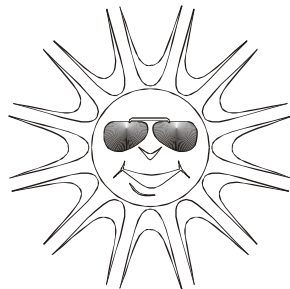




Smithsonian Tropical Research Institute

2020 Meteorological Summary for the Agua Salud, Celestino Tower

Prepared by: Steven Paton



Introduction

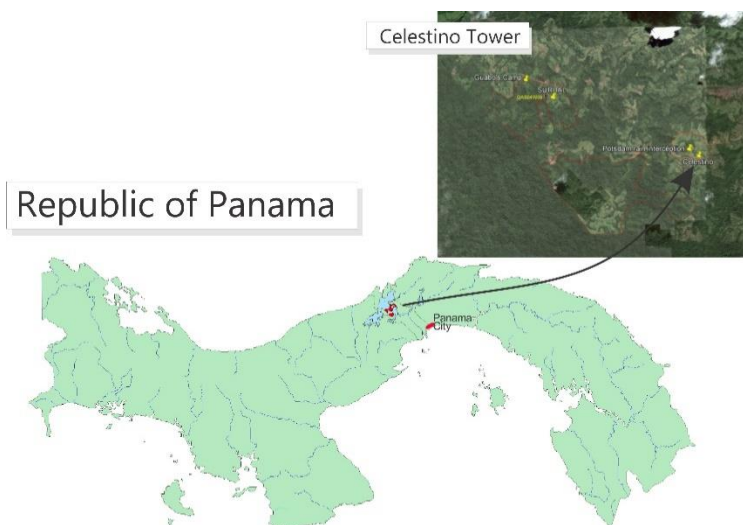
This is the 3rd yearly reports summarising the past year's Smithsonian Tropical Research Institute's Physical Monitoring Program at the Agua Salud, Celestino Tower. This report is not meant to be exhaustive in its coverage in that it summarizes only some of the most 'important' or interesting parameters available. Any comments on how future yearly summaries could be improved would be appreciated. Copies of this report, reports from previous years, and downloadable data from the Galeta and other research locations, can be obtained from:

biogeodb.stri.si.edu/physical_monitoring/research/aguasalud

Setting

Installed in 2015, the Celestino Tower physical monitoring station (9.21142N, 79.72656W) is located approximately 13 km WNW of BCI and 25.5 km SSW of Galeta. The tower is 40ft (12.2m) tall. The tower is part of the Agua Salud research program but is operated by the Physical Monitoring Program. For more information about the Agua Salud Project, visit the following web site: <https://stri.si.edu/facility/agua-salud>

The station receives an average of 2665.2 mm of rain per year. The meteorological year is divided into two parts: a pronounced dry season (approximately from mid-December to the end of April), and a wet season (May to mid-December). On average, only 221mm of rain falls during the dry season. Relative humidity, air temperature, solar radiation, wind speed and direction, sea surface temperature (SST) all show marked seasonal differences.



This report summarises the following data:

Air temperature
Net Radiation
Relative humidity
Rainfall
Solar radiation
Wind speed and direction

Rainfall

Rainfall is recorded as the average of two Hydrological Services CS700 Tipping Buckets



The daily rainfall data for 2020 are shown on page 6.

Page 7-8 show the monthly totals for 2020. The graph on the same page compares this year's monthly totals with the average monthly totals (\pm SD) for the period 1974 to 2019.

Page 8 shows yearly rainfall totals for all years since 1974. Time series graph and frequency histograms are presented for these data.

Pages 9 and 10 show an analysis of rainfall 'events' (*storms*). For convenience, and again somewhat arbitrarily, I have defined a storm as any continuous period of rain separated by at least an hour from any other rainfall. Since this analysis required the timing of rainfall events, tipping bucket data were used. As a result, the absolute size of rainfall events should be considered only as an estimate since tipping buckets will tend to underestimate the size of storms - larger storms will be more underestimated than smaller ones. Keeping this in mind, the tables and graphs compare maximum and average storm size, and average storm duration per month for the period 2004 to 2019 versus 2020.

Relative Humidity

Relative humidity is recorded using a Viasala HMP60 electronic temperature/humidity sensor. The sensor is protected by a ventilated shield and is located on the side of the tower at 12m. Data are recorded at 15- minute intervals by dataloggers controlling the sensors. The average monthly relative humidity data are shown in tabular and graphical forms on page 11.

Air Temperature

Shaded air temperature data is currently recorded using a Viasala HMP60 electronic temperature/humidity sensor. The sensor is protected by a ventilated shield and is located on the side of the tower at 2m. Data are recorded at 15-minute intervals by dataloggers controlling the sensors.

The monthly average temperatures from the electronic sensors are shown in tabular and graphical form on pages 12-14.



Solar Radiation



Currently, Celestino is the only station where both Photosynthetically Active Radiation (PAR) and solar flux (Pyranometer) is measured by STRI's Physical Monitoring Program.

PAR is measured using two Kipp&Zonen PQS1 sensors. Solar flux is measured using Kipp&Zonen pyranometers (one CMP10 and one CMP3).

All sensors are located near the top of the tower



Daily total solar radiation (Pyranometer) is shown on page 15. Total PAR is shown on page 16. Monthly average daily total solar radiation and PAR are shown on pages 17 and 18, respectively.

Wind Speed and Direction

Wind speed and direction are recorded with a RM Model 05103 Young anemometer located at the top of the tower. 15-minute interval average, maximum and minimum wind speed plus average wind direction are recorded.

Page 19 shows average and maximum daily wind speeds from the Young Anemometer located at the top of the Pier tower. Page 20 shows daily average wind direction. The angles indicated in the table and graph on this page represent the direction from which the wind was predominately blowing on a given day. Page 21 shows the monthly average wind speed and monthly average directions for the year.

Net Radiation

Net radiation is measured using a Kipp & Zonen CNR4 Net-Radiometer. The sensor is mounted on the tower, 1.5m above the grass covered ground. The associated soil temperature probe is located nearby at a depth of 20cm

Pages 22-24 show the monthly average Net Radiation, Net Long and Shortwave Radiation, respectively.



Air Pressure

Air pressure is measured using a Vaisala PTB110 barometric sensor. The sensor is mounted on the tower, 1.5m above the grass covered ground. Air pressure is recorded hourly.

Page 25 shows the monthly average air pressure.

Times Series

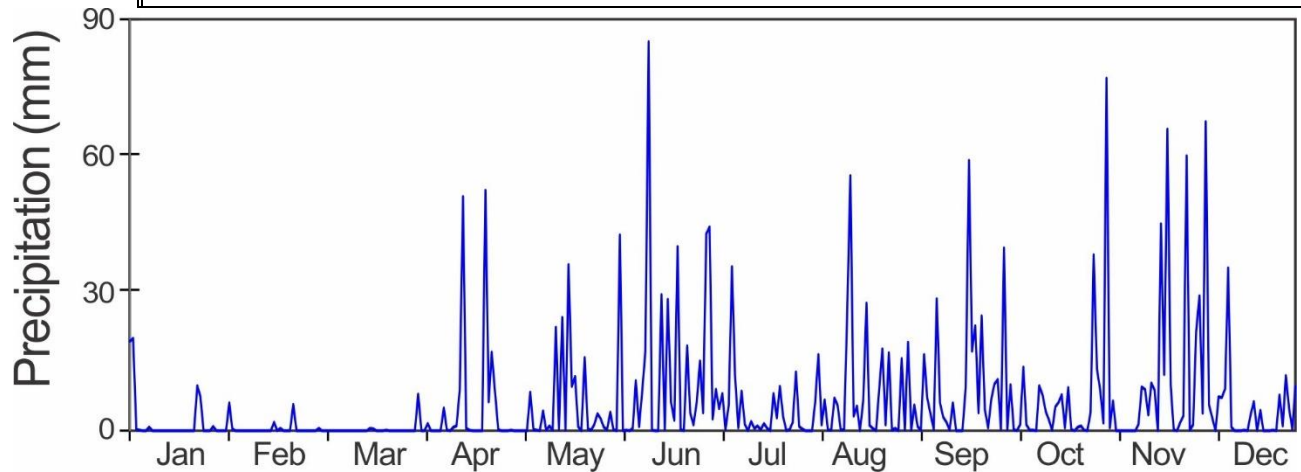
Graphs showing the 2020 daily (Pages 26-7) and monthly averages for the entire period of record (Pages 28-30) for Relative Humidity, Air Temperature, Rainfall, Wind Speed, Solar Radiation and Water Temperature.

Daily Patterns

Pages 31 and 32 show the daily patterns for Relative Humidity, Air Temperature, Rainfall, Wind Speed, Solar Radiation, and Air Pressure.

2020 Daily Rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	19.6	6.1	0.0	0.0	0.0	0.0	2.5	0.0	0.1	0.3	77.1	3.8
2	20.2	0.4	0.0	0.0	0.0	42.8	9.0	6.1	5.6	10.0	0.6	67.6
3	0.3	0.0	0.0	1.5	0.0	0.0	4.8	16.6	0.9	0.3	6.5	5.6
4	0.1	0.0	0.0	0.0	0.0	0.1	8.1	1.3	0.1	0.0	0.0	2.8
5	0.0	0.0	0.0	0.0	8.4	0.0	0.3	6.7	16.6	1.3	0.0	0.0
6	0.0	0.0	0.0	0.0	0.3	0.5	5.6	0.1	7.2	13.8	0.0	7.4
7	0.8	0.0	0.0	0.0	0.1	10.9	35.8	0.1	3.7	1.3	0.0	7.2
8	0.0	0.0	0.0	5.0	0.0	0.9	12.1	7.1	0.3	0.1	0.0	9.1
9	0.0	0.0	0.0	0.1	4.3	8.9	0.6	5.6	28.8	0.1	0.0	35.6
10	0.0	0.0	0.0	0.0	0.1	17.4	8.6	0.1	6.0	0.0	0.0	0.8
11	0.0	0.0	0.0	0.8	1.0	85.1	1.4	0.3	2.9	9.8	1.4	0.0
12	0.0	0.0	0.0	1.0	0.1	0.1	0.0	25.0	1.8	7.9	9.5	0.0
13	0.0	0.0	0.0	8.9	22.6	0.0	2.0	55.8	0.1	4.2	9.0	0.0
14	0.0	0.0	0.0	51.2	0.3	0.0	0.5	3.2	6.1	2.4	3.4	0.1
15	0.0	1.8	0.0	0.5	24.8	29.7	1.0	5.3	0.0	0.1	10.4	0.0
16	0.0	0.0	0.5	0.1	0.1	0.3	0.3	0.0	0.0	5.2	8.9	3.4
17	0.0	0.5	0.4	0.0	36.3	28.7	1.5	6.5	0.0	6.2	0.0	6.4
18	0.0	0.0	0.0	0.0	9.7	6.2	0.5	27.9	9.4	7.9	45.2	0.0
19	0.0	0.0	0.0	0.0	11.8	2.3	0.0	1.1	59.1	0.6	12.3	4.4
20	0.0	0.0	0.0	0.0	0.9	40.3	8.1	0.5	17.4	9.4	65.9	0.0
21	0.0	5.7	0.1	52.6	0.0	0.3	2.8	0.0	22.9	0.3	9.9	0.0
22	9.8	0.0	0.0	6.4	16.0	0.0	9.7	9.4	3.9	0.0	0.1	0.0
23	7.5	0.0	0.0	17.1	0.4	18.5	3.0	17.9	25.1	0.8	0.0	0.1
24	0.0	0.0	0.0	8.5	0.1	3.9	0.0	1.3	4.6	1.0	1.8	0.0
25	0.0	0.0	0.0	0.3	1.3	1.3	0.3	17.0	0.6	0.1	3.2	7.7
26	0.0	0.0	0.0	0.0	3.7	6.2	1.8	0.1	7.0	0.0	60.1	1.0
27	0.9	0.0	0.0	0.0	2.7	15.2	12.8	0.5	10.2	4.1	0.1	12.1
28	0.0	0.0	0.0	0.0	0.8	3.9	0.9	0.0	11.2	38.5	1.3	4.8
29	0.0	0.5	0.0	0.1	0.3	43.1	0.4	15.7	0.3	13.5	21.7	0.4
30	0.0		0.0	0.0	4.1	44.6	0.0	0.1	40.0	8.9	29.5	9.7
31	0.0		8.0		0.3		0.0	19.3		1.7		0.1
	59.1	15.0	9.0	154.1	150.2	411.2	134.5	250.8	291.9	149.6	378.0	190.1



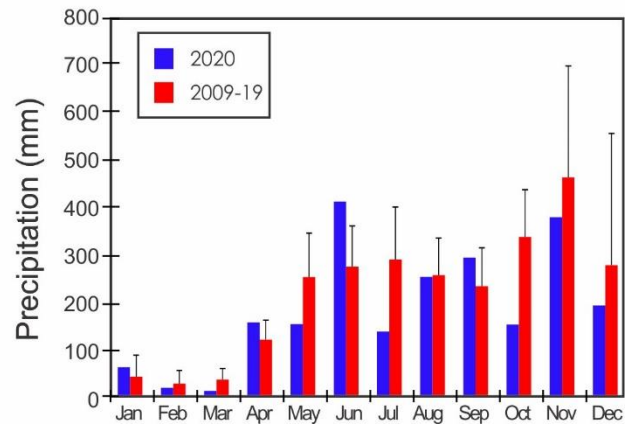
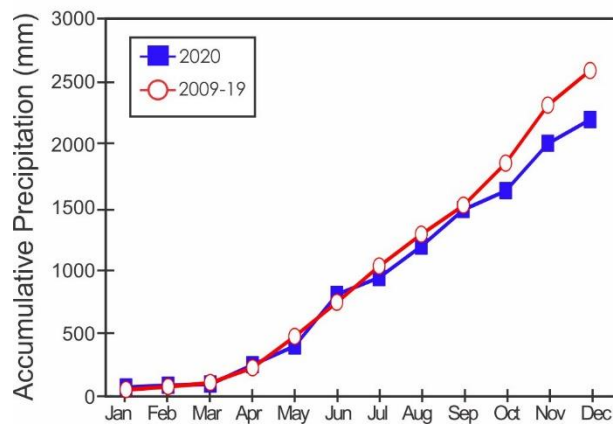
Monthly Rainfall (mm)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2009	42.1	38.6	37.6	48.4	138.8	377.9	285.9	349.0	100.0	305.0	449.0	117.0	2289.3
2010	0.0	42.0	8.0	122.0	121.0	298.0	400.0	351.0	146.0	372.0	586.0	1083.2	3529.2
2011	122.0	100.0	36.0	126.0	242.0	168.0	496.0	187.0	259.0	388.0	828.0	446.0	3398.0
2012	5.0	14.0	51.0	170.0	310.0	226.0	349.0	389.0	158.7	231.0	519.0	352.0	2774.7
2013	5.0	34.0	59.0	142.0	357.0	289.0	272.0	280.0	241.0	283.0	231.0	152.0	2345.0
2014	19.0	1.0	48.0	86.0	311.0	215.0	151.0	270.0	216.0	295.0	503.0	220.0	2335.0
2015	35.7	15.7	18.5	62.7	136.7	151.5	151.0	123.1	263.2	275.9	170.8	96.6	1501.1
2016	6.7	21.8	3.9	139.1	343.9	270.7	231.2	241.2	289.2	463.8	919.7	159.7	3090.7
2017	21.2	4.3	22.7	111.5	335.9	257.5	351.0	233.3	192.9	355.4	500.9	312.3	2698.8
2018	136.7	1.0	80.8	172.5	217.4	399.0	261.7	176.2	410.6	513.2	219.1	20.1	2608.2
2019	9.4	1.5	19.6	74.7	341.6	205.5	367.0	202.7	206.8	310.9	252.2	160.5	2152.4
2020	59.1	15.0	9.0	154.1	150.2	411.2	134.5	250.8	291.8	149.6	378.0	190.1	2193.4
Mean	38.5	24.1	32.8	117.5	250.5	272.8	288.0	254.6	231.3	335.9	462.7	275.8	2584.5
sd	46.0	28.0	23.5	41.4	93.6	86.6	111.2	78.8	81.5	100.4	236.6	280.1	564.5
Min	119.7	116.3	71.6	35.2	37.4	31.7	38.6	30.9	35.3	29.9	51.1	101.6	21.8
Max	0.0	1.0	3.9	48.4	121.0	151.5	134.5	123.1	100.0	149.6	170.8	20.1	1501.1
Rank*	3	7	10	3	9	1	12	6	2	12	8	6	11

