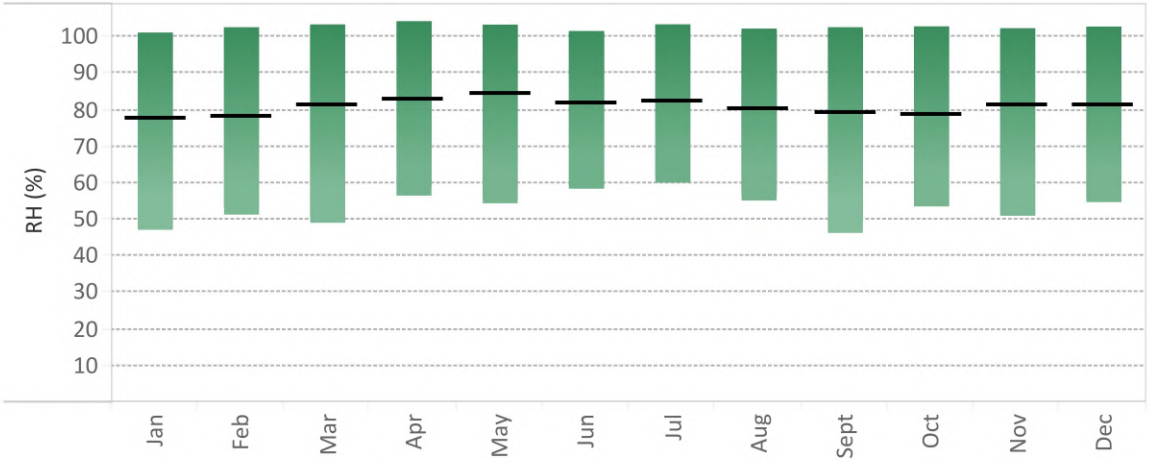

Figure 26: Monthly average, maximum and minimum relative humidity

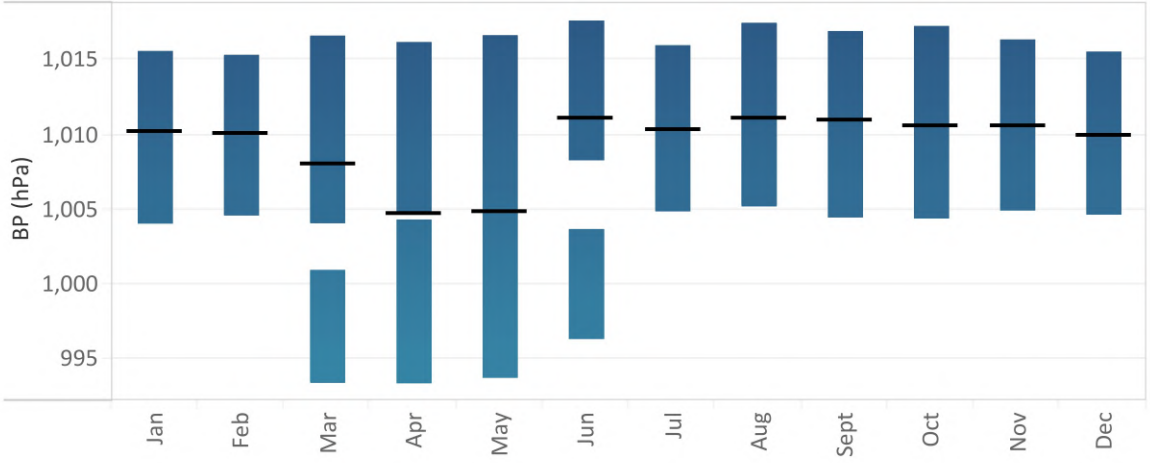

Figure 27: Monthly average, maximum and minimum barometric pressure

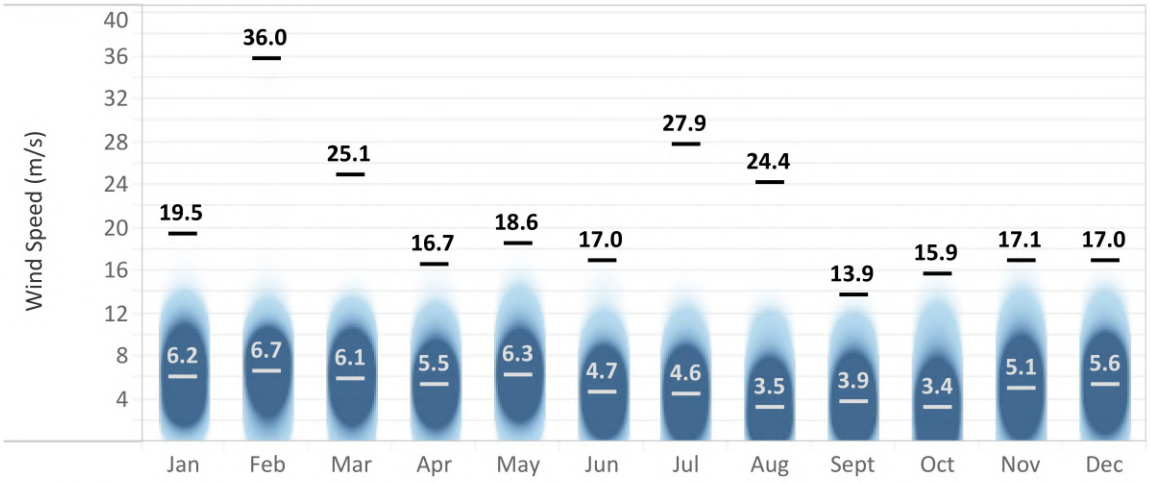

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

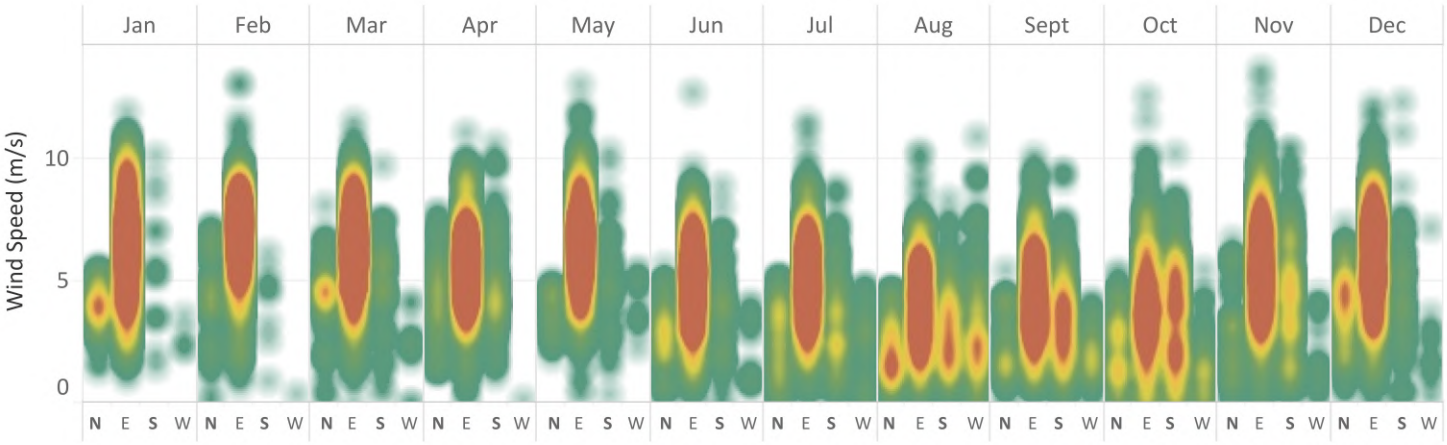

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

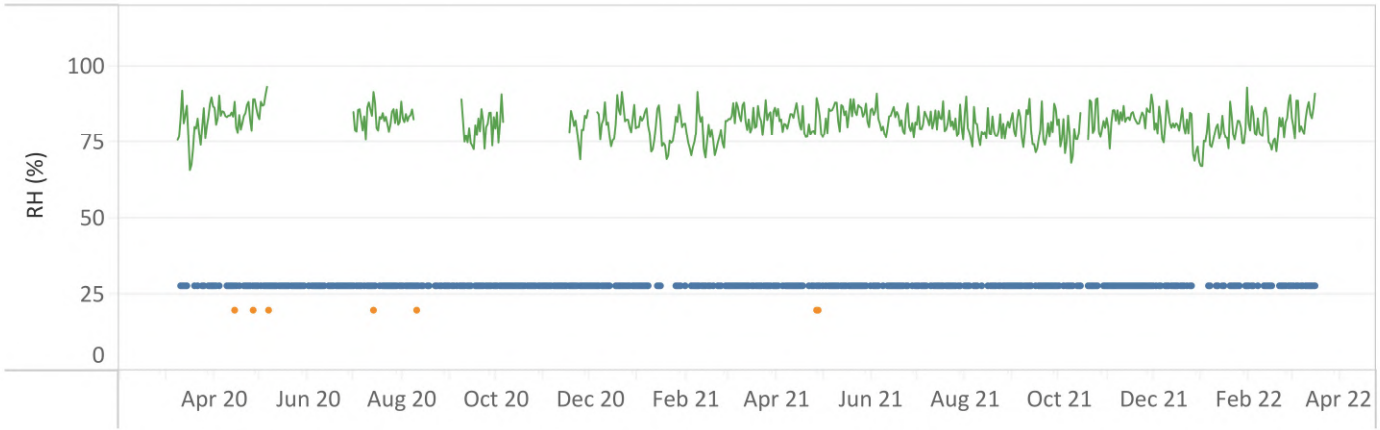

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

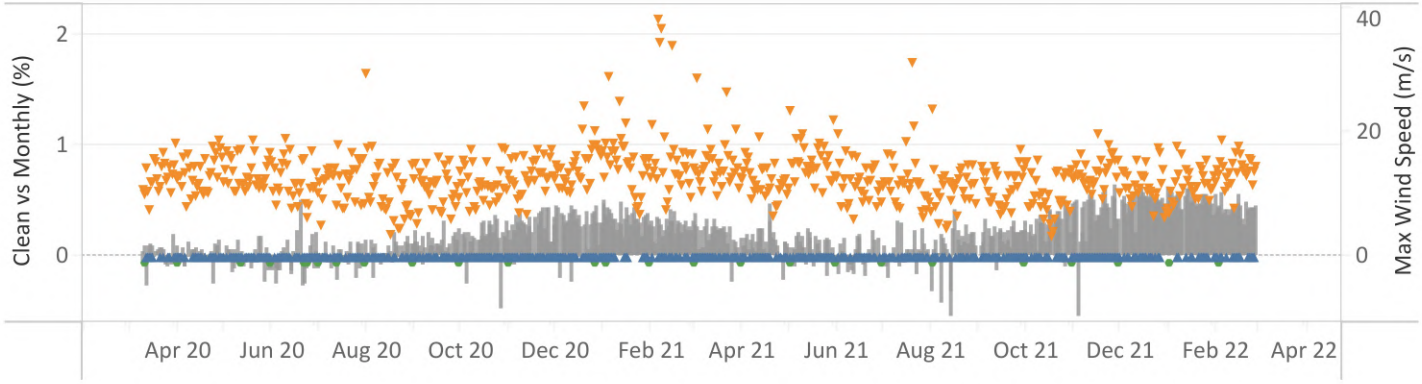

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

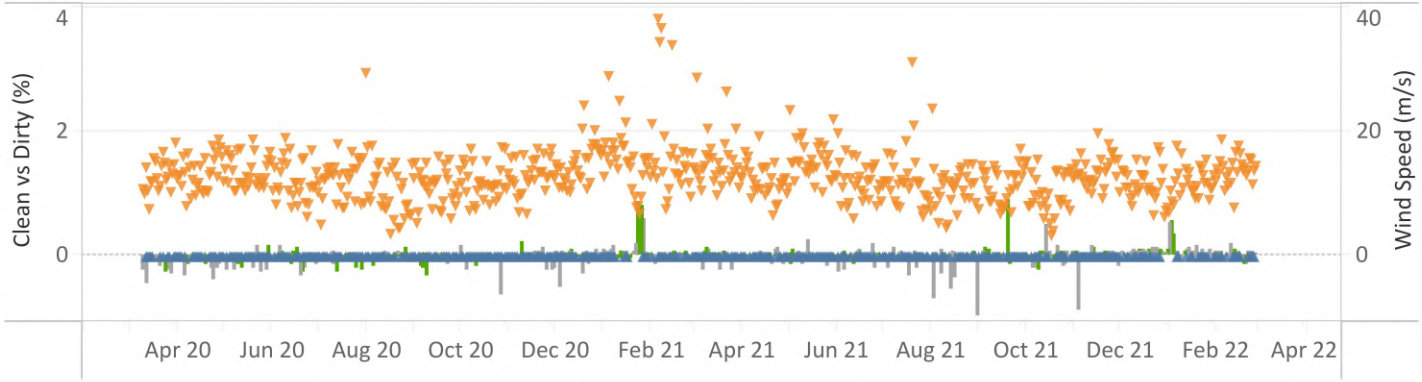

Figure 32: Soiling Measurement (Clean vs Dirty)

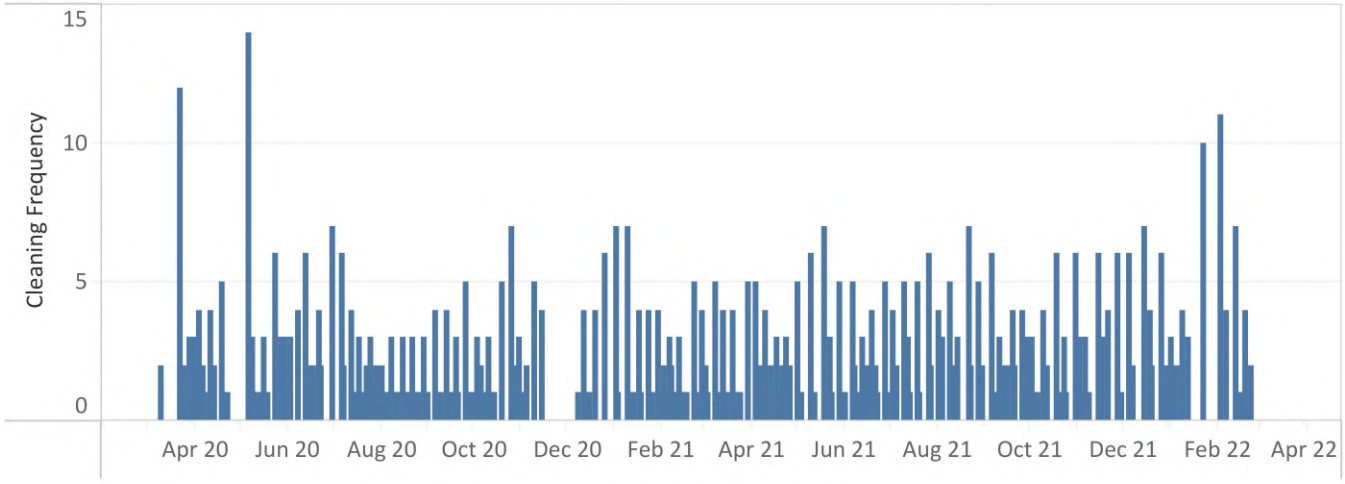

Figure 33: Consecutive days without cleaning

3.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

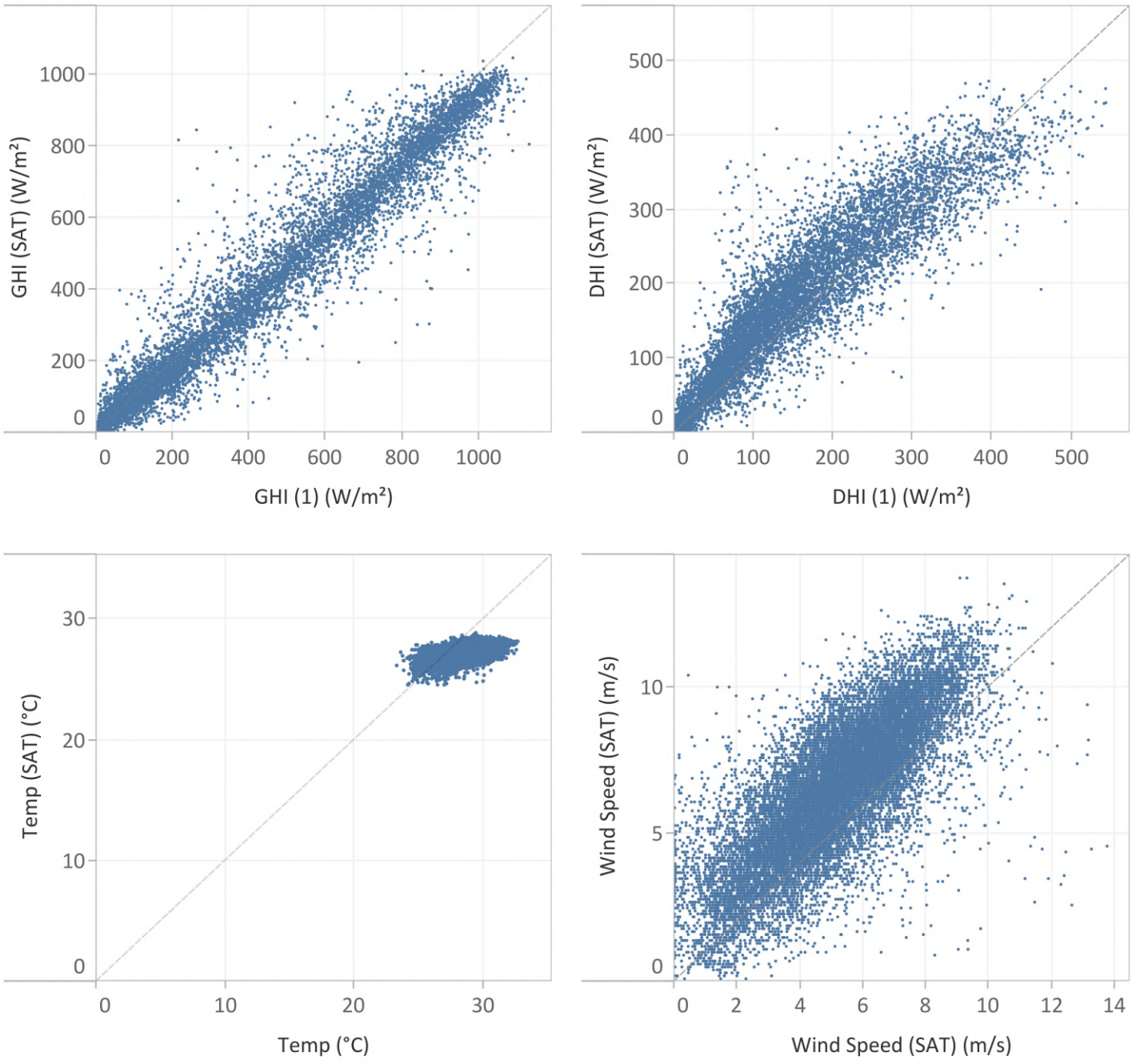

Figure 34: Ground measured data compared to satellite derived (Solargis) data

3.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 1.87%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

March 2020	The barometric pressure sensor was faulty and replaced on 24 March 2020.
May 2020	The temperature and humidity sensor started recording faulty values on 9 May 2020, all affected data has been removed.
June 2020	The temperature and humidity sensor started recording faulty values from 9 May 2020, and the barometer from 4 June 2020. All affected data has been removed.
July 2020	The temperature and humidity sensor started recording faulty values from 9 May 2020, and the barometer from 4 June 2020. All affected data has been removed. Both sensors were replaced on 2 July 2020 and data during the site visit was affected and removed.
August 2020	The temperature and humidity sensor started recording faulty values from 7 August 2020, all affected data has been removed. Hourly satellite data for the following timestamps were removed due to no data value available:1 August 2020 08:00 until 10:00. The daily value was removed due to insufficient hourly values.
September 2020	The temperature and humidity sensor started recording faulty values from 12 August 2020 until 10 September 2020, all affected data has been removed. Data during the site visit on 10 September 2020 was affected and removed.
October 2020	The temperature and humidity sensor started recording faulty values from 9 October 2020. All affected data has been removed.
November 2020	The temperature and humidity sensor started recording faulty values from 9 Octobe r2020. Allaffected data has been removed.The sensor was replaced on 19 November 2020. Data during this site visit was affected and removed. During the site visit the pushbutton which records a cleaning event was accidentally disconnected. If the gate entries logged (cleaner entering and exiting the site) are assumed as cleaning events then the cleaning frequency is still acceptable.

December 2020	The temperature and humidity sensor started recording faulty values after a site visit on 3 December 2020. All affected data has been removed. The sensor was reconnected on 7 December 2020. Data during this site visits was affected and removed. During a site visit on 19 November 2020 the pushbutton which records a cleaning event was accidentally disconnected. If the gate entries logged (cleaner entering and exiting the site)are assumed as cleaning events then the cleaning frequency is still acceptable. The pushbutton was fixed on 7 December 2020.
February 2021	Site visits occurred on 17 and 25 February 2021. Data during these visits were affected and removed.
October 2021	Intermittent communication with the station resulted in lost data on 16 October 2021 as well as between 18 and 21 October 2021.
November 2021	Intermittent communication with the station resulted in lost data on 2 November 2021.
December 2021	GTI (Clean) measured slightly lower irradiation values than GTI (Monthly)and GTI (Soil)for a couple of hours due to heavy rain on the instrument. This occurred late afternoon during the following day:3 December 2021. GTI (Clean) and GTI (Soil) were unaffected.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	99.47	99.47	100.00	100.00	100.00	100.00	100.00	100.00	35.56	100.00	100.00
	Apr	99.78	99.78	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.82	99.82	100.00	25.97	25.97	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.67	99.67	100.00	0.00	0.00	99.99	99.99	99.99	11.43	100.00	100.00
	Jul	99.42	99.42	99.51	95.26	95.27	99.76	99.76	99.76	95.27	99.51	99.51
	Aug	99.84	99.84	99.96	36.45	36.45	99.98	99.98	99.98	99.98	99.96	99.96
	Sept	99.65	99.65	99.71	68.56	68.56	99.86	99.86	99.86	99.85	99.71	99.71
	Oct	99.75	99.75	99.96	26.69	26.69	99.98	99.98	99.98	99.98	99.96	99.96
	Nov	98.32	98.32	98.49	37.42	37.42	99.22	99.22	99.22	99.22	98.49	98.49
	Dec	99.60	99.60	99.88	87.09	87.09	99.94	99.94	99.94	99.94	99.88	99.88
2021	Jan	99.88	99.88	99.98	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98
	Feb	99.56	99.56	99.70	99.86	99.86	99.86	99.86	99.86	99.86	99.70	99.70
	Mar	99.89	99.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.86	99.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.97	99.97	99.99	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Jun	99.81	99.81	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Jul	99.73	99.73	99.99	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Aug	99.92	99.92	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.82	99.82	99.99	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Oct	98.33	98.33	98.40	94.62	94.62	94.62	94.62	94.62	94.62	98.40	98.40
	Nov	99.82	99.82	99.85	99.92	99.92	99.92	99.92	99.92	99.92	99.85	99.85
	Dec	99.87	99.87	99.97	99.98	99.98	99.98	99.98	99.98	99.98	99.97	99.97
2022	Jan	99.95	99.95	99.97	99.98	99.98	99.98	99.98	99.98	99.98	99.97	99.97
	Feb	99.68	99.68	99.94	99.97	99.97	99.97	99.97	99.97	99.97	99.94	99.94
	Mar	99.95	99.95	99.98	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98
Total		99.65	99.65	99.80	82.27	82.27	99.71	99.71	99.71	94.09	99.80	99.80

4. Nauru

4.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
February 2020	71	149
March 2020	68	171
April 2020	55	185
May 2020	48	195
June 2020	38	189
July 2020	47	189
August 2020	47	208
September 2020	46	214
October 2020	47	224
November 2020	50	208
December 2020	51	209
January 2021	62	208
Total (kWh/m²/year)	630	2348

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
February 2021	58	181
March 2021	46	226
April 2021	58	179
May 2021	58	174
June 2021	44	175
July 2021	53	188
August 2021	40	210
September 2021	46	215
October 2021	46	224
November 2021	43	217
December 2021	58	187
January 2022	63	186
Total (kWh/m²/year)	612	2363

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
8 pm	1	1	0									
7 pm	75	74	63	47	40	53	61	63	45	31	29	43
6 pm	279	248	252	224	197	229	242	269	247	215	214	215
5 pm	505	445	472	409	384	424	448	494	493	454	450	412
4 pm	675	602	670	581	582	621	615	701	724	687	682	580
3 pm	804	740	808	749	727	743	768	857	899	865	835	756
2 pm	866	781	909	863	812	823	842	926	985	975	943	886
1 pm	872	831	896	850	814	822	854	940	987	1,003	995	890
12 pm	804	746	822	791	796	786	777	872	907	952	942	858
11 am	669	599	689	647	692	667	665	713	795	824	807	740
10 am	469	425	486	520	505	501	474	516	581	639	612	550
9 am	255	228	261	293	294	285	264	300	353	397	392	330
8 am	68	51	67	86	93	87	71	81	115	155	160	113
7 am	0		0	1	2	1	0	1	3	10	11	4

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
8 pm	1	1	0									
7 pm	47	52	39	35	29	33	39	37	28	20	21	31
6 pm	112	125	98	101	89	79	98	84	79	72	80	92
5 pm	170	188	162	151	134	113	133	116	115	113	124	136
4 pm	221	239	192	186	175	132	169	136	146	150	153	178
3 pm	232	271	226	216	194	149	191	163	172	169	170	210
2 pm	240	280	217	232	222	168	197	176	174	168	165	203
1 pm	265	284	219	231	223	159	179	160	180	162	159	223
12 pm	243	271	222	225	191	154	179	145	188	176	162	198
11 am	184	231	187	198	170	142	161	135	164	166	165	175
10 am	152	179	145	152	142	113	134	120	133	133	149	153
9 am	107	110	94	104	96	80	96	93	102	104	114	106
8 am	41	35	36	44	48	40	40	38	51	59	66	54
7 am	0		0	2	2	1	0	1	3	7	9	4

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	27	27	27	27	28	28	28	28	28	27	27	28
10 pm	27	27	28	28	28	28	28	28	28	28	28	28
9 pm	27	27	28	28	28	28	28	28	28	28	28	28
8 pm	27	28	28	28	28	28	28	28	28	28	28	28
7 pm	28	28	28	29	29	29	29	29	29	28	28	28
6 pm	29	29	29	29	29	30	30	30	29	29	29	29
5 pm	29	29	29	29	30	30	30	30	30	30	29	29
4 pm	29	29	30	30	30	31	30	30	30	30	30	30
3 pm	29	30	30	30	30	31	30	31	30	30	30	30
2 pm	29	30	30	30	30	31	30	31	30	30	30	30
1 pm	29	30	30	30	30	31	30	31	30	30	30	30
12 pm	29	30	30	30	30	30	30	30	30	30	30	30
11 am	29	29	29	29	30	30	30	30	30	30	29	29
10 am	28	29	29	29	30	30	29	30	29	29	29	29
9 am	27	28	28	28	29	29	29	29	29	29	28	28
8 am	27	27	27	27	28	28	27	28	28	28	28	27
7 am	26	27	27	27	27	27	27	27	27	27	27	27
6 am	26	27	27	27	27	27	27	27	27	27	27	27
5 am	26	27	27	27	27	27	27	27	27	27	27	27
4 am	26	27	27	27	27	27	27	27	27	27	27	27
3 am	26	27	27	27	27	27	27	27	27	27	27	27
2 am	27	27	27	27	28	27	27	27	27	27	27	27
1 am	27	27	27	27	28	27	28	28	28	27	27	27
12 am	27	27	27	27	28	28	28	28	28	27	27	27

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	83	87	85	87	84	81	82	79	80	79	79	83
10 pm	82	86	84	86	84	81	81	78	80	78	79	82
9 pm	81	85	84	84	83	80	80	77	79	77	78	82
8 pm	81	84	83	84	82	78	79	77	78	77	77	81
7 pm	78	81	80	81	80	75	76	74	76	75	76	78
6 pm	75	79	78	79	78	72	73	71	73	72	72	76
5 pm	73	78	76	78	76	71	72	70	71	70	70	74
4 pm	73	77	75	77	76	70	71	69	70	69	69	73
3 pm	73	76	74	76	75	70	71	68	69	68	69	73
2 pm	73	76	75	77	75	70	71	69	70	68	69	72
1 pm	72	76	75	77	75	70	72	69	71	69	69	73
12 pm	73	77	77	78	76	71	73	70	71	70	69	73
11 am	75	79	77	79	77	72	74	71	72	71	71	75
10 am	77	81	79	80	78	74	75	73	74	72	73	76
9 am	80	84	82	83	81	77	79	75	76	75	75	79
8 am	83	88	86	89	86	83	84	81	80	79	78	83
7 am	84	89	87	90	87	86	85	83	82	82	81	85
6 am	84	89	87	90	87	86	85	82	82	82	81	85
5 am	84	89	87	90	87	85	85	82	82	82	81	85
4 am	84	89	87	89	87	85	84	82	82	82	81	85
3 am	84	89	87	89	87	84	84	81	82	81	81	85
2 am	83	88	86	89	86	84	84	81	81	81	80	84
1 am	83	88	86	88	85	83	83	80	81	80	80	84
12 am	83	88	85	88	85	82	83	80	81	79	80	83

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	0.6	1.4	4.6	42.0	27.2	2.6	1.8	0.0	0.6	0.0	2.6	0.0
10 pm	2.4	5.8	15.8	11.0	6.0	0.0	4.8	0.0	1.2	0.0	0.0	0.2
9 pm	3.6	20.8	39.0	4.8	8.6	4.0	2.2	2.6	0.0	0.0	0.0	0.0
8 pm	1.4	37.2	73.6	0.2	12.2	0.6	2.4	0.2	1.0	0.0	0.0	0.0
7 pm	15.8	22.2	15.2	2.4	8.6	0.2	10.0	0.0	0.8	0.0	0.0	0.0
6 pm	1.2	5.6	17.0	0.0	16.0	0.0	1.2	0.0	0.4	0.0	0.0	3.0
5 pm	2.6	28.2	5.6	8.2	46.6	0.8	1.2	0.8	0.0	0.0	0.4	6.2
4 pm	15.4	10.4	9.8	14.0	5.2	2.8	3.0	7.2	0.0	0.0	0.0	2.0
3 pm	2.2	18.0	6.8	5.2	3.2	4.6	0.4	0.4	0.0	0.0	0.0	0.0
2 pm	4.0	7.6	5.2	2.2	2.4	3.2	0.2	0.0	1.2	0.4	0.6	0.0
1 pm	4.2	3.6	5.8	4.4	8.0	15.8	0.8	0.0	0.2	0.0	0.0	14.4
12 pm	3.6	5.2	1.6	13.8	1.2	2.0	5.0	0.6	7.2	0.0	0.0	0.0
11 am	14.2	10.6	3.4	32.6	4.2	7.8	0.0	8.8	0.0	0.4	0.0	0.0
10 am	14.2	19.0	6.0	19.4	18.6	2.0	1.6	0.0	0.0	0.2	0.0	0.0
9 am	19.8	16.8	7.0	10.6	13.4	0.0	1.2	1.6	0.2	0.6	0.0	0.2
8 am	1.4	6.8	9.8	12.2	7.0	0.6	0.2	6.2	0.2	0.0	3.2	0.0
7 am	0.2	11.0	12.2	3.6	1.0	0.6	4.0	15.6	0.6	3.6	0.0	1.4
6 am	3.6	6.6	31.2	21.2	0.4	0.2	7.4	0.6	4.6	0.2	0.4	1.0
5 am	21.4	18.0	113.8	35.4	0.0	2.6	4.6	4.6	13.2	1.4	0.0	1.8
4 am	0.8	13.0	53.8	6.4	0.6	2.6	7.6	2.2	1.2	0.0	0.0	3.8
3 am	1.0	65.8	11.4	18.4	9.6	19.6	7.2	3.4	0.0	0.0	0.0	0.2
2 am	1.0	23.2	20.0	19.8	0.8	4.0	3.0	0.0	0.0	1.2	0.2	2.6
1 am	2.6	2.8	16.4	10.6	2.2	3.0	6.6	0.0	0.0	0.8	0.0	10.8
12 am	5.0	0.8	9.0	23.6	4.4	0.4	3.0	0.0	0.2	0.0	0.4	13.8

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,008	1,008	1,009	1,010	1,009	1,010	1,009	1,010	1,010	1,010	1,010	1,009
10 pm	1,008	1,007	1,009	1,009	1,009	1,010	1,009	1,010	1,010	1,010	1,010	1,009
9 pm	1,008	1,007	1,008	1,009	1,009	1,009	1,008	1,009	1,009	1,009	1,009	1,008
8 pm	1,007	1,006	1,007	1,008	1,008	1,009	1,008	1,009	1,008	1,008	1,008	1,007
7 pm	1,006	1,005	1,006	1,007	1,007	1,008	1,007	1,008	1,008	1,008	1,007	1,007
6 pm	1,006	1,005	1,006	1,007	1,007	1,008	1,007	1,008	1,007	1,007	1,007	1,006
5 pm	1,005	1,005	1,006	1,006	1,006	1,007	1,006	1,007	1,007	1,007	1,006	1,006
4 pm	1,005	1,005	1,006	1,006	1,006	1,008	1,007	1,008	1,007	1,007	1,006	1,006
3 pm	1,006	1,005	1,006	1,007	1,007	1,008	1,007	1,008	1,007	1,007	1,007	1,006
2 pm	1,007	1,006	1,007	1,008	1,008	1,009	1,008	1,009	1,008	1,008	1,008	1,007
1 pm	1,007	1,007	1,008	1,009	1,008	1,009	1,008	1,009	1,009	1,009	1,008	1,008
12 pm	1,008	1,007	1,009	1,009	1,009	1,010	1,009	1,010	1,010	1,009	1,009	1,008
11 am	1,008	1,008	1,009	1,010	1,010	1,010	1,009	1,010	1,010	1,010	1,009	1,008
10 am	1,008	1,008	1,009	1,010	1,010	1,010	1,009	1,010	1,010	1,010	1,010	1,009
9 am	1,008	1,007	1,008	1,009	1,009	1,010	1,009	1,010	1,010	1,010	1,009	1,008
8 am	1,007	1,007	1,008	1,008	1,008	1,009	1,008	1,009	1,009	1,009	1,009	1,008
7 am	1,007	1,006	1,007	1,008	1,008	1,009	1,008	1,009	1,009	1,009	1,008	1,007
6 am	1,007	1,006	1,007	1,007	1,007	1,009	1,007	1,009	1,008	1,008	1,008	1,007
5 am	1,006	1,005	1,007	1,007	1,007	1,008	1,007	1,009	1,008	1,008	1,008	1,006
4 am	1,006	1,005	1,007	1,007	1,007	1,009	1,008	1,009	1,008	1,008	1,008	1,007
3 am	1,007	1,006	1,007	1,008	1,008	1,009	1,008	1,009	1,009	1,008	1,008	1,007
2 am	1,008	1,007	1,008	1,008	1,008	1,010	1,008	1,010	1,009	1,009	1,009	1,008
1 am	1,008	1,007	1,009	1,009	1,009	1,010	1,009	1,010	1,010	1,010	1,009	1,008
12 am	1,008	1,008	1,009	1,010	1,009	1,010	1,009	1,010	1,010	1,010	1,010	1,009

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	3.1	2.0	2.4	1.5	1.8	1.6	2.1	1.8	2.7	2.5	2.9	2.3
10 pm	3.2	2.1	2.4	1.5	1.8	1.6	2.2	1.8	2.8	2.6	2.9	2.4
9 pm	3.2	2.2	2.4	1.5	1.9	1.7	2.2	1.9	2.8	2.6	3.0	2.5
8 pm	3.2	2.5	2.6	1.6	2.0	1.8	2.2	2.0	2.9	2.6	3.1	2.6
7 pm	3.7	2.8	3.0	1.9	2.1	2.2	2.6	2.4	3.2	2.9	3.3	2.9
6 pm	4.1	3.2	3.4	2.4	2.6	2.6	2.9	2.9	3.6	3.2	3.6	3.2
5 pm	4.4	3.5	3.7	2.6	2.8	2.8	3.2	3.2	3.9	3.5	4.0	3.5
4 pm	4.5	3.6	3.9	2.8	2.9	3.0	3.3	3.4	4.1	3.6	4.2	3.7
3 pm	4.6	3.7	4.0	2.9	3.1	3.1	3.5	3.6	4.2	3.8	4.3	3.9
2 pm	4.6	3.7	4.0	3.0	3.1	3.2	3.5	3.6	4.3	3.9	4.5	4.1
1 pm	4.6	3.7	4.0	2.9	3.1	3.2	3.3	3.6	4.3	3.9	4.5	4.1
12 pm	4.5	3.7	4.0	2.8	3.1	3.2	3.3	3.5	4.3	3.8	4.5	4.1
11 am	4.4	3.5	3.9	2.6	3.0	3.1	3.2	3.3	4.2	3.7	4.4	3.9
10 am	4.1	3.2	3.6	2.3	2.8	2.8	2.9	3.1	3.9	3.5	4.2	3.6
9 am	3.7	2.7	3.1	1.9	2.4	2.2	2.4	2.6	3.4	3.2	3.7	3.2
8 am	3.1	2.3	2.5	1.3	1.7	1.5	1.7	1.9	2.7	2.5	3.1	2.5
7 am	2.9	2.1	2.2	1.1	1.4	1.3	1.5	1.7	2.3	2.0	2.7	2.1
6 am	2.8	2.1	2.3	1.1	1.5	1.2	1.5	1.7	2.4	2.0	2.6	2.1
5 am	2.9	2.0	2.2	1.2	1.4	1.1	1.6	1.6	2.4	2.0	2.6	2.1
4 am	2.8	2.0	2.3	1.2	1.5	1.2	1.7	1.7	2.3	2.0	2.6	2.1
3 am	2.9	2.0	2.3	1.2	1.4	1.3	1.8	1.6	2.4	2.0	2.6	2.1
2 am	2.8	2.0	2.3	1.2	1.5	1.3	1.9	1.8	2.6	2.1	2.7	2.2
1 am	2.9	2.0	2.3	1.2	1.6	1.4	1.8	1.7	2.6	2.3	2.8	2.3
12 am	3.0	2.0	2.3	1.3	1.6	1.5	2.0	1.7	2.6	2.4	2.8	2.3

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	E	NE	E	E	E	E	E	E	E	E	E	E
10 pm	E	NE	E	E	E	E	E	E	E	E	E	E
9 pm	E	NE	E	E	E	E	E	E	E	E	E	E
8 pm	E	NE E	E	E	E	E	E	E	E	E	E	E
7 pm	E	E	E	E	E	E	E	E	E	E	E	E
6 pm	E	E	E	E	E	E	E	E	E	E	E	E
5 pm	E	E	E	E	E	E	E	E	E	E	E	E
4 pm	E	E	E	E	E	E	E	E	E	E	E	E
3 pm	E	NE E	E	E	E	E	E	E	E	E	E	E
2 pm	E	NE	E	E	E	E	E	E	E	E	E	E
1 pm	E	NE	E	E	E	E	E	E	E	E	E	E
12 pm	E	NE	E	E	E	E	E	E	E	E	E	E
11 am	E	NE	E	E	E	E	E	E	E	E	E	E
10 am	E	NE	E	E	E	E	E	E	E	E	E	E
9 am	E	NE	E	E	E	E	E	E	E	E	E	E
8 am	E	NE	E	E	E	E	E	E	E	E	E	E
7 am	E	NE	E	E	E	E	E	E	E	E	E	E
6 am	E	NE	E	E	E	E	E	E	E	E	E	E
5 am	E	NE	E	E	E	E	E	E	E	E	E	E
4 am	E	NE	E	E	E	E	E	E	E	E	E	E
3 am	E	NE	E	E	E	E	E	E	E	E	E	E
2 am	E	NE	E	E	E	E	E	E	E	E	E	E
1 am	E	NE	E	E	E	E	E	E	E	E	E	E
12 am	E	NE	E	E	E	E	E	E	E	E	E	E

Figure 9: Dominant hourly Wind Direction

4.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

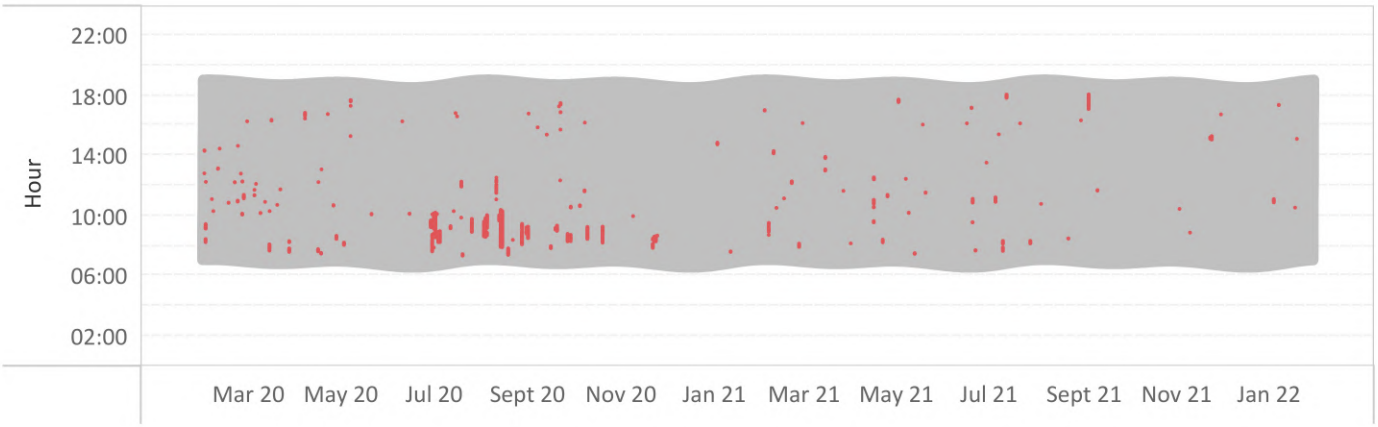

Figure 10: Quality control for GHI (1)

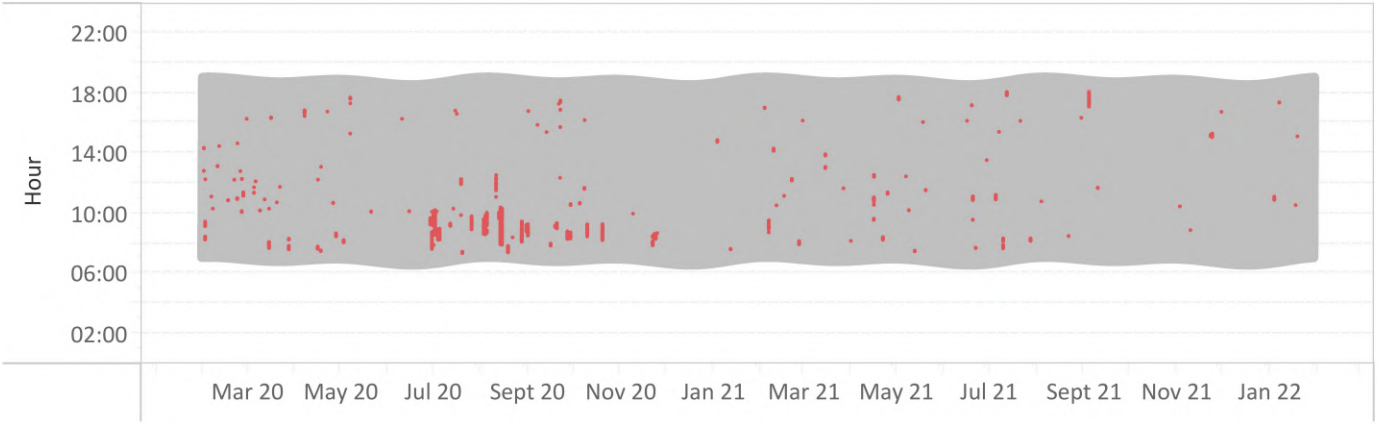

Figure 11: Quality control for GHI (2)

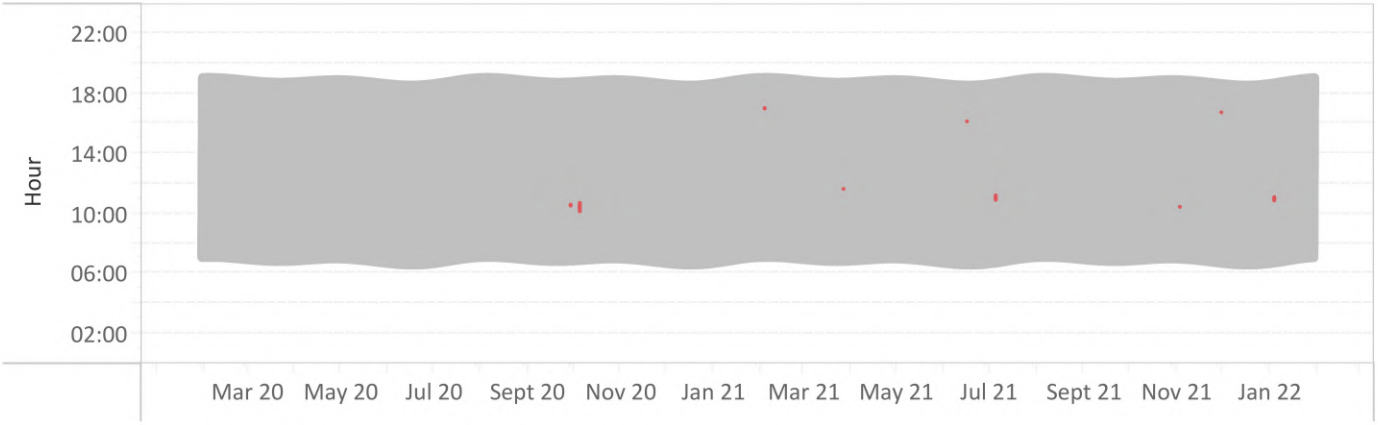

Figure 12: Quality control for DHI (1)

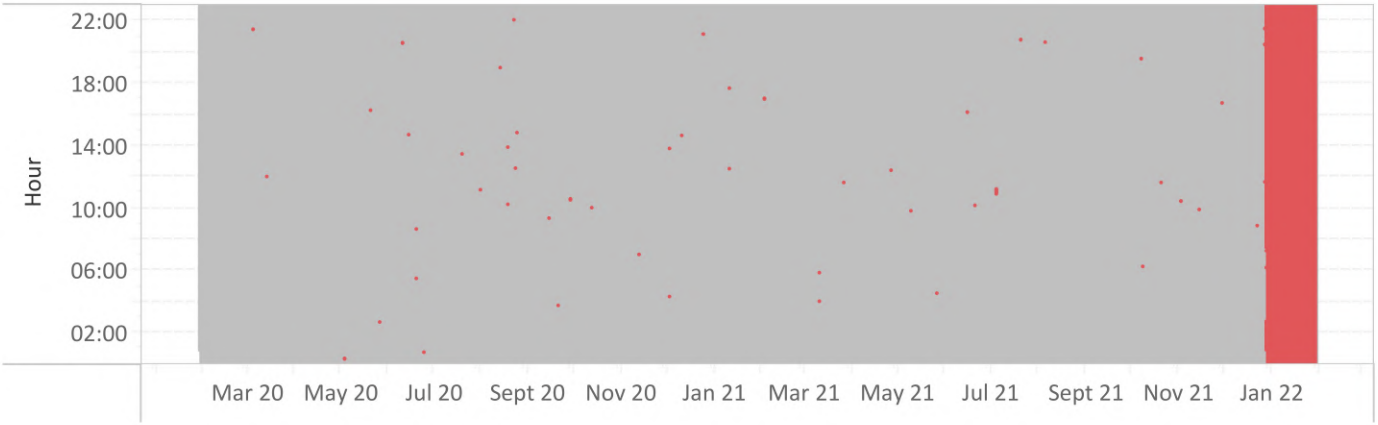

Figure 13: Quality Control for Temp

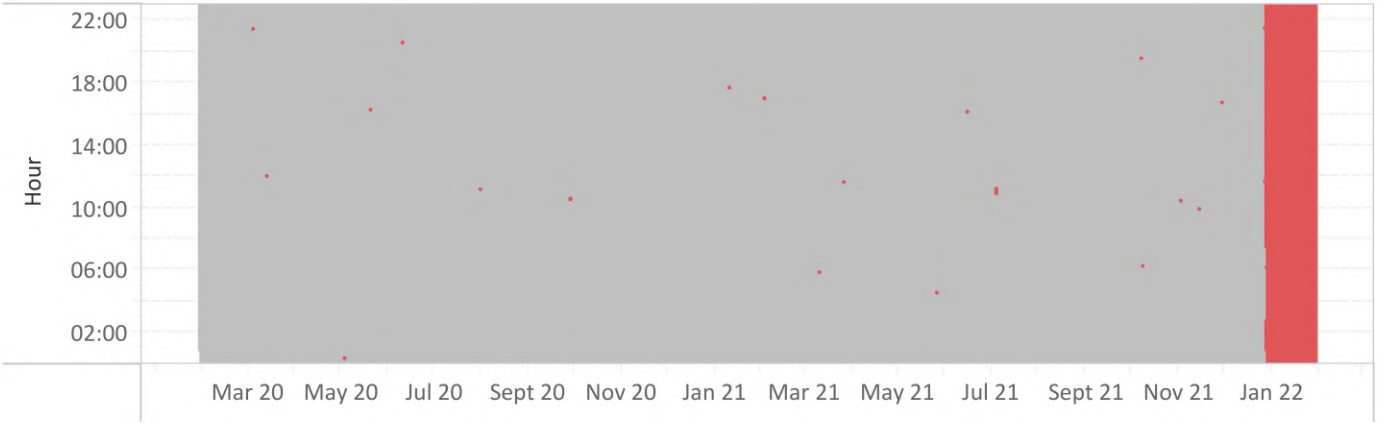

Figure 14: Quality Control for RH

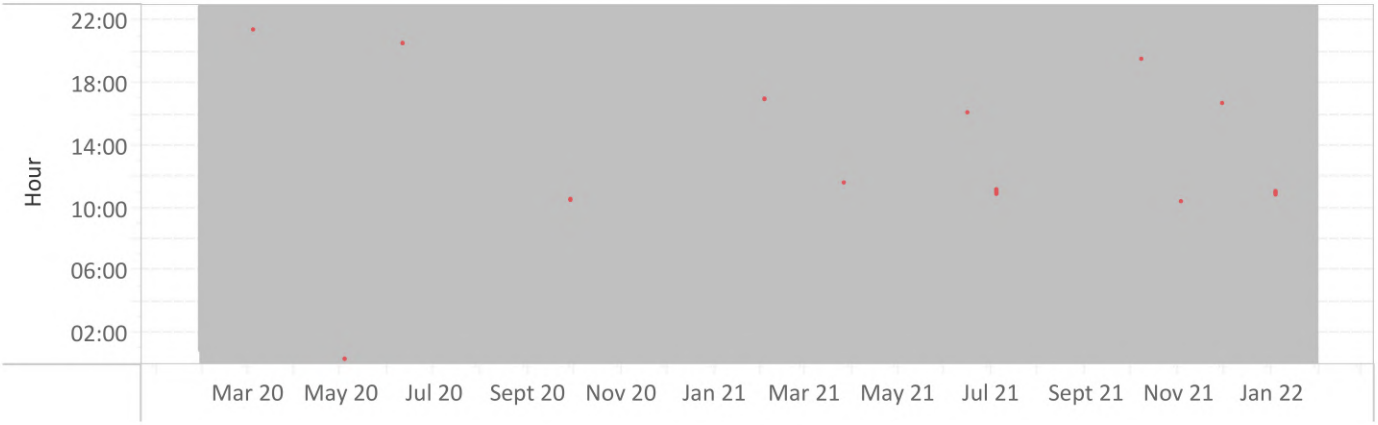

Figure 15: Quality Control for Rain

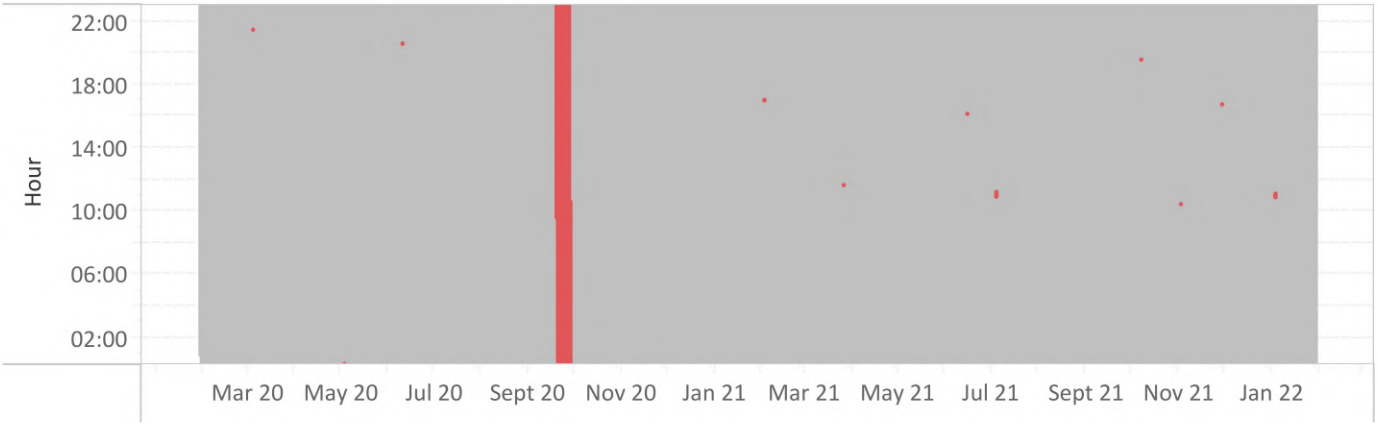

Figure 16: Quality Control for BP

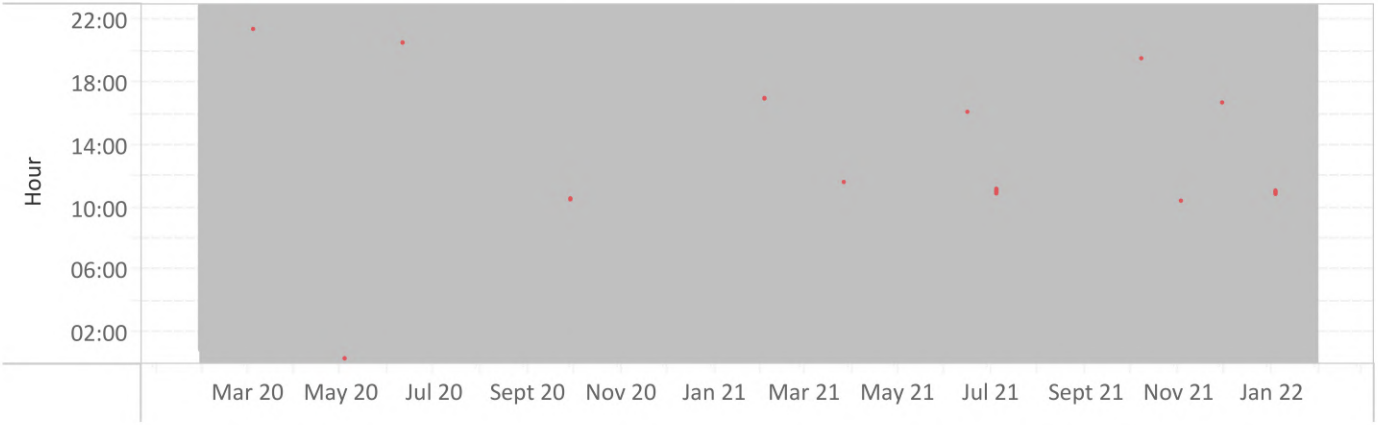

Figure 17: Quality Control for Wind Direction

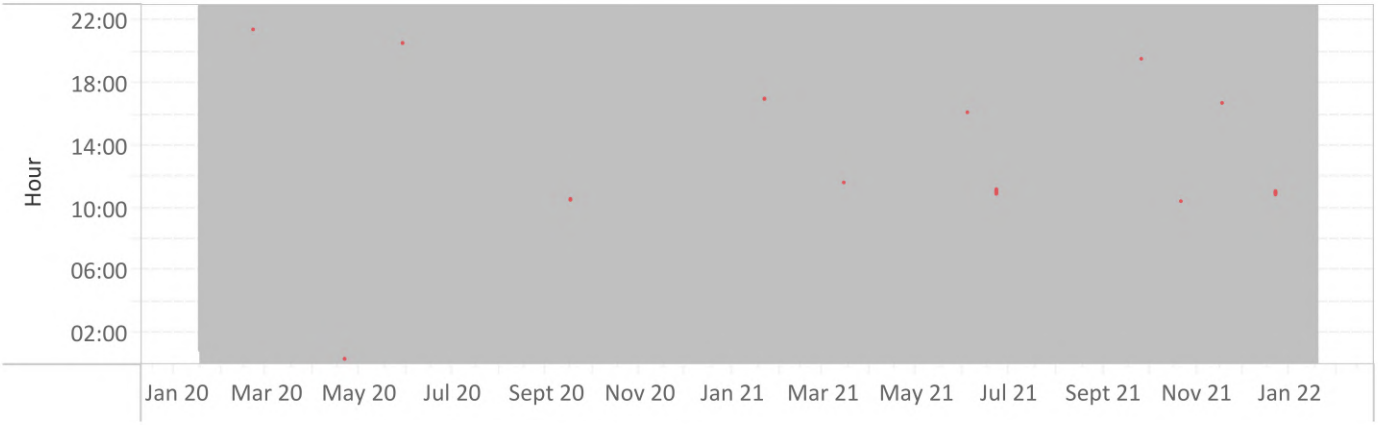

Figure 18: Quality Control for Wind Speed

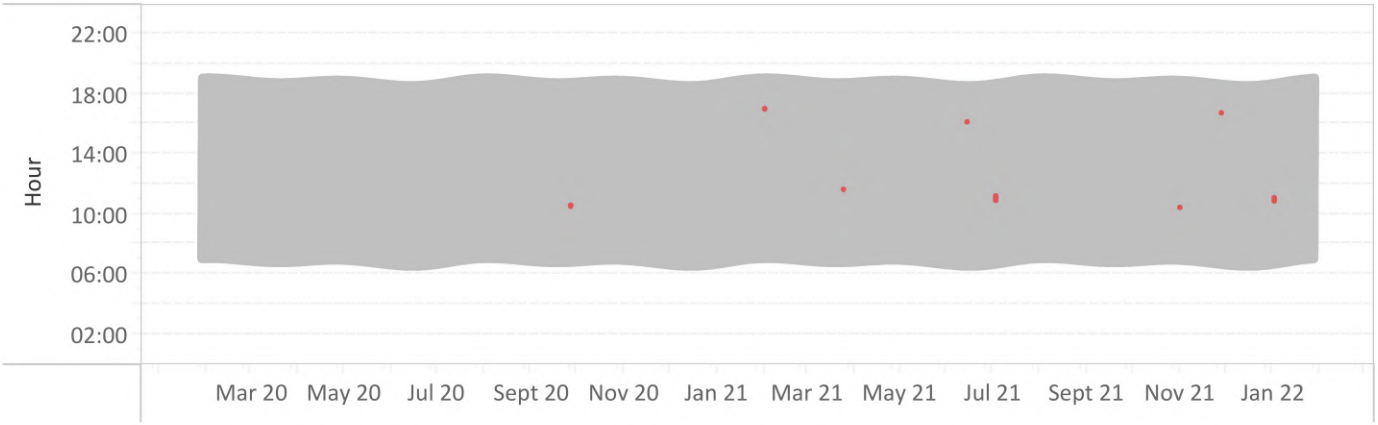

Figure 19: Quality control for soiling measurement (monthly cleaned)

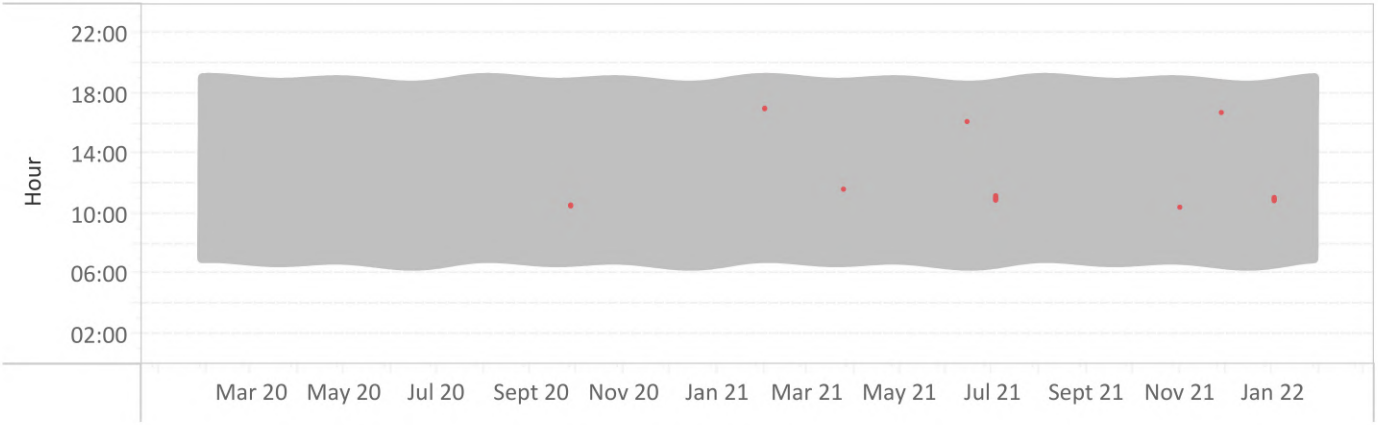

Figure 20: Quality control for soiling measurement (continuous soiling)

