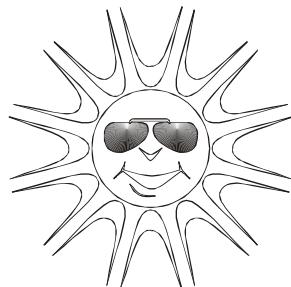




Smithsonian Tropical Research Institute

2022 Meteorological and Oceanographic Summary for the Bocas del Toro Research Station

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Introduction

This is the 10th in a series of yearly reports summarising the past year's Smithsonian Tropical Research Institute's Physical Monitoring Program on and around the Bocas del Toro Research Station (BRS). 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. Additional copies of this report, reports from previous years, and downloadable data from the Bocas and other research locations, can be obtained from:

http://biogeodb.stri.si.edu/physical_monitoring/research/bocas

Setting

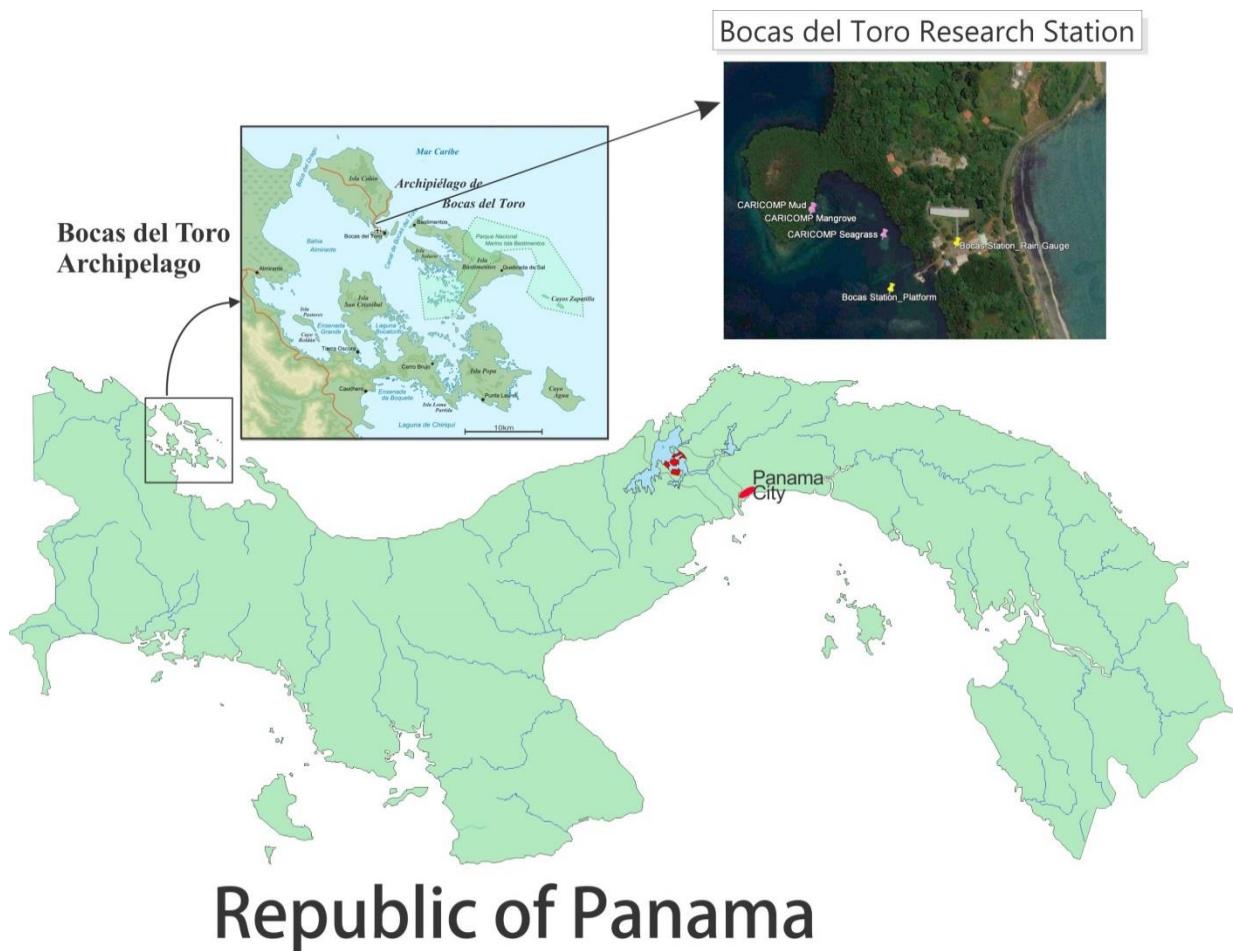
Established in 2002, the BRS (9.351553° , -82.256565°) is located near the western end of Isla Colon - part of the Bocas del Toro Archipelago. The archipelago is a complex region of islands, mainland bays, rivers and forested mountain slopes on the Caribbean side of the Panamanian isthmus.

The station receives an average of 3614.8mm of rain per year. The meteorological year is divided into four parts: two periods of lower rainfall (approximately from mid-December to the end of May, and the months of August to October), and two wetter periods (June-July and November-December) – see the figure on page 7. Relative humidity, solar radiation, air and sea surface temperature, wind speed (but not direction), and salinity all show seasonal patterns.

This report summarises data taken from a meteorology tower located on a platform located approximately 60m from the end of the station's dock, as well as several Sea Surface Temperature (SST) probes located approximately 225m north west of the dock (see map on the following page), as well as the station's aquariums. The current platform was built in 2012 to replace the original platform (see photo at right).

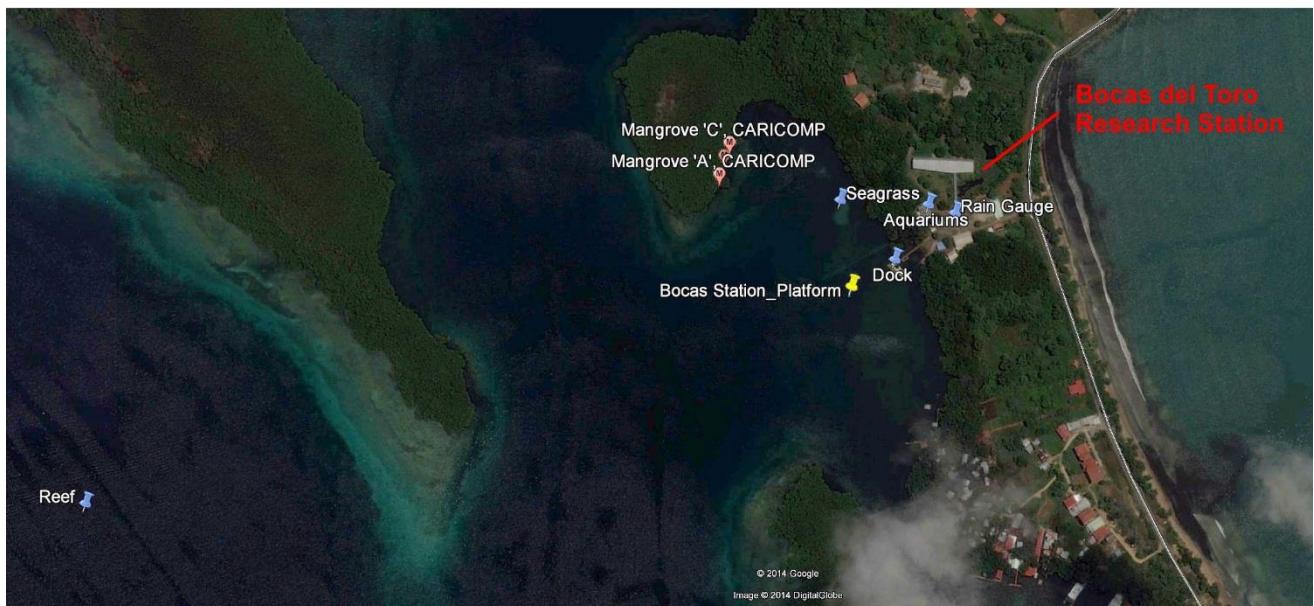
The platform and tower are used to measure air and water temperature, wind speed and direction, relative humidity and solar radiation.





Republic of Panama

Some summaries (temperature, relative humidity, and soil humidity) are based entirely on manual measurements. Other summaries (solar radiation, wind direction) are based entirely on electro-mechanical measurements. Finally, some summaries (rainfall and wind speed) are based on combinations of manual and electro-mechanical measurements.



The Mangrove ‘A’, ‘B’, and ‘C’ locations refer to three mangrove census sampling sites located in the mangrove fringe 240m NW of the dock. The Seagrass location refers to the location of the former Seagrass sampling site approximately 90 NW of the dock.

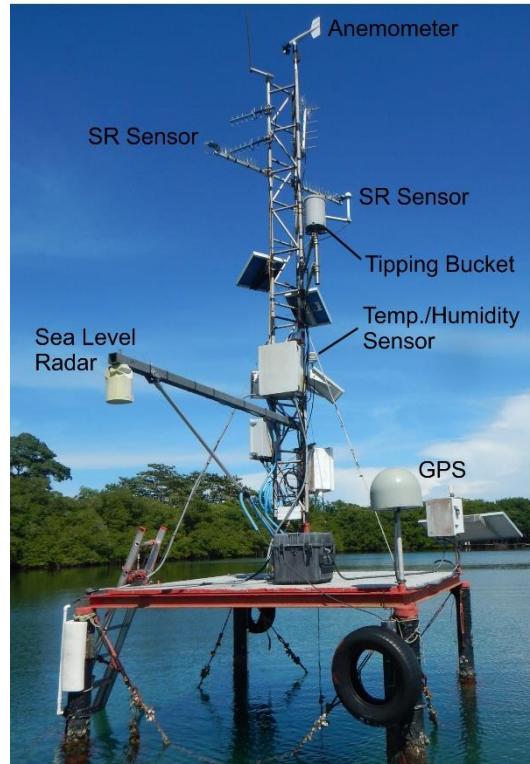
The Data

Data were collected the following locations:

Name	Measurements	Dec Lat.	Dec. Long
Main Platform	Electronic air temperature, wind, solar radiation, rel. humidity, tide, water temperature	9.350827	-82.257943
Mangrove A	Weekly water temperature and salinity	9.351917	-82.259083
Mangrove B	Weekly water temperature and salinity	9.352111	-82.259028
Mangrove C	Weekly water temperature and salinity	9.352250	-82.258972
Reef	Weekly water temperature and salinity	9.348500	-82.266000
Seagrass	Weekly water temperature and salinity, Electronic water temp.	9.351694	-82.257806
Dock (muelle)	Daily water temperature, salinity & DO	9.351039	-82.257208
Aquariums (aquarios)	Salinity	9.351635	-82.256852

This report summarises the following data:

Platform	Relative humidity Air temperature Water temperature Wind speed and direction Solar radiation
Dock	Water temperature Water Transparency Salinity DO
Aquarium	Salinity DO
Mangrove	Water temperature Salinity
Seagrass	Water temperature Salinity



The 2020-1 Pandemic

Beginning on March 20, 2020, STRI was forced to shut down almost all field operations. This resulted in the Physical Monitoring Program suspending of all manual measurements at and near the Bocas station, as well as sensor replacements and calibrations (the latter two were reestablished in Nov.). This includes the manual rain gauge and all ocean water quality measurements. None of the sea surface temperature sensors were recovered during 2021. Manual water quality measurements were all suspended for several months in 2021. With the exception of water transparency, measurements were reestablished at some locations by Sept.

The Data

Rainfall

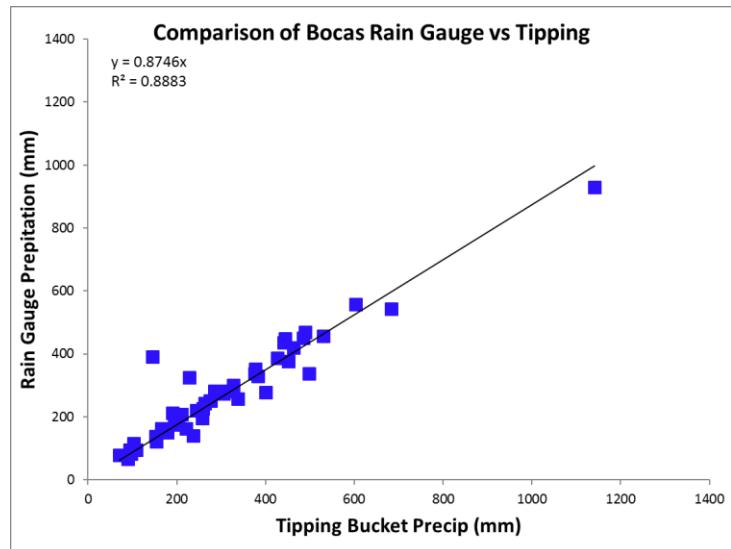
Because of the pandemic shutdown, rainfall was collected by a rain gauge near the centre of the station only until mid-Feb.. Rainfall was collected throughout 2021 by a tipping bucket on the platform. The rain gauge was read at approximately 8:00am every day except some weekends and holidays. Tipping buckets generate ‘events’ for every 0.254 mm of rainfall recorded. In order to ‘fill in’ the missing rain gauge data, a computer program was written by the author that uses tipping bucket rainfall data to distribute the rain gauge data for those days when readings were not made. The program takes the total rainfall collected in the rain gauge and divides it up proportionally according to the rainfall patterns recorded by the tipping bucket. The estimated rainfall for the missing days is exactly equal to the rainfall collected by the rain gauge. The daily rainfall data for 2022 are shown on page 7.

Because manual rain gauge measurements were suspended in Feb., tipping bucket data have been used to estimate rainfall. A simple correlation analysis between monthly Tipping Bucket and Rain Gauge data shows that on average the Tipping Bucket underestimates rainfall by 14.34%. This value was used to adjust rainfall values from mid-Feb until the end of the year.

Pages 8 shows the monthly rainfall totals. The graph on page 9 compares this year’s monthly totals with the average monthly totals (\pm SD) for the period 2002 to 2021.

Page 10 shows yearly rainfall totals for all years since 2003. Time series graph and frequency histograms are presented for these data.

Pages 11 and 12 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 as estimates since they will tend to disproportionately underestimate the size of storms - larger storms will be more underestimated than smaller ones. Keeping this in mind, the tables and graphs on this page compare



the maximum storm size and the average storm size and duration per month for the period 2002 to 2021 and for the year 2022.

Relative Humidity

Data were collected on the platform, approximately 3m above Mean Sea Level, at 15-minute intervals by dataloggers attached to Campbell Sci. CS215 temperature/humidity sensors (Viasala HMP 35/45 sensors prior to 2010).

The average monthly relative humidity data are shown in tabular and graphical form on page 13.

Air Temperature

Shaded air temperature data were collected on the platform, approximately 3m above Mean Sea Level, at 15-minute intervals by dataloggers attached to Campbell Sci. CS215 electronic temperature/humidity sensors (Viasala HMP 35/45 sensors prior to 2010). The monthly average temperature plus monthly maximum and minimum temperatures are shown in tabular and graphical form on pages 14 to 17.

Solar Radiation

Global solar radiation was measured at the platform tower approximately 4m above Mean Sea Level using a Li-Cor LI200SB pyranometer attached to a datalogger. 15-minute interval total (MJ m^{-2}), maximum and minimum ($\text{J m}^{-2} \text{s}^{-1}$) are collected.

Page 18 shows the Daily Global Radiation values. Page 19 shows total monthly Global Radiation.

Wind Speed and Direction

15-minute average, maximum and minimum wind speed plus average wind direction was recorded on the platform tower approximately 7m above Mean Sea Level using a Model 05103 Young Anemometer connected to a data logger.

Page 20 shows average and maximum daily wind speeds from the Young Anemometer located at the top of the platform tower. Page 21 shows daily average wind direction. The angles indicated in the table and graph on this page represent the direction into which the wind was predominately blowing on a given day. Pages 22 & 23 show the monthly average wind speed, monthly average daily maximum wind speed, and monthly average directions (Young Anemometer) for the year.

Given the location of the sensor platform with respect to surrounding topography, it is believed that these data reflect very local wind direction, and to a lesser extent wind speed, conditions

Air Pressure

Page 23 shows monthly Average air pressure.

Sea Surface Temperature (SST)

Water temperature data were collected at the platform at a depth of 1m, at 15-minute intervals by dataloggers attached to Campbell Model 107 electronic temperature sensor. Data were also collected at all other locations using Hobo U22 Water Temperature Pro V2 sensors at varying depths.

The monthly average temperature, plus monthly maximum and minimum temperatures for all locations are shown in tabular and graphical form on page 24 and 25, respectively.

Salinity

Determined from recently collected water samples (taken from a depth of 0.5m) at seven locations, using salinometer Lab-Comb model SCT (precision of 0.01 ppt), or the YSI temperature-salinity-oxygen meter model 85 (precision 0.1 ppt). Monthly averages are shown on page 26 and 27.