Data in Green are from the ACP Agua Salud station

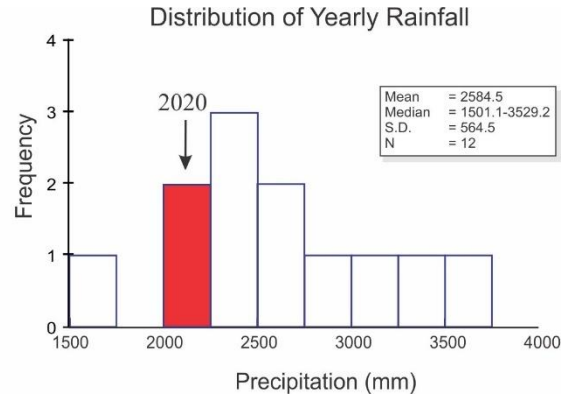
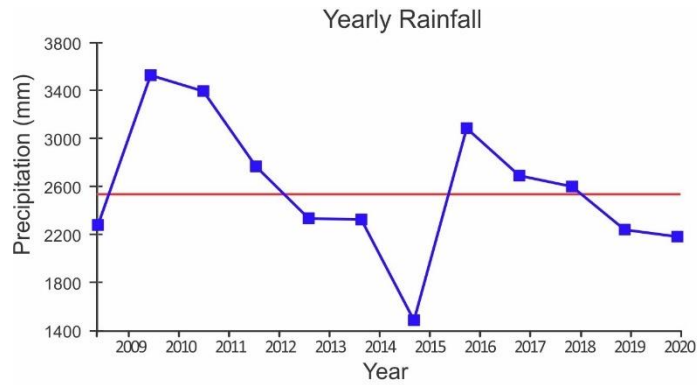
Data in Purple estimated entirely or in part from STRI's BCI Clearing station

*Rank 1 = Wettest



Yearly Rainfall (mm)

Year	Rain	Year	Rain
2009	2289.3	2015	1501.1
2010	3529.2	2016	3090.7
2011	3398.0	2017	2698.8
2012	2774.7	2018	2608.2
2013	2345.0	2019	2251.0
2014	2335.0	2020	2193.4



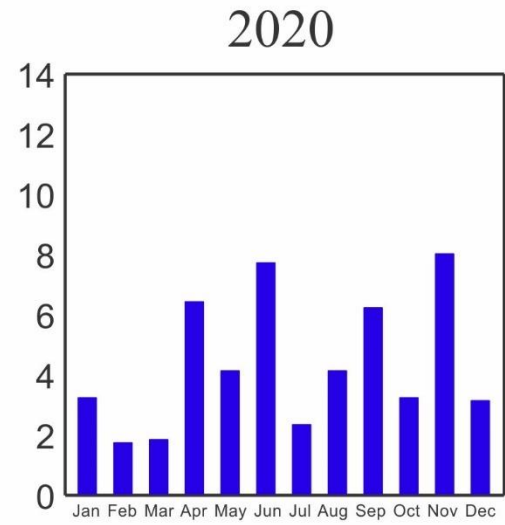
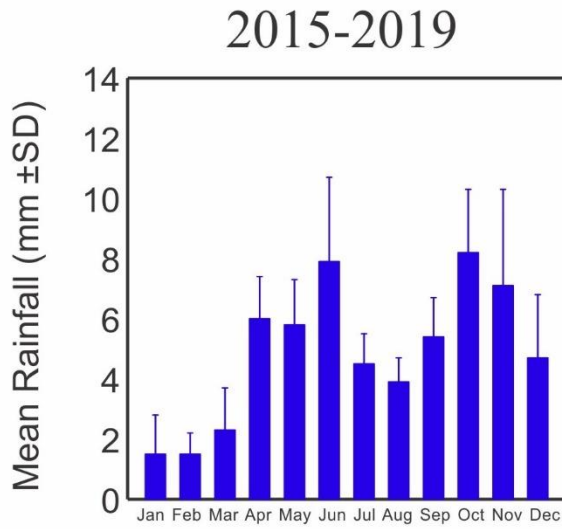
Storm Analysis

	Max. Rainfall per Storm			Storm Duration (min.)		
	2015-2019		2020	2015-2019		2020
	Mean	S.D.		Mean	S.D.	
January	12.4	20.1	19.8	30.4	23.1	32.7
February	6.2	4.9	5.1	59.3	16.8	36.1
March	13.3	13.7	5.3	43.8	20.3	13.6
April	42.0	12.7	51.8	48.9	13.1	43.6
May	53.9	16.4	35.6	64.5	11.8	42.1
June	49.9	12.7	84.1	64.8	10.2	64.3
July	45.4	15.8	31.2	57.7	8.1	46.2
August	31.0	14.8	54.4	56.2	8.4	43.5
September	50.4	15.7	58.2	62.7	12.4	61.5
October	68.1	16.2	25.1	66.1	11.5	35.7
November	105.5	109.4	77.0	77.2	22.4	79.5
December	40.3	26.1	66.3	54.5	11.7	32.6

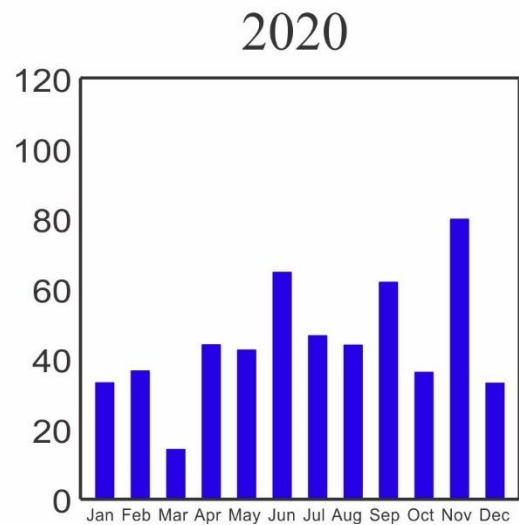
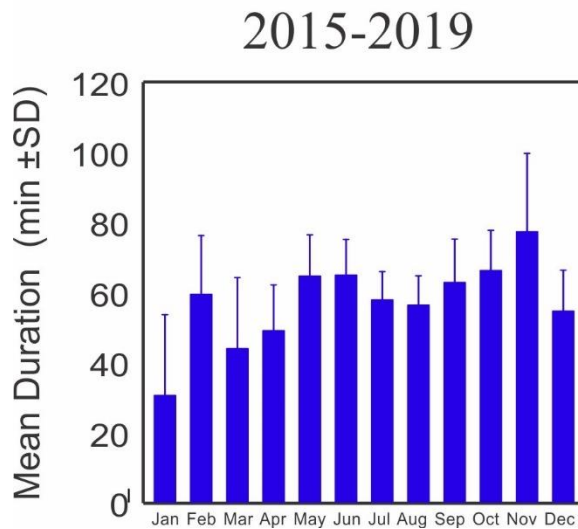
Av. Rainfall per Storm (mm)

	2015-2019		2020
	Mean	S.D.	
January	1.5	1.3	3.2
February	1.5	0.7	1.7
March	2.3	1.4	1.8
April	6.0	1.4	6.4
May	5.8	1.5	4.1
June	7.9	2.8	7.7
July	4.5	1.0	2.3
August	3.9	0.8	4.1
September	5.4	1.3	6.2
October	8.2	2.1	3.2
November	7.1	3.2	8.0
December	4.7	2.1	3.1

Average Monthly Storm Size

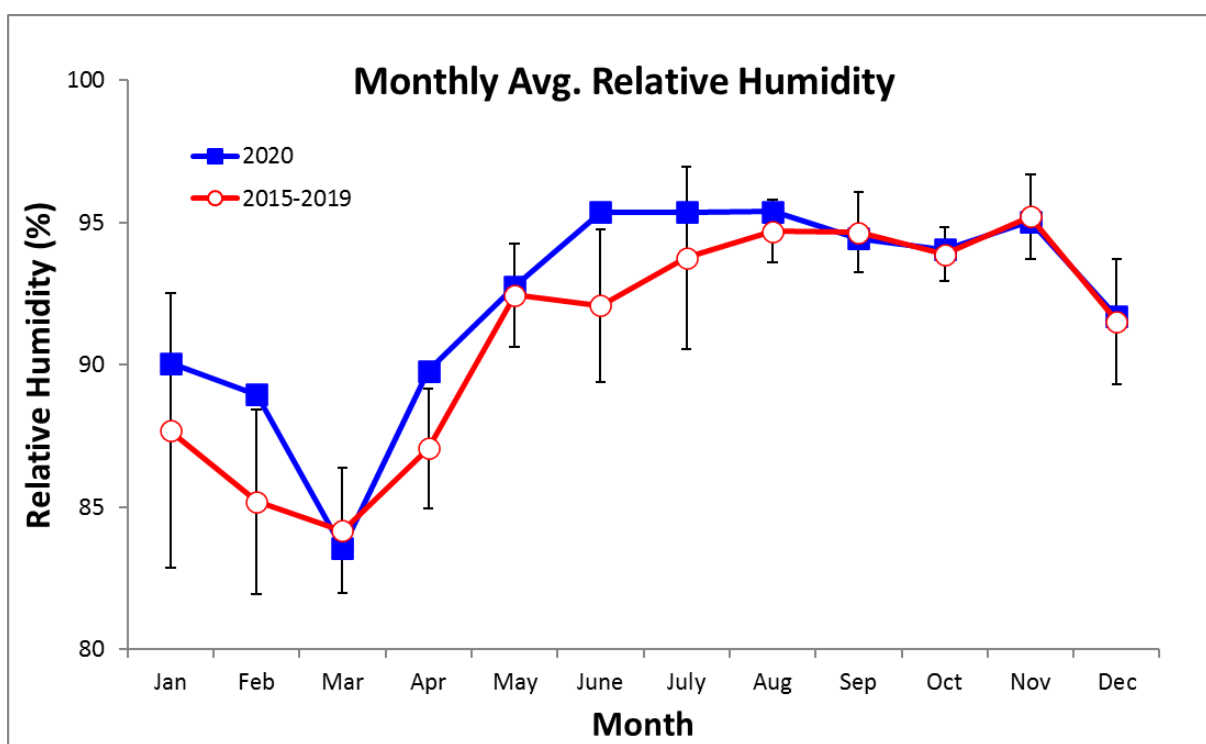


Average Monthly Storm Duration



Relative Humidity (%)

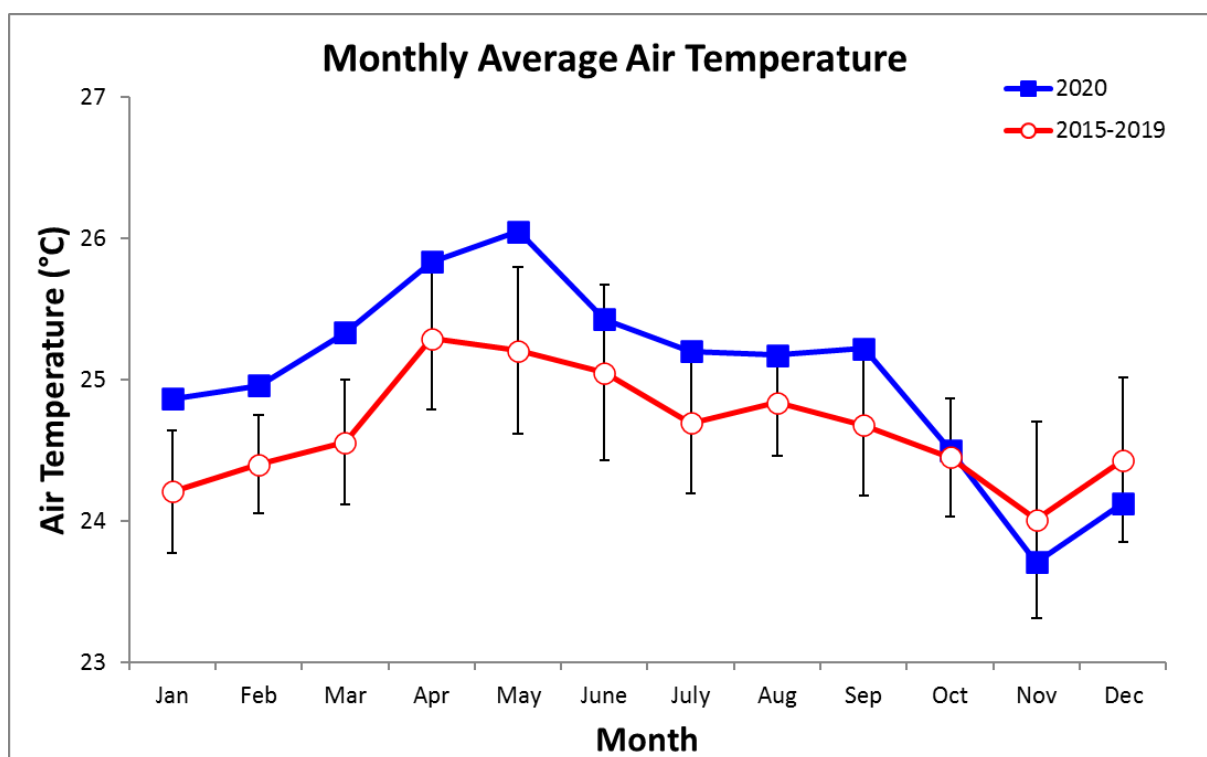
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		82.9	81.1	84.1	89.2	88.1	92.5	93.0	94.0	92.4	92.4	89.7
2016	82.9	82.4	84.3	86.0	91.9	90.6	94.7	93.8	93.2	93.3	95.3	89.9
2017	82.8	82.2	82.9	86.9	93.8	93.7	96.6	94.8	93.6	94.1	96.6	93.0
2018	94.0	84.0	87.2	89.2	94.4	90.8	87.9	95.9	96.4	94.1	96.2	89.8
2019	88.7	88.4	86.1	86.5	92.6	93.9	95.6	95.3	96.3	95.3	95.7	95.1
2020	90.1	89.0	83.6	89.8	92.8	95.4	95.4	95.4	94.4	94.1	95.0	91.7
mean	87.7	85.2	84.2	87.1	92.4	92.1	93.8	94.7	94.7	93.9	95.2	91.5
sd	4.8	3.2	2.2	2.1	1.8	2.7	3.2	1.1	1.4	0.9	1.5	2.2
min	5.5	3.8	2.6	2.4	2.0	2.9	3.4	1.2	1.5	1.0	1.5	2.4
max	82.8	82.2	81.1	84.1	89.2	88.1	87.9	93.0	93.2	92.4	92.4	89.7



Monthly Average of Daily Maximum & Minimum Temperatures (°C)