4.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

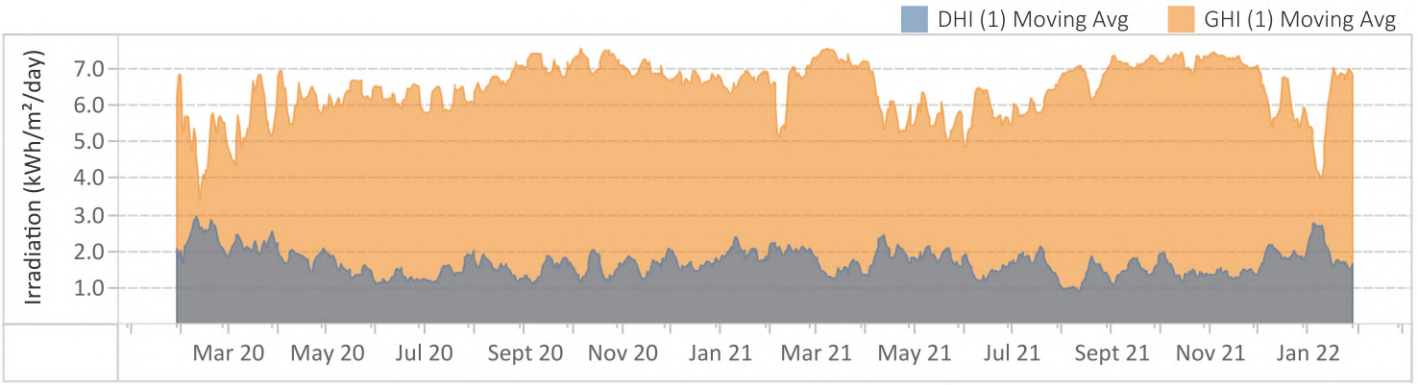

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

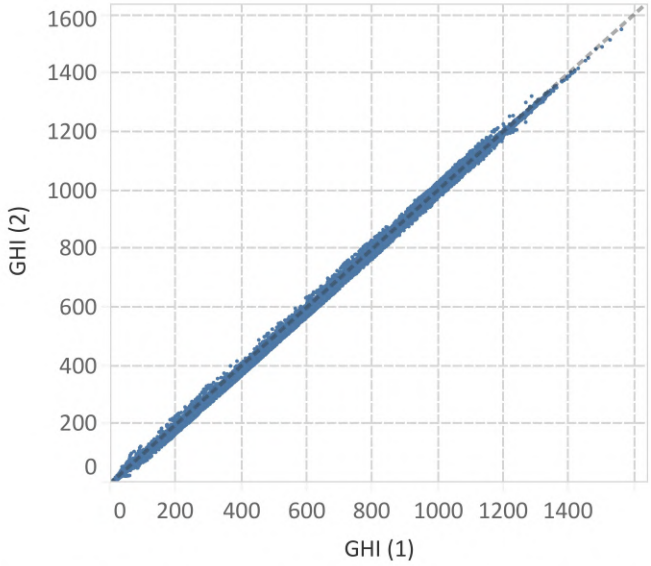

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

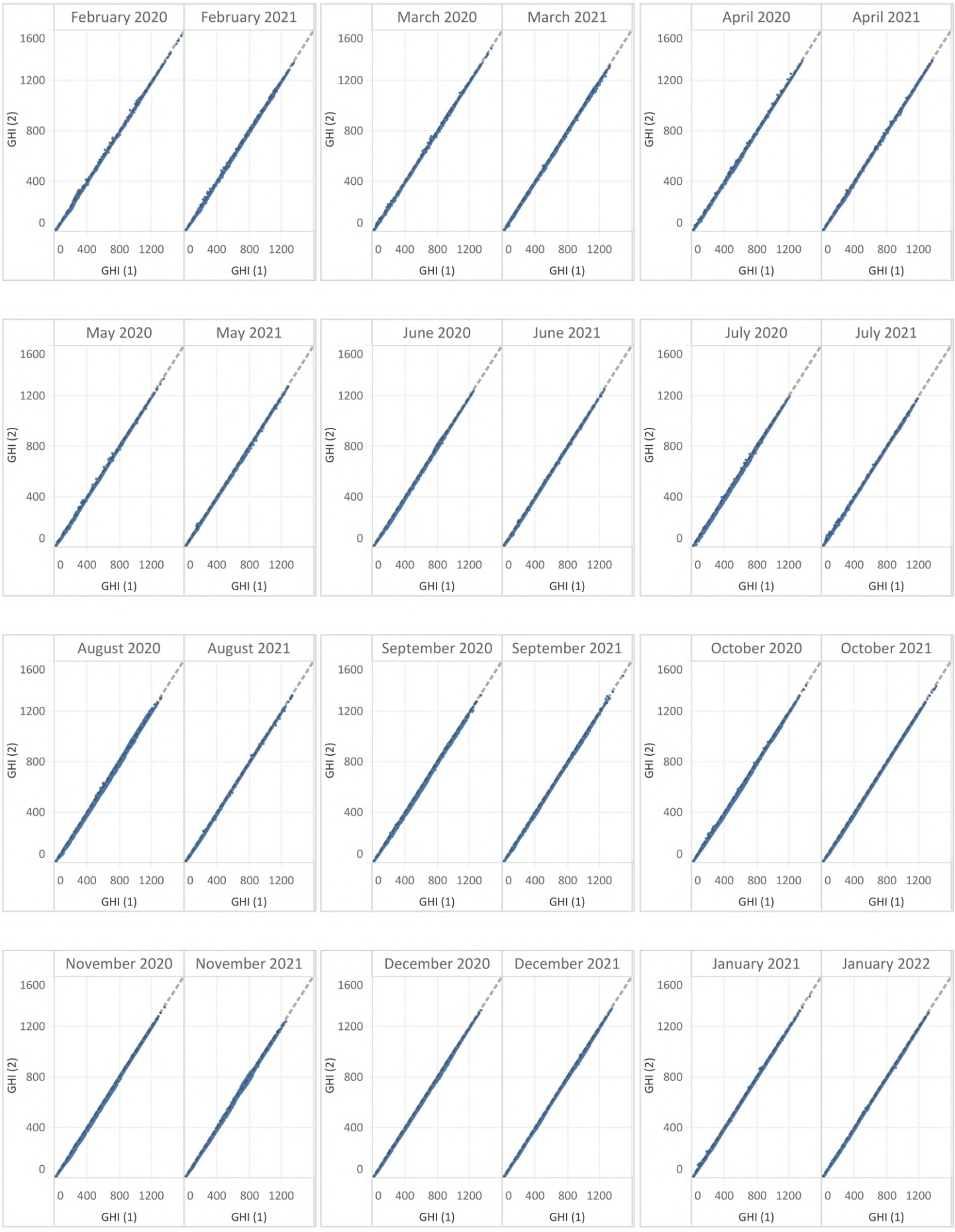

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

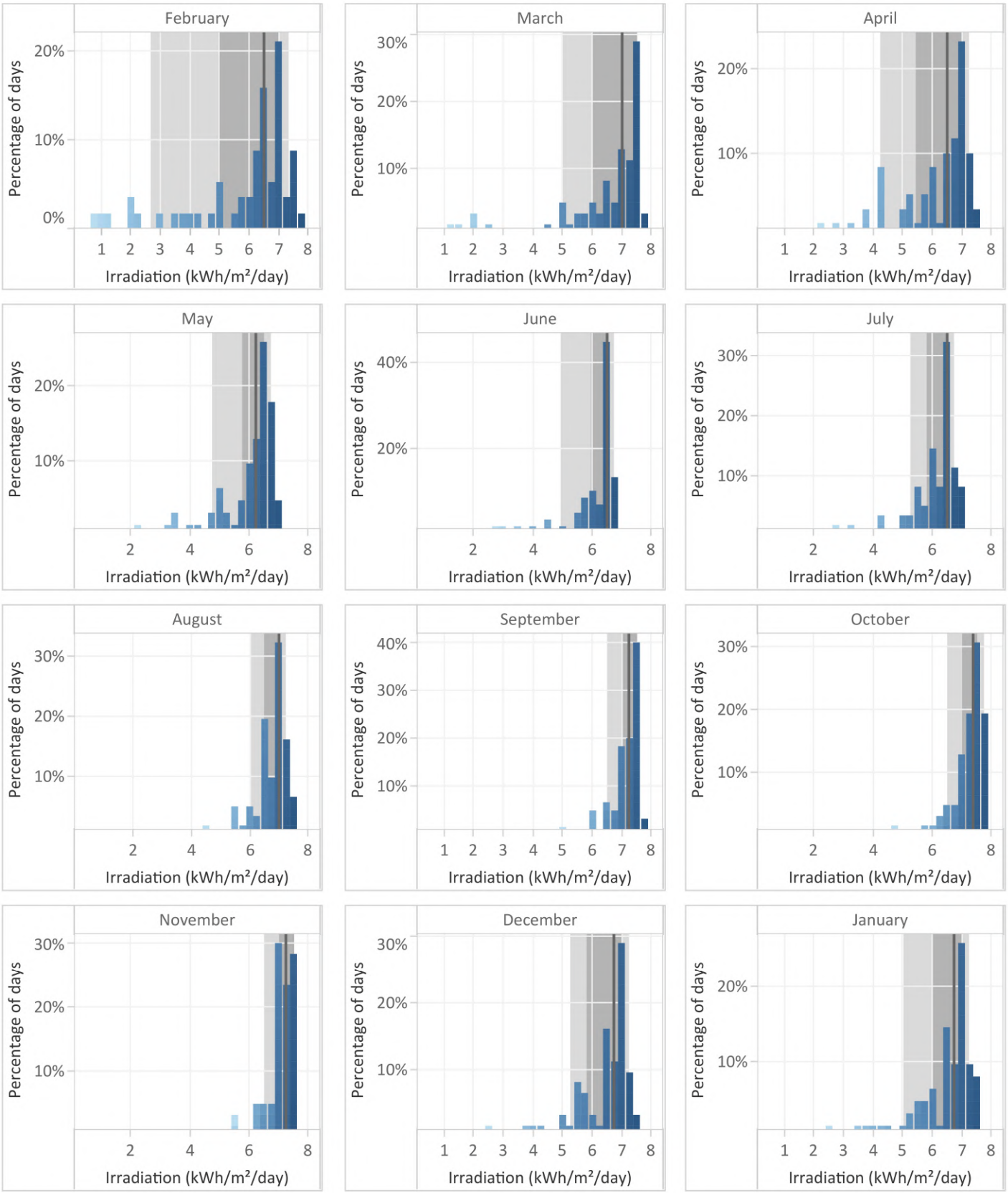

Figure 24: Daily summary of GHI (1)

4.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

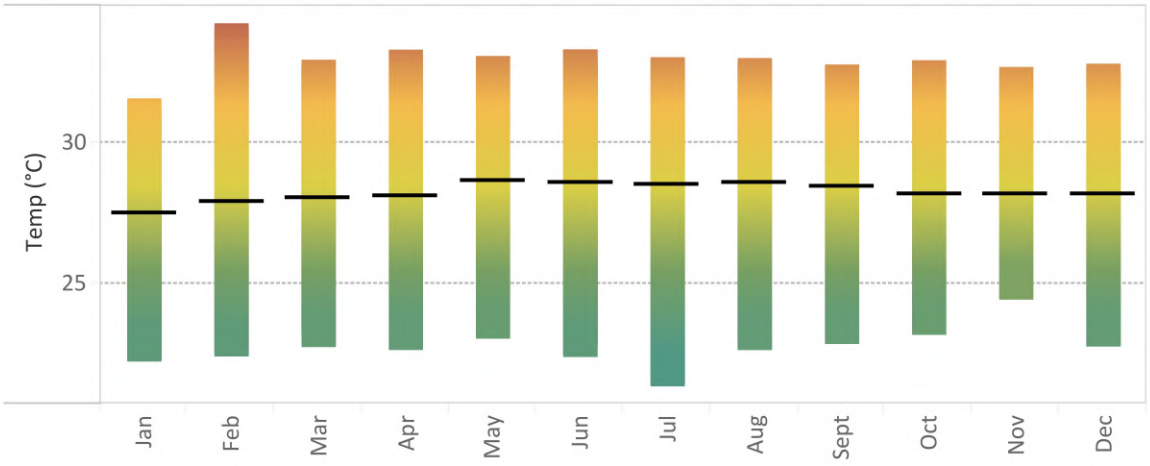

Figure 25: Monthly average, maximum and minimum temperature

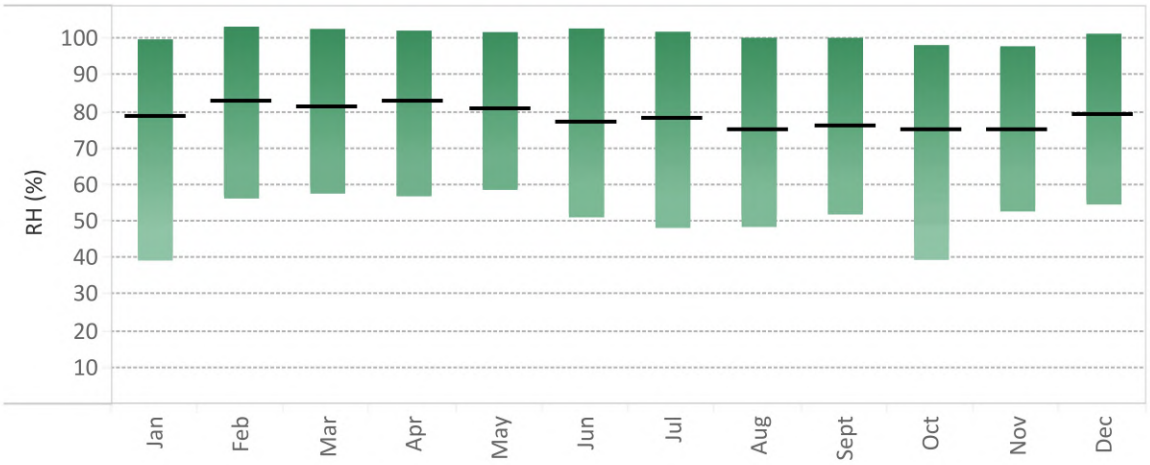

Figure 26: Monthly average, maximum and minimum relative humidity

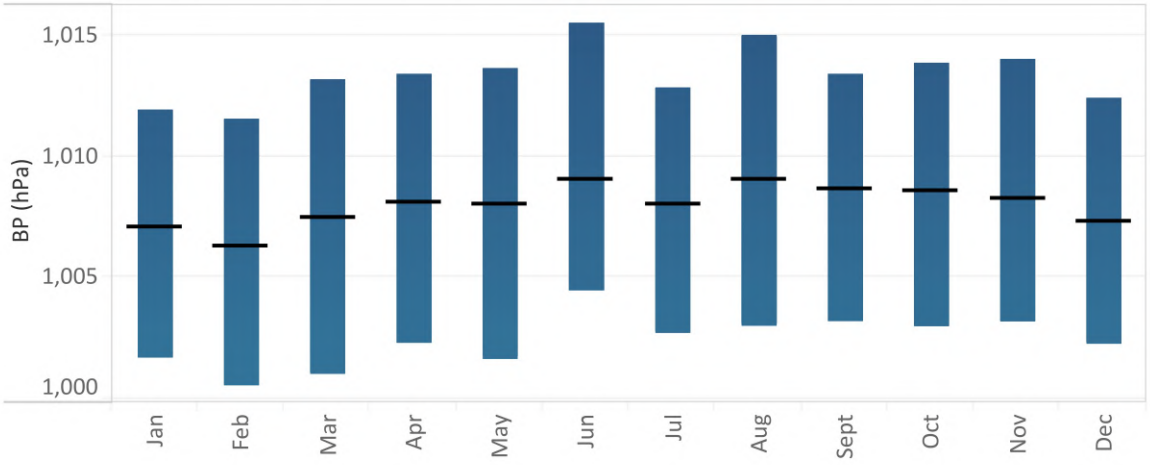

Figure 27: Monthly average, maximum and minimum barometric pressure

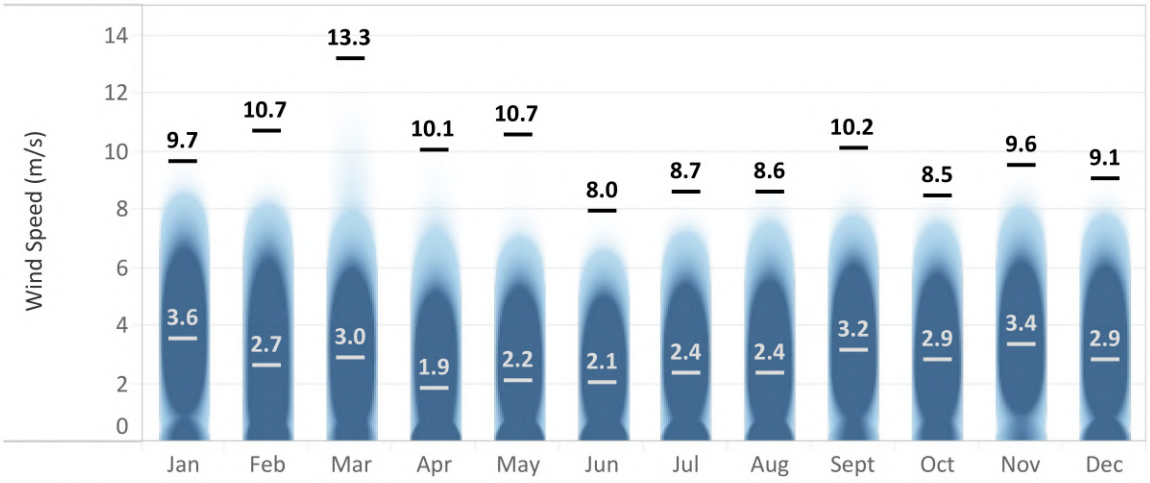

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

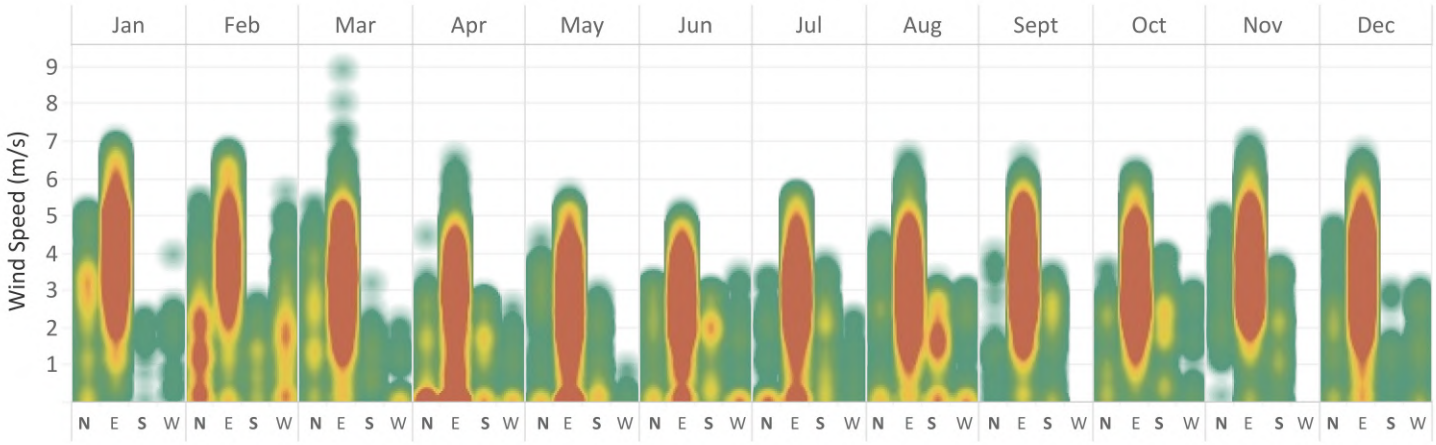

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

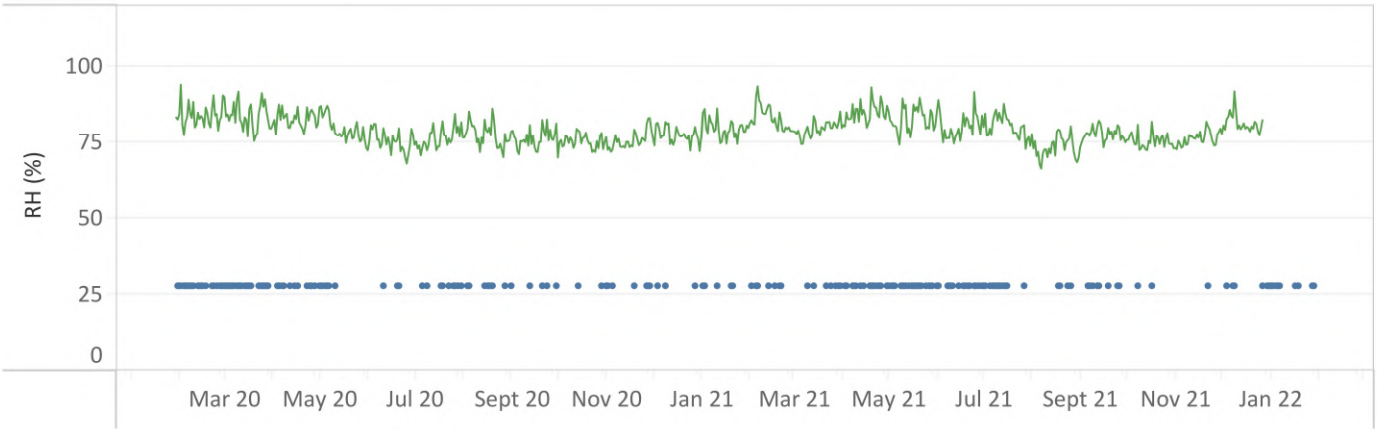

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

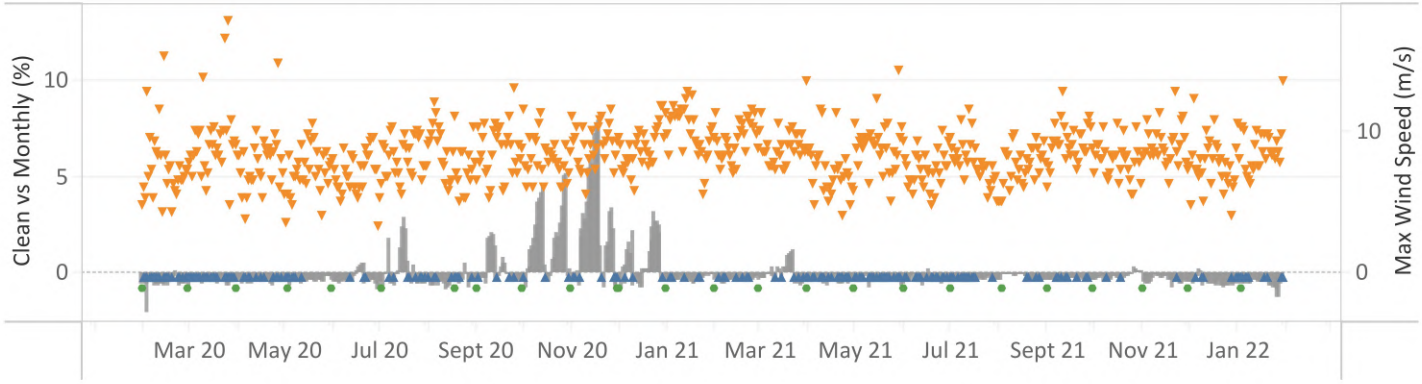

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

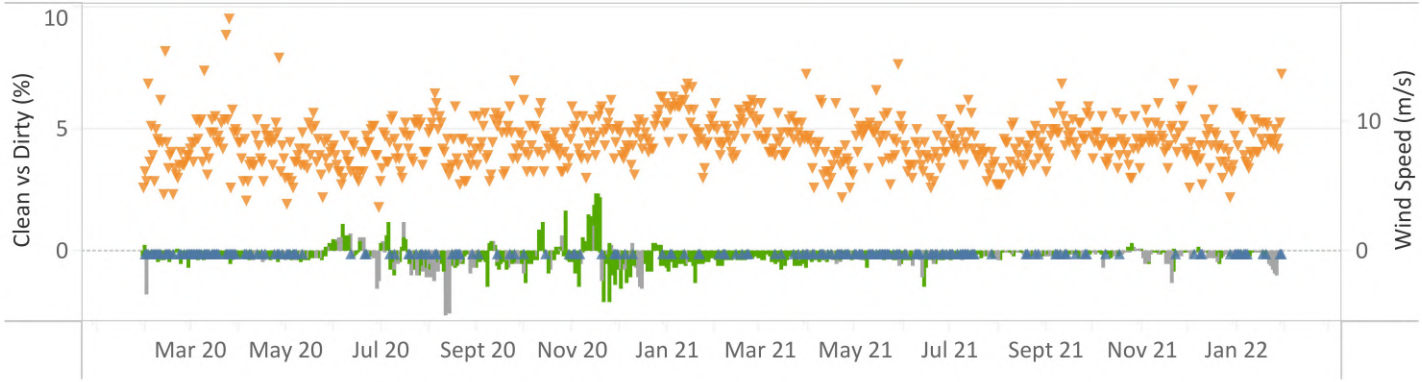

Figure 32: Soiling Measurement (Clean vs Dirty)

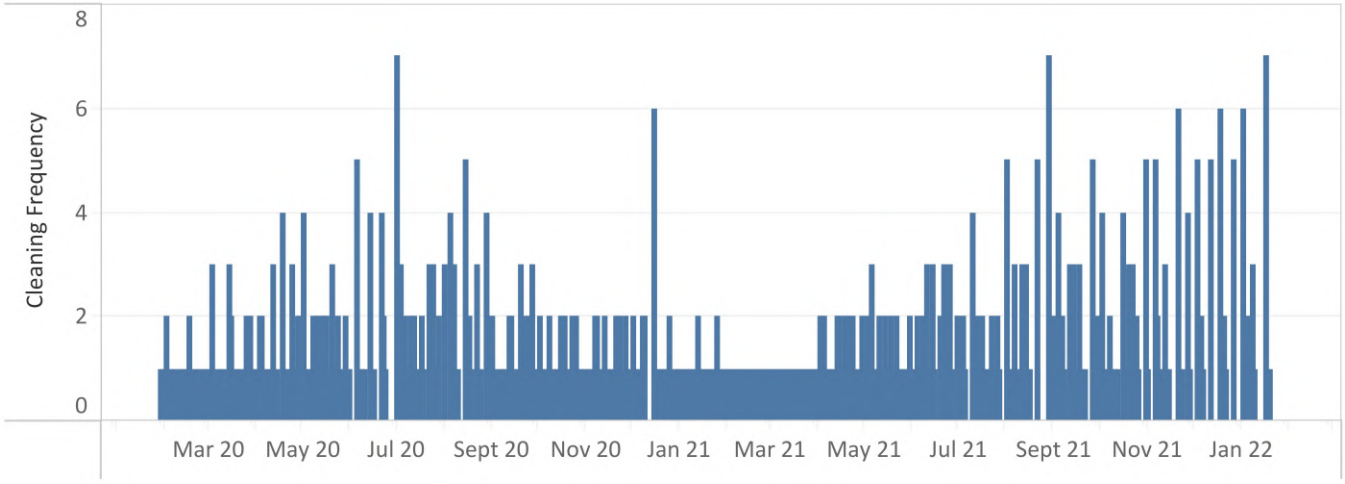

Figure 33: Consecutive days without cleaning

4.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

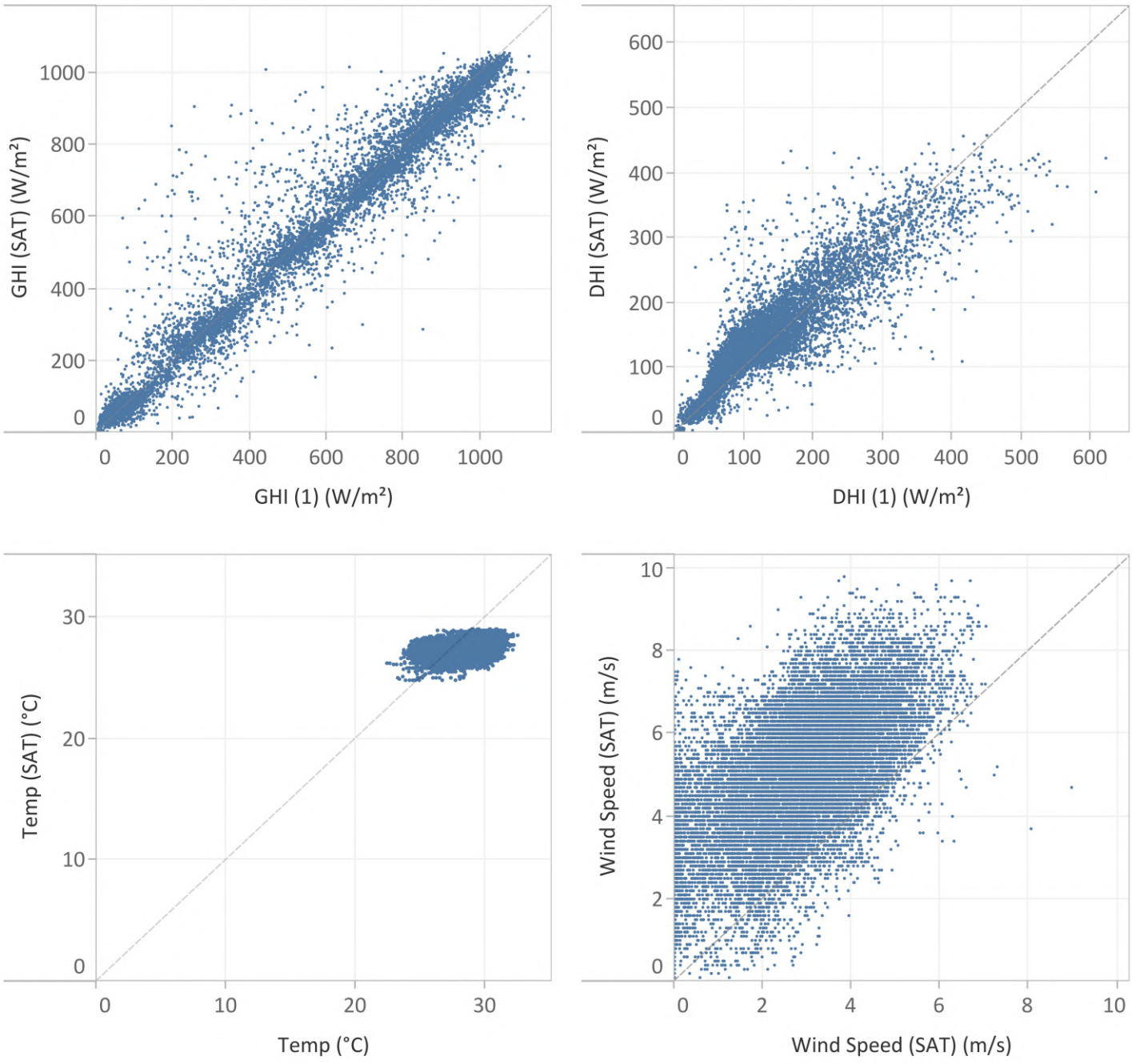

Figure 34: Ground measured data compared to satellite derived (Solargis) data

4.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.45%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

February 2020	Water residue affected early morning irradiation measurements on the following day:3 February 2020.
March 2020	Water residue affected early morning irradiation measurements on the following day:29 March 2020.
April 2020	Water residue affected early morning irradiation measurements on the following days:17 and 19 April 2020.
June 2020	GHI(2)measured slightly lower irradiation values than GHI (1) for a couple of minutes due to soiling on the instrument. This occurred early morning during the following day:30 June 2020.
July 2020	GHI (2) measured slightly lower values than GHI (1) during early morning hours on the following days:1 - 13 July 2020 and 26 - 31 July 2020.
August 2020	GHI (2) measured slightly lower values than GHI (1) during early morning hours on the following days:1 - 29 August 2020.
September 2020	The barometric pressure sensor recorded faulty values during the following days:21 September 2020 09:40 until 30 September 2020 10:40. A site visit occurred on 30 September during which data was affected for 5 minutes. GHI (2) measured slightly lower values than GHI (1) during early morning hours on the following days:1, 9 and 28 September 2020.

October 2020	A site visit occurred on 6 Octocber 2020 during which DHI (1) data was affected and removed. GHI (2) measured slightly lower values than GHI (1) during early morning hours on the following days:4, 11 and 20 October 2020.
February 2021	A site visit occurred on 5 February 2021 during which a general inspection was done on the instruments.
July 2021	A site visit was conducted on 6 July 202, data during the site visit was affected and removed.
December 2021	The temperature and humidity sensor was suspected of measuring inaccurate temperature and humidity values from 30 December 2021. All affected data during this period was removed.
January 2022	The temperature and humidity sensor was suspected of measuring inaccurate temperature and humidity values from 30 December 2021. All affected data during this period was removed.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Feb	99.69	99.69	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.76	99.76	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.81	99.81	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.91	99.91	100.00	99.99	99.99	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.87	99.87	100.00	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	98.31	98.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	97.35	97.35	100.00	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.25	99.25	99.98	99.98	99.99	99.99	99.99	99.99	69.86	99.98	99.98
	Oct	99.45	99.45	99.84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.72	99.72	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.96	99.96	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.74	99.74	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Mar	99.95	99.95	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.76	99.76	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.90	99.90	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.88	99.88	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.68	99.68	99.92	99.95	99.96	99.96	99.96	99.96	99.96	99.92	99.92
	Aug	99.98	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.74	99.74	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.91	99.91	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	100.00	100.00	100.00	94.31	94.33	100.00	100.00	100.00	100.00	100.00	100.00
2022	Jan	99.92	99.92	99.94	0.00	0.00	99.97	99.97	99.97	99.97	99.94	99.94
Total		99.65	99.65	99.98	95.51	95.51	100.00	100.00	100.00	98.76	99.99	99.99

5. Palau

5.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
February 2020	71	148
March 2020	73	188
April 2020	67	176
May 2020	70	159
June 2020	68	142
July 2020	69	154
August 2020	63	154
September 2020	62	163
October 2020	71	136
November 2020	62	145
December 2020	69	129
January 2021	75	143
Total (kWh/m²/year)	819	1837

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
February 2021	72	132
March 2021	70	166
April 2021	67	143
May 2021	75	134
June 2021	62	147
July 2021	76	142
August 2021	65	156
September 2021	65	145
October 2021	59	150
November 2021	63	155
December 2021	69	127
January 2022	71	155
Total (kWh/m²/year)	814	1750

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	0	2	2	1	1	3	5	2	0			
6 pm	57	75	89	74	55	79	88	75	57	25	22	23
5 pm	202	237	276	226	169	214	225	222	197	138	148	129
4 pm	373	412	444	412	310	360	374	372	361	305	310	268
3 pm	507	522	603	525	420	525	475	533	493	420	467	403
2 pm	672	650	695	629	552	559	577	617	594	517	602	534
1 pm	703	677	804	736	626	621	642	693	716	636	693	607
12 pm	691	696	807	730	666	626	648	672	737	650	717	611
11 am	619	632	731	678	603	593	631	615	660	625	682	566
10 am	499	496	598	564	562	519	499	538	567	564	601	476
9 am	325	331	397	439	425	407	348	389	417	424	446	327
8 am	141	151	209	238	244	238	197	212	242	233	248	152
7 am	19	20	43	60	74	73	55	59	71	71	67	30
6 am				1	2	2	0	0	1	1	1	

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	0	2	2	2	2	3	5	3	0			
6 pm	46	56	56	47	41	51	64	49	37	22	19	21
5 pm	125	134	130	117	104	115	130	109	101	88	91	100
4 pm	198	217	202	196	185	179	187	182	149	165	162	181
3 pm	250	265	260	238	242	232	239	226	209	220	211	242
2 pm	305	320	283	263	296	243	282	240	254	244	248	263
1 pm	321	335	287	271	299	262	305	245	274	269	266	289
12 pm	323	337	296	280	293	263	303	256	290	279	277	308
11 am	277	315	283	280	281	265	283	243	265	275	270	291
10 am	234	252	231	227	247	232	229	213	235	230	229	244
9 am	169	169	151	165	192	174	170	158	164	167	169	166
8 am	92	88	93	103	111	106	97	97	100	101	102	93
7 am	16	16	27	36	46	42	33	35	38	40	39	23
6 am				0	2	1	0	0	1	1	1	

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	26	26	26	26	26	25	26	25	26	26	26	26
10 pm	26	26	26	26	26	26	26	26	26	26	26	26
9 pm	26	26	26	26	26	26	26	26	26	26	26	26
8 pm	26	26	27	27	26	26	26	26	26	26	26	27
7 pm	27	27	27	27	27	27	27	27	27	27	27	27
6 pm	28	28	28	28	28	28	28	28	28	27	28	27
5 pm	28	28	29	29	28	28	29	29	29	28	29	28
4 pm	29	28	29	29	28	29	29	29	29	29	29	28
3 pm	29	29	29	29	29	29	29	29	29	29	30	29
2 pm	29	29	29	29	29	29	29	29	29	29	30	29
1 pm	29	29	29	29	29	29	29	29	30	29	30	29
12 pm	29	29	29	29	29	29	29	29	30	29	30	29
11 am	29	29	29	29	29	29	29	29	30	29	30	29
10 am	29	28	29	29	29	29	29	29	29	29	29	29
9 am	28	28	28	28	29	29	28	28	29	29	29	28
8 am	27	27	27	27	28	28	27	27	28	28	28	27
7 am	26	26	26	26	26	26	26	26	26	26	26	26
6 am	26	26	25	25	26	25	25	25	25	25	25	26
5 am	26	26	25	25	26	25	25	25	25	25	25	26
4 am	26	26	25	25	26	25	25	25	25	25	25	26
3 am	26	26	26	25	26	25	25	25	25	25	26	26
2 am	26	26	26	26	26	25	25	25	25	26	26	26
1 am	26	26	26	26	26	25	25	25	25	26	26	26
12 am	26	26	26	26	26	25	26	25	25	26	26	26

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	91	90	89	92	95	96	94	95	94	93	94	93
10 pm	90	89	89	92	95	95	94	94	94	93	93	93
9 pm	90	89	89	91	94	95	93	93	93	93	93	92
8 pm	90	89	88	90	94	93	91	92	92	92	92	91
7 pm	89	87	86	88	92	90	88	90	89	90	90	90
6 pm	86	84	82	84	89	85	84	85	84	87	86	88
5 pm	83	81	79	80	86	83	81	82	81	84	83	86
4 pm	81	79	78	79	85	81	80	81	79	82	80	84
3 pm	80	79	77	79	85	80	79	80	79	82	79	84
2 pm	79	78	77	78	83	81	79	80	79	81	78	83
1 pm	79	78	76	78	82	81	79	80	78	81	79	82
12 pm	80	78	77	78	83	81	79	81	79	81	79	83
11 am	81	79	78	78	83	81	80	81	80	82	80	84
10 am	82	81	79	80	83	82	83	82	81	82	82	85
9 am	86	83	82	83	86	84	86	86	85	85	85	88
8 am	90	87	86	89	90	90	91	91	89	90	90	92
7 am	91	90	91	94	95	96	96	96	95	95	95	94
6 am	91	91	92	95	96	97	97	96	96	96	96	94
5 am	91	90	92	95	96	97	96	96	96	95	96	94
4 am	92	91	92	95	96	97	96	96	96	95	96	94
3 am	92	90	92	95	96	97	96	96	96	94	95	94
2 am	91	90	91	94	96	96	96	96	95	94	95	94
1 am	92	90	91	93	95	96	95	96	95	94	95	93
12 am	91	90	90	92	95	96	95	96	95	94	94	93

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	16.2	24.2	4.6	10.0	25.6	48.6	4.2	17.4	7.4	49.0	53.0	19.0
10 pm	43.8	10.4	4.6	17.4	39.8	14.8	23.6	30.8	23.2	17.6	17.8	17.0
9 pm	46.0	14.4	3.8	24.6	19.8	30.0	23.8	31.2	34.4	36.4	18.2	21.4
8 pm	20.8	22.4	9.2	24.4	22.2	23.6	18.8	15.8	7.8	37.4	29.6	23.8
7 pm	15.4	44.2	14.0	29.6	46.4	18.2	34.0	22.8	4.0	60.6	20.0	29.2
6 pm	20.6	14.0	3.2	25.2	37.2	17.2	4.6	41.6	18.2	56.2	10.8	36.4
5 pm	16.8	21.2	2.2	29.2	42.6	18.4	16.0	47.0	29.8	31.8	21.6	16.8
4 pm	7.0	28.8	10.6	16.4	81.2	15.4	14.0	58.8	37.0	14.0	8.0	14.6
3 pm	37.0	34.0	16.8	14.4	62.8	21.2	55.0	53.4	30.0	67.2	14.8	28.8
2 pm	4.0	12.4	26.4	56.4	102.8	54.0	15.0	54.4	68.6	64.0	16.8	51.4
1 pm	15.2	22.6	13.6	49.2	102.2	31.2	14.0	111.6	36.0	68.0	44.6	43.6
12 pm	21.2	37.6	11.6	27.6	34.0	35.0	16.2	52.2	22.0	55.4	18.8	36.4
11 am	13.4	30.8	12.4	25.6	47.4	25.6	22.4	34.4	25.0	28.8	7.2	10.8
10 am	11.8	55.4	12.2	23.6	58.0	10.2	24.0	44.6	18.0	75.2	14.2	29.4
9 am	18.4	59.8	18.6	15.2	61.0	24.6	25.0	18.8	64.2	43.0	3.0	26.6
8 am	9.8	10.8	22.6	65.4	23.4	9.4	47.2	23.8	70.6	57.0	6.6	79.0
7 am	28.6	15.0	8.0	49.6	10.0	16.0	17.2	25.6	6.8	63.2	4.4	83.6
6 am	24.4	11.2	6.6	28.4	19.2	9.6	19.4	10.0	15.6	51.8	16.2	41.0
5 am	27.2	6.6	32.2	31.6	15.8	23.8	32.0	7.6	9.0	26.6	4.4	32.2
4 am	16.8	13.4	21.0	53.4	32.0	11.6	33.6	14.2	2.2	41.0	8.2	26.0
3 am	36.8	20.0	1.0	31.8	57.6	33.8	38.2	24.8	40.4	26.2	9.0	22.8
2 am	11.2	41.4	9.6	16.8	38.6	33.6	20.8	38.8	11.4	45.8	20.6	16.4
1 am	18.6	33.0	25.6	24.6	25.4	13.6	11.6	31.4	3.2	40.6	27.2	13.6
12 am	15.6	10.2	19.4	7.2	34.0	32.8	4.2	38.8	2.2	21.0	19.8	7.6

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,006	1,005	1,006	1,006	1,006	1,007	1,006	1,007	1,006	1,005	1,005	1,005
10 pm	1,006	1,005	1,006	1,006	1,006	1,007	1,006	1,007	1,006	1,006	1,006	1,005
9 pm	1,006	1,005	1,005	1,005	1,005	1,006	1,005	1,006	1,006	1,005	1,005	1,005
8 pm	1,005	1,005	1,005	1,005	1,005	1,006	1,005	1,006	1,005	1,005	1,005	1,005
7 pm	1,005	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,005	1,004	1,004	1,004
6 pm	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,004	1,004	1,004	1,003
5 pm	1,004	1,003	1,003	1,003	1,003	1,004	1,003	1,004	1,004	1,003	1,003	1,003
4 pm	1,003	1,003	1,003	1,003	1,003	1,004	1,003	1,004	1,004	1,003	1,003	1,003
3 pm	1,003	1,003	1,004	1,003	1,003	1,004	1,003	1,004	1,004	1,003	1,003	1,003
2 pm	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,004	1,003	1,003	1,003
1 pm	1,005	1,004	1,005	1,004	1,004	1,006	1,004	1,005	1,005	1,004	1,004	1,004
12 pm	1,005	1,005	1,006	1,005	1,005	1,006	1,005	1,006	1,005	1,005	1,005	1,005
11 am	1,006	1,006	1,006	1,006	1,005	1,006	1,005	1,006	1,006	1,005	1,005	1,005
10 am	1,006	1,006	1,006	1,006	1,006	1,007	1,006	1,006	1,006	1,006	1,006	1,006
9 am	1,006	1,006	1,006	1,006	1,006	1,007	1,006	1,006	1,006	1,006	1,006	1,006
8 am	1,006	1,005	1,006	1,006	1,005	1,006	1,005	1,006	1,006	1,005	1,005	1,005
7 am	1,005	1,005	1,005	1,005	1,005	1,006	1,005	1,006	1,005	1,005	1,005	1,004
6 am	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,005	1,004	1,004	1,004
5 am	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,004	1,004	1,004	1,003
4 am	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,004	1,003	1,003	1,003
3 am	1,004	1,004	1,004	1,004	1,004	1,005	1,004	1,005	1,005	1,004	1,004	1,003
2 am	1,005	1,004	1,005	1,004	1,004	1,005	1,005	1,005	1,005	1,004	1,004	1,004
1 am	1,005	1,005	1,005	1,005	1,005	1,006	1,005	1,006	1,005	1,005	1,005	1,004
12 am	1,006	1,005	1,006	1,005	1,005	1,007	1,006	1,006	1,006	1,005	1,005	1,005

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1.4	1.9	1.4	1.2	1.0	0.4	0.7	0.5	0.4	0.9	0.7	1.3
10 pm	1.5	2.0	1.5	1.3	1.0	0.4	0.7	0.6	0.4	0.8	0.6	1.3
9 pm	1.5	1.9	1.4	1.3	1.1	0.4	0.7	0.7	0.5	1.0	0.6	1.5
8 pm	1.4	2.0	1.5	1.3	1.1	0.5	0.8	0.7	0.5	1.0	0.7	1.5
7 pm	1.5	2.1	1.7	1.5	1.2	0.6	1.1	0.9	0.6	1.1	0.8	1.6
6 pm	2.0	2.5	2.5	2.1	1.7	1.2	1.5	1.5	1.2	1.5	1.2	1.9
5 pm	2.5	3.0	3.0	2.7	2.1	1.7	2.0	1.9	1.6	2.1	1.8	2.3
4 pm	3.0	3.2	3.4	3.0	2.5	2.0	2.3	2.2	2.0	2.3	2.3	2.6
3 pm	3.3	3.4	3.6	3.1	2.6	2.2	2.4	2.3	2.2	2.5	2.6	2.9
2 pm	3.5	3.7	3.8	3.4	3.1	2.4	2.5	2.4	2.3	2.6	2.7	3.2
1 pm	3.7	3.8	3.8	3.6	3.1	2.3	2.7	2.5	2.3	2.7	2.9	3.2
12 pm	3.6	3.8	3.8	3.6	3.2	2.4	2.7	2.3	2.4	2.7	2.8	3.3
11 am	3.5	3.6	3.7	3.3	3.0	2.3	2.4	2.3	2.2	2.6	2.8	3.0
10 am	3.2	3.4	3.4	2.9	2.8	2.1	2.2	2.0	1.8	2.4	2.6	2.9
9 am	2.5	3.0	2.9	2.5	2.5	1.7	1.7	1.5	1.6	2.0	2.1	2.5
8 am	1.7	2.3	2.2	1.8	1.8	0.9	1.1	0.9	1.0	1.2	1.3	1.8
7 am	1.3	1.9	1.4	1.2	1.2	0.4	0.6	0.6	0.5	0.9	0.7	1.4
6 am	1.3	1.8	1.3	1.1	1.1	0.4	0.7	0.6	0.5	0.9	0.6	1.4
5 am	1.3	1.8	1.2	1.1	1.0	0.3	0.5	0.6	0.4	0.8	0.5	1.3
4 am	1.2	1.8	1.1	1.1	1.1	0.3	0.6	0.5	0.5	0.9	0.5	1.3
3 am	1.1	1.7	1.0	1.1	1.1	0.4	0.6	0.5	0.4	0.9	0.5	1.3
2 am	1.2	1.7	1.1	1.1	1.0	0.4	0.6	0.5	0.4	0.9	0.6	1.2
1 am	1.3	1.7	1.3	1.1	1.0	0.4	0.5	0.5	0.4	0.9	0.6	1.3
12 am	1.3	1.8	1.4	1.1	1.0	0.4	0.7	0.5	0.5	0.8	0.6	1.3

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	NE	NE	NE	NE	NE	NE	N	NE N	N	NE N	NE	NE
10 pm	NE	NE	NE	NE	NE	NE	NE	W NE	N	NE N	NE	NE
9 pm	NE	NE	NE	NE	NE E	NE	N	W	NE	NE	NE	NE
8 pm	NE	NE	NE	NE	NE	NE	N	N	N	NE	NE	NE
7 pm	NE	NE	NE	NE	E	E	E	W	NE	NE	NE	NE
6 pm	NE	NE	NE	E	E	E	E	W	W NE	SW	NE	NE
5 pm	E	NE	NE	E	E	E	E	W	SE	W	E	E
4 pm	E	NE	E	E	E	E	SW	W	W SE	W	E	NE E
3 pm	E	NE	E	E	E	E	SE	W	W	W	E	E
2 pm	E	NE E	E	E	E	E	E	W	W SE	W	E	E
1 pm	E	NE	E	E	E	SE	SE E	W	SE	W	E	E
12 pm	E	E	E	E	E	SE	E	W	SE	W	E	E
11 am	E	NE	E	E	E	E	E	W	S	W	E	E
10 am	E	E	NE	E	E	E	E	W	SE	W	E	E
9 am	E	E	NE E	NE	E	E	E	SW		SE	E	E
8 am	NE	NE	NE	NE	E	E	NE	NE	NE	NE	NE	NE
7 am	NE	NE	NE	NE	E	NE	NE	W	NE N	NE	NE	NE
6 am	NE	NE	NE	NE	E	NE	NE	W	N		NE	NE
5 am	NE	NE	NE	NE	NE	NE	NE	NW	N	NE	NE	NE
4 am	E	NE	NE	NE	NE	NE	NE	NW	NE	NW	NE	NE E
3 am	NE	NE	NE	NE	E	NE	N	W	NE	N	NE	NE
2 am	NE	NE	NE	NE	NE	NE	N	NW	N	NE	NE	NE
1 am	NE	NE	NE	NE	NE	NE	NW N	W	N	NW	NE	NE
12 am	NE	NE	NE	NE	NE	NE	NE	W	N	NW	NE	NE

Figure 9: Dominant hourly Wind Direction

5.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

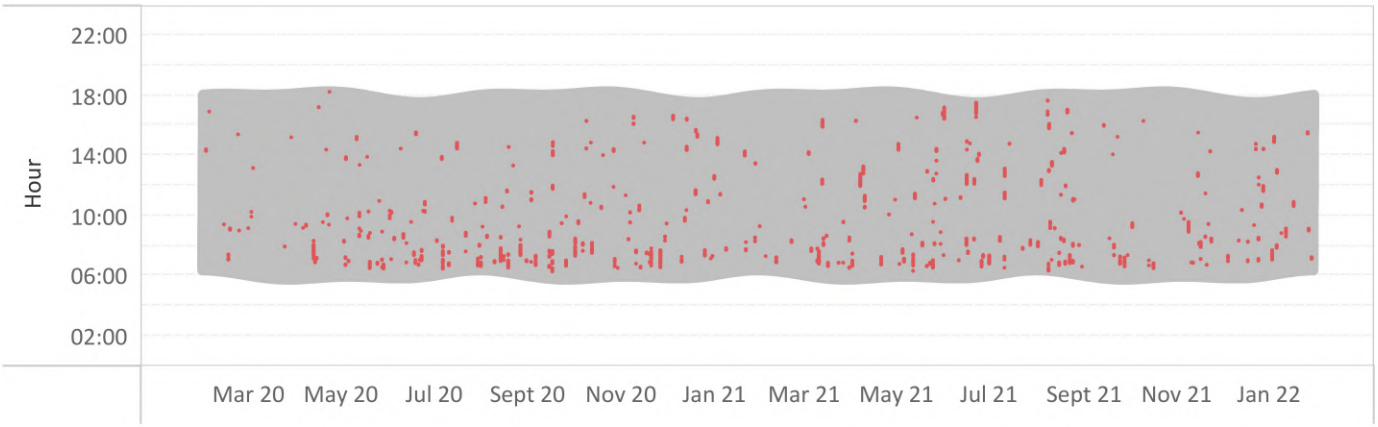

Figure 10: Quality control for GHI (1)

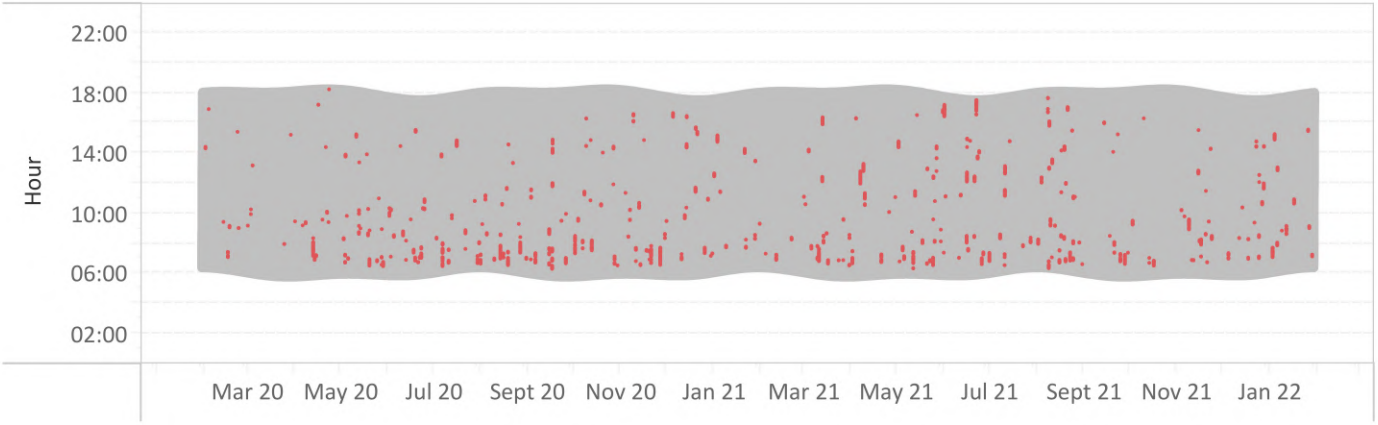

Figure 11: Quality control for GHI (2)

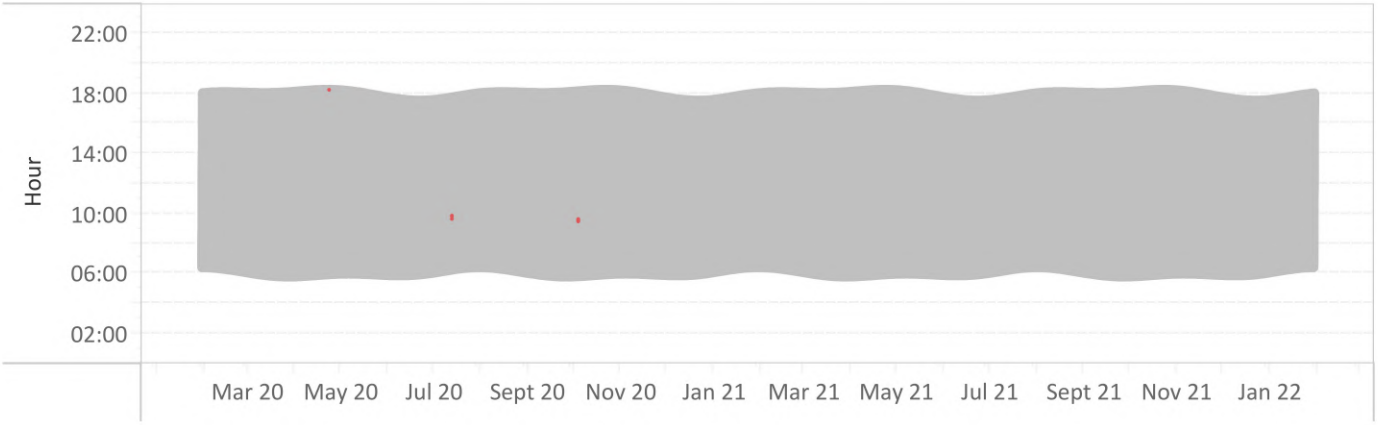

Figure 12: Quality control for DHI (1)

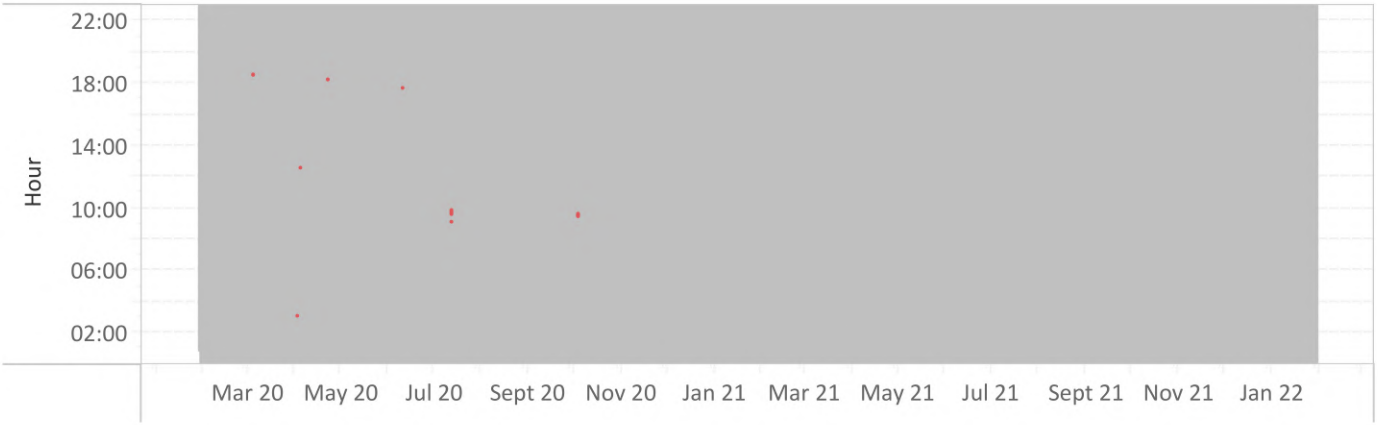

Figure 13: Quality Control for Temp

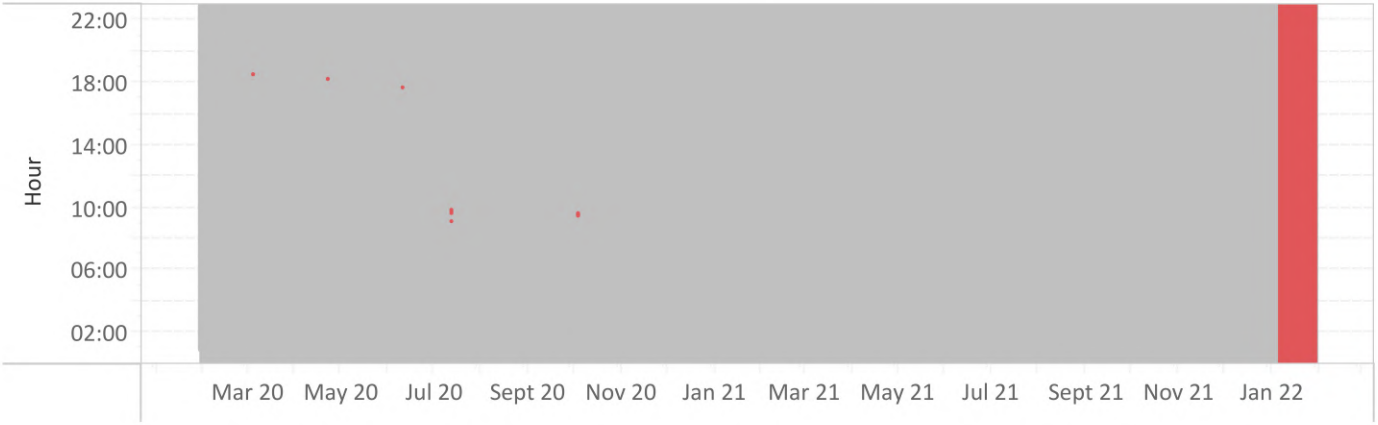

Figure 14: Quality Control for RH

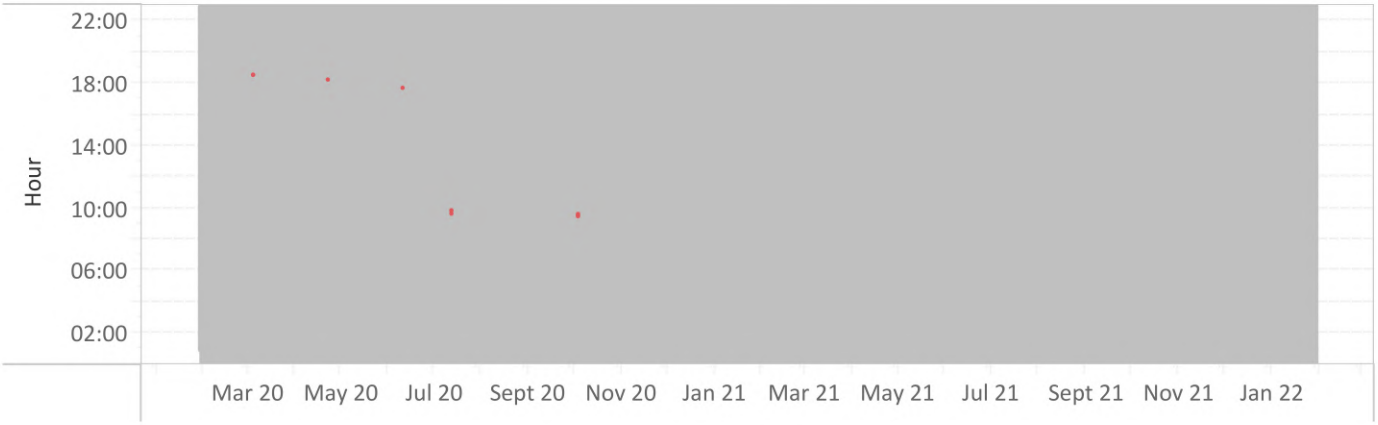

Figure 15: Quality Control for Rain

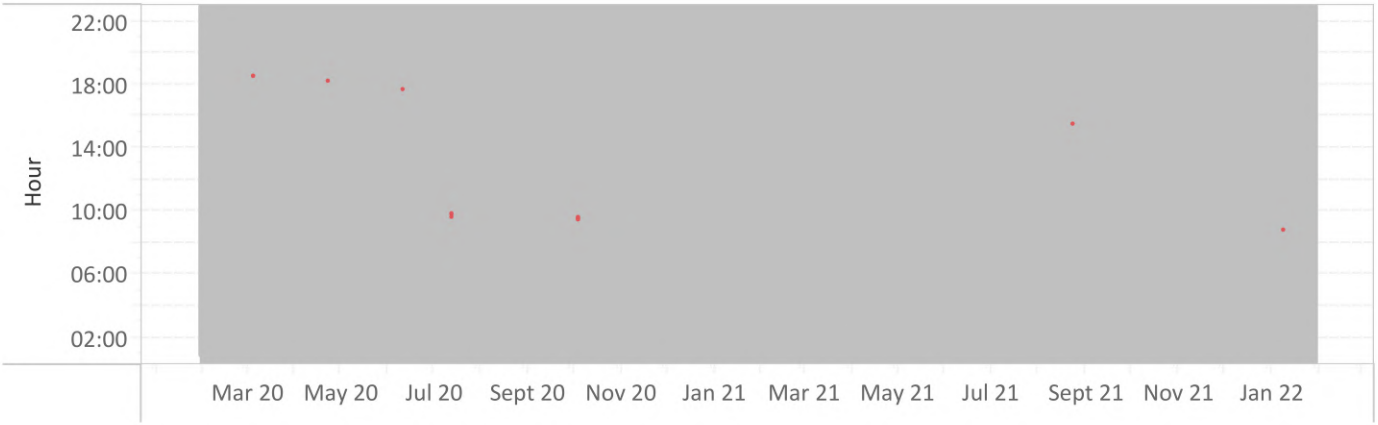

Figure 16: Quality Control for BP

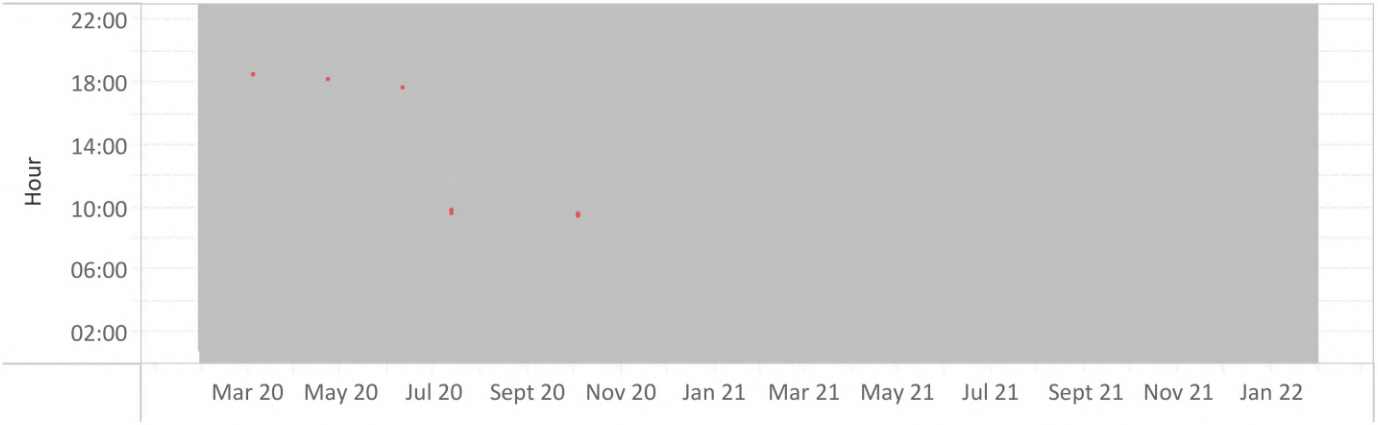

Figure 17: Quality Control for Wind Direction

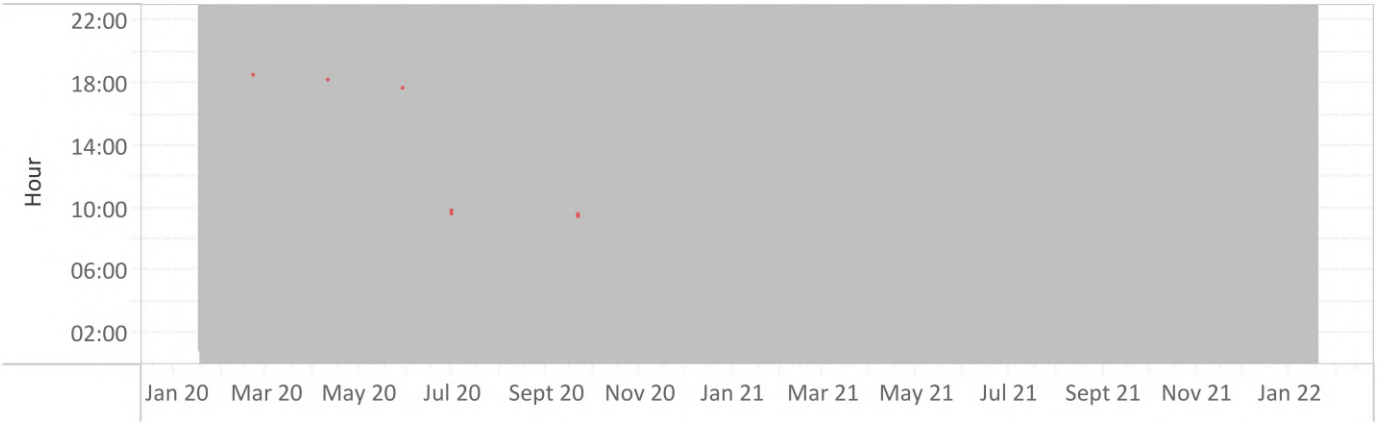

Figure 18: Quality Control for Wind Speed

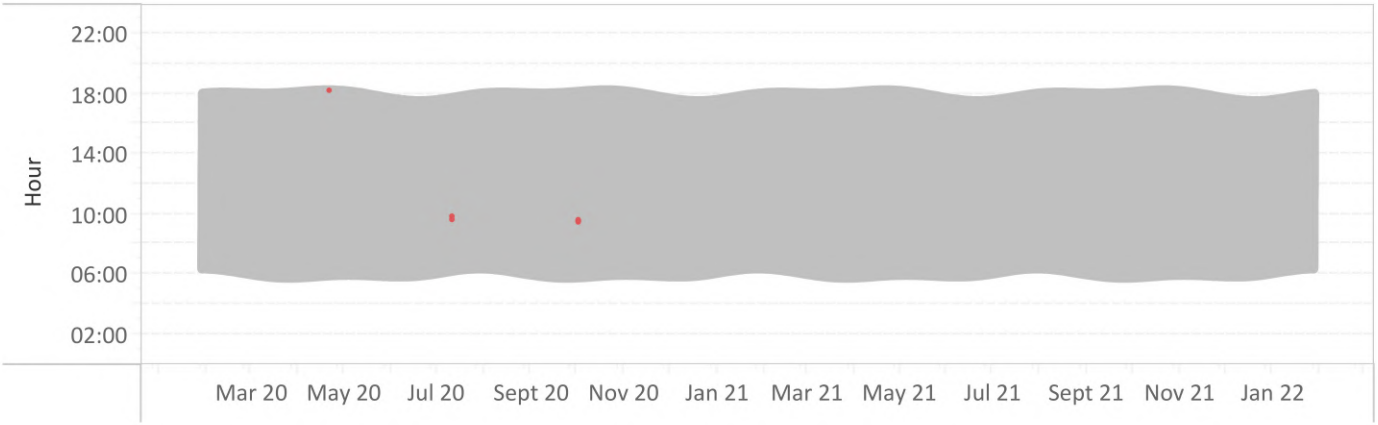

Figure 19: Quality control for soiling measurement (monthly cleaned)

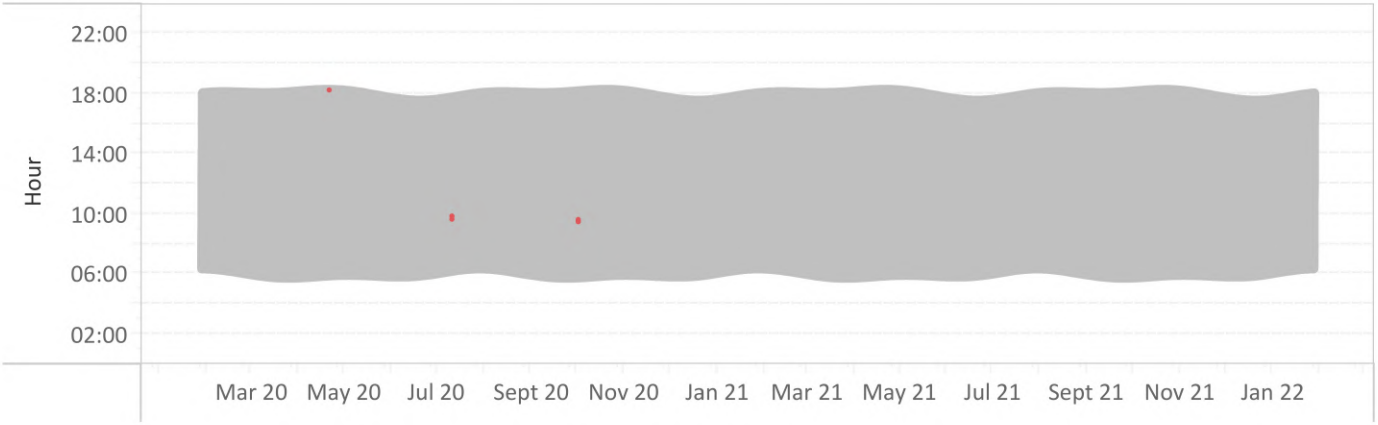

Figure 20: Quality control for soiling measurement (continuous soiling)