Water Transparency

Measured using a standard Secchi Disk at the Coral and Seagrass sites. Monthly averages are shown on page 28 and 29.

Dissolved Oxygen

Measured manually at the Dock and the Aquarium using a YSI 2030 Pro sensor. Monthly averages are shown on pages 30 to 31.

Times Series

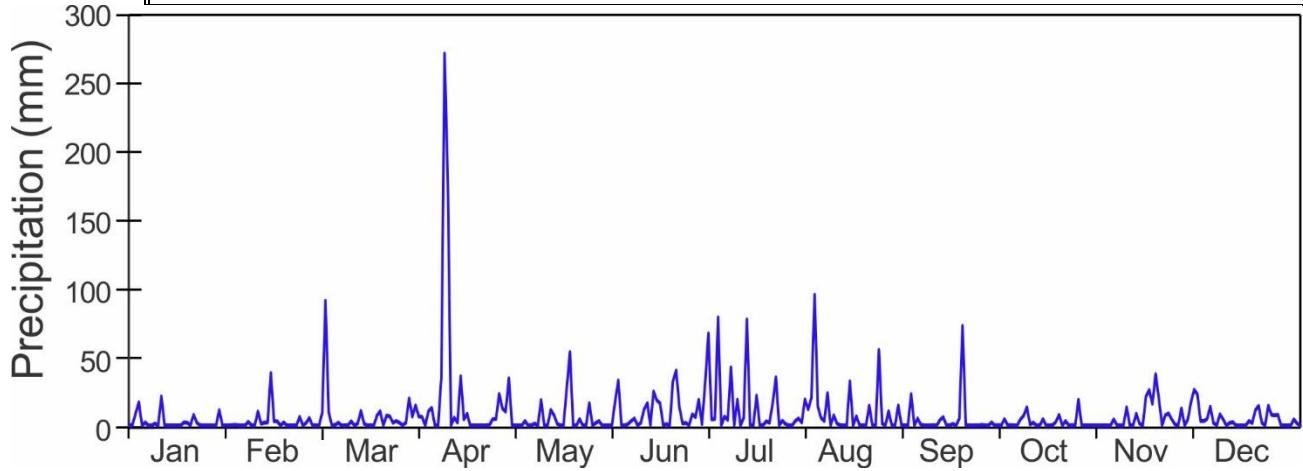
Graphs showing the daily Air Temperature, Relative Humidity, Rainfall, Solar Radiation and Wind Speed averages for 2022 (pages 32 and 33) and monthly averages for the entire period of recorded SST, Salinity, Secchi depth and DO (pages 34 to 36).

Daily Patterns

Pages 37 and 38 show the daily patterns for air temperature, relative humidity, solar radiation, rainfall and wind speed. These figures were built using electronic sensor data from the platform.

2022 Daily Rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	0.0	0.0	0.0	6.6	0.0	17.3	4.6	20.1	22.9	0.3	0.0	3.3
2	0.5	0.3	9.4	6.4	0.0	32.8	4.8	95.5	0.0	0.3	0.0	4.8
3	8.9	0.5	91.2	0.0	0.0	0.0	79.0	14.0	5.1	0.0	4.6	13.7
4	17.0	0.0	9.7	10.4	3.3	0.0	0.0	5.6	0.8	0.0	0.3	1.8
5	0.0	0.0	0.0	13.0	0.0	1.0	6.6	3.3	0.0	4.6	0.0	0.3
6	2.3	0.0	0.5	0.0	0.3	3.3	4.1	23.6	0.0	7.1	0.0	8.1
7	0.0	2.8	2.0	0.0	1.5	5.1	42.4	0.0	0.0	13.2	13.2	4.6
8	0.0	0.3	0.0	35.1	0.0	0.0	0.3	7.4	0.3	0.8	0.3	0.0
9	1.5	0.0	0.0	271.8	18.5	2.0	18.8	1.5	0.0	2.0	0.0	1.8
10	0.0	10.2	0.3	179.8	0.0	11.9	0.0	0.3	4.1	0.0	8.6	2.5
11	21.3	1.3	3.0	0.3	0.0	16.3	5.6	0.0	6.1	0.0	1.5	0.0
12	0.0	2.0	0.0	5.8	11.4	0.5	77.5	0.0	0.3	4.8	0.0	0.0
13	0.0	2.3	1.5	2.3	7.6	24.9	0.0	32.3	0.0	0.0	21.3	0.0
14	0.0	38.4	10.7	35.8	1.3	18.3	0.5	0.0	1.3	0.0	25.9	0.0
15	0.0	3.0	1.3	4.6	0.0	16.3	21.8	6.9	0.0	0.3	16.0	3.3
16	0.0	3.0	0.0	8.6	0.0	0.3	0.0	0.3	5.1	2.8	37.6	1.8
17	0.0	0.0	0.0	27.2	1.0	0.3	0.0	72.9	7.9	19.6	11.2	
18	2.3	2.3	0.0	0.0	53.6	0.0	3.0	0.0	0.5	0.0	0.3	14.2
19	2.0	0.0	7.4	0.0	0.0	32.5	2.0	14.5	0.0	3.3	7.6	2.0
20	0.3	0.0	10.4	0.0	0.0	40.1	16.3	0.0	0.0	0.0	8.9	0.0
21	7.9	0.0	0.3	0.0	4.8	13.5	35.3	0.0	0.0	0.3	4.6	14.5
22	2.0	0.0	7.1	0.0	0.0	1.5	0.3	55.4	0.0	0.0	0.8	7.9
23	0.3	6.4	6.9	0.5	0.0	1.8	3.6	1.5	0.5	18.8	0.0	7.6
24	0.0	0.0	2.0	4.8	16.3	0.3	1.0	0.0	0.0	0.0	12.4	7.9
25	0.0	1.8	3.3	4.8	0.0	8.1	0.0	10.4	0.0	0.0	0.0	0.0
26	0.0	5.6	2.0	23.1	1.8	6.1	0.0	0.0	2.3	0.0	4.6	0.0
27	0.0	0.0	0.3	12.4	3.3	18.8	3.3	0.0	0.0	0.0	17.0	0.0
28	0.0	0.0	2.0	10.2	0.0	1.0	5.1	14.7	0.3	0.0	26.2	0.0
29	11.2		19.8	34.5	0.0	31.0	2.3	0.3	0.0	0.0	22.9	4.6
30	0.0		6.6	0.0	0.0	67.3	19.1	0.0	4.8	0.0	3.3	1.5
31	0.0		14.7	0.0		11.9	0.0		0.0		0.0	
	77.5	80.0	212.3	670.8	150.9	372.9	369.3	307.3	127.0	66.3	257.3	117.3

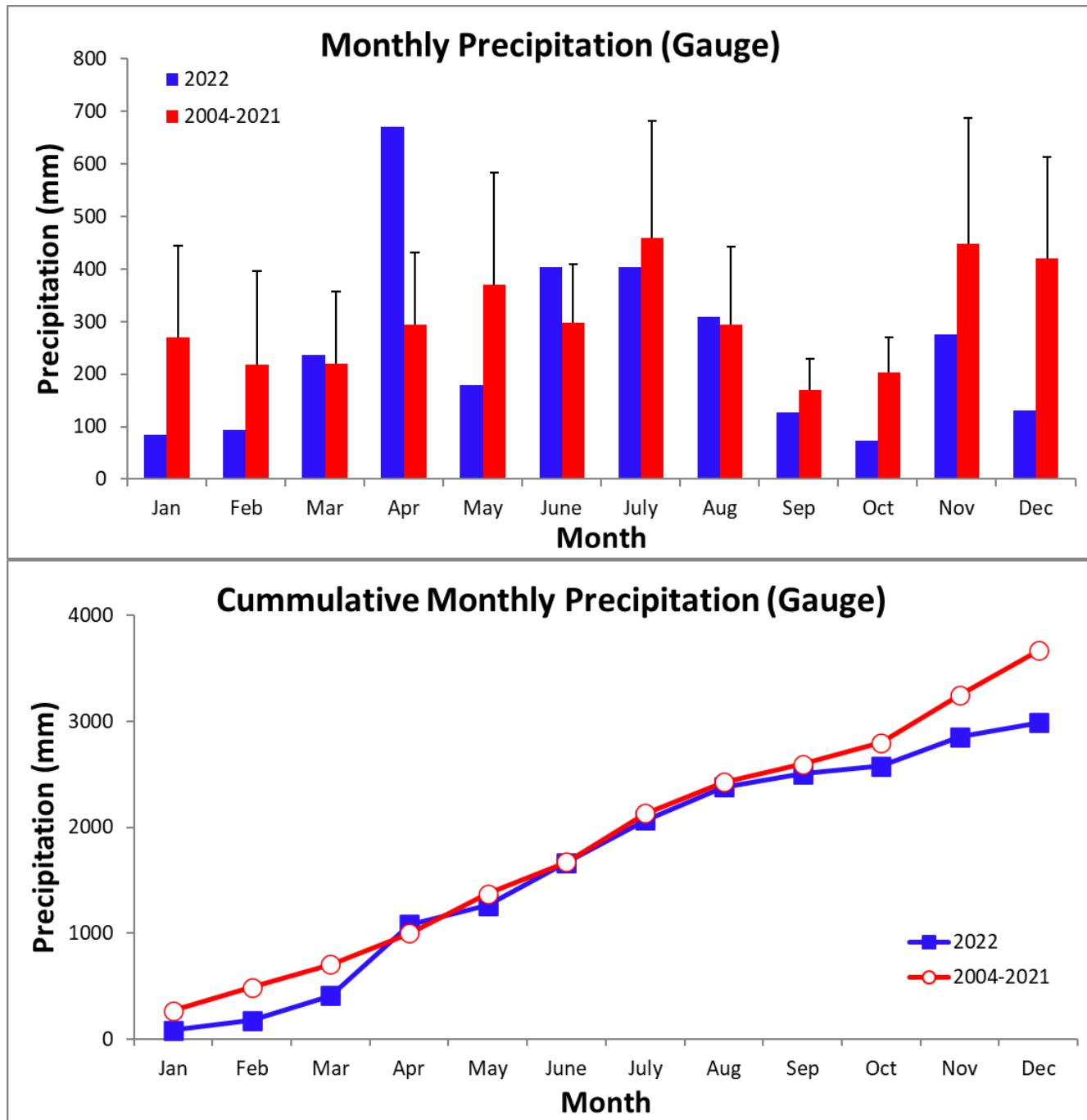


Monthly Rainfall (mm)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2002						255.6	734.8	714.4	200.4	226.5	760.9	220.7	
2003	107.5	124.9	133.6	270.1	676.7	258.5	310.7	348.5	78.4	127.8	244.0	659.2	3339.8
2004	133.6	183.0	319.5	453.1	702.8	344.3	292.9	342.6	160.8	205.0	783.3	662.8	4583.6
2005	792.2	146.7	73.8	436.2	131.8	210.4	411.1	425.1	238.8	266.5	430.8	177.6	3741.0
2006	393.6	231.7	534.1	206.8	120.4	213.4	400.9	426.0	165.1	238.4	215.1	375.1	3520.6
2007	345.7	45.4	57.5	208.2	361.6	315.8	306.5	209.5	96.9	159.7	510.6	680.5	3297.9
2008	185.1	185.5	141.0	193.6	208.5	159.3	416.3	267.4	158.7	162.1	1209.2	264.8	3551.5
2009	306.9	739.3	425.1	221.5	504.8	89.3	434.2	359.7	167.9	378.6	526.2	199.4	4352.9
2010	314.2	175.3	409.8	268.7	463.2	233.7	123.5	267.6	107.0	140.0	450.2	586.0	3539.2
2011	267.3	366.0	203.9	258.1	369.4	152.1	301.7	100.4	218.2	272.7	185.0	561.8	3256.6
2012	207.2	171.0	316.6	185.2	158.2	214.6	549.6	114.1	177.6	176.7	633.8	335.4	3240.0
2013	69.6	118.7	168.3	218.2	183.0	417.3	620.6	84.3	93.9	172.8	341.2	284.7	2772.6
2014	189.5	76.9	77.0	263.3	434.7	362.5	612.8	303.8	151.5	241.2	315.1	483.9	3512.2
2015	480.4	273.5	225.9	482.9	820.7	302.4	572.3	441.2	261.1	187.0	282.5	474.6	4804.4
2016	103.3	337.4	108.4	196.0	166.1	327.7	489.1	314.5	195.4	236.6	440.9	462.6	3378.0
2017	258.7	70.9	375.2	90.0	244.8	401.7	285.2	102.8	152.4	154.3	263.9	743.5	3143.4
2018	683.8	400.2	178.2	485.6	221.3	451.9	1140.9	210.8	203.2	275.0	427.0	152.2	4830.1
2019	97.6	93.6	190.5	228.9	498.2	530.4	376.7	383.1	306.3	257.9	443.6	603.1	4009.9
2020	276.6	145.8	104.6	376.7	257.6	460.3	179.2	210.8	154.0	260.3	388.8	339.4	3092.0
2021	280.4	175.3	283.7	396.2	514.7	228.9	701.1	325.4	163.3	191.5	279.0	361.7	3901.1
2022	84.9	92.9	235.9	670.8	178.2	403.5	404.0	308.8	127.0	73.1	276.2	130.6	2985.9
Mean	279.9	225.5	218.8	275.2	380.0	292.6	462.6	294.2	171.4	210.3	456.7	434.0	3647.9
sd	173.1	179.4	142.1	107.6	213.1	111.7	227.3	152.4	61.5	61.3	243.0	186.7	561.3
Min	68.4	45.4	57.5	90.0	81.4	89.3	123.5	84.3	78.4	127.8	185.0	152.2	2770.7
Max	786.1	725.5	534.2	482.9	819.7	530.4	1058.6	714.4	306.3	378.8	1212.2	743.5	4713.3
Rank*	19	17	8	1	17	3	12	11	16	21	17	21	18

Data in green are from the tipping bucket. All other data are from the station's manual rain gauge

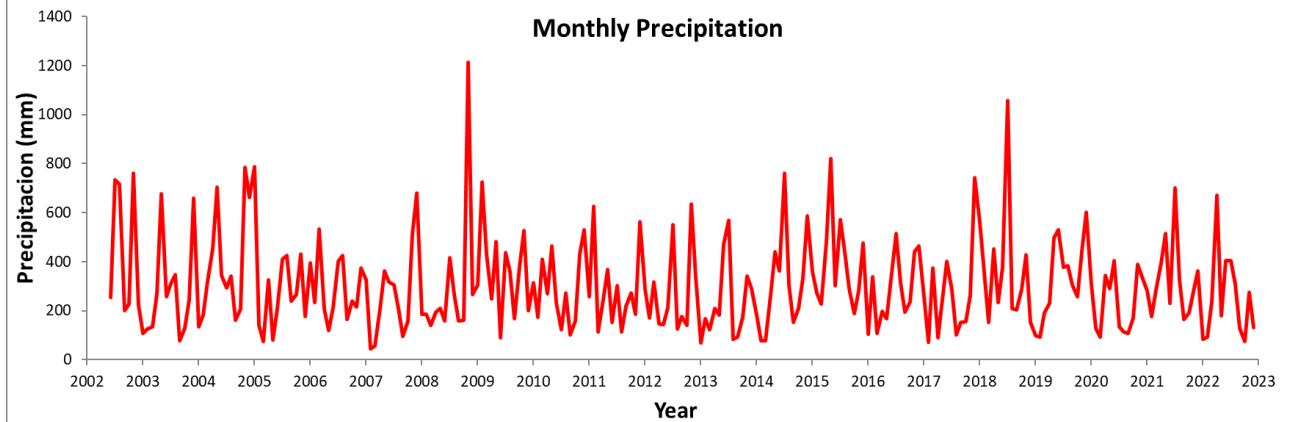
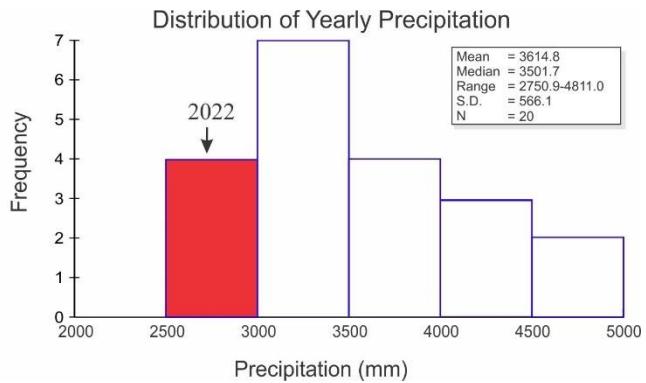
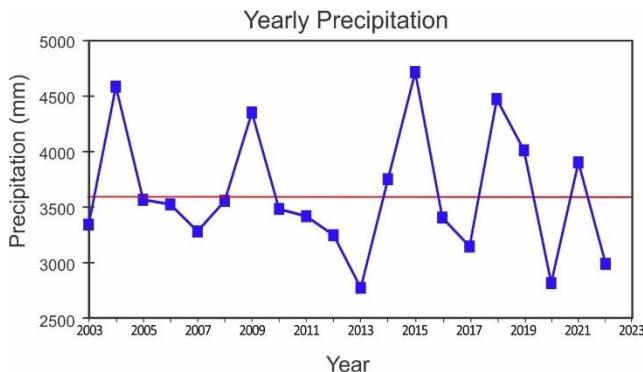
* Rank of latest year months compared to all other years. 1 = wettest