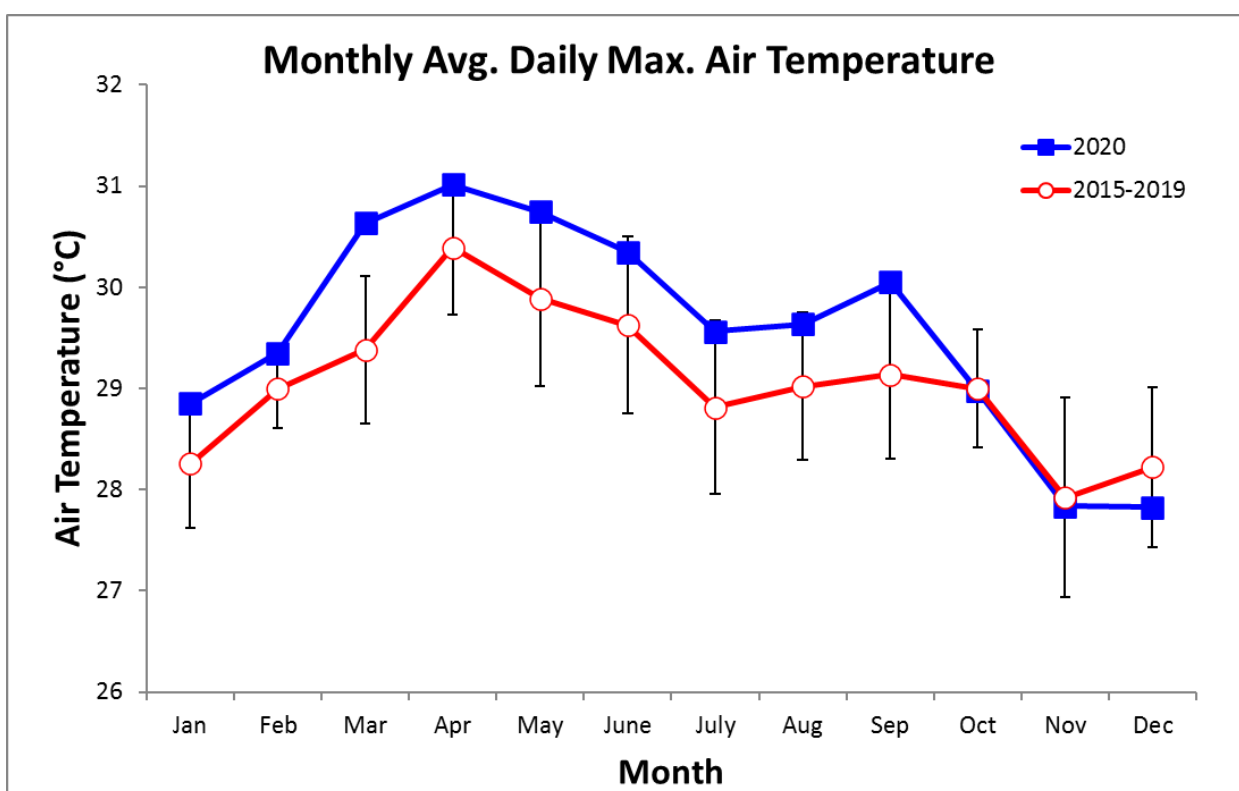
Monthly Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		24.3	24.2	25.1	24.9	25.4	24.5	24.6	24.7	24.6	24.3	24.9
2016	24.2	24.1	24.3	24.9	24.9	24.4	23.9	24.3	23.8	23.6	22.9	23.6
2017	24.2	24.5	24.8	25.5	25.0	24.8	24.5	24.8	24.9	24.8	23.8	24.0
2018	23.7	24.2	24.2	24.7	24.6	24.3	25.0	24.9	24.5	24.5	24.5	24.8
2019	24.1	24.3	24.6	25.9	25.8	25.9	25.1	25.3	25.0	24.7	24.9	25.1
2020	24.9	25.0	25.3	25.8	26.1	25.4	25.2	25.2	25.2	24.5	23.7	24.1
mean	24.2	24.4	24.6	25.3	25.2	25.1	24.7	24.8	24.7	24.5	24.0	24.4
sd	0.4	0.3	0.4	0.5	0.6	0.6	0.5	0.4	0.5	0.4	0.7	0.6
min	23.7	24.1	24.2	24.7	24.6	24.3	23.9	24.3	23.8	23.6	22.9	23.6
max	24.9	25.0	25.3	25.9	26.1	25.9	25.2	25.3	25.2	24.8	24.9	25.1



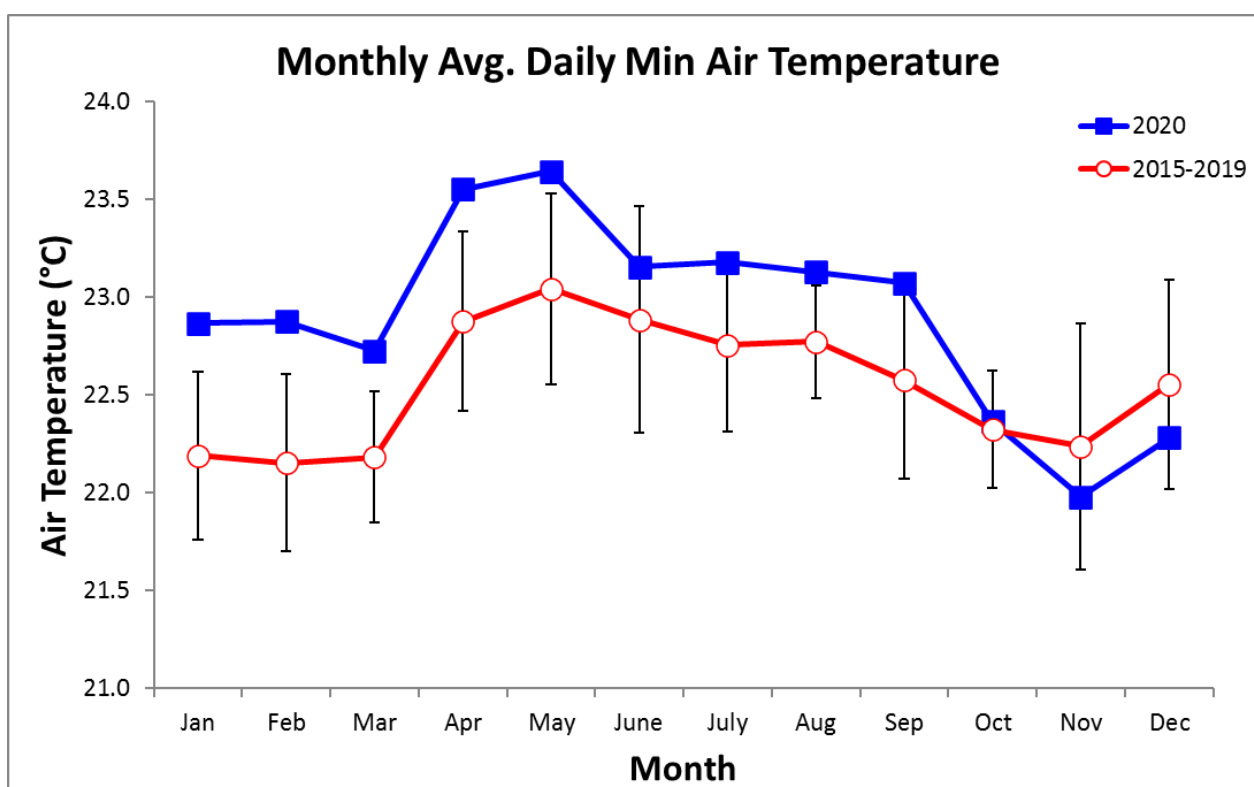
Monthly Average of Daily Maximum Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		28.2	28.8	30.3	28.8	30.0	28.0	28.3	29.0	29.0	28.2	28.6
2016	28.5	28.4	29.1	29.9	29.5	28.9	27.6	27.9	27.7	27.9	26.1	27.0
2017	28.7	29.2	29.6	30.7	30.0	29.4	28.8	29.2	29.6	29.3	28.0	28.0
2018	27.2	29.3	28.6	29.4	29.2	28.4	29.3	29.3	29.0	29.2	28.3	29.0
2019	28.1	28.8	29.5	31.1	31.0	30.7	29.6	29.7	29.5	29.6	29.1	29.0
2020	28.9	29.3	30.6	31.0	30.7	30.3	29.6	29.6	30.1	29.0	27.8	27.8
mean	28.3	29.0	29.4	30.4	29.9	29.6	28.8	29.0	29.1	29.0	27.9	28.2
sd	0.6	0.4	0.7	0.7	0.9	0.9	0.9	0.7	0.8	0.6	1.0	0.8
min	27.2	28.4	28.6	29.4	28.8	28.4	27.6	27.9	27.7	27.9	26.1	27.0
max	28.9	29.3	30.6	31.1	31.0	30.7	29.6	29.7	30.1	29.6	29.1	29.0



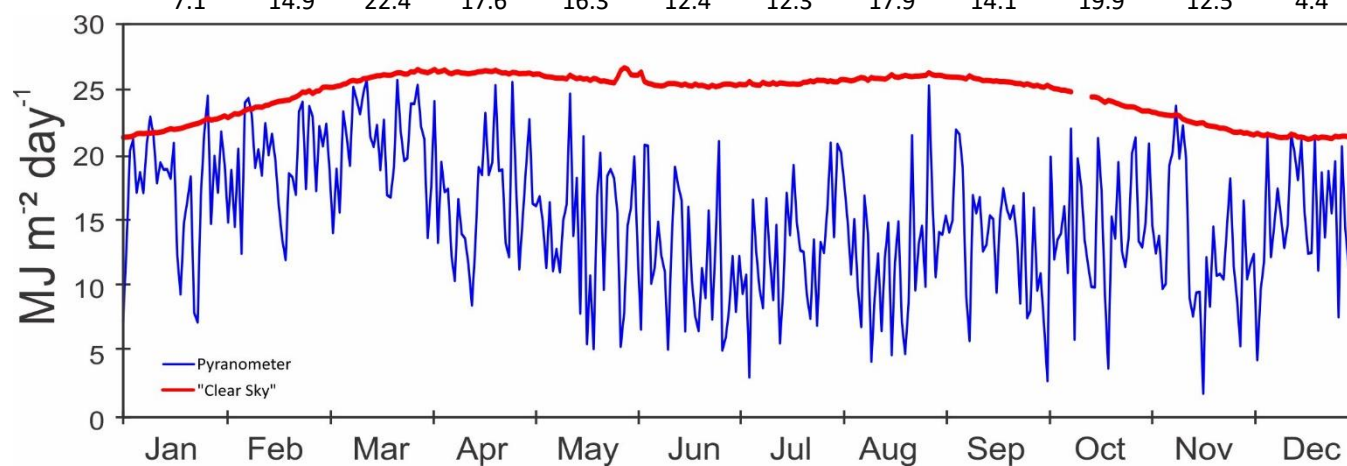
Monthly Average of Daily Minimum Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		22.2	21.8	22.7	22.9	23.1	22.7	22.7	22.4	22.4	22.4	23.1
2016	22.2	21.9	21.9	22.5	22.7	22.1	22.0	22.3	21.7	21.7	21.2	21.8
2017	21.8	22.0	22.3	22.8	22.7	22.8	22.6	22.6	22.7	22.6	22.1	22.2
2018	21.8	21.7	22.0	22.4	22.6	22.4	23.1	22.8	22.6	22.4	22.8	22.8
2019	22.3	22.3	22.3	23.3	23.7	23.8	23.0	23.1	22.9	22.5	22.9	23.1
2020	22.9	22.9	22.7	23.6	23.6	23.2	23.2	23.1	23.1	22.4	22.0	22.3
mean	22.2	22.2	22.2	22.9	23.0	22.9	22.8	22.8	22.6	22.3	22.2	22.6
sd	0.4	0.5	0.3	0.5	0.5	0.6	0.4	0.3	0.5	0.3	0.6	0.5
min	21.8	21.7	21.8	22.4	22.6	22.1	22.0	22.3	21.7	21.7	21.2	21.8
max	22.9	22.9	22.7	23.6	23.7	23.8	23.2	23.1	23.1	22.6	22.9	23.1



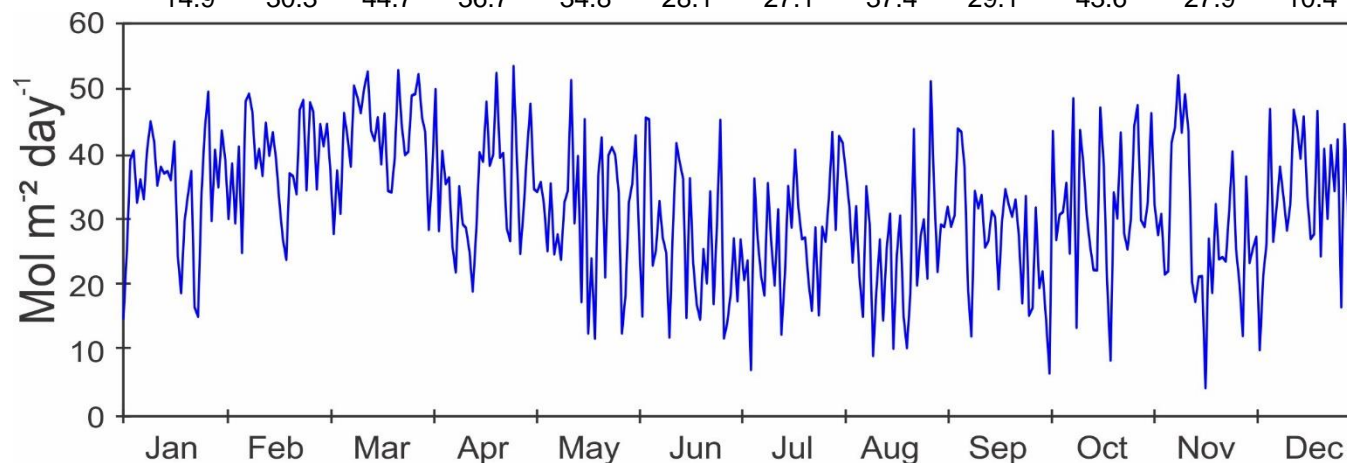
2020 Daily Total Radiation (MJ m⁻² day⁻¹)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	7.1	14.9	22.4	17.6	16.3	12.4	12.3	17.9	14.1	19.9	12.5	4.4
2	12.9	18.9	18.8	24.1	16.1	6.7	9.4	15.0	15.0	12.1	13.8	9.8
3	20.3	14.6	14.1	13.3	16.9	20.8	10.9	10.9	21.9	13.6	9.8	11.8
4	21.2	20.5	19.0	19.5	14.9	20.7	3.1	15.1	21.6	14.0	10.2	21.4
5	17.1	12.5	15.6	17.2	11.4	10.2	16.6	10.0	19.1	16.1	19.2	12.2
6	18.7	24.0	23.3	17.4	16.4	11.4	12.8	6.9	9.4	11.0	20.3	14.6
7	17.1	24.4	21.6	12.3	11.2	14.9	9.8	16.9	5.8	22.0	23.8	17.4
8	20.8	23.1	19.2	10.4	12.8	12.3	8.4	14.0	16.9	6.0	19.8	15.2
9	22.9	19.0	25.2	16.6	11.1	11.1	16.7	4.3	15.6	19.7	22.2	12.9
10	21.5	20.4	24.3	14.0	15.0	5.2	12.3	9.1	16.8	17.6	19.7	14.7
11	17.9	18.5	23.2	13.7	16.2	13.1	9.0	12.5	12.7	13.5	9.1	21.5
12	19.4	22.4	24.8	11.7	24.7	19.1	14.7	6.6	13.2	11.7	7.7	20.2
13	18.9	20.0	25.8	8.5	13.9	17.7	5.7	12.1	15.4	10.0	9.5	18.1
14	18.9	21.6	21.4	12.9	18.2	16.6	9.9	14.8	15.1	9.9	9.5	21.1
15	18.2	19.5	20.7	19.1	7.9	6.6	17.1	4.8	9.5	21.3	1.8	15.6
16	20.9	16.2	22.3	18.5	21.4	16.0	13.9	11.8	15.1	17.3	12.2	12.5
17	12.3	13.6	18.9	23.2	5.6	10.4	19.2	14.9	17.5	9.3	8.5	12.6
18	9.4	12.0	22.7	18.5	10.8	7.7	14.9	7.2	15.9	3.7	14.5	21.3
19	14.9	18.6	17.0	19.4	5.2	6.6	12.7	4.9	15.1	15.3	10.8	11.2
20	16.6	18.3	16.8	25.3	16.8	11.4	12.6	8.7	16.1	13.7	10.9	18.7
21	18.4	17.0	19.1	18.8	20.2	9.1	9.3	21.5	13.6	19.4	10.5	13.8
22	8.0	23.4	25.7	18.9	9.7	15.7	7.6	9.7	8.7	12.7	14.3	18.8
23	7.3	24.1	21.8	13.3	18.4	7.5	13.5	13.2	17.1	11.5	18.2	15.6
24	16.9	17.4	19.6	12.2	18.9	13.4	7.0	14.6	7.6	13.7	11.6	19.5
25	21.8	23.7	19.8	25.6	18.3	21.0	13.4	10.0	8.1	20.1	9.1	7.6
26	24.5	23.0	23.9	18.3	15.6	5.1	12.6	25.3	16.0	21.3	5.4	20.7
27	14.8	17.3	23.9	11.3	5.4	6.1	15.8	17.2	9.7	13.4	16.5	14.4
28	19.9	22.2	25.3	15.0	8.0	8.2	20.9	10.7	11.0	13.0	10.6	11.5
29	17.2	20.7	22.2	19.0	14.7	12.3	13.8	14.1	7.1	14.9	11.7	15.8
30	21.8		21.3	22.7	16.0	8.1	20.9	14.0	2.8	20.9	12.4	15.9
31	19.3		13.7		19.9		20.2	15.4		14.6		14.6
30	7.1	14.9	22.4	17.6	16.3	12.4	12.3	17.9	14.1	19.9	12.5	4.4