5.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

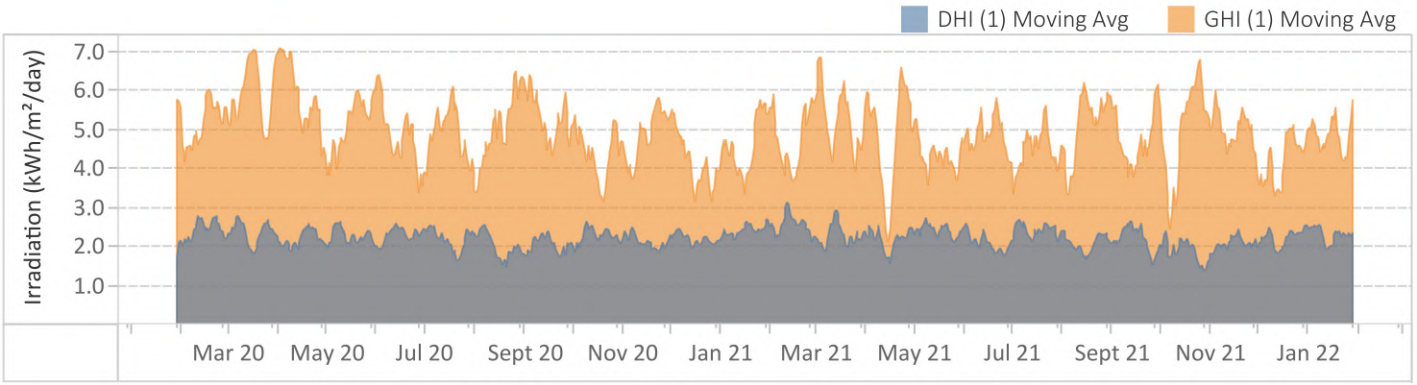

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

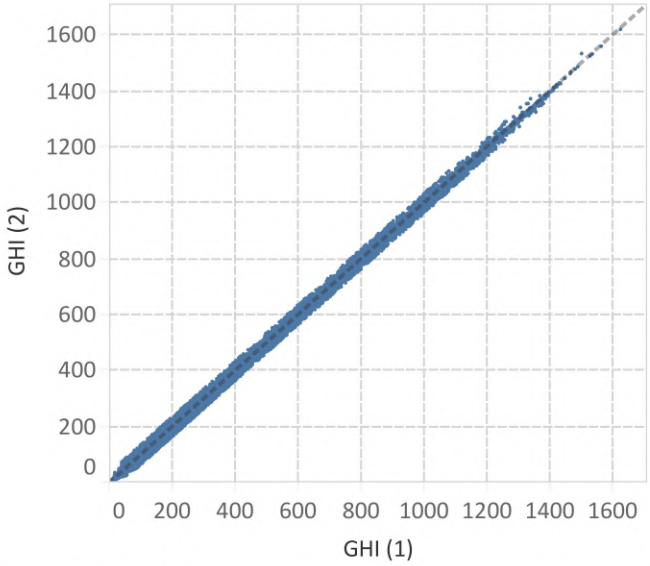

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

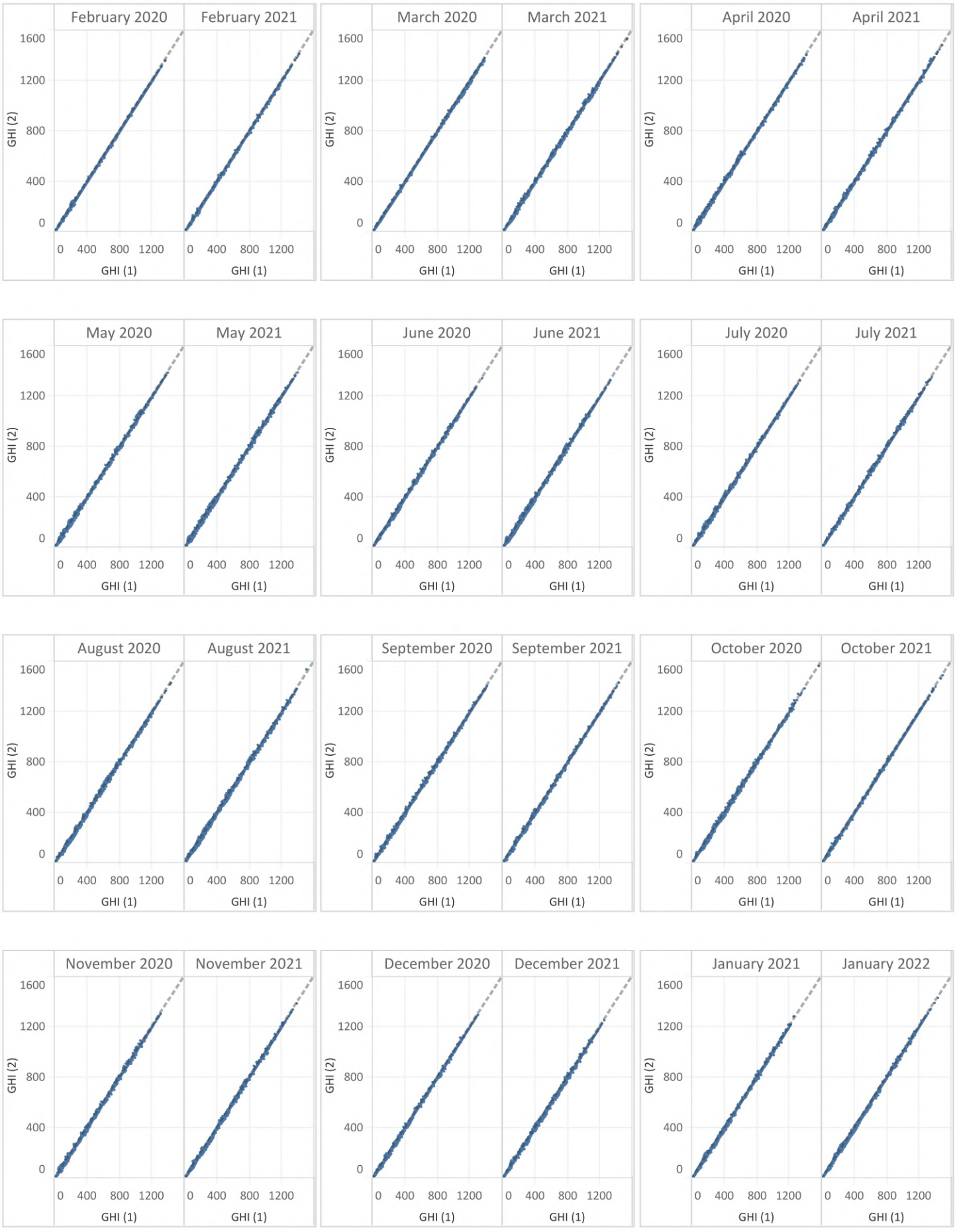

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

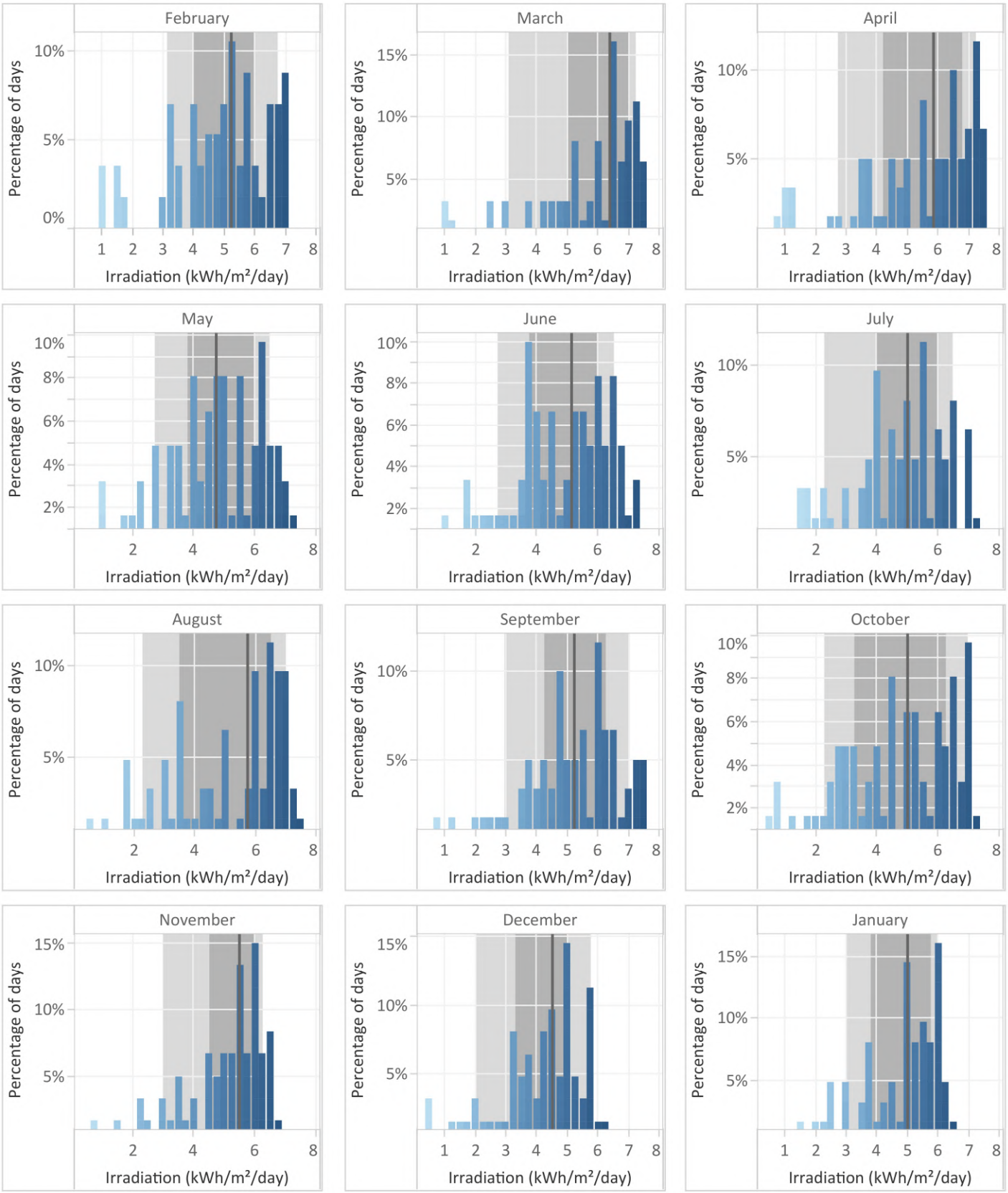

Figure 24: Daily summary of GHI (1)

5.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

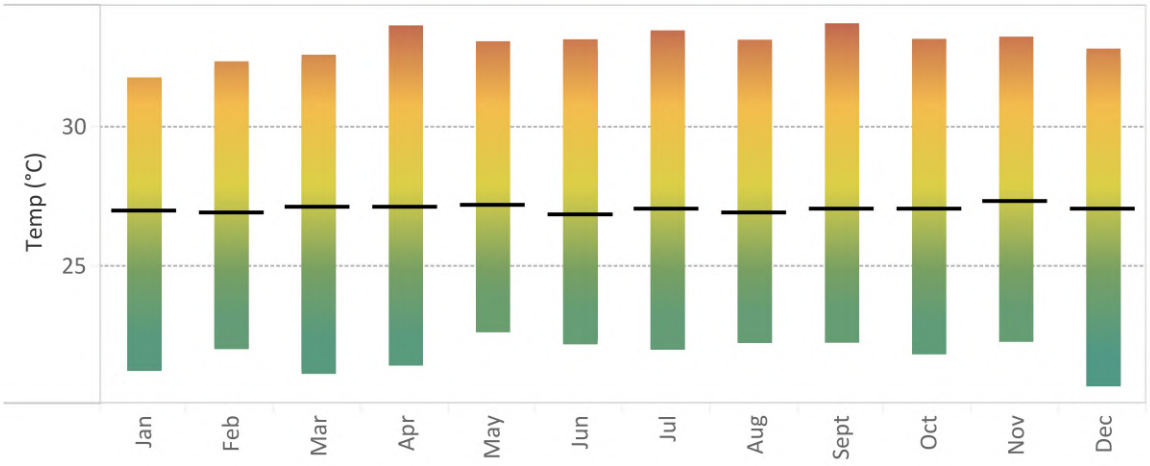

Figure 25: Monthly average, maximum and minimum temperature

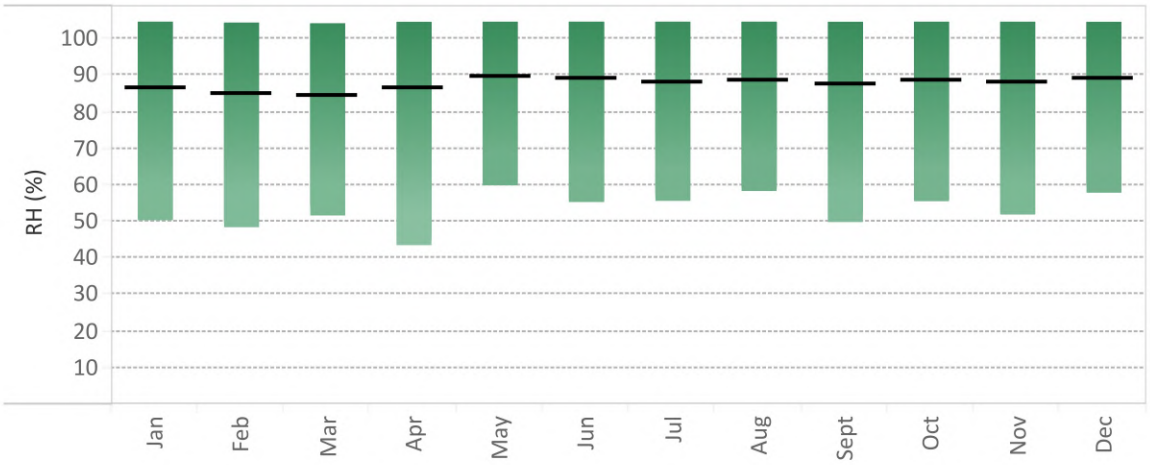

Figure 26: Monthly average, maximum and minimum relative humidity

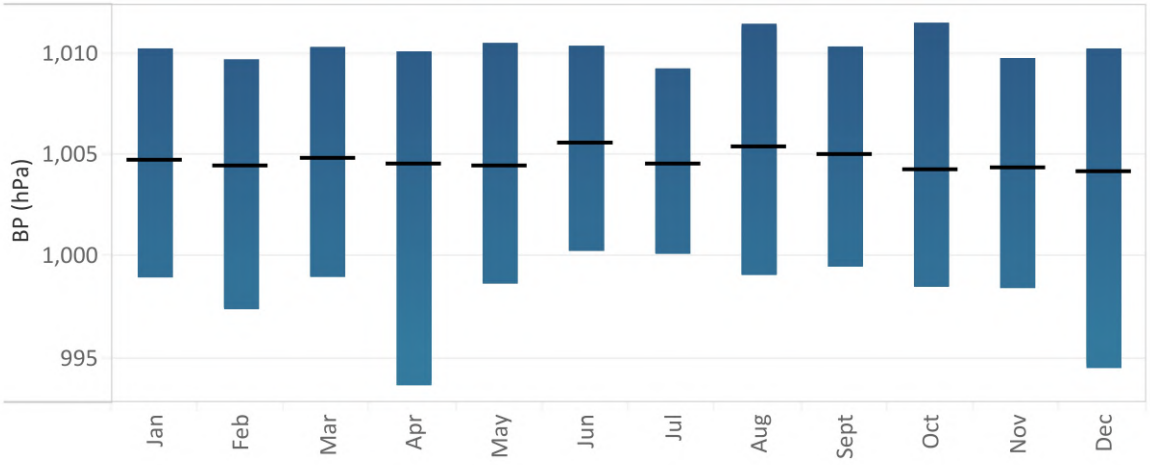

Figure 27: Monthly average, maximum and minimum barometric pressure

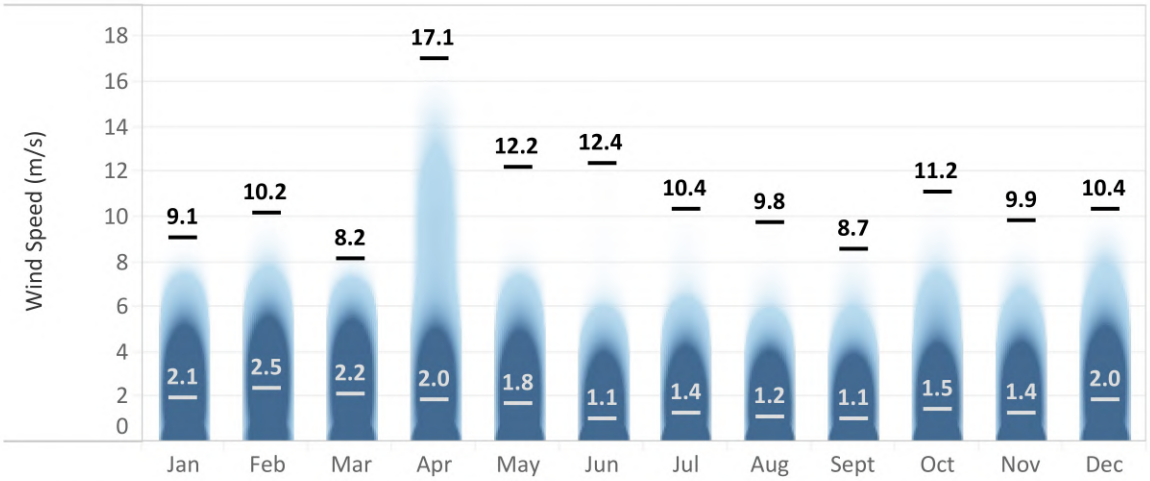

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

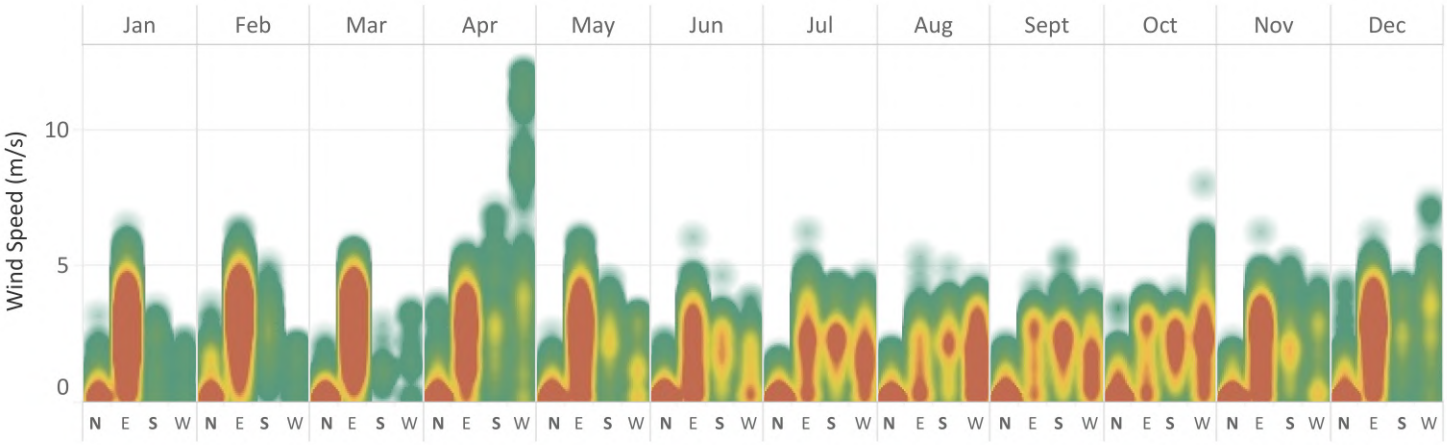

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

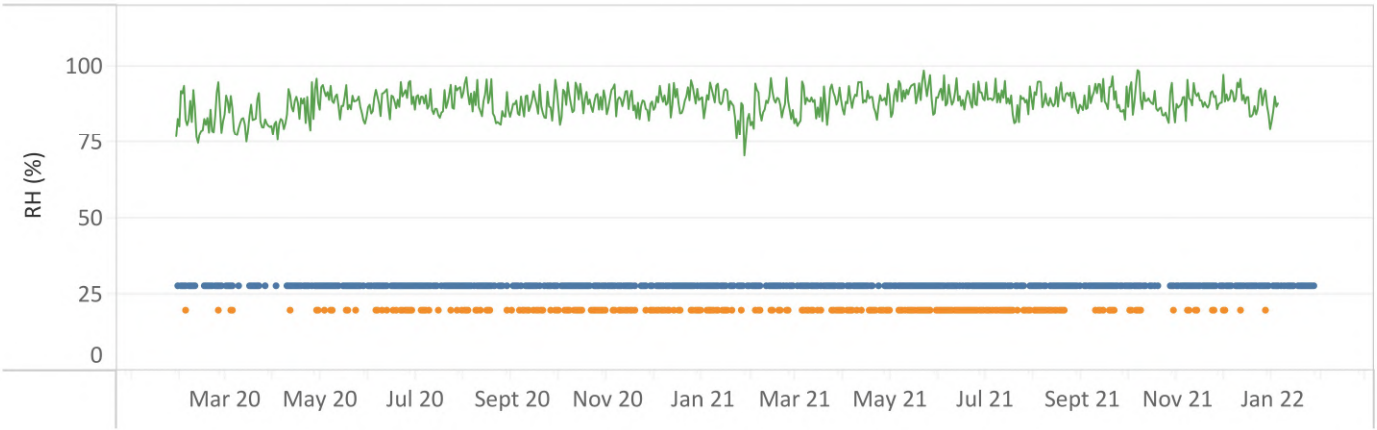

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

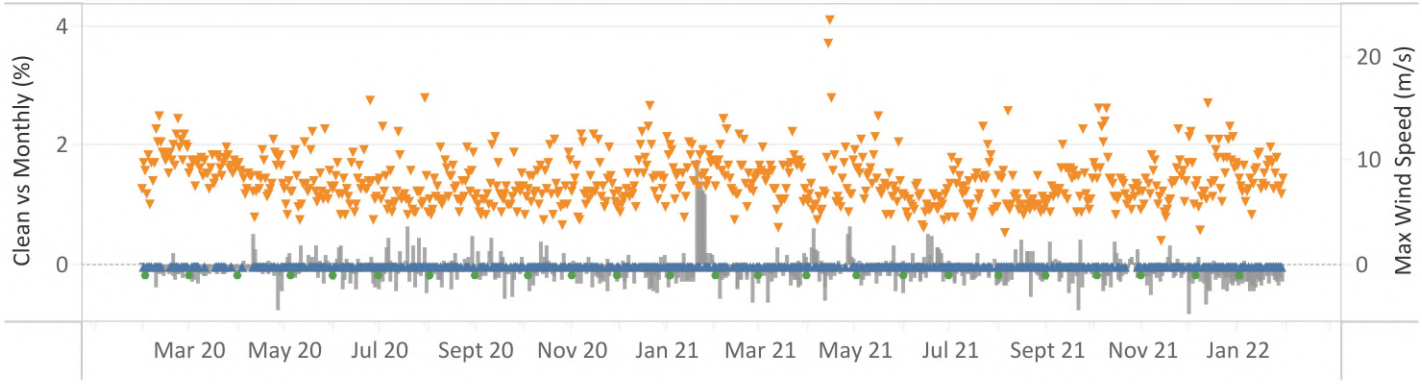

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

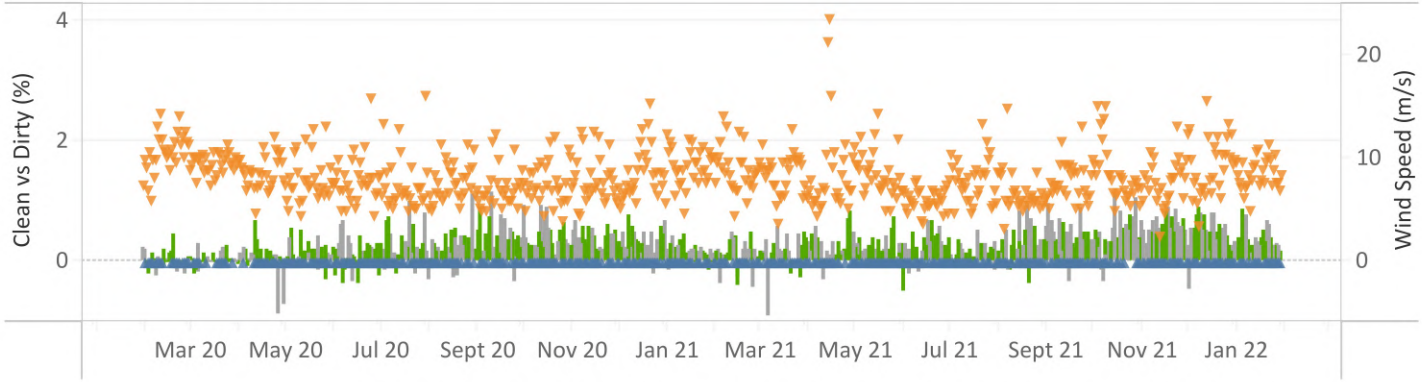

Figure 32: Soiling Measurement (Clean vs Dirty)

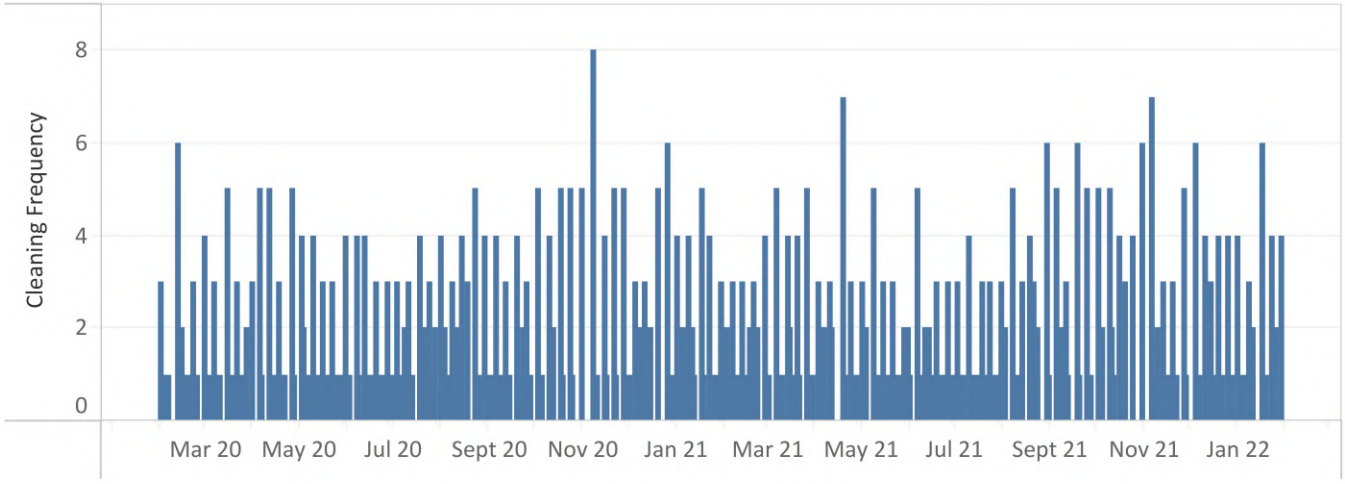

Figure 33: Consecutive days without cleaning

5.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

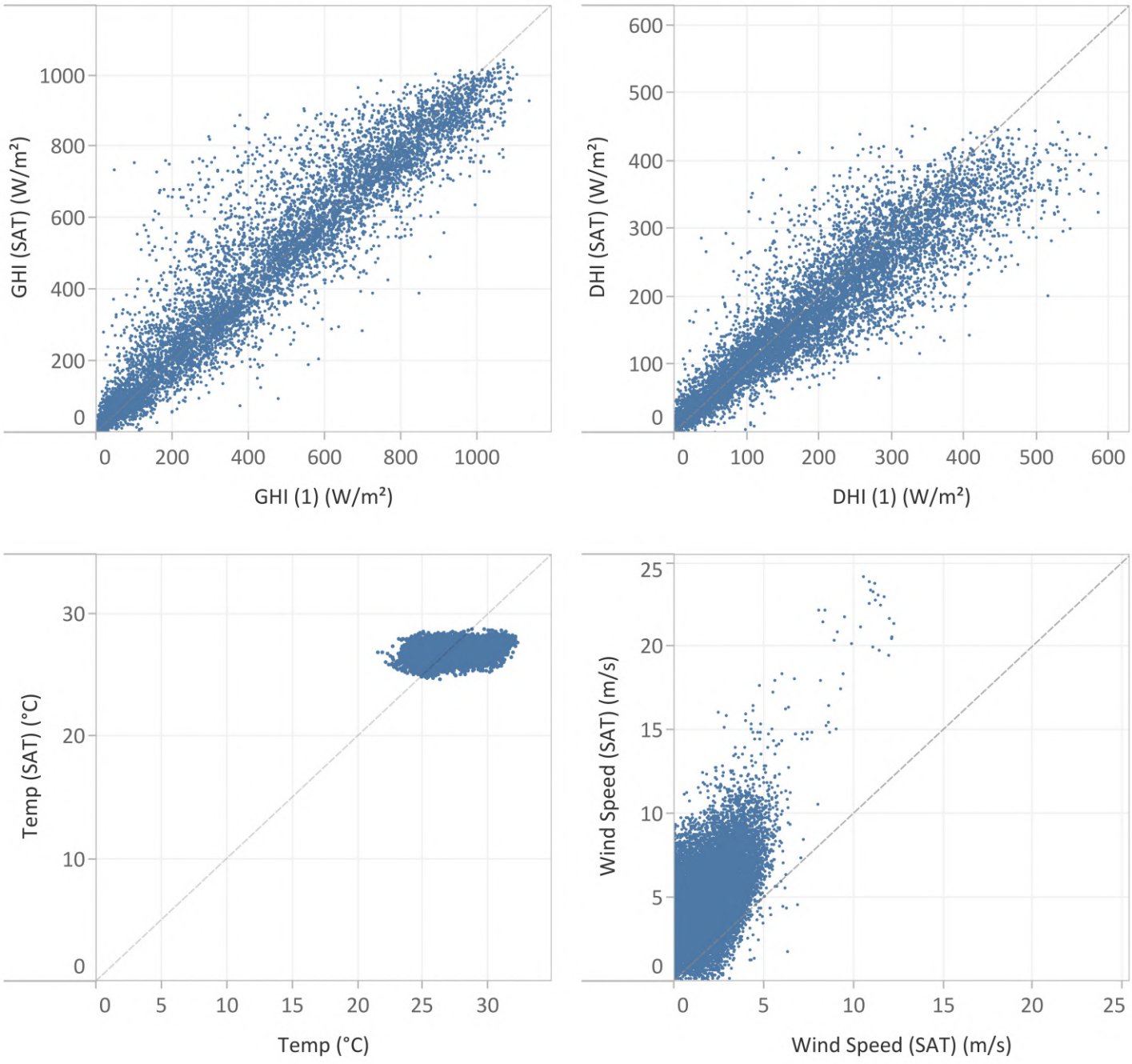

Figure 34: Ground measured data compared to satellite derived (Solargis) data

5.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.39%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

February 2020	Water residue affected early morning irradiation measurements on the following days:3 and 18 February 2020.
April 2020	Water residue affected early morning irradiation measurements on the following days:14, 15 and 16 April 2020.
May 2020	Water residue affected early morning irradiation measurements on the following days:5, 6 and 30 May 2020.
July 2020	Water residue affected early morning irradiation measurements on the following days:8 and 11 July 2020. Heavy rainfall affected GHI (2) midday irradiation measurements on the following day:17 July 2020.
August 2020	Water residue affected early morning irradiation measurements on the following days:15, 20 and 28 August 2020.
September 2020	Water residue affected early morning irradiation measurements on the following days:7, 16, 17, 18 and 27 September 2020.
October 2020	A site visit was conducted on 5 October 2020. Data during the site visit was affected and removed. Water residue affected early morning irradiation measurements on the following day:14 October 2020.
November 2020	Water residue affected early morning irradiation measurements on the following days:22 and 28 November 2020.
December 2020	Water residue affected early morning irradiation measurements on the following days:12 and 27 December 2020.
January 2021	The 12 month site visit was conducted on 20 January 2021 and a general inspection was done on all the instruments.

February 2021	Water residue affected early morning irradiation measurements on the following days:12 and 22 February 2021.
March 2021	Water residue affected early morning irradiation measurements on the following days:12, 15 and 18 March 2021.
April 2021	Water residue affected early morning irradiation measurements on the following days:3 and 22 April 2021.
May 2021	Water residue affected early morning irradiation measurements on the following days:7, 13, 19, 22, 24 and 26 May 2021.
June 2021	Water residue affected early morning irradiation measurements on the following days:17, 18, 27 and 28 June 2021.
July 2021	Water residue affected early morning irradiation measurements on the following days:2, 9 and 29 July 2021.
August 2021	Water residue affected early morning irradiation measurements on the following days:17, 20, 24 and 26 August 2021.
October 2021	Water residue affected early morning irradiation measurements on the following days:4 and 18 October 2021.
November 2021	Water residue affected early morning irradiation measurements on the following days:10, 18 and 25 November 2021.
January 2022	The humidity sensor was suspected of measuring inaccurate values from 8 January 2022. All affected data has been removed.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Feb	99.85	99.85	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.96	99.96	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.65	99.65	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.50	99.50	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.47	99.47	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.41	99.41	99.99	99.98	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Aug	99.19	99.19	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.20	99.20	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.37	99.37	99.96	99.98	99.98	99.98	99.98	99.98	99.98	99.96	99.96
	Nov	99.30	99.30	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.51	99.51	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.62	99.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.87	99.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.30	99.30	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.31	99.31	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.16	99.16	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	98.88	98.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.48	99.48	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	98.91	98.91	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.64	99.64	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.84	99.84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.52	99.52	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.66	99.66	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2022	Jan	99.38	99.38	100.00	100.00	22.58	100.00	100.00	100.00	100.00	100.00	100.00
Total		99.46	99.46	100.00	100.00	96.71	100.00	100.00	100.00	100.00	100.00	100.00

6. Vanuatu

6.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020		131
April 2020		111
May 2020		131
June 2020	51	80
July 2020	58	109
August 2020	54	112
September 2020	69	147
October 2020	77	159
November 2020	78	177
December 2020	86	161
January 2021	84	146
February 2021	68	183
Total (kWh/m²/year)	625	1648

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	70	158
April 2021	59	130
May 2021	56	120
June 2021	54	112
July 2021	53	99
August 2021	62	132
September 2021	71	129
October 2021	74	133
November 2021	80	164
December 2021	81	187
January 2022	82	167
February 2022	64	122
March 2022	70	147
Total (kWh/m²/year)	877	1799

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	7	4	0								0	3
6 pm	94	90	48	15	5	3	8	16	22	27	49	80
5 pm	227	251	190	116	98	83	106	133	157	148	191	221
4 pm	362	407	340	238	244	205	240	282	311	280	346	353
3 pm	535	539	487	377	387	326	330	393	441	392	511	493
2 pm	597	641	586	469	511	404	408	485	551	520	597	605
1 pm	617	703	643	521	564	438	443	557	617	563	663	643
12 pm	632	717	653	589	586	459	491	558	639	625	721	713
11 am	591	670	619	558	566	455	464	508	608	632	725	721
10 am	534	594	520	496	482	374	404	445	548	563	660	653
9 am	426	448	403	361	347	276	287	336	411	456	535	541
8 am	273	271	236	206	188	132	137	177	247	318	394	356
7 am	117	95	76	54	41	20	18	37	85	153	213	187
6 am	14	4	1	0					4	22	44	33

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	7	5	0								0	4
6 pm	72	59	41	16	4	4	8	13	19	24	39	59
5 pm	145	125	117	88	53	55	64	71	90	91	117	141
4 pm	221	184	190	148	117	121	139	133	163	161	198	204
3 pm	280	227	252	215	181	187	197	201	209	215	269	269
2 pm	310	271	291	265	228	235	230	234	276	269	294	306
1 pm	309	294	308	263	256	247	259	266	311	297	297	322
12 pm	316	299	294	263	260	270	269	276	322	312	296	320
11 am	312	298	261	238	254	240	243	239	295	301	312	327
10 am	284	252	204	204	211	186	173	191	262	270	301	278
9 am	218	184	167	154	143	122	120	145	204	235	239	221
8 am	136	108	104	95	84	69	66	79	128	161	164	147
7 am	64	45	43	35	23	13	12	23	51	78	86	79
6 am	10	3	1	0					3	13	25	20

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	25	25	24	24	22	22	22	22	22	23	23	24
10 pm	25	25	25	24	22	23	22	22	22	23	23	24
9 pm	25	25	25	24	23	23	22	22	22	23	24	25
8 pm	25	25	25	24	23	23	22	22	22	23	24	25
7 pm	26	26	25	25	23	23	22	22	22	24	24	25
6 pm	27	27	26	25	23	23	23	23	23	24	25	27
5 pm	27	28	27	26	25	24	24	24	24	26	26	27
4 pm	28	28	27	27	25	25	25	25	25	26	27	28
3 pm	28	29	28	27	26	26	25	25	26	27	27	28
2 pm	28	29	28	28	26	26	26	26	26	27	28	28
1 pm	28	29	28	28	26	26	26	26	26	27	28	29
12 pm	28	29	28	28	26	26	26	26	26	28	28	29
11 am	28	29	28	28	26	26	26	26	26	28	28	29
10 am	28	29	28	28	26	25	25	25	26	27	28	29
9 am	28	28	27	27	25	24	24	24	25	27	28	28
8 am	27	27	26	26	24	23	23	23	24	26	27	27
7 am	26	25	25	24	22	22	22	21	22	24	25	26
6 am	25	24	24	24	22	22	22	21	21	23	23	24
5 am	25	24	24	24	22	22	22	21	21	23	23	24
4 am	25	24	24	24	22	22	22	21	21	23	23	24
3 am	25	25	24	24	22	22	22	21	21	23	23	24
2 am	25	25	24	24	22	22	22	21	21	23	23	24
1 am	25	25	24	24	22	22	22	21	22	23	23	24
12 am	25	25	24	24	22	22	22	21	22	23	23	24

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	96	96	96	95	92	92	91	91	91	95	94	96
10 pm	96	95	96	95	91	91	91	90	90	94	94	95
9 pm	96	95	96	95	91	91	91	90	90	94	94	95
8 pm	95	94	95	94	90	91	91	89	89	93	93	94
7 pm	93	92	93	93	89	91	90	88	88	92	91	92
6 pm	89	87	90	91	87	89	88	85	85	88	87	88
5 pm	88	85	87	87	83	85	83	81	79	85	83	85
4 pm	86	84	86	86	80	83	80	79	77	83	82	84
3 pm	85	83	85	84	79	81	79	78	76	82	81	83
2 pm	86	83	85	84	78	80	79	78	74	80	81	83
1 pm	86	83	85	83	78	81	78	77	74	80	81	83
12 pm	86	83	84	82	78	81	78	78	74	79	80	82
11 am	86	83	85	83	79	82	79	78	75	79	80	82
10 am	86	84	86	85	81	85	82	80	76	81	80	83
9 am	88	87	88	88	84	88	86	83	80	84	82	84
8 am	91	90	91	91	87	92	90	87	85	87	86	88
7 am	94	96	96	95	92	94	93	91	90	92	91	93
6 am	96	97	97	96	93	94	93	91	92	95	95	96
5 am	97	97	97	96	93	93	93	91	91	95	96	97
4 am	97	97	97	96	92	93	93	91	91	95	96	97
3 am	97	97	97	96	92	93	93	91	91	95	96	96
2 am	97	96	97	96	92	93	93	91	91	95	95	96
1 am	97	96	96	96	93	93	92	91	91	95	95	96
12 am	97	96	96	95	93	93	92	91	91	95	95	96

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	4.8	9.0	23.6	8.0	14.4	0.8	0.6	3.0	2.8	5.6	5.0	25.0
10 pm	27.0	17.0	17.4	8.6	9.8	1.2	0.2	1.4	4.6	3.2	24.6	8.4
9 pm	32.4	14.4	25.8	10.2	9.4	0.6	0.6	3.4	1.4	1.4	9.2	20.6
8 pm	11.0	17.0	11.4	6.8	9.4	0.2	0.4	0.8	3.8	6.4	27.0	17.0
7 pm	12.0	29.0	11.6	6.6	16.0	0.8	1.0	1.2	3.2	33.6	17.4	4.2
6 pm	25.4	30.0	19.4	12.6	19.2	1.4	2.2	2.0	4.6	13.4	13.6	19.8
5 pm	41.8	3.8	25.2	10.6	2.8	0.6	2.8	0.6	9.6	8.6	13.8	44.4
4 pm	42.8	11.8	34.4	24.4	4.8	7.0	1.0	10.2	6.0	13.6	5.0	35.2
3 pm	8.6	22.0	67.8	35.0	9.4	1.6	1.4	2.0	6.4	6.8	20.2	29.4
2 pm	9.8	34.0	20.2	12.0	15.8	3.4	4.8	3.4	4.2	33.2	42.4	43.8
1 pm	10.2	54.2	25.6	31.2	7.0	3.0	2.6	1.6	4.6	14.0	37.2	39.4
12 pm	14.2	46.4	42.8	4.6	6.6	0.2	0.6	2.8	0.2	16.6	28.6	27.8
11 am	13.2	38.6	50.4	2.6	2.8	0.4	1.6	7.2	0.6	17.8	16.2	16.6
10 am	26.0	20.4	77.0	5.4	3.2	1.8	0.8	5.4	1.2	8.6	11.2	11.6
9 am	22.6	25.0	12.8	12.0	2.6	0.6	1.4	6.4	3.8	13.8	6.8	4.0
8 am	48.8	30.8	24.0	4.0	19.6	1.6	0.8	7.0	4.8	4.6	5.8	9.8
7 am	15.4	35.4	9.6	1.6	11.8	3.8	2.0	5.6	6.8	2.2	5.2	8.6
6 am	28.2	38.8	24.6	7.4	7.4	2.2	2.6	4.4	6.8	12.8	0.4	6.0
5 am	26.2	39.2	66.4	4.2	8.2	3.0	6.0	4.2	3.4	1.8	0.6	3.4
4 am	18.0	58.6	40.0	3.8	2.8	0.4	2.4	11.0	5.0	12.8	0.8	9.0
3 am	17.2	79.4	33.6	9.0	4.8	4.6	0.8	4.4	3.8	9.0	3.2	7.8
2 am	32.4	22.2	33.4	3.0	12.2	1.8	1.4	17.6	1.0	34.0	6.8	3.8
1 am	27.8	18.2	18.4	2.2	20.2	11.8	2.8	7.2	1.6	15.4	19.0	23.6
12 am	14.8	8.2	44.0	3.4	8.8	2.4	1.4	9.2	5.2	7.6	7.8	7.6

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	991	990	994	995	996	999	998	999	999	997	996	993
10 pm	991	990	994	995	996	999	998	999	999	997	996	993
9 pm	990	990	994	995	996	998	998	999	999	997	996	993
8 pm	990	990	993	995	995	998	998	998	998	996	996	992
7 pm	989	989	993	994	995	998	997	998	998	996	995	992
6 pm	989	988	992	993	994	997	997	997	997	995	994	991
5 pm	988	988	991	993	994	997	996	997	996	994	994	991
4 pm	988	988	991	993	994	996	996	996	996	994	993	990
3 pm	989	988	991	993	994	996	996	996	996	994	994	991
2 pm	989	988	992	993	994	997	996	997	997	995	994	991
1 pm	989	989	992	994	995	997	997	997	997	995	995	991
12 pm	990	989	993	994	995	998	997	998	998	996	995	992
11 am	990	990	993	995	996	998	998	999	999	996	995	992
10 am	990	990	994	995	996	999	998	999	999	997	996	992
9 am	990	990	994	995	996	999	998	999	999	997	996	992
8 am	990	990	993	995	996	998	998	999	999	997	996	992
7 am	990	989	993	994	995	998	997	998	998	996	995	992
6 am	989	989	992	994	995	997	997	998	998	995	995	992
5 am	989	988	992	993	994	997	997	997	997	995	994	991
4 am	989	988	992	993	994	997	996	997	997	995	994	991
3 am	989	988	992	994	994	997	997	997	997	995	994	991
2 am	989	989	992	994	995	998	997	998	998	995	994	991
1 am	990	989	993	994	995	998	998	998	998	996	995	992
12 am	990	990	994	995	996	998	998	999	999	996	996	993

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1.1	1.5	1.1	0.8	1.0	1.2	0.9	0.9	1.0	0.8	0.5	0.5
10 pm	1.0	1.4	1.1	0.8	1.1	1.2	0.9	0.9	1.0	0.8	0.6	0.6
9 pm	1.0	1.5	1.1	0.8	1.1	1.3	0.9	0.9	1.0	1.0	0.6	0.6
8 pm	1.0	1.5	1.2	0.9	1.1	1.3	1.0	0.9	1.1	0.9	0.7	0.5
7 pm	1.2	1.6	1.2	0.9	1.1	1.3	1.0	1.1	1.2	1.0	0.9	0.6
6 pm	1.3	1.7	1.5	1.1	1.2	1.4	1.1	1.2	1.4	1.2	1.1	0.8
5 pm	1.7	2.0	1.7	1.2	1.4	1.6	1.3	1.4	1.5	1.4	1.3	1.1
4 pm	1.9	2.3	2.1	1.6	1.6	1.7	1.5	1.6	1.8	1.4	1.6	1.3
3 pm	2.0	2.5	2.2	1.8	1.8	1.8	1.6	1.7	2.0	1.5	1.9	1.4
2 pm	2.1	2.5	2.4	1.8	1.8	1.8	1.7	1.8	2.1	1.7	2.1	1.5
1 pm	2.0	2.6	2.4	1.8	1.8	1.9	1.7	1.7	2.1	1.7	2.1	1.4
12 pm	2.0	2.5	2.3	1.7	1.8	1.9	1.7	1.7	2.1	1.7	2.1	1.6
11 am	1.9	2.3	2.0	1.5	1.7	1.8	1.6	1.6	2.0	1.6	1.8	1.4
10 am	1.8	2.1	1.7	1.2	1.4	1.6	1.4	1.6	1.8	1.4	1.6	1.2
9 am	1.7	1.8	1.4	1.0	1.1	1.3	1.0	1.4	1.5	1.2	1.3	0.9
8 am	1.5	1.5	1.1	0.8	0.9	1.1	0.8	1.1	1.1	0.9	1.1	0.7
7 am	1.2	1.4	1.0	0.8	0.9	1.1	0.8	1.1	0.9	0.7	0.7	0.5
6 am	1.1	1.5	1.1	0.9	1.0	1.2	0.8	1.1	0.9	0.6	0.5	0.4
5 am	1.1	1.4	1.1	0.9	1.0	1.3	0.8	1.0	0.9	0.7	0.6	0.4
4 am	1.1	1.5	1.1	0.9	0.9	1.3	0.7	1.1	1.0	0.7	0.6	0.4
3 am	1.1	1.5	1.2	0.9	0.9	1.3	0.7	1.1	1.0	0.7	0.6	0.5
2 am	1.1	1.5	1.2	0.8	0.9	1.2	0.8	1.1	1.1	0.7	0.6	0.4
1 am	1.1	1.6	1.2	0.8	1.0	1.1	0.9	1.0	1.0	0.8	0.6	0.4
12 am	1.0	1.6	1.2	0.8	1.0	1.2	0.9	0.9	1.0	0.9	0.6	0.5

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
10 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
9 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
8 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
7 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
6 pm	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
5 pm	NW	NW	NW	NW	S NW	NW	NW	NW	NW	NW	S NW	NW
4 pm	NW	W	S	S	S	S	NW	NW	NW	NW	S	S
3 pm	NW	NW	S	S	S	S	NW	NW	S	S	S	S
2 pm	NW	NW	S	S	S	S	S	S	S	S	S	S
1 pm	NW	NW	S	S	S	S	NW	S	S	S	S	S
12 pm	NW	NW	S	S	S	S	S NW	S	S	S	S	S
11 am	NW	W	S	S	S	S	S	S	S	S	S	S
10 am	NW	NW	S	S	S	S	NW	S	S	NW	S	S
9 am	NW	NW	S	SW	S	S	NW	S	S	S	S	S
8 am	NW	NW	W NW	W S	NW	S	NW	S	S	S	S	S
7 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	S	S	S
6 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
5 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
4 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
3 am	NW	NW	NW	W NW	NW	NW	NW	NW	NW	NW	NW	NW
2 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
1 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW
12 am	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW

Figure 9: Dominant hourly Wind Direction

6.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

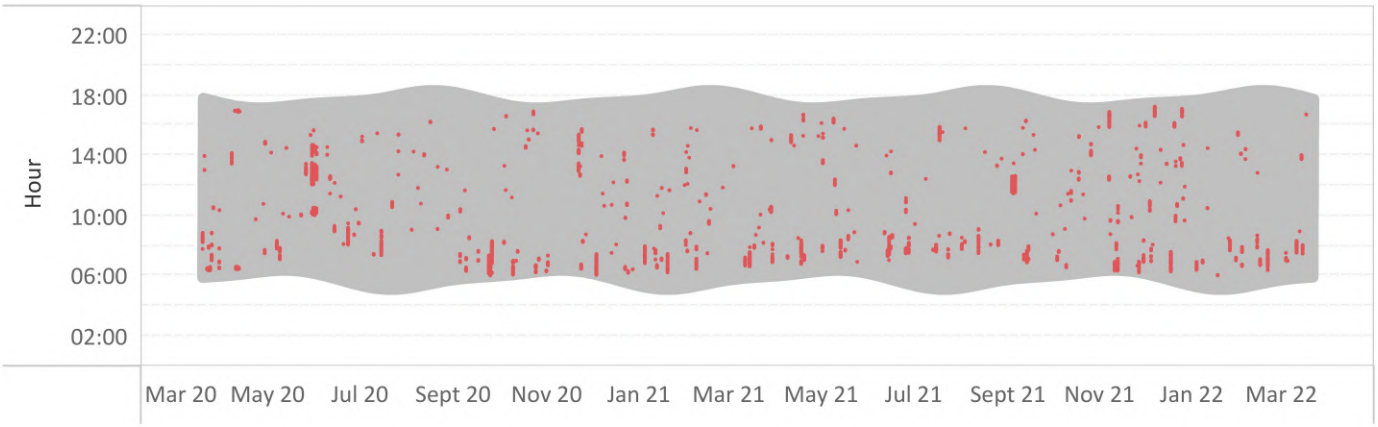

Figure 10: Quality control for GHI (1)

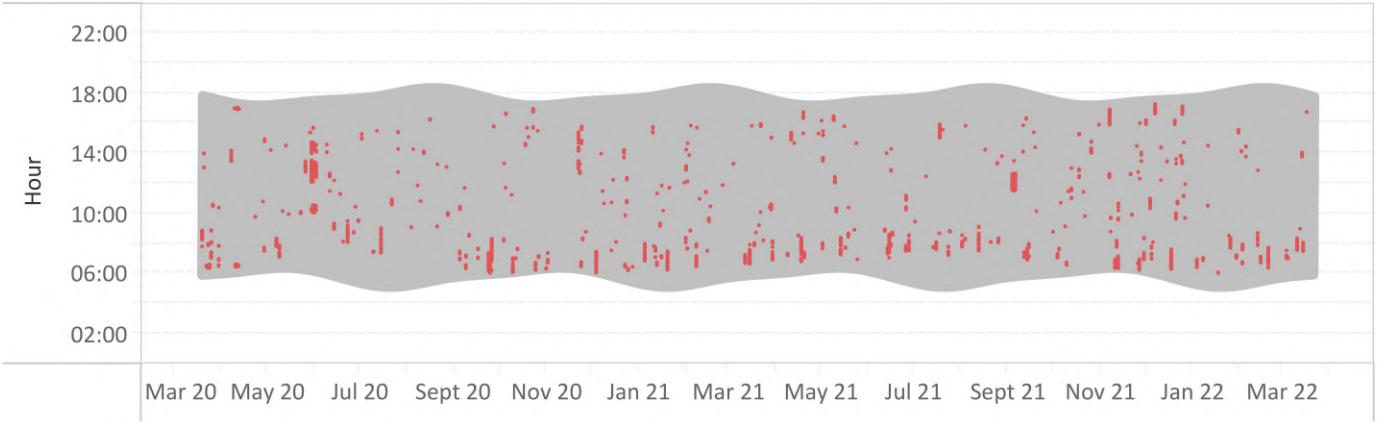

Figure 11: Quality control for GHI (2)

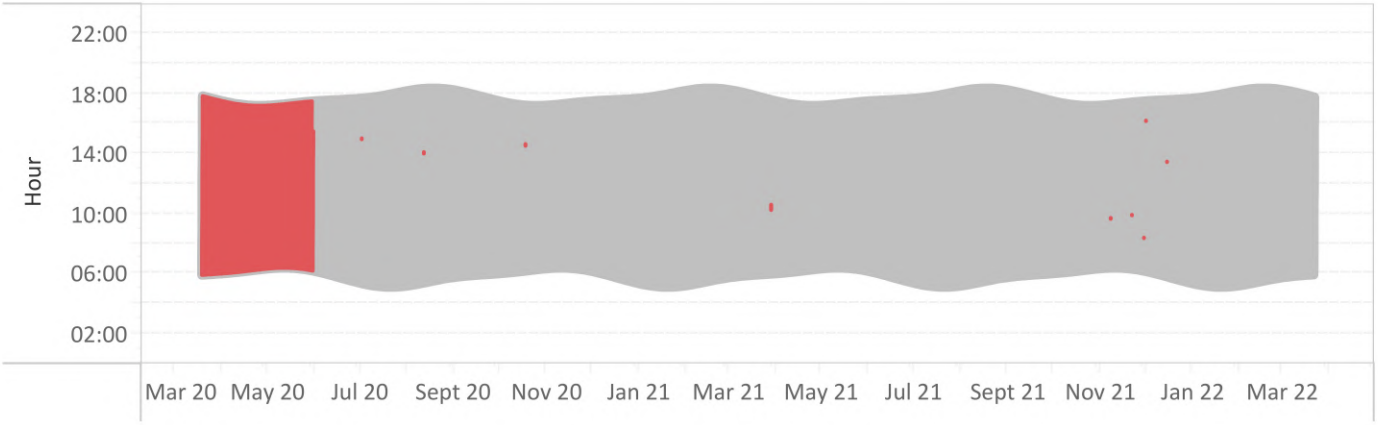

Figure 12: Quality control for DHI (1)

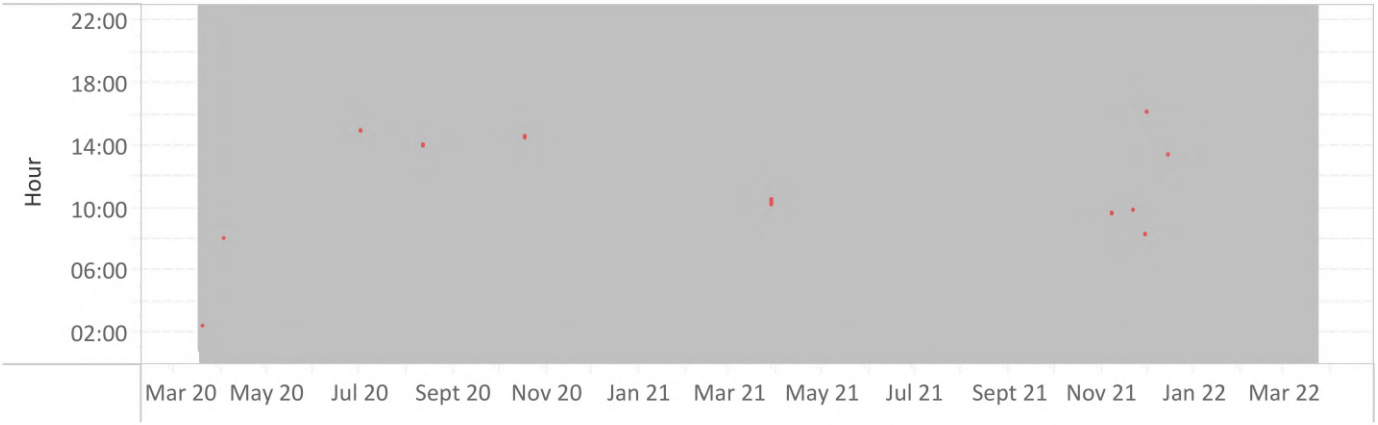

Figure 13: Quality Control for Temp

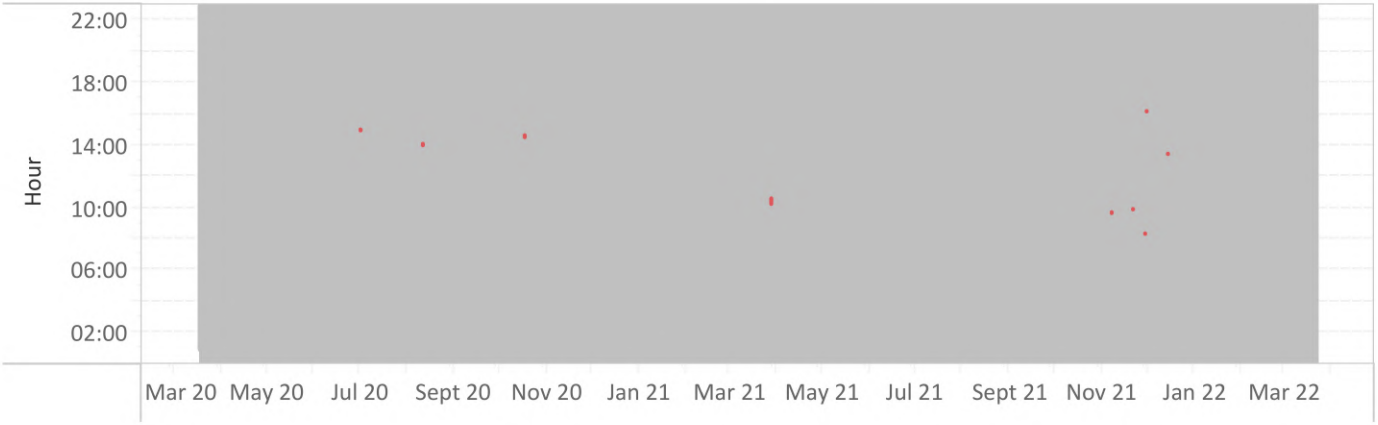

Figure 14: Quality Control for RH

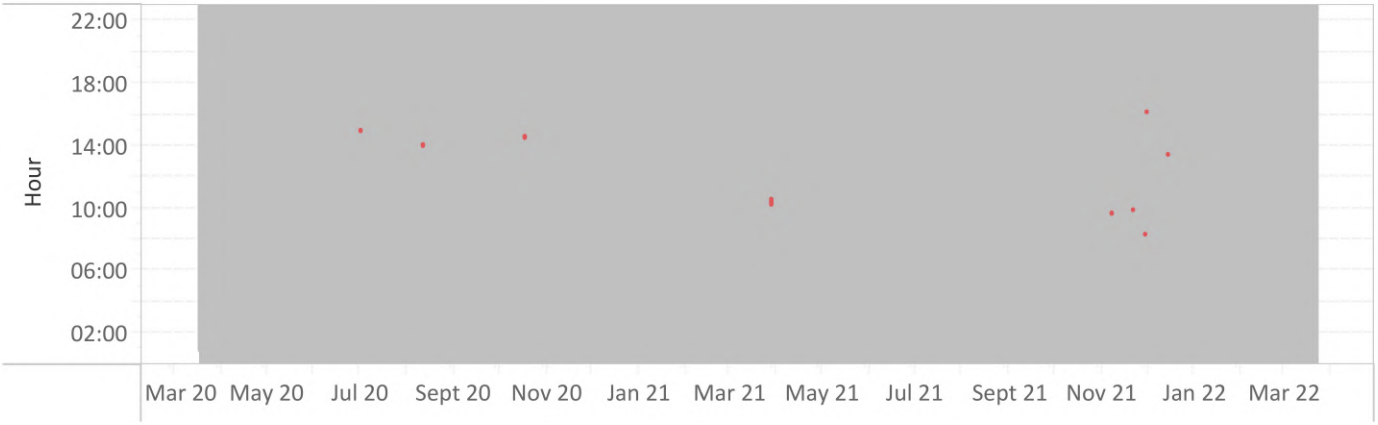

Figure 15: Quality Control for Rain

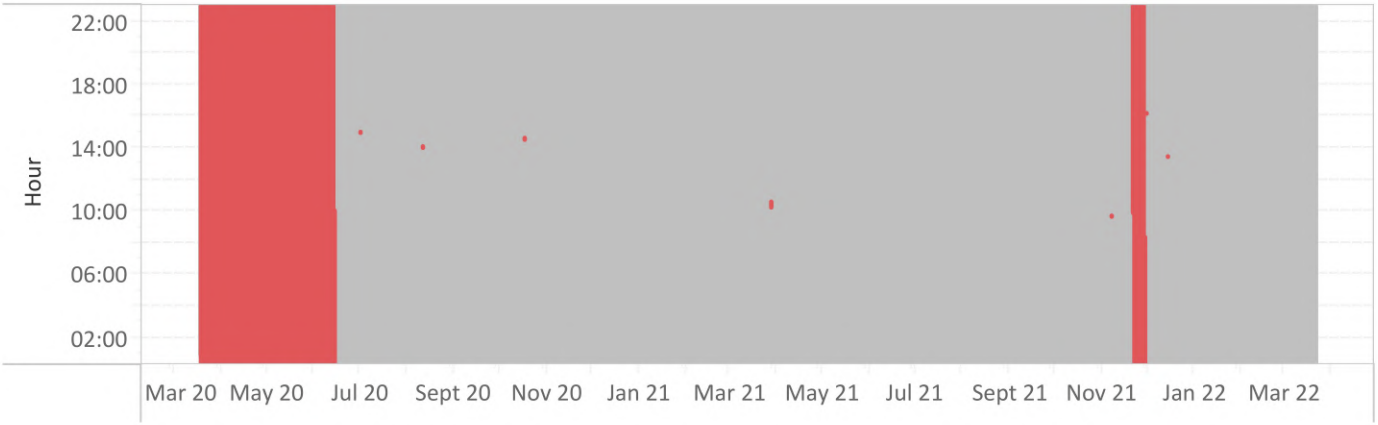

Figure 16: Quality Control for BP

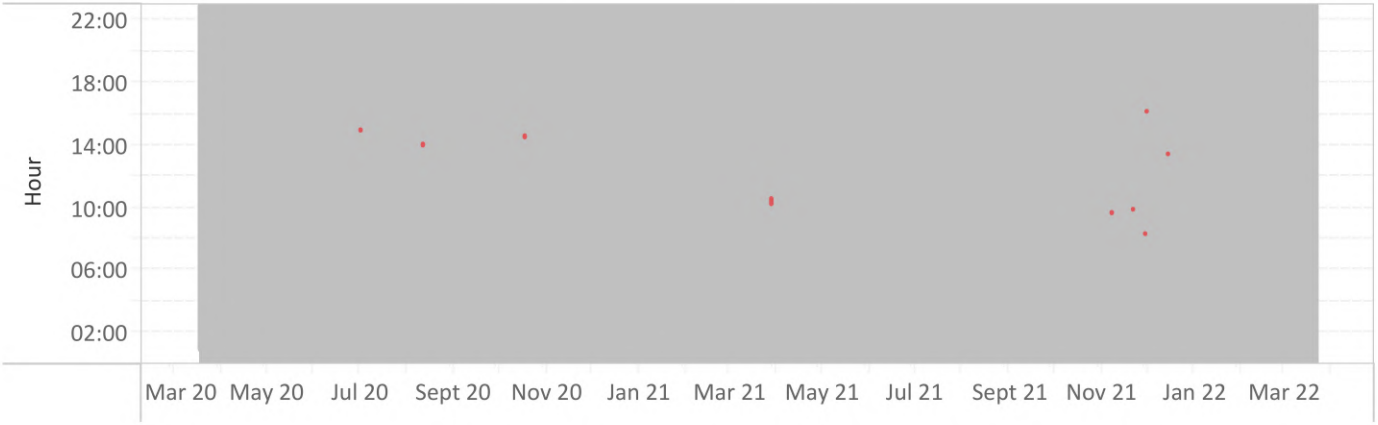

Figure 17: Quality Control for Wind Direction

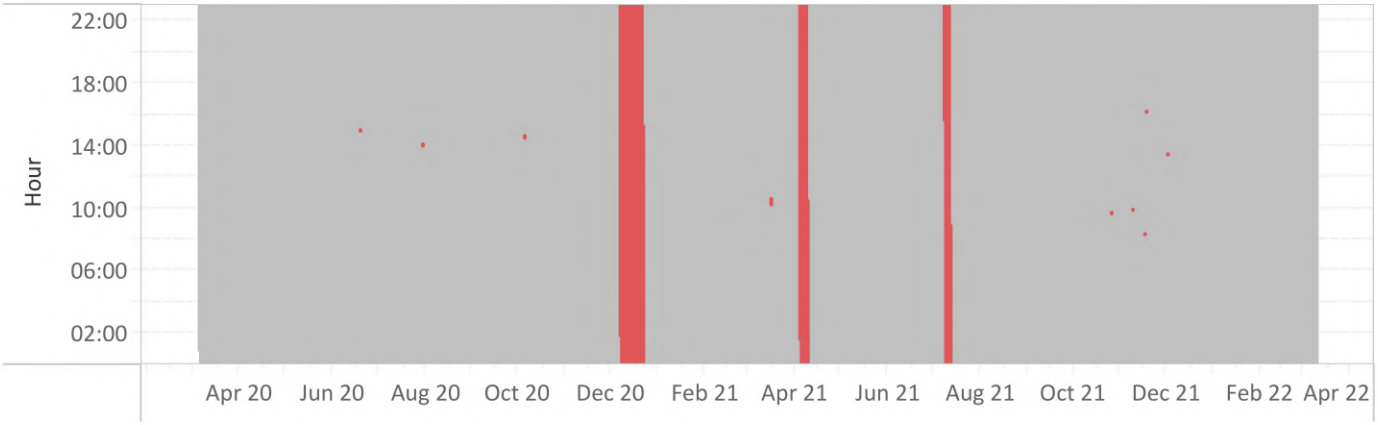

Figure 18: Quality Control for Wind Speed

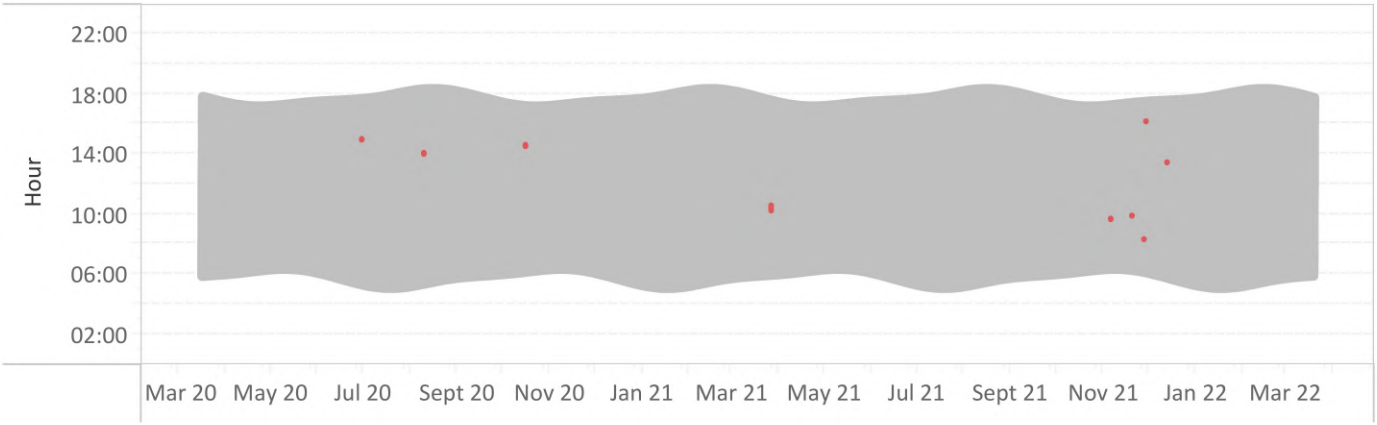

Figure 19: Quality control for soiling measurement (monthly cleaned)