Yearly Rainfall (mm)

Year	Rain	Year	Rain	Year	Rain
2003	2910.0*	2010	3448.4	2017	2050.1
2004	4358.9*	2011	3158.8	2018	4811.0
2005	3741.0	2012	3106.8	2019	4009.9
2006	3473.6	2013	2750.9	2020	2814.0
2007	3212.5	2014	3512.2	2021	3901.1
2008	3518.3	2015	4622.9	2022	2985.9
2009	4352.9	2016	3378.0		

* Data from tipping bucket. All other data from rain gauge

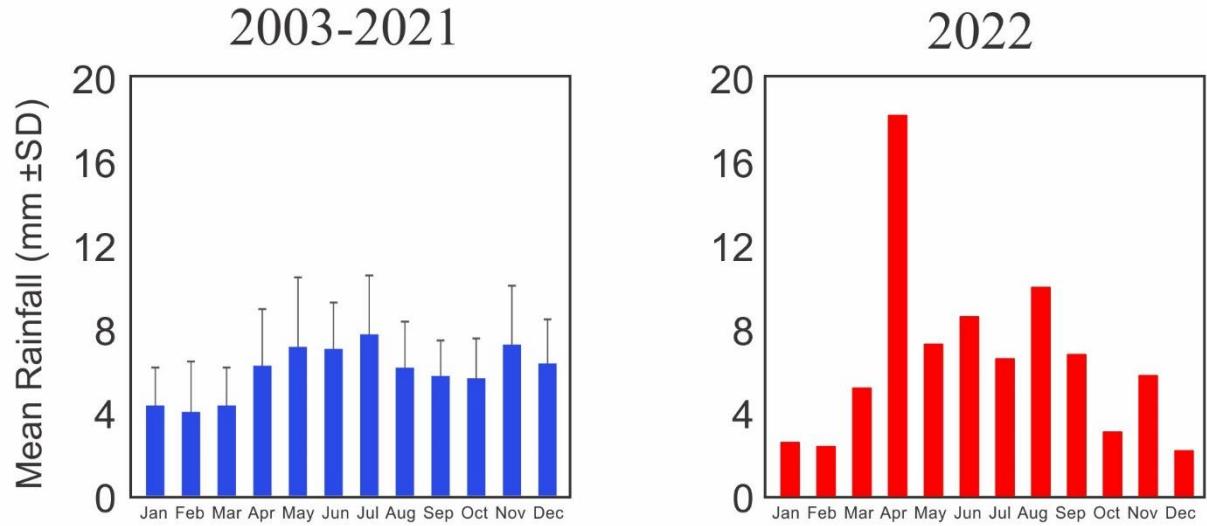


Storm Analysis

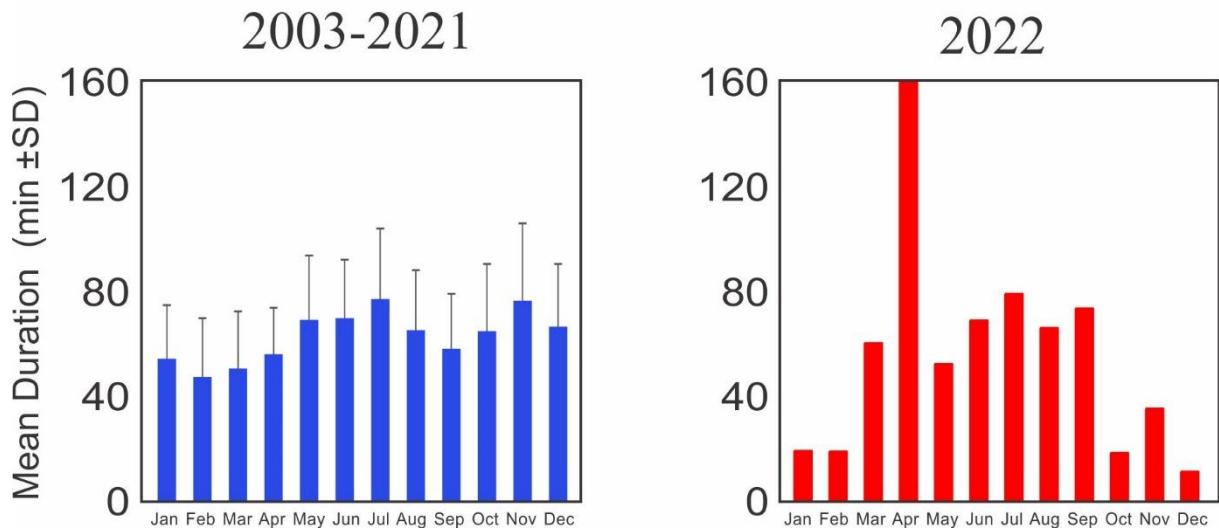
	Max. Rainfall per Storm (mm)			Storm Duration (min.)		
	2002-2021		2022	2002-2021		2022
	Mean	S.D.		Mean	S.D.	
January	45.5	32.2	70.4	54.0	21.0	50.5
February	37.0	35.7	26.4	45.8	22.5	66.1
March	41.4	36.0	42.7	49.1	22.0	68.1
April	47.6	27.3	81.8	54.5	17.5	74.7
May	56.4	37.3	93.0	68.3	25.0	75.2
June	62.1	29.7	50.8	67.7	22.0	95.6
July	66.5	38.6	173.0	74.1	25.3	120.7
August	54.0	26.6	43.4	61.3	17.7	126.5
September	42.0	15.8	28.4	57.7	21.4	57.9
October	42.9	17.0	38.3	64.9	26.1	54.2
November	73.6	56.5	65.8	76.8	29.9	59.3
December	77.0	56.3	65.0	65.3	24.2	80.2

	Av. Rainfall per Storm (mm)		
	2002-2021		2022
	Mean	S.D.	
January	4.4	1.8	3.9
February	4.0	2.4	5.0
March	4.2	1.9	4.6
April	6.1	2.8	7.5
May	7.2	3.4	6.3
June	6.9	2.2	7.5
July	7.3	2.2	14.9
August	5.9	2.1	9.6
September	5.7	1.8	5.2
October	5.5	1.9	6.0
November	7.2	2.9	6.3
December	6.3	2.2	6.3

Average Monthly Storm Size

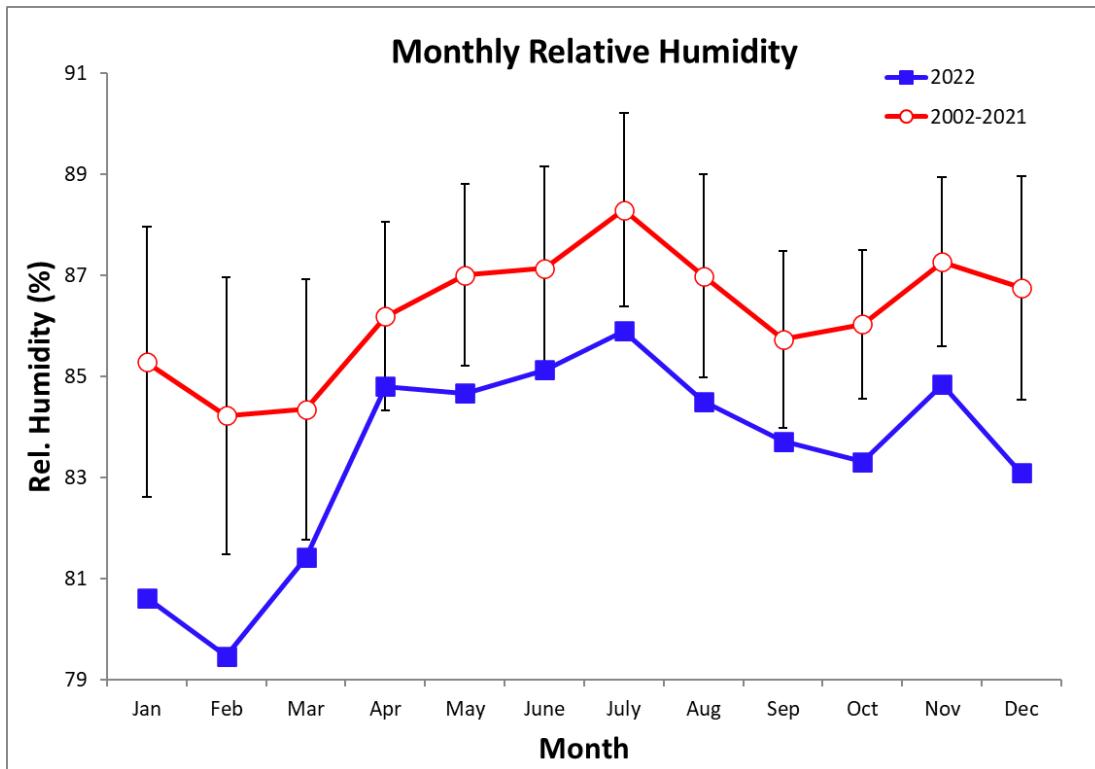


Average Monthly Storm Duration



Relative Humidity (%)

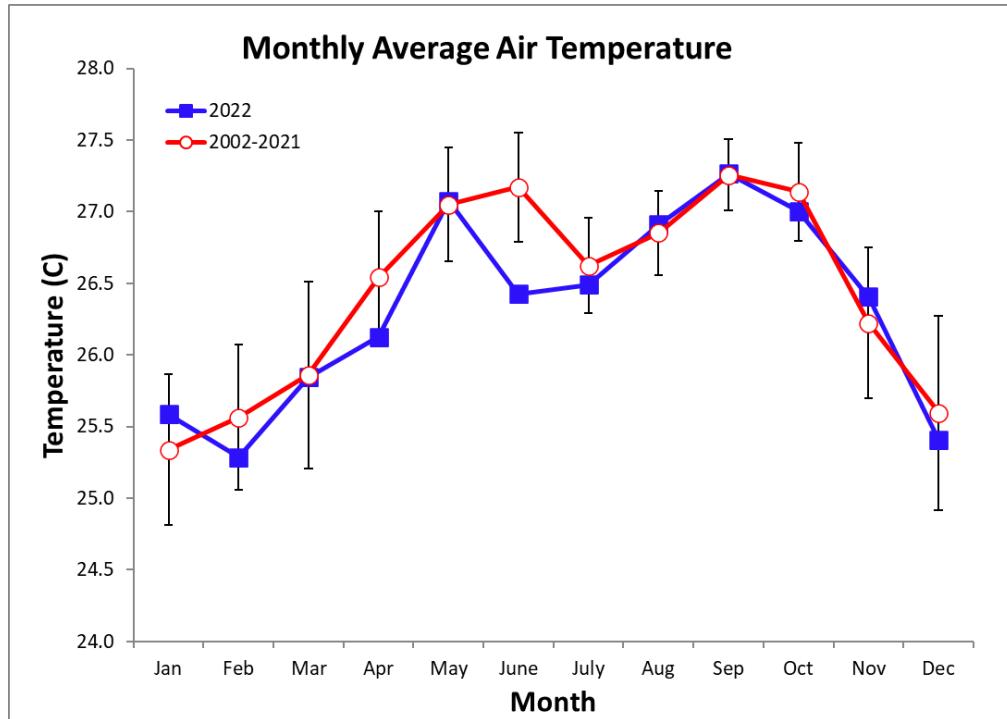
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2009								83.7	81.6	83.6	85.5	83.0
2010	83.0	87.4	87.5	87.4	87.8	86.3	87.2	87.6	85.8	85.5	87.3	89.2
2011	88.3	86.0	84.3	86.1	87.8	87.1	88.8	86.9	86.9	87.3	88.2	89.4
2012	87.1	85.8	87.3	88.5	85.7	86.0	88.4	86.7	86.6	86.5	90.1	88.6
2013	85.6	85.6	88.1	88.1	88.0	89.6	90.6	88.2	86.8	88.1	88.3	86.9
2014	87.1	85.7	83.3	86.7	87.8	89.8	91.8	89.2	87.3	87.8	88.1	88.6
2015	88.0	85.9	84.5	87.0	89.3	89.3	89.9	89.9	88.2	87.2	87.5	88.4
2016	86.0	86.0	85.9	85.5	86.6	87.6	88.9	88.9	87.5	87.3	88.2	87.5
2017	82.9	80.8	82.0	82.9	84.2	85.3	86.7	84.4	83.8	84.6	83.7	85.4
2018	87.1							87.7	85.6	86.9	87.9	83.9
2019	83.2	82.8	85.4	85.9	88.8	87.9	88.2	88.8	87.9	86.4	88.6	89.0
2020	88.1	85.4	82.3	88.2	88.9	88.5	88.2	87.8	86.2	86.3	87.7	
2021	81.7	79.9	80.1	83.1	84.6	83.2	85.2	83.4	82.5	84.0	85.9	84.9
2022	80.6	79.5	81.4	84.8	84.7	85.1	85.9	84.5	83.7	83.3	84.8	83.1
mean	86.0	85.1	85.1	86.6	87.5	87.7	88.9	87.5	86.2	86.4	87.6	87.3
sd	2.1	1.9	2.2	1.7	1.6	1.6	1.6	1.5	1.2	1.0	1.5	2.1
min	82.9	80.8	82.0	82.9	84.2	85.3	86.7	83.8	81.6	83.6	83.7	83.0
max	88.3	87.4	88.1	88.5	89.3	89.8	91.8	89.9	88.2	88.1	90.1	89.4



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

Monthly Average Temperature

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2002						26.9	26.3	26.2	27.6	26.9	26.4	
2003	25.7	26.2	27.1	27.3	27.1	27.2	26.7	26.6	27.6	27.6	26.9	25.4
2004	25.6	25.8	25.8	26.5	26.4	26.8	26.4	26.5	27.4	27.4	25.6	25.1
2005	24.4	25.0	27.3	26.3		28.2	27.5	27.0	27.1	27.5	25.9	25.9
2006	25.5	25.3	25.2	26.3	27.1	27.3	26.9	27.0	27.1	27.3	26.3	26.1
2007	25.3	26.1	26.5	27.0	27.2	27.3	26.8	27.1	27.1	27.2	25.9	25.3
2008	25.1	25.3	25.6	26.2	26.8	26.9	26.3	26.9	27.5	27.1	25.6	25.1
2009	25.0	24.5	24.9	26.2	26.7	27.2	26.5	26.7	27.5	26.9	26.1	26.2
2010	25.6	26.0	26.0	26.9	27.2	27.2	27.0	26.9	27.1	26.5	25.2	23.7
2011	24.6	25.1	25.2	25.7	26.8	27.2	26.5	27.0	26.9	26.4	25.6	24.7
2012	24.5	25.1	24.8		27.6	27.5	26.4	27.2	27.0	27.0	25.6	25.8
2013	25.9	25.7	25.8	26.7	26.8	26.8	26.5	27.0	27.6	27.2	26.6	26.0
2014	25.5	25.6	25.9	26.1	26.5	26.5	26.1	26.3	26.8	26.7	26.3	25.5
2015	25.2	25.6	25.7	26.5	26.6	27.2	26.4	26.8	27.1	27.6	27.1	26.9
2016	26.1	25.7	26.6	27.3	27.8	27.4	26.4	26.9	27.1	27.3	26.4	25.8
2017	25.5	26.0	25.7	27.1	27.6	27.3	26.4	27.1	27.5	27.3	26.5	25.1
2018	24.4	24.7	25.6	25.9	27.0	27.3	26.9	26.5	27.2	26.9	26.5	26.2
2019	25.9	26.1	25.7	26.7	27.3	27.6	26.9	27.1	27.3	27.3	26.5	26.2
2020	25.9	26.2	26.5	27.0	27.6	27.3	27.2	27.4	27.6	27.6	27.3	25.8
2021	25.6	26.0	25.6	26.4	26.8	27.0	26.7	26.9	27.2	27.4	26.1	25.7
2022	25.6	25.3	25.8	26.1	27.1	26.4	26.5	26.9	27.3	27.0	26.4	25.4
mean	25.3	25.6	25.9	26.5	27.1	27.2	26.6	26.9	27.3	27.1	26.2	25.6
sd	0.5	0.5	0.7	0.5	0.4	0.4	0.3	0.3	0.2	0.3	0.5	0.7
min	24.4	24.5	24.8	25.7	26.4	26.4	26.1	26.2	26.8	26.4	25.2	23.7
max	26.1	26.2	27.3	27.3	27.8	28.2	27.5	27.4	27.6	27.6	27.3	26.9