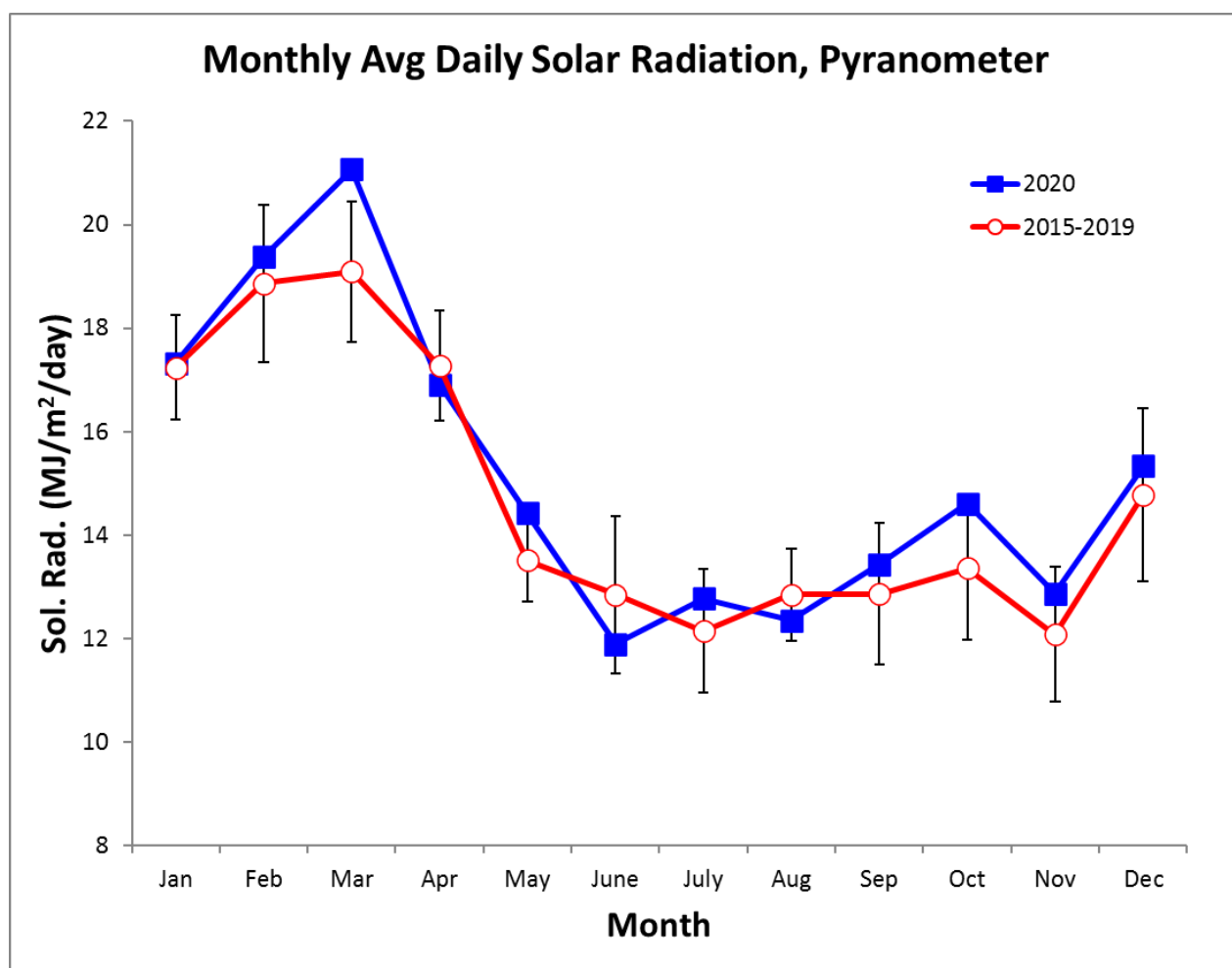
2020 Daily PAR (Mol m⁻² day⁻¹)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	14.9	30.3	44.7	36.7	34.8	28.1	27.1	37.4	29.1	43.6	27.9	10.4
2	25.5	38.7	37.7	50.0	34.4	15.5	21.1	32.1	30.8	27.1	31.0	21.7
3	39.3	29.7	28.0	28.5	35.9	45.7	23.9	23.7	44.0	30.9	21.9	26.5
4	40.6	41.2	37.6	40.6	32.5	45.4	7.4	32.2	43.5	31.4	22.4	47.0
5	32.8	25.2	31.1	35.6	25.4	23.2	36.4	21.7	38.1	35.8	41.9	26.9
6	36.3	48.2	46.3	36.6	35.7	25.5	27.2	15.5	19.3	25.1	44.2	32.3
7	33.3	49.3	43.0	26.1	25.0	33.0	21.6	35.2	12.5	48.6	52.1	38.2
8	40.8	46.6	38.3	22.2	27.9	27.5	18.7	29.5	34.5	13.8	43.4	33.6
9	45.1	38.0	50.5	35.2	24.1	25.2	35.7	9.5	31.9	43.8	49.2	28.6
10	42.1	40.9	48.7	29.5	32.8	12.3	26.4	19.5	33.9	38.7	43.5	32.4
11	35.4	36.9	46.4	28.9	34.5	29.0	20.2	27.1	26.0	30.8	20.6	46.9
12	38.2	44.9	50.3	25.3	51.4	41.8	31.7	14.9	26.9	26.3	17.8	44.3
13	37.2	39.9	52.7	19.3	29.7	38.9	12.7	25.7	31.4	22.5	21.5	39.5
14	37.5	43.4	43.7	28.5	39.8	36.4	21.8	31.1	30.6	22.5	21.6	45.8
15	36.2	39.4	42.2	40.4	17.7	15.3	35.2	10.6	19.6	47.2	4.6	33.8
16	42.0	32.6	45.7	39.0	45.4	36.5	29.0	24.9	30.1	38.3	27.3	27.3
17	24.6	27.3	38.6	48.1	12.9	23.6	40.7	30.8	34.8	20.9	19.1	27.9
18	19.0	24.1	46.3	38.4	24.2	17.3	32.0	15.4	32.4	8.8	32.5	46.7
19	29.9	37.2	34.6	40.1	12.1	15.0	27.2	10.7	30.7	34.3	24.2	24.7
20	33.8	36.8	34.3	52.4	36.8	25.7	27.5	18.9	33.2	30.4	24.4	40.9
21	37.5	34.1	39.7	39.6	42.6	20.5	20.6	43.9	27.7	43.4	23.8	30.4
22	16.9	47.0	52.9	40.3	21.5	34.4	16.4	20.2	17.5	28.1	31.8	41.5
23	15.5	48.3	44.9	28.9	40.0	17.4	29.0	27.7	33.7	25.7	40.5	34.6
24	34.4	34.7	40.0	27.0	41.1	29.5	15.7	30.2	15.6	30.2	25.7	42.3
25	43.9	48.0	40.5	53.5	40.0	45.3	29.1	21.3	16.8	44.4	20.5	16.9
26	49.6	46.6	49.0	39.3	34.3	12.2	26.9	51.2	32.0	47.6	12.5	44.7
27	30.0	34.8	49.3	25.0	12.9	14.4	33.6	34.9	19.8	30.1	36.7	31.9
28	40.8	44.7	52.3	31.9	18.6	18.9	43.5	22.3	22.3	29.1	23.6	25.7
29	35.1	41.4	45.7	40.6	32.8	27.3	28.7	29.4	14.9	32.9	25.9	34.4
30	43.7		43.5	47.8	35.6	17.8	42.9	29.1	6.9	46.3	27.6	34.7
31	39.3		28.7		43.0		41.8	32.1		32.5		32.0
	14.9	30.3	44.7	36.7	34.8	28.1	27.1	37.4	29.1	43.6	27.9	10.4



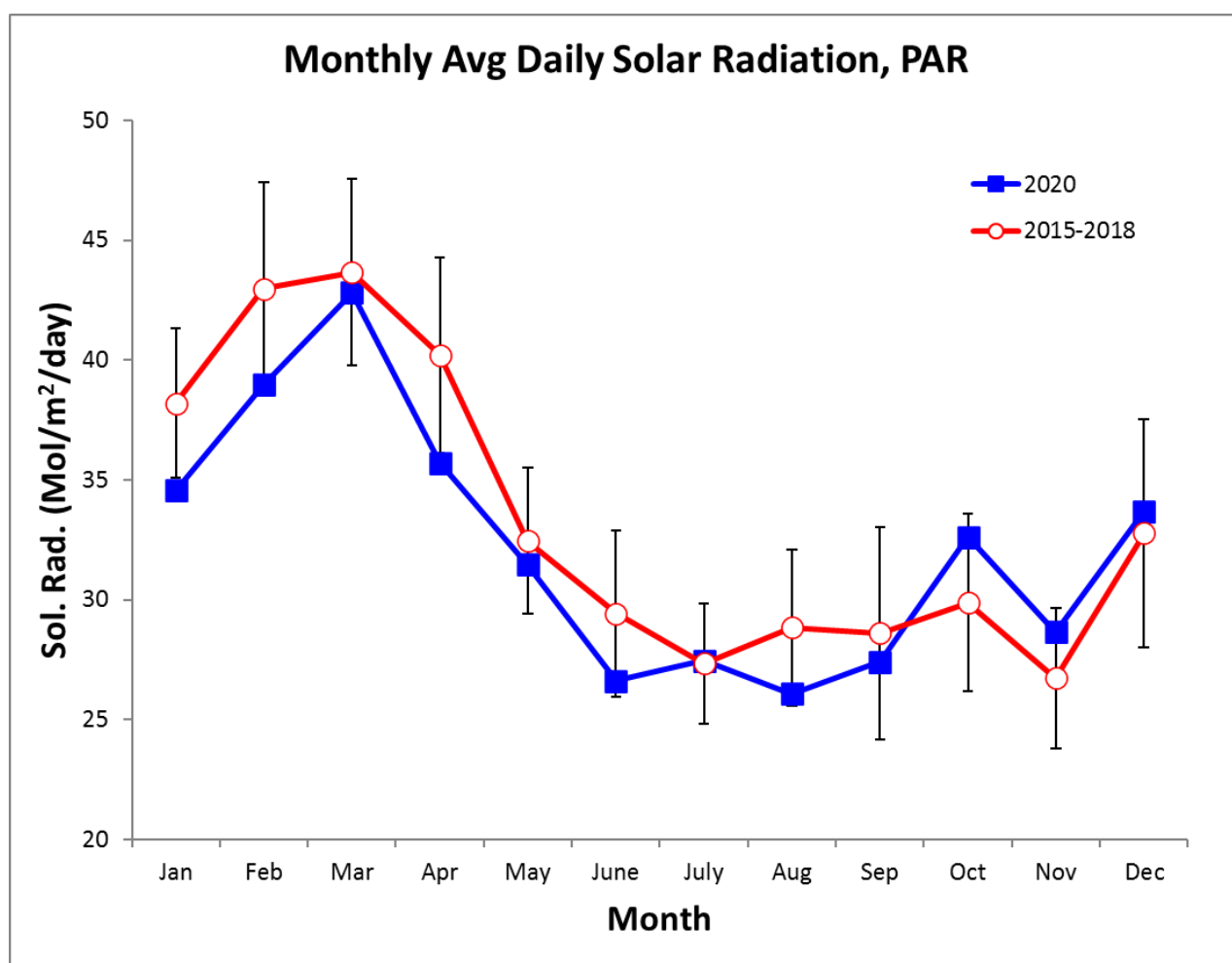
Monthly Average Total Daily Solar Radiation ($\text{MJ m}^{-2} \text{ day}^{-1}$)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		18.6	18.9	16.7	13.2	15.4	13.1	13.0	12.2	12.5	12.4	14.6
2016	17.3	16.6	17.2	17.0	13.2	12.1	10.0	11.7	11.1	11.2	9.5	13.1
2017	17.6	18.5	18.2	16.6	12.5	11.7	11.5	14.3	15.2	14.4	12.8	15.2
2018	15.6	21.3	19.6	18.2	14.5	10.7	12.7	13.3	12.9	14.6	12.0	17.5
2019	18.4	18.8	19.7	19.2	14.2	13.1	12.8	12.5	12.5	12.9	12.9	13.0
2020	17.3	19.4	21.1	16.9	14.4	11.9	12.8	12.4	13.4	14.6	12.9	15.3
mean	17.2	18.9	19.1	17.3	13.5	12.8	12.1	12.9	12.9	13.4	12.1	14.8
sd	1.0	1.5	1.4	1.1	0.8	1.5	1.2	0.9	1.4	1.4	1.3	1.7
min	15.6	16.6	17.2	16.6	12.5	11.7	10.0	11.7	11.1	11.2	9.5	13.0
max	18.4	21.3	21.1	19.2	14.4	15.4	13.1	14.3	15.2	14.6	12.9	17.5



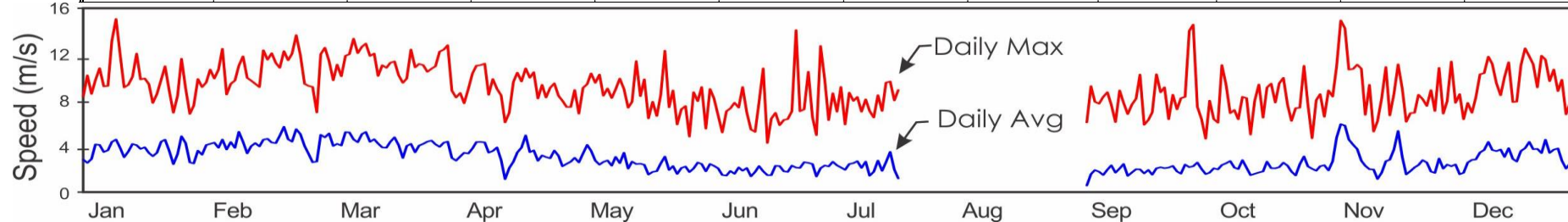
Monthly Average Daily PAR (Mols m⁻² day⁻¹)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		31.4	41.9	37.5	30.0	34.6	29.1	29.3	27.7	28.6	27.6	33.6
2016	40.1	38.5	37.9	36.5	29.1	27.1	22.4	25.6	23.8	24.4	21.0	29.0
2017	39.4	48.3	49.6	44.4	34.5	32.5	27.6	34.5	36.8	33.5	29.0	34.0
2018	35.3	46.8	45.6	44.3	37.3	27.5	26.6	27.5	26.5	29.8	25.0	36.2
2019	37.6	38.3	39.8	38.6	29.2	26.7	25.7	24.9	24.0	24.5	23.8	23.7
2020	34.6	39.0	42.8	35.7	31.5	26.6	27.5	26.1	27.4	32.6	28.7	33.7
mean	38.2	43.0	43.6	40.2	32.5	29.4	27.3	28.8	28.6	29.9	26.7	32.8
sd	3.1	4.5	3.9	4.1	3.0	3.5	2.5	3.3	4.4	3.7	2.9	4.8
min	34.6	38.5	37.9	35.7	29.1	26.1	22.4	25.6	23.8	24.4	21.0	26.3
max	41.7	48.3	49.6	44.4	37.3	34.6	29.1	34.5	36.8	33.5	29.0	40.1