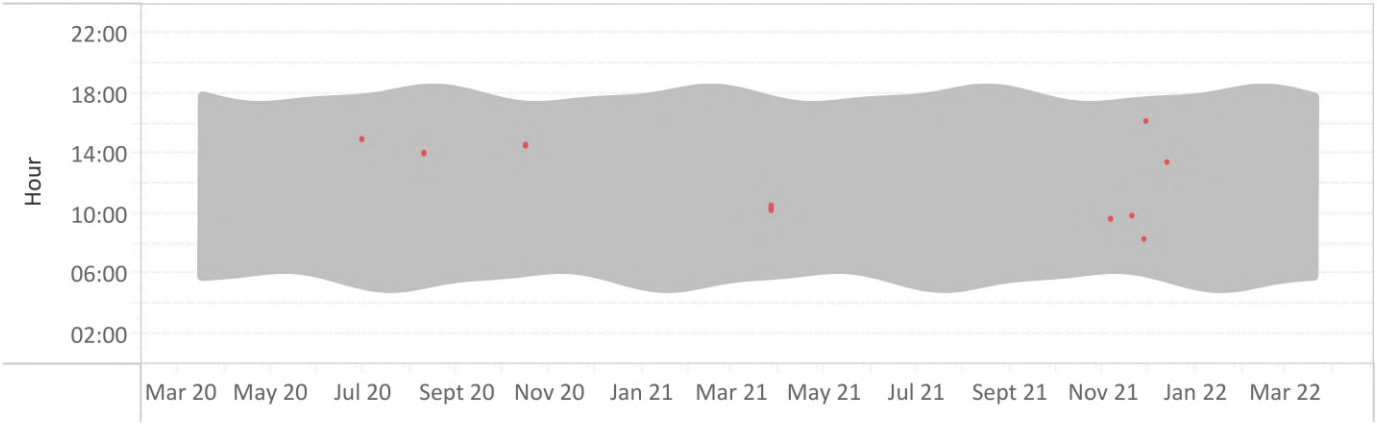

Figure 20: Quality control for soiling measurement (continuous soiling)

6.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

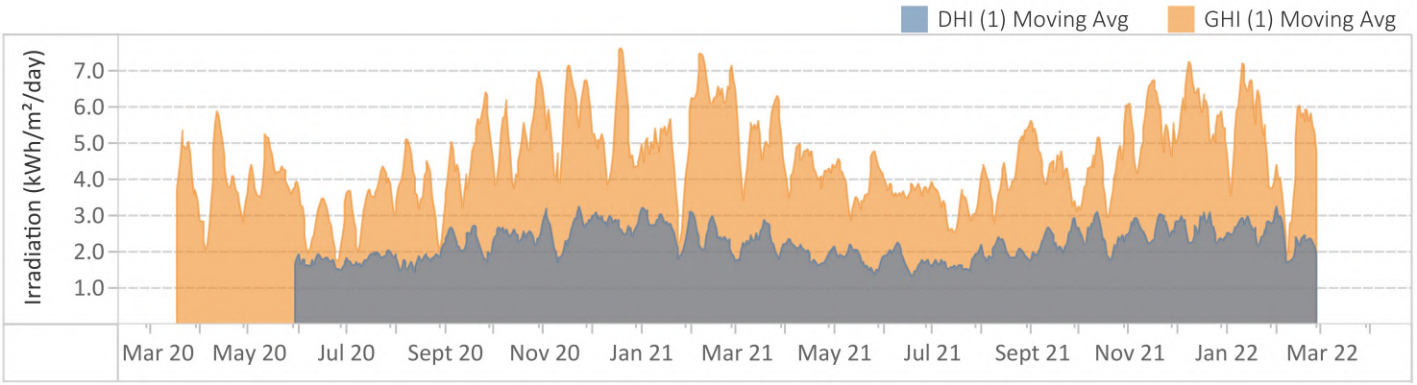

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

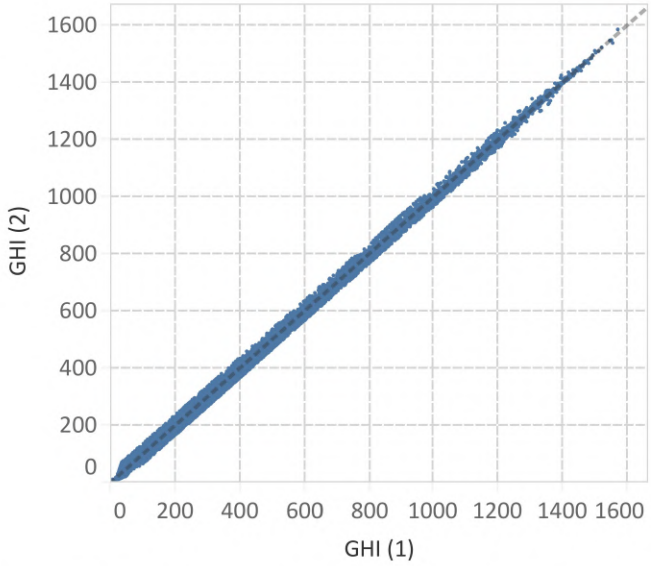

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

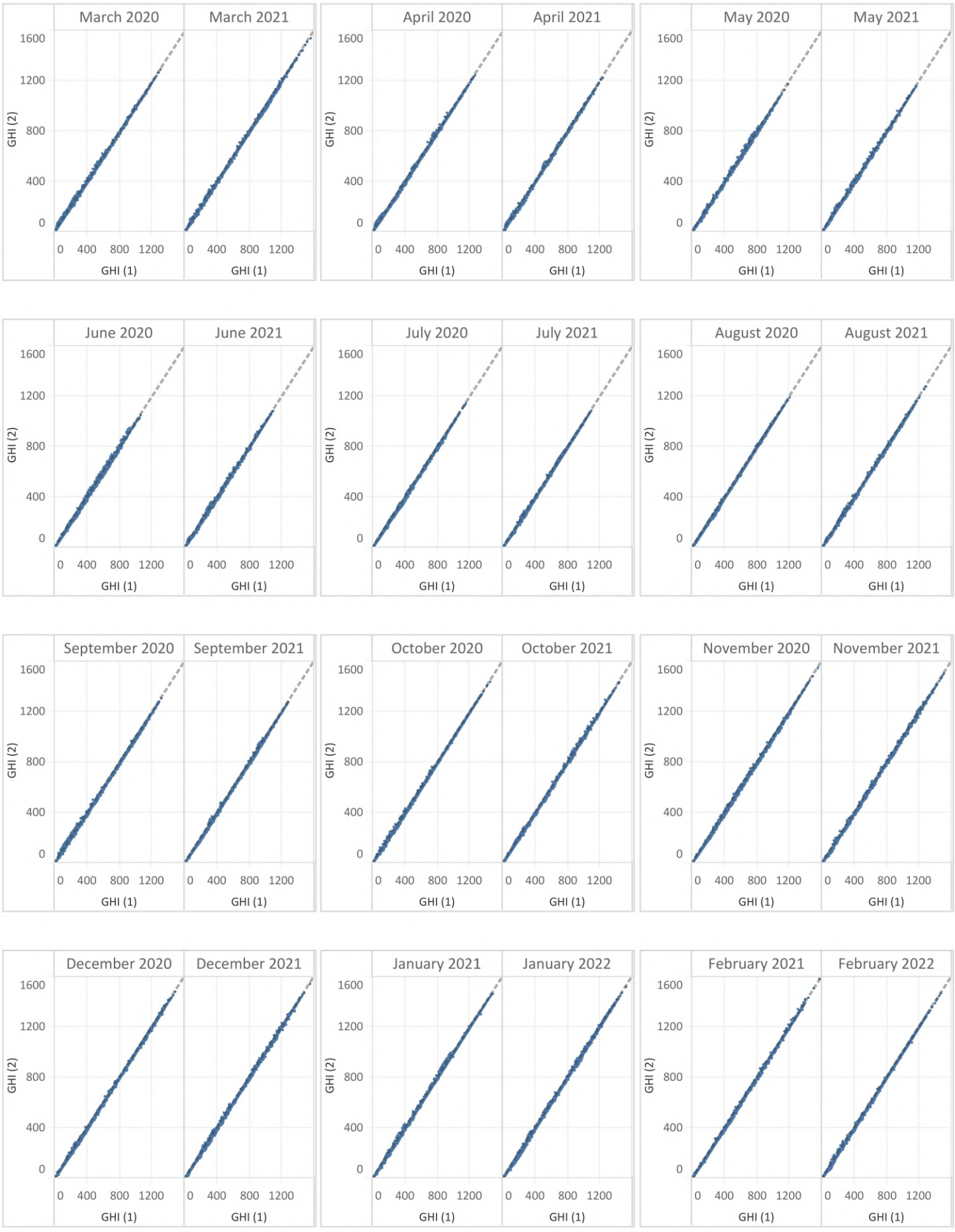

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

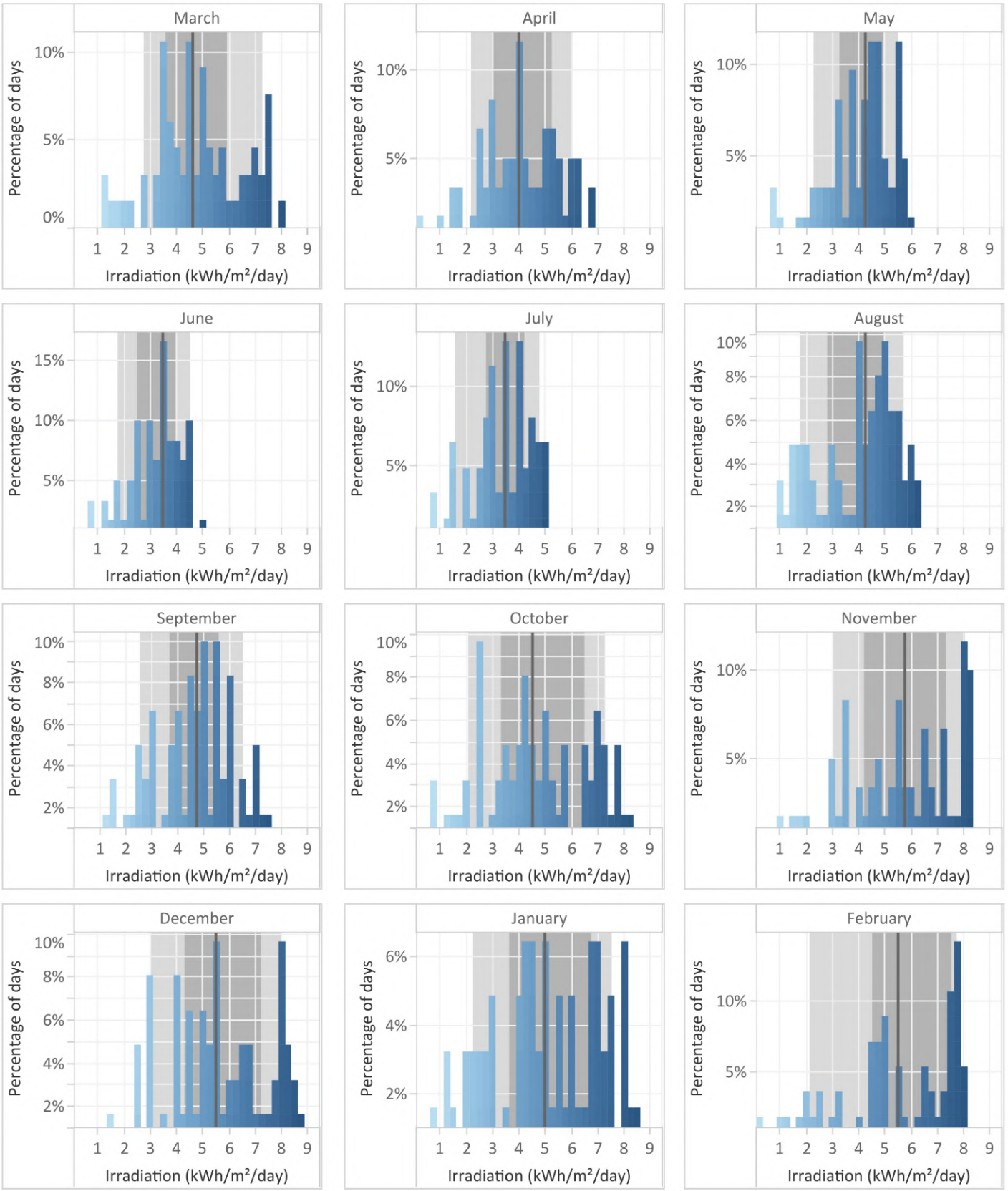

Figure 24: Daily summary of GHI (1)

6.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

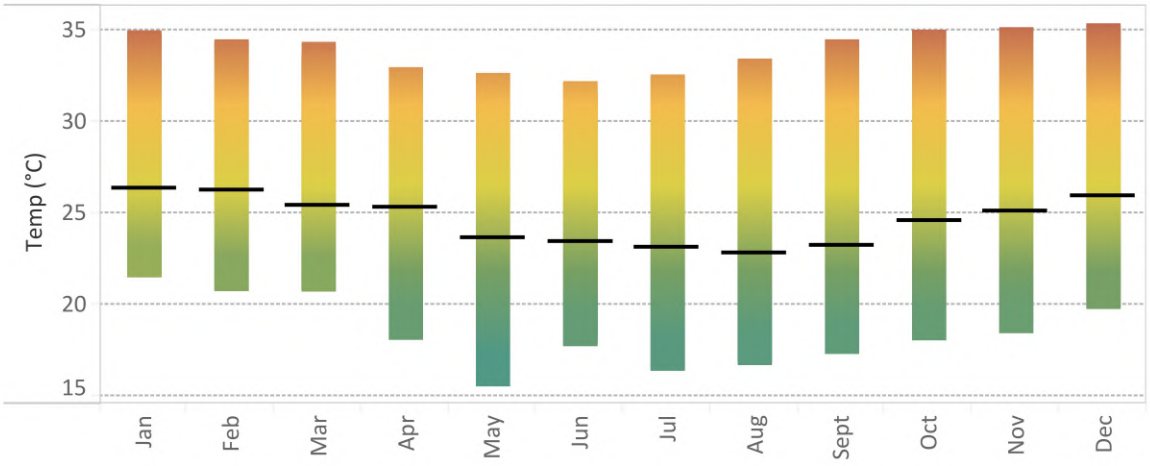

Figure 25: Monthly average, maximum and minimum temperature

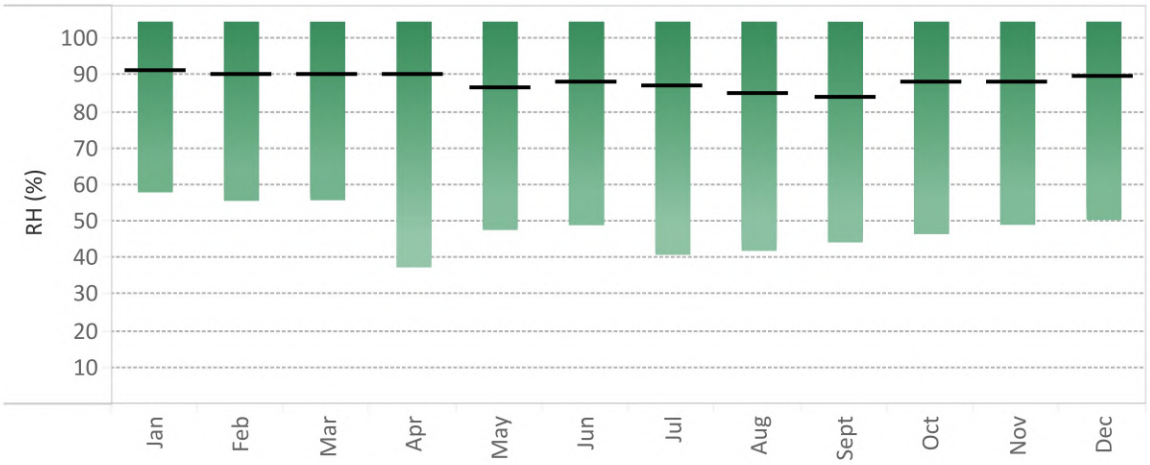

Figure 26: Monthly average, maximum and minimum relative humidity

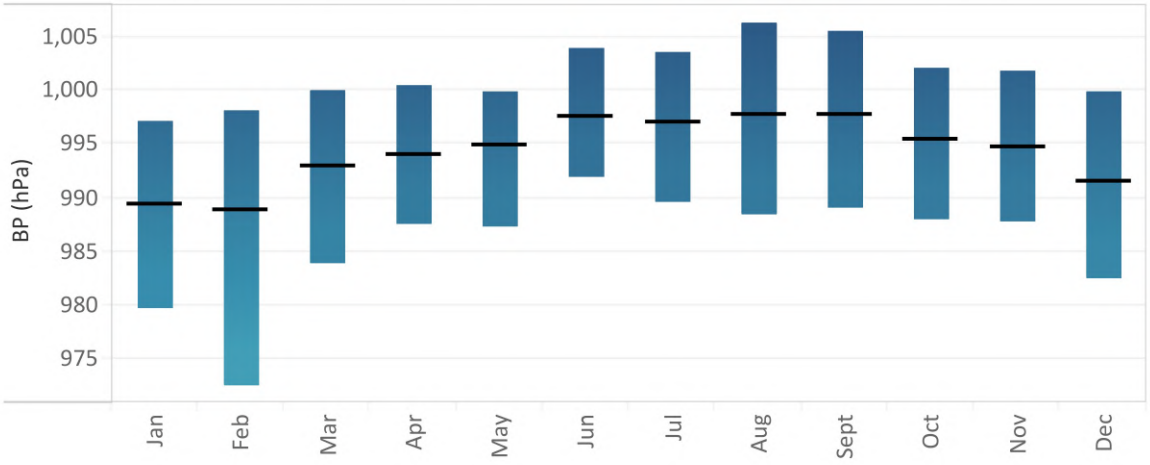

Figure 27: Monthly average, maximum and minimum barometric pressure

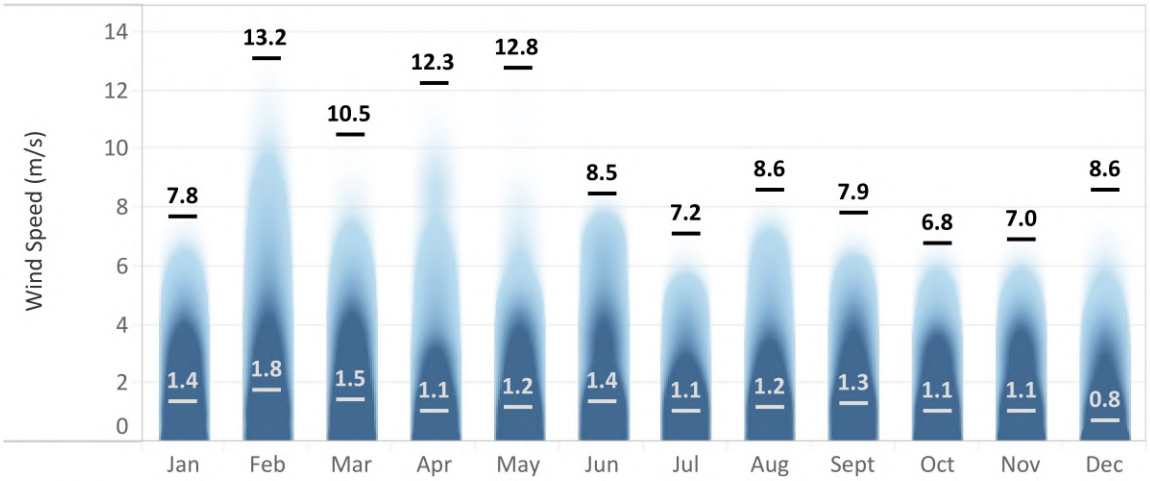

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

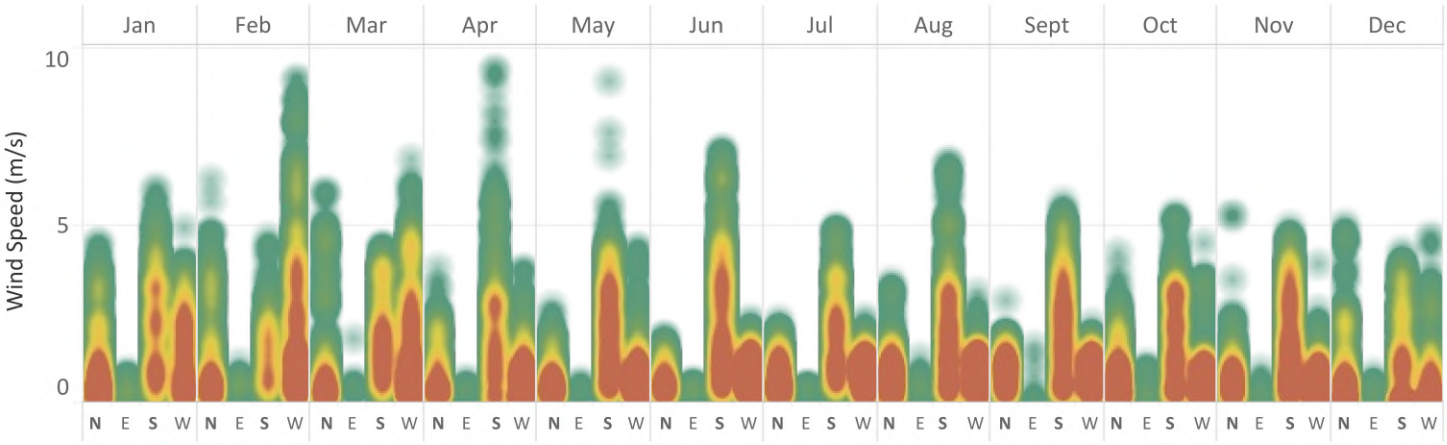

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

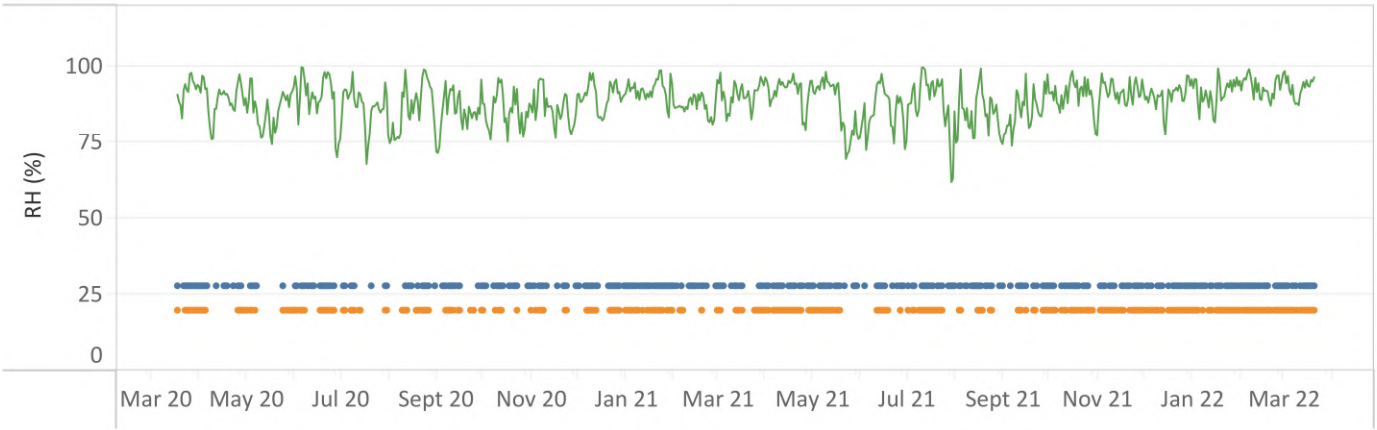

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

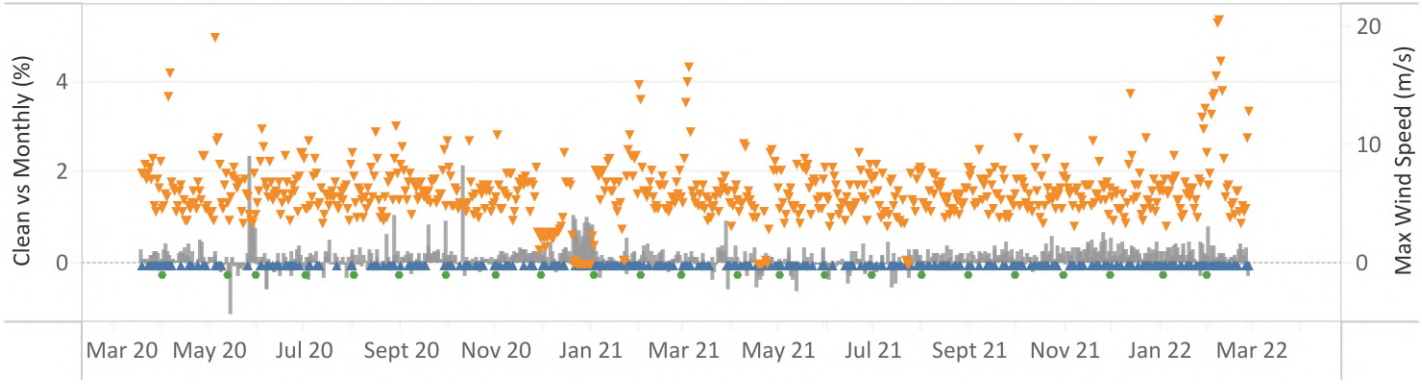

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

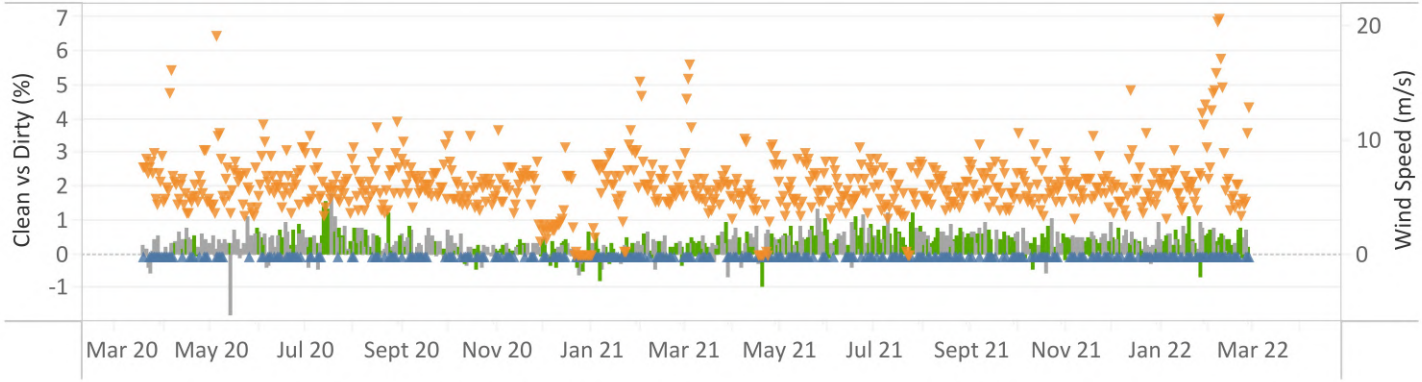

Figure 32: Soiling Measurement (Clean vs Dirty)

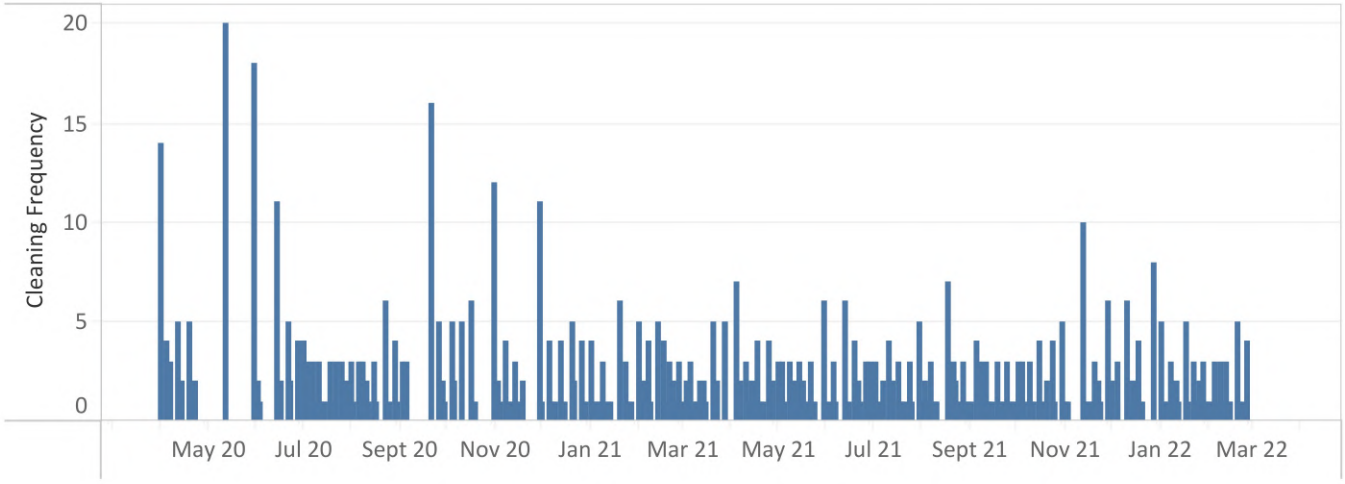

Figure 33: Consecutive days without cleaning

6.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

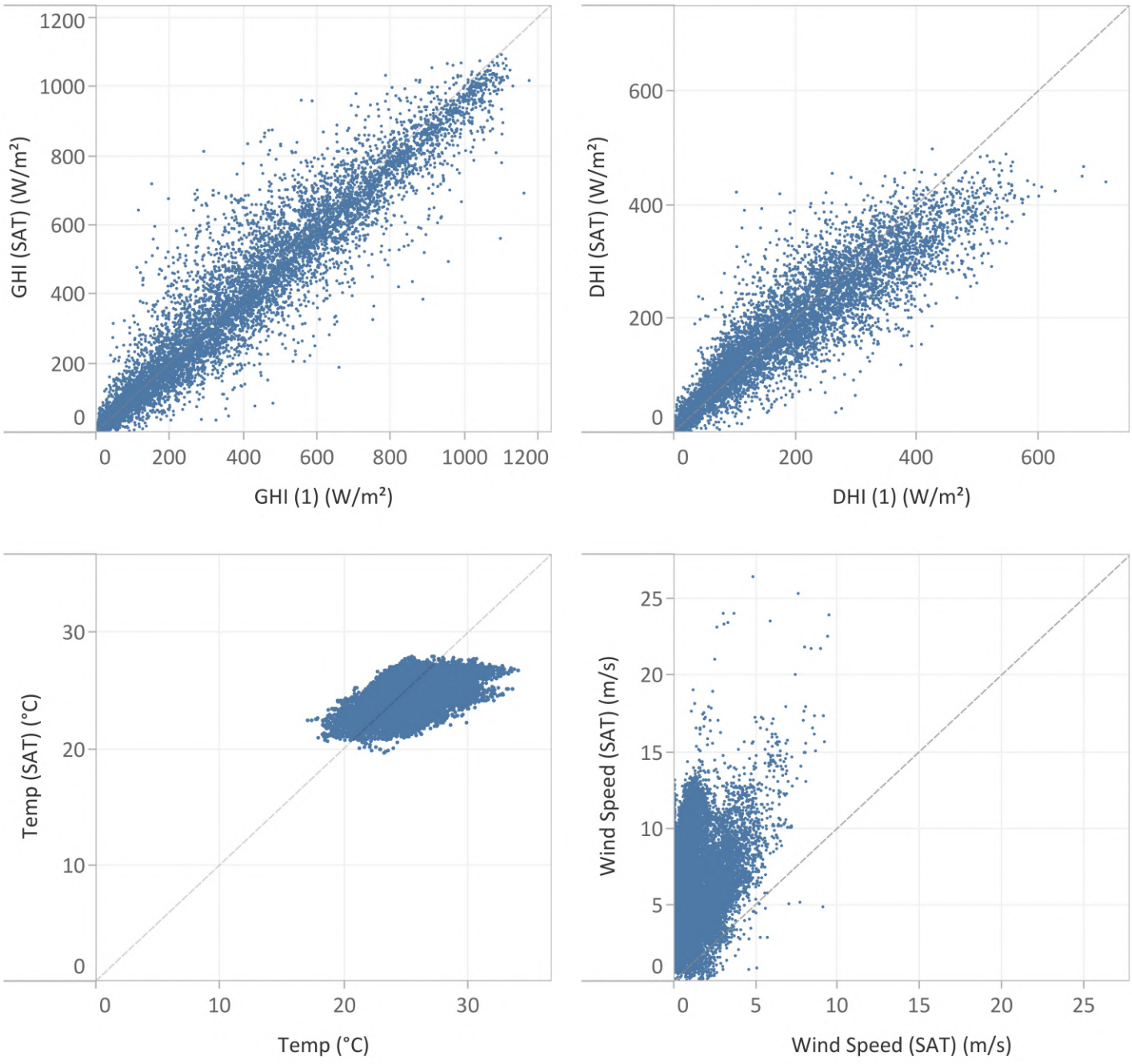

Figure 34: Ground measured data compared to satellite derived (Solargis) data

6.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.87%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

March 2020	The barometric pressure sensor as well as the SPN1 pyranometer (measuring DHI (1)) was found to be faulty and new instruments have been shipped to site.
April 2020	The barometric pressure sensor as well as the SPN1 pyranometer (measuring DHI (1)) was found to be faulty and new instruments have been shipped to site. GHI(1) measured slightly lower irradiation values in the early morning and late afternoon for a couple of minutes due to soiling on the instrument. This occurred during the following days:9 - 19 April 2020.
May 2020	The barometric pressure sensor as well as the SPN1 pyranometer (measuring DHI (1)) was found to be faulty and new instruments have been shipped to site. GHI(1) measured slightly lower irradiation values in the early morning and late afternoon for a couple of minutes due to soiling on the instrument. This occurred during the following days: 27 and 31 May 2020.
June 2020	Water residue affected early morning irradiation measurements on the following day:24 June 2020. The SPN1 pyranometer (measuring DHI(1)) as well as the barometric pressure sensor were found to be faulty and new instruments were installed on 1 June and 16 June 2020 respectively.
July 2020	Water residue affected early morning irradiation measurements on the following day:16 July 2020.
August 2020	A site visit was conducted on 13 August 2020. The data durin gthe site visit was affected and removed for the following timestamp:14:04 until 14:10.
September 2020	Water residue affected early morning irradiation measurements on the following day:10 September 2020.

October 2020	A site visit was conducted on 19 October 2020. The data during the site visit was affected and removed.Water residue affected early morning irradiation measurements on the following days:11 and 26 October 2020.
December 2020	The anemometer is suspected of measuring inaccurate wind speeds from 21 December 2020. A site visit on 5 January 2021 found that a spider's web was hindering the movement of the anemometer, the instrument was cleaned and all affecteddata has been removed.
January 2021	The anemometer is suspected of measuring inaccurate wind speeds from 21 December 2020. A site visit on 5 January 2021 found that a spider's web was hindering the movement of the anemometer, the instrument was cleaned and all affecteddata has been removed.
February 2021	Water residue affected early morning irradiation measurements on the following day:9 February 2021.
March 2021	Water residue affected early morning irradiation measurements on the following days:13, 16, 19 and 31 March 2021. A site visit was conducted on 30 March 2021, data during the site visit was affected and removed.
April 2021	Water residue affected early morning irradiation measurements on the following days:19 and 21 April 2021. The anemometer is suspected of recording faulty wind speed values from 18 until 23 April 2021. The affected data was removed.
May 2021	Water residue affected early morning irradiation measurements on the following days:3, 15, 18 and 24 May 2021.
June 2021	Water residue affected early morning irradiation measurements on the following days:15, 16, 17, 18, 27 and 29 June 2021.
July 2021	Water residue affected early morning irradiation measurements on the following days:17 and 26 July 2021. The anemometer is suspected of measuring inaccurate wind speed values from 22 July until 26 July 2021, a spider's web was hindering the movement of the anemometer and was cleaned on 26 July 2021.
August 2021	Water residue affected early morning irradiation measurements on the following days:3, 14 and 27 August 2021.
September 2021	Water residue affected early morning irradiation measurements on the following days:15 and 16 September 2021.

November 2021	Water residue affected early morning irradiation measurements on the following days:12, 13, 14 and 28 November 2021. The barometric pressure sensor was suspected of measuring inaccurate values from 23 November 2021. All affected data during this period was removed.
December 2021	Water residue affected early morning irradiation measurements on the following days:1 and 19 December 2021. The barometric pressure sensor was suspected of measuring inaccurate values from 23 November 2021 until 1 December 2021.All affected data during this period was removed.
January 2022	Water residue affected early morning irradiation measurements on the following day:27 January 2022.
February 2022	Water residue affected early morning irradiation measurements on the following days:4, 14, 16 and 21 February 2022.
March 2022	Water residue affected early morning irradiation measurements on the following day:12 March 2022.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	98.59	98.59	0.00	99.99	100.00	100.00	100.00	100.00	0.00	100.00	100.00
	Apr	99.62	99.62	0.00	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00
	May	98.87	98.87	0.00	100.00	100.00	100.00	100.00	100.00	0.00	100.00	100.00
	Jun	98.64	98.64	97.36	100.00	100.00	100.00	100.00	100.00	48.59	100.00	100.00
	Jul	99.49	99.49	99.98	99.99	99.99	99.99	99.99	99.99	99.99	99.98	99.98
	Aug	99.89	99.89	99.97	99.98	99.98	99.98	99.98	99.98	99.98	99.97	99.97
	Sept	98.78	98.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.48	99.48	99.96	99.98	99.98	99.98	99.98	99.98	99.98	99.96	99.96
	Nov	99.48	99.48	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.42	99.42	100.00	100.00	100.00	100.00	64.77	100.00	100.00	100.00	100.00
2021	Jan	99.27	99.27	100.00	100.00	100.00	100.00	85.03	100.00	100.00	100.00	100.00
	Feb	99.50	99.50	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.25	99.25	99.90	99.95	99.95	99.95	99.95	99.95	99.95	99.90	99.90
	Apr	99.32	99.32	100.00	100.00	100.00	100.00	82.10	100.00	100.00	100.00	100.00
	May	99.32	99.32	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.13	99.13	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.55	99.55	100.00	100.00	100.00	100.00	88.01	100.00	100.00	100.00	100.00
	Aug	99.58	99.58	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	98.76	98.76	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.61	99.61	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	98.92	98.92	99.96	99.98	99.98	99.98	99.98	99.98	74.70	99.96	99.96
	Dec	98.88	98.88	99.96	99.98	99.98	99.98	99.98	99.98	98.85	99.96	99.96
2022	Jan	99.62	99.62	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.37	99.37	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.46	99.46	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total		99.29	99.29	90.54	99.99	99.99	99.99	96.64	99.99	86.87	99.99	99.99

7. Solomon Islands

7.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020	61	183
April 2020	58	169
May 2020	56	160
June 2020	51	148
July 2020	60	135
August 2020	57	154
September 2020	62	160
October 2020	60	183
November 2020	68	167
December 2020	68	187
January 2021	73	183
February 2021	71	123
Total (kWh/m²/year)	746	1951

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	73	180
April 2021	57	154
May 2021	57	152
June 2021	54	144
July 2021	52	154
August 2021	60	157
September 2021	63	178
October 2021	62	189
November 2021	57	184
December 2021	77	151
January 2022	83	160
February 2022	78	150
March 2022	63	185
Total (kWh/m²/year)	836	2138

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	23	21	12	3	1	1	2	3	3	2	4	13
6 pm	133	123	110	77	55	66	76	84	83	68	85	98
5 pm	290	251	249	226	197	236	232	249	258	193	219	211
4 pm	452	345	433	394	361	395	402	410	432	369	356	325
3 pm	575	511	639	587	548	567	543	587	610	576	509	487
2 pm	736	670	829	732	694	679	629	688	736	762	718	653
1 pm	803	730	863	792	766	706	687	726	786	866	828	773
12 pm	765	708	823	778	726	686	672	688	790	866	849	805
11 am	657	591	764	689	646	625	575	605	722	794	769	744
10 am	512	452	583	557	516	478	447	500	606	659	653	608
9 am	348	302	363	361	340	298	280	317	400	482	486	431
8 am	175	137	156	157	147	118	101	124	187	275	291	247
7 am	32	16	17	17	15	8	5	10	30	70	88	67
6 am										0	1	0

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	23	21	12	4	1	1	3	4	3	3	5	14
6 pm	94	98	79	63	43	48	55	60	57	53	60	80
5 pm	169	180	140	134	105	117	116	132	123	114	130	142
4 pm	226	247	204	190	168	168	177	190	177	159	184	198
3 pm	259	320	262	236	218	204	217	229	234	216	208	253
2 pm	291	334	275	238	223	232	239	252	267	252	242	274
1 pm	322	335	282	237	247	250	249	242	258	245	250	270
12 pm	305	336	261	222	244	229	235	215	266	245	251	276
11 am	292	300	240	217	210	176	210	216	266	242	266	274
10 am	240	241	203	172	173	154	157	166	208	181	223	240
9 am	169	157	129	127	121	107	106	116	140	132	139	166
8 am	98	78	67	66	63	54	48	58	74	85	92	111
7 am	24	13	12	11	10	6	4	7	19	33	39	41
6 am										0	1	0

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	26	26	26	26	26	25	25	25	25	25	25	26
10 pm	26	26	26	26	26	25	25	25	26	26	26	26
9 pm	27	27	26	26	27	26	26	26	26	26	26	27
8 pm	28	27	27	27	27	26	27	27	27	27	27	27
7 pm	29	28	28	28	28	28	28	28	28	28	28	28
6 pm	30	29	29	29	29	29	29	29	29	29	29	29
5 pm	31	30	30	30	30	31	30	30	30	30	30	30
4 pm	31	30	31	31	31	31	31	31	31	31	31	31
3 pm	32	31	31	31	32	32	31	31	31	32	31	31
2 pm	32	31	32	31	32	32	31	31	31	32	32	32
1 pm	32	31	31	31	32	31	31	31	31	32	32	32
12 pm	31	30	31	31	31	31	31	31	31	32	32	31
11 am	30	30	31	30	30	30	30	30	30	31	31	31
10 am	29	29	29	29	29	29	28	28	29	30	30	30
9 am	28	27	28	28	28	27	27	27	28	29	29	29
8 am	26	26	26	26	26	25	24	25	25	26	27	27
7 am	25	25	24	24	24	23	23	23	23	24	24	25
6 am	24	25	24	24	24	23	23	23	23	23	23	24
5 am	25	25	24	24	24	23	23	23	23	24	24	24
4 am	25	25	24	24	24	24	23	23	24	24	24	25
3 am	25	25	25	24	24	24	24	24	24	24	24	25
2 am	25	25	25	25	25	24	24	24	24	24	24	25
1 am	25	25	25	25	25	24	24	24	24	25	25	25
12 am	26	26	25	25	25	24	25	25	25	25	25	26

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	88	92	92	92	90	89	89	89	89	90	88	90
10 pm	87	90	91	90	89	88	88	87	87	88	87	89
9 pm	85	89	90	89	87	86	86	85	85	86	85	87
8 pm	82	87	87	86	85	83	84	83	83	84	83	85
7 pm	79	85	84	83	81	80	81	80	80	81	80	83
6 pm	77	83	80	80	78	76	77	77	76	77	77	80
5 pm	76	82	78	78	75	73	75	75	74	75	75	79
4 pm	76	82	76	77	74	73	75	74	74	74	74	78
3 pm	76	82	76	76	74	73	75	74	74	73	74	78
2 pm	78	84	77	78	75	75	76	75	74	74	75	79
1 pm	81	86	79	80	77	77	78	77	76	75	77	81
12 pm	84	88	82	83	81	81	82	81	79	78	79	85
11 am	88	91	85	86	85	86	87	85	83	82	83	88
10 am	90	93	88	90	90	90	90	90	88	86	86	90
9 am	92	94	91	93	92	93	93	92	91	90	89	92
8 am	93	95	94	94	94	94	94	94	93	92	91	93
7 am	94	96	96	96	96	95	95	95	95	94	93	95
6 am	94	96	96	96	95	95	95	95	95	95	94	95
5 am	93	95	96	95	95	95	94	94	94	94	93	94
4 am	93	95	96	95	94	94	94	94	94	94	93	94
3 am	92	95	95	95	94	93	93	93	93	93	92	93
2 am	91	94	95	94	93	93	92	92	92	93	91	93
1 am	90	93	94	93	92	92	91	91	91	92	90	92
12 am	89	93	93	93	91	91	90	90	90	91	89	91

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	6.6	30.8	61.4	68.4	9.6	2.0	5.2	19.0	16.2	0.8	3.2	10.0
10 pm	10.8	48.6	29.4	15.2	5.2	3.0	0.6	17.4	13.0	3.0	0.0	18.8
9 pm	12.2	18.8	64.4	28.0	1.2	1.8	4.6	16.0	4.0	37.0	1.4	61.0
8 pm	13.4	19.8	79.6	23.4	2.8	2.2	0.8	8.0	18.0	3.2	1.2	19.0
7 pm	15.0	16.2	34.4	65.2	6.0	1.2	1.2	10.2	6.4	7.6	9.6	6.8
6 pm	16.0	35.2	11.8	27.8	16.2	2.6	1.6	7.4	2.2	0.6	4.0	35.6
5 pm	17.0	23.4	27.8	18.8	0.2	1.6	11.4	2.2	5.2	6.4	12.2	82.8
4 pm	35.8	42.4	46.4	36.0	2.2	0.0	10.6	6.4	8.2	29.2	11.6	54.0
3 pm	19.2	20.4	62.4	15.4	1.8	0.4	5.6	6.4	25.8	7.2	16.2	6.8
2 pm	17.4	19.8	47.2	5.6	1.6	0.0	1.2	12.6	27.2	17.6	12.8	4.0
1 pm	7.2	18.4	7.6	7.0	1.0	0.4	2.2	9.8	28.0	1.2	47.0	21.2
12 pm	8.4	7.0	38.0	10.4	0.2	1.4	0.4	12.4	24.8	2.6	17.2	47.2
11 am	13.4	20.8	6.8	9.8	3.4	1.8	2.8	16.6	12.6	3.0	13.8	13.2
10 am	12.4	14.6	8.8	5.4	0.6	0.6	1.4	0.8	1.8	4.2	21.4	39.4
9 am	15.4	35.8	5.0	6.2	3.2	5.0	1.0	3.4	5.0	0.8	15.2	81.6
8 am	17.4	10.2	4.8	30.4	3.6	1.6	3.6	0.8	3.8	0.0	29.0	8.0
7 am	9.0	29.8	10.6	36.6	2.0	1.6	4.0	10.8	4.6	2.6	0.4	3.4
6 am	5.4	23.4	25.2	26.8	49.6	5.0	4.6	20.6	5.4	1.2	1.6	11.4
5 am	10.8	23.2	25.6	3.4	20.6	3.6	9.4	7.6	27.2	9.8	8.6	20.0
4 am	35.8	44.2	32.4	30.6	2.6	0.8	23.8	2.2	28.8	10.6	22.2	18.6
3 am	19.6	35.8	20.0	25.2	6.0	2.4	16.4	2.0	23.0	12.8	7.0	7.8
2 am	29.0	46.0	29.8	24.4	21.8	0.2	39.2	7.2	39.0	10.4	1.0	3.6
1 am	13.6	20.4	23.0	23.6	21.4	0.8	0.8	6.6	3.2	0.6	1.2	14.4
12 am	19.8	43.0	11.4	13.0	4.2	1.4	0.8	35.0	4.6	0.6	5.8	10.8

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,010	1,010	1,012	1,012	1,013	1,014	1,013	1,014	1,013	1,013	1,012	1,011
10 pm	1,010	1,010	1,011	1,012	1,013	1,013	1,013	1,014	1,013	1,013	1,012	1,011
9 pm	1,010	1,010	1,011	1,012	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,010
8 pm	1,009	1,009	1,010	1,011	1,012	1,012	1,012	1,013	1,012	1,012	1,011	1,010
7 pm	1,009	1,008	1,009	1,010	1,011	1,012	1,011	1,012	1,011	1,011	1,011	1,009
6 pm	1,008	1,008	1,009	1,010	1,010	1,011	1,010	1,011	1,011	1,010	1,010	1,008
5 pm	1,007	1,007	1,008	1,009	1,010	1,011	1,010	1,011	1,010	1,010	1,010	1,008
4 pm	1,007	1,007	1,008	1,009	1,009	1,011	1,010	1,011	1,010	1,010	1,009	1,008
3 pm	1,008	1,007	1,008	1,009	1,010	1,011	1,010	1,011	1,010	1,010	1,010	1,008
2 pm	1,008	1,008	1,009	1,010	1,010	1,011	1,011	1,012	1,011	1,010	1,010	1,009
1 pm	1,009	1,009	1,010	1,010	1,011	1,012	1,012	1,012	1,012	1,011	1,011	1,009
12 pm	1,010	1,010	1,011	1,011	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,010
11 am	1,010	1,010	1,011	1,012	1,013	1,014	1,013	1,014	1,013	1,013	1,012	1,010
10 am	1,010	1,010	1,012	1,012	1,013	1,014	1,013	1,014	1,014	1,013	1,013	1,011
9 am	1,010	1,010	1,011	1,012	1,013	1,014	1,013	1,014	1,014	1,013	1,012	1,011
8 am	1,010	1,009	1,011	1,011	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,010
7 am	1,009	1,009	1,010	1,011	1,012	1,013	1,012	1,013	1,012	1,012	1,011	1,010
6 am	1,009	1,008	1,010	1,010	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,009
5 am	1,008	1,008	1,009	1,010	1,011	1,012	1,011	1,012	1,011	1,011	1,010	1,009
4 am	1,008	1,008	1,009	1,010	1,011	1,012	1,011	1,012	1,011	1,010	1,010	1,008
3 am	1,008	1,008	1,010	1,010	1,011	1,012	1,011	1,012	1,012	1,011	1,010	1,009
2 am	1,009	1,009	1,010	1,011	1,012	1,013	1,012	1,013	1,012	1,011	1,011	1,009
1 am	1,010	1,010	1,011	1,011	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,010
12 am	1,010	1,010	1,011	1,012	1,012	1,013	1,013	1,014	1,013	1,012	1,012	1,011

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	0.2	0.4	0.1	0.3	0.1	0.0	0.2	0.3	0.3	0.1	0.1	0.2
10 pm	0.4	0.5	0.2	0.2	0.2	0.1	0.2	0.4	0.3	0.2	0.2	0.2
9 pm	0.3	0.6	0.2	0.3	0.3	0.2	0.3	0.5	0.5	0.2	0.2	0.3
8 pm	0.4	0.5	0.3	0.4	0.3	0.3	0.5	0.6	0.8	0.2	0.3	0.3
7 pm	0.8	1.0	0.4	0.5	0.5	0.4	0.8	0.9	1.1	0.4	0.6	0.4
6 pm	1.5	1.7	0.8	0.9	0.9	1.3	1.4	1.5	1.8	1.0	1.1	1.0
5 pm	2.1	2.0	1.4	1.4	1.6	2.1	2.1	2.1	2.4	1.7	1.6	1.5
4 pm	2.4	2.2	1.8	2.0	2.1	2.5	2.6	2.7	2.9	2.3	2.0	1.8
3 pm	2.7	2.4	2.1	2.3	2.6	2.8	2.9	3.0	3.2	2.8	2.5	2.1
2 pm	2.8	2.6	2.3	2.5	2.8	2.9	3.1	3.2	3.4	3.1	2.9	2.4
1 pm	2.6	2.6	2.2	2.5	2.7	2.8	3.0	3.0	3.5	3.1	2.9	2.4
12 pm	2.3	2.3	2.1	2.3	2.4	2.5	2.7	2.6	3.2	2.8	2.7	2.4
11 am	1.9	2.0	1.8	1.7	1.9	2.0	2.2	2.3	2.9	2.4	2.4	2.0
10 am	1.4	1.4	1.0	1.2	1.4	1.3	1.5	1.6	2.3	1.8	1.9	1.4
9 am	0.9	0.8	0.5	0.7	0.7	0.6	0.7	0.8	1.1	1.1	1.1	0.8
8 am	0.5	0.3	0.2	0.4	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.4
7 am	0.2	0.2	0.1	0.2	0.1	0.0	0.1	0.2	0.1	0.2	0.2	0.1
6 am	0.2	0.3	0.1	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
5 am	0.3	0.3	0.1	0.3	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4 am	0.3	0.3	0.2	0.2	0.1	0.0	0.2	0.1	0.1	0.1	0.1	0.1
3 am	0.3	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2 am	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1
1 am	0.3	0.4	0.2	0.2	0.1	0.0	0.2	0.2	0.2	0.1	0.1	0.1
12 am	0.3	0.3	0.1	0.2	0.1	0.0	0.2	0.3	0.2	0.1	0.1	0.1

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	S	S	S	S	SE	S	SE	SE	SE	S	S	S
10 pm	S	W	S	S	SE	SE	SE	S	SE	S	S	S
9 pm	SW	W	S	S	SE	SE	SE	SE	SE	SE	S	S
8 pm	W	W	S	S	SE	SE	E	E	E	S	S	SE
7 pm	W NW	W	SE	SE S	E	E	E	E	E	S	E	S
6 pm	NW	NW	NW	NE	E	E	E	E	E	S E	E	NW NE
5 pm	NW	W NW	N	NE	E	E	E	E	E	NE	NE	NW
4 pm	N	NW	N	NE	NE	NE	E	E	E	NE	NE	NW
3 pm	NW	NW	N	NE	NE	NE	E	NE	NE	NE	NE	N
2 pm	NW	NW	N	NE	NE	NE	E	NE	NE	NE	NE	NW N
1 pm	NW	NW	N	NE	NE	NE	E	NE	E	NE	NE	N
12 pm	NW	NW	NE	NE	NE	E	E	E	E	NE	NE	NE
11 am	NW	NW	NE	NE	E	E	E	E	E	NE	NE	NE
10 am	W	W	E	E	E	SE	SE	E	E	E	E	NE
9 am	S	SW	S	S	S	S	SE	SE	SE	SE	SE	SE
8 am	S	S	S	S	S	S	S	S	S	S	S	S
7 am	S	S	S	S	S	S	S	SE S	S	S	S	S
6 am	S	S	S	S	S	S	SE	S	S	S	S	S
5 am	S	S	S	S	S	S	S	S	SE	S	S	S
4 am	S	S	S	S	S	S	SE	S	S	S	S	S
3 am	S	S	S	S	S	S	SE	S	S	S	S	S
2 am	S	S	S	S	S	S	S	S	S	S	S	S
1 am	S	S	S	S	S	S	S	SE	S	S	S	S
12 am	S	S	S	S	S	S	SE	S	S	S	S	S

Figure 9: Dominant hourly Wind Direction

7.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

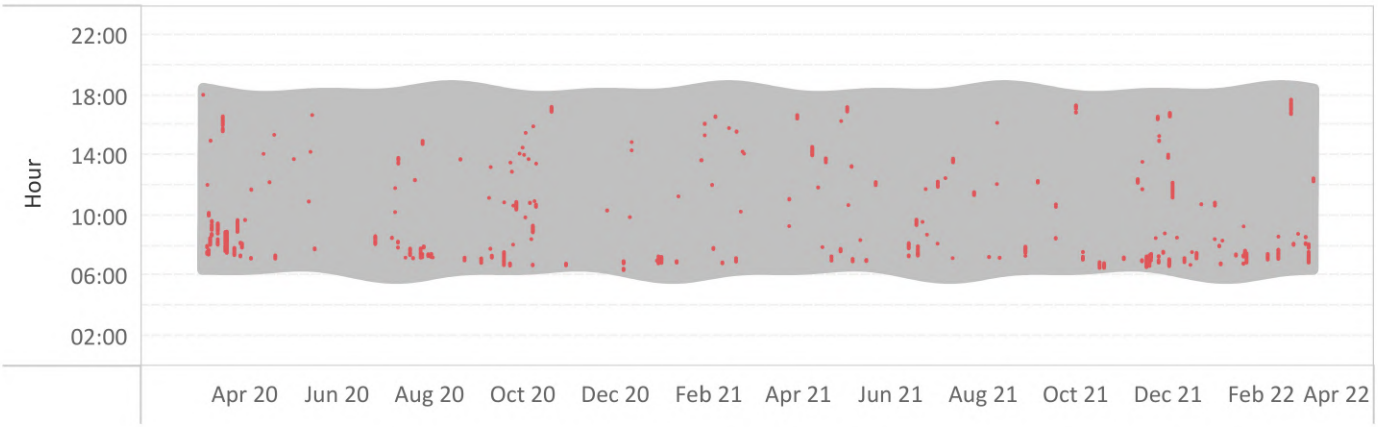

Figure 10: Quality control for GHI (1)

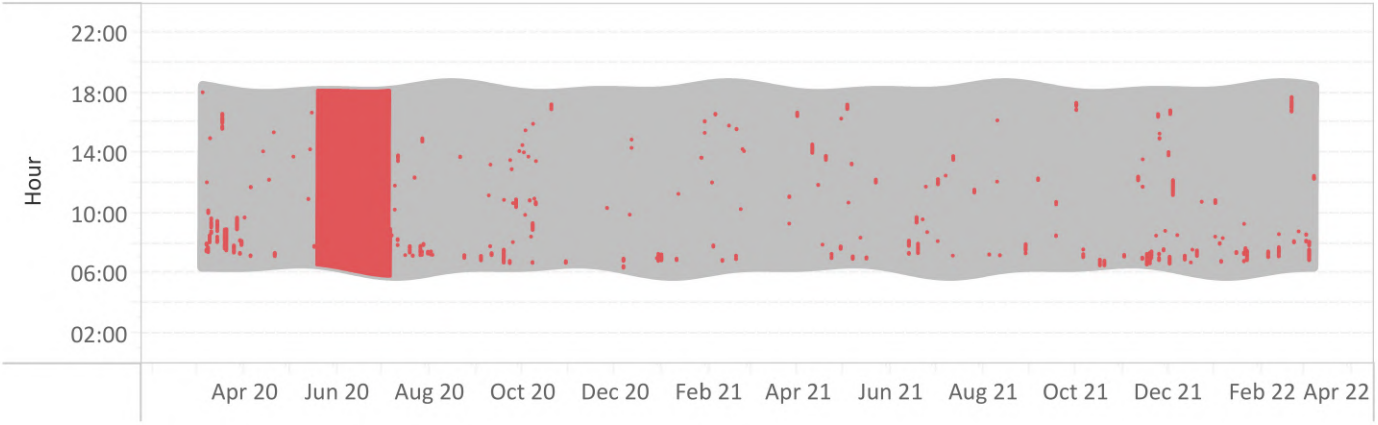

Figure 11: Quality control for GHI (2)

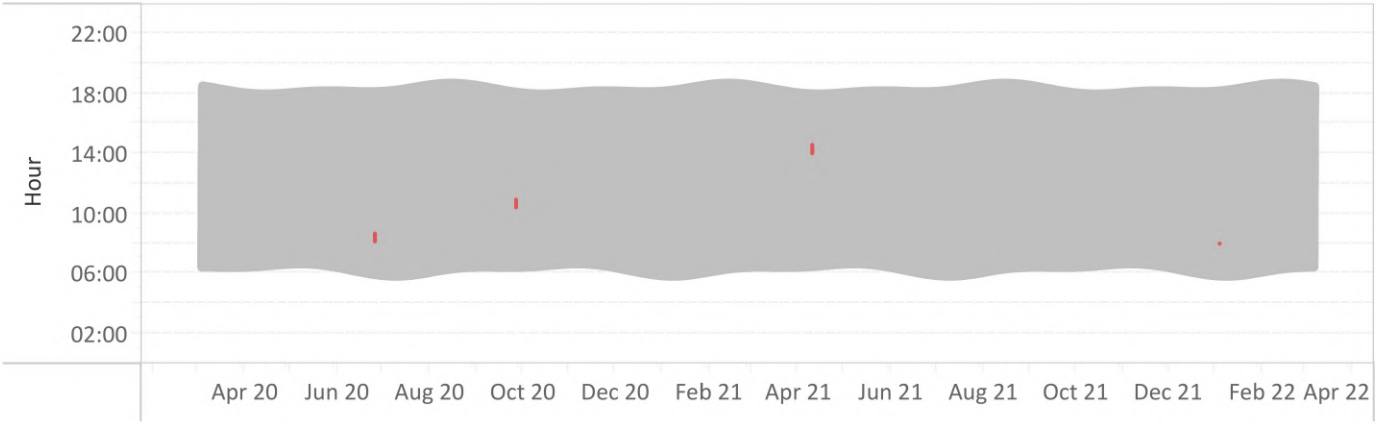

Figure 12: Quality control for DHI (1)