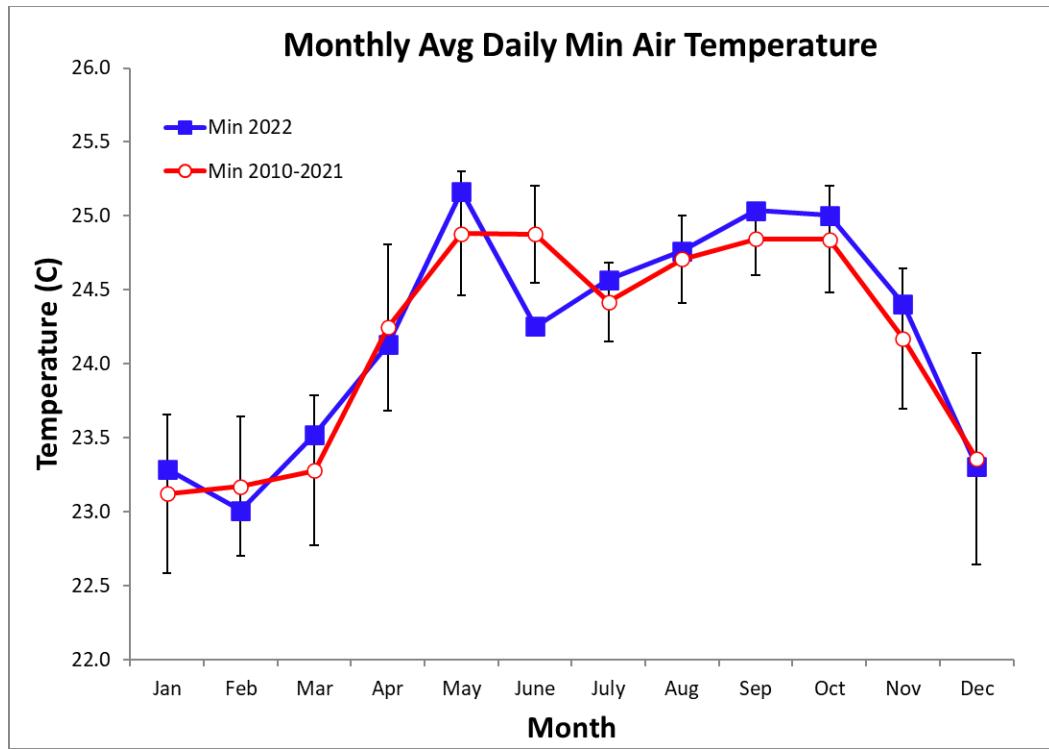
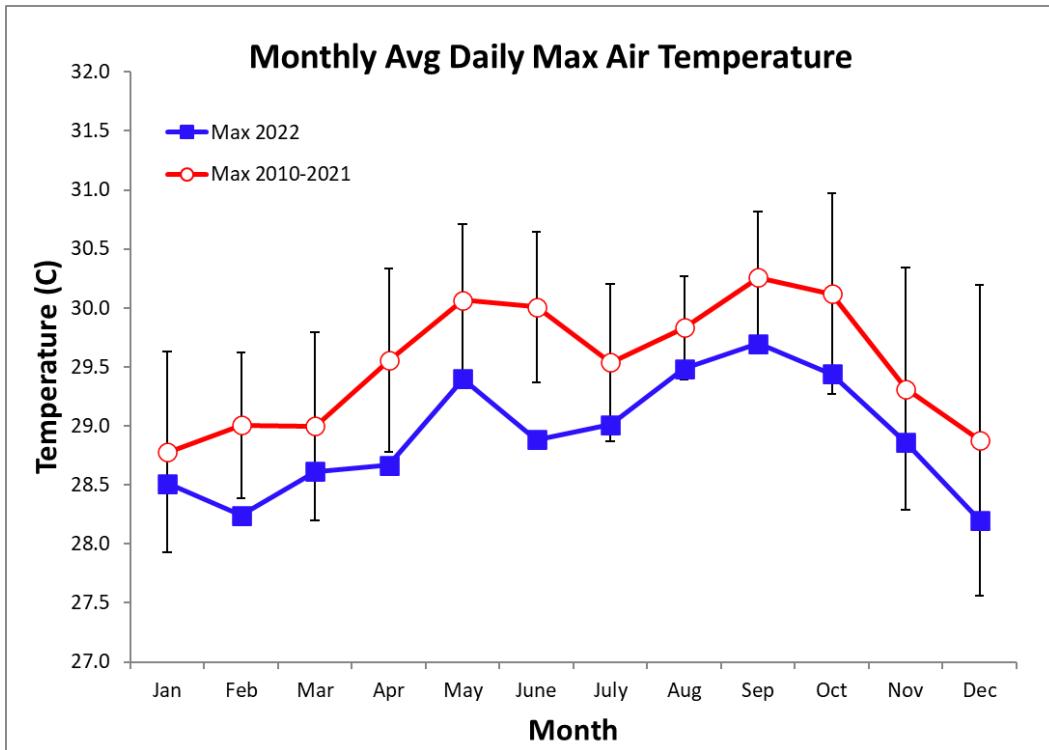


Year	Monthly Average of Daily Maximum Temperature											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2010					29.9	29.9	29.4	29.5	29.9	29.0	27.8	26.1
2011	27.6	28.4	28.0	28.5	29.3	29.7	29.0	29.6	29.6	28.8	28.1	27.4
2012	27.6	28.3	27.6		30.4	30.2	29.1	29.9	29.7	29.7	27.9	28.5
2013	29.0	28.6	28.6	29.4	29.4	29.3	28.9	29.6	30.3	29.8	29.5	29.0
2014	28.3	28.5	28.7	28.7	29.2	29.0	28.5	29.1	29.5	29.2	28.9	28.3
2015	28.5	29.6	29.7	30.4	29.8	30.4	29.8	30.2	30.6	31.4	30.9	31.3
2016	30.2	29.5	29.7	31.0	31.1	30.6	30.0	29.8	31.0	30.8	30.0	29.8
2017	29.2	29.5	29.4	30.2	30.9	30.5	29.4	30.2	30.9	30.8	29.7	29.0
2018	27.9	28.7	28.9	29.1	30.5	30.5	30.9	29.7	30.7	30.4	30.3	30.4
2019	29.9	29.7	29.0	29.6	30.5	30.8	30.0	30.1	30.3	30.9	29.9	29.6
2020	29.3	29.6	30.6	30.0	30.7	30.5	30.5	30.9	31.1	31.2	30.5	29.4
2021	29.3	29.6	29.1	29.5	29.7	30.0	29.6	29.9	30.1	30.2	28.7	28.6
2022	28.5	28.2	28.6	28.7	29.4	28.9	29.0	29.5	29.7	29.4	28.9	28.2
mean	28.8	29.0	29.0	29.6	30.1	30.0	29.5	29.8	30.3	30.1	29.3	28.9
sd	0.9	0.6	0.8	0.8	0.6	0.6	0.7	0.4	0.6	0.9	1.0	1.3
min	27.6	28.2	27.6	28.5	29.2	28.9	28.5	29.1	29.5	28.8	27.8	26.1
max	30.2	29.7	30.6	31.0	31.1	30.8	30.9	30.9	31.1	31.4	30.9	31.3

Monthly Average of Daily Minimum Temperature

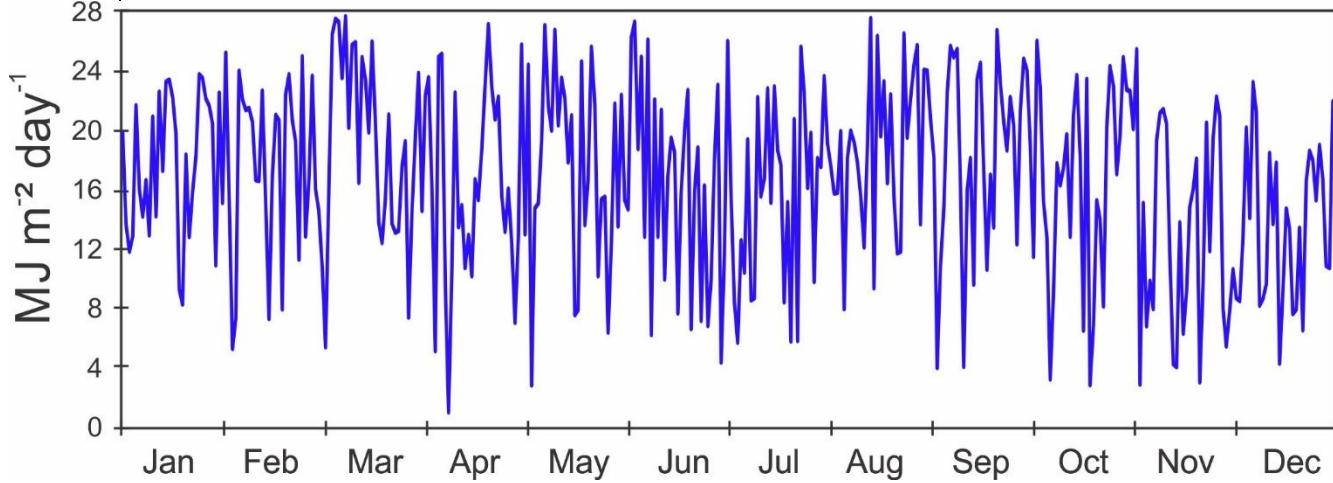
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2010					24.9	24.9	24.9	24.7	24.9	24.3	23.2	21.8
2011	22.5	22.6	22.6	23.3	24.7	24.9	24.4	24.9	24.6	24.2	23.7	22.8
2012	22.2	22.8	22.6		25.3	25.2	24.1	24.8	24.7	24.7	23.8	23.8
2013	23.5	23.4	23.6	24.6	24.7	24.6	24.3	25.0	25.4	25.1	24.2	23.6
2014	23.4	23.1	23.4	24.0	24.3	24.5	24.4	24.1	24.4	24.5	24.3	23.4
2015	23.1	23.1	23.2	24.2	24.4	25.1	24.3	24.6	24.7	25.4	24.8	24.6
2016	23.8	23.3	24.4	24.8	25.5	25.2	23.9	24.7	24.7	25.1	24.2	23.6
2017	23.1	23.6	23.2	24.9	25.2	25.0	24.4	24.8	25.1	25.0	24.0	22.7
2018	22.4	22.2	23.2	23.4	24.6	24.9	24.5	24.1	24.7	24.6	24.2	23.5
2019	23.4	23.7	23.3	24.6	25.2	25.3	24.5	25.0	24.9	24.7	24.3	24.1
2020	23.8	23.9	23.7	24.9	25.2	25.0	24.8	25.1	25.0	25.2	25.1	22.8
2021	29.3	29.6	29.1	29.5	29.7	30.0	29.6	29.9	30.1	30.2	28.7	28.6
2022	23.3	23.0	23.5	24.1	25.2	24.3	24.6	24.8	25.0	25.0	24.4	23.3
mean	23.1	23.2	23.3	24.2	24.9	24.9	24.4	24.7	24.8	24.8	24.2	23.4
sd	0.5	0.5	0.5	0.6	0.4	0.3	0.3	0.3	0.2	0.4	0.5	0.7
min	22.2	22.2	22.6	23.3	24.2	24.3	23.9	24.1	24.4	24.2	23.2	21.8
max	23.8	23.9	24.4	24.9	25.5	25.3	24.9	25.1	25.4	25.4	25.1	24.6

Monthly Air Temperature (°C)



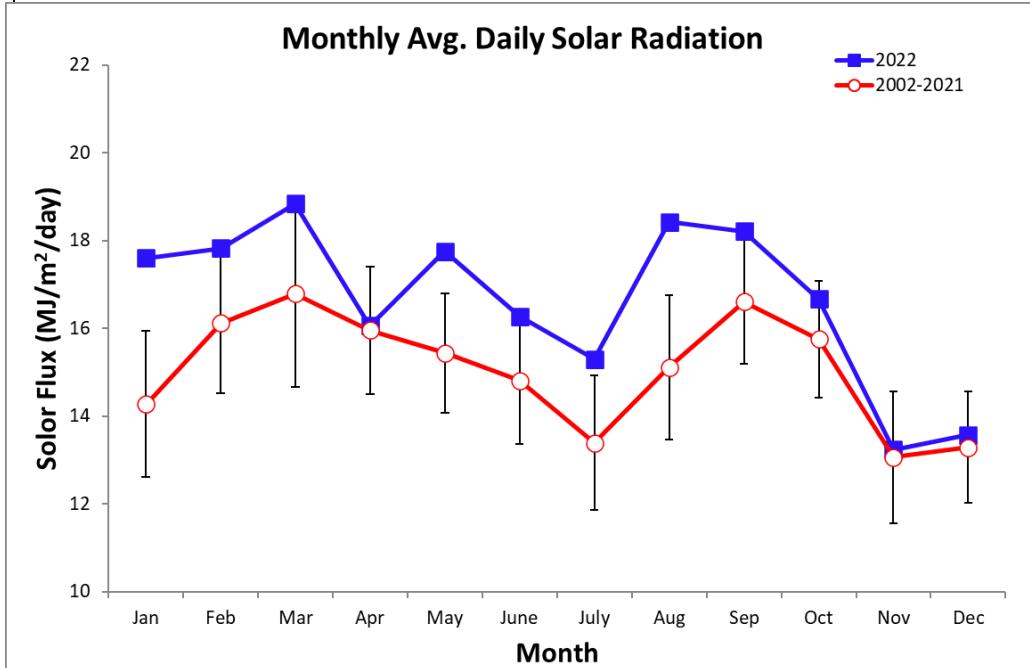
2022 Daily Total Radiation ($\text{MJ m}^{-2} \text{ day}^{-1}$)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	19.8	25.2	14.6	14.6	25.7	15.3	11.6	19.1	20.8	19.1	20.1	10.6
2	13.7	15.8	10.7	22.3	13.0	14.7	25.9	17.5	18.1	11.5	25.4	8.7
3	11.9	5.3	5.4	23.5	24.4	26.2	15.4	15.8	4.1	26.0	2.9	8.6
4	12.9	7.3	15.9	16.3	2.9	27.2	8.4	15.8	10.9	22.8	15.1	12.9
5	21.6	24.0	26.4	5.2	14.8	18.7	5.8	19.9	14.9	15.2	6.9	20.1
6	16.0	22.0	27.4	24.9	15.1	24.9	12.6	8.0	22.5	12.7	9.9	14.1
7	14.2	21.3	27.3	25.1	19.3	12.9	10.5	18.1	25.6	3.3	8.0	23.2
8	16.6	21.5	23.5	9.8	27.0	26.0	19.4	19.9	24.9	9.1	19.2	21.2
9	12.9	20.5	27.6	1.1	21.6	6.3	8.6	19.2	25.4	17.8	21.2	8.2
10	20.9	16.7	20.2	10.5	20.0	22.0	8.7	17.8	16.2	16.3	21.4	8.7
11	14.2	16.6	25.7	22.5	26.7	12.9	22.2	15.6	4.1	17.5	20.4	9.7
12	22.5	22.6	25.9	13.5	20.3	21.3	15.6	12.2	16.0	19.7	11.7	18.4
13	17.3	15.0	16.5	14.9	23.5	10.0	16.7	18.9	18.1	12.9	4.3	13.7
14	23.2	7.3	24.9	10.8	22.1	16.9	22.8	27.5	9.6	21.0	4.1	17.8
15	23.4	16.8	23.4	13.0	17.8	19.5	15.1	9.4	23.4	23.7	13.8	4.3
16	22.2	21.0	19.8	10.2	21.0	18.5	22.9	26.3	24.5	18.3	6.4	9.0
17	19.7	20.6	25.9	16.7	7.6	7.7	18.6	19.6	17.3	6.6	9.1	14.7
18	9.3	8.0	20.7	15.3	7.9	15.8	17.7	23.2	10.6	23.4	14.8	13.4
19	8.3	22.4	13.8	18.7	24.6	20.0	8.4	16.4	17.0	2.9	16.1	7.7
20	18.3	23.7	12.4	23.0	13.6	22.7	15.1	22.4	13.5	6.9	18.1	8.0
21	12.8	20.7	15.3	27.1	16.7	6.7	5.8	15.5	26.7	15.3	3.1	13.4
22	15.8	19.3	21.0	22.8	25.6	15.9	20.7	11.7	23.1	14.0	9.7	6.6
23	18.3	11.3	13.7	20.7	21.7	18.8	5.9	11.9	20.6	8.2	20.5	16.6
24	23.7	24.9	13.1	22.2	10.2	7.2	25.6	26.5	18.7	20.1	11.9	18.6
25	23.5	12.9	13.2	15.6	15.3	16.3	22.5	19.5	22.2	24.3	19.4	18.0
26	22.1	16.7	17.6	13.2	15.5	6.9	16.1	22.2	20.3	23.0	22.2	15.3
27	21.6	23.6	19.2	16.0	6.4	10.0	19.8	24.4	12.3	17.1	20.9	19.0
28	20.4	16.0	7.4	12.5	12.4	18.0	9.8	25.7	21.2	19.6	8.0	16.7
29	10.9		14.6	7.1	21.8	23.0	18.1	13.7	24.8	24.9	5.5	10.9
30	22.5		19.4	12.8	13.5	4.4	17.5	24.0	24.0	22.7	8.0	10.8
31	15.1		23.8		22.3		23.6	24.0		22.6		21.9