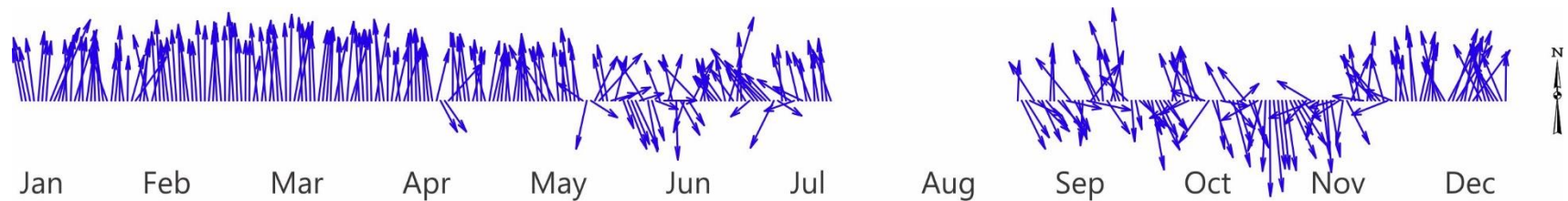
2020 Daily Average Wind Speed (m/s)

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max
1	2.9	8.3	4.3	10.7	5.2	11.5	2.8	8.3	2.7	6.9	1.9	5.6	2.3	6.3					1.7	4.7	2.8	8.4	2.5	7.8
2	2.7	10.2	4.4	9.9	4.1	9.8	3.2	8.7	3.5	9.1	2.6	9.0	2.7	8.7			0.7	6.2	1.8	8.0	4.8	11.0	1.7	8.6
3	3.0	8.6	4.0	10.7	4.3	11.1	3.5	7.8	4.2	9.5	2.4	8.2	2.4	7.1			1.7	9.3	2.2	6.4	6.0	14.9	1.8	6.4
4	4.2	9.8	4.7	12.5	4.1	10.1	3.5	9.0	3.7	10.4	2.2	6.8	2.2	9.2			2.0	7.9	2.1	6.1	5.9	14.3	2.7	7.8
5	4.2	10.8	3.8	8.6	5.3	11.9	3.9	10.4	2.8	9.6	1.6	5.3	2.0	6.0			1.9	7.8	2.5	11.1	4.7	10.7	2.9	7.0
6	3.6	9.3	4.4	9.5	5.3	12.0	4.4	11.0	2.5	10.3	1.5	7.1	2.5	8.7			1.6	8.4	2.6	9.4	4.2	10.8	2.9	8.3
7	3.7	9.3	3.9	9.8	4.7	13.4	4.5	11.1	2.7	8.5	1.9	7.4	2.6	8.0			2.1	8.7	2.8	6.9	3.8	11.1	3.5	10.3
8	4.5	13.2	5.3	11.0	4.4	12.1	4.4	11.2	2.8	9.1	1.7	7.8	2.8	8.3			2.4	7.7	2.2	7.2	2.8	10.8	3.8	10.4
9	4.7	15.1	4.5	11.8	5.1	12.7	3.5	8.5	2.4	8.3	2.2	7.4	2.2	7.1			1.8	6.2	2.1	6.4	2.4	6.8	4.5	11.8
10	3.9	12.0	3.5	10.0	5.3	12.9	3.7	9.9	3.2	9.0	2.0	9.2	2.7	8.1			2.2	8.9	2.9	8.4	2.1	9.4	3.8	11.2
11	3.1	9.2	4.1	9.8	4.5	11.9	4.0	9.0	2.6	9.9	2.2	7.0	1.5	7.1			2.5	7.8	2.2	8.2	2.1	5.4	3.7	9.5
12	3.6	9.4	4.3	9.5	4.7	12.1	2.9	8.5	3.5	9.0	1.5	5.5	1.9	6.6			1.5	6.9	1.6	5.1	1.3	6.3	3.8	8.5
13	4.3	10.1	4.1	9.2	4.3	10.2	1.2	6.2	2.1	7.4	1.9	5.3	2.8	8.5			1.8	7.7	1.7	8.0	1.8	8.2	3.2	10.1
14	4.2	12.1	4.6	12.4	4.0	11.1	2.2	7.0	2.8	7.9	2.4	7.9	2.0	7.1			2.1	8.2	1.8	9.4	2.8	10.9	3.9	11.3
15	3.8	9.9	4.7	11.6	4.0	10.9	2.8	9.6	2.5	11.4	1.9	10.8	2.7	9.6			2.1	10.3	1.9	6.6	2.9	6.7	3.0	7.9
16	4.0	9.9	4.4	12.1	4.5	11.3	3.5	10.4	2.6	8.4	1.6	4.4	3.6	9.7			1.7	5.9	2.8	9.2	3.8	8.6	2.8	7.9
17	3.5	9.5	4.4	11.3	4.9	11.4	4.0	9.7	2.5	9.9	1.6	6.5	2.1	8.0			2.0	6.4	2.2	9.5	5.4	11.2	3.7	11.1
18	3.2	7.8	5.0	10.9	4.2	10.2	5.0	10.8	1.6	6.5	2.4	7.0	1.3	8.9			1.6	7.0	2.2	7.9	3.2	9.0	3.9	12.5
19	3.5	8.6	5.8	12.3	3.1	9.6	3.6	10.0	1.9	7.9	2.4	5.9					2.2	10.3	2.3	9.5	1.7	6.2	4.4	11.8
20	4.5	9.8	4.7	11.5	4.1	9.9	3.7	10.5	1.9	6.7	1.9	6.4					2.3	8.7	2.7	10.0	1.9	6.9	3.8	11.2
21	4.6	11.0	4.5	12.1	4.3	12.4	2.8	8.2	2.6	8.5	1.9	6.4					2.2	9.2	2.4	7.7	2.3	7.0	3.9	9.2
22	3.7	8.9	5.6	13.7	3.6	10.9	3.3	9.4	3.2	12.3	2.4	7.1					2.2	6.4	1.9	6.3	2.5	8.5	3.5	11.9
23	2.5	7.0	5.1	12.0	4.1	11.2	3.1	8.3	2.0	7.5	2.2	14.1					2.4	8.5	1.6	7.4	2.9	8.2	4.7	11.6
24	3.4	8.4	4.1	9.5	4.3	11.1	3.0	9.1	2.4	8.9	2.2	7.1					1.9	7.3	2.5	7.4	2.7	7.6	3.5	9.7
25	4.9	11.6	3.4	9.3	4.5	10.5	3.7	9.5	1.7	6.0	2.7	7.3					1.7	8.2	3.2	11.0	1.9	8.9	3.8	10.7
26	4.3	9.1	2.7	9.2	4.6	10.8	3.3	8.4	2.2	7.3	2.6	10.5					2.5	8.4	2.3	7.7	1.8	7.1	3.9	8.8
27	2.7	6.9	2.8	7.0	4.2	11.0	2.3	8.0	2.3	7.6	2.6	6.6					2.3	14.1	2.1	4.8	3.0	10.8	2.8	9.8
28	2.6	7.6	5.1	12.0	4.0	12.3	2.6	7.5	1.9	4.9	1.5	5.0					2.4	14.6	2.0	8.1	2.1	6.9	2.2	6.8
29	3.7	9.9	4.8	12.6	4.4	12.4	2.7	7.5	2.2	8.7	2.2	12.7					2.7	7.5	2.4	8.6	2.5	8.0	2.6	7.9
30	3.3	9.2			4.5	12.8	3.1	8.9	2.7	8.0	2.4	9.8					2.1	6.4	2.4	6.6	2.3	11.4	2.4	8.5
31	4.2	9.6			3.1	8.9			2.5	9.2									2.0	8.9			2.6	7.5



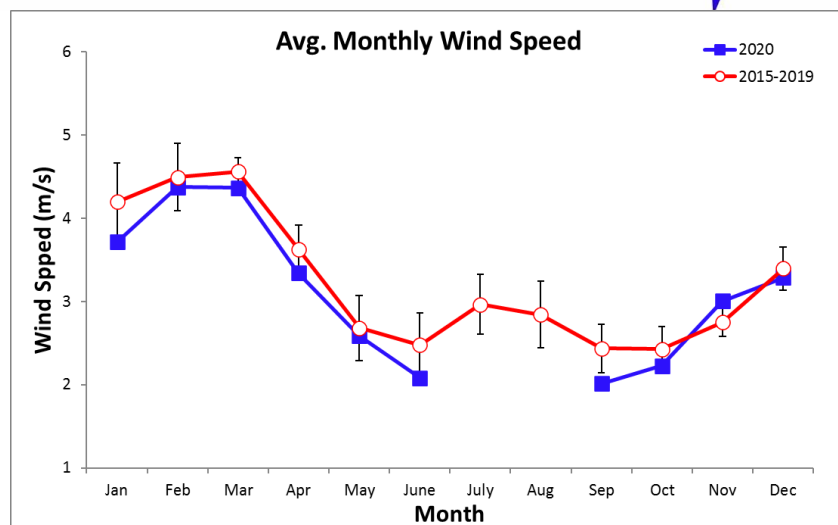
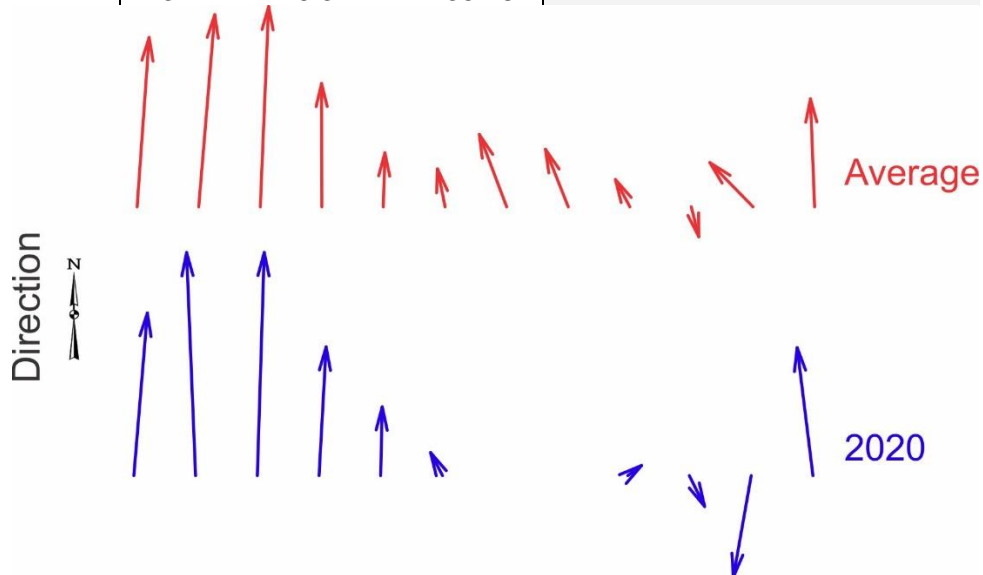
2020 Average Daily Wind Direction (°)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	345.0	341.6	353.5	10.0	12.0	78.5	303.7			162.2	202.0	336.8
2	343.1	21.6	7.3	19.0	6.1	316.3	303.2		3.0	121.1	183.8	255.0
3	343.1	354.6	352.6	350.4	358.8	164.6	305.6		143.9	131.7	179.3	285.3
4	349.1	356.1	355.2	25.6	354.2	155.1	216.7		136.6	148.8	171.9	1.8
5	7.4	353.7	350.4	0.7	348.8	104.7	113.0		107.7	165.2	171.1	4.9
6	7.0	349.2	358.5	358.2	326.1	329.8	353.1		315.7	144.1	170.9	338.8
7	6.9	352.4	1.5	358.5	351.9	90.2	336.2		123.1	144.5	167.8	342.4
8	31.2	354.5	15.7	354.2	353.6	24.4	293.2		145.2	130.1	146.1	356.5
9	33.7	357.6	15.2	356.5	316.3	342.8	256.7		129.1	136.8	140.8	349.2
10	22.1	355.0	356.3	351.3	343.0	177.8	340.4		3.6	12.9	136.6	18.2
11	12.4	348.2	355.4	347.4	323.9	139.6	287.3		357.1	331.8	126.4	19.5
12	357.5	355.1	357.6	20.0	352.9	207.2	346.6		126.2	244.8	233.9	11.9
13	3.7	353.6	356.0	141.3	1.0	136.4	330.9		135.6	338.3	291.5	1.8
14	25.1	356.5	10.7	133.7	349.0	37.9	356.4		98.9	253.1	255.3	341.7
15	9.6	0.3	8.8	53.3	348.9	304.9	345.5		309.4	339.4	205.5	329.5
16	357.7	8.1	6.5	0.3	355.1	24.7	354.3		143.0	335.5	168.9	318.4
17	12.0	4.4	2.6	5.3	346.3	355.1	349.2		162.6	310.5	174.5	38.3
18	5.7	355.1	16.6	347.3	294.8	335.8	332.1		184.6	281.2	165.8	27.6
19	357.2	352.6	0.8	350.3	198.2	309.3			98.2	226.7	259.4	44.0
20	355.6	359.5	353.8	348.6	113.0	306.9			49.5	152.0	246.4	27.7
21	348.6	3.2	7.2	19.6	36.9	313.7			327.0	166.8	192.8	13.5
22	331.9	355.3	23.3	356.2	53.7	342.7			321.6	97.3	142.4	25.4
23	8.8	357.0	10.9	359.9	342.4	23.8			352.8	322.7	31.7	47.7
24	8.1	356.0	355.5	337.2	345.2	312.6			134.5	126.4	339.5	5.6
25	0.7	0.3	354.9	14.2	79.2	5.3			20.4	158.8	345.4	324.0
26	348.8	0.5	357.7	19.0	20.8	356.5			342.3	154.6	275.5	337.6
27	1.4	12.3	357.8	13.8	74.1	317.9			330.6	57.0	8.8	333.0
28	22.7	352.3	14.5	6.8	150.9	240.4			350.0	309.3	318.5	320.0
29	46.7	9.8	354.7	5.7	149.3	309.2			301.3	148.3	302.6	316.1
30	14.8		350.2	352.3	148.4	308.8			173.3	158.0	307.5	327.7
31	6.7		0.3		144.9					249.9		1.0