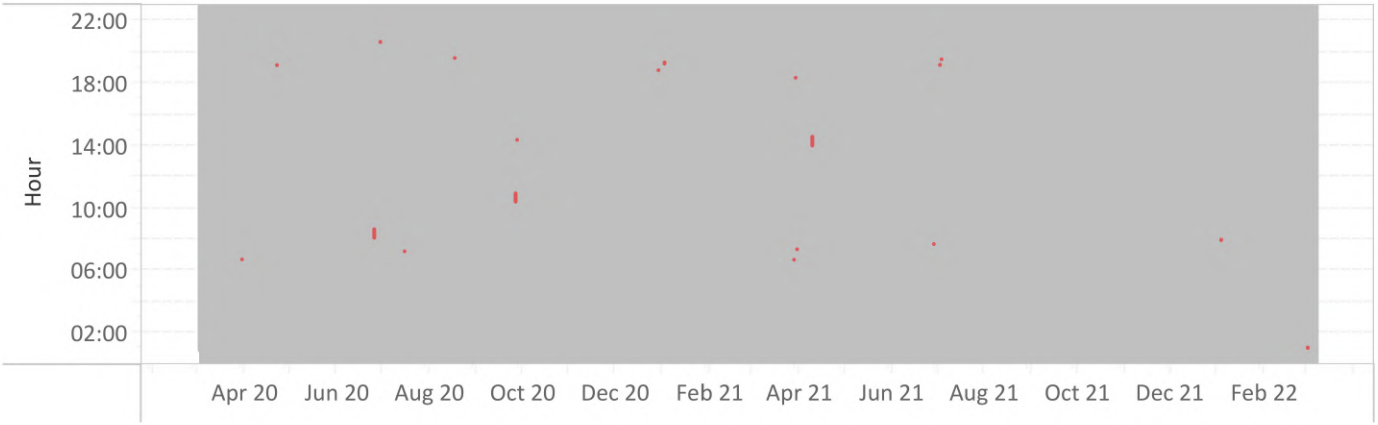

Figure 13: Quality Control for Temp

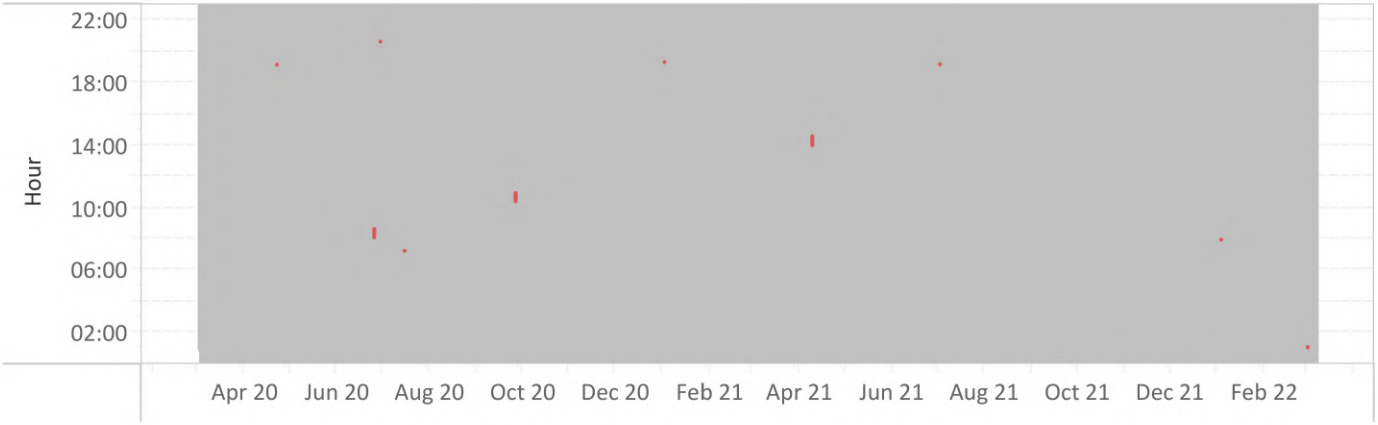

Figure 14: Quality Control for RH

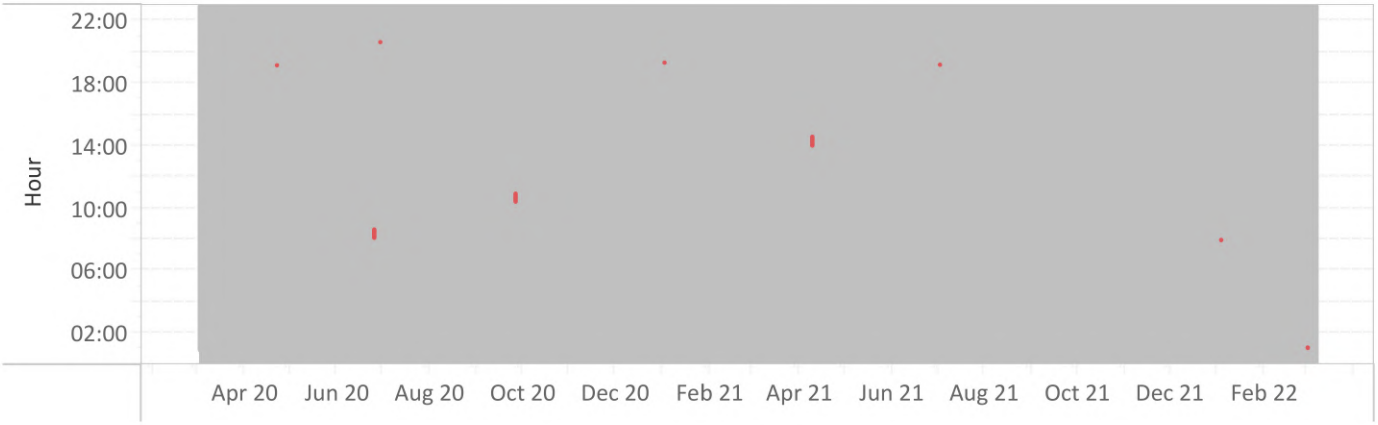

Figure 15: Quality Control for Rain

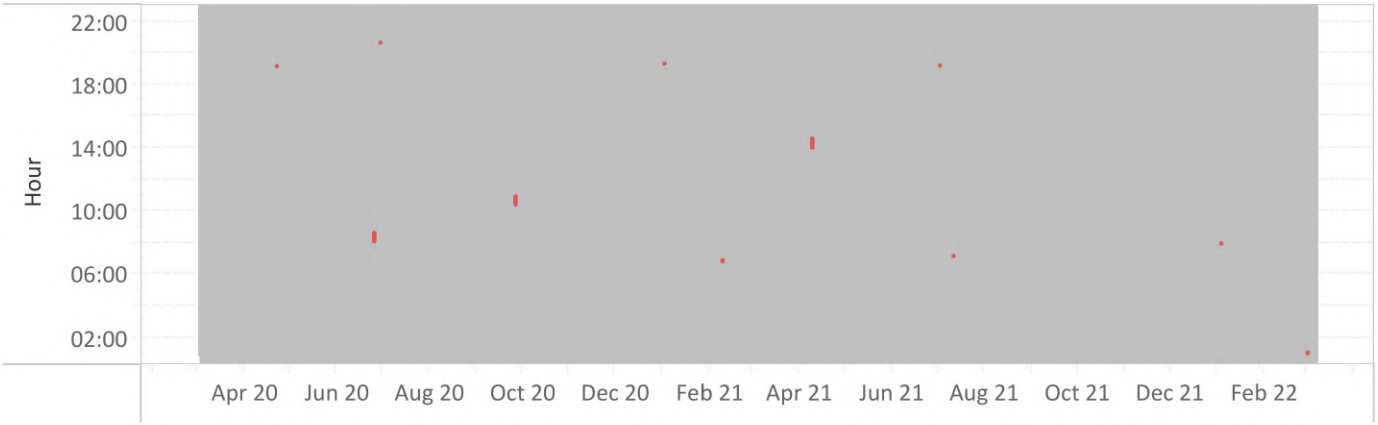

Figure 16: Quality Control for BP

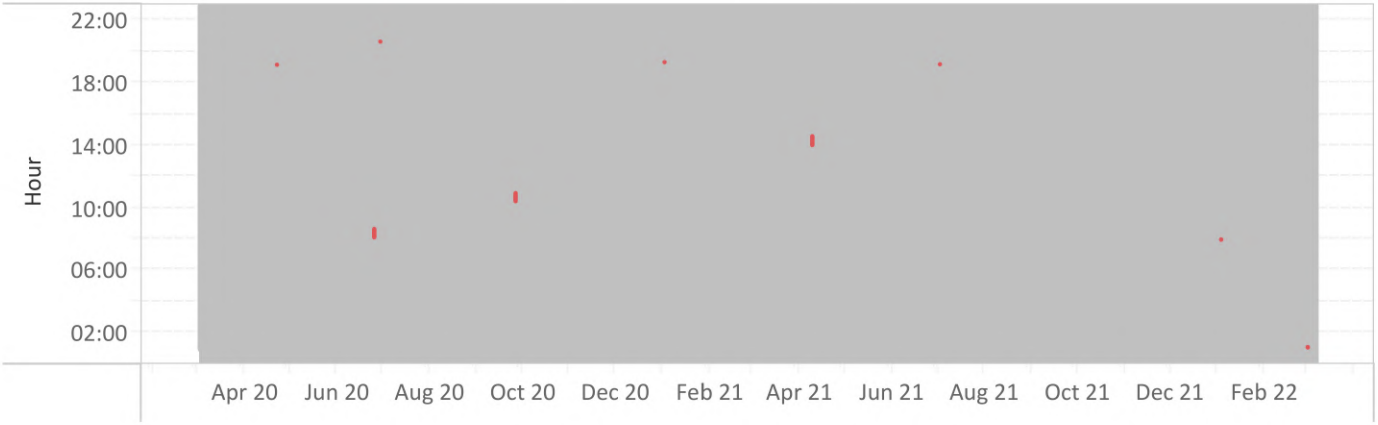

Figure 17: Quality Control for Wind Direction

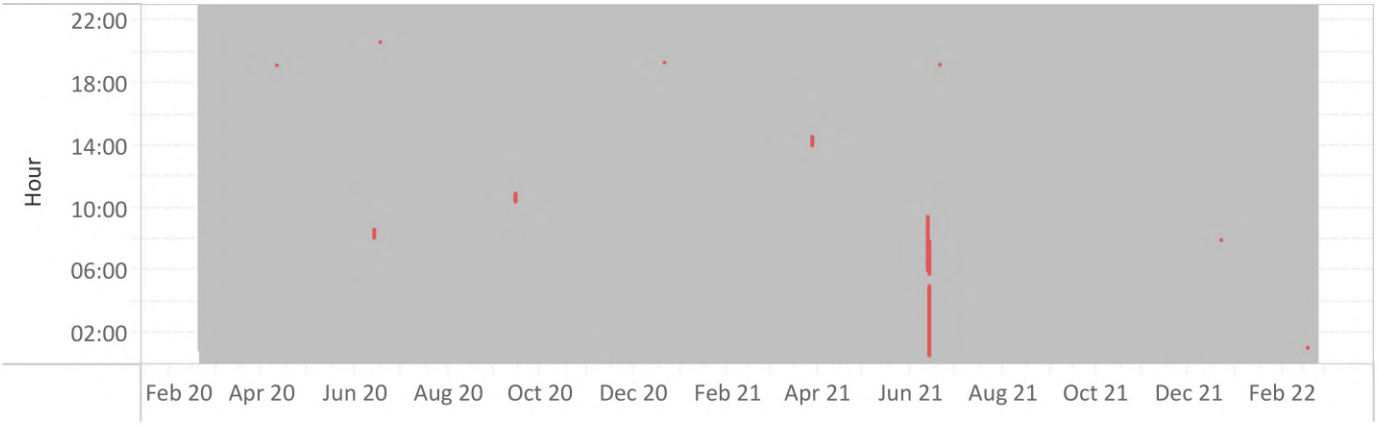

Figure 18: Quality Control for Wind Speed

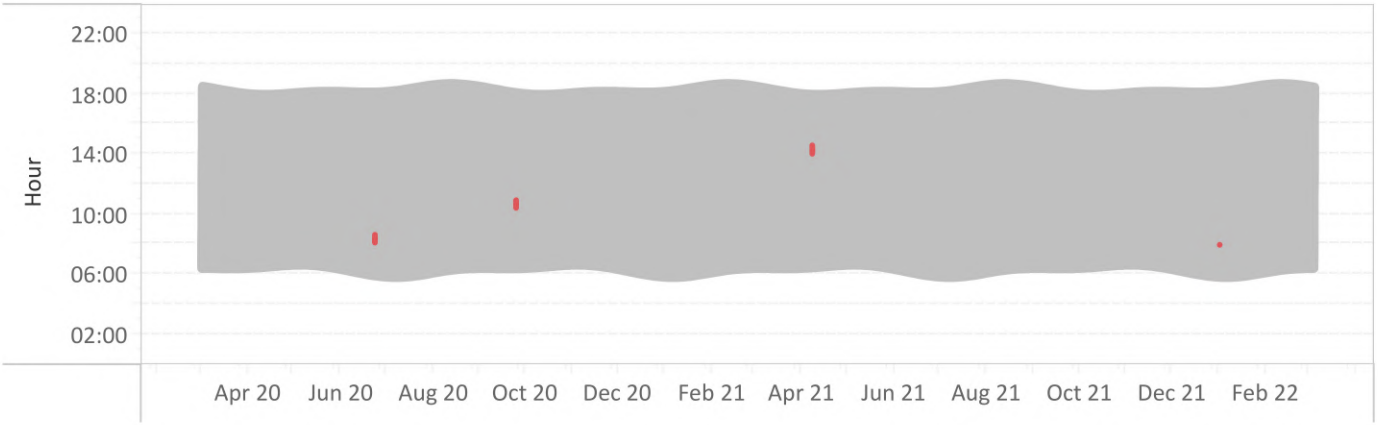

Figure 19: Quality control for soiling measurement (monthly cleaned)

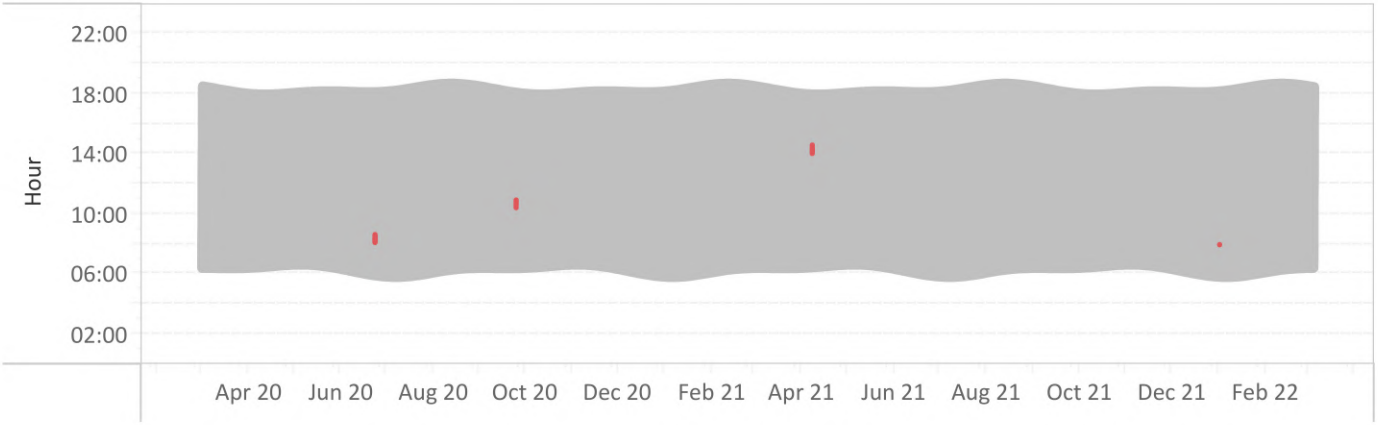

Figure 20: Quality control for soiling measurement (continuous soiling)

7.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

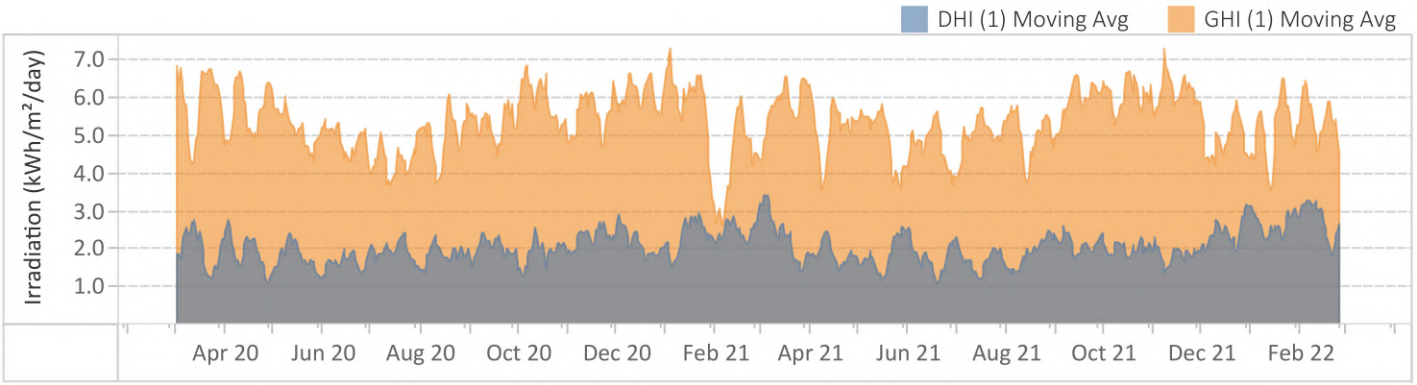

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

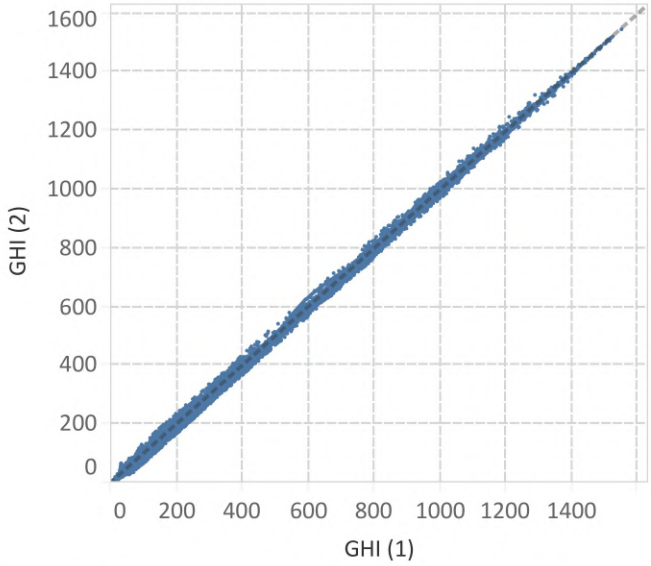

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

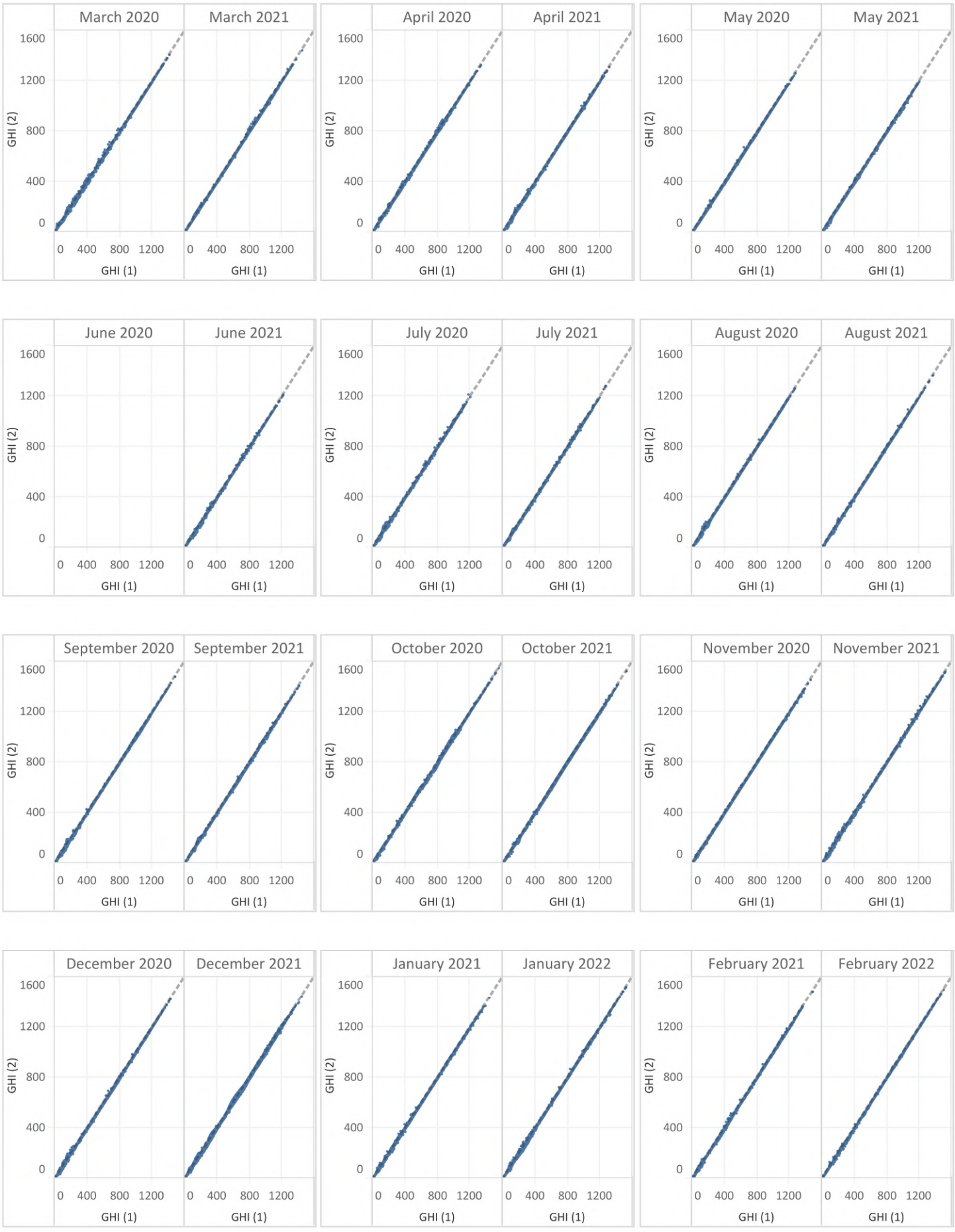

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

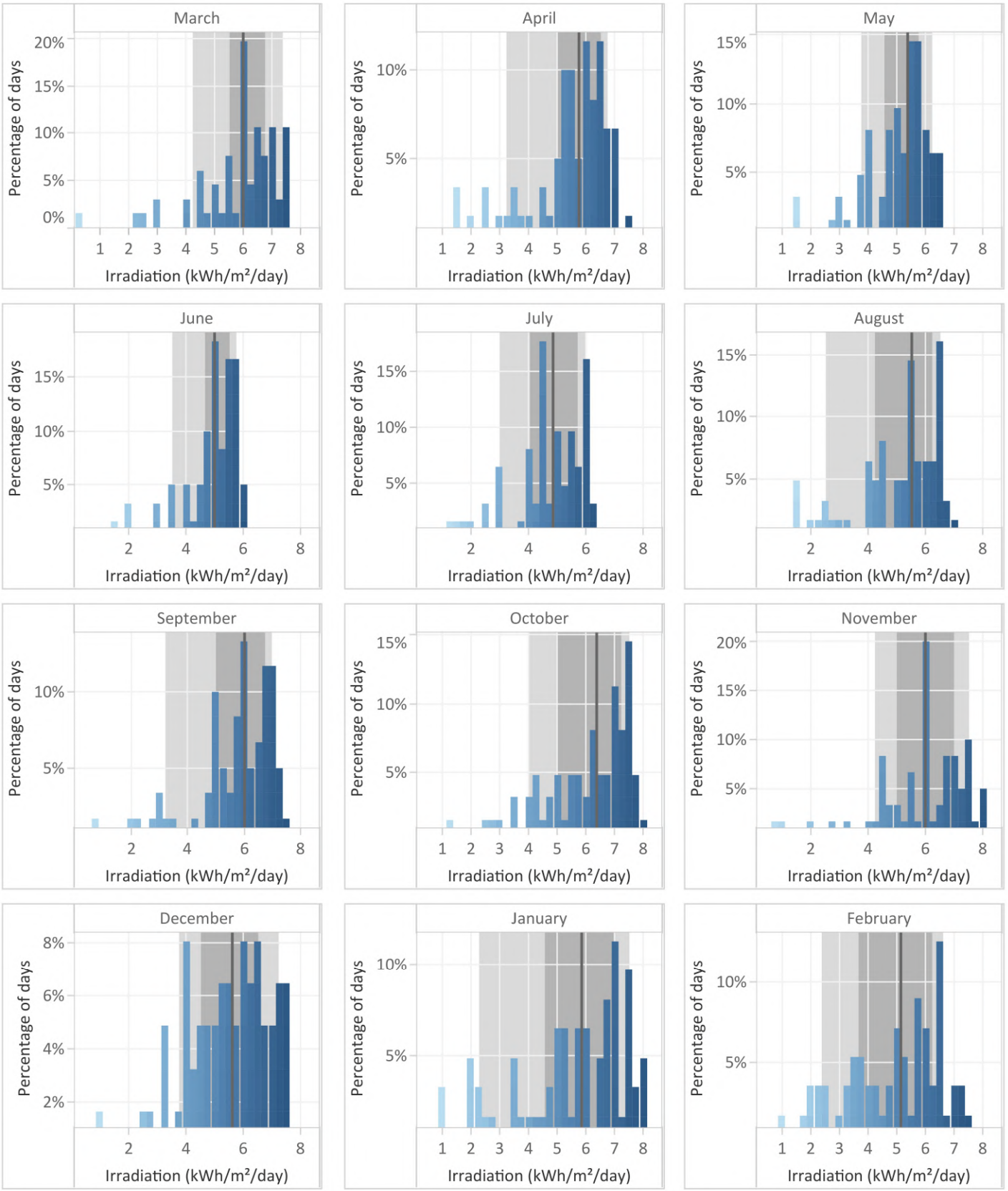

Figure 24: Daily summary of GHI (1)

7.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

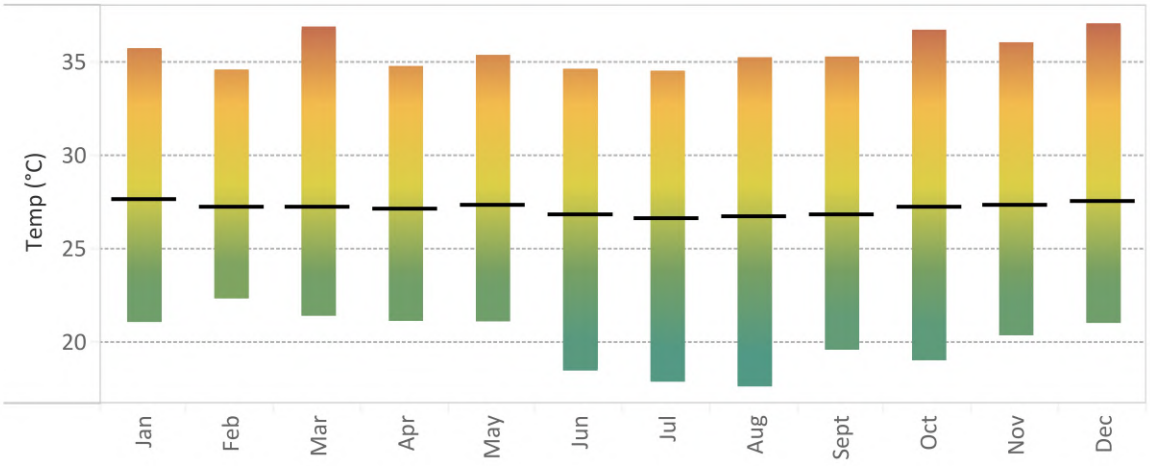

Figure 25: Monthly average, maximum and minimum temperature

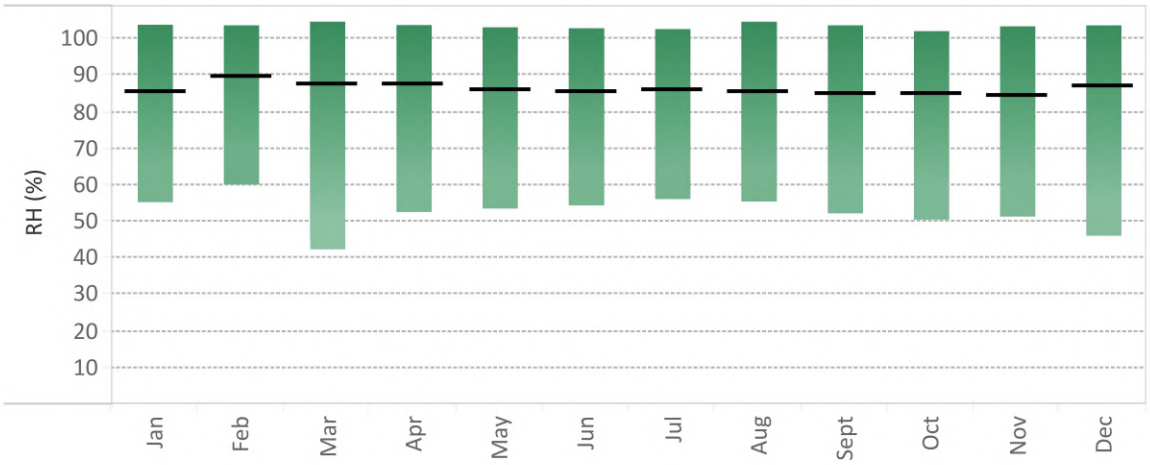

Figure 26: Monthly average, maximum and minimum relative humidity

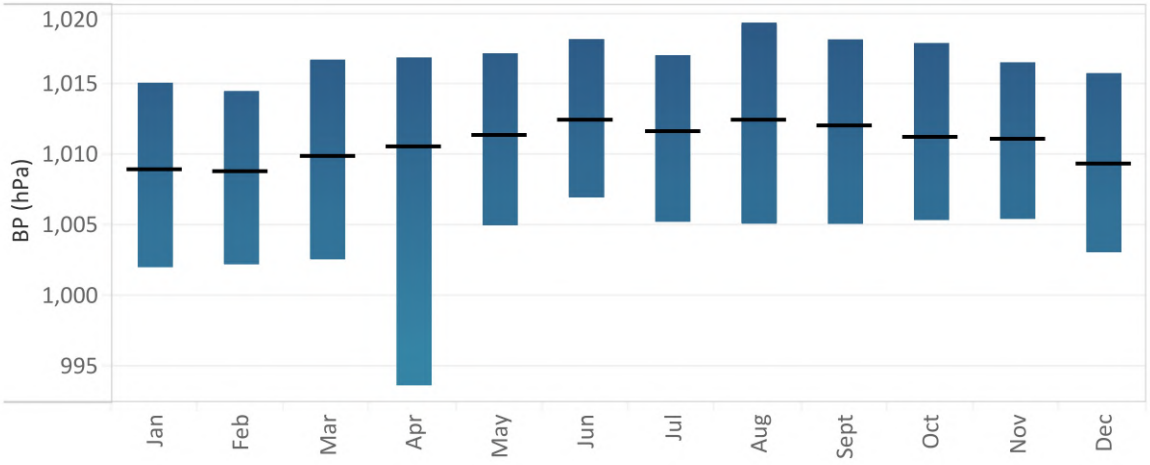

Figure 27: Monthly average, maximum and minimum barometric pressure

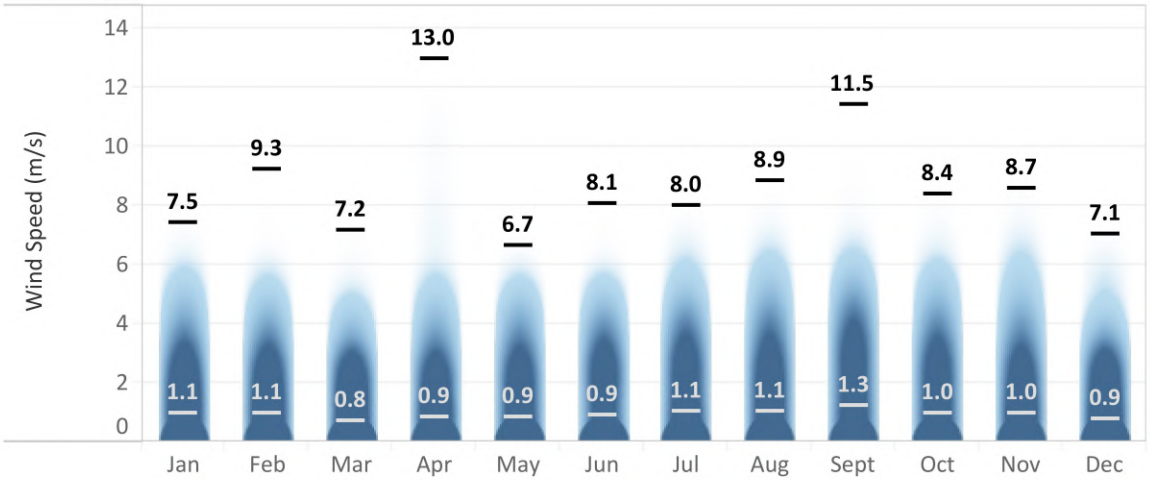

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

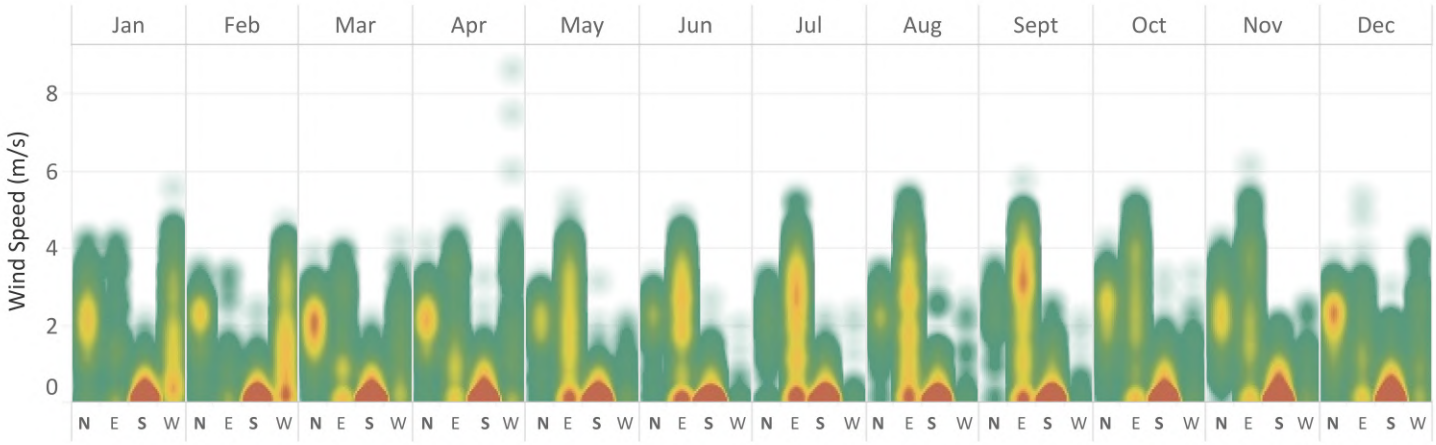

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

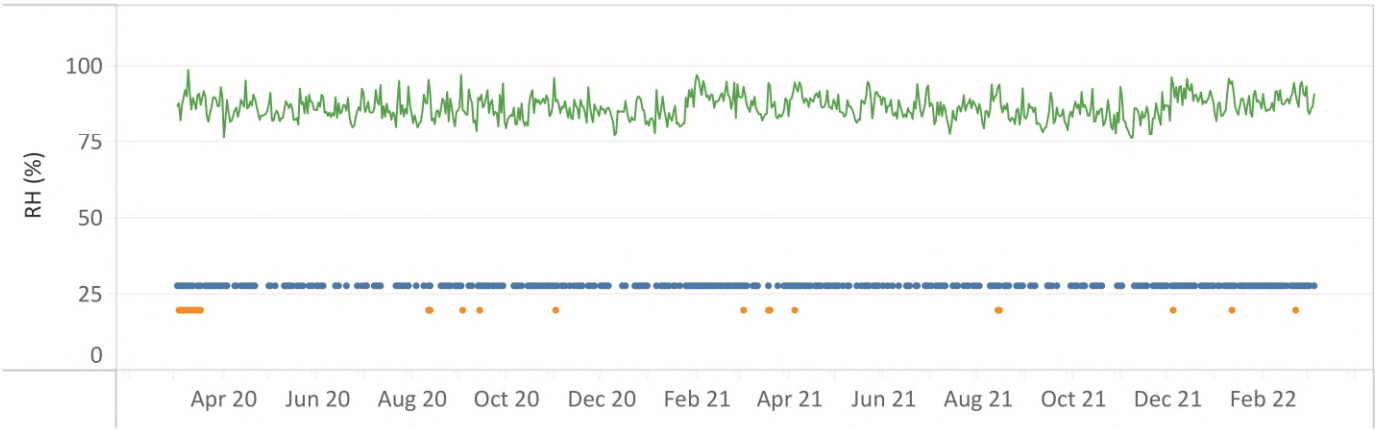

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

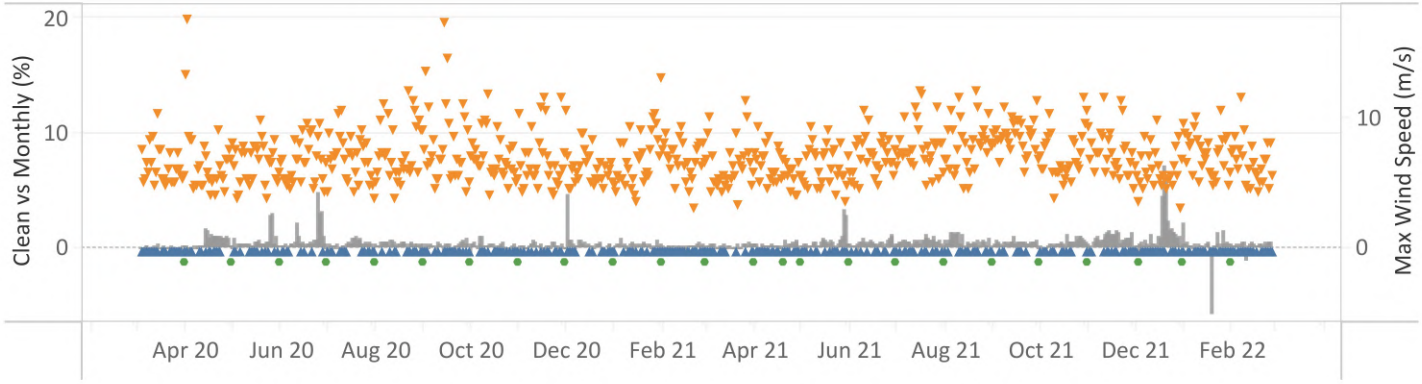

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

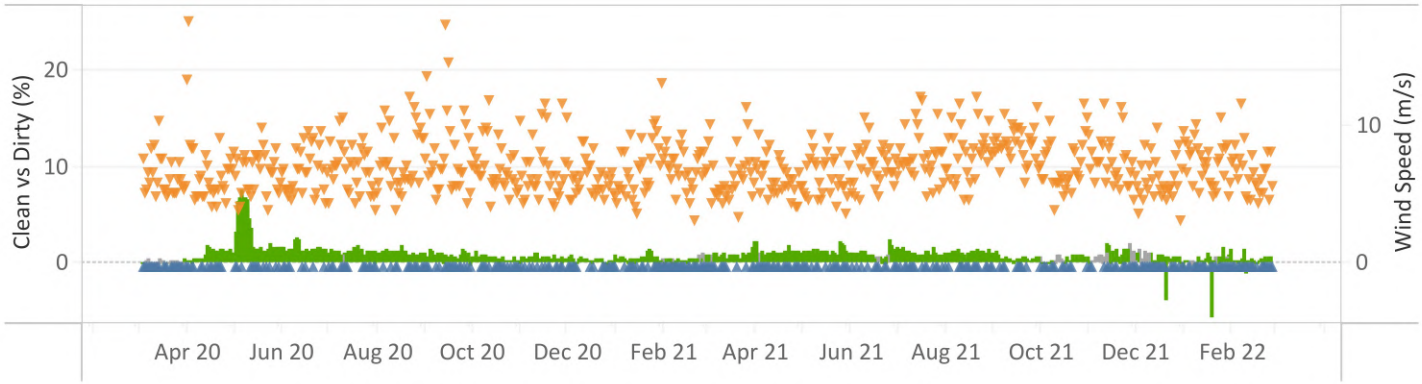

Figure 32: Soiling Measurement (Clean vs Dirty)

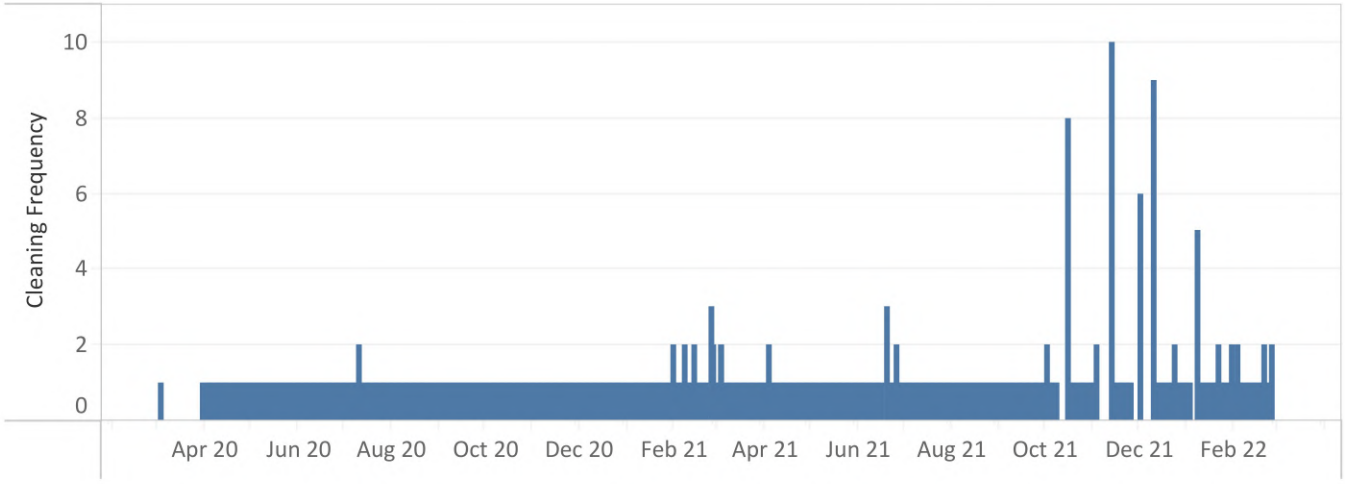

Figure 33: Consecutive days without cleaning

7.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

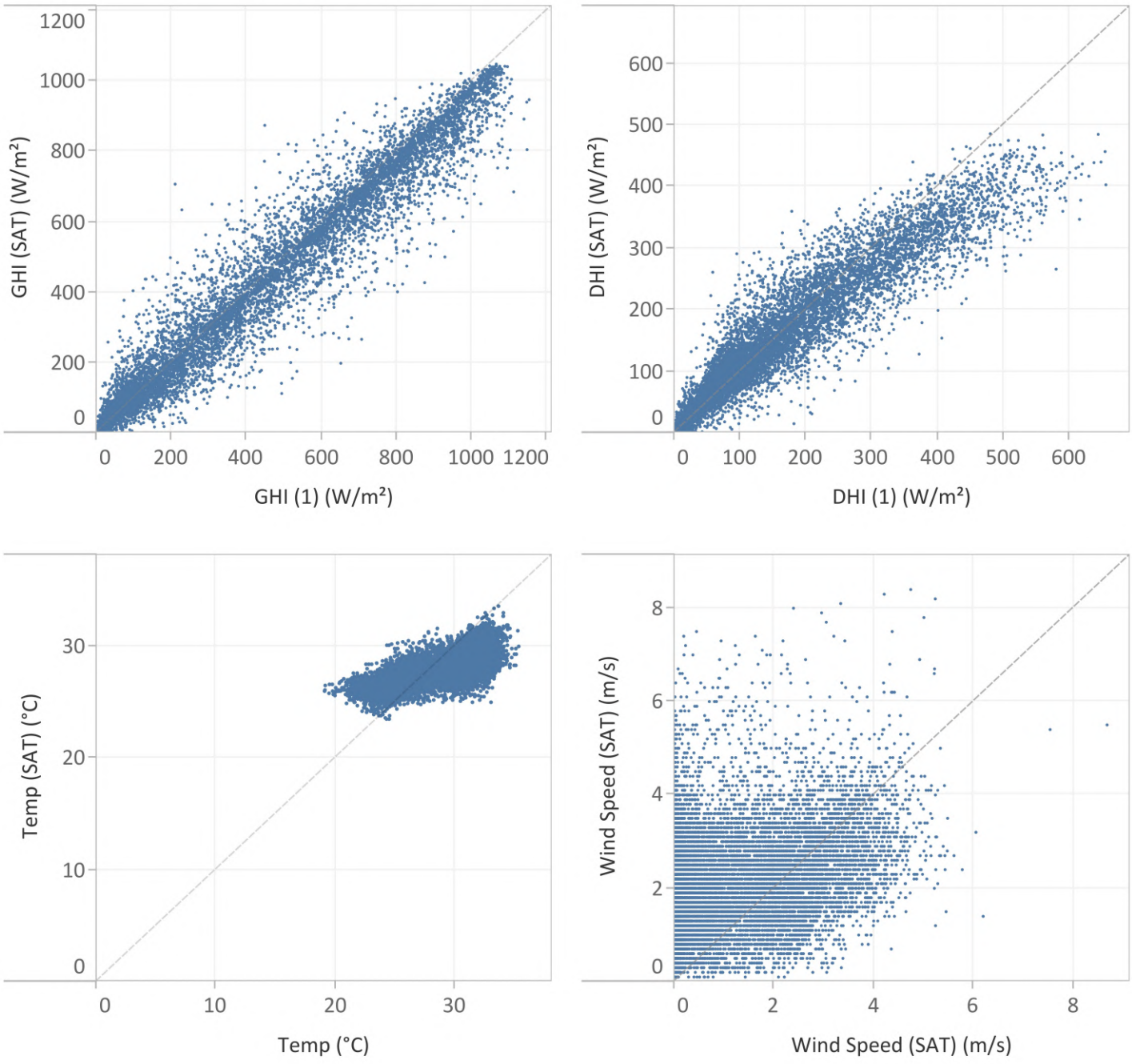

Figure 34: Ground measured data compared to satellite derived (Solargis) data

7.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.68%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

March 2020	Water residue affected early morning irradiation measurements on the following days:10, 12, 15, 20, 21, 26 and 28 March 2020.
May 2020	The pyranometer measuring GHI (2) recorded faulty values from 20 May 2020. GHI (1) is still recording accurate GHI values.
June 2020	The pyranometer measuring GHI (2) recorded faulty values from 20 May 2020. A site visit was conducted on 27 June 2020 during which a general inspection was done. Data was affected during the site visit and removed for the following timestamp:27-06-2020 08:10 until 27-06-2020 08:43
July 2020	The pyranometer measuring GHI (2) recorded faulty values from 20 May 2020 until 07 July 2020 when a site visi twas conducted to address this. GHI (1) recorded accurate GHI values throughout this period.
August 2020	Water residue affected early morning irradiation measurements on the following days:1, 3 and 4 August 2020.
September 2020	Water residue affected early morning irradiation measurements on the following days:5, 20 and 25 September 2020. A site visit was conducted on 28 September 2020 during which 32 minutes of data was affected and removed.
January 2021	Water residue affected early morning irradiation measurements on the following day:2 January 2021.
February 2021	Water residue affected early morning irradiation measurements on the following day:20 February 2021.
March 2021	Water residue affected early morning irradiation measurements on the following day:2 March 2021.
April 2021	Water residue affected early morning irradiation measurements on the following day:30 April 2021. A site visit was conducted on 11 April 2021 during which the station experienced down time and data was not collected.

June 2021	Water residue affected early morning irradiation measurements on the following days:14, 19 and 20 June 2021.
August 2021	Water residue affected early morning irradiation measurements on the following day:30 August 2021.
October 2021	Water residue affected early morning irradiation measurements on the following days:18 and 21 October 2021.
November 2021	Water residue affected early morning irradiation measurements on the following days:18 and 20 November 2021.
December 2021	Water residue affected early morning irradiation measurements on the following days:3 and 21 December 2021.
January 2022	Water residue affected early morning irradiation measurements on the following days:6, 16, 21, 22 and 23 January 2022.
February 2022	Water residue affected early morning irradiation measurements on the following days:6 and 13 February 2022.
March 2022	Water residue affected early morning irradiation measurements on the following day:5 March 2022.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	97.77	97.77	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.87	99.87	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.95	60.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.85	0.00	99.85	99.92	99.92	99.92	99.92	99.92	99.92	99.85	99.85
	Jul	99.56	79.61	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.87	99.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.45	99.45	99.85	99.92	99.93	99.93	99.93	99.93	99.93	99.85	99.85
	Oct	99.65	99.65	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.99	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.84	99.84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.86	99.86	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.86	99.86	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
	Mar	99.98	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.60	99.60	99.83	99.92	99.92	99.92	99.92	99.92	99.92	99.83	99.83
	May	99.78	99.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.68	99.68	100.00	100.00	100.00	100.00	98.61	100.00	100.00	100.00	100.00
	Jul	99.78	99.78	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.87	99.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.93	99.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.68	99.68	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.26	99.26	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.34	99.34	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2022	Jan	99.62	99.62	99.99	99.99	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Feb	99.53	99.53	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	98.76	98.76	100.00	99.97	99.97	99.97	99.97	99.97	99.97	100.00	100.00
Total		99.65	93.09	99.98	99.99	99.99	99.99	99.93	99.99	99.99	99.98	99.98

8. Tuvalu

8.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020	54	202
April 2020	47	175
May 2020	47	166
June 2020	44	138
July 2020	51	147
August 2020	58	157
September 2020	59	169
October 2020	61	200
November 2020	65	182
December 2020	73	154
January 2021	73	198
February 2021	76	116
Total (kWh/m²/year)	708	2006

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	53	190
April 2021	59	155
May 2021	46	172
June 2021	40	143
July 2021	52	154
August 2021	52	152
September 2021	48	199
October 2021	66	176
November 2021	57	194
December 2021	77	158
January 2022	71	162
February 2022	65	167
March 2022	66	175
Total (kWh/m²/year)	751	2199

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	9	8	3	0				0			0	3
6 pm	111	100	101	62	38	38	50	56	56	50	58	76
5 pm	287	260	295	235	211	192	209	213	237	215	229	223
4 pm	450	407	502	417	401	363	391	397	452	400	422	371
3 pm	636	570	681	589	551	506	540	554	641	604	610	522
2 pm	723	633	821	701	668	601	662	658	756	738	751	638
1 pm	801	703	882	779	778	668	707	717	819	791	825	684
12 pm	796	698	836	787	795	663	702	719	870	846	842	685
11 am	726	640	771	689	720	620	614	631	786	807	824	608
10 am	581	512	644	561	597	500	488	511	674	674	694	542
9 am	407	334	449	413	413	333	314	333	490	512	530	380
8 am	214	164	233	219	211	162	157	163	274	310	342	212
7 am	54	34	43	48	38	24	19	30	68	106	128	75
6 am	0								0	4	8	3

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	9	8	4	0				0			0	3
6 pm	77	73	54	41	28	28	37	42	39	35	41	56
5 pm	153	149	104	104	91	84	97	105	105	97	102	127
4 pm	211	223	155	163	135	124	149	163	161	149	158	197
3 pm	260	276	195	200	166	150	173	205	193	200	217	251
2 pm	284	309	209	224	181	171	196	210	222	241	244	277
1 pm	262	333	209	241	182	174	231	225	225	241	238	288
12 pm	264	310	197	216	185	169	218	221	205	254	230	297
11 am	261	290	195	178	169	158	207	207	184	261	237	290
10 am	223	241	169	154	144	143	158	177	169	220	207	251
9 am	169	178	132	136	115	108	120	125	138	176	168	198
8 am	111	99	88	89	77	71	69	74	95	120	123	127
7 am	39	27	28	29	23	17	14	20	37	54	65	52
6 am	0								0	4	7	3

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	28	28	28	28	29	28	28	28	28	28	28	27
10 pm	28	28	29	28	29	28	28	28	28	28	28	28
9 pm	28	28	29	28	29	28	28	28	28	28	28	28
8 pm	28	28	29	28	29	28	28	28	28	28	28	28
7 pm	28	28	29	28	29	28	28	28	28	28	28	28
6 pm	29	29	30	29	29	29	29	28	29	29	29	28
5 pm	29	29	30	30	30	29	29	29	29	29	30	29
4 pm	30	29	31	30	30	30	29	29	30	30	30	29
3 pm	30	30	31	30	30	30	30	30	30	30	30	29
2 pm	30	30	31	30	31	30	30	29	30	30	30	29
1 pm	30	30	31	30	31	30	30	29	30	30	30	29
12 pm	30	30	31	30	31	30	30	29	30	30	30	29
11 am	30	30	31	30	31	30	30	29	30	30	30	29
10 am	29	29	31	30	30	30	29	29	30	30	30	29
9 am	29	29	30	30	30	29	29	29	29	29	30	28
8 am	28	28	29	29	29	29	28	28	29	29	29	28
7 am	28	27	28	28	28	28	28	27	28	28	28	27
6 am	27	27	28	28	28	27	27	27	28	27	28	27
5 am	27	27	28	28	28	27	27	27	28	27	28	27
4 am	27	27	28	28	28	28	27	27	28	27	28	27
3 am	28	27	28	28	28	28	28	27	28	27	28	27
2 am	28	27	28	28	28	28	28	27	28	27	28	27
1 am	28	28	28	28	28	28	28	27	28	27	28	27
12 am	28	28	28	28	28	28	28	27	28	28	28	27

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	78	75	82	81	81	81	82	83	79	81	78	82
10 pm	78	75	81	81	80	81	82	83	79	81	78	81
9 pm	78	75	80	81	80	80	81	83	79	80	77	80
8 pm	78	75	79	81	80	81	81	82	79	79	77	80
7 pm	77	74	79	80	80	80	80	81	78	78	76	79
6 pm	76	71	76	77	78	78	79	79	76	76	74	77
5 pm	74	70	74	75	75	76	77	78	74	75	72	76
4 pm	72	69	73	74	74	75	76	77	74	74	71	75
3 pm	72	69	72	74	74	75	75	76	74	73	70	75
2 pm	72	69	72	73	74	75	75	76	73	73	70	76
1 pm	72	69	73	74	73	75	75	77	73	74	71	76
12 pm	72	70	73	74	73	75	75	77	73	74	71	77
11 am	74	71	73	75	74	75	76	78	74	75	72	77
10 am	74	72	75	76	75	76	77	78	74	76	73	77
9 am	76	74	76	76	76	77	78	80	75	76	74	79
8 am	77	75	79	78	78	79	80	82	77	79	76	81
7 am	79	77	83	82	82	82	83	85	80	82	78	82
6 am	80	77	84	83	82	82	83	85	80	83	80	83
5 am	80	76	84	83	83	82	83	85	80	83	80	83
4 am	80	76	84	83	82	82	83	85	80	83	79	82
3 am	80	76	84	82	82	82	82	85	80	83	79	82
2 am	80	76	84	82	81	82	82	84	80	82	79	82
1 am	79	76	83	82	81	81	81	84	80	82	79	82
12 am	79	75	83	82	81	81	81	84	80	82	78	81

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	13.6	27.4	8.6	1.6	37.6	6.0	6.4	40.4	4.0	19.0	6.6	170.8
10 pm	18.4	10.0	2.2	2.6	1.4	3.2	16.6	18.2	7.4	23.6	0.4	48.6
9 pm	31.4	7.6	1.6	17.8	10.0	5.6	16.6	8.6	13.2	24.8	10.6	23.6
8 pm	28.8	22.0	50.0	26.2	4.0	4.2	14.6	6.0	17.4	8.2	11.8	14.2
7 pm	11.2	11.4	20.2	52.4	20.6	7.2	37.0	20.0	1.6	17.0	39.4	11.0
6 pm	36.0	3.6	8.0	6.4	17.0	6.4	12.4	21.8	6.2	24.2	32.8	44.2
5 pm	89.0	9.6	9.4	2.6	17.0	6.0	5.8	10.0	7.4	38.6	13.8	106.4
4 pm	53.0	8.4	2.6	7.8	16.0	24.2	14.6	10.8	4.8	27.8	28.8	9.8
3 pm	24.6	23.4	12.6	5.6	2.8	6.2	9.6	20.2	7.0	51.2	1.6	17.6
2 pm	15.2	28.4	5.8	8.8	2.6	40.0	28.2	23.8	12.2	20.0	4.6	47.2
1 pm	21.6	45.2	12.8	9.0	19.8	2.0	6.0	26.8	15.8	38.2	6.0	62.6
12 pm	11.2	43.8	16.4	16.6	4.2	7.6	16.0	10.8	1.0	13.8	15.6	41.8
11 am	19.8	25.8	8.0	104.0	0.8	0.6	5.8	46.8	26.2	21.2	1.4	40.6
10 am	30.6	9.8	5.2	21.2	0.8	15.0	2.6	14.6	15.6	55.0	9.6	36.6
9 am	5.4	90.6	3.2	30.0	10.6	6.4	13.0	30.2	2.0	15.6	12.6	77.6
8 am	33.6	83.4	23.2	17.2	6.0	2.2	35.2	76.0	12.4	8.4	6.8	111.6
7 am	27.4	76.6	16.8	8.6	47.6	28.2	33.6	64.0	47.4	31.2	14.0	48.0
6 am	16.4	47.6	13.6	50.4	18.2	10.0	49.2	21.6	28.2	34.0	14.4	90.4
5 am	36.2	43.0	7.4	10.6	25.6	8.2	35.0	22.8	2.8	19.2	20.0	41.0
4 am	84.8	35.8	25.0	49.0	27.8	35.4	14.8	23.6	12.0	40.2	0.4	41.4
3 am	41.8	40.2	8.8	5.0	7.0	8.2	22.0	25.2	35.6	50.6	0.6	57.2
2 am	19.0	51.2	15.8	18.0	10.0	18.4	6.6	29.0	8.8	21.8	5.8	61.8
1 am	21.0	24.8	11.8	2.4	0.4	48.4	16.4	56.8	6.2	38.0	8.0	71.4
12 am	24.0	16.6	21.2	11.2	2.0	6.6	19.4	78.4	7.6	47.6	31.0	70.2

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,012	1,012	1,012	1,013	1,013	1,013	1,013	1,014	1,014	1,013	1,013	1,012
10 pm	1,011	1,011	1,012	1,013	1,013	1,013	1,013	1,014	1,014	1,013	1,013	1,012
9 pm	1,011	1,011	1,012	1,012	1,012	1,013	1,013	1,013	1,013	1,013	1,012	1,011
8 pm	1,010	1,010	1,011	1,012	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,011
7 pm	1,010	1,010	1,010	1,011	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,010
6 pm	1,009	1,009	1,010	1,010	1,011	1,012	1,011	1,012	1,011	1,011	1,011	1,010
5 pm	1,009	1,009	1,009	1,010	1,010	1,011	1,011	1,011	1,011	1,010	1,010	1,009
4 pm	1,009	1,009	1,009	1,010	1,010	1,011	1,010	1,011	1,011	1,010	1,010	1,009
3 pm	1,009	1,009	1,009	1,010	1,010	1,011	1,011	1,011	1,011	1,010	1,010	1,009
2 pm	1,010	1,009	1,010	1,010	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,010
1 pm	1,010	1,010	1,011	1,011	1,011	1,013	1,012	1,013	1,012	1,012	1,011	1,010
12 pm	1,011	1,011	1,012	1,012	1,012	1,013	1,013	1,013	1,013	1,012	1,012	1,011
11 am	1,011	1,011	1,012	1,013	1,013	1,014	1,013	1,014	1,014	1,013	1,013	1,011
10 am	1,011	1,011	1,012	1,013	1,013	1,014	1,013	1,014	1,014	1,013	1,013	1,012
9 am	1,011	1,011	1,012	1,013	1,013	1,014	1,013	1,014	1,014	1,014	1,013	1,012
8 am	1,011	1,011	1,012	1,012	1,013	1,014	1,013	1,014	1,014	1,013	1,013	1,012
7 am	1,011	1,010	1,011	1,012	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,011
6 am	1,010	1,010	1,011	1,011	1,011	1,012	1,012	1,012	1,012	1,012	1,012	1,010
5 am	1,010	1,009	1,010	1,011	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,010
4 am	1,009	1,009	1,010	1,011	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,010
3 am	1,010	1,009	1,010	1,011	1,011	1,012	1,011	1,012	1,012	1,011	1,011	1,010
2 am	1,010	1,010	1,011	1,011	1,012	1,013	1,012	1,013	1,012	1,012	1,011	1,010
1 am	1,011	1,010	1,012	1,012	1,012	1,013	1,012	1,013	1,013	1,012	1,012	1,011
12 am	1,011	1,011	1,012	1,012	1,012	1,013	1,013	1,014	1,013	1,013	1,013	1,012

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	2.5	1.9	1.6	1.5	1.7	1.4	2.2	1.8	2.2	1.2	1.6	2.0
10 pm	2.4	1.8	1.7	1.5	1.6	1.5	2.2	1.7	2.2	1.2	1.6	2.0
9 pm	2.5	1.9	1.7	1.5	1.7	1.5	2.3	1.7	2.2	1.3	1.7	2.0
8 pm	2.5	1.8	1.7	1.6	1.7	1.4	2.1	1.8	2.1	1.3	1.8	1.9
7 pm	2.5	2.0	1.7	1.7	1.7	1.4	2.2	1.7	2.1	1.3	1.8	1.9
6 pm	2.9	2.1	1.8	1.8	1.9	1.5	2.2	1.8	2.3	1.6	2.0	2.2
5 pm	3.1	2.2	2.1	2.0	2.1	1.7	2.4	1.9	2.4	1.8	2.3	2.4
4 pm	3.3	2.5	2.3	2.2	2.2	2.0	2.4	2.1	2.5	1.9	2.5	2.4
3 pm	3.5	2.7	2.4	2.4	2.3	2.1	2.5	2.1	2.7	2.0	2.6	2.6
2 pm	3.5	2.8	2.5	2.6	2.3	2.3	2.6	2.2	2.9	2.1	2.8	2.7
1 pm	3.4	2.9	2.5	2.6	2.4	2.2	2.7	2.3	2.9	2.3	2.9	2.7
12 pm	3.4	2.9	2.6	2.5	2.3	2.2	2.6	2.3	2.9	2.2	2.9	2.9
11 am	3.4	2.9	2.5	2.5	2.3	2.1	2.6	2.3	3.0	2.2	3.0	2.8
10 am	3.4	2.6	2.4	2.4	2.3	2.1	2.5	2.2	2.9	2.0	2.7	2.7
9 am	3.2	2.3	2.3	2.2	2.1	2.0	2.4	2.0	2.7	1.7	2.6	2.5
8 am	2.9	2.1	2.0	1.9	1.9	1.7	2.2	1.8	2.6	1.6	2.6	2.4
7 am	2.6	2.0	1.7	1.6	1.8	1.6	2.0	1.7	2.4	1.4	2.3	2.2
6 am	2.6	1.9	1.7	1.6	1.7	1.6	2.1	1.6	2.3	1.3	2.1	2.0
5 am	2.7	1.8	1.6	1.7	1.5	1.6	2.1	1.7	2.2	1.2	1.9	2.0
4 am	2.6	2.0	1.6	1.7	1.5	1.6	2.2	1.6	2.2	1.1	1.8	2.1
3 am	2.5	1.9	1.6	1.6	1.5	1.4	2.2	1.7	2.2	1.1	1.8	2.1
2 am	2.5	1.8	1.6	1.6	1.6	1.5	2.2	1.8	2.1	1.0	1.7	2.0
1 am	2.4	1.8	1.6	1.5	1.7	1.5	2.2	1.8	2.2	1.1	1.7	2.1
12 am	2.4	1.9	1.6	1.6	1.7	1.4	2.3	1.8	2.3	1.1	1.7	2.0

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	NE	NE	E	E	E	E	E	E	E	E	E	NE E
10 pm	N E	NE	E	E	E	E	E	E	E	E	E	E
9 pm	N E	NE	E	E	E	E	E	E	E	E	E	E
8 pm	N E	NE	E	E	E	E	E	E	E	E	E	NE
7 pm	N E	NE	E	E	E	E	E	E	E	E	E	NE
6 pm	N	NE	E	E	E	E	E	E	E	E	E	NE
5 pm	N	NE	E	E	E	E	E	E	E	E	E	NE
4 pm	N	NE	E	E	E	E	E	E	E	E	E	N
3 pm	N	NE	E	E	E	E	E	E	E	E	NE	N
2 pm	N	NE	E	E	E	E	E	E	E	E	NE	N
1 pm	N	NE	E	E	E	E	E	E	E	E	NE	NE
12 pm	N	NE	E	E	E	E	E	E	E	E	NE	NE
11 am	N	NE	E	E	E	E	E	E	E	E	NE	NE
10 am	N	NE	E	E	E	E	E	E	E	E	NE	NE
9 am	NE	NE	E	E	E	E	E	E	E	E	E	NE
8 am	NE	NE	E	E	E	E	E	E	E	E	E	NE
7 am	N	NE	E	E	E	E	E	E	E	E	E	NE
6 am	N	NE	E	E	E	E	E	E	E	E	E	NE
5 am	N	NE	E	E	E	E	E	E	E	E	E	NE
4 am	N	NE	E	E	E	E	E	E	E	E	E	NE
3 am	N	NE	E	E	E	E	E	E	E	E	E	NE
2 am	N	NE	E	E	E	E	E	E	E	E	E	NE
1 am	N	NE	E	E	E	E	E	E	E	E	E	NE
12 am	N E	NE	E	E	E	E	E	E	E	E	E	NE

Figure 9: Dominant hourly Wind Direction

8.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

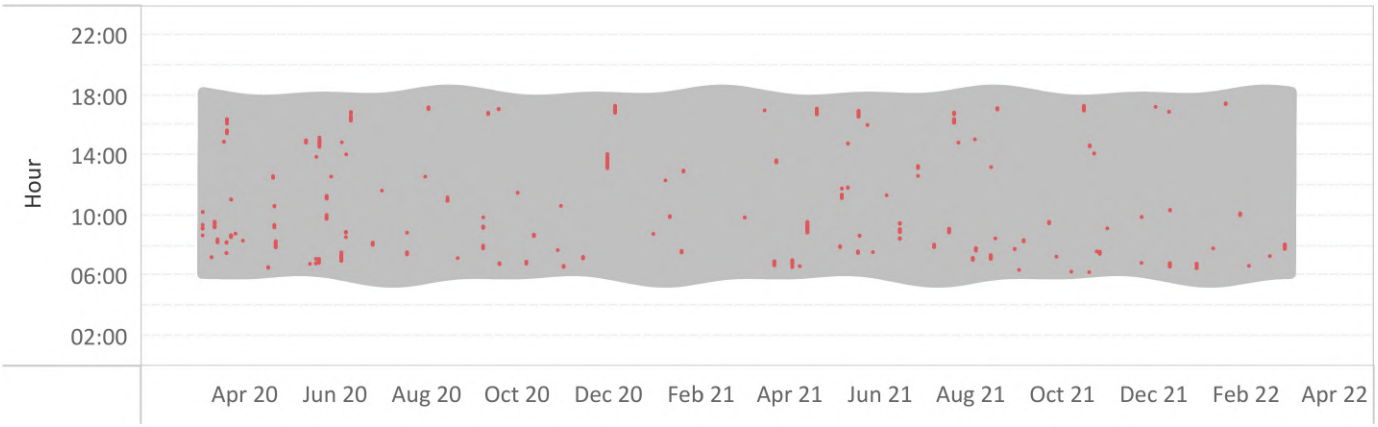

Figure 10: Quality control for GHI (1)