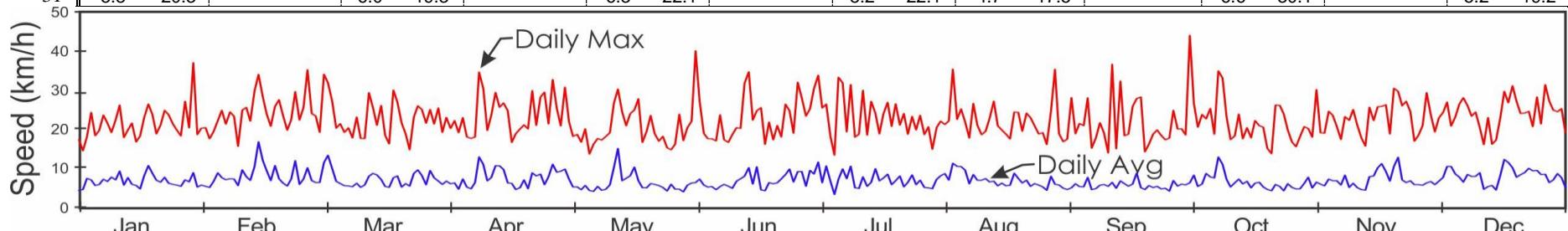
Monthly Average Total Daily Solar Radiation ($\text{MJ m}^{-2} \text{ day}^{-1}$)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2002								15.2	17.2	13.9	11.6	12.3
2003	14.4	17.8	18.1	18.8	14.4	15.4	13.8	13.7	17.2	15.9	14.0	12.8
2004	16.3	15.6	16.3	16.0	13.0	14.5	13.7	13.0	18.3	16.1	11.8	13.3
2005	11.1	15.6	19.9	12.9		17.9	15.8	14.2	13.6	17.1	12.2	14.2
2006	12.1	14.9	12.4	15.6	14.6	14.8	13.1	13.1	14.6	15.0	11.8	13.2
2007	11.4	18.0	17.4	16.2	16.3	13.9	13.3	16.0	17.1	16.5	12.3	13.4
2008	15.2	16.7	17.2	16.4	16.6	14.4	15.1	17.8	16.5	14.8	12.1	13.8
2009	13.0	12.2	15.1	17.6	15.5	15.3	12.1	13.1	16.6	13.8	11.5	13.5
2010	14.8	12.9	15.4	15.5	15.8	15.5	14.6	15.8	17.2	14.4	12.7	10.2
2011	14.0	16.9	16.7	17.1	17.0	16.1	13.6	16.6	15.9	13.7	12.9	11.5
2012	13.8	16.8	12.3	13.1	15.9	15.5	11.2	16.5	15.5	15.4	10.0	13.4
2013	13.9	14.7	15.1	14.8	13.3	11.7	12.2	15.3	18.0	15.7	15.3	14.8
2014	14.6	16.6	17.4	14.6	15.2	11.9	11.0	14.2	16.3	14.4	11.9	12.1
2015	13.1	16.0	17.7	15.4	13.3	13.3	12.7	13.3	14.6	16.0	14.4	13.6
2016	16.0	15.0	17.0	17.6	15.2	14.7	12.2	13.1	14.7	16.0	13.4	13.0
2017	15.7	17.5	17.0	17.5	16.1	14.9	12.8	16.4	18.1	15.5	15.9	12.7
2018	13.3	15.6	18.0	16.3	17.6	14.0	11.1	13.6	17.6	16.0	14.1	15.9
2019	16.2	17.7	15.5	16.0	14.9	15.2	14.3	15.4	15.9	17.4	13.9	12.4
2020	14.2	16.8	21.0	15.2	15.8	14.5	16.3	16.0	18.9	18.3	15.7	15.1
2021	14.8	17.6	17.6	16.6	15.1	16.7	13.6	16.7	16.9	18.2	13.4	14.5
2022	17.6	17.8	18.8	16.1	17.8	16.3	15.3	18.4	18.2	16.7	13.2	13.6
mean	14.3	16.1	16.8	16.0	15.4	14.8	13.4	15.1	16.6	15.8	13.1	13.3
sd	1.7	1.6	2.1	1.5	1.4	1.5	1.5	1.7	1.4	1.3	1.5	1.3
min	11.1	12.2	12.3	12.9	13.0	11.7	11.0	13.0	13.6	13.7	10.0	10.2
max	17.6	18.0	21.0	18.8	17.8	17.9	16.3	18.4	18.9	18.3	15.9	15.9



2022 Daily Average Wind Speed (km/h)

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.		
	Avg	Max	Avg																						
1	4.4	17.4	5.5	20.5	6.5	19.3	6.8	23.0	7.4	22.0	6.5	40.0	11.7	33.8	8.7	21.3	5.1	28.1	8.3	26.7	6.0	19.2	7.8	24.3	
2	4.7	14.6	5.2	17.6	11.5	34.1	6.1	20.3	5.3	18.2	7.3	27.3	6.4	25.5	7.1	22.2	6.1	18.9	5.5	20.6	5.6	19.1	10.5	27.0	
3	7.5	18.1	6.7	19.4	13.4	31.9	6.4	22.2	5.3	18.7	5.8	19.0	10.7	26.5	11.3	35.4	5.4	21.5	6.1	23.8	7.3	24.6	10.5	20.9	
4	7.1	24.3	8.9	22.2	10.0	27.2	4.8	19.2	4.6	16.8	5.3	17.6	6.8	18.2	10.6	22.6	5.4	21.0	8.7	22.7	6.9	23.6	8.6	23.2	
5	5.7	18.4	7.7	24.8	6.8	20.3	7.4	23.0	5.7	20.1	5.4	17.6	3.4	13.4	10.5	25.2	7.8	28.1	7.9	25.3	6.9	20.8	7.8	26.5	
6	5.9	19.7	7.2	21.3	6.2	21.5	5.3	18.1	4.4	13.7	4.6	17.1	7.3	33.3	9.6	21.9	4.6	15.2	7.6	18.8	5.8	17.5	6.6	28.1	
7	7.3	23.6	7.4	24.5	5.6	19.3	4.8	17.7	4.2	16.2	5.4	23.7	9.9	31.9	6.1	17.8	4.9	17.9	13.0	34.9	8.3	23.3	8.5	26.0	
8	6.7	21.6	7.3	23.3	5.6	20.4	6.5	18.1	5.4	17.7	6.0	17.4	7.4	19.4	8.5	26.6	5.7	21.7	11.1	33.1	5.2	22.3	8.0	23.4	
9	7.8	19.2	5.7	15.7	5.4	17.9	13.0	34.6	4.5	17.3	5.5	16.7	10.6	31.4	7.0	21.1	6.0	19.1	7.3	23.2	6.3	25.1	8.1	24.4	
10	7.1	22.4	9.7	24.9	6.2	23.1	11.1	30.5	4.7	18.2	5.0	18.7	5.1	18.0	7.0	18.7	5.5	14.0	5.3	17.4	5.2	21.2	8.9	20.5	
11	9.4	26.2	8.0	25.6	5.2	17.7	6.9	19.8	5.8	19.2	6.8	20.5	4.9	18.8	7.4	19.5	6.5	36.6	6.4	18.4	4.6	17.8	4.7	16.1	
12	5.8	18.0	7.0	22.1	5.8	17.7	7.7	23.6	10.3	26.7	7.4	20.3	7.9	30.0	6.6	22.8	5.0	15.1	7.3	23.9	4.5	15.8	5.4	23.0	
13	7.7	19.9	10.5	29.8	8.0	29.4	10.7	29.4	15.1	30.3	8.1	31.8	5.5	18.6	6.8	27.2	6.9	32.3	6.1	17.6	7.9	25.7	5.7	16.2	
14	6.0	21.6	16.8	34.0	8.8	25.6	10.7	25.7	6.9	24.5	10.2	34.7	6.5	27.1	5.6	20.9	6.2	18.4	6.8	20.4	8.1	22.3	4.5	17.3	
15	5.7	16.8	12.1	28.4	8.4	21.1	9.8	26.7	7.6	21.0	6.1	22.4	10.0	24.1	6.3	19.9	5.5	18.8	5.1	17.9	10.2	25.8	8.3	22.9	
16	4.8	18.3	9.4	23.9	7.2	26.1	6.4	24.8	8.2	24.0	10.5	24.8	6.9	18.9	5.6	18.8	6.1	25.9	6.3	22.2	11.2	25.9	12.3	29.7	
17	8.2	23.0	7.0	20.8	5.4	18.5	6.2	16.7	10.4	25.0	4.6	25.5	7.6	24.0	5.8	17.6	8.9	27.9	6.5	21.0	9.3	26.3	11.6	26.8	
18	10.8	26.5	10.8	25.9	5.2	16.3	4.7	18.9	6.9	27.8	4.4	16.2	8.6	26.9	8.8	24.4	5.1	28.3	5.3	20.6	6.8	18.8	10.2	31.1	
19	8.8	23.8	7.4	27.6	7.7	30.0	5.1	20.1	5.1	16.7	6.4	21.8	5.9	20.8	7.5	24.3	4.7	14.3	4.7	15.2	10.6	30.5	7.8	27.2	
20	7.0	18.9	6.3	23.6	8.1	27.0	7.1	21.1	5.1	19.5	6.1	17.4	6.9	26.5	6.3	19.6	5.7	16.2	4.3	13.8	12.9	29.7	8.4	24.1	
21	6.5	21.1	5.6	19.8	5.3	21.6	4.9	20.1	6.2	23.5	6.4	21.0	8.1	21.1	7.0	24.1	5.2	18.8	5.9	26.2	7.1	26.0	9.0	24.2	
22	7.8	24.8	7.3	22.5	6.2	18.9	8.9	29.9	6.0	18.9	7.4	18.1	5.4	24.0	5.5	23.0	5.5	19.9	5.4	26.1	6.4	27.2	10.1	24.6	
23	6.3	23.7	12.0	29.6	5.5	14.8	8.1	21.0	5.7	17.0	8.5	26.4	6.5	18.8	6.2	21.0	4.8	18.5	4.4	24.0	6.9	24.6	9.4	20.7	
24	6.0	21.4	6.0	22.4	8.8	23.2	8.6	28.3	5.2	18.2	9.9	24.8	8.4	23.3	5.8	18.8	5.0	17.4	6.1	19.9	5.9	17.0	9.5	28.3	
25	5.8	19.8	7.3	25.6	9.7	26.0	5.9	29.5	4.3	15.3	6.6	19.1	5.9	19.9	5.3	19.2	4.3	17.8	5.2	16.8	5.9	18.6	8.5	21.4	
26	5.5	18.4	10.2	35.2	8.2	25.1	7.9	21.4	6.0	14.8	9.2	32.0	7.0	23.6	4.5	16.2	6.9	24.9	4.8	15.6	5.8	21.0	8.6	31.4	
27	7.1	27.2	6.9	24.0	5.9	21.6	11.1	32.7	4.8	16.2	9.3	28.1	5.2	18.7	8.0	24.7	5.5	20.1	4.9	18.1	6.3	29.4	6.4	27.2	
28	6.6	20.4	6.5	23.4	9.5	25.1	9.1	25.4	4.8	23.9	5.5	23.4	5.1	20.7	6.0	35.3	6.0	20.2	6.2	20.7	6.7	23.7	7.1	24.9	
29	8.9	37.0			7.7	21.4	9.3	20.9	4.1	17.2	9.5	25.2	4.9	15.0	5.8	18.9	5.8	18.6	7.8	20.2	5.9	19.4	8.7	24.5	
30	5.3	18.7			6.8	25.4	9.9	30.8	5.8	20.4	8.6	30.4	7.3	20.5	5.0	16.9	6.4	44.0	5.1	18.0	6.8	22.9	7.7	25.3	
31	5.8	20.3			6.0	19.3			6.3	22.1			8.2	22.1	4.7	17.5			6.6	30.1			5.2	19.2	



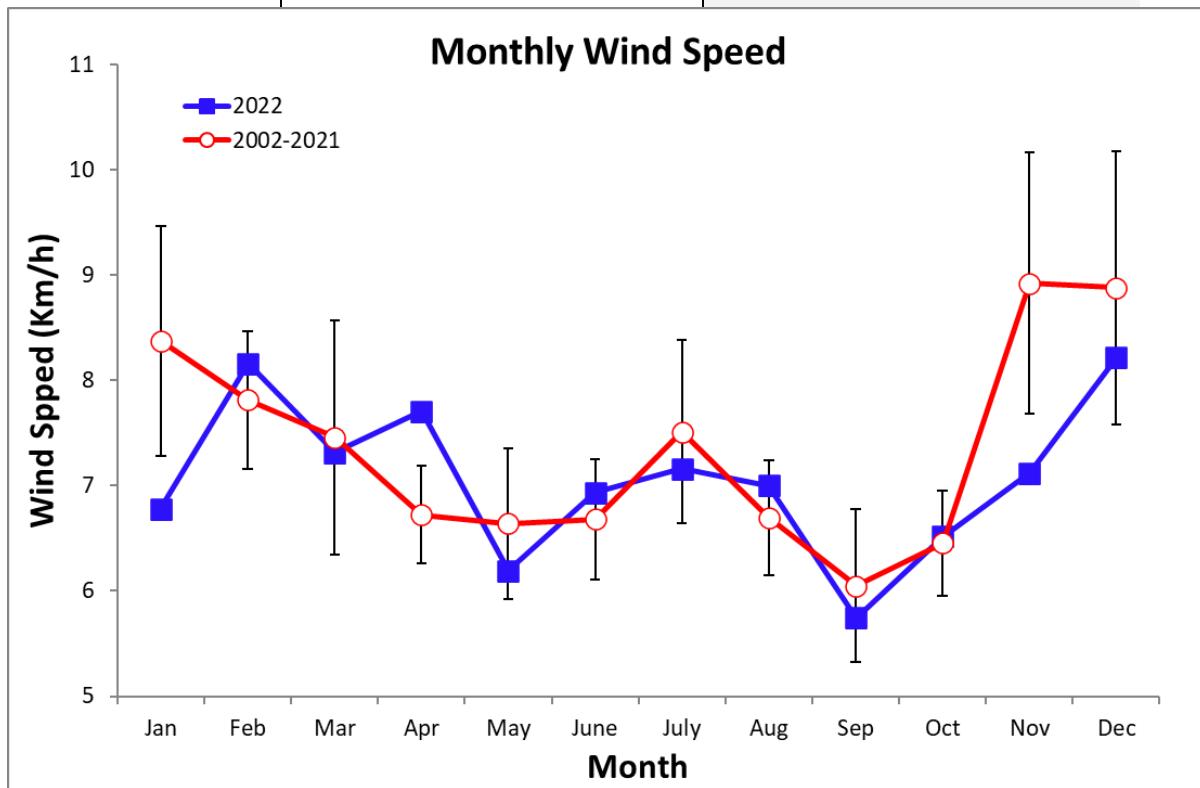
2022 Average Daily Wind Direction (°)