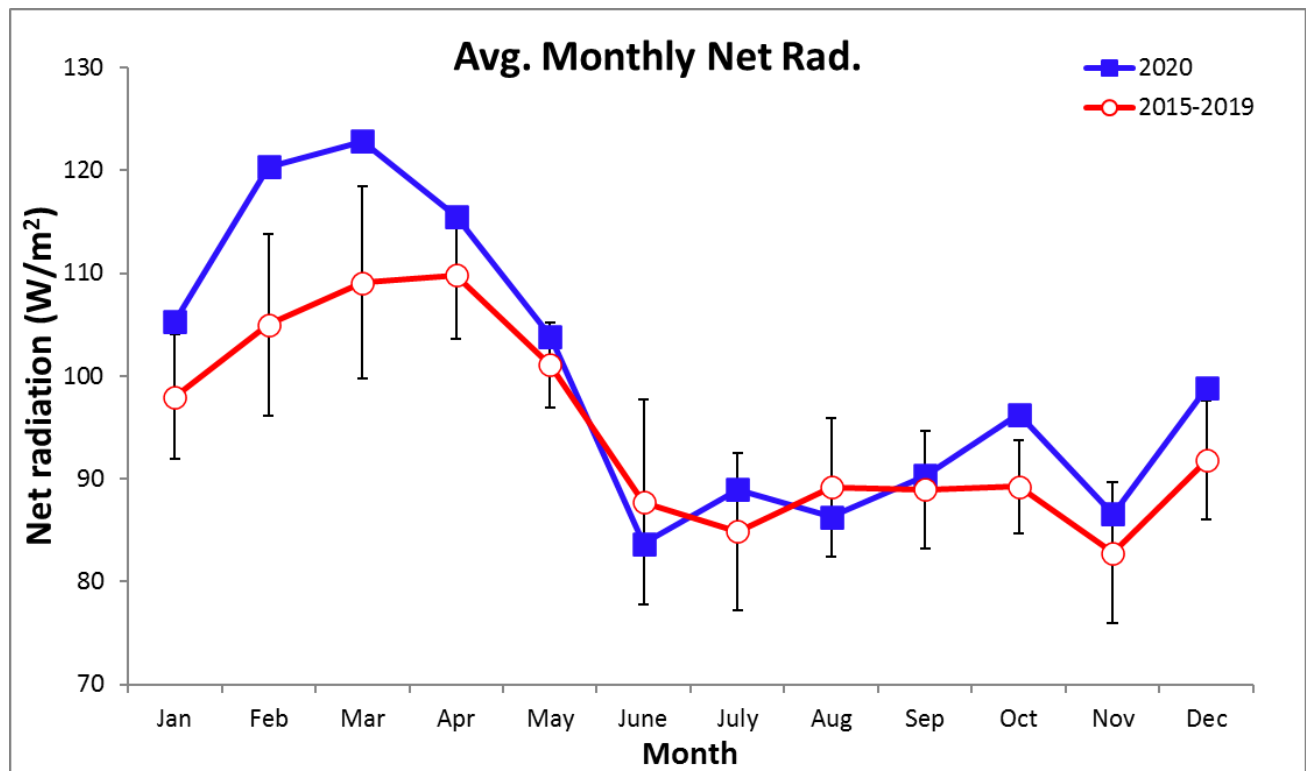
Average Monthly Wind Speed (km/h) and Direction (°)

	Long-term Av.			2020		
	Speed	Wsmx	Dir.	Speed	Wsmx	Dir.
January	4.2	10.5	4.1	3.7	9.7	4.8
February	4.5	11.1	4.8	4.4	10.8	357.7
March	4.6	11.3	2.4	4.4	11.3	1.8
April	3.6	9.9	359.9	3.3	9.1	3.2
May	2.7	8.5	1.6	2.6	8.5	1.3
June	2.5	8.1	348.9	2.1	7.6	332.6
July	3.0	8.6	339.3			
August	2.8	8.7	338.4			
September	2.4	8.6	332.1	2.0	8.3	53.9
October	2.4	8.2	165.9	2.2	7.8	153.7
November	2.8	8.5	315.7	3.0	9.1	189.9
December	3.4	9.3	357.8	3.3	9.5	353.0



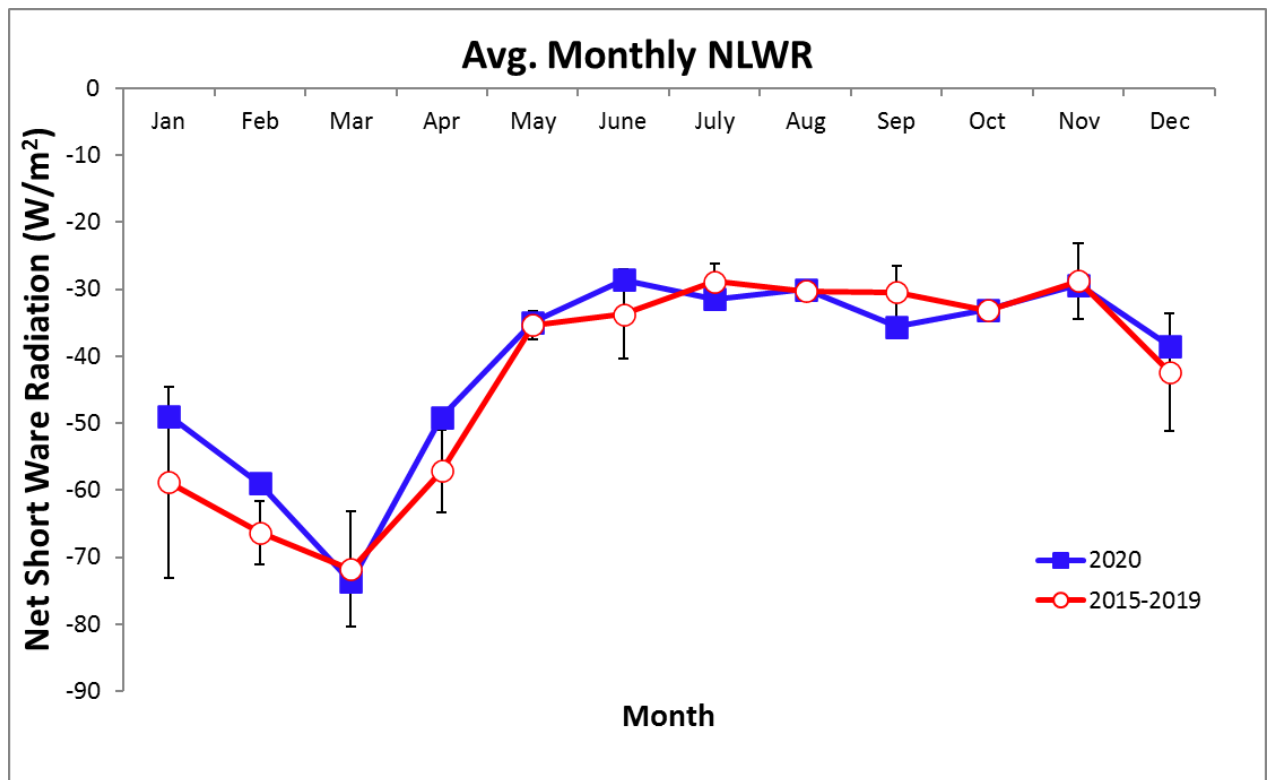
Monthly Average Net Radiation (W m^{-2})

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015					107.3	103.6	97.0	99.1	95.3	92.9	90.2	96.0
2016	94.3	98.3	96.9	105.2	102.6	91.4	78.1	90.2	84.0	87.6	82.4	94.0
2017	101.5	100.7	106.1	101.5	98.0	88.0	75.9	93.6	93.7	87.0	81.5	83.5
2018	89.9	103.6	109.3	112.3	97.9	73.1	83.7	86.2	80.4	83.7	70.5	91.6
2019	98.8	101.9	110.2	114.4	96.9	86.6	85.7	79.6	90.1	88.1	85.7	86.8
2020	105.4	120.3	122.9	115.5	103.9	83.7	89.0	86.3	90.3	96.3	86.6	98.8
mean	98.0	105.0	109.1	109.8	101.1	87.7	84.9	89.2	89.0	89.3	82.8	91.8
sd	6.1	8.8	9.3	6.1	4.1	10.0	7.6	6.8	5.7	4.5	6.8	5.8
min	89.9	98.3	96.9	101.5	96.9	73.1	75.9	79.6	80.4	83.7	70.5	83.5
max	105.4	120.3	122.9	115.5	107.3	103.6	97.0	99.1	95.3	96.3	90.2	98.8



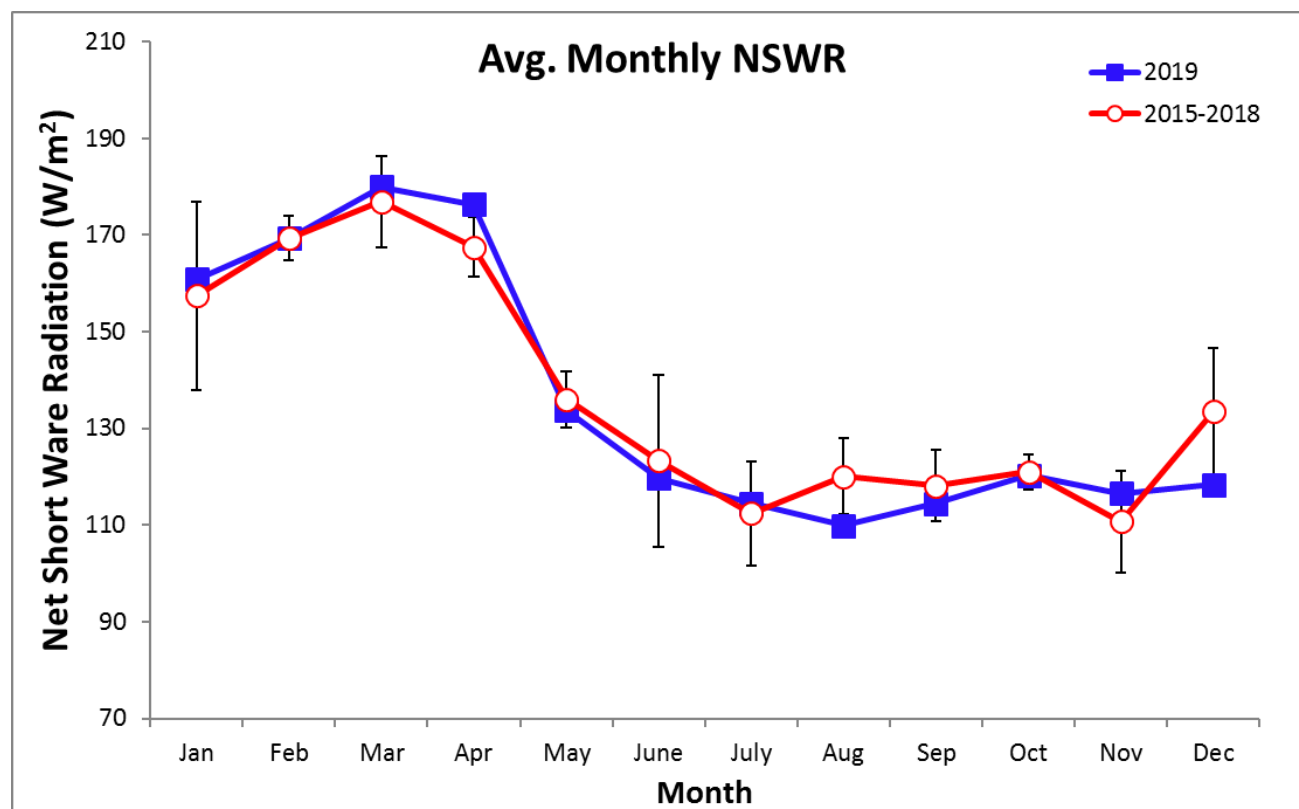
Monthly Average Net Longwave Radiation (W m^{-2})

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015					-38.6	-45.0	-32.1	-30.6	-28.8	-34.3	-36.3	-48.0
2016	-71.0	-65.5	-73.4	-61.8	-33.5	-36.0	-26.6	-28.4	-29.9	-31.0	-20.5	-40.3
2017	-72.6	-68.6	-82.9	-61.0	-32.8	-33.8	-25.5	-32.5	-34.1	-33.6	-24.1	-39.0
2018	-39.6	-71.4	-59.2	-51.8	-35.6	-25.9	-28.8	-30.0	-30.2	-34.7	-31.8	-56.8
2019	-62.0	-67.4	-69.7	-61.9	-36.9	-33.2	-28.8	-30.3	-24.4	-32.3	-30.8	-31.6
2020	-48.9	-59.0	-73.7	-49.1	-34.9	-28.6	-31.5	-30.1	-35.6	-33.1	-29.3	-38.5
mean	-58.8	-66.3	-71.8	-57.1	-35.4	-33.7	-28.9	-30.3	-30.5	-33.2	-28.8	-42.4
sd	14.3	4.7	8.6	6.2	2.1	6.6	2.6	1.3	4.0	1.4	5.7	8.8
min	-72.6	-71.4	-82.9	-61.9	-38.6	-45.0	-32.1	-32.5	-35.6	-34.7	-36.3	-56.8
max	-39.6	-59.0	-59.2	-49.1	-32.8	-25.9	-25.5	-28.4	-24.4	-31.0	-20.5	-31.6



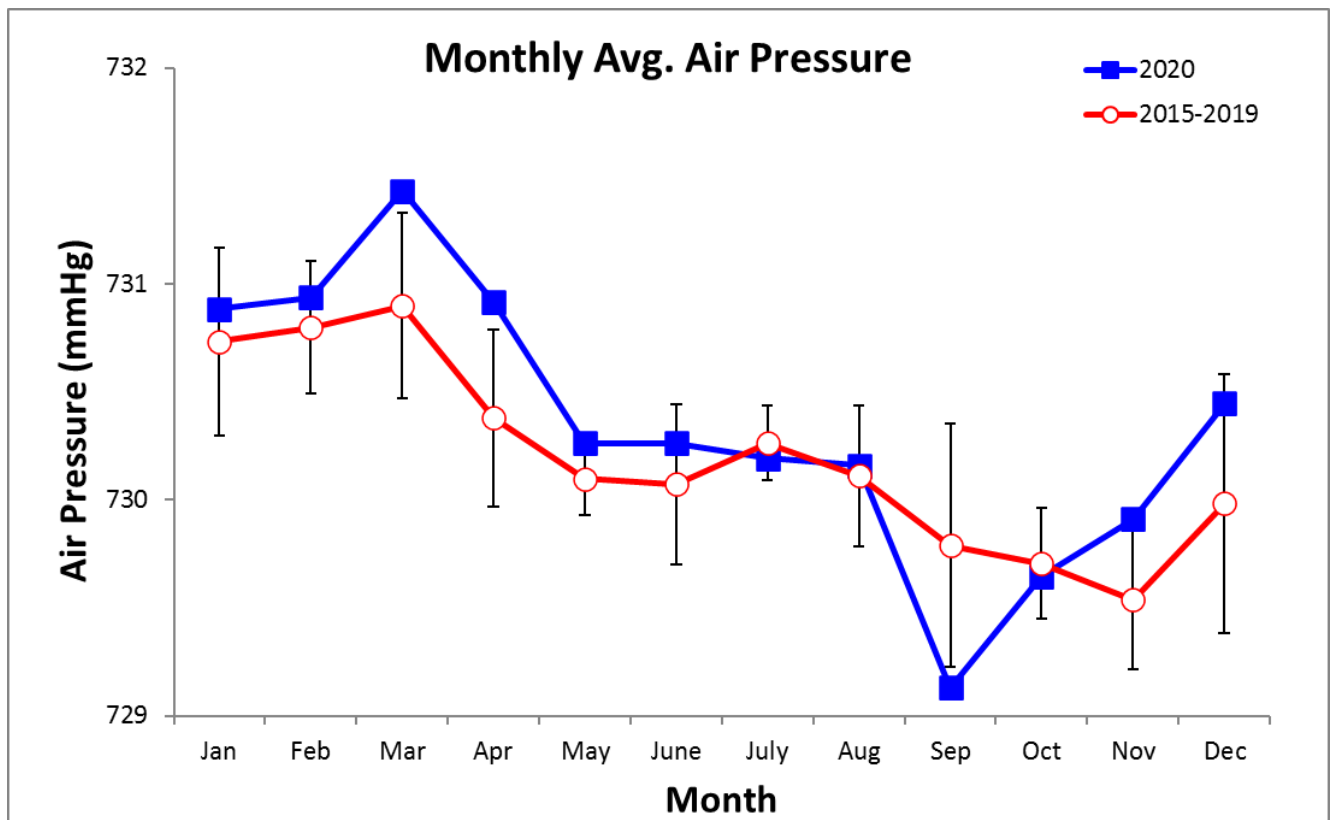
Monthly Average Net Shortwave Radiation (w m⁻²)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015					145.8	148.5	129.1	129.7	124.1	127.2	126.5	144.0
2016	165.3	163.8	170.2	167.0	136.1	127.4	104.7	118.6	113.8	118.6	102.9	134.3
2017	174.2	169.3	189.0	162.5	130.8	121.8	101.3	126.1	127.7	120.6	105.6	122.5
2018	129.5	175.0	168.5	164.2	133.5	98.9	112.6	116.2	110.6	118.3	102.3	148.4
2019	160.8	169.3	179.9	176.3	133.7	119.8	114.5	109.9	114.5	120.3	116.6	118.4
2020	193.1	217.6	236.4	195.7	167.2	137.6	146.6	142.0	155.6	161.1	144.4	172.3
mean	195.6	211.2	222.2	202.1	162.0	145.5	136.9	144.6	145.7	150.0	137.3	167.0
sd	21.8	6.3	15.2	5.7	7.0	19.4	12.9	6.8	9.2	6.3	12.2	14.6
min	160.4	203.4	205.6	195.7	153.3	120.3	121.0	135.7	135.4	142.5	122.5	149.3
max	218.1	217.6	239.9	210.5	172.8	179.5	153.5	154.9	156.6	161.1	152.7	186.7