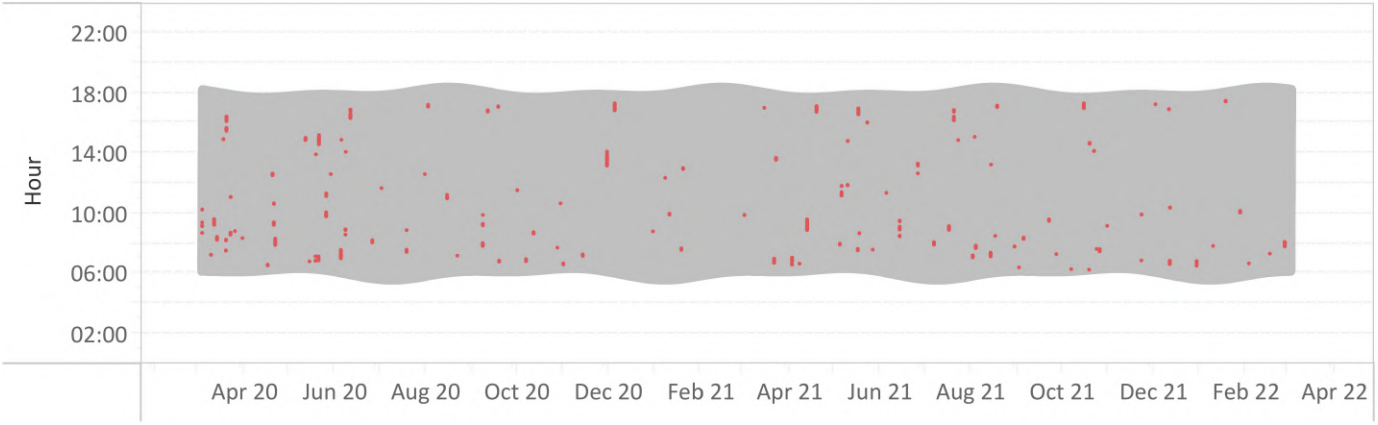

Figure 11: Quality control for GHI (2)

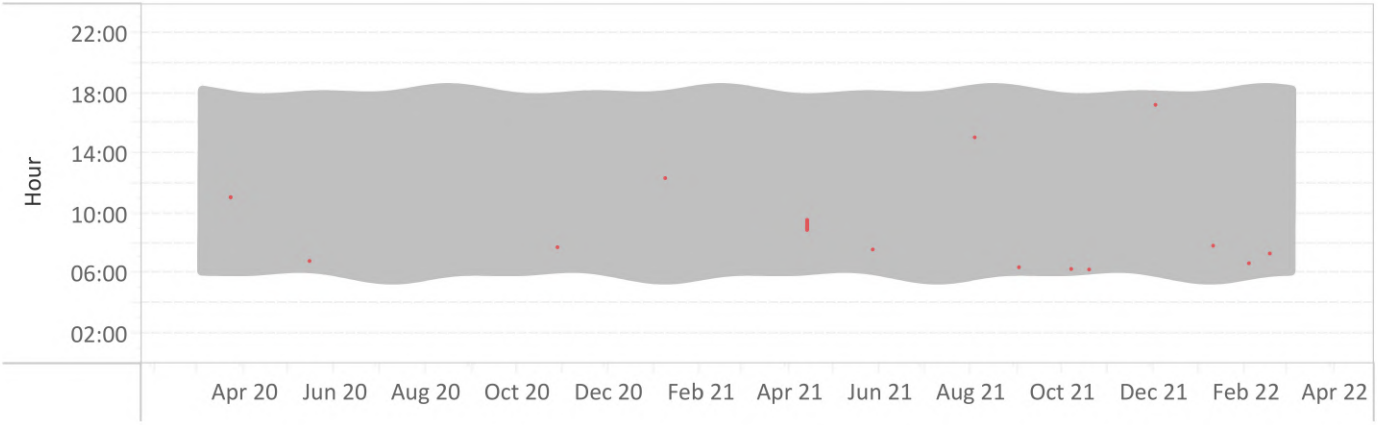

Figure 12: Quality control for DHI (1)

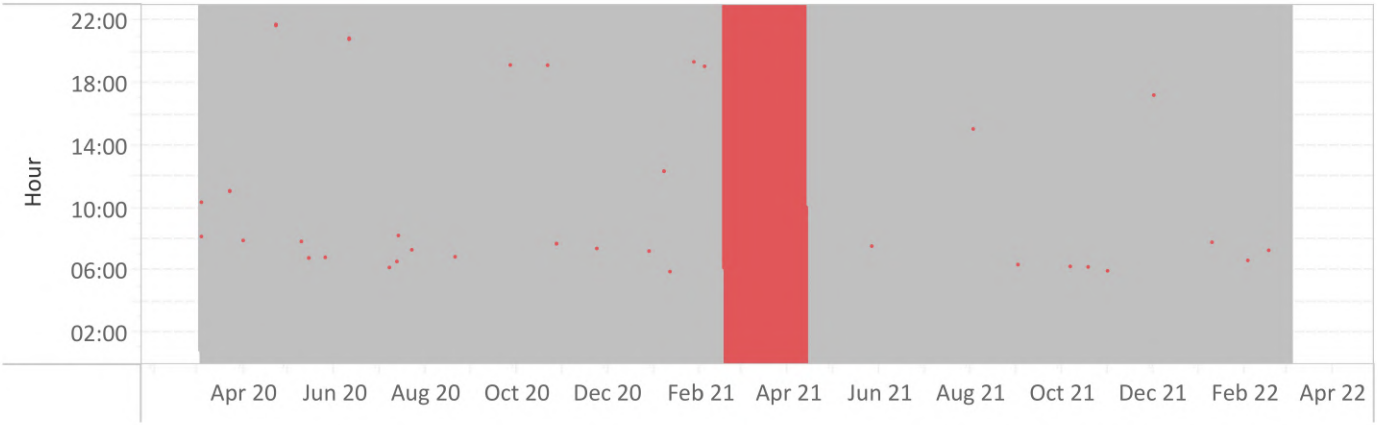

Figure 13: Quality Control for Temp

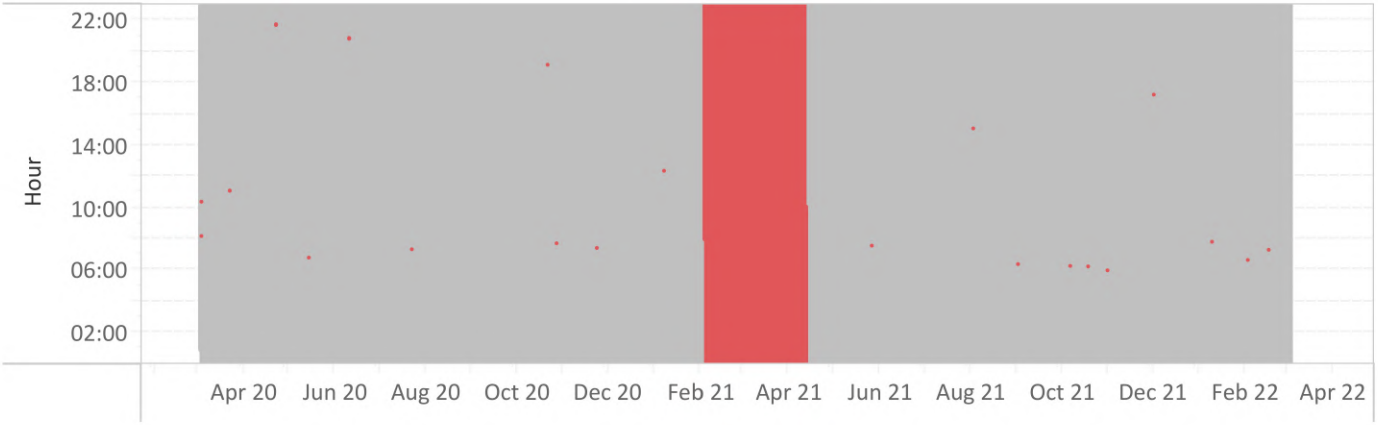

Figure 14: Quality Control for RH

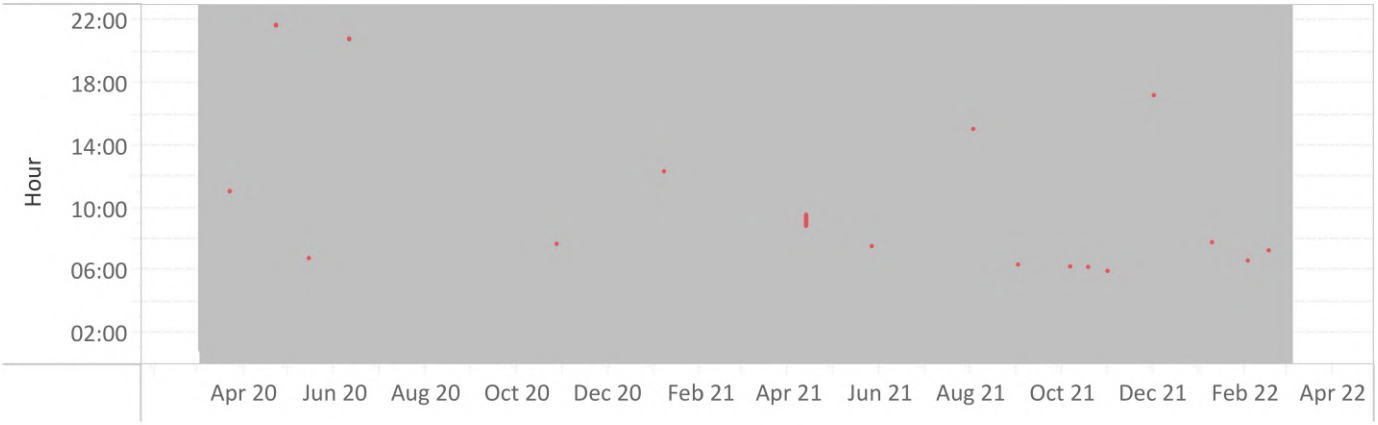

Figure 15: Quality Control for Rain

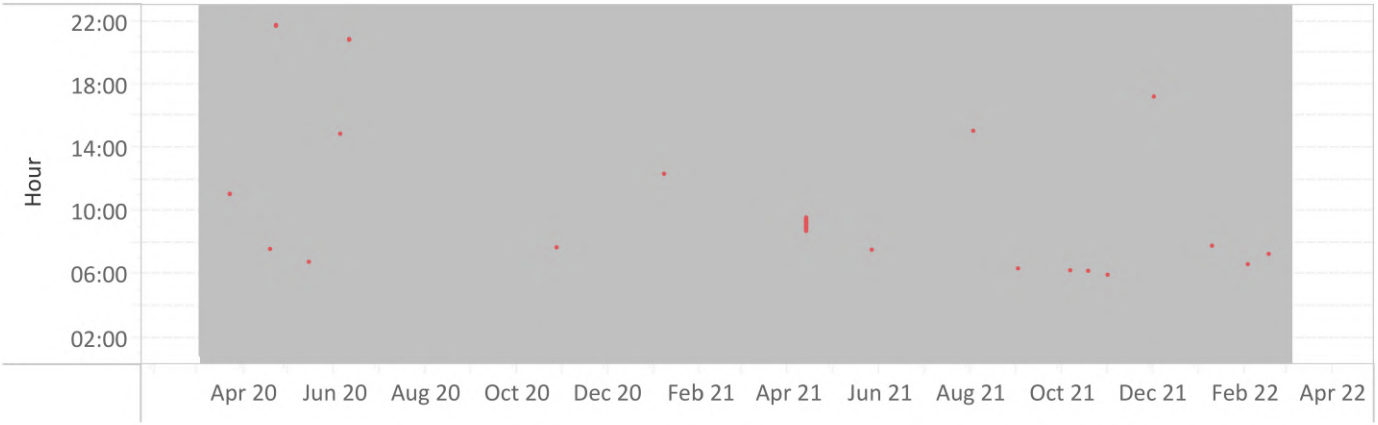

Figure 16: Quality Control for BP

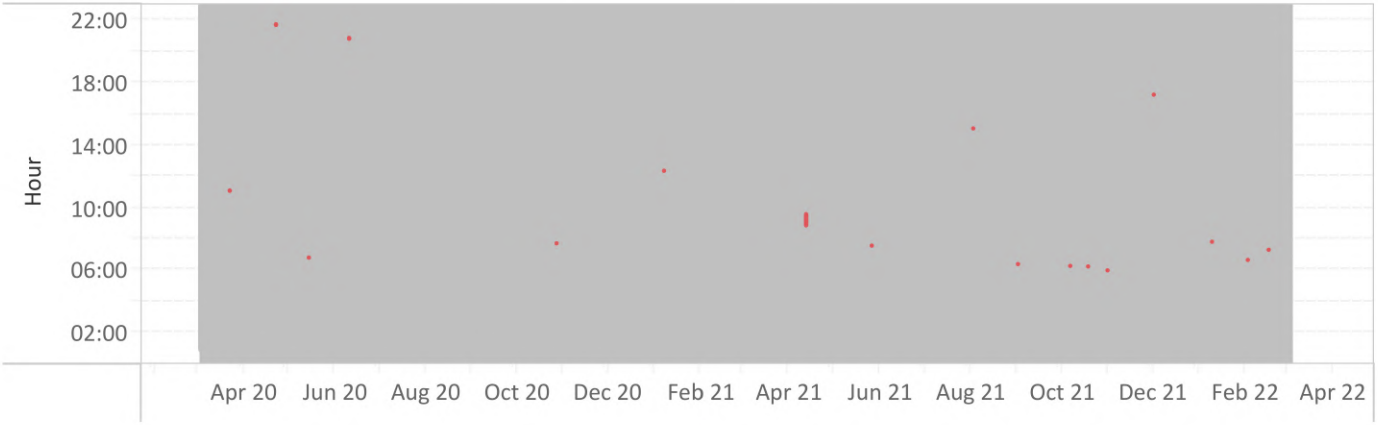

Figure 17: Quality Control for Wind Direction

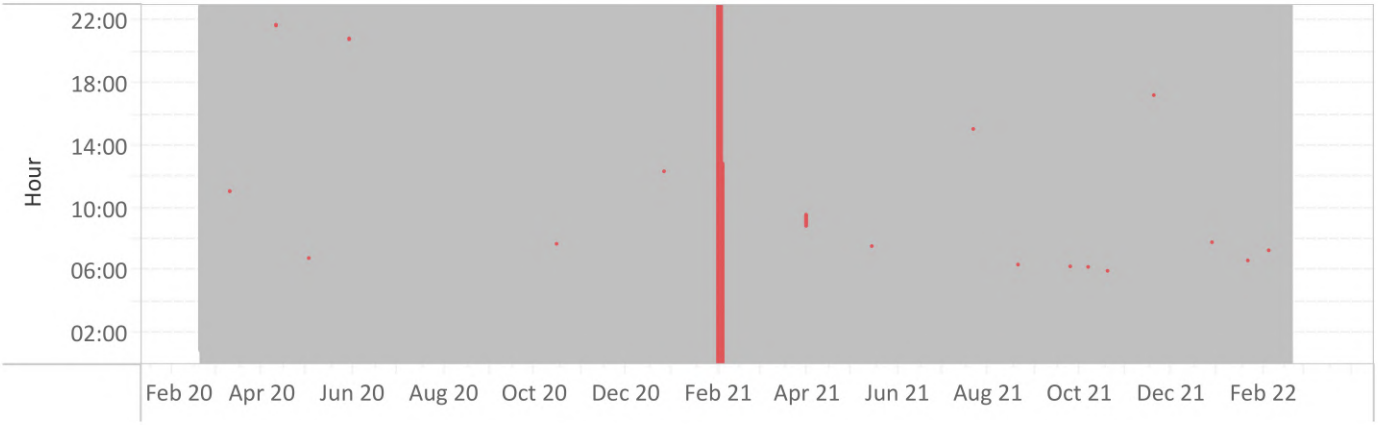

Figure 18: Quality Control for Wind Speed

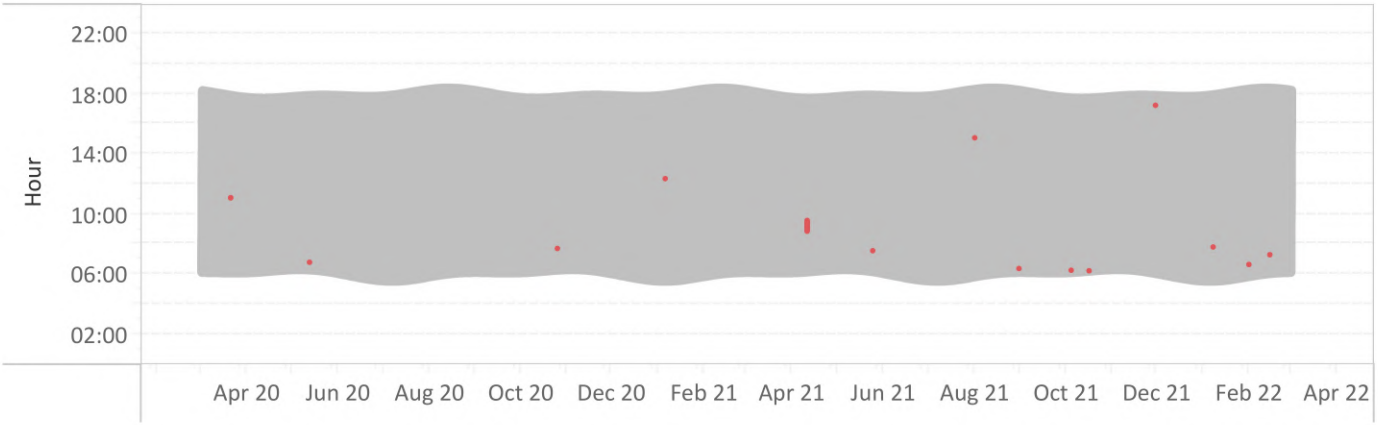

Figure 19: Quality control for soiling measurement (monthly cleaned)

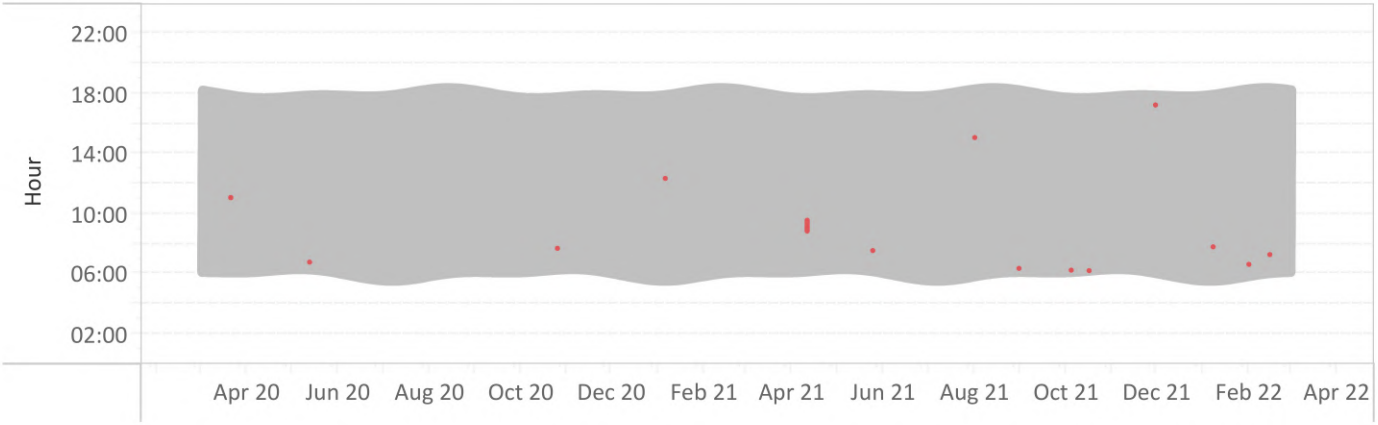

Figure 20: Quality control for soiling measurement (continuous soiling)

8.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

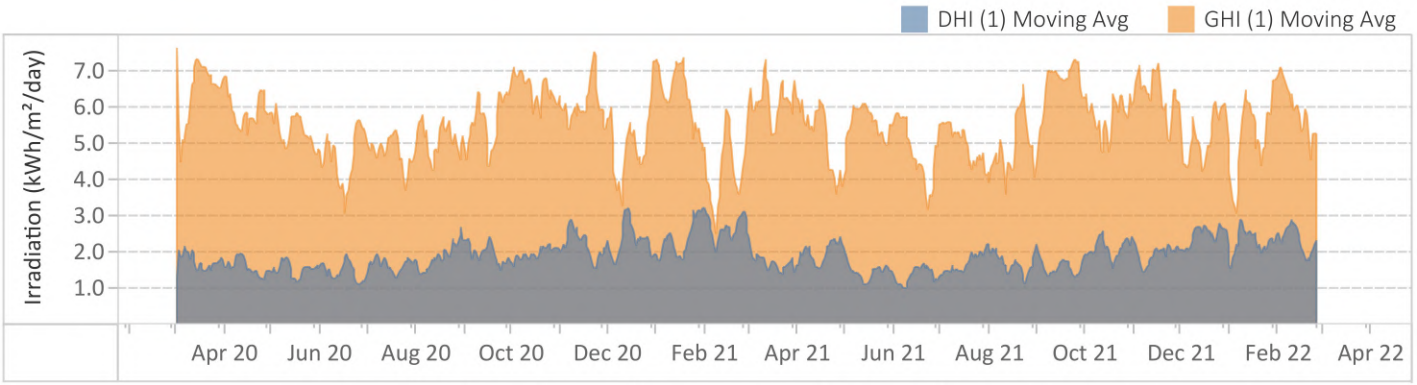

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

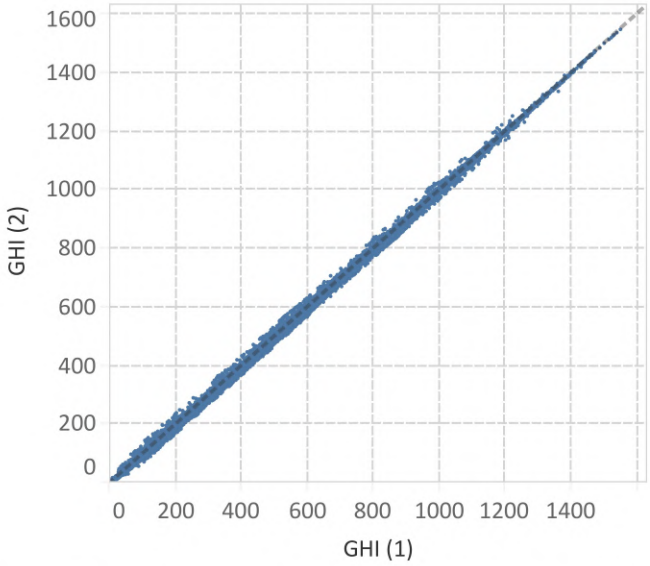

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

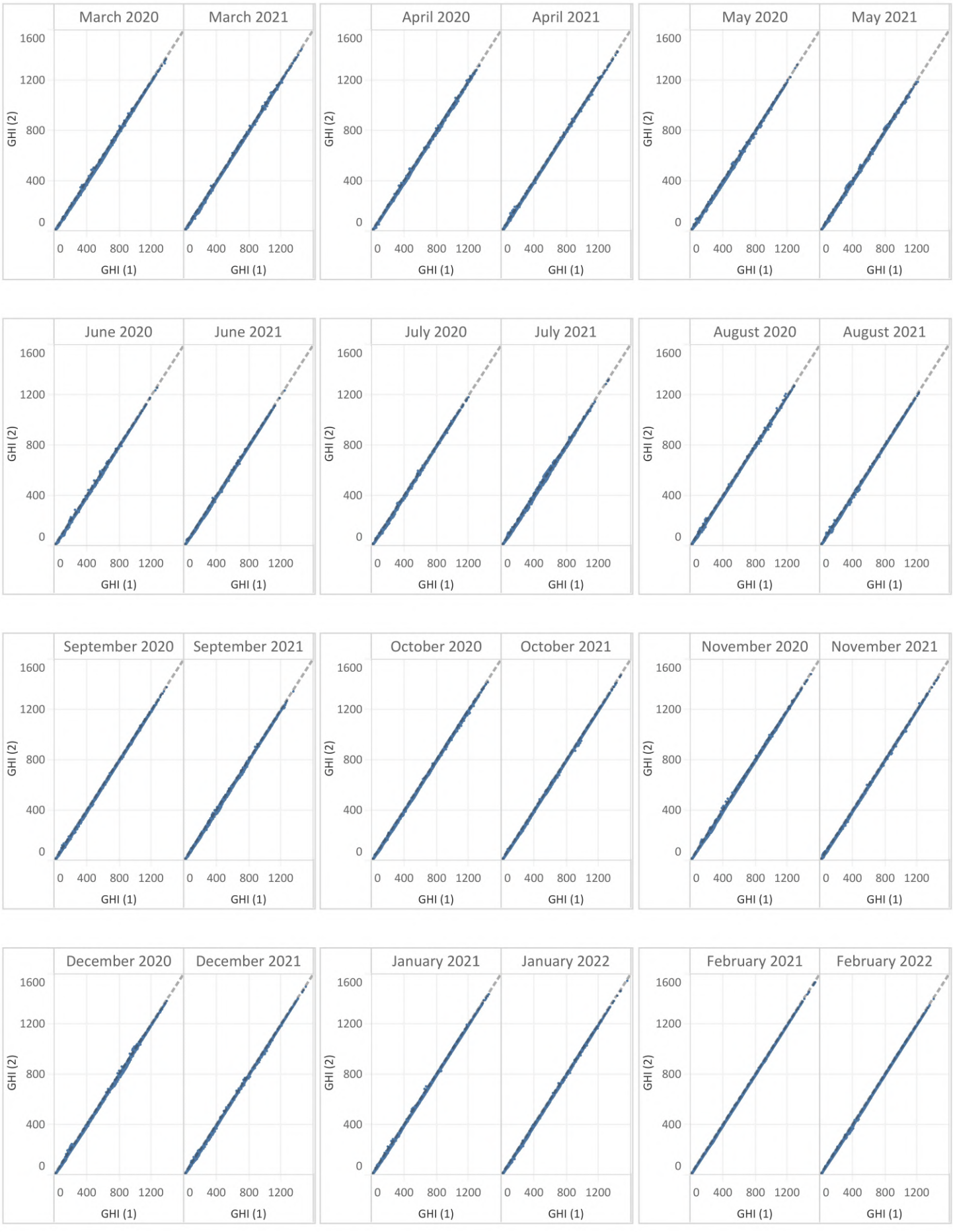

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

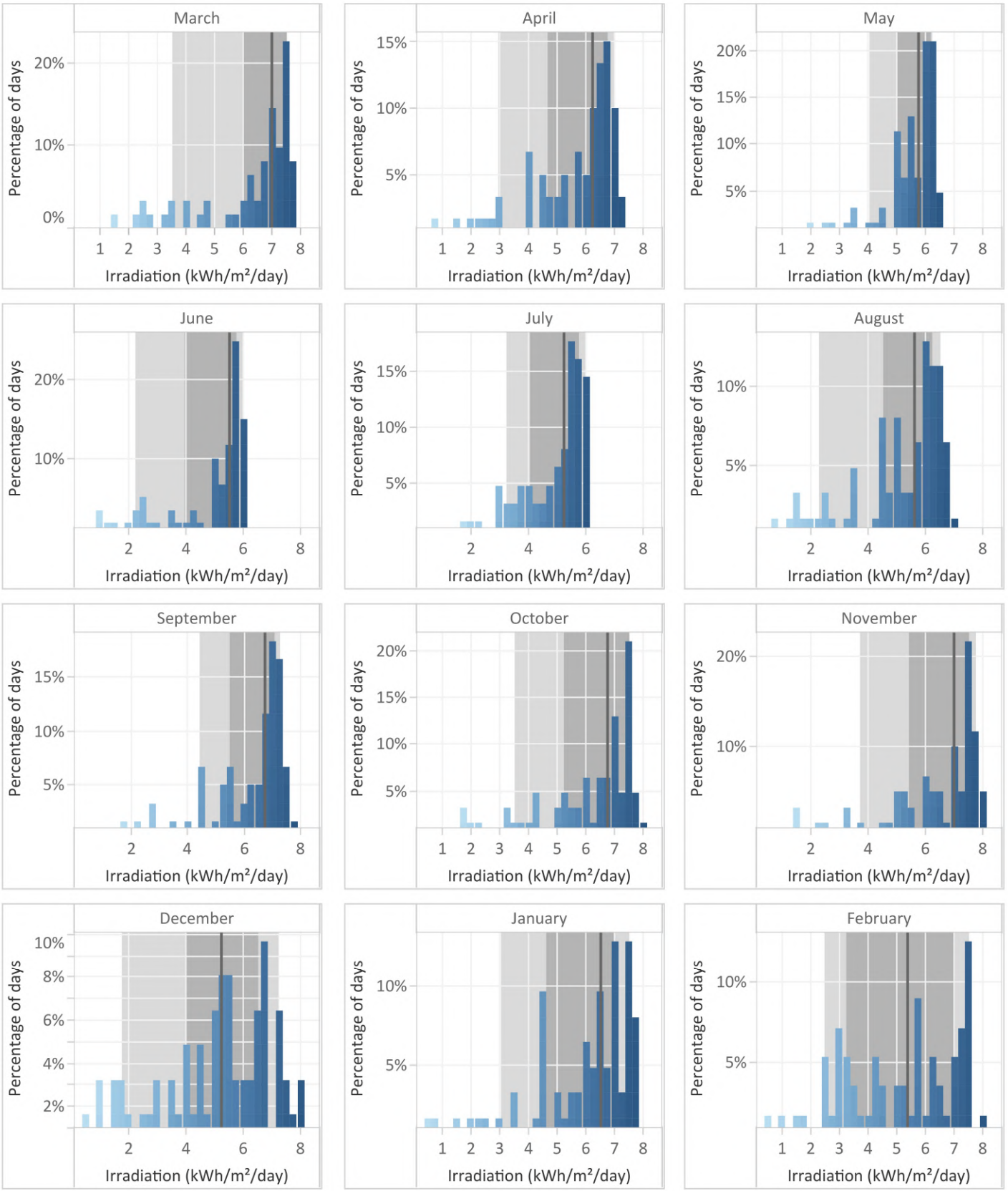

Figure 24: Daily summary of GHI (1)

8.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

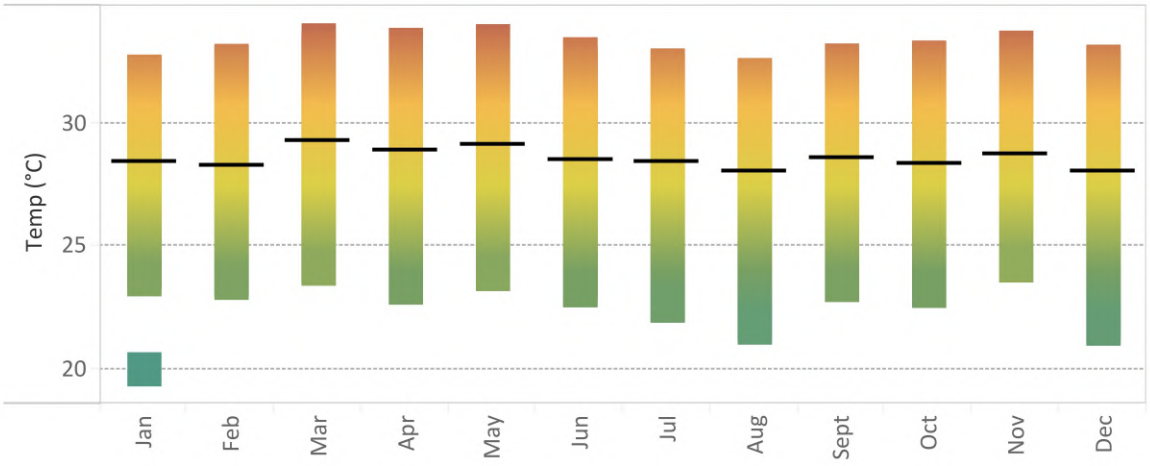

Figure 25: Monthly average, maximum and minimum temperature

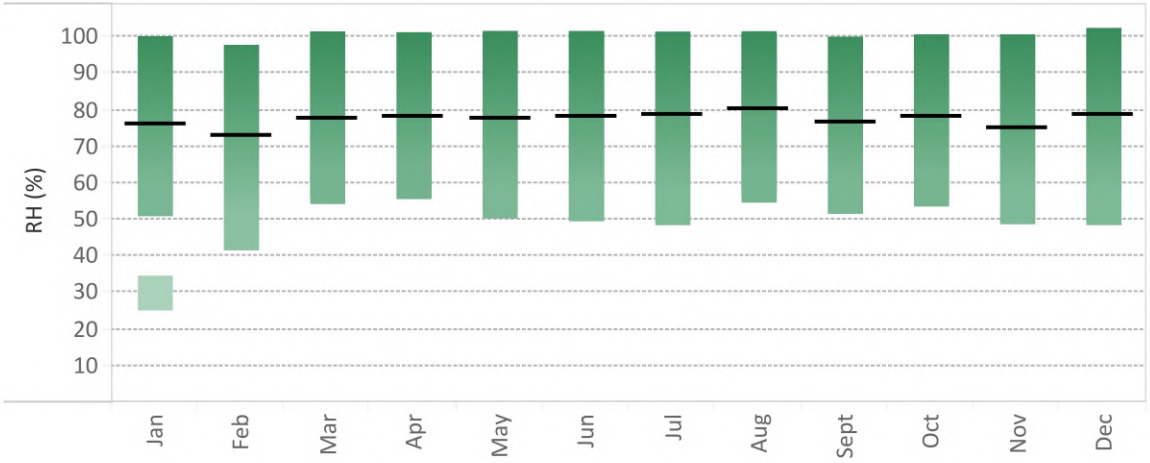

Figure 26: Monthly average, maximum and minimum relative humidity

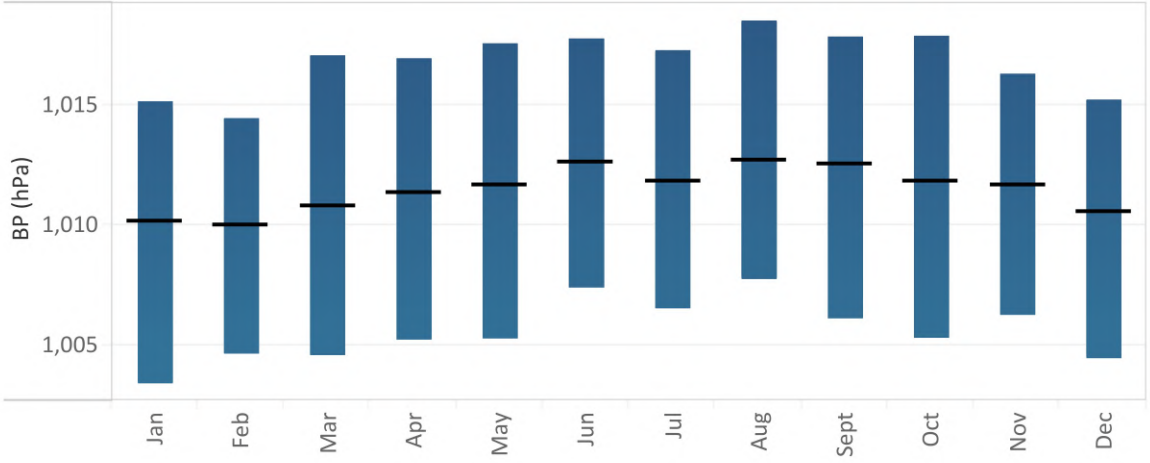

Figure 27: Monthly average, maximum and minimum barometric pressure

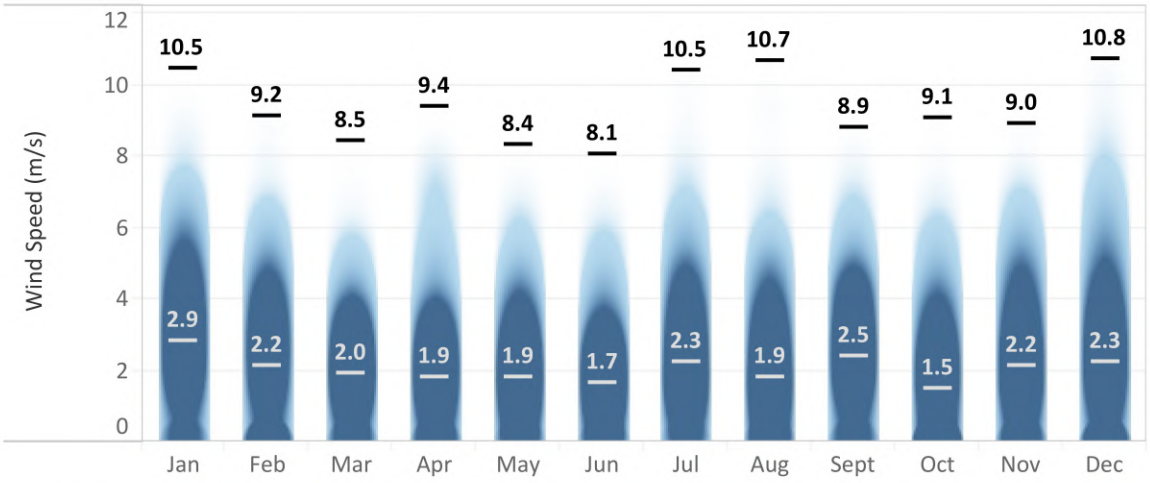

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

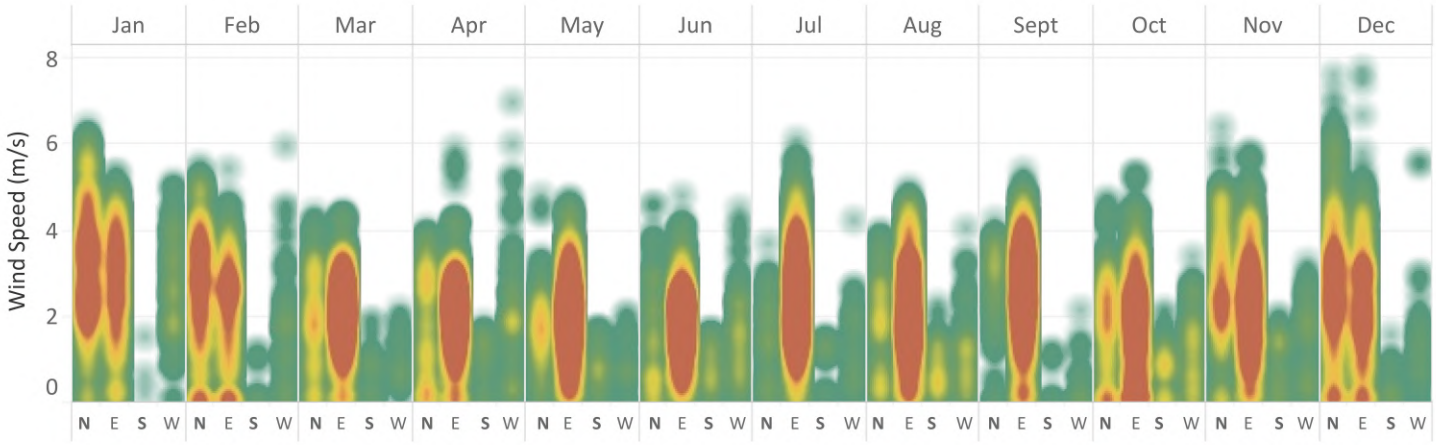

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

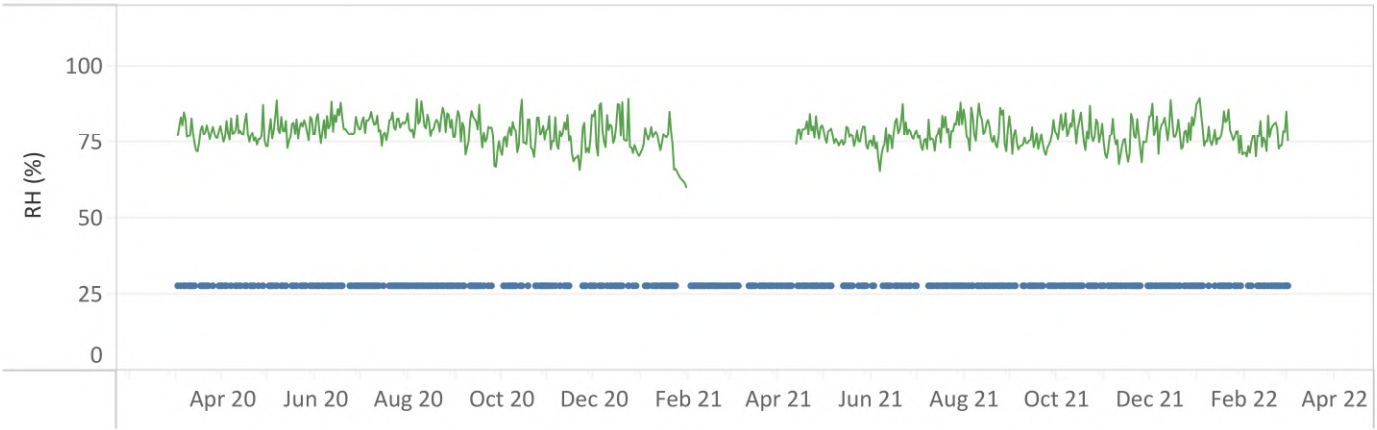

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

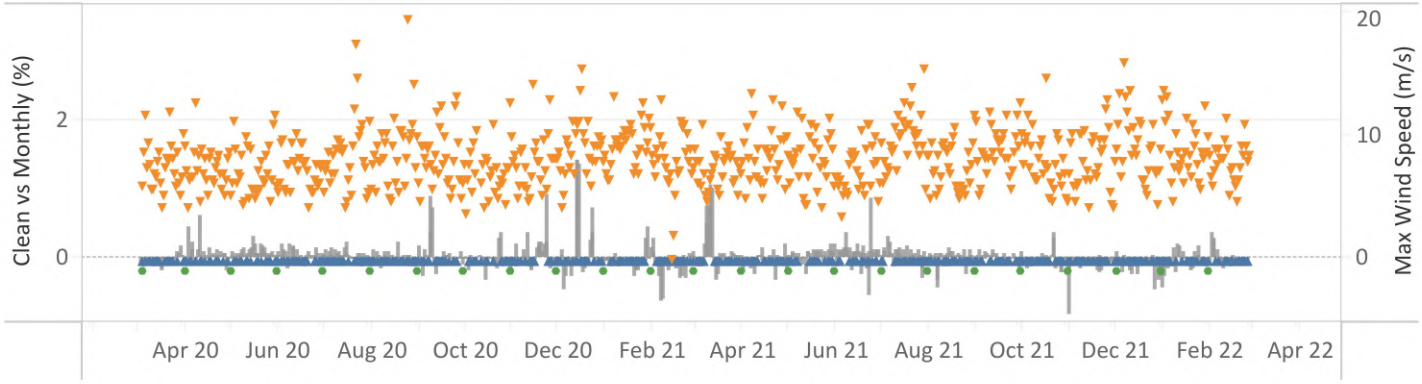

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

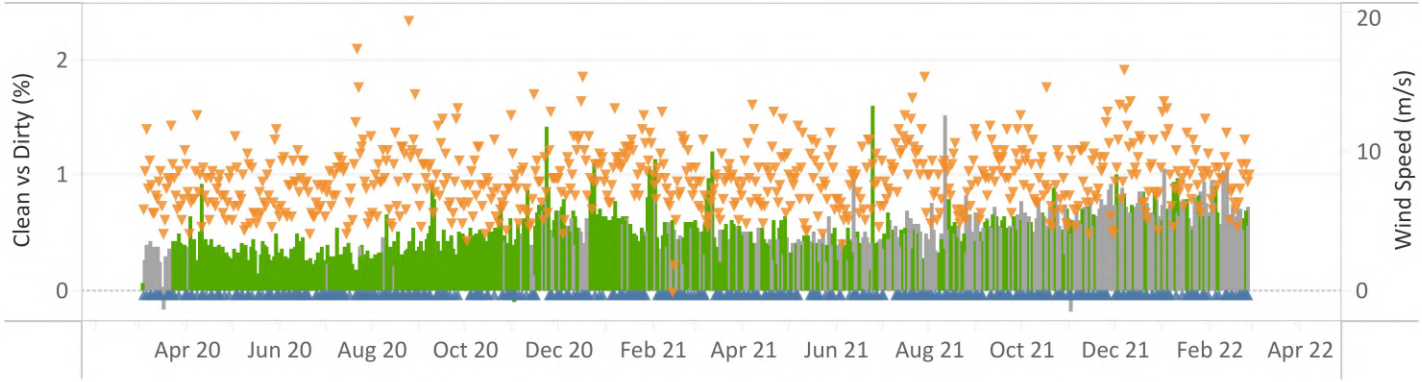

Figure 32: Soiling Measurement (Clean vs Dirty)

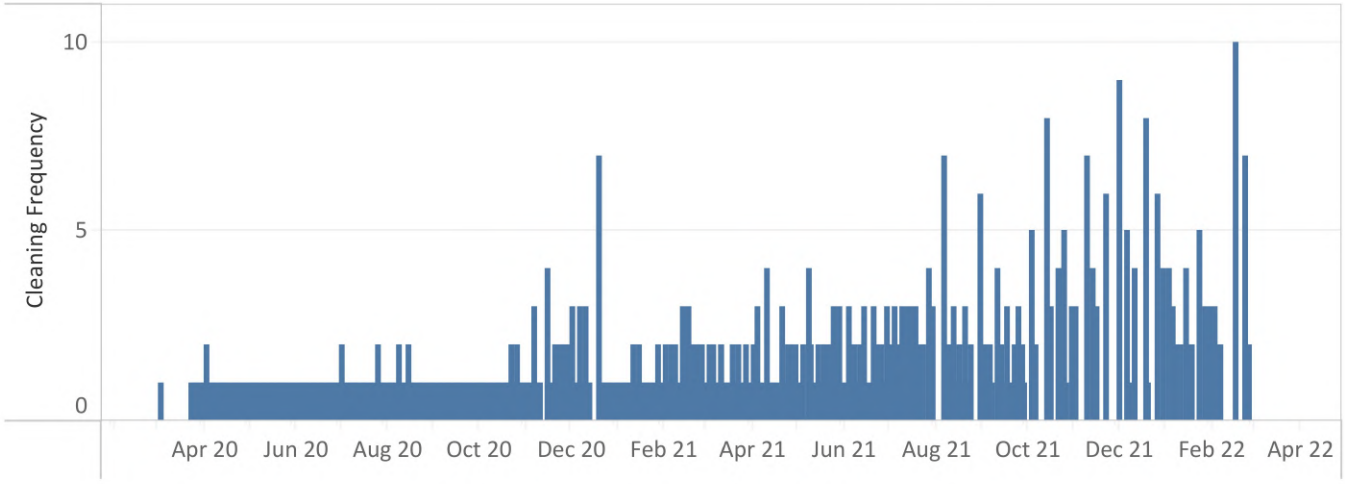

Figure 33: Consecutive days without cleaning

8.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

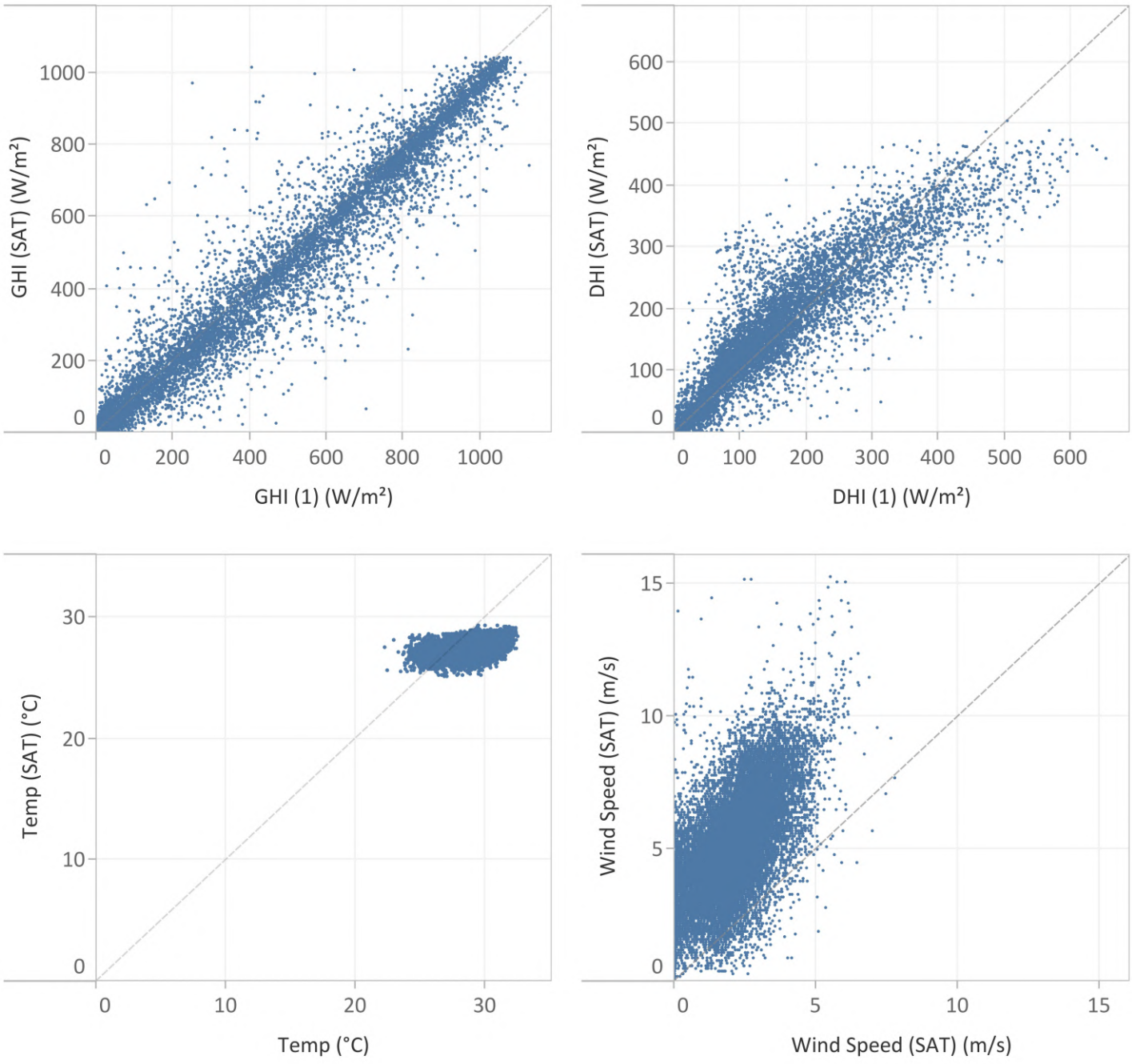

Figure 34: Ground measured data compared to satellite derived (Solargis) data

8.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.49%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

May 2020	Water residue affected early morning irradiation measurement on the following day:22 May 2020.
June 2020	Water residue affected early morning irradiation measurement on the following day:6 June 2020.
August 2020	Hourly satellite data for the following timestamps were removed due to no data value available:1 August 2020 08:00 until 11:00. The daily value was removed due to insufficient hourly values.
November 2020	Water residue affected early morning irradiation measurement on the following day:15 November 2020
February 2021	The anemometer is suspected of recording inaccurate Wind Speed values from 14 February until 17 February 2021. Data during this time period has been removed. The temperature and humidity senso rrecorded faulty values during the month of February. Humidity data is affected from 5 February 2021 and Temperature data from 18 February 2021
March 2021	The temperature and humidity sensor recorded faulty values during the month of March 2021, all affected data was removed.Water residue affected early morning irradiation measurement on the following day:23 March 2021.
April 2021	Water residue affected early morning irradiation measurement on the following day:4 April 2021. The temperature and humidity sensor recorded faulty values until 14 April 2021, all affected data was removed. A site visit was conducted on 14 April 2021, during which the temperature and humidity sensor was r..
May 2021	Water residue affected early morning irradiation measurement on the following days:6 and 18 May 2021.
July 2021	Water residue affected early morning irradiation measurement on the following days:7 and 18 July 2021.
August 2021	Water residue affected early morning irradiation measurement on the following days:3, 5 and 15 August 2021.

September 2021	Water residue affected early morning irradiation measurement on the following days:6 and 23 September 2021.
October 2021	Water residue affected early morning irradiation measurement on the following day:27 October 2021.
December 2021	Water residue affected early morning irradiation measurement on the following days:13 and 31 December 2021.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	99.61	99.61	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Apr	99.78	99.78	100.00	99.99	99.99	99.99	99.99	99.99	99.99	100.00	100.00
	May	99.66	99.66	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.68	99.68	100.00	99.99	99.99	99.99	99.99	99.99	99.99	100.00	100.00
	Jul	99.95	99.95	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.93	99.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.84	99.84	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.93	99.93	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.94	99.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.68	99.68	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.93	99.93	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	100.00	100.00	100.00	61.64	15.48	100.00	87.36	100.00	100.00	100.00	100.00
	Mar	99.90	99.90	100.00	0.00	0.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.60	99.60	99.79	55.26	55.26	99.90	99.90	99.90	99.88	99.79	99.79
	May	99.75	99.75	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.88	99.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.78	99.78	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.80	99.80	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Sept	99.93	99.93	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.84	99.84	99.99	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Nov	99.98	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.87	99.87	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2022	Jan	99.94	99.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.92	99.92	99.99	100.00	100.00	100.00	100.00	100.00	100.00	99.99	99.99
	Mar	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total		99.84	99.84	99.99	92.44	90.67	99.99	99.51	99.99	99.99	99.99	99.99

9. Papua New Guinea

9.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020	75	153
April 2020	59	178
May 2020	64	124
June 2020	64	100
July 2020	62	93
August 2020	66	139
September 2020	77	109
October 2020	75	169
November 2020	75	160
December 2020	65	199
January 2021	73	177
February 2021	78	149
Total (kWh/m²/year)	833	1749

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	73	177
April 2021	69	139
May 2021	65	133
June 2021	61	108
July 2021	61	112
August 2021	66	109
September 2021	72	117
October 2021	69	199
November 2021	56	207
December 2021	86	176
January 2022	85	186
February 2022	78	150
March 2022	80	190
Total (kWh/m²/year)	922	2003

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	6	5	1								0	3
6 pm	87	76	51	30	18	19	22	29	24	38	48	77
5 pm	228	210	182	167	131	128	127	146	122	186	199	213
4 pm	404	386	360	378	283	246	250	296	259	366	379	317
3 pm	573	523	550	558	424	359	346	435	384	559	560	511
2 pm	729	638	716	668	562	468	445	538	499	708	729	709
1 pm	822	700	799	734	615	533	506	577	529	790	803	795
12 pm	822	737	802	740	619	512	493	584	537	851	809	856
11 am	768	733	738	710	539	472	436	526	508	767	771	796
10 am	618	622	637	597	437	363	341	415	422	688	702	735
9 am	448	421	425	421	311	240	217	283	285	524	558	552
8 am	252	212	218	206	145	99	98	140	149	308	363	330
7 am	76	50	50	43	29	15	13	23	36	116	150	131
6 am	2								1	7	14	10

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm	7	5	1								0	4
6 pm	64	62	40	25	16	18	21	24	22	28	35	61
5 pm	135	139	113	99	77	90	90	95	93	92	96	128
4 pm	219	214	188	186	148	160	161	176	184	152	156	177
3 pm	251	285	252	244	219	223	210	231	257	213	193	254
2 pm	289	347	303	267	244	269	258	283	322	265	234	287
1 pm	308	367	318	280	285	303	287	290	359	280	255	283
12 pm	332	375	317	280	304	293	288	292	339	306	272	294
11 am	323	341	306	272	282	259	248	274	309	309	280	302
10 am	260	284	256	210	237	232	209	224	270	279	260	264
9 am	193	207	181	153	165	160	138	157	190	201	197	183
8 am	125	118	104	91	84	69	72	84	108	129	130	127
7 am	49	37	30	26	22	12	11	18	29	59	68	68
6 am	2								0	5	10	8

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	25	25	25	25	24	24	24	23	24	24	25	25
10 pm	25	25	25	25	24	24	24	23	24	25	25	25
9 pm	26	25	25	25	25	25	24	24	24	25	26	26
8 pm	26	26	26	26	25	25	25	24	25	26	26	26
7 pm	27	27	27	27	26	25	25	25	25	26	27	27
6 pm	29	28	28	28	27	26	26	26	26	28	28	29
5 pm	30	29	29	29	28	27	27	27	26	29	29	29
4 pm	31	30	30	30	28	28	27	27	27	29	30	30
3 pm	31	31	31	30	29	28	27	27	27	30	30	31
2 pm	32	31	31	31	29	28	27	28	27	30	31	31
1 pm	32	31	31	31	29	28	27	27	27	30	31	31
12 pm	32	31	31	30	29	28	27	27	27	30	30	32
11 am	31	31	31	30	28	28	27	27	27	29	30	31
10 am	30	30	30	29	28	27	26	26	26	29	30	31
9 am	29	28	28	28	27	26	25	25	26	28	29	30
8 am	27	26	26	26	25	24	24	24	24	27	28	28
7 am	24	24	24	24	24	23	23	22	23	24	25	25
6 am	24	23	23	23	23	23	23	22	23	23	24	24
5 am	24	24	24	23	23	23	23	22	23	23	24	24
4 am	24	24	24	24	24	23	23	22	23	23	24	24
3 am	24	24	24	24	24	24	23	22	23	23	24	24
2 am	24	24	24	24	24	24	24	22	23	24	24	24
1 am	24	24	24	24	24	24	24	23	23	24	24	24
12 am	25	24	24	24	24	24	24	23	24	24	24	25

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	97	98	98	97	98	98	98	98	98	98	96	98
10 pm	96	97	97	96	97	98	97	97	97	96	95	97
9 pm	94	95	95	94	96	97	96	96	97	95	93	95
8 pm	92	93	93	92	94	96	95	94	95	93	90	92
7 pm	87	89	90	88	91	94	93	92	93	90	86	88
6 pm	80	84	85	83	88	91	91	89	91	85	82	83
5 pm	76	79	80	78	84	87	88	85	88	81	78	79
4 pm	73	76	76	74	82	85	87	83	86	79	76	77
3 pm	71	73	73	73	80	85	86	82	85	78	74	74
2 pm	69	72	72	72	80	84	85	81	84	77	73	72
1 pm	68	71	70	71	80	85	85	81	86	76	73	71
12 pm	68	71	72	72	80	85	85	82	86	76	74	69
11 am	71	73	73	74	82	86	87	83	87	78	74	70
10 am	76	77	77	78	85	89	89	86	89	80	76	73
9 am	81	84	84	83	89	93	94	91	93	84	79	79
8 am	92	95	93	92	96	98	99	97	98	92	86	88
7 am	99	99	99	98	99	100	99	100	100	98	95	97
6 am	100	100	100	99	99	100	99	100	100	100	98	99
5 am	99	99	100	99	99	100	99	100	100	100	98	99
4 am	99	99	99	99	99	100	99	100	100	100	98	99
3 am	99	99	99	99	99	100	99	99	99	99	98	99
2 am	99	98	99	98	99	99	99	99	99	99	98	99
1 am	99	98	99	98	99	99	99	99	99	99	97	99
12 am	98	98	98	98	98	99	99	98	99	98	97	98

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	30.2	14.0	12.4	3.2	20.6	28.2	15.2	32.2	40.0	4.0	7.2	1.0
10 pm	4.6	19.4	23.4	2.4	17.0	21.0	11.6	35.0	19.8	1.0	0.0	0.6
9 pm	33.2	7.2	16.4	4.4	13.6	9.2	11.6	14.8	6.4	1.0	4.8	2.2
8 pm	20.0	13.2	7.6	13.8	13.2	16.0	13.0	16.8	9.0	2.2	1.4	5.0
7 pm	34.8	28.0	22.6	13.0	16.0	15.0	8.2	18.0	18.2	5.8	0.8	2.0
6 pm	58.2	23.0	28.0	8.4	16.2	10.0	4.4	12.6	16.0	3.8	0.0	2.6
5 pm	17.6	10.6	35.2	10.6	31.4	4.2	12.2	5.0	6.6	3.4	8.8	16.0
4 pm	3.8	12.4	41.2	15.2	13.6	13.6	8.2	7.0	9.8	0.0	1.0	49.4
3 pm	20.4	5.6	12.6	34.4	20.0	24.6	27.0	13.8	2.8	0.0	10.6	56.4
2 pm	34.6	23.2	15.2	10.6	30.4	19.6	33.0	11.8	6.8	0.6	4.0	3.2
1 pm	12.8	18.6	7.0	2.4	34.4	17.0	37.2	12.8	13.8	12.6	2.8	11.6
12 pm	0.6	16.6	2.6	3.8	63.4	7.6	41.4	23.6	20.8	1.0	4.6	4.8
11 am	0.8	1.4	9.6	0.0	27.0	37.0	35.6	40.8	14.2	0.6	20.0	2.2
10 am	1.8	2.4	0.4	2.6	7.2	24.4	23.6	31.6	10.6	0.0	2.8	3.8
9 am	2.0	1.8	1.6	4.8	46.4	5.4	25.8	28.4	16.8	2.4	8.2	8.6
8 am	3.4	0.8	0.0	13.4	64.8	11.0	30.0	18.8	23.2	1.2	0.2	7.4
7 am	4.0	4.2	0.6	2.2	34.4	18.8	24.0	14.2	26.0	2.0	0.2	15.0
6 am	5.8	2.4	2.0	12.2	12.8	22.6	31.2	9.2	34.0	7.6	6.6	4.4
5 am	4.8	1.6	1.6	4.8	27.6	26.8	101.0	19.4	20.8	13.0	4.0	4.2
4 am	7.6	0.4	5.2	6.4	17.8	47.2	59.0	22.6	31.0	4.6	4.4	4.2
3 am	12.8	0.4	11.4	5.2	26.6	16.2	67.8	37.4	36.2	0.4	0.4	0.2
2 am	3.4	1.8	11.6	19.6	32.8	22.4	49.2	29.2	31.0	1.2	0.4	3.2
1 am	5.4	1.4	5.4	5.2	23.4	13.4	49.0	29.6	16.2	2.4	0.4	0.6
12 am	4.0	7.4	8.0	1.4	24.2	16.4	30.6	24.2	21.8	3.4	1.4	1.8

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	997	997	998	999	1,000	1,001	1,001	1,002	1,001	1,000	998	997
10 pm	996	997	998	999	1,000	1,001	1,001	1,002	1,001	1,000	998	997
9 pm	996	996	997	999	1,000	1,001	1,000	1,001	1,001	999	998	997
8 pm	996	996	997	998	999	1,000	1,000	1,001	1,001	999	998	996
7 pm	995	995	996	997	999	1,000	999	1,000	1,000	998	997	995
6 pm	994	994	995	997	998	999	999	1,000	999	997	996	995
5 pm	994	994	995	996	997	999	998	999	999	996	996	994
4 pm	993	994	995	996	997	998	998	999	998	996	995	994
3 pm	994	994	995	996	997	998	998	999	999	996	995	994
2 pm	994	994	995	996	998	999	999	1,000	999	997	996	995
1 pm	995	995	996	997	998	1,000	999	1,000	1,000	998	997	995
12 pm	996	996	997	998	999	1,001	1,000	1,001	1,001	999	998	996
11 am	996	997	998	999	1,000	1,001	1,001	1,002	1,002	999	998	997
10 am	997	997	998	999	1,001	1,002	1,001	1,002	1,002	1,000	999	997
9 am	997	997	998	999	1,001	1,001	1,001	1,002	1,002	1,000	999	997
8 am	996	997	998	999	1,000	1,001	1,000	1,002	1,001	1,000	999	997
7 am	996	996	997	998	999	1,000	1,000	1,001	1,000	999	998	996
6 am	995	995	996	997	999	1,000	999	1,000	1,000	998	997	996
5 am	995	995	996	997	998	999	999	1,000	999	998	997	995
4 am	994	995	996	997	998	999	999	1,000	999	997	996	995
3 am	995	995	996	997	998	999	999	1,000	999	997	996	995
2 am	995	995	996	997	999	1,000	999	1,000	1,000	998	997	995
1 am	996	996	997	998	999	1,000	1,000	1,001	1,000	998	997	996
12 am	996	997	998	999	1,000	1,001	1,000	1,001	1,001	999	998	997

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.4	0.4	0.2	0.2	0.2
10 pm	0.3	0.3	0.3	0.4	0.5	0.5	0.6	0.5	0.5	0.3	0.3	0.2
9 pm	0.4	0.3	0.3	0.5	0.6	0.6	0.8	0.6	0.7	0.4	0.4	0.3
8 pm	0.4	0.5	0.4	0.6	0.8	0.8	0.9	0.8	1.0	0.7	0.7	0.4
7 pm	0.7	0.8	0.8	0.9	1.1	0.9	1.2	1.0	1.2	1.2	1.1	0.6
6 pm	1.3	1.2	1.3	1.4	1.7	1.5	1.8	1.7	1.6	2.0	1.6	1.1
5 pm	1.9	1.7	2.0	2.1	2.4	2.3	2.6	2.4	2.2	2.9	2.4	1.7
4 pm	2.4	2.3	2.5	2.7	2.9	2.8	2.9	2.8	2.7	3.5	2.9	2.3
3 pm	2.7	2.4	2.8	2.8	3.1	3.0	3.1	3.1	3.0	3.8	3.2	2.9
2 pm	2.7	2.4	2.8	2.9	3.2	3.1	3.1	3.0	3.0	3.7	3.2	3.0
1 pm	2.6	2.2	2.6	2.6	3.1	2.9	3.1	2.8	2.9	3.6	3.0	2.8
12 pm	2.2	2.1	2.3	2.4	2.7	2.4	2.6	2.4	2.7	3.2	2.9	2.3
11 am	1.7	1.7	1.8	2.1	2.2	2.0	2.1	2.0	2.3	2.7	2.7	1.9
10 am	1.2	1.2	1.3	1.4	1.6	1.3	1.5	1.5	1.7	2.3	2.2	1.5
9 am	0.8	0.7	0.7	0.8	1.0	0.6	0.8	0.9	0.9	1.4	1.6	1.0
8 am	0.5	0.4	0.3	0.4	0.5	0.3	0.4	0.4	0.5	0.5	0.8	0.6
7 am	0.3	0.2	0.2	0.2	0.3	0.2	0.4	0.3	0.3	0.2	0.4	0.4
6 am	0.2	0.1	0.2	0.2	0.4	0.3	0.5	0.3	0.2	0.1	0.2	0.2
5 am	0.2	0.1	0.2	0.3	0.4	0.3	0.5	0.2	0.3	0.1	0.2	0.2
4 am	0.2	0.1	0.2	0.3	0.4	0.3	0.4	0.2	0.2	0.1	0.2	0.2
3 am	0.2	0.1	0.2	0.3	0.4	0.3	0.4	0.2	0.2	0.1	0.2	0.2
2 am	0.2	0.2	0.2	0.3	0.4	0.3	0.5	0.3	0.3	0.1	0.2	0.2
1 am	0.2	0.2	0.2	0.3	0.3	0.3	0.5	0.4	0.3	0.1	0.2	0.2
12 am	0.2	0.2	0.2	0.3	0.5	0.5	0.6	0.4	0.3	0.2	0.2	0.2