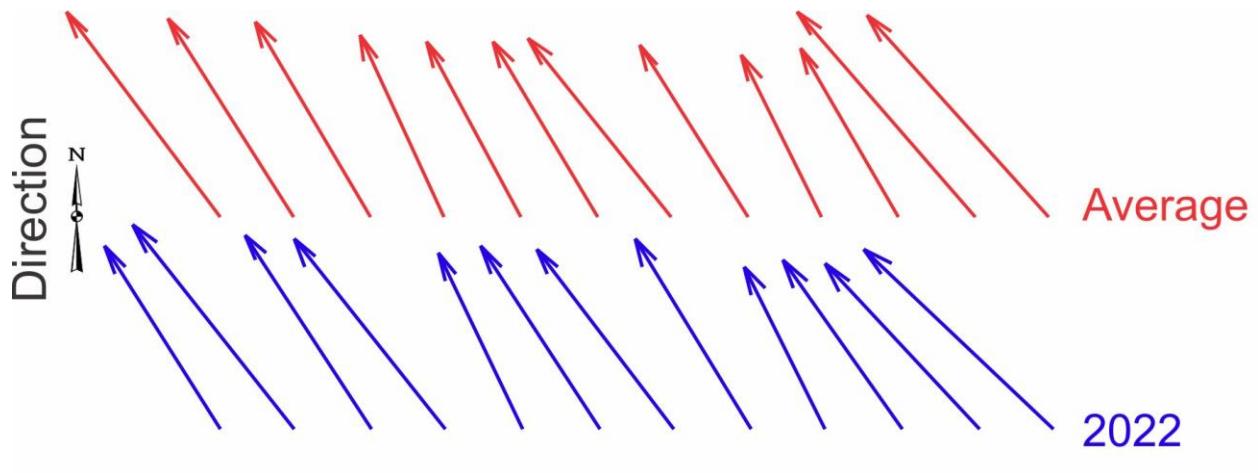
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	339.2	354.7	308.5	331.3	321.7	310.9	303.0	319.0	340.0	310.8	330.7	308.9
2	327.0	336.8	320.1	342.9	328.6	317.6	81.0	321.1	324.5	341.1	349.7	309.3
3	318.9	323.4	299.0	345.6	329.1	87.3	317.2	301.9	337.2	323.4	309.9	281.4
4	332.9	303.8	325.5	329.9	330.2	17.4	319.8	312.0	332.1	317.9	314.5	298.3
5	335.8	337.0	326.6	318.1	331.6	329.1	338.0	319.7	327.5	310.7	314.4	299.1
6	311.3	334.8	329.2	357.7	327.9	25.4	325.5	316.8	340.7	316.2	1.3	312.6
7	308.3	311.1	335.1	349.4	354.4	332.0	315.2	336.6	343.5	303.5	299.9	302.5
8	325.4	326.0	347.6	293.0	24.4	355.7	321.9	319.6	340.8	279.5	320.1	325.6
9	296.7	329.8	350.6	305.5	5.9	332.2	303.7	321.5	354.6	303.8	333.4	296.5
10	317.5	322.8	325.2	285.1	357.7	335.8	319.2	327.3	307.1	328.1	338.1	301.9
11	319.7	317.7	357.6	330.3	348.7	321.5	325.9	316.3	305.4	326.2	342.6	339.7
12	332.1	331.0	336.8	318.5	315.2	306.4	317.6	330.5	317.9	322.2	333.8	338.4
13	315.3	313.5	327.3	288.8	310.0	320.5	309.4	314.4	349.1	313.4	319.2	2.8
14	321.0	303.0	337.7	309.9	328.2	288.6	327.9	355.9	314.6	330.1	288.4	343.6
15	3.0	301.8	321.6	322.9	325.5	324.6	304.1	317.4	339.6	357.8	314.0	321.7
16	5.6	325.2	331.2	299.8	321.8	316.1	337.3	353.3	320.6	336.2	291.4	313.3
17	330.0	318.9	350.4	321.6	310.5	309.8	324.8	335.1	310.9	304.9	279.0	310.1
18	314.4	298.2	349.5	286.1	210.9	340.4	317.5	339.2	301.7	344.7	302.3	299.7
19	307.6	330.4	315.8	345.9	0.0	49.4	323.9	315.6	330.9	335.1	302.8	299.5
20	316.8	327.6	313.2	308.4	350.8	359.1	315.9	338.8	329.6	330.7	313.2	309.8
21	325.7	334.4	339.0	351.0	329.5	319.5	311.7	325.3	4.8	328.9	311.6	304.1
22	329.3	329.8	28.2	316.2	332.2	321.5	318.1	339.7	355.5	327.0	307.7	304.8
23	335.2	295.9	293.6	326.6	7.8	319.7	317.7	299.6	0.0	276.2	315.4	295.4
24	335.5	335.6	295.0	327.6	335.2	312.0	323.6	308.5	344.1	331.2	317.3	319.8
25	342.0	312.7	299.2	340.7	341.3	319.1	352.6	345.4	342.8	339.5	321.9	332.5
26	353.8	318.9	332.1	307.3	342.6	316.4	312.0	346.3	316.9	330.4	324.7	321.6
27	328.1	331.0	339.8	318.3	327.8	309.5	336.6	320.9	18.3	335.8	329.7	319.8
28	327.9	328.0	315.8	315.8	357.7	333.4	339.2	354.6	317.5	328.4	316.9	323.0
29	329.1		322.5	311.7	354.3	313.1	325.0	338.3	327.1	330.3	309.2	306.5
30	347.3		335.3	314.4	332.3	312.5	330.6	73.1	331.0	341.1	324.9	323.6
31	337.0		344.1		330.6		334.2	3.9		323.3		329.5



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

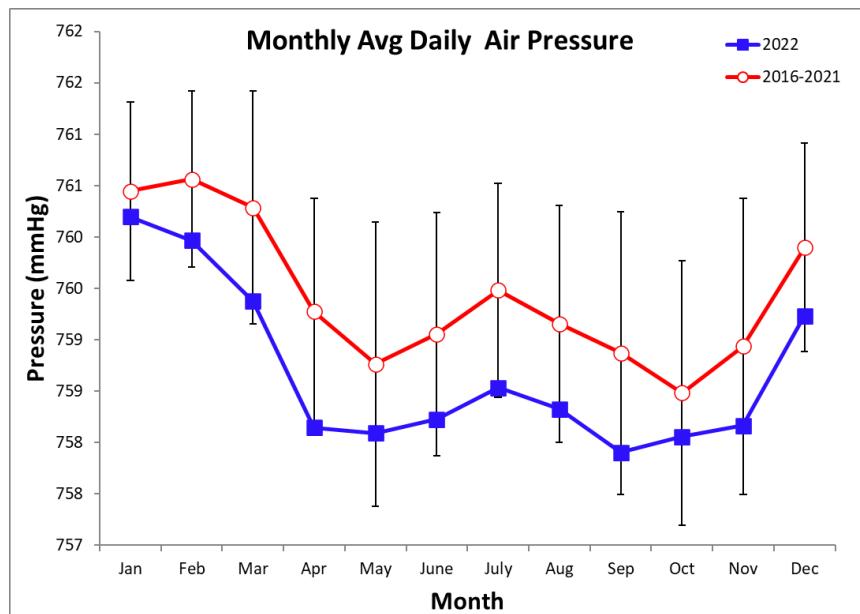
	Long-term Av.			2022		
	Speed	Sp max	Dir.	Speed	Sp max	Dir.
January	8.4	23.8	324.5	6.8	21.5	327.6
February	7.8	23.4	329.0	8.2	24.2	321.7
March	7.5	23.1	331.2	7.3	22.8	327.5
April	6.7	21.9	335.8	7.7	23.8	320.9
May	6.6	22.3	332.9	6.2	20.0	334.7
June	6.7	22.9	330.9	6.9	23.3	327.2
July	7.5	24.2	322.9	7.2	23.0	322.3
August	6.7	23.1	328.8	7.0	22.0	328.6
September	6.0	22.7	334.7	5.7	22.0	333.4
October	6.5	22.8	331.2	6.5	21.7	325.0
November	8.9	25.9	321.2	7.1	22.8	316.7
December	8.9	25.1	319.4	8.2	24.2	313.3





Air Pressure (mmHg)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2016			759.7	758.7	758.4	758.8	759.2	758.3	758.7	757.5	757.8	759.2
2017	760.4	760.2	760.4	758.6	758.3	758.2	759.1	758.7	758.1	757.4	758.0	759.4
2018	759.5	760.8	759.6	759.6	758.5	758.7	759.0	758.9	757.7	758.0	758.4	759.6
2019	760.4	759.9	760.2	759.3	757.8	759.0	759.6	759.4	759.5	759.1	759.7	760.1
2020												No data available
2021	761.9	762.0	762.5	761.3	761.5	761.4	761.5	761.3	761.3	760.8	761.6	761.8
2022	760.2	760.0	759.4	758.1	758.1	758.2	758.5	758.3	757.9	758.1	758.2	759.2
mean	760.4	760.6	760.3	759.3	758.8	759.1	759.5	759.2	758.9	758.5	758.9	759.9
sd	0.9	0.9	1.1	1.1	1.4	1.2	1.0	1.1	1.4	1.3	1.4	1.0
min	759.5	759.9	759.4	758.1	757.8	758.2	758.5	758.3	757.7	757.4	757.8	759.2
max	761.9	762.0	762.5	761.3	761.5	761.4	761.5	761.3	761.3	760.8	761.6	761.8



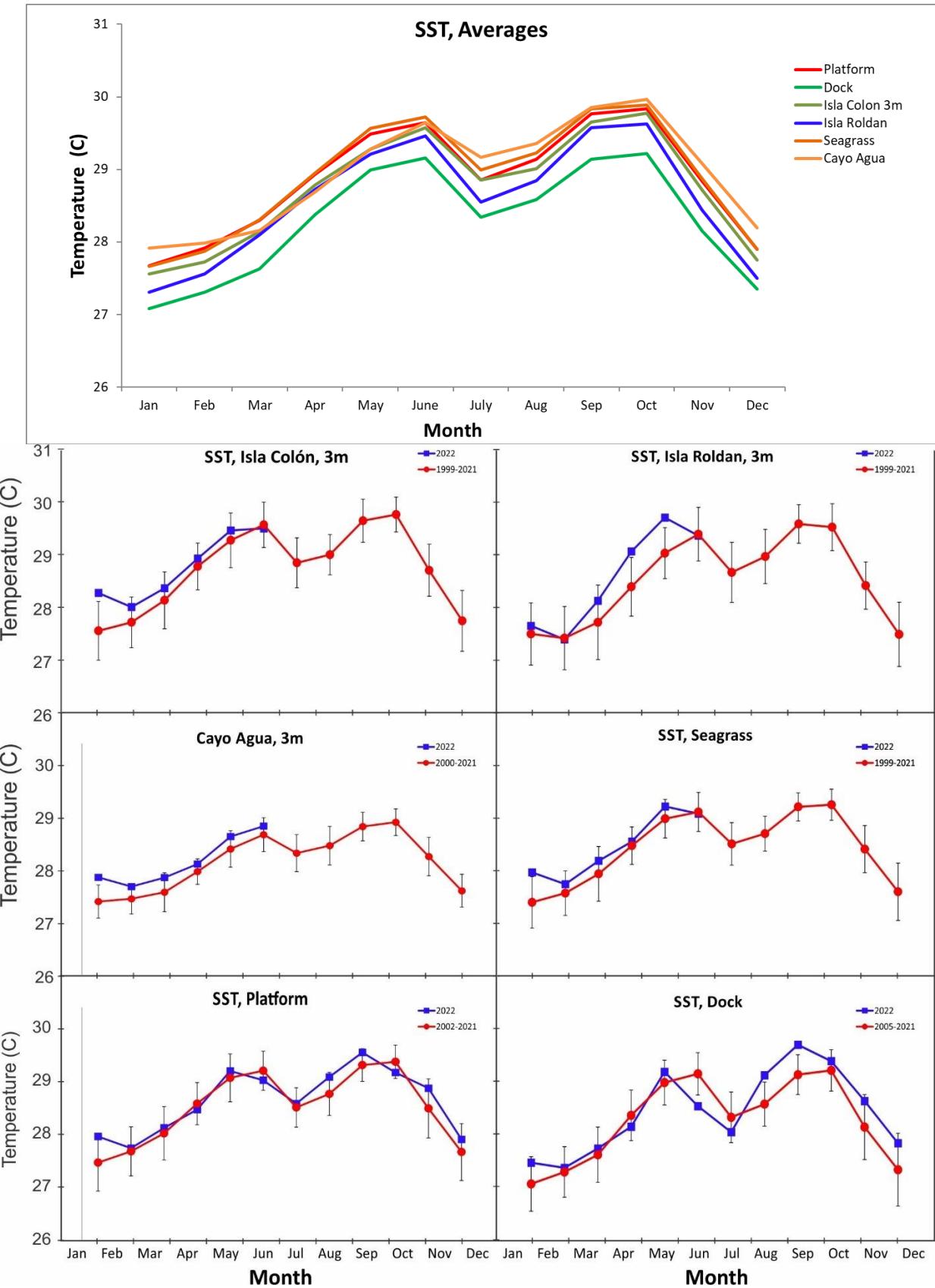
Average Sea Surface Temperature (°C)

Long-term Average Monthly Temperatures (1999-2021)

	Dock	Platform	Sea grass	Isla Colon 3m	Cayo Aguas 3m	Isla Roldan 3m
January	27.4		27.5	27.6	27.0	
February	27.7		27.8	27.8	27.2	
March	28.2		28.2	28.2	27.6	
April	29.1		28.9	28.9	28.4	
May	29.3		29.6	29.5	29.0	
June	29.5		29.7	29.6	29.2	
July	28.6		28.9	28.8	28.4	
August	29.0		29.2	29.1	28.6	
September	29.8		29.8	29.7	29.1	
October	29.8		29.8	29.8	29.2	
November	28.5		28.8	28.7	28.0	
December	27.5		27.8	27.8	27.3	

Average Monthly Temperatures (2022)

	Dock	Platform	Sea grass	Isla Colon 3m	Cayo Aguas 3m	Isla Roldan 3m
January	27.5	28.2	28.3	28.3	28.5	28.7
February	27.4	28.0	28.1	28.0	28.3	28.4
March	27.7	28.4	28.6	28.4	28.5	29.1
April	28.2	28.8	29.0	28.9	28.9	30.1
May	29.2	29.6	29.8	29.5	29.6	30.7
June	28.5	29.4	29.7	29.5	29.9	30.4
July	28.1	28.9				
August	29.1	29.5				
September	29.7	30.0				
October	29.4	29.6				
November	28.6	29.3				
December	27.8	28.2				



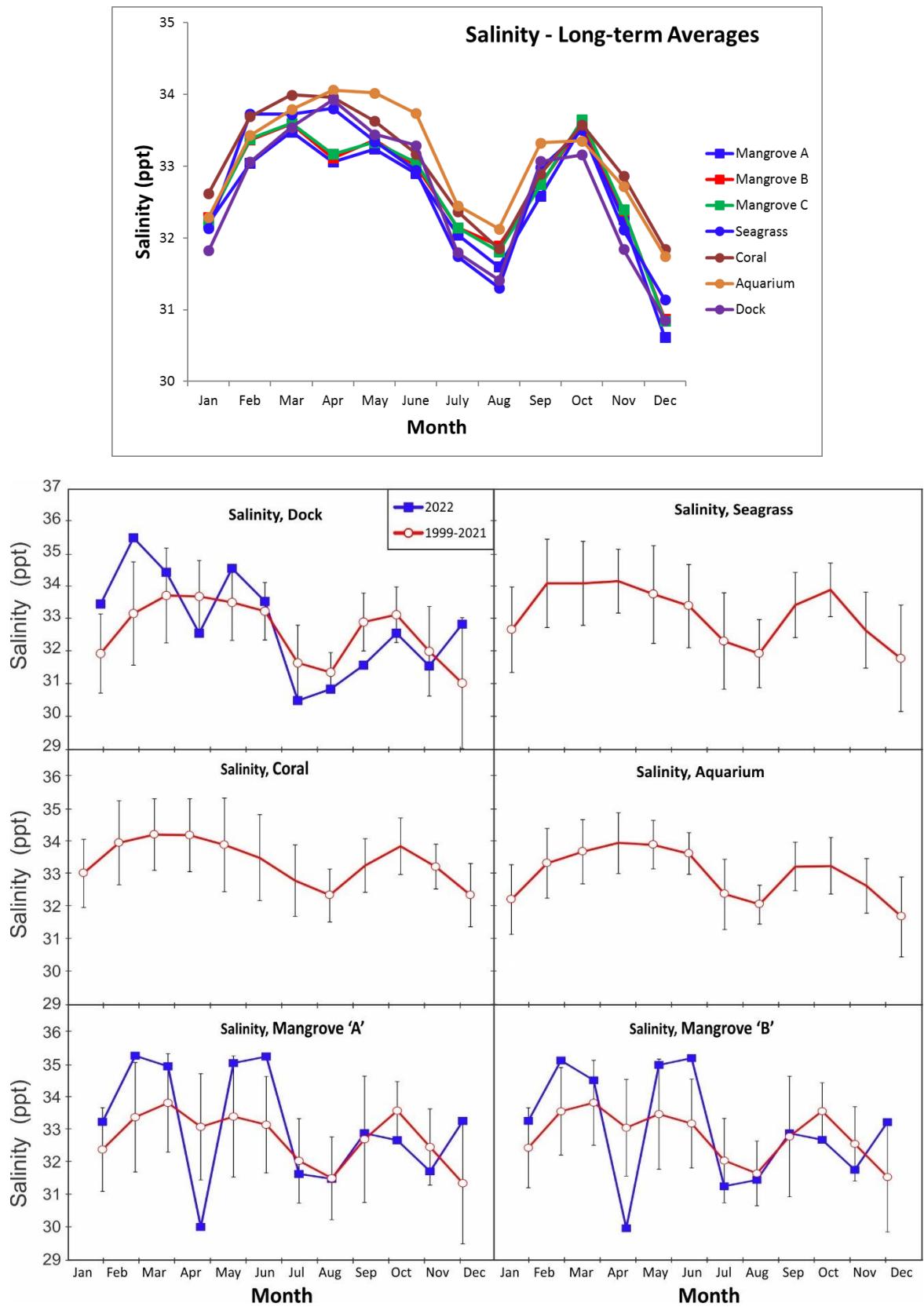
Average Salinity (ppt)