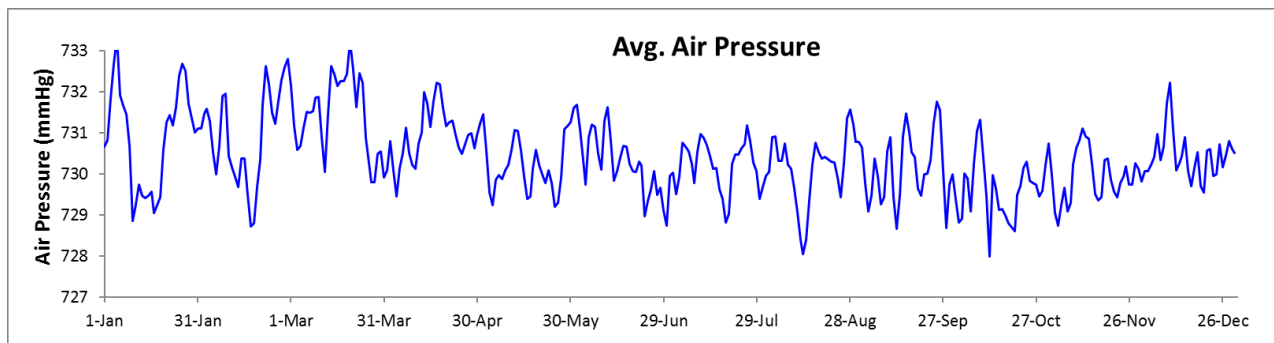
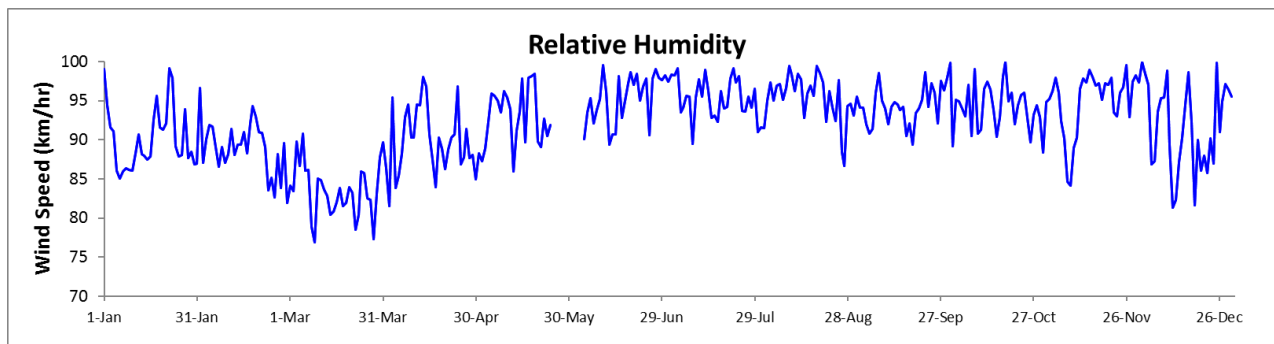
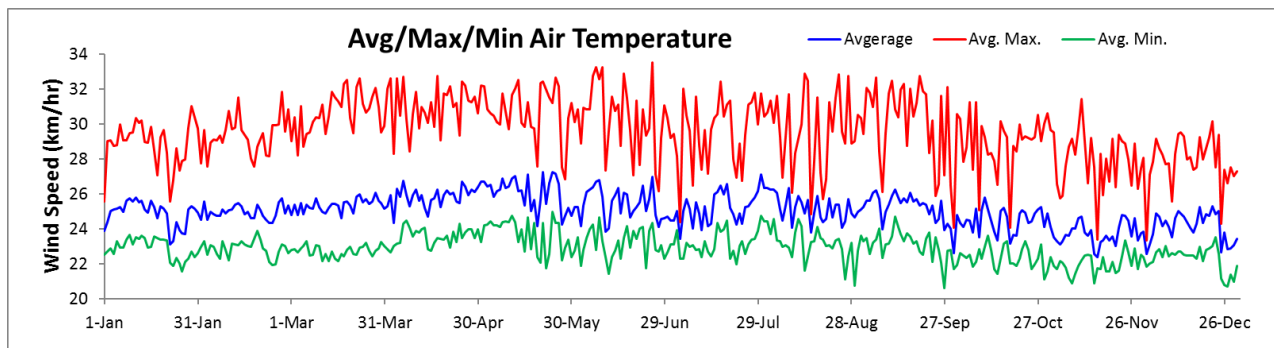
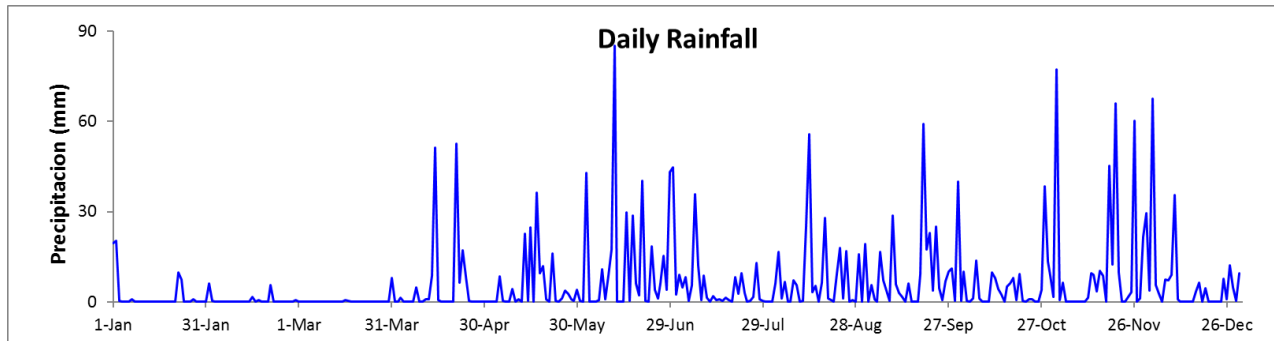


Monthly Average Daily Air Pressure (mmHg)

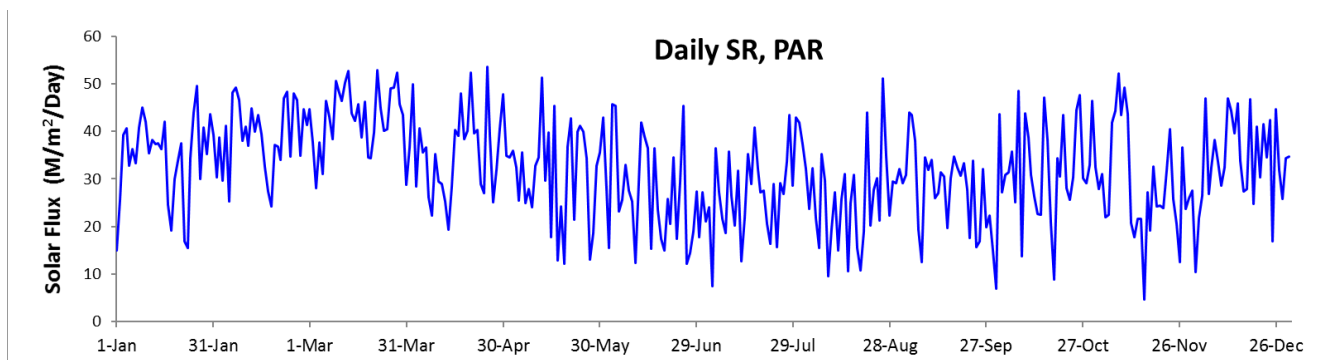
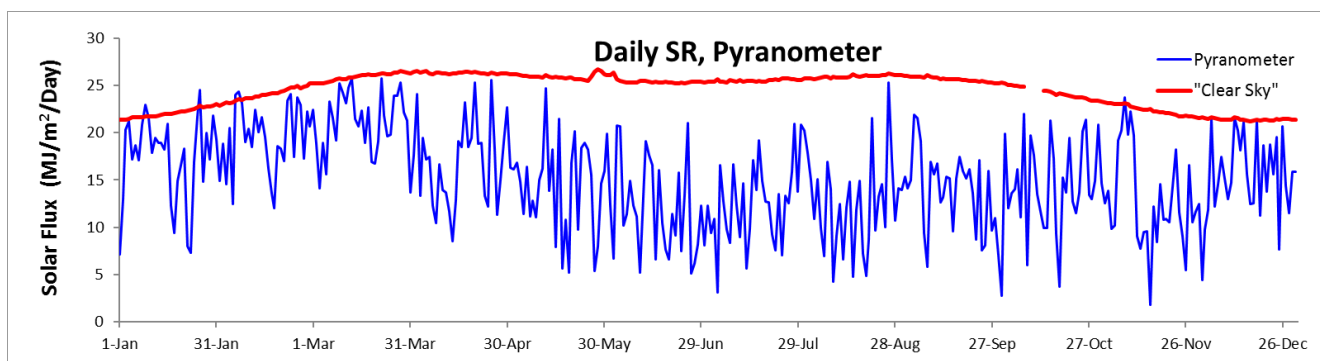
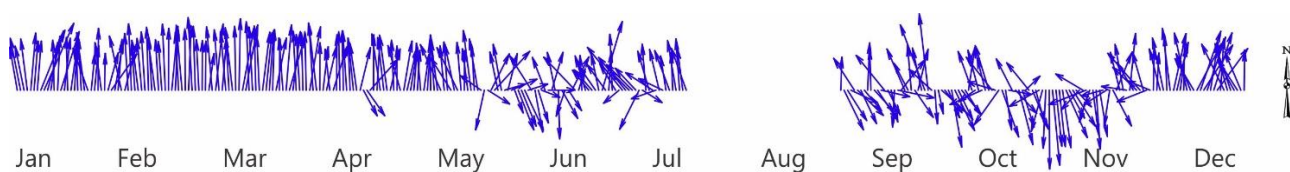
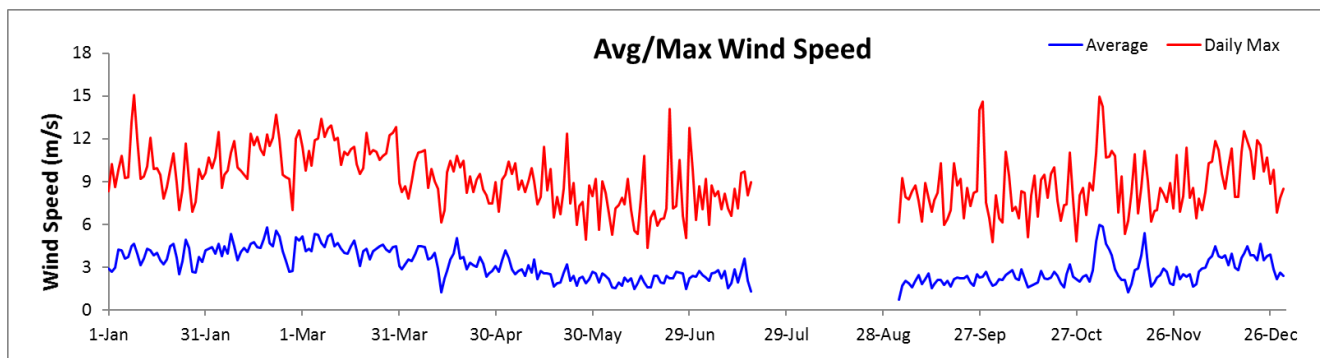
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2015		731.1	731.2	730.1	730.2	729.5	730.0	729.5	729.4	729.8	729.0	728.9
2016	730.7	730.3	731.0	730.1	730.2	730.6	730.5	729.9	730.5	729.6	729.5	730.1
2017	730.9	730.9	730.8	729.9	730.1	730.1	730.4	730.3	729.9	729.3	729.5	730.1
2018	730.0	731.1	730.2	730.7	730.1	730.0	730.3	730.4	729.5	730.0	729.7	730.6
2019	731.1	730.8	730.7	730.6	729.8	730.1	730.3	730.4	730.3	729.9	729.7	729.7
2020	730.9	730.9	731.4	730.9	730.3	730.3	730.2	730.2	729.1	729.6	729.9	730.4
mean	730.7	730.8	730.9	730.4	730.1	730.1	730.3	730.1	729.8	729.7	729.5	730.0
sd	0.4	0.3	0.4	0.4	0.2	0.4	0.2	0.3	0.6	0.3	0.3	0.6
min	730.0	730.3	730.2	729.9	729.8	729.5	730.0	729.5	729.1	729.3	729.0	728.9
max	731.1	731.1	731.4	730.9	730.3	730.6	730.5	730.4	730.5	730.0	729.9	730.6