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	W NW	W	W	NW	W	W	W	W	W	NW	NW	W
10 pm	W	NW	NW	NW	NW	W	NW	NW	NW	NW	NW	W
9 pm	NW	NW	NW	NW	NW	NE	NE	NW	NW	NW	NW	NW
8 pm	NW	NW	NW	NW	W	NE	NE	NE	NW	NE	NW	NW
7 pm	W	W	NW	NW	NE	NE	NE	NE	E	E	E	W
6 pm	W	W	E	E	E	E	E	E	E	E	N E	E
5 pm	W	SW	E	E	E	E	E	E	E	E	E	E
4 pm	SW	SW	E	E	E	E	E	E	E	E	E	E
3 pm	SW	SW	E	E	E	E	E	E	E	E	E	E
2 pm	SW	SW	E	E	E	E	E	E	E	E	E	E
1 pm	SW	SW	SE	E	E	E	E	E	E	E	E	E
12 pm	SW	SW	E	E	E	E	E	E	E	E	E	SW
11 am	SW	SW	E	E	E	E	E	E	E	E	E	SW
10 am	SW	SW	SE		E	E	E	E	E	SE E	SE	SW
9 am	SW	SW	SW SE	W	W	W	NW	W	E	SE E	SE	SW
8 am	W	W	W	W	W	W	W	W	W	W	W	W
7 am	W	W	W	W	W	W	W	W	NW	W	W	W
6 am	W	W	W	W	W	W	W	W	NW	NW	W	W
5 am	W	W	NW	W	W	W	W	W	NW	W	W	W
4 am	W	W	W	W	W	W	W	W	NW	W	W	W
3 am	W	NW	W	W	W	W	W	W	W NW	W	W	W
2 am	W	NW	W	W	W	W	W	W	W NW	W	W	W
1 am	NW	W	W	W	W	W	W	W	W	W	W	W
12 am	W	NW	W	W	W	W	W	W	W	W	W	W

Figure 9: Dominant hourly Wind Direction

9.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

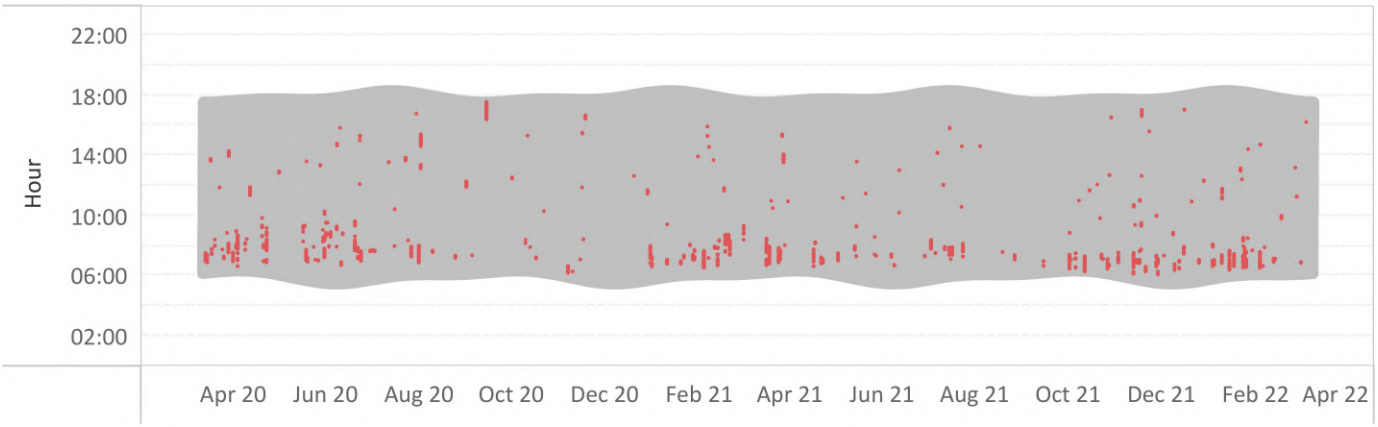

Figure 10: Quality control for GHI (1)

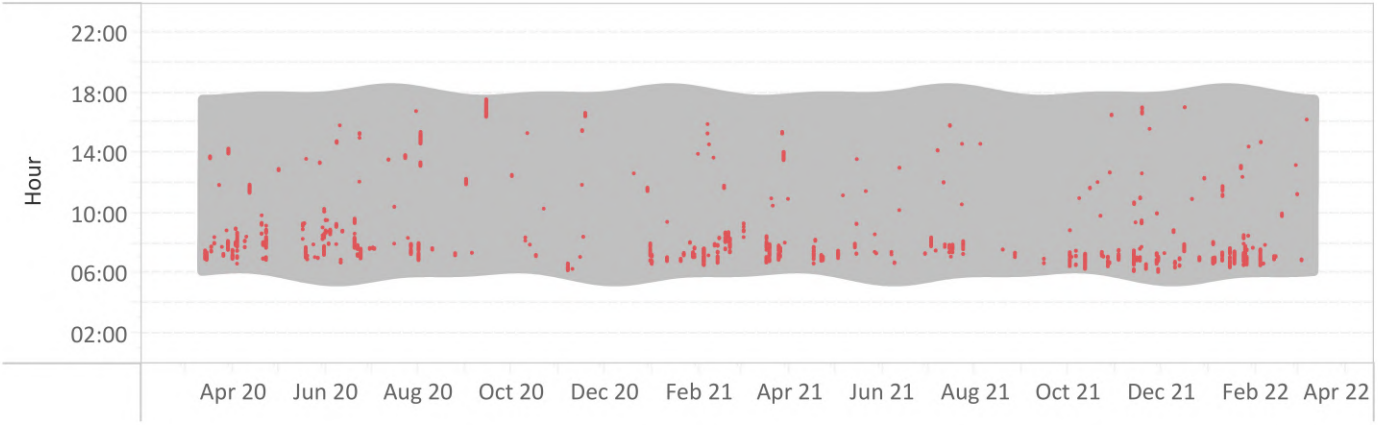

Figure 11: Quality control for GHI (2)

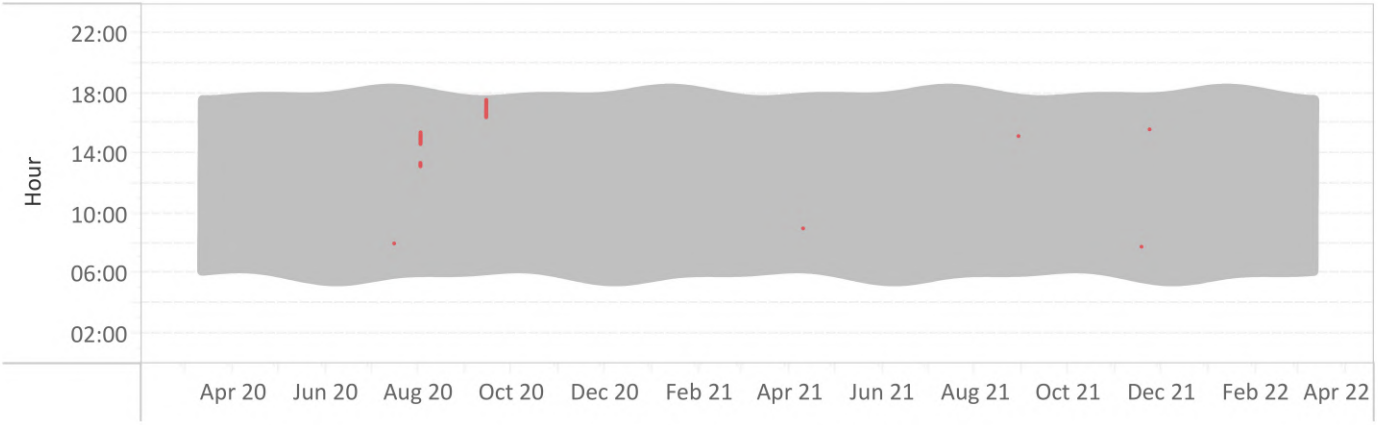

Figure 12: Quality control for DHI (1)

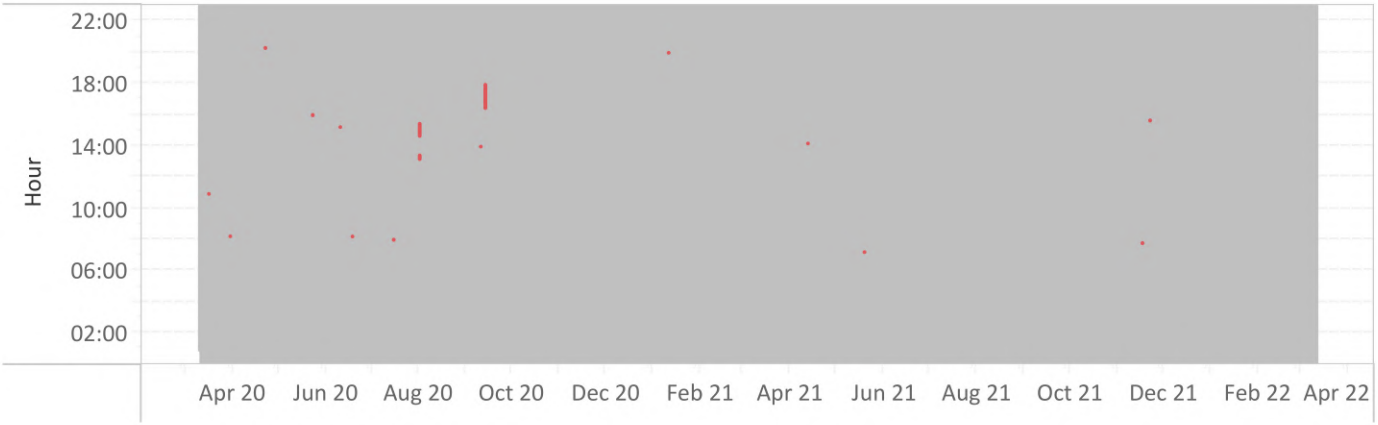

Figure 13: Quality Control for Temp

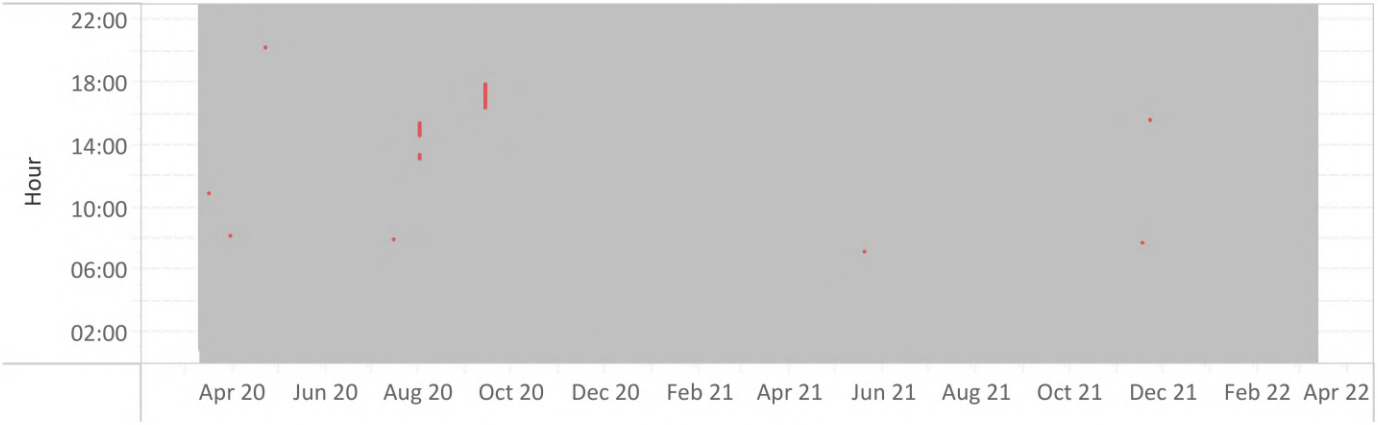

Figure 14: Quality Control for RH

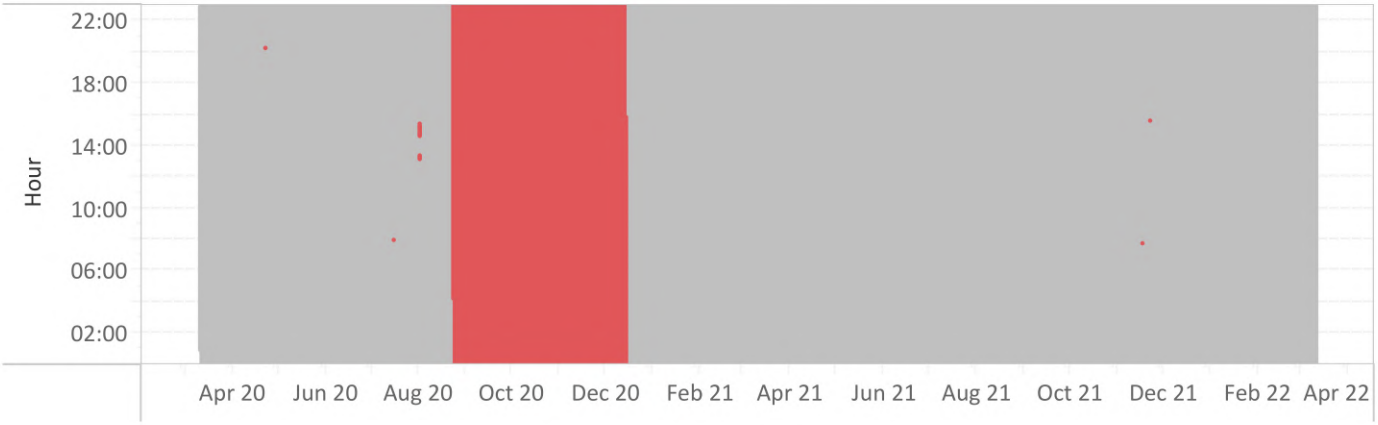

Figure 15: Quality Control for Rain

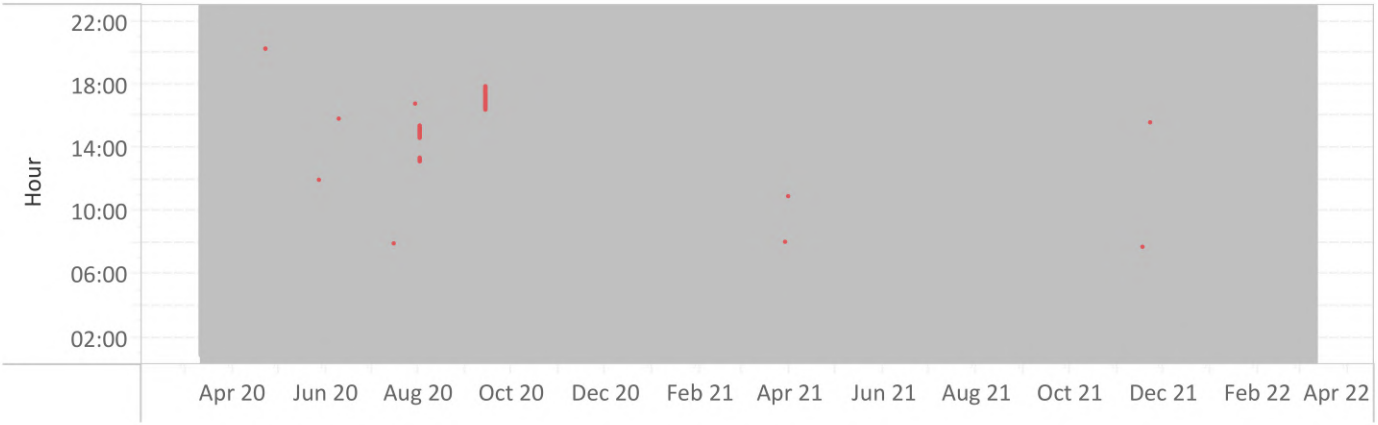

Figure 16: Quality Control for BP

Figure 17: Quality Control for Wind Direction

Figure 18: Quality Control for Wind Speed

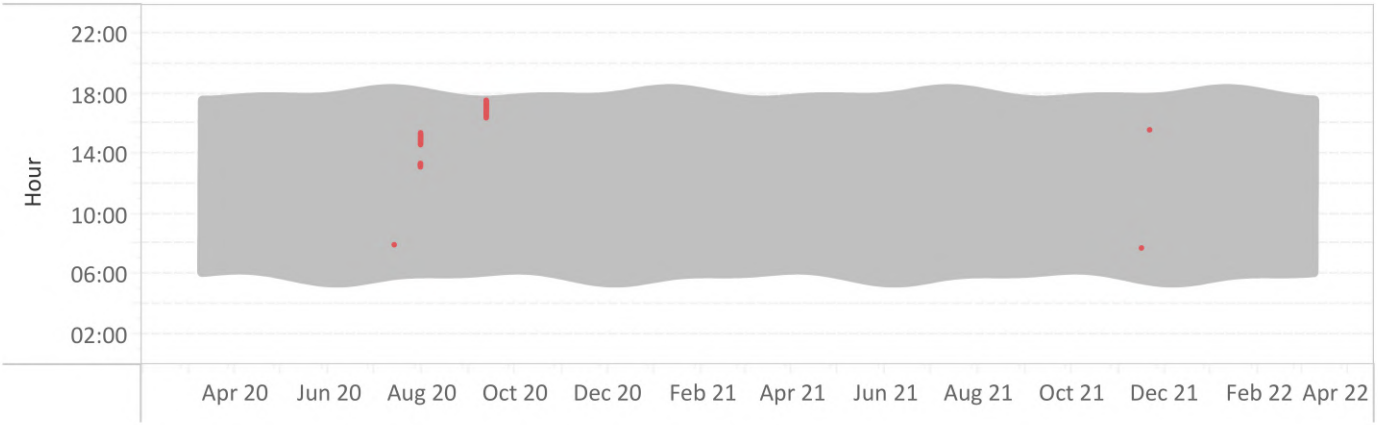

Figure 19: Quality control for soiling measurement (monthly cleaned)

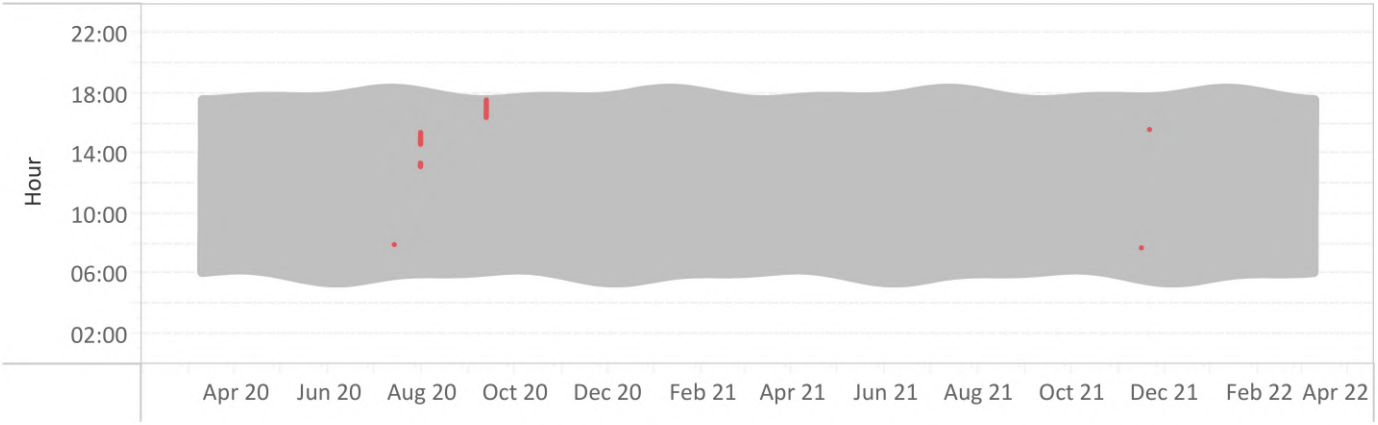

Figure 20: Quality control for soiling measurement (continuous soiling)

9.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

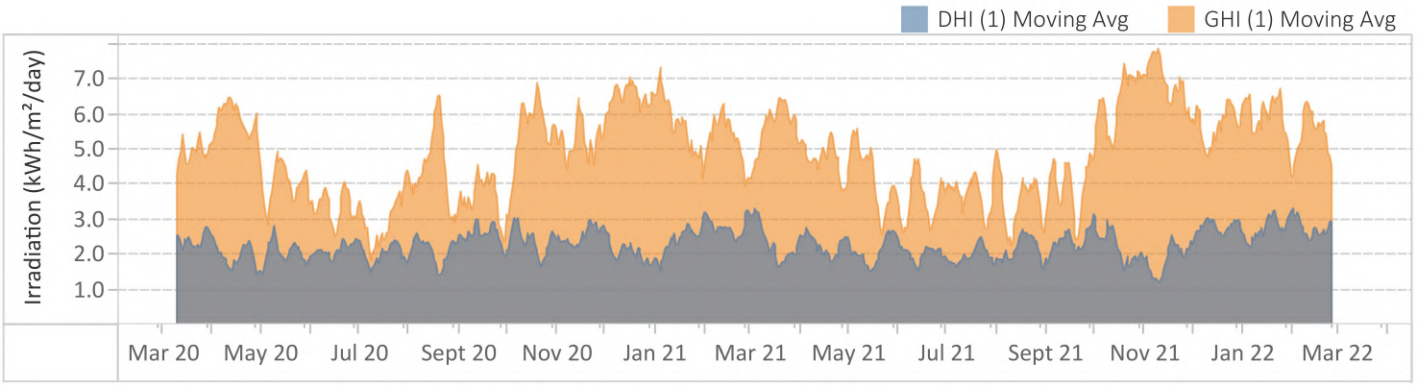

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

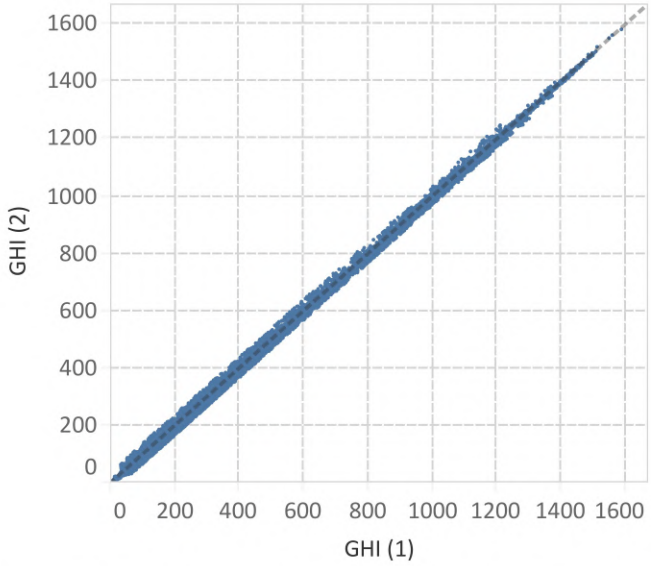

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

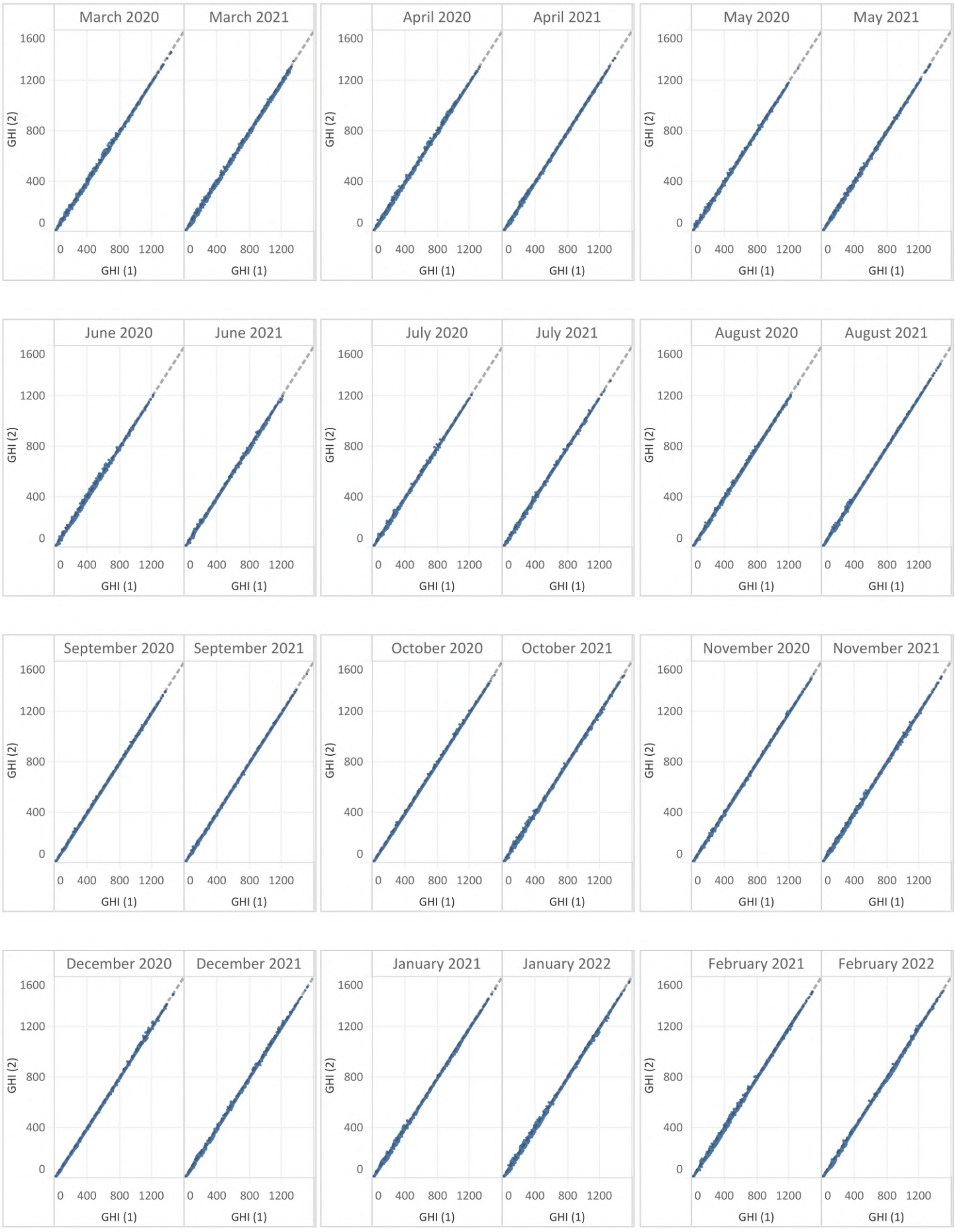

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

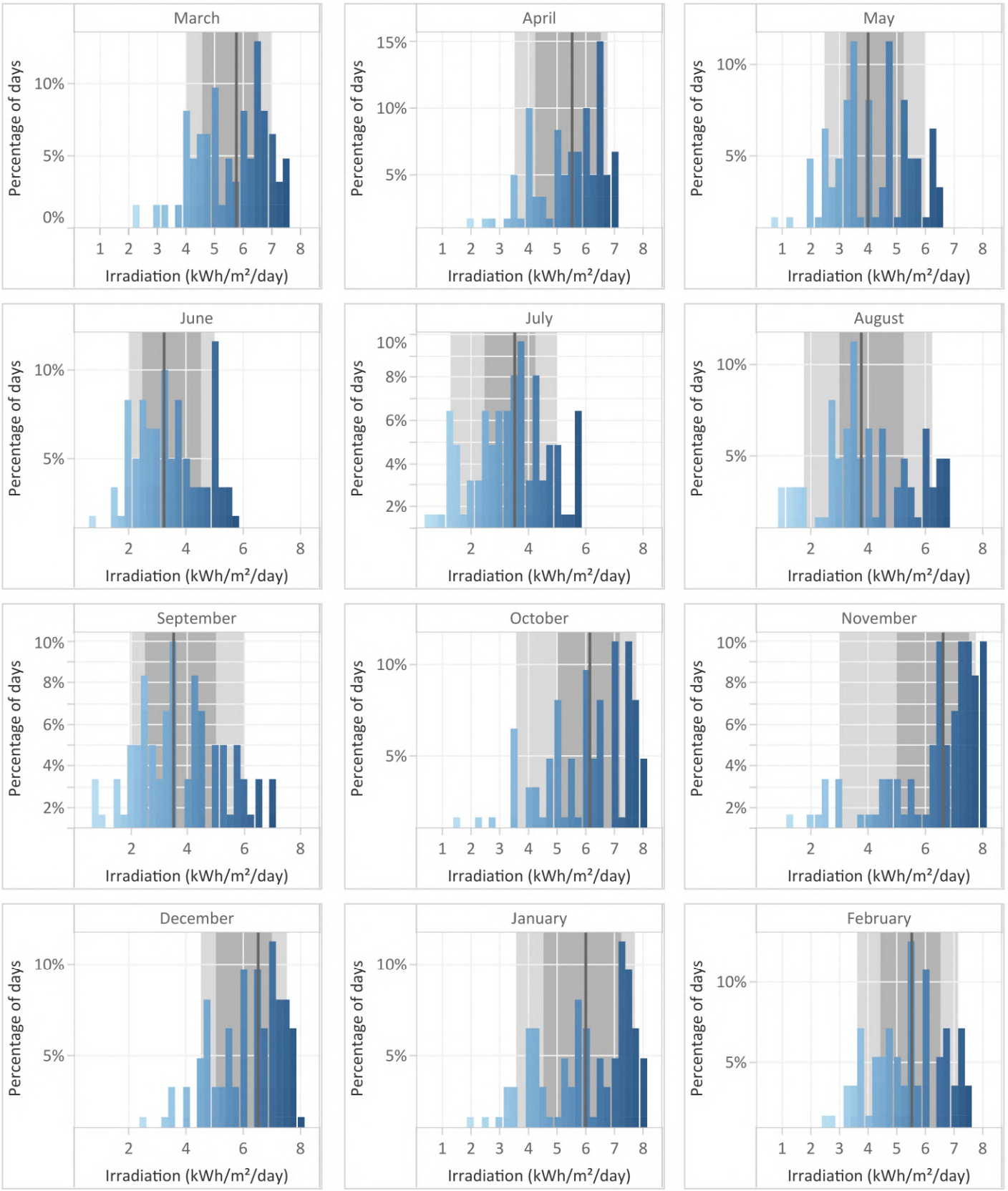

Figure 24: Daily summary of GHI (1)

9.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

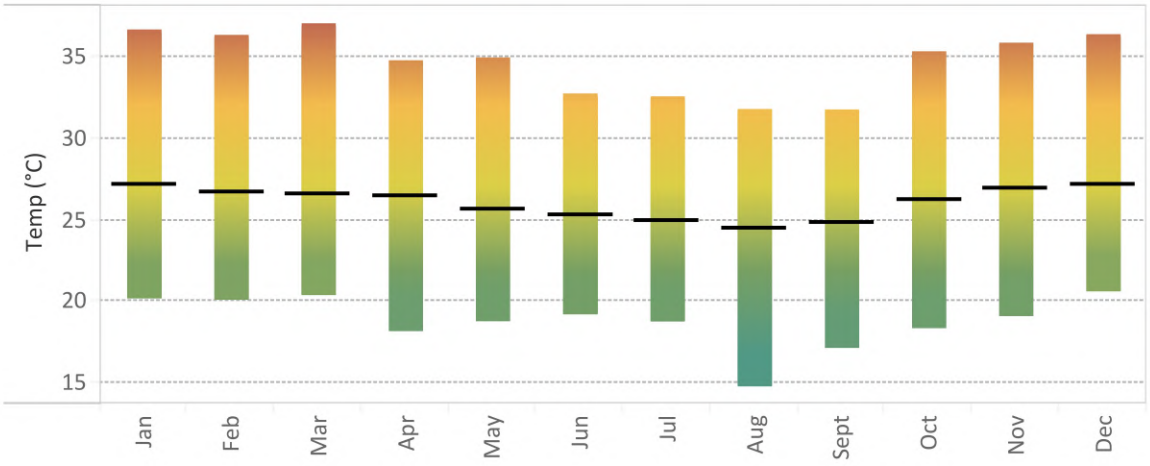

Figure 25: Monthly average, maximum and minimum temperature

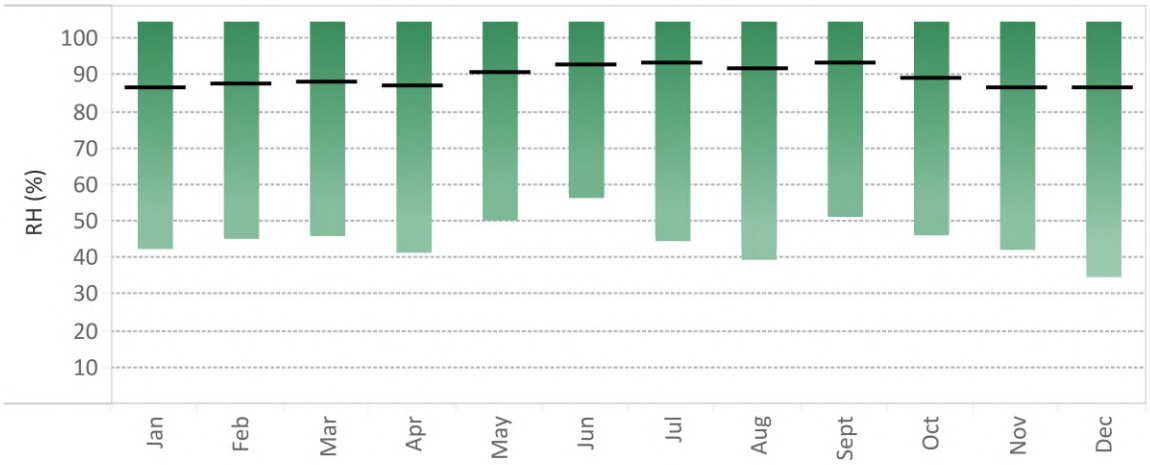

Figure 26: Monthly average, maximum and minimum relative humidity

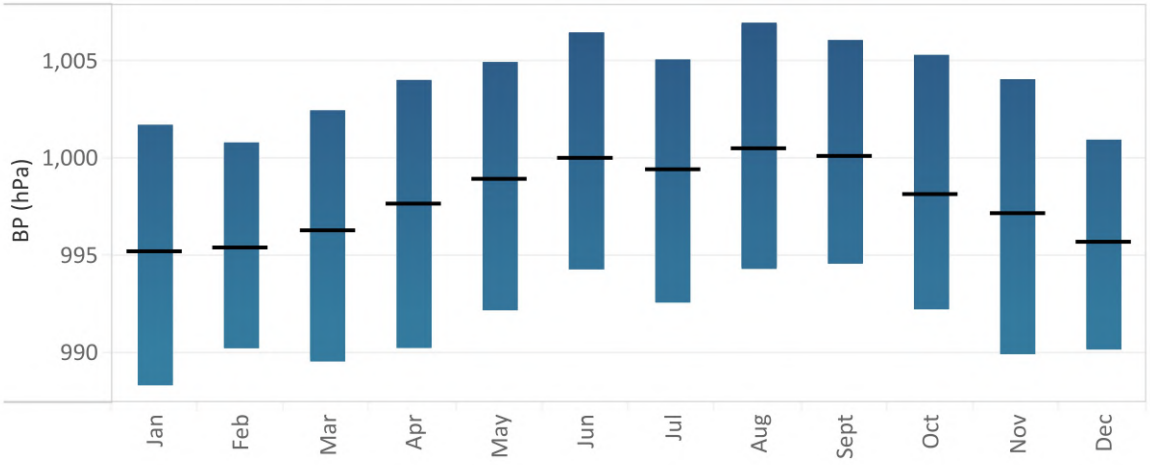

Figure 27: Monthly average, maximum and minimum barometric pressure

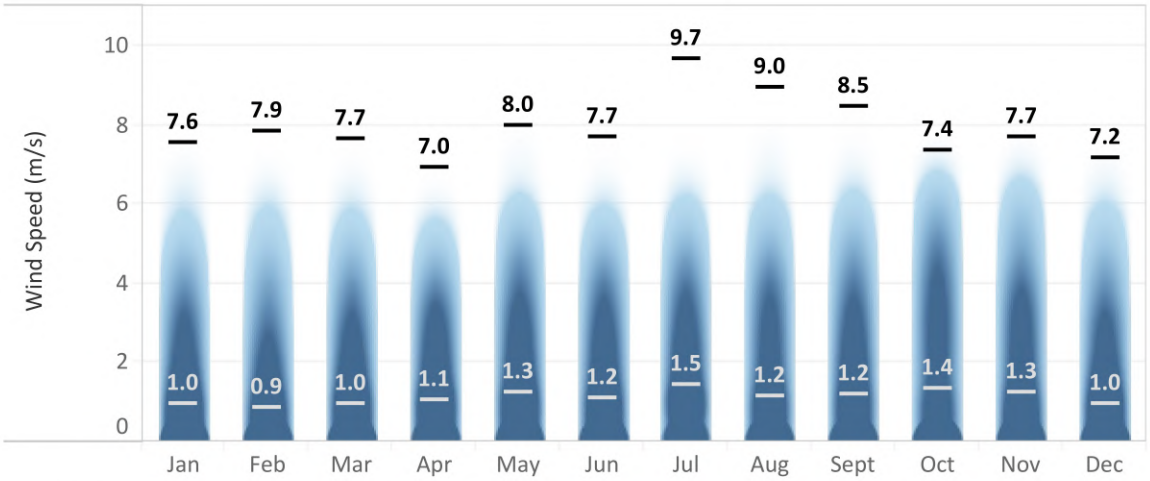

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

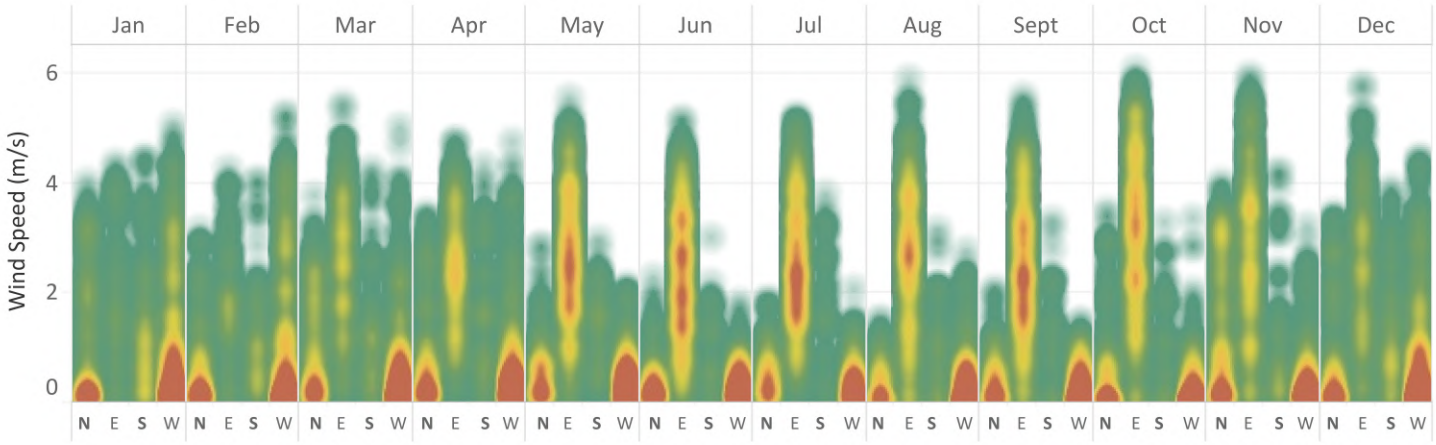

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

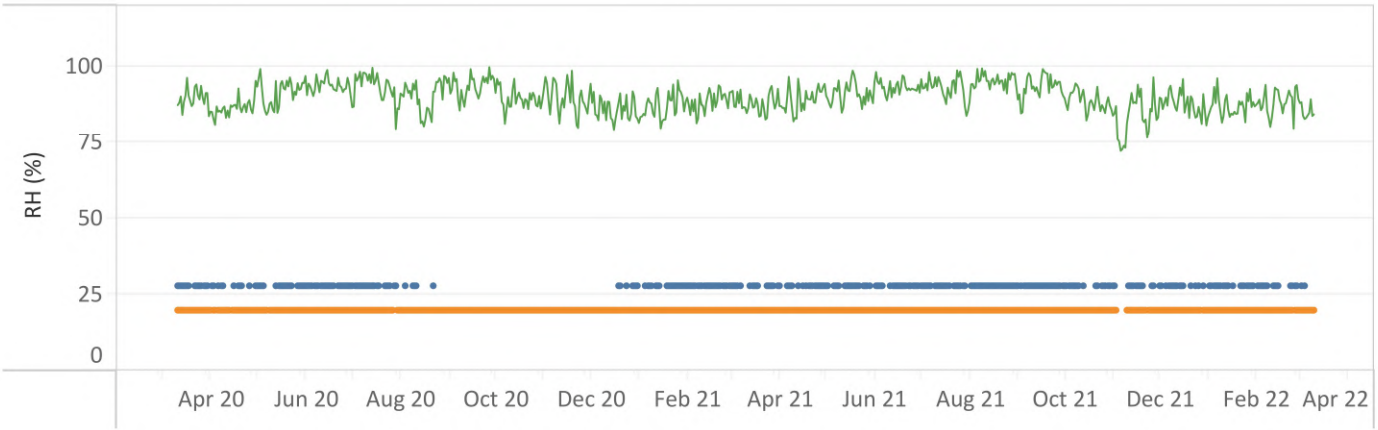

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

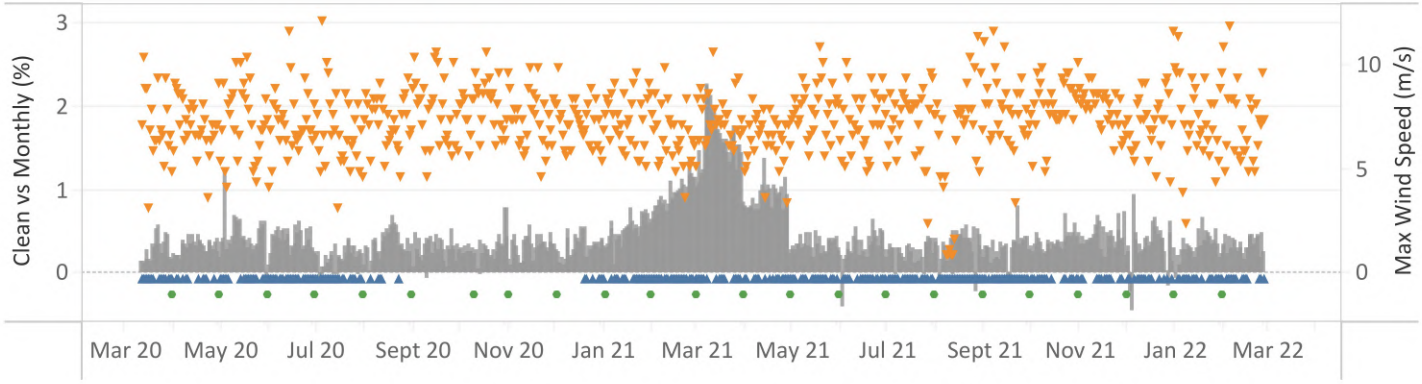

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

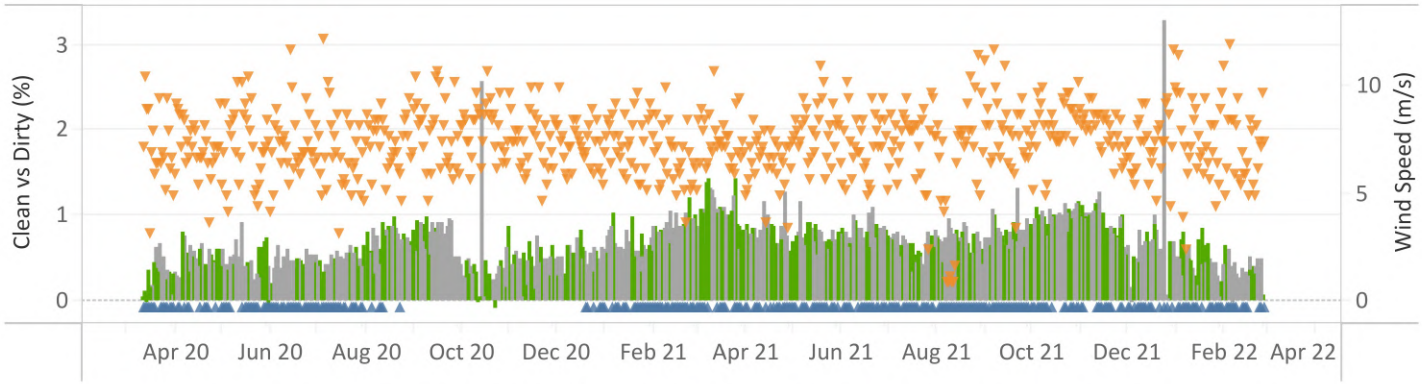

Figure 32: Soiling Measurement (Clean vs Dirty)

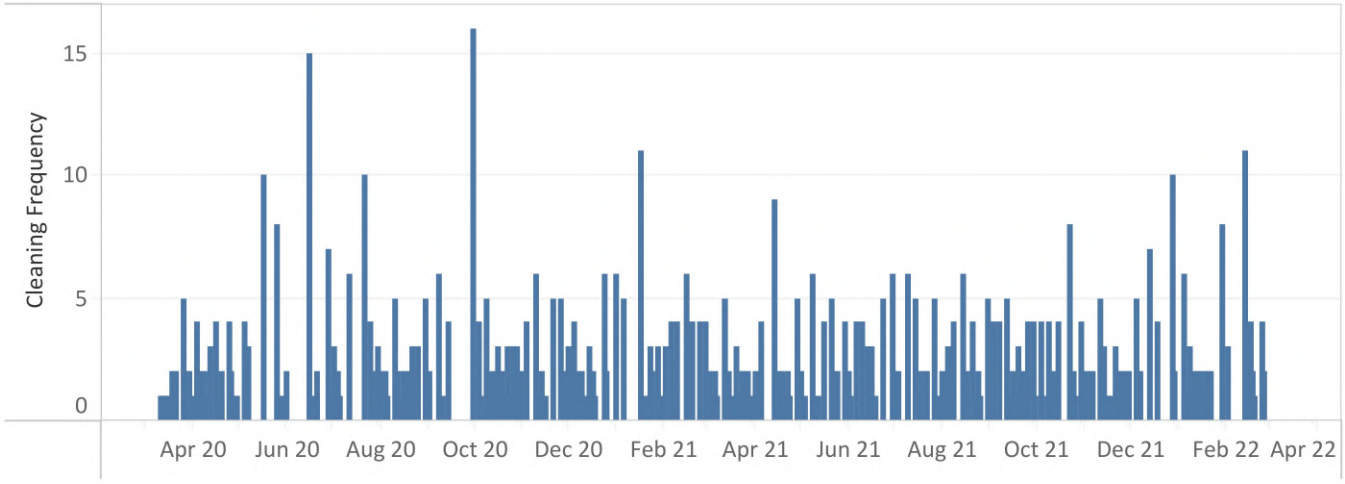

Figure 33: Consecutive days without cleaning

9.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

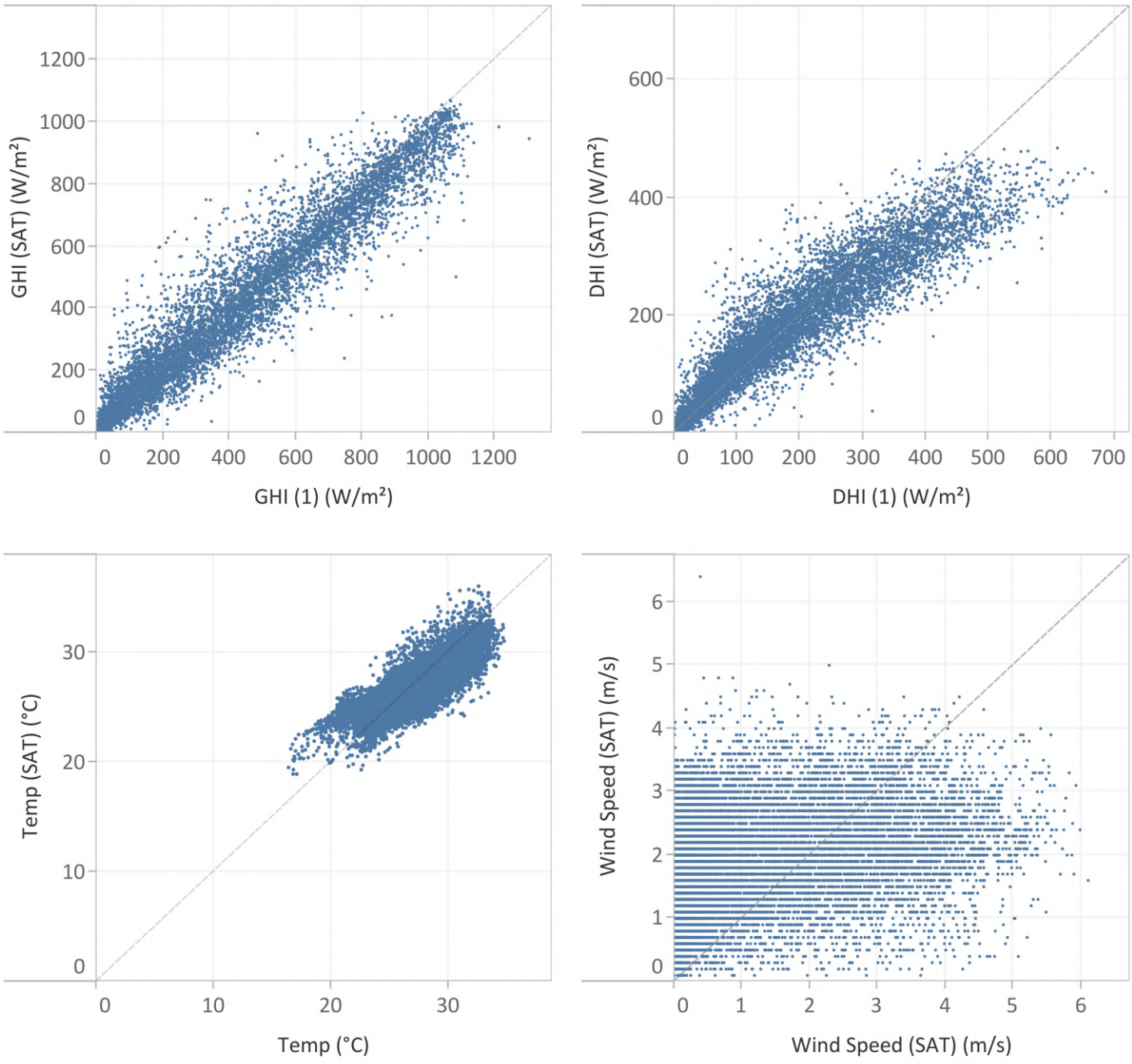

Figure 34: Ground measured data compared to satellite derived (Solargis) data

9.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.93%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

March 2020	Water Residue affected early morning irradiation measurements on the following days: 15, 16, 19, 21, 27 and 30 March 2020.
April 2020	Water residue affected early morning irradiation measurements on the following days: 2, 4, 5, 22 and 24 April 2020. The pyranometer measuring GHI (1)measured slightly lower irradiation for a couple of minutes due to soiling during the following day: 19 April 2020. GHI (2) was not affected. The pyranometer measuring GHI(2)measured slightly lower irradiation for a couple of minutes due to soiling during the following day: 13 April 2020. GHI (1) was not affected.
May 2020	Water residue affected early morning irradiation measurements on the following day: 20 May 2020.
June 2020	Water residue affected early morning irradiation measurements on the following days: 1, 5, 21, 23 and 25 June 2020.
July 2020	Water residue affected early morning irradiation measurements on the following day: 28 July 2020.
August 2020	Water residue affected early morning irradiation measurements on the following day: 2 August 2020. A site visit was conducted on 3 August 2020. Data during the site visit was affected and removed. The rain gauge is suspected of measuring inaccurate values from 25 August 2020. All rain data from this date onwards has been removed as none of the data can be assumed to be correct.
September 2020	The rain gauge is suspected of measuring inaccurate values from 25 August 2020. All rain data from this date onwards has been removed as none of the data can be assumed to be correct.

October 2020	The rain gauge is suspected of measuring inaccurate values from 25 August 2020. All rain data from this date onwards has been removed as none of the data can be assumed to be correct.
November 2020	The rain gauge is suspected of measuring inaccurate values from 25 August 2020. All rain data from this date onwards has been removed as none of the data can be assumed to be correct.
December 2020	The rain gauge is suspected of measuring inaccurate values from 25 August 2020. All rain data from this date onwards has been removed as none of the data can be assumed to be correct. A site visit was conducted on 16 December 2020 during which the rain gauge was replaced.
January 2021	Water residue affected early morning irradiation measurements on the following days: 1, 12, 26 and 29 January 2021.
February 2021	Water residue affected early morning irradiation measurements on the following days :5, 14 and 22 February 2021.
March 2021	Water residue affected early morning irradiation measurements on the following days: 18, 20, 26 and 27 March 2021.
April 2021	Water residue affected early morning irradiation measurements on the following day: 18, 23, 24 April 2021.
May 2021	Water residue affected early morning irradiation measurements on the following day: 4 May 2021.
July 2021	Water residue affected early morning irradiation measurements on the following days: 4, 16, 18 and 25 July 2021. The anemometer was suspected of measuring inaccurate wind speed values for extended periods from 2 July until 30 July 2021. All affected data during this period was removed.
August 2021	Water residue affected early morning irradiation measurements on the following days: 28 August 2021. The anemometer was suspected of measuring inaccurate wind speed values for extended periods throughout the month. All affected data during this period was removed.

September 2021	The anemometer was suspected of measuring inaccurate wind speed values on 30 Spetember 2021. All affected data during this period was removed.
October 2021	Water residue affected early morning irradiation measurements on the following days: 3, 13 and 28 October 2021. The anemometer was suspected of measuring inaccurate windspeed values on 1, 12 and 16 October 2021. All affected data was removed. A site visit was conducted on 27 Octobe..
November 2021	Water residue affected early morning irradiation measurements on the following days: 4, 14, 16 and 30 November 2021.
December 2021	Water residue affected early morning irradiation measurements on the following days: 14 and 17 December 2021.
January 2022	Water residue affected early morning irradiation measurements on the following days: 5, 16, 19, 25, 26 and 27 January 2022. The anemometer was suspected of measuring inaccurate values from 30 January 2022. All affected data has been removed.
February 2022	Water residue affected early morning irradiation measurements on the following day: 5 February 2022.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	98.94	98.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	98.89	98.89	100.00	99.99	99.99	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.70	99.70	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	98.96	98.96	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.71	99.71	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.45	99.45	99.73	99.87	99.87	77.86	99.87	99.87	99.87	99.73	99.73
	Sept	99.53	99.53	99.66	99.79	99.79	0.00	99.79	99.79	99.79	99.66	99.66
	Oct	99.94	99.94	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00
	Nov	99.82	99.82	100.00	100.00	100.00	0.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.94	99.94	100.00	100.00	100.00	49.47	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.39	99.39	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	98.94	98.94	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	98.89	98.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.63	99.63	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.79	99.79	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.95	99.95	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.53	99.53	100.00	100.00	100.00	100.00	66.68	100.00	100.00	100.00	100.00
	Aug	99.95	99.95	100.00	100.00	100.00	100.00	80.92	100.00	100.00	100.00	100.00
	Sept	99.98	99.98	100.00	100.00	100.00	100.00	96.95	100.00	100.00	100.00	100.00
	Oct	99.25	99.25	100.00	100.00	100.00	100.00	98.75	99.95	100.00	100.00	100.00
	Nov	98.92	98.92	99.99	99.99	99.99	100.00	100.00	100.00	100.00	99.99	99.99
	Dec	99.66	99.66	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2022	Jan	98.52	98.52	100.00	100.00	100.00	100.00	99.01	100.00	100.00	100.00	100.00
	Feb	99.60	99.60	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.89	99.89	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total		99.47	99.47	99.97	99.98	99.98	84.45	97.54	99.98	99.98	99.97	99.97

10. Federated States of Micronesia

10.1. Monthly Summary of Ground Measured Data

This chapter summarises the monthly values of the measured data. Table 2 displays the sum of GHI (1) and DHI (1) per month, as well as the total for months measured to date. Figures 2 through to 9 indicates the hourly distribution of solar data for each month. The visual representation contrasts the measurement value between when it was higher and lower than the average. Only sunlight hours are displayed for irradiation measurements, while all hours are displayed for meteorological measurements.

Table 2: Monthly irradiation sum

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2020	72	207
April 2020	66	185
May 2020	71	154
June 2020	62	150
July 2020	65	170
August 2020	53	172
September 2020	52	158
October 2020	64	166
November 2020	60	141
December 2020	59	118
January 2021	61	155
February 2021	64	152
Total (kWh/m²/year)	749	1927

	DHI (1) kWh/m²/month	GHI (1) kWh/m²/month
March 2021	72	169
April 2021	60	183
May 2021	68	119
June 2021	64	167
July 2021	65	162
August 2021	54	192
September 2021	60	143
October 2021	57	157
November 2021	58	141
December 2021	65	137
January 2022	65	161
February 2022	66	159
March 2022	75	156
Total (kWh/m²/year)	829	2047

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm		0	0		0	1	2	1				
6 pm	40	60	59	58	41	57	67	72	36	17	10	18
5 pm	197	243	229	234	148	201	214	255	179	129	120	133
4 pm	387	425	416	442	303	365	380	456	330	304	269	291
3 pm	563	614	564	602	412	518	534	608	488	468	424	430
2 pm	663	722	670	758	502	639	692	707	607	635	603	529
1 pm	733	789	767	824	560	738	752	780	669	680	671	578
12 pm	717	764	807	853	584	724	712	792	725	744	670	594
11 am	664	724	734	784	593	664	647	730	644	702	605	536
10 am	540	592	611	674	515	568	574	601	548	613	552	450
9 am	368	398	417	519	396	432	430	469	424	489	436	326
8 am	186	200	225	280	246	267	257	295	256	300	252	170
7 am	35	39	55	89	86	96	86	92	92	110	84	46
6 am			0	3	5	5	3	2	3	5	2	0

Figure 2: Hourly averages of GHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
7 pm		0	0		0	1	2	1				
6 pm	30	44	44	41	32	42	45	43	25	14	9	15
5 pm	105	130	124	112	97	111	105	102	93	72	74	86
4 pm	176	203	191	172	167	164	170	152	156	137	143	154
3 pm	228	261	235	222	218	216	233	183	204	191	197	221
2 pm	243	279	289	259	266	260	249	206	229	234	237	267
1 pm	260	282	292	258	272	258	254	205	239	250	248	274
12 pm	270	307	297	240	283	246	258	204	245	255	260	270
11 am	240	276	298	239	292	232	242	208	212	231	243	241
10 am	199	230	254	207	250	208	208	156	182	201	218	198
9 am	155	172	183	174	185	173	163	132	145	184	177	154
8 am	100	108	119	124	123	117	114	92	91	124	116	91
7 am	25	28	37	51	54	56	47	40	43	61	49	31
6 am				2	4	4	2	1	2	3	2	0

Figure 3: Hourly averages of DHI (1) (Wh/m²)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	28	28	28	28	28	28	28	28	28	28	28	28
10 pm	28	28	28	28	28	28	28	28	28	28	28	28
9 pm	28	28	28	28	28	28	28	28	28	28	28	28
8 pm	28	28	28	28	28	28	28	28	28	28	28	28
7 pm	28	28	28	29	28	28	28	29	28	28	28	28
6 pm	28	28	28	29	28	28	29	29	29	29	29	28
5 pm	28	28	28	29	28	29	29	30	29	29	29	29
4 pm	29	28	28	29	28	29	29	30	29	30	29	29
3 pm	29	28	28	29	28	29	29	30	29	30	29	29
2 pm	28	28	28	29	28	29	29	30	29	30	29	29
1 pm	28	28	28	29	28	29	29	29	29	30	29	28
12 pm	28	28	28	29	28	29	29	29	29	30	29	28
11 am	28	28	28	29	28	29	29	29	29	30	29	28
10 am	28	28	28	29	29	29	29	29	29	30	29	28
9 am	28	28	28	29	28	29	29	29	29	30	29	28
8 am	28	28	28	29	28	29	29	29	29	29	29	28
7 am	28	28	28	28	28	28	28	28	28	28	28	28
6 am	28	28	28	28	28	28	28	28	27	28	28	28
5 am	28	28	28	28	28	28	28	28	28	28	28	28
4 am	28	28	28	28	28	28	28	28	28	28	28	28
3 am	28	28	28	28	28	28	28	28	28	28	28	28
2 am	28	28	28	28	28	28	28	28	28	28	28	28
1 am	28	28	28	28	28	28	28	28	28	28	28	28
12 am	28	28	28	28	28	28	28	28	28	28	28	28

Figure 4: Hourly Temp averages (°C)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	82	82	86	84	88	86	86	84	84	84	85	86
10 pm	82	82	85	84	87	86	85	83	84	84	85	85
9 pm	82	82	85	84	87	86	85	83	84	83	84	85
8 pm	82	82	85	83	87	86	84	83	84	82	84	85
7 pm	82	82	85	83	87	86	83	82	84	82	84	85
6 pm	81	81	85	82	86	85	82	79	82	81	83	84
5 pm	81	81	84	81	86	83	81	78	80	79	83	83
4 pm	80	81	84	81	86	82	81	78	80	78	82	83
3 pm	80	81	84	81	86	82	81	78	80	78	82	83
2 pm	80	81	84	81	86	82	81	78	80	77	81	84
1 pm	80	81	84	81	86	83	81	79	80	78	82	84
12 pm	80	81	84	81	86	83	81	79	81	78	82	84
11 am	80	81	84	82	86	83	81	79	81	78	82	84
10 am	81	81	84	82	86	84	82	80	82	78	82	85
9 am	81	81	84	82	86	84	82	80	82	79	83	85
8 am	81	82	84	83	86	84	83	81	82	80	84	85
7 am	82	82	85	85	87	86	85	84	85	84	85	86
6 am	82	83	86	86	87	87	86	86	87	86	86	85
5 am	82	83	86	86	87	87	87	86	86	85	87	85
4 am	82	83	86	86	88	87	87	86	86	85	87	86
3 am	82	83	86	86	88	86	87	86	86	85	86	86
2 am	82	83	86	86	89	87	87	85	85	85	85	86
1 am	82	82	86	85	88	86	87	85	85	85	85	86
12 am	82	82	86	84	88	86	86	85	85	84	85	86

Figure 5: Hourly RH averages (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	2.8	7.0	29.6	1.0	16.4	18.2	6.6	6.2	5.4	23.4	4.8	14.6
10 pm	4.2	1.0	37.2	7.4	14.8	10.8	17.6	8.8	0.8	29.4	20.2	35.6
9 pm	5.8	3.0	48.8	32.4	8.8	5.4	24.4	3.2	10.6	26.8	26.0	78.6
8 pm	7.6	2.4	3.0	54.0	7.0	6.2	22.6	29.2	10.6	15.8	7.8	55.6
7 pm	10.8	9.8	7.4	13.2	8.6	49.4	23.6	31.0	36.6	34.8	21.6	30.0
6 pm	2.6	2.8	25.6	10.8	35.2	27.4	13.2	12.6	33.6	73.8	19.4	10.8
5 pm	4.6	3.0	17.4	16.0	19.2	20.8	17.8	3.6	17.2	29.8	17.8	26.2
4 pm	12.2	8.6	30.2	7.6	19.0	24.8	30.0	11.0	21.4	22.4	24.4	13.6
3 pm	8.2	9.8	32.0	6.0	30.0	21.6	18.6	12.6	32.2	23.4	5.6	4.8
2 pm	9.4	4.6	20.6	6.4	26.4	17.8	13.8	15.4	26.2	29.2	7.4	12.4
1 pm	12.8	4.0	11.4	6.0	34.6	12.0	31.8	28.0	25.0	19.4	3.6	6.6
12 pm	1.2	11.0	9.6	4.6	93.2	13.0	12.4	37.8	60.6	7.4	11.4	19.8
11 am	7.8	10.6	10.8	4.4	79.4	26.4	24.6	2.6	24.6	17.2	29.2	32.2
10 am	9.2	19.4	21.0	7.6	51.2	7.6	30.6	11.2	55.8	11.6	11.6	43.8
9 am	17.4	32.8	28.6	18.4	38.0	21.2	37.2	19.8	59.4	6.6	34.0	39.2
8 am	6.0	16.4	11.4	4.6	19.4	11.6	10.6	7.6	111.8	23.4	19.2	33.4
7 am	7.8	5.2	15.8	18.4	50.8	22.8	10.8	14.0	19.0	17.4	29.6	34.8
6 am	35.4	2.6	11.2	3.6	31.4	8.6	7.0	6.4	22.6	12.6	11.6	27.4
5 am	13.2	13.0	19.4	2.2	16.6	7.2	32.4	18.2	53.2	8.2	35.4	46.2
4 am	10.2	36.0	18.0	15.0	25.2	7.8	20.4	0.4	14.2	11.6	57.6	36.4
3 am	18.2	18.0	29.4	5.4	10.6	7.8	22.2	6.4	39.8	7.8	66.0	53.4
2 am	16.0	9.6	24.4	2.4	20.4	4.6	7.6	27.6	5.6	30.4	7.8	24.6
1 am	15.4	5.6	9.8	13.8	25.2	9.6	12.4	21.4	6.2	13.0	8.2	23.4
12 am	3.8	2.6	20.8	6.4	16.8	4.6	5.8	21.0	6.8	19.6	8.8	22.2

Figure 6: Total hourly Rain (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	1,000	1,000	1,000	1,001	1,000	1,001	1,000	1,001	1,001	1,000	1,000	999
10 pm	1,000	1,000	1,000	1,000	1,000	1,001	1,000	1,001	1,001	1,000	1,000	1,000
9 pm	1,000	1,000	1,000	1,000	1,000	1,001	1,000	1,001	1,000	1,000	1,000	1,000
8 pm	999	999	999	1,000	999	1,000	999	1,000	1,000	1,000	1,000	999
7 pm	999	999	999	999	999	1,000	999	1,000	999	999	999	998
6 pm	998	998	998	998	998	999	998	999	999	998	998	998
5 pm	998	998	998	998	998	999	998	999	998	998	998	997
4 pm	997	997	998	997	998	999	998	998	998	997	997	997
3 pm	997	997	998	998	998	999	998	999	998	997	997	997
2 pm	998	998	998	998	998	999	998	999	998	998	998	997
1 pm	999	999	999	999	999	1,000	999	1,000	999	998	998	998
12 pm	999	1,000	1,000	1,000	1,000	1,001	999	1,000	1,000	999	999	999
11 am	1,000	1,000	1,001	1,000	1,000	1,001	1,000	1,001	1,001	1,000	1,000	1,000
10 am	1,001	1,001	1,001	1,001	1,001	1,001	1,000	1,001	1,001	1,001	1,001	1,000
9 am	1,001	1,001	1,001	1,001	1,001	1,001	1,000	1,001	1,001	1,001	1,001	1,000
8 am	1,000	1,000	1,000	1,000	1,000	1,001	1,000	1,001	1,001	1,000	1,000	1,000
7 am	999	999	1,000	1,000	1,000	1,001	999	1,000	1,000	1,000	1,000	999
6 am	999	998	999	999	999	1,000	999	1,000	999	999	999	998
5 am	998	998	998	998	998	1,000	999	999	999	998	998	998
4 am	998	998	998	998	998	999	998	999	999	998	998	997
3 am	998	998	998	998	998	1,000	998	999	999	998	998	998
2 am	998	999	999	999	999	1,000	999	1,000	999	999	999	998
1 am	999	999	999	999	999	1,000	999	1,000	1,000	999	999	999
12 am	1,000	1,000	1,000	1,000	1,000	1,001	1,000	1,001	1,000	1,000	1,000	999

Figure 7: Hourly BP averages (hPa)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	7.1	8.6	7.0	4.8	6.0	4.4	3.1	2.3	1.9	2.5	4.0	6.8
10 pm	7.0	8.6	7.0	4.9	6.1	4.4	3.3	2.2	1.8	2.7	4.1	6.7
9 pm	7.0	8.6	7.0	5.1	6.0	4.5	3.4	2.3	1.8	2.7	4.4	6.6
8 pm	6.9	8.5	6.9	5.2	6.1	4.4	3.5	2.4	2.0	2.8	4.4	6.6
7 pm	6.9	8.4	6.9	5.2	5.9	4.6	3.8	2.4	2.1	2.6	4.6	6.3
6 pm	6.9	8.4	7.0	5.1	6.0	4.8	4.0	2.9	2.2	2.8	4.8	6.3
5 pm	6.8	8.4	7.0	5.2	6.1	4.7	4.3	3.1	2.5	2.9	4.6	6.3
4 pm	6.7	8.3	7.0	5.5	6.0	4.9	4.4	3.1	2.6	3.0	4.5	6.3
3 pm	6.7	8.2	7.0	5.6	6.2	5.1	4.4	3.1	2.9	3.2	4.5	6.3
2 pm	6.8	8.4	7.3	5.6	6.2	5.0	4.6	3.3	3.0	3.2	4.7	6.6
1 pm	6.9	8.6	7.3	5.7	6.5	5.2	4.7	3.5	3.1	3.4	4.9	6.9
12 pm	7.1	8.8	7.4	5.7	6.5	5.2	4.6	3.6	3.3	3.5	5.1	6.7
11 am	7.0	8.7	7.5	5.5	6.4	5.1	4.7	3.4	3.4	3.5	5.1	6.7
10 am	7.1	8.7	7.5	5.6	6.3	5.2	4.7	3.3	3.1	3.5	5.0	6.7
9 am	7.3	8.9	7.3	5.4	6.5	5.0	4.6	3.2	2.8	3.4	5.1	6.9
8 am	7.4	8.9	7.0	5.4	6.3	4.7	4.1	2.8	2.4	2.9	4.6	6.7
7 am	7.2	8.8	6.8	5.3	6.1	4.4	3.8	2.3	1.8	2.4	4.1	6.7
6 am	7.1	8.6	6.7	5.1	5.8	4.1	3.6	2.1	1.7	2.2	4.2	6.5
5 am	7.2	8.4	6.7	4.7	5.7	4.0	3.6	2.0	1.7	1.9	4.2	6.4
4 am	7.1	8.4	6.6	4.6	5.8	4.0	3.6	2.0	1.6	2.0	4.1	6.3
3 am	6.9	8.3	6.7	4.6	5.7	4.2	3.6	1.9	1.8	2.1	4.1	6.4
2 am	6.8	8.3	6.9	4.3	5.6	4.0	3.5	2.2	1.7	2.1	4.0	6.6
1 am	6.9	8.4	7.1	4.3	5.6	4.1	3.5	2.1	1.8	2.2	3.9	6.4
12 am	6.9	8.4	7.3	4.5	5.8	4.1	3.1	2.2	1.9	2.3	3.9	6.7

Figure 8: Hourly Wind Speed averages (m/s)

Figure 9 displays the dominant hourly wind direction throughout the day (cardinal direction from where the wind originates). Two directions are indicated if they occurred at an equal frequency, but if more than two dominant wind directions occurred it is considered to have no definitive dominant wind direction and that hour is left blank.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
11 pm	E	E	E	E	E	E	E	S	S	SE	E	E
10 pm	E	E	E	E	E	E	E	S	S	S	E	E
9 pm	E	E	E	E	E	E	E	S	S	S	E	E
8 pm	E	E	E	E	E	E	E	SE	S	SE S	E	E
7 pm	E	E	E	E	E	E	E	E	S	S	E	E
6 pm	E	E	E	E	E	E	E	E	E	S	E	E
5 pm	E	E	E	E	E	E	E	E	E	SE	E	E
4 pm	E	E	E	E	E	E	E	NE	E	E	E	E
3 pm	E	E	E	E	E	E	E	E	E	SE	E	E
2 pm	E	E	E	E	E	E	E	E	E	SE	E	E
1 pm	E	E	E	E	E	E	E	E	E	SE	E	E
12 pm	E	E	E	E	E	E	E	E	E	E	E	E
11 am	E	E	E	E	E	E	E	E	E	E	E	E
10 am	E	E	E	E	E	E	E	E	E	E	E	E
9 am	E	E	E	E	E	E	E	E	E	E	E	E
8 am	E	E	E	E	E	E	E	E	SE	E	E	E
7 am	E	E	E	E	E	E	E	SE	SE	SE	E	E
6 am	E	E	E	E	E	E	E	S	S	S	E	E
5 am	E	E	E	E	E	E	E	S	S	S	SE E	E
4 am	E	E	E	E	E	E	E	S	S	S	E	E
3 am	E	E	E	E	E	E	E	S	S	S	E	E
2 am	E	E	E	E	E	E	E	S	S	S	SE E	E
1 am	E	E	E	E	E	E	E	S E	S	S	E	E
12 am	E	E	E	E	E	E	E	E	S	S	E	E

Figure 9: Dominant hourly Wind Direction

10.2 Quality Assessment of Measured Data

An overview of each measurement is provided below, displaying the data available to date in grey, and highlighting data that failed quality checks in red.