Long-term Average Monthly Salinity (1999-2021)

	Mangrove			Aquarium	Coral	Dock	Seagrass
	'A'	'B'	'C'				
January	32.4	32.4	32.4	31.6	32.0	32.0	31.6
February	33.3	33.6	33.6	32.9	33.7	33.2	32.9
March	33.8	33.8	33.9	33.4	33.6	33.7	33.4
April	33.0	33.0	33.1	33.8	33.7	33.7	33.8
May	33.4	33.5	33.4	33.4	33.3	33.5	33.4
June	33.1	33.2	33.2	33.3	32.9	33.3	33.3
July	32.0	32.0	32.0	31.8	31.9	31.7	31.8
August	31.5	31.6	31.6	31.4	31.4	31.4	31.4
September	32.7	32.8	32.8	33.2	33.0	32.9	33.2
October	33.5	33.6	33.6	33.2	33.5	33.2	33.2
November	32.4	32.5	32.5	31.8	32.1	32.0	31.8
December	31.3	31.5	31.5	30.6	30.9	31.1	30.6

Average Monthly Salinity (2022)

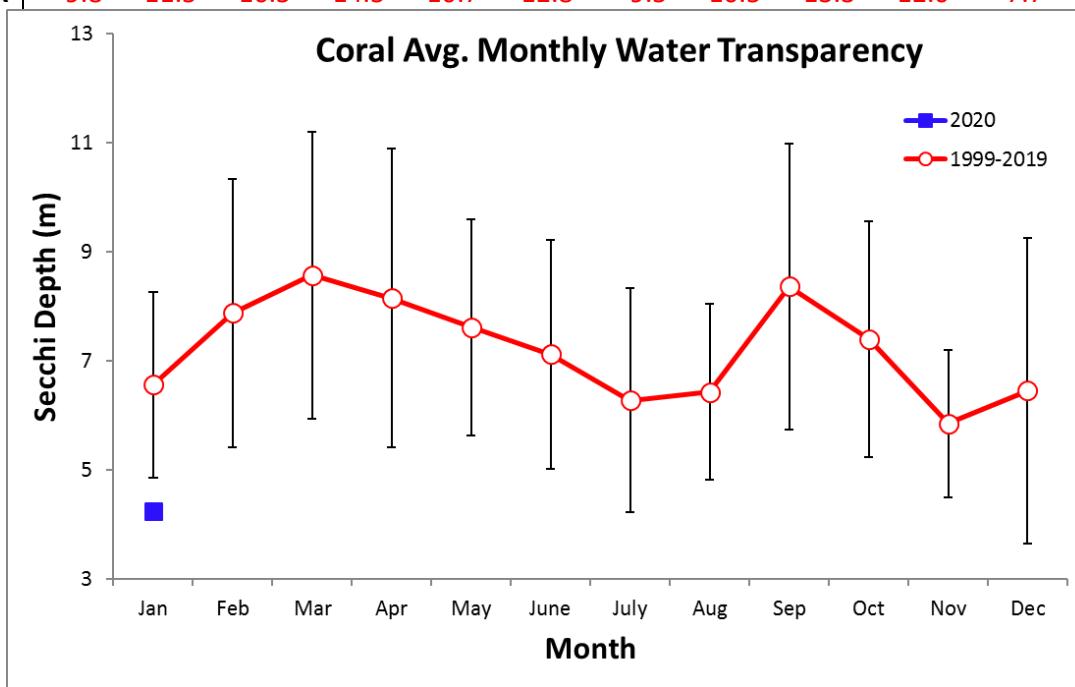
	Mangrove			Aquarium	Coral	Dock	Seagrass
	'A'	'B'	'C'				
January	33.2	33.3	33.3			33.5	
February	35.2	35.2	35.2			35.5	
March	34.9	34.6	34.9			34.5	
April	30.0	29.9	29.8			32.6	
May	35.0	35.0	34.9			34.6	
June	35.2	35.3	35.3			33.6	
July	31.6	31.2	31.0			30.5	
August	31.5	31.4	31.4			30.9	
September	32.9	32.9	32.9			31.6	
October	32.6	32.7	32.7			32.6	
November	31.7	31.7	31.8			31.6	
December	33.2	33.2	33.2			32.9	



Average Water Transparency (Secchi depth)

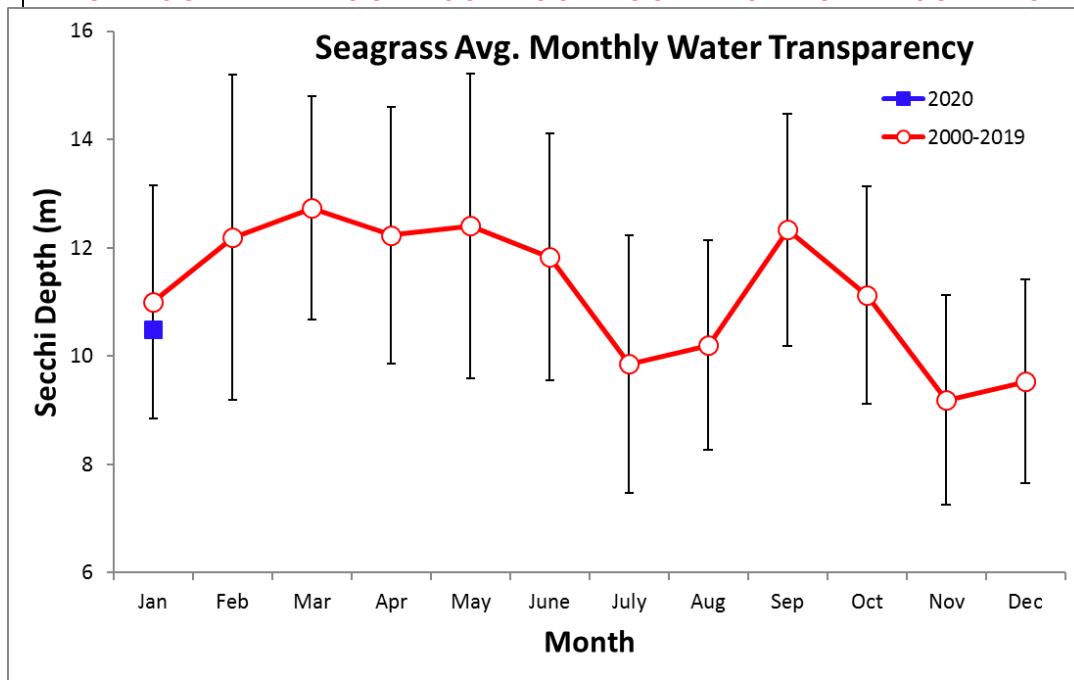
Coral

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2001									9.5	6.8	8.2	7.7
2002	5.8	7.1	8.9	9.4	6.4	8.3	6.3	5.6	9.4	11.2	8.5	6.6
2003	9.9	11.3	10.4	8.8	6.7	6.9	7.4	6.3	7.5	9.9	8.5	9.6
2004	7.9	11.4	8.6	5.2	7.9	7.1	6.3	4.5	9.9	11.5	7.4	9.1
2005	9.8	10.1	10.8	8.4	7.3	8.3	8.3	6.1	10.0	7.1	6.9	4.5
2006	8.5	9.1	7.2	10.0	6.1	7.3	6.2	6.7	13.1	12.0	5.2	5.0
2007	4.9	6.3	11.3	11.0	9.6	12.8	9.0	5.4	9.4	8.0	6.7	11.5
2008	5.3	10.8	6.0	10.4	9.4	8.0	7.8	10.5	9.8	6.8	7.2	9.9
2009	4.3	11.5	16.5	8.4	10.7	7.3	7.0	7.4	13.3	6.2	2.9	7.3
2010	6.0	9.8	9.2	9.7	9.0	7.8	5.5	7.3	7.0	7.5	6.3	5.5
2011	7.5	4.2	9.8	11.8	8.4	10.1	7.9	5.6	8.8	7.6	5.6	6.5
2012	7.3	8.0	7.1	14.5	10.3	6.3	9.5	6.1	6.8	9.5	5.5	0.8
2013	8.1	8.0	11.4	8.4	8.7	8.4	7.8	8.3	7.5	7.8	7.0	5.3
2014	8.0	5.5	6.7	8.3	8.8	4.3	6.0	5.4	9.5	8.6	7.5	10.3
2015	8.5	8.5	8.0	7.8	4.5	6.6	4.0	6.4	9.2	7.3	5.3	6.3
2016	5.5	4.9	8.0	6.8	4.7	5.9	4.3	5.5	5.0	6.0	4.5	5.5
2017	4.8	4.5	6.9	4.3	6.5							
2018			6.6	5.3	4.8	5.6	3.4	6.1	5.5	5.2	4.8	3.7
2019	4.9	9.5	7.5	6.1	7.7	5.9	7.1	8.3	8.3	6.5	4.8	4.1
2020	4.3											
									Discontinued			
mean	6.6	7.9	8.6	8.2	7.6	7.1	6.3	6.4	8.4	7.4	5.9	6.5
sd	1.7	2.5	2.6	2.7	2.0	2.1	2.1	1.6	2.6	2.2	1.4	2.8
min	4.3	4.2	6.0	4.3	4.5	4.3	2.3	3.5	4.6	4.1	2.9	0.8
max	9.8	11.5	16.5	14.5	10.7	12.8	9.5	10.5	13.3	12.0	7.7	11.5



Seagrass

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2000							9.9	9.6	14.4	13.2	10.6	9.5
2001	12.8	14.3	11.9	12.5	12.6	10.8	8.0	9.8	9.5	12.9	9.7	12.1
2002	11.6	14.9	12.9	7.5	10.5	13.6	8.0	7.0	12.4	11.7	8.8	9.5
2003	11.8	13.5	14.4	11.6	9.9	11.0	9.8	11.4	13.4	12.0	10.9	8.0
2004	10.7	12.0	13.3	11.0	7.1	8.4	10.0	10.7	14.6	16.5	10.4	6.7
2005	8.3	8.0	15.7	12.6	15.6	13.4	10.5	8.8	15.3	11.5	10.6	11.1
2006	12.2	12.5	12.4	10.9	14.4	15.5	12.5	11.7	15.4	11.8	11.9	10.0
2007	11.6	16.8	17.7	13.9	16.0	13.3	13.3	13.9	15.2	11.0	8.3	11.5
2008	11.6	14.8	12.0	13.7	14.6	12.5	9.0	10.3	10.6	9.1	10.8	11.0
2009	11.9	6.3	14.3	14.0	14.1	14.1	9.6	10.3	11.9	9.8	8.9	10.0
2010	8.3	13.6	12.1	15.8	15.3	12.0	13.0	9.8	10.3	10.0	8.2	7.5
2011	12.6	11.5	13.8	14.8	14.2	14.5	11.3	14.3	13.1	13.4	11.0	10.0
2012	17.3	9.8	12.8	14.5	16.3	11.0	11.5	11.5	10.8	12.5	6.8	9.5
2013	10.5	16.0	12.0	15.3	9.0	12.0	6.3	9.0	15.0	12.2	9.5	12.5
2014	11.0	9.3	12.3	13.7	10.5	10.0	7.7	9.0	10.5	10.1	11.3	12.0
2015	9.5	11.0	11.3	8.7	11.0							
2016				11.1	10.3	12.0	13.3	11.8	9.1	10.5	9.7	9.8
2017	7.6	16.2	8.3	11.1	10.3	9.5	10.5	9.8	10.3	11.0	7.5	8.3
2018	9.3	10.8	10.3	11.0	13.5	7.4	4.6	7.7	11.5	7.7	5.0	5.5
2019	11.8	10.3	12.5	9.8	9.0	9.5	8.1	9.1	8.8	9.2	6.5	9.3
2020	10.5											
												Discontinued
mean	11.0	12.2	12.7	12.2	12.4	11.8	9.9	10.2	12.3	11.1	9.2	9.5
sd	2.2	3.0	2.1	2.4	2.8	2.3	2.4	1.9	2.1	2.0	1.9	1.9
min	7.6	6.3	8.3	7.5	7.1	7.4	4.6	7.0	8.8	7.7	5.0	5.5
max	17.3	16.8	17.7	15.8	16.3	15.5	13.3	14.3	15.4	16.5	11.9	12.5



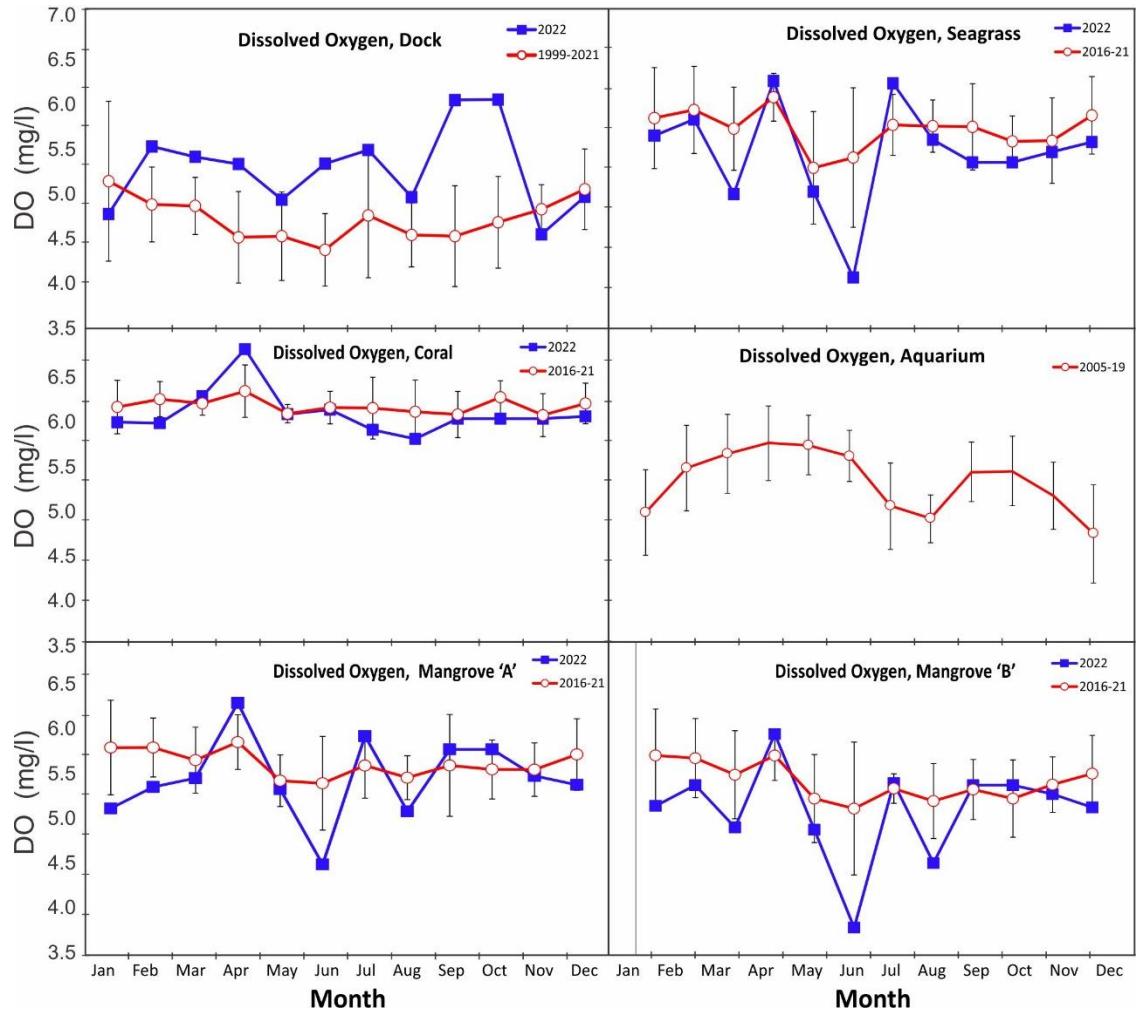
Average Dissolved Oxygen (mg/l)

Long-term Average Monthly Temperatures (1999-2021)