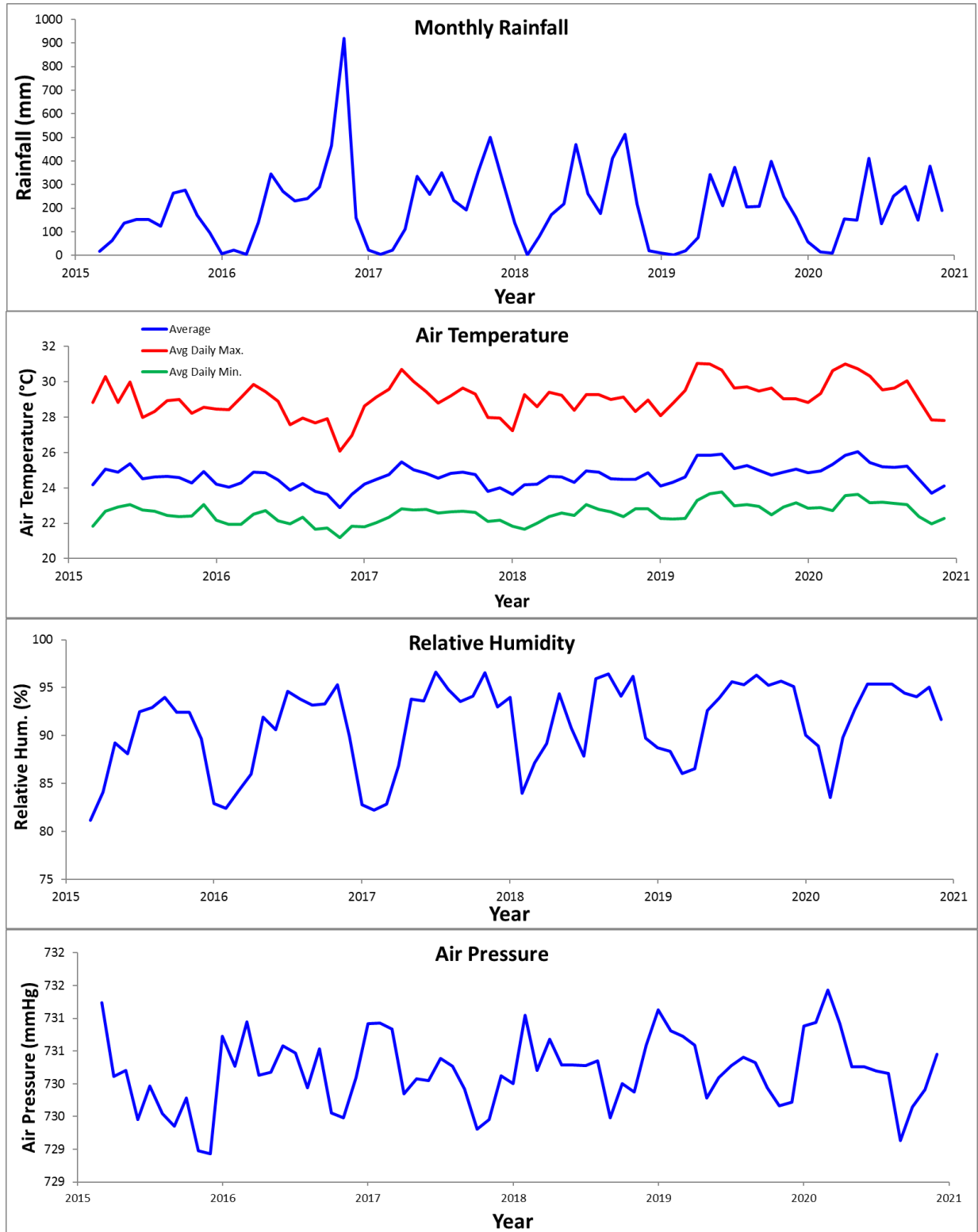
Time Series – Daily 2020



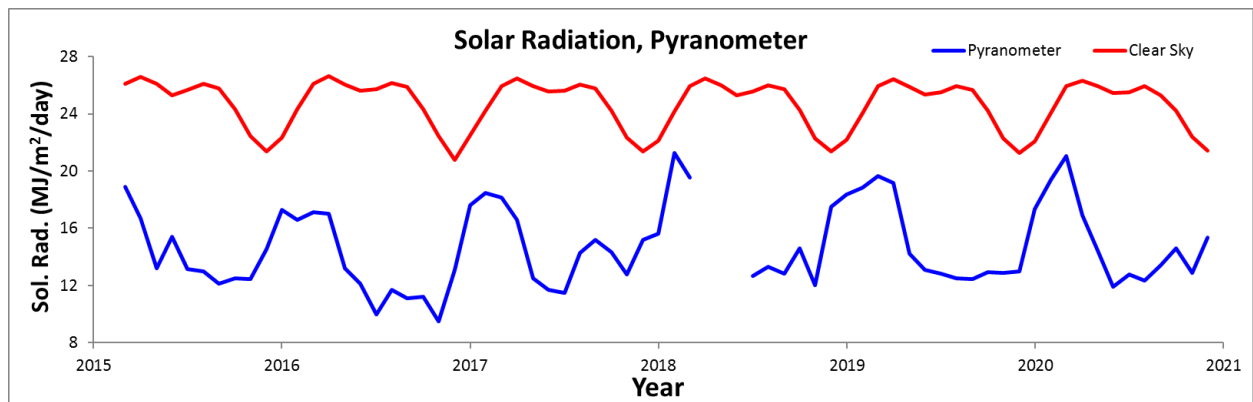
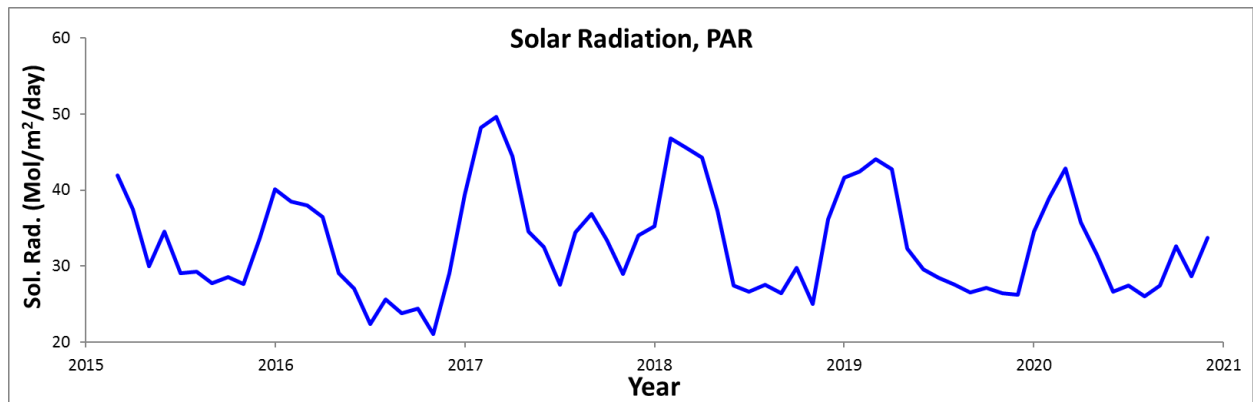
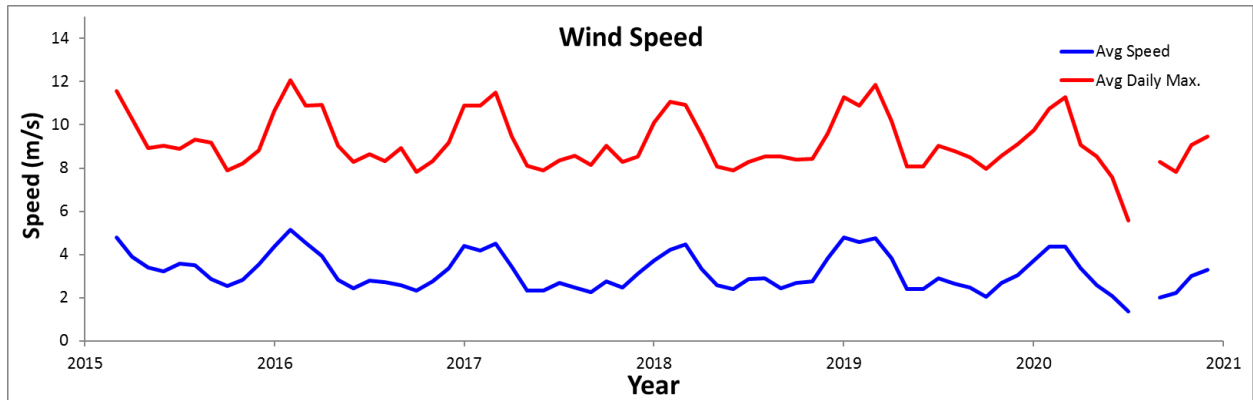
Time Series – Daily 2020



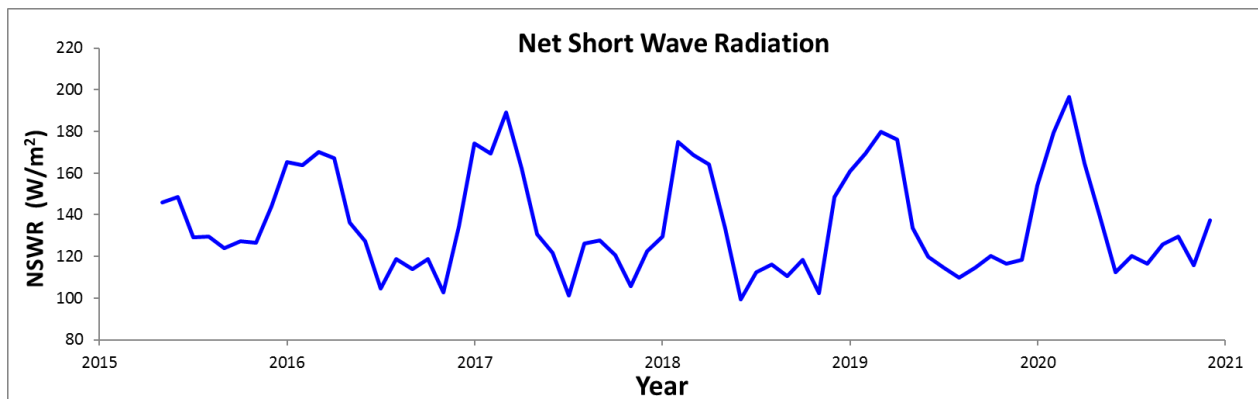
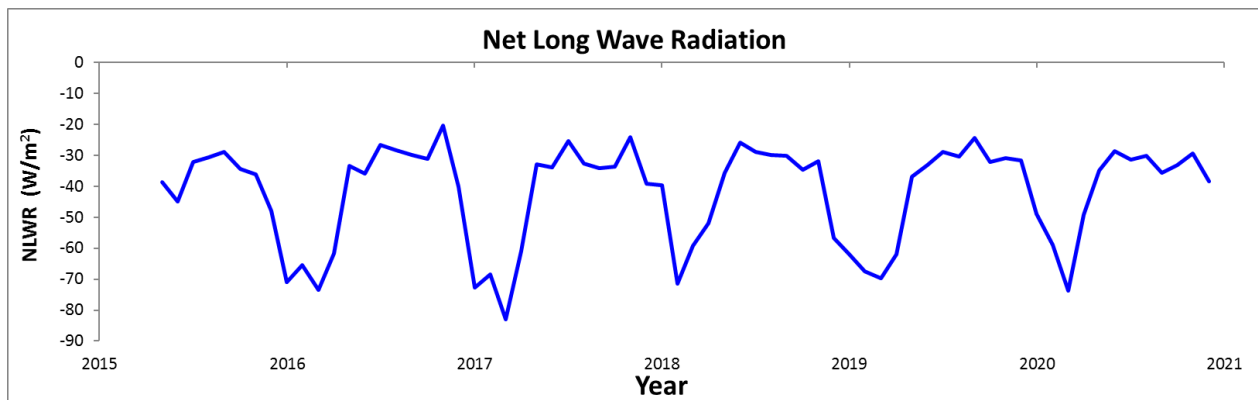
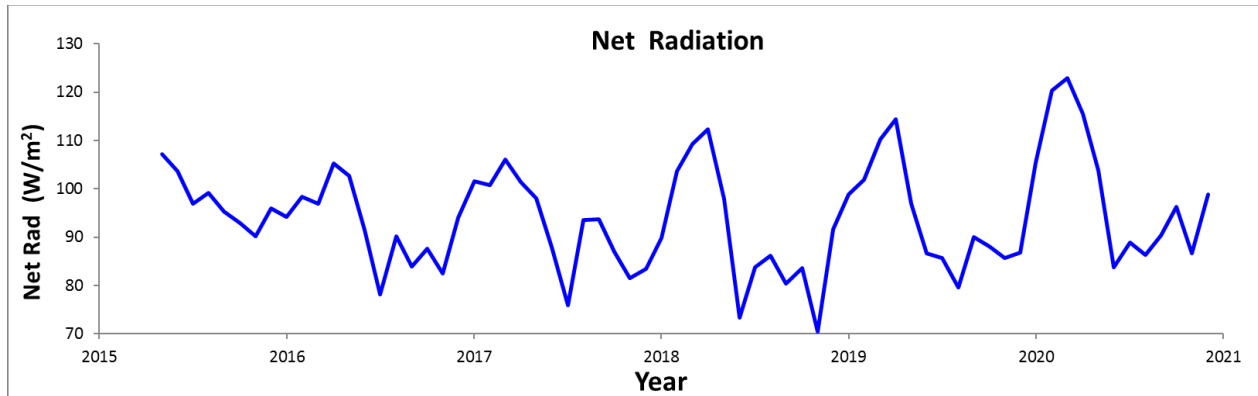
Time Series - Monthly



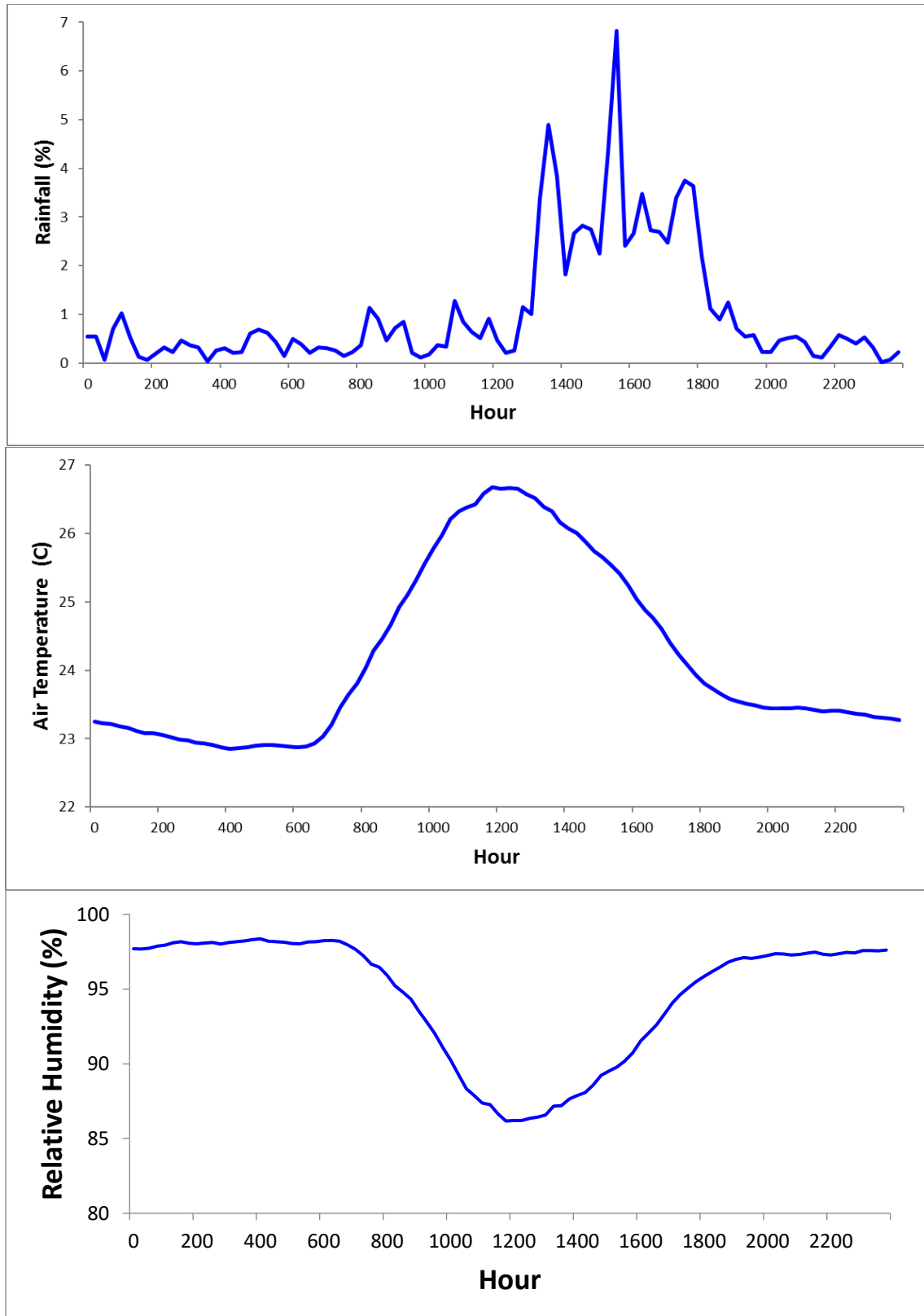
Time Series - Monthly



Time Series – Monthly



Average Daily Cycles



Average Daily Cycles