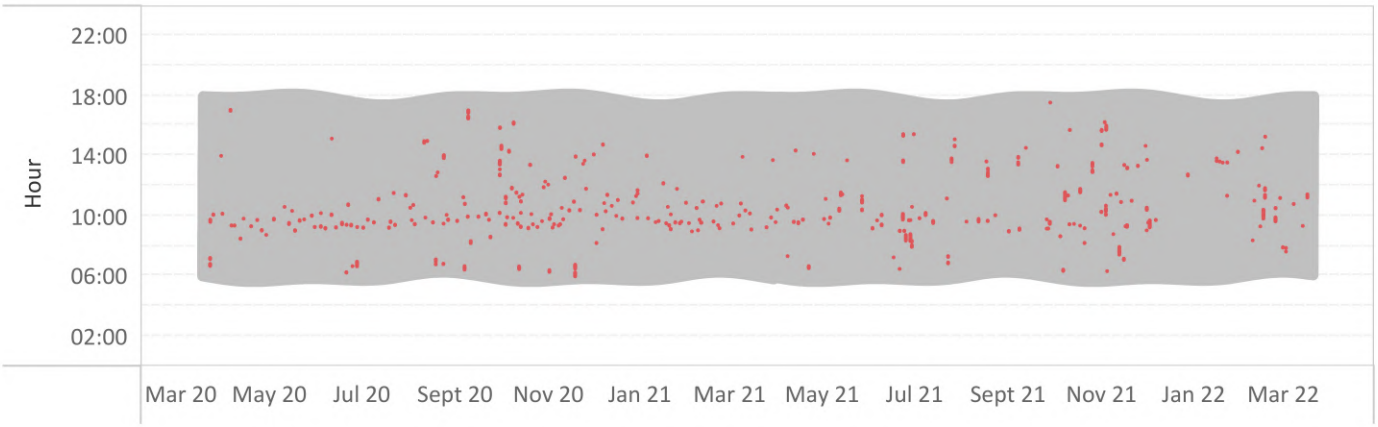

Figure 10: Quality control for GHI (1)

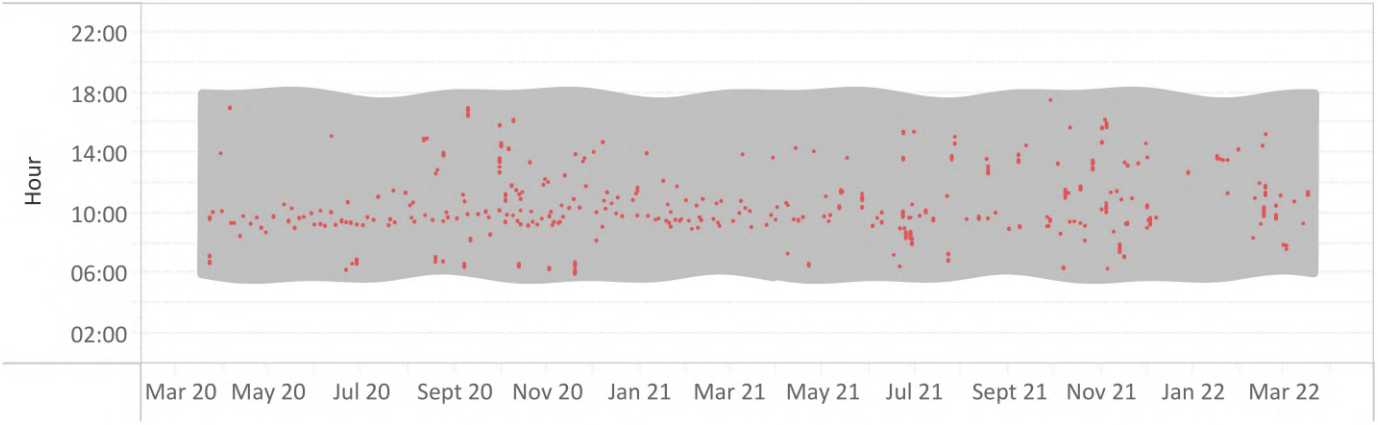

Figure 11: Quality control for GHI (2)

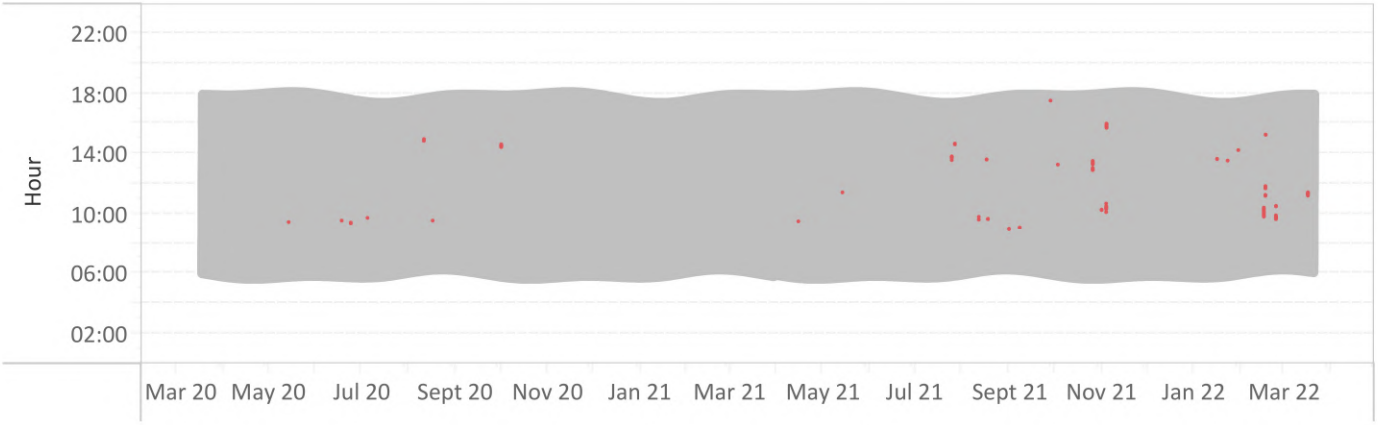

Figure 12: Quality control for DHI (1)

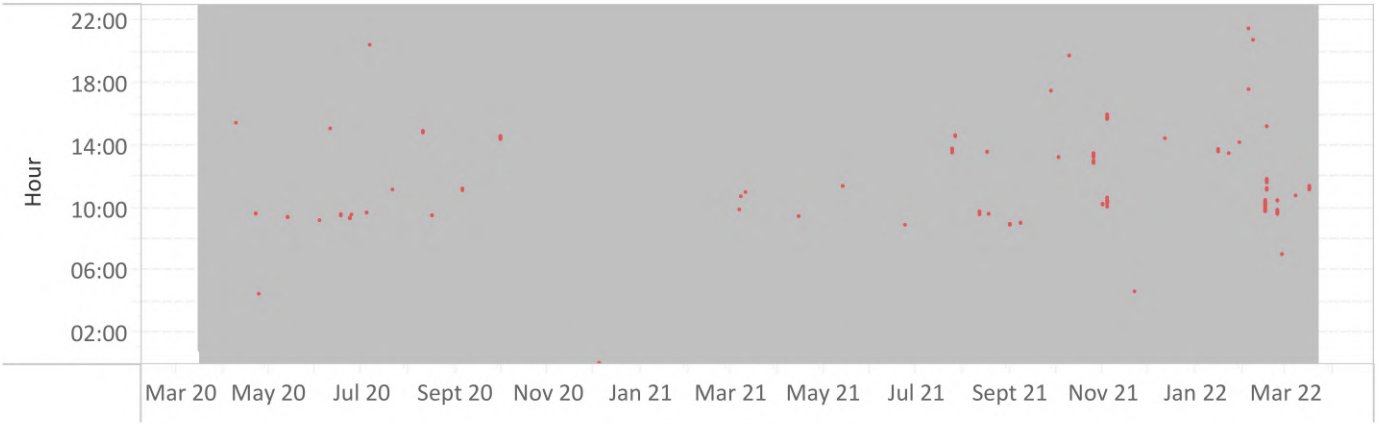

Figure 13: Quality Control for Temp

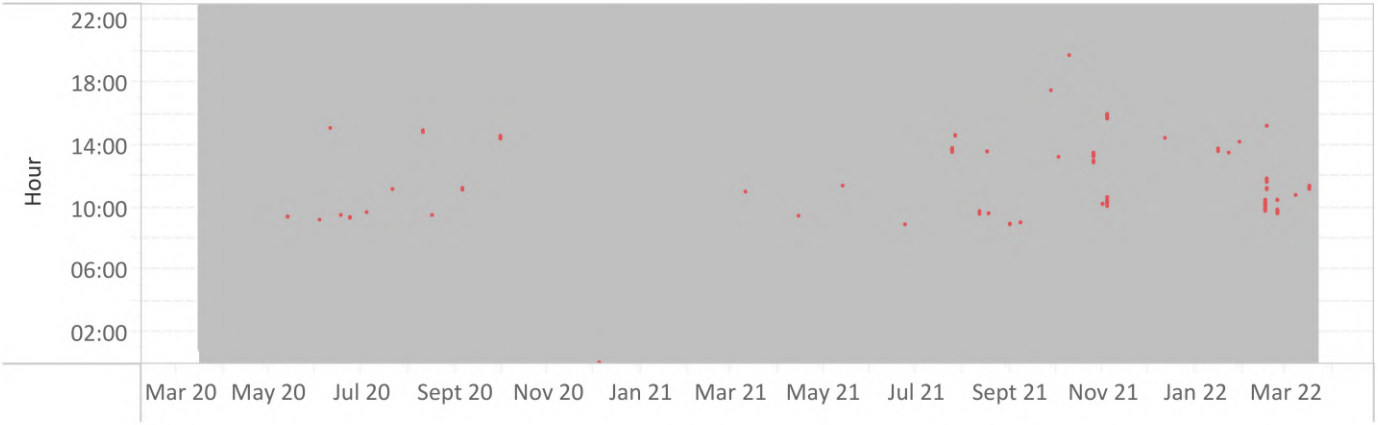

Figure 14: Quality Control for RH

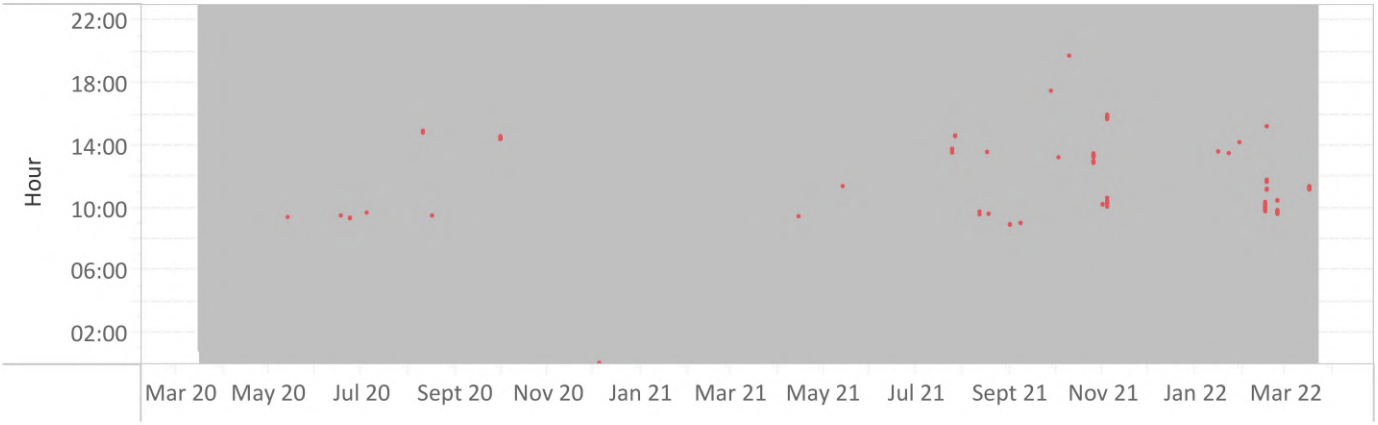

Figure 15: Quality Control for Rain

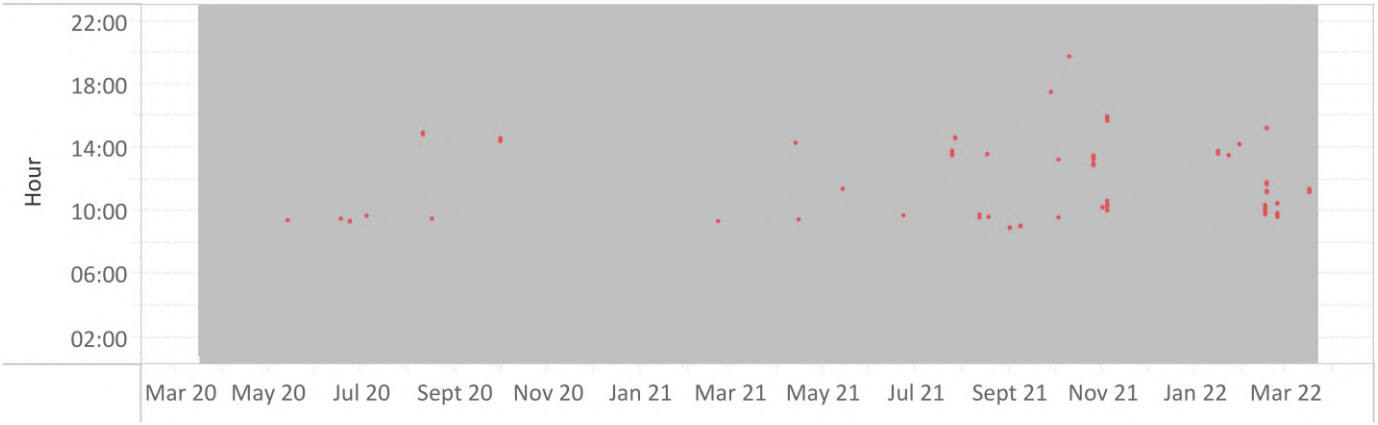

Figure 16: Quality Control for BP

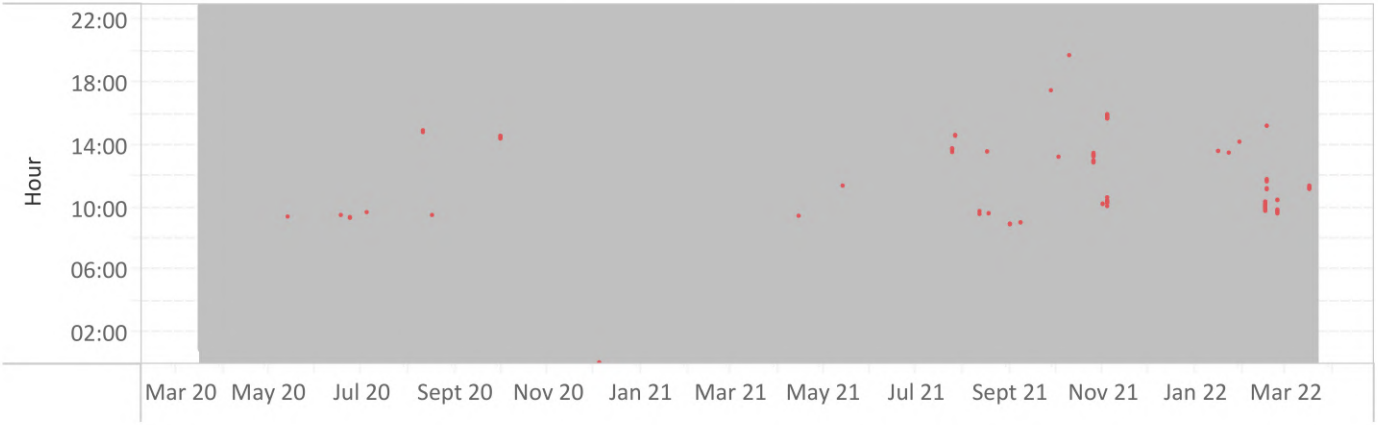

Figure 17: Quality Control for Wind Direction

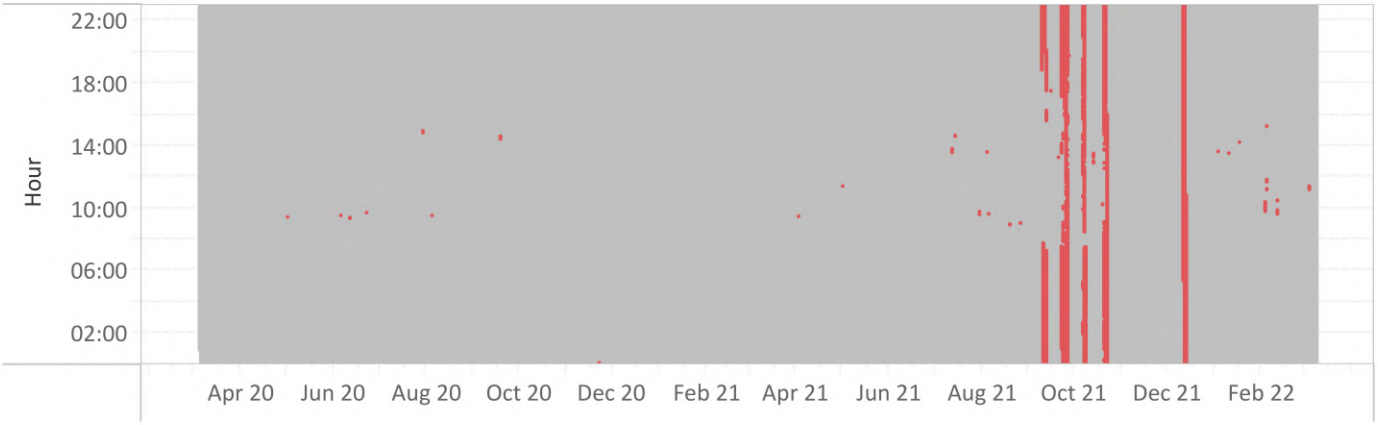

Figure 18: Quality Control for Wind Speed

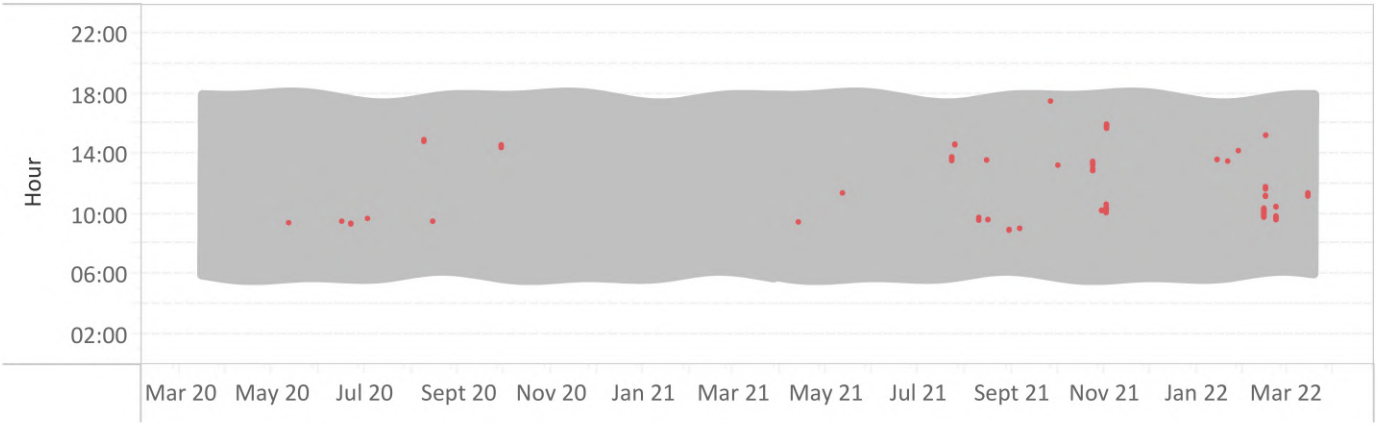

Figure 19: Quality control for soiling measurement (monthly cleaned)

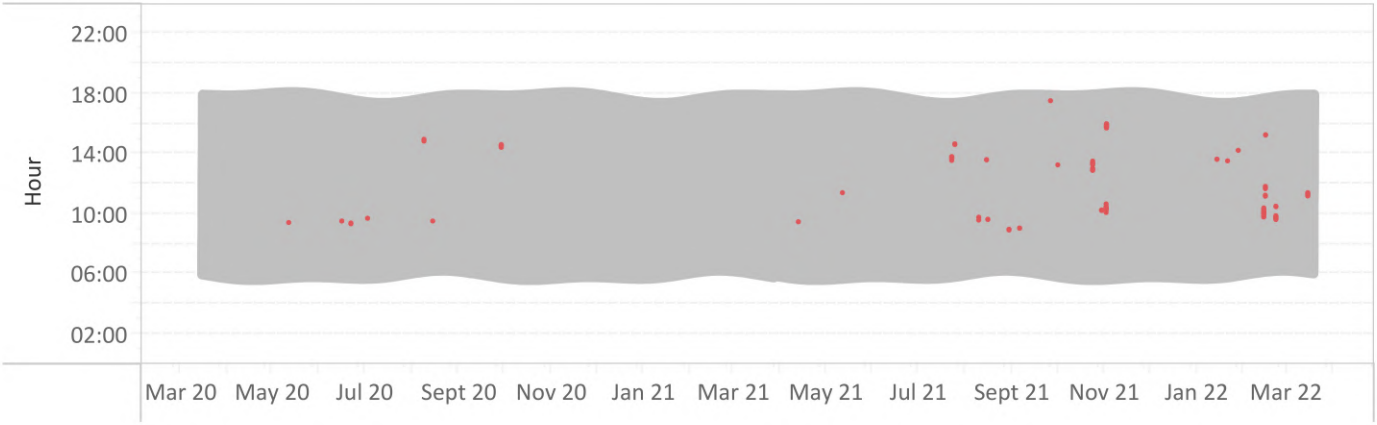

Figure 20: Quality control for soiling measurement (continuous soiling)

10.3. Summary of Irradiation Data

In this section irradiation data is displayed and compared to the redundant measurement for quality purposes. Figure 21 displays the seven day moving average of daily values (YTD) to emphasize trends in the data whilst filtering noise.

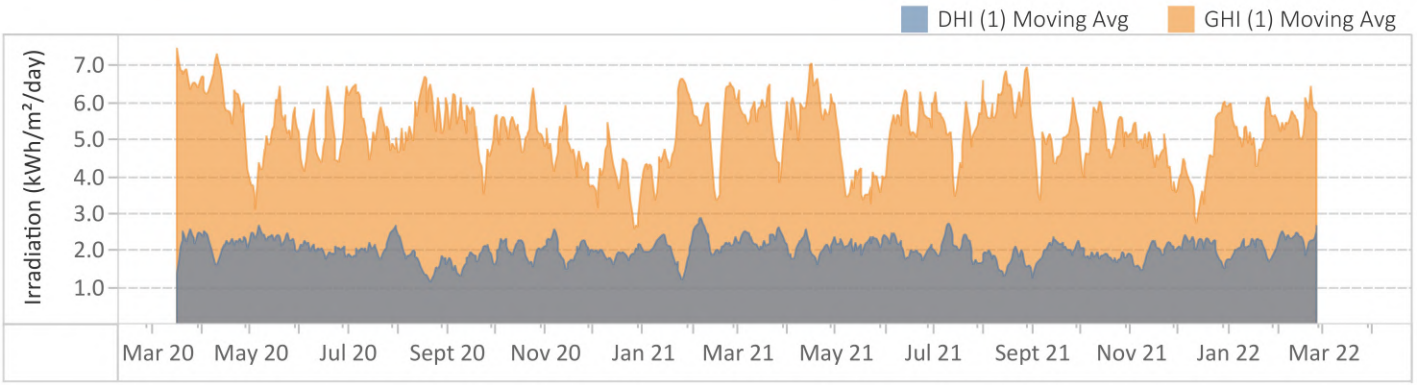

Figure 21: 7-day Moving Average for GHI (1) and DHI (1)

Figure 22 shows the comparison between GHI (1) and GHI (2) minute values (YTD), while Figure 23 shows the comparison for each individual month. Deviations with clear trends at low irradiation values can typically be attributed to water residue on the dome of an instrument during early mornings due to rain or dew before instrument cleaning occurred.

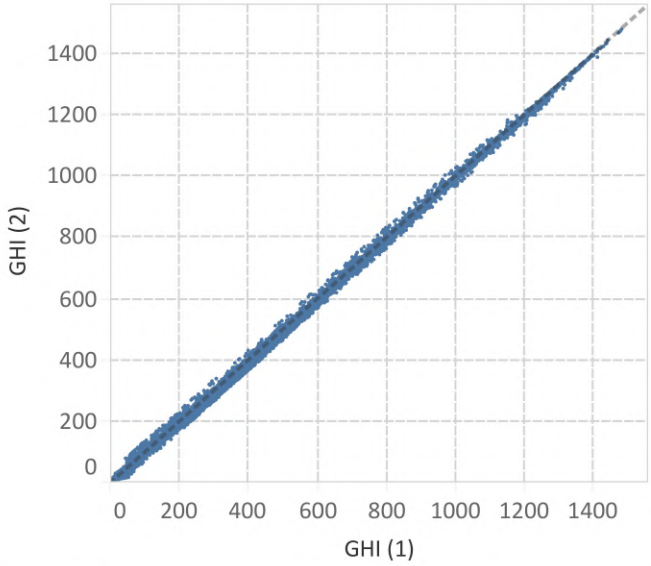

Figure 22: Comparison of GHI (1) and GHI (2) (YTD) (W/m²)

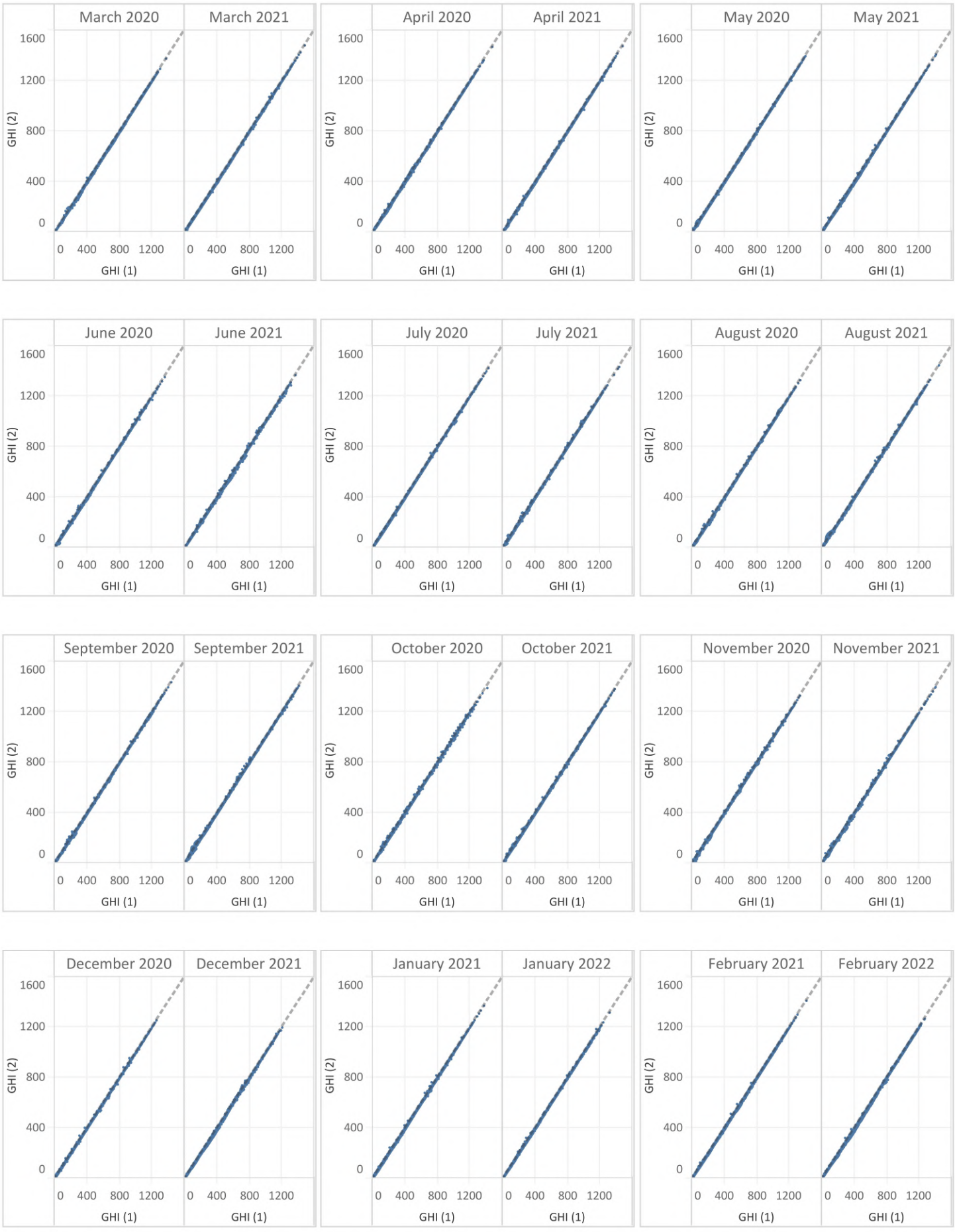

Figure 23: Comparison of GHI (1) and GHI (2) (W/m²)

Figure 24 shows the percentage distribution of daily GHI (1) averages per month. A median is indicated by the dark vertical line while the 10 and 90 percentile spread is indicated by the light grey band, and 25 and 75 percentile is indicated by the dark grey band.

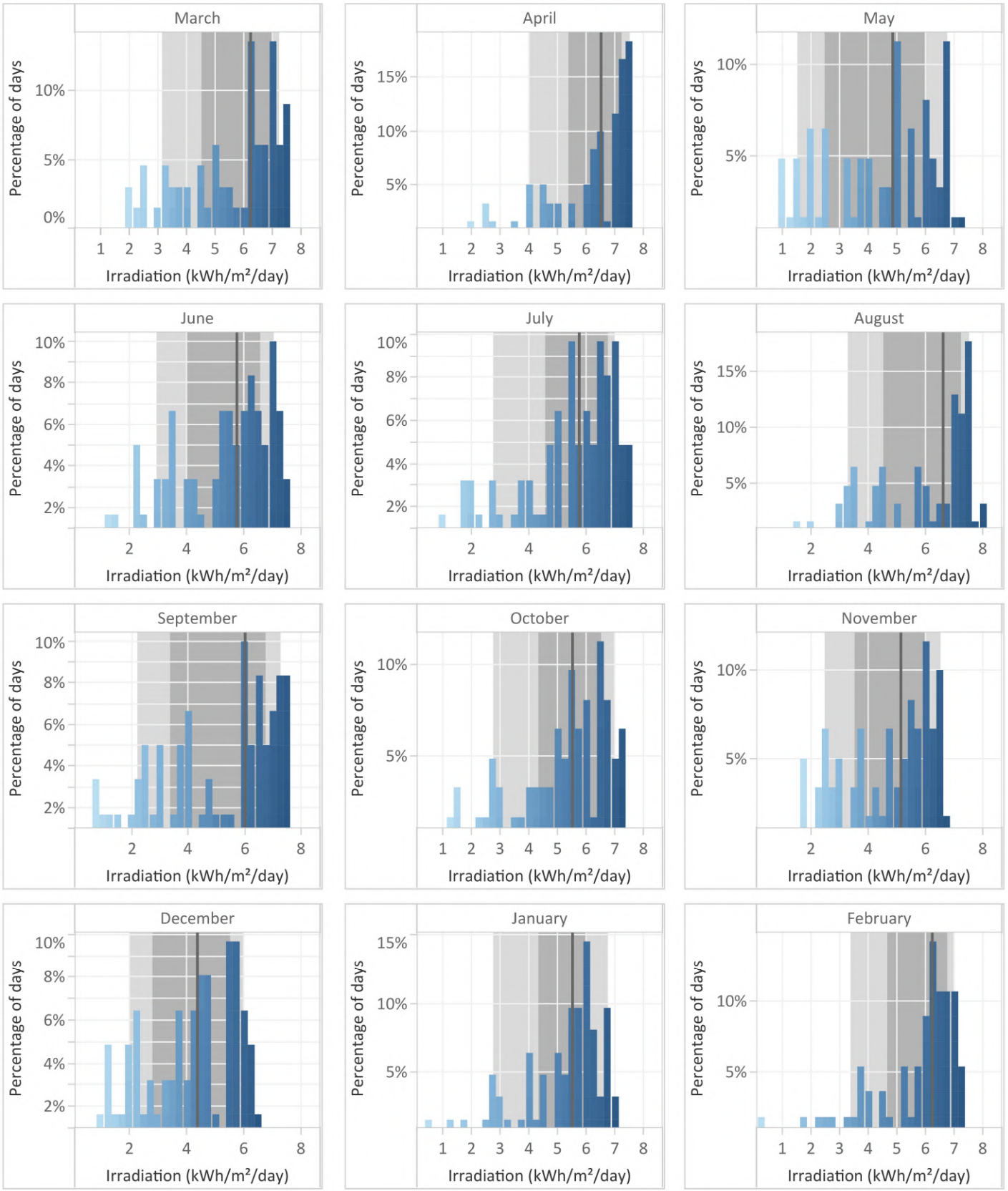

Figure 24: Daily summary of GHI (1)

10.4. Summary of Meteorological Data

In this section the rest of the meteorological data is plotted, as well as displayed alongside satellite derived data as a high level comparison.

Figures 25 to 28 display the average, maximum and minimum values for each month of the year.

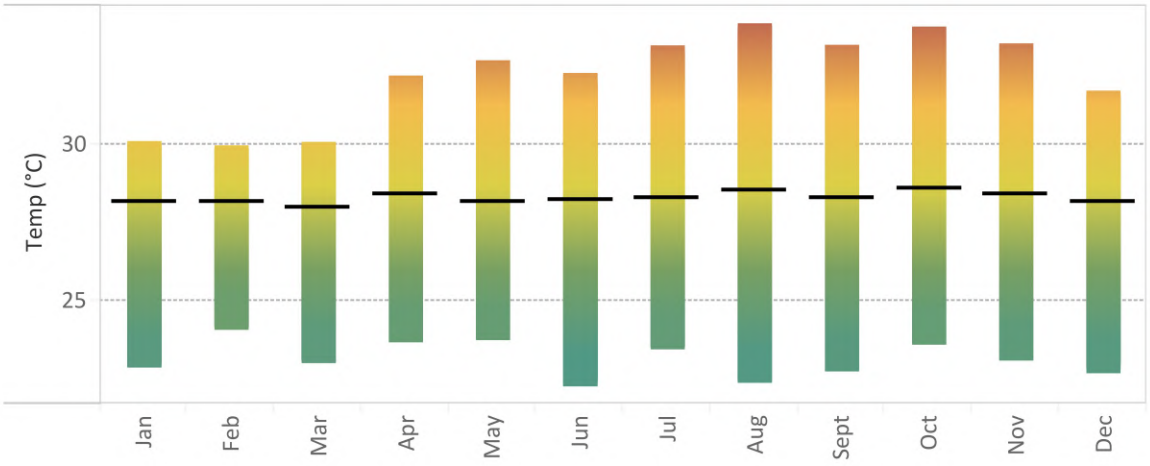

Figure 25: Monthly average, maximum and minimum temperature

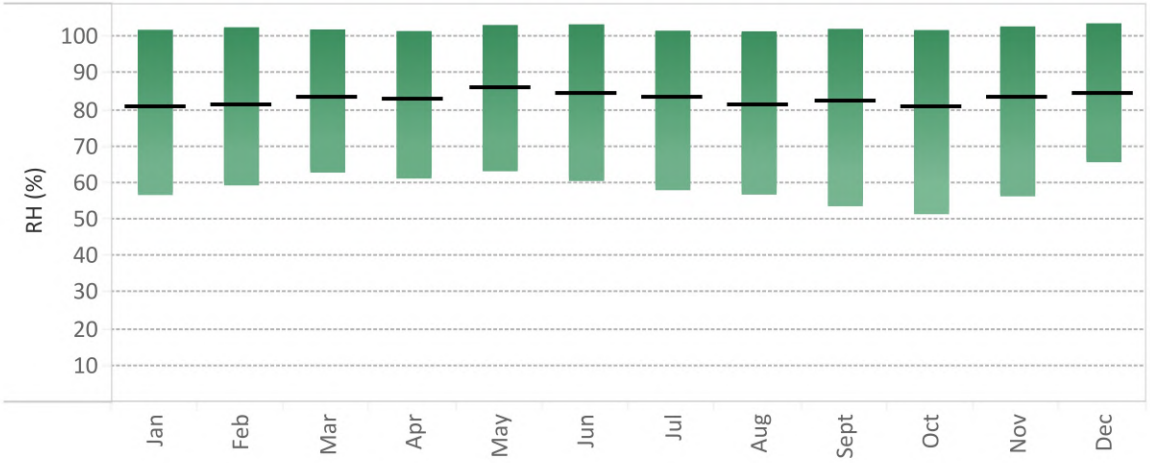

Figure 26: Monthly average, maximum and minimum relative humidity

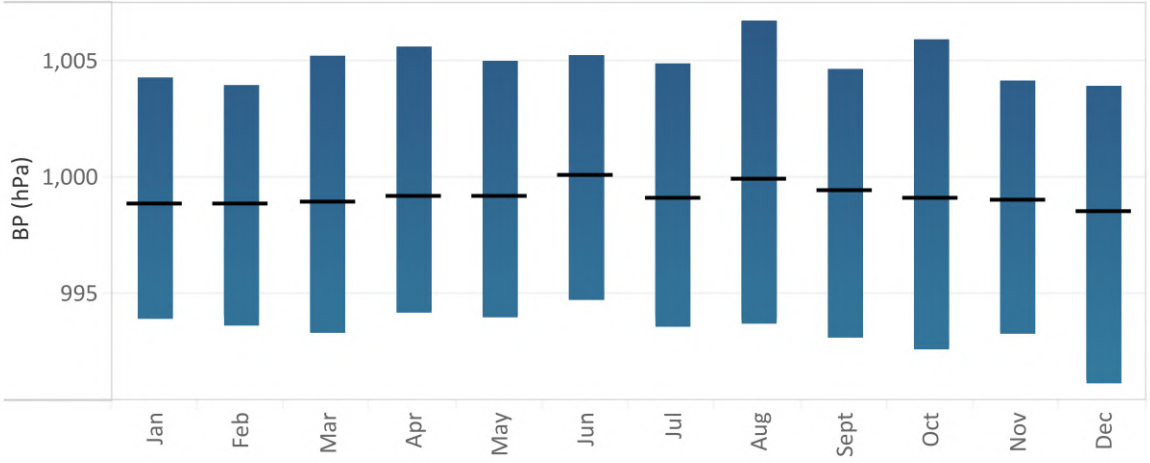

Figure 27: Monthly average, maximum and minimum barometric pressure

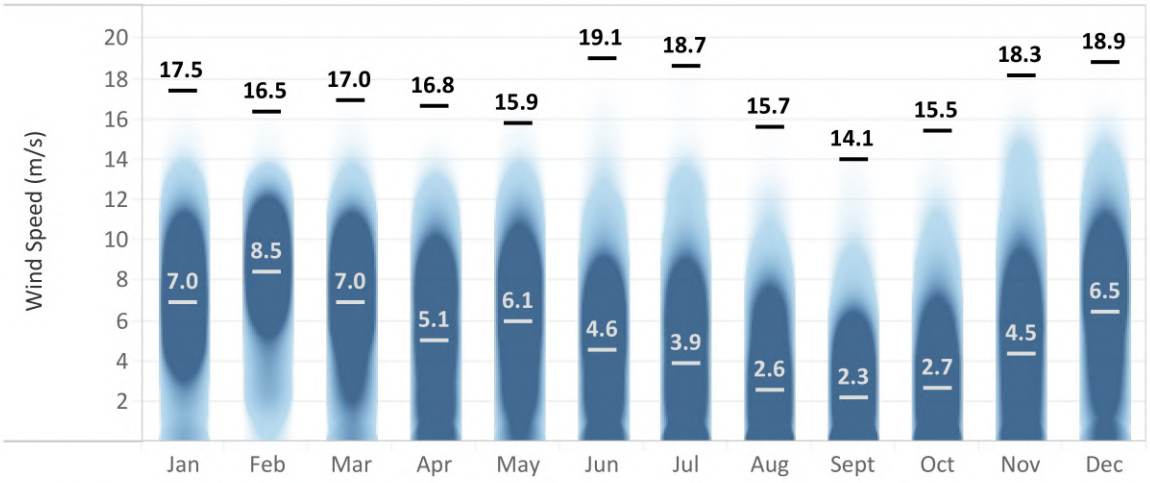

Figure 28: Monthly average and maximum Wind Speed (colour indicating frequency of occurance).

Figure 29 displays the hourly wind speed average as it relates to the cardinal direction from where the wind originates. The red zones indicate the most frequent occurrence of a certain wind speed from the corresponding direction, while green represents a less frequent occurrence of a specific wind speed.

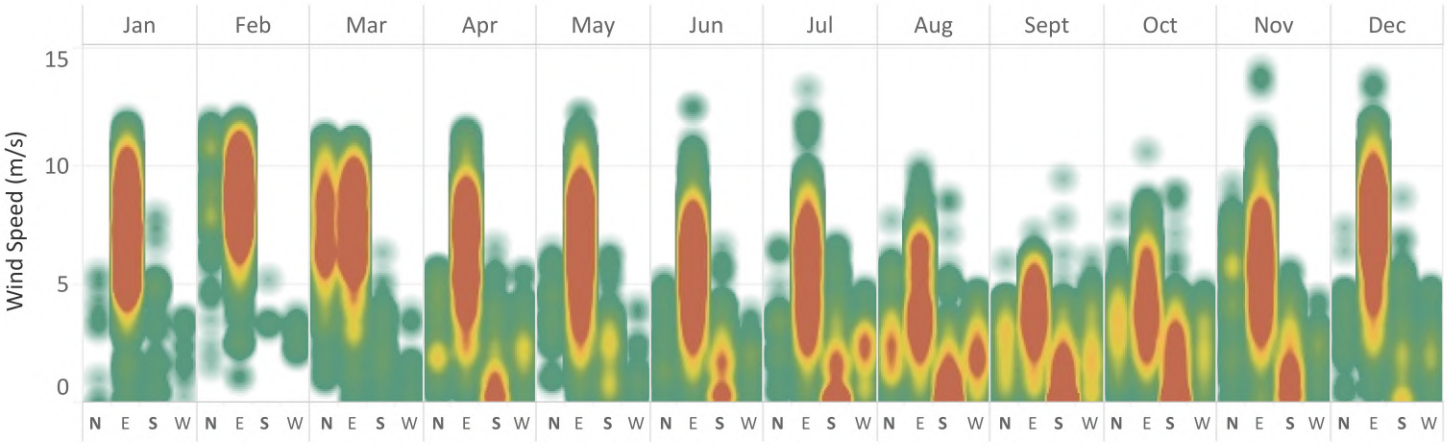

Figure 29: Hourly Wind Speed average compared to hourly Wind Direction

Figure 30 indicates the occurrence of rain (blue dot) as well as days when dew point temperature was reached (orange dot). The daily average value for humidity (green line) is also shown.

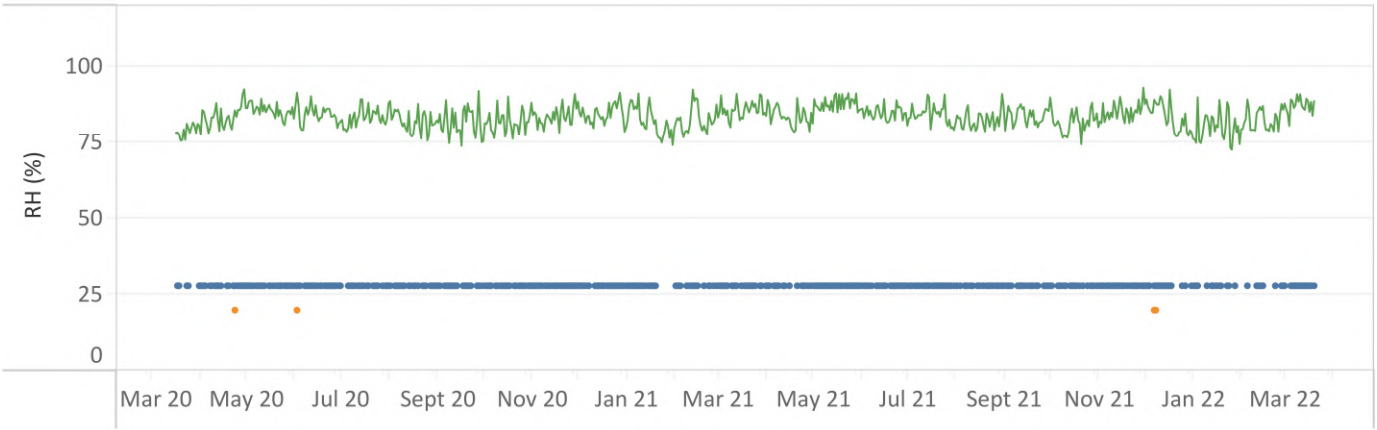

Figure 30: Humidity, the occurrence of dew point reached temperature, and rain

Soiling is represented by the percentage difference between the outputs of three silicone irradiance sensors. One of them is cleaned with every cleaning event and is used as the reference for the percentage difference (GTI (Clean)). The second instrument is only cleaned once a month (GTI (Monthly), while the last one is never cleaned (GTI (Soiled)).

Figure 31 displays the daily percentage difference between the cleaned and the monthly cleaned irradiance sensor (grey). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown. The monthly cleaning event is indicated with a green dot.

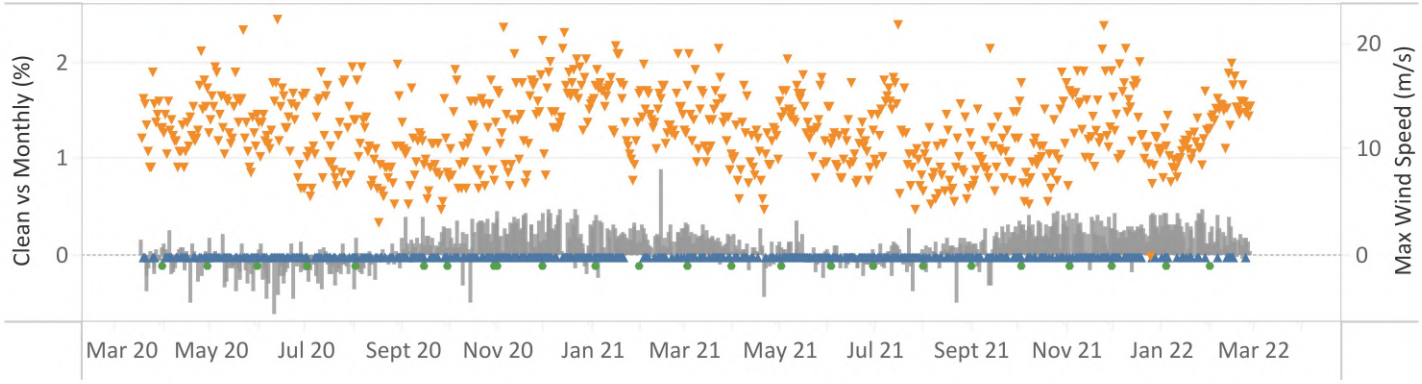

Figure 31: Soiling Measurement (Clean vs Monthly)

Figure 32 displays the daily percentage difference between the cleaned and the dirty irradiance sensor (grey and green bars; the green bars indicate the cleaning events). The maximum wind gust (orange triangle) and the occurrence of rain (blue triangle) is also shown.

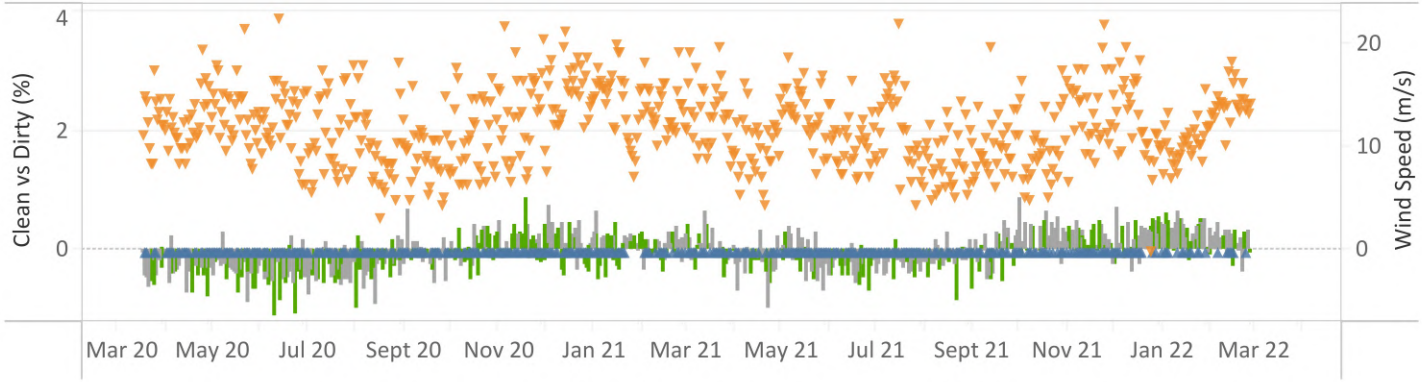

Figure 32: Soiling Measurement (Clean vs Dirty)

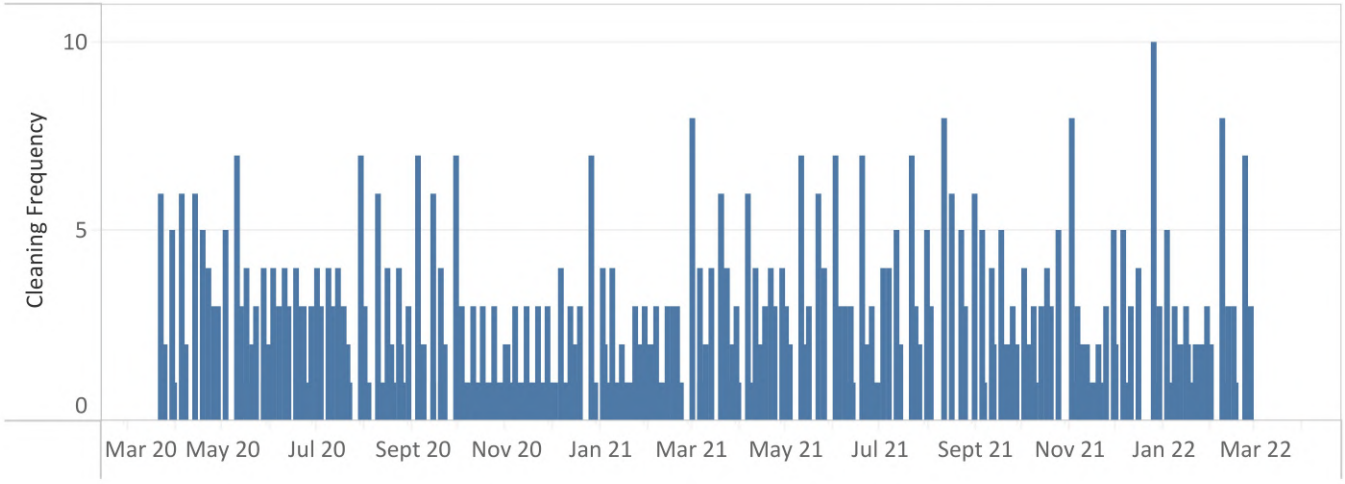

Figure 33: Consecutive days without cleaning

10.5. Satellite Data

Hourly ground measured values to date are compared with satellite derived data of the same parameter for the same period (reference: https://solargis.com/docs/accuracy-and-comparisons/overview). Satellite derived data is used as a high level comparison here and should not be seen as the primary quality check.

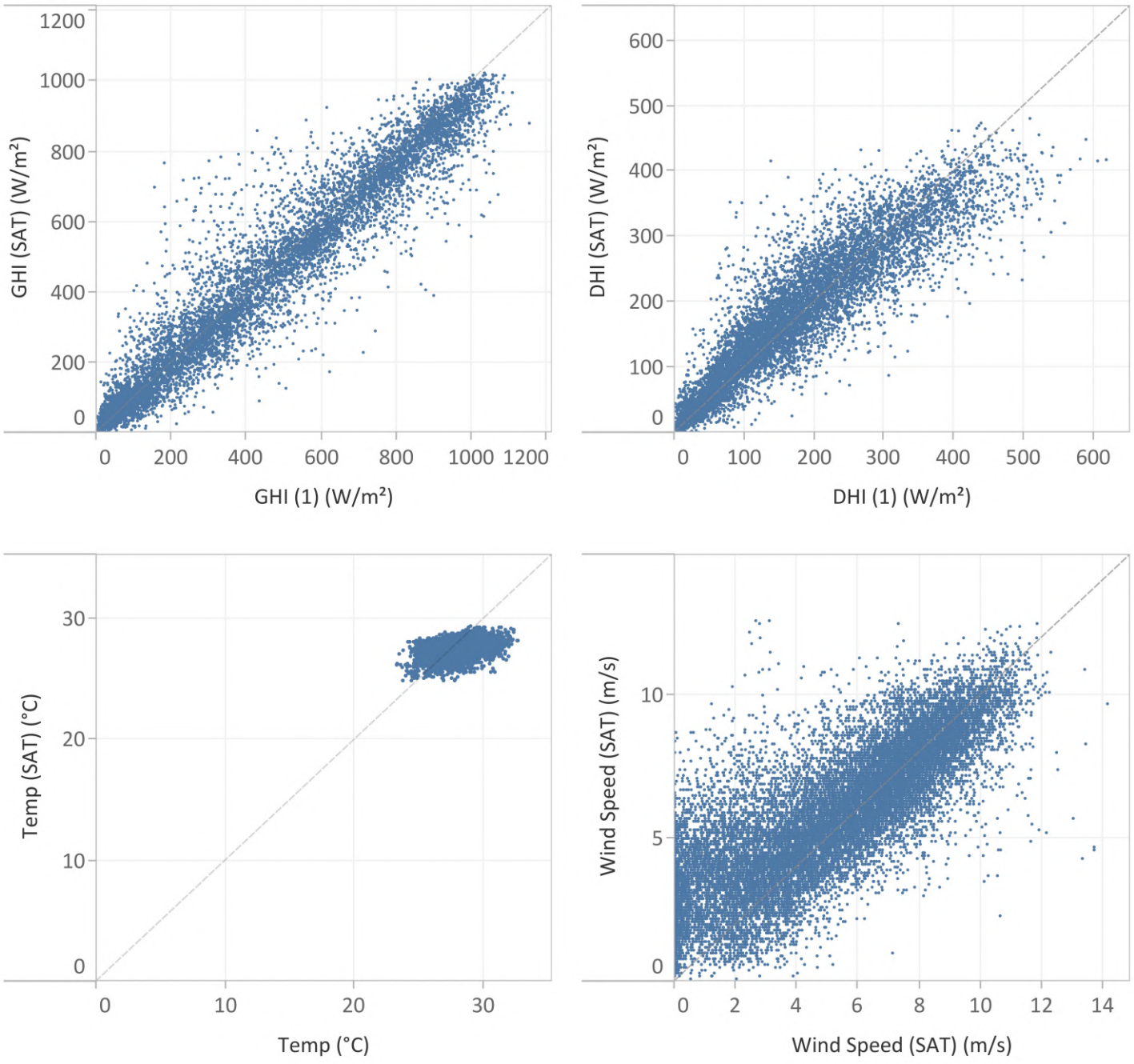

Figure 34: Ground measured data compared to satellite derived (Solargis) data

10.6. Summary

The primary quality check for the GHI measurement is the comparison between the two thermopile pyranometers (GHI (1) and GHI (2)) and from this it can be concluded that the GHI data quality is good. The average daily percentage difference between the two measurements up to date of this report is 0.51%.

The data is quality checked on a daily basis, and if any noteworthy issues occurred during the measurement campaign it will be reported on in this summary.

June 2020	Water residue affected early morning irradiation measurements on the following day: 29 June 2020
October 2020	A site visit occurred on 2 October 2020. Data during this time was affected and removed.
November 2020	Water residue affected early morning irradiation measurements on the following day:20 November 2020.
April 2021	Water residue affected early morning irradiation measurements on the following day:23 April 2021.
June 2021	Water residue affected early morning irradiation measurements on the following days:26 and 29 June 2021. A site visit ocurred on 24 June 2021, data during the site visit was affected and removed.
September 2021	The anemometer was suspected of recording inaccurate wind speed values for extended periods from 23 September 2021. All affected data during this period was removed.
October 2021	The anemometer was suspected of recording inaccurate wind speed values for extended periods from 23 September 2021. All affected data during this period was removed. A site visit was conducted on 27 October 2021 during which the anemometer was replaced. Data during the site visit was affected and removed.
November 2021	The anemometer was suspected of recording inaccurate wind speed values for extended periods from 23 September 2021. All affected data during this period was removed. A site visit was conducted on 5 November 2021 during which the anemometer was replaced. Data during the site visit was affected and removed.
December 2021	The anemometer was suspected of recording inaccurate wind speed values for extended periods from 23 September 2021. All affected data during this period was removed.

Data that did not pass the quality checks (or was affected by maintenance site visits, program uploads or station restarts) will be removed from the data set. Table 4 shows the data recovery rate percentage for each measurement.

Table 4: Summary of data recovery rate

		GHI (1)	GHI (2)	DHI (1)	Temp	RH	Rain	Wind Speed	Wind Direction	BP	Continuous Soiling	Monthly Soiling
2020	Mar	99.73	99.73	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.90	99.90	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	May	99.90	99.90	100.00	99.99	99.99	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.75	99.75	99.99	99.98	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Jul	99.87	99.87	100.00	99.99	99.99	100.00	100.00	100.00	100.00	100.00	100.00
	Aug	99.78	99.78	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99	99.99
	Sept	99.72	99.72	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Oct	99.49	99.49	99.95	99.97	99.97	99.97	99.97	99.97	99.97	99.95	99.95
	Nov	99.67	99.67	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Dec	99.86	99.86	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2021	Jan	99.88	99.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Feb	99.88	99.88	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Mar	99.92	99.92	100.00	99.99	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Apr	99.88	99.88	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00
	May	99.82	99.82	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jun	99.49	99.49	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Jul	99.79	99.79	99.95	99.96	99.98	99.98	99.98	99.98	99.97	99.95	99.95
	Aug	99.87	99.87	99.97	99.98	99.98	99.99	99.99	99.99	99.99	99.97	99.97
	Sept	99.81	99.81	99.97	99.98	99.98	99.98	96.16	99.98	99.98	99.97	99.97
	Oct	99.62	99.62	99.94	99.94	99.96	99.97	85.37	99.97	99.96	99.94	99.94
	Nov	99.53	99.53	99.84	99.91	99.91	99.92	93.13	99.92	99.91	99.83	99.83
	Dec	99.82	99.82	100.00	100.00	100.00	100.00	92.81	100.00	100.00	100.00	100.00
2022	Jan	99.94	99.94	99.98	99.99	99.99	99.99	99.99	99.99	99.98	99.98	99.98
	Feb	99.67	99.67	99.74	99.80	99.85	99.88	99.88	99.88	99.87	99.74	99.74
	Mar	99.85	99.85	99.91	99.95	99.95	99.96	99.96	99.96	99.96	99.91	99.91
Total		99.78	99.78	99.97	99.98	99.98	99.98	98.63	99.98	99.98	99.97	99.97

11. Conclusion

This project commenced with the outbreak of and endured for the duration of the COVID-19 pandemic. In spite of logistical challenges associated with this, as well as harsh environments experienced, the solar measurement campaign was completed successfully with high quality, bankable data sets delivered.