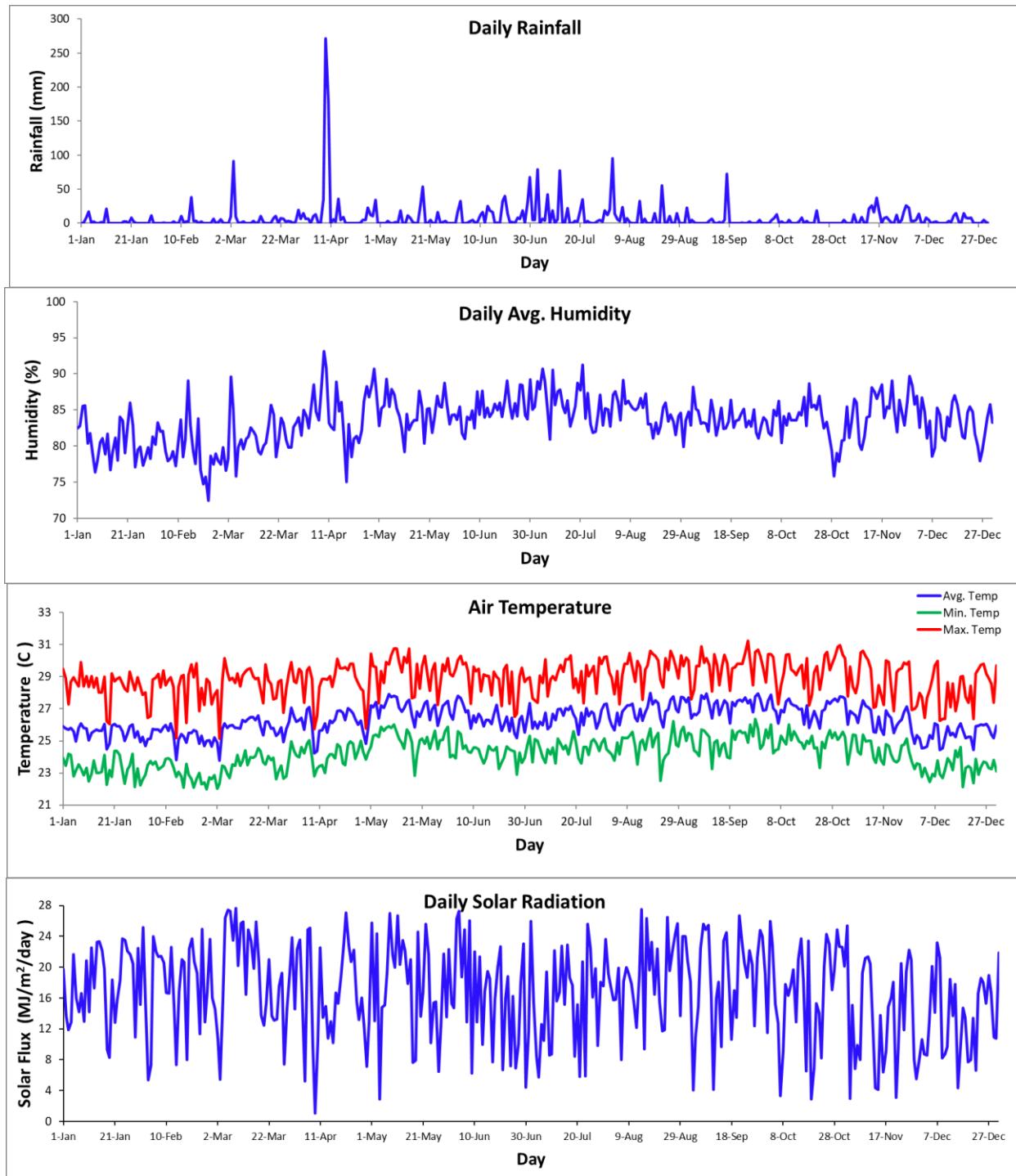
	Aquarium	Dock	Coral	Sea grass	Mangrove		
					'A'	'B'	'C'
January	5.8	5.1	6.1	5.8	5.8	5.7	5.7
February	5.6	4.9	6.2	5.9	5.8	5.7	5.7
March	5.6	4.8	6.2	5.7	5.7	5.5	5.6
April	5.4	4.5	6.3	6.0	5.9	5.7	5.8
May	5.3	4.5	6.1	5.3	5.4	5.2	5.3
June	5.3	4.4	6.1	5.4	5.4	5.1	5.1
July	5.5	4.7	6.1	5.7	5.6	5.4	5.3
August	5.4	4.5	6.1	5.7	5.5	5.2	5.3
September	5.4	4.5	6.0	5.7	5.6	5.4	5.3
October	5.4	4.7	6.2	5.6	5.6	5.2	5.3
November	5.6	4.8	6.0	5.6	5.6	5.4	5.4
December	5.6	5.0	6.2	5.8	5.7	5.5	5.6

Average Monthly Temperatures (2022)

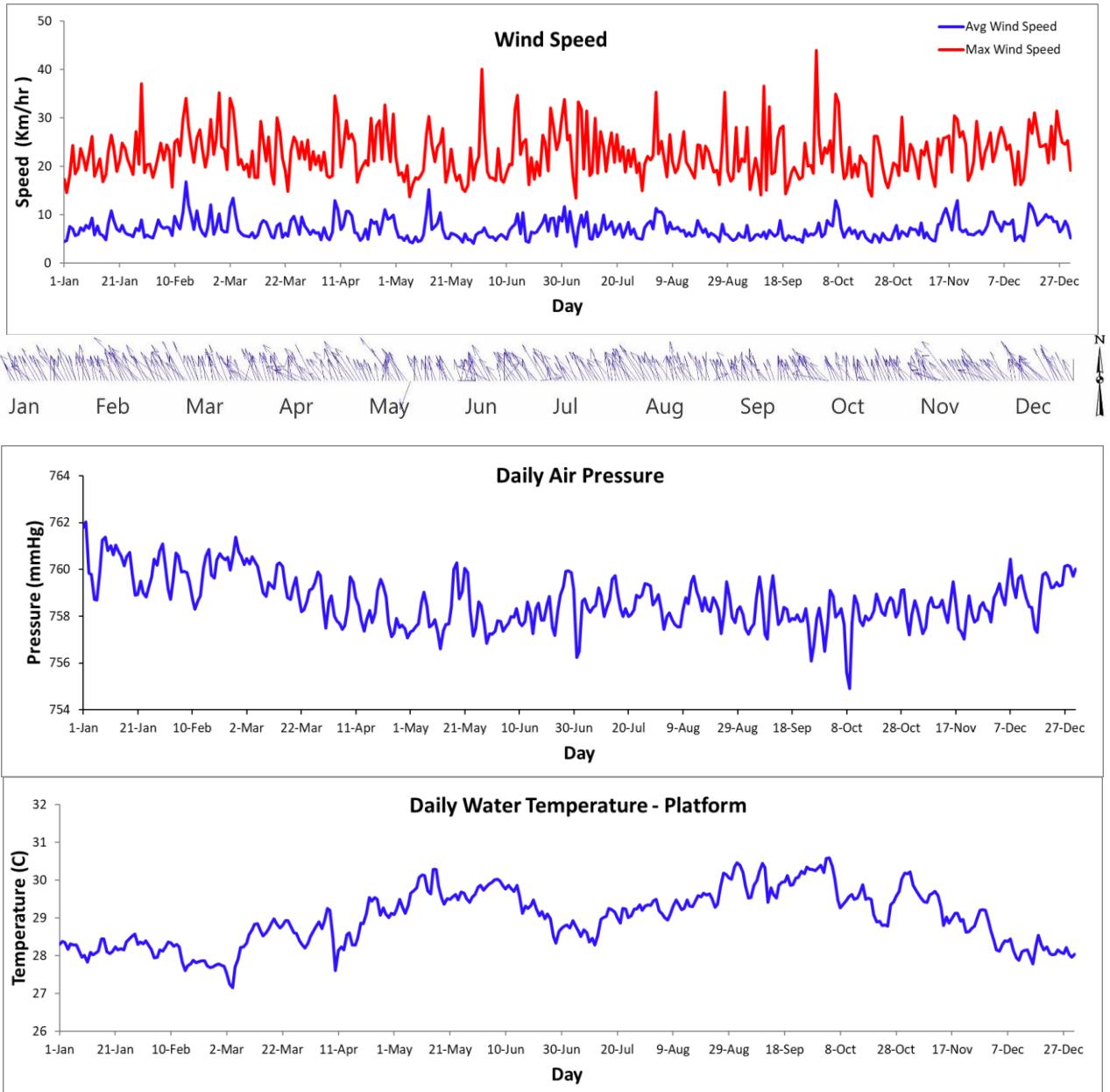
	Aquarium	Dock	Coral	Sea grass	Mangrove		
					'A'	'B'	'C'
January		4.8	6.0	5.6	5.2	5.1	5.2
February		5.5	6.0	5.8	5.4	5.4	5.3
March		5.4	6.3	5.0	5.5	4.9	5.2
April		5.3	6.8	6.2	6.3	6.0	6.2
May		4.9	6.1	5.0	5.4	4.9	4.9
June		5.3	6.1	4.1	4.5	3.8	4.0
July		5.5	5.9	6.2	6.0	5.4	5.7
August		4.9	5.8	5.6	5.1	4.5	4.6
September		6.0	6.0	5.3	5.8	5.4	5.5
October		6.0	6.0	5.3	5.8	5.4	5.5
November		4.5	6.0	5.4	5.5	5.3	5.3
December		4.9	6.0	5.6	5.4	5.2	5.3



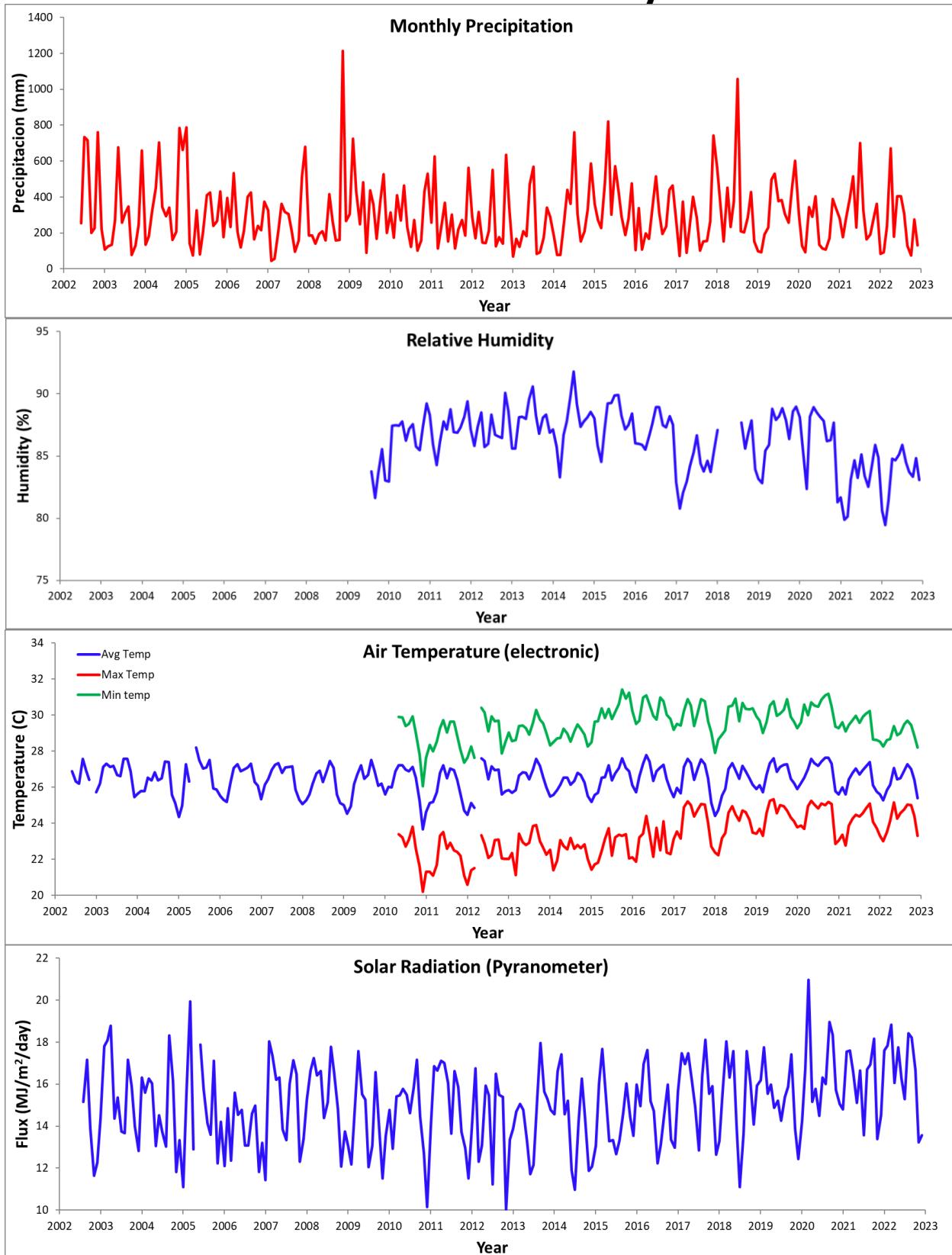
Time Series – Daily, 2022



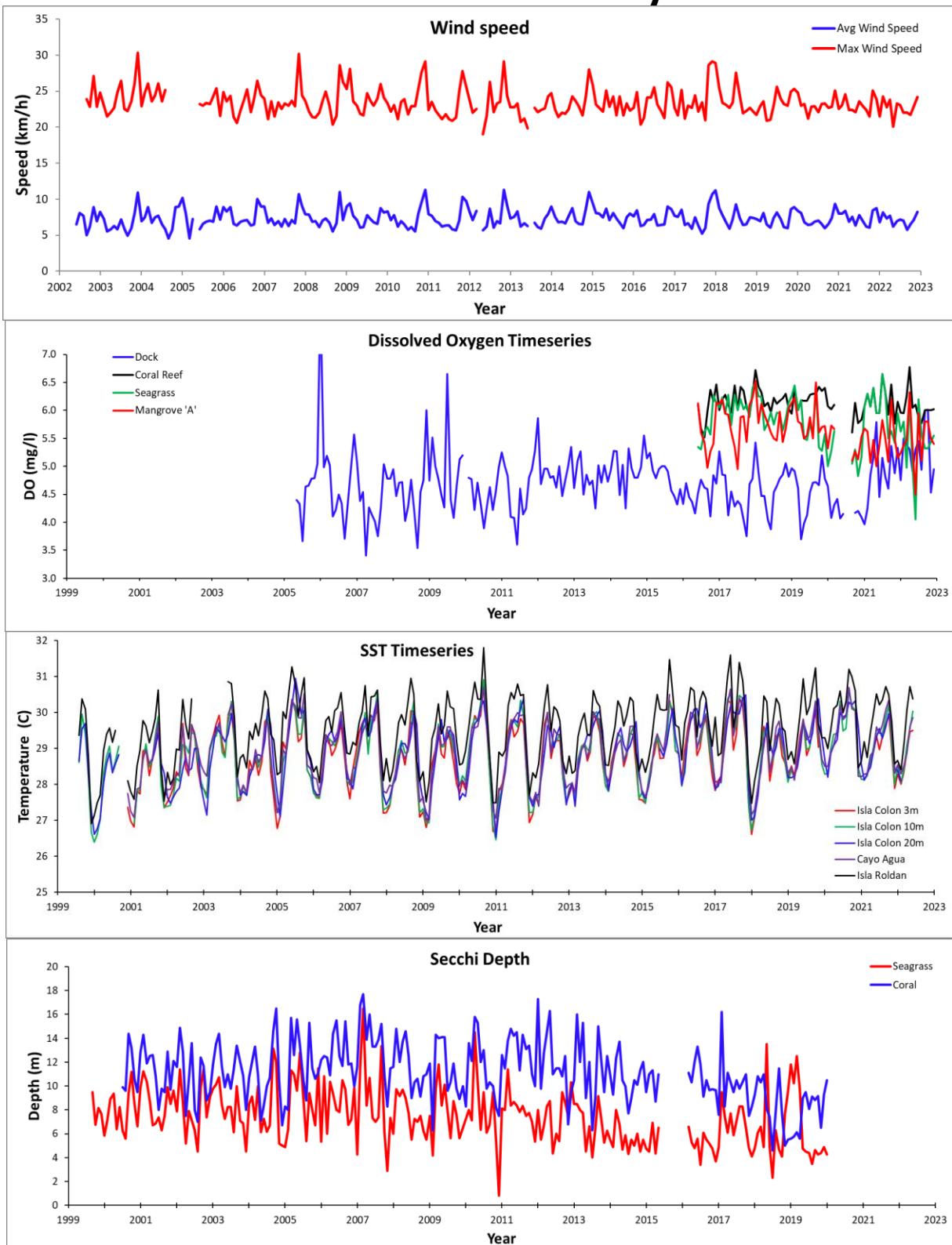
Time Series – Daily, 2022



Time Series – Monthly



Time Series – Monthly



Time Series – Monthly

