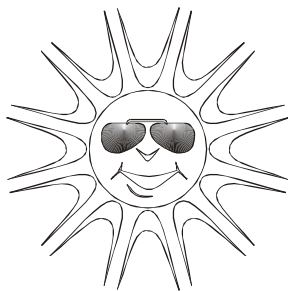




Smithsonian Tropical Research Institute

2019 Meteorological and Oceanographic  
Summary for the  
Bocas del Toro Research Station

Prepared by: Steven Paton



## Introduction

This is the 7<sup>th</sup> of 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](http://biogeodb.stri.si.edu/physical_monitoring/research/bocas)

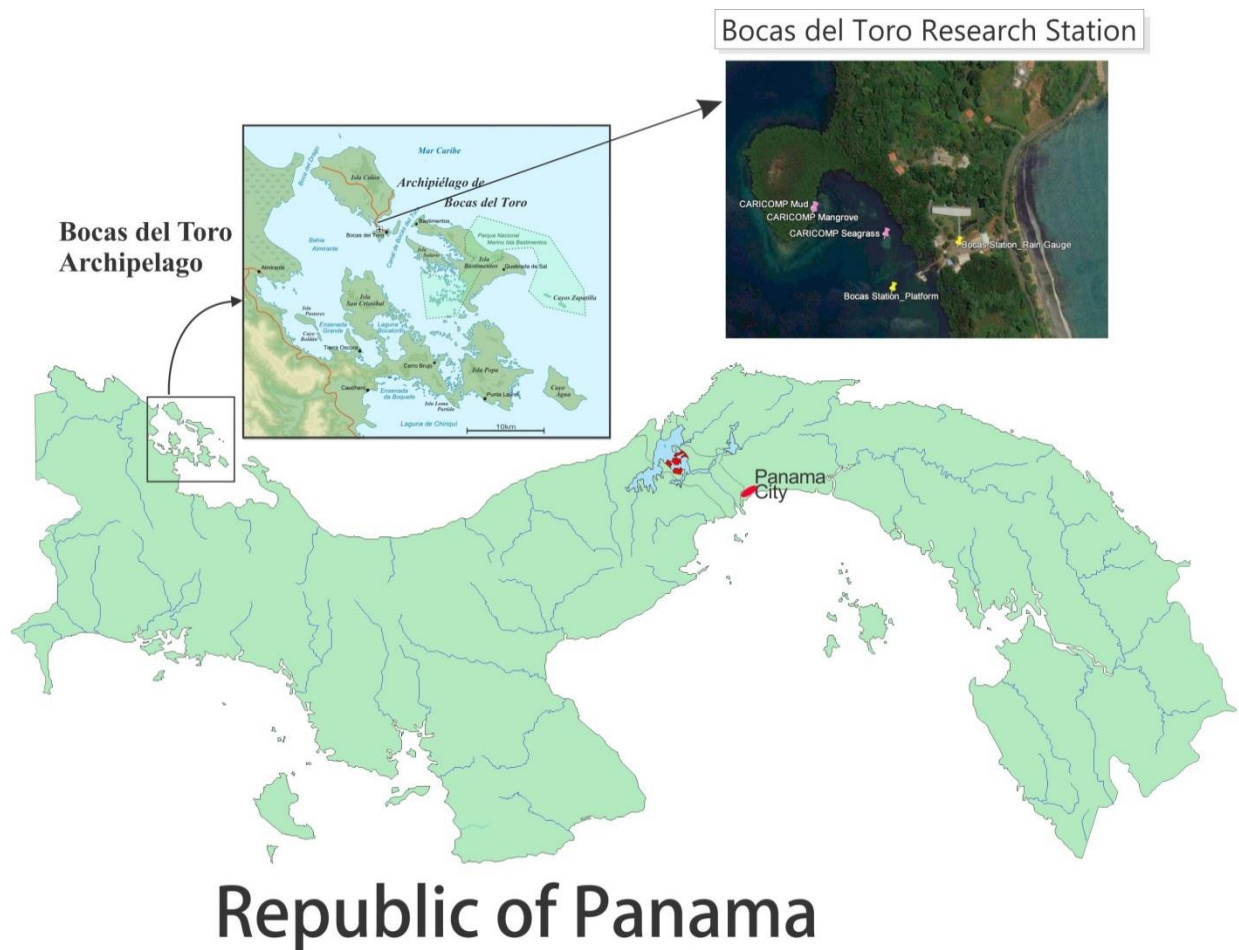
## Setting

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.

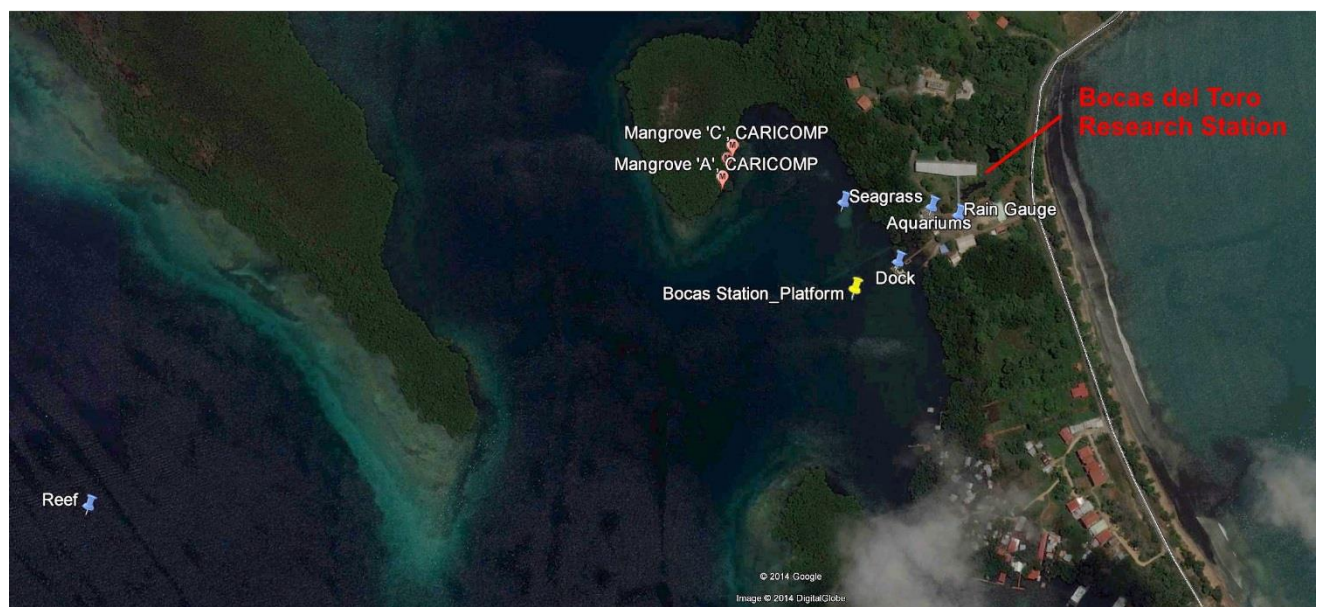
The station receives an average of 3431.8 mm of rain per year. The meteorological year is divided into four parts: two periods of lower rainfall (approximately from mid-December to the end of May, and the months of August to October), and two wetter periods (June-July and November-December) – see the 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.





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.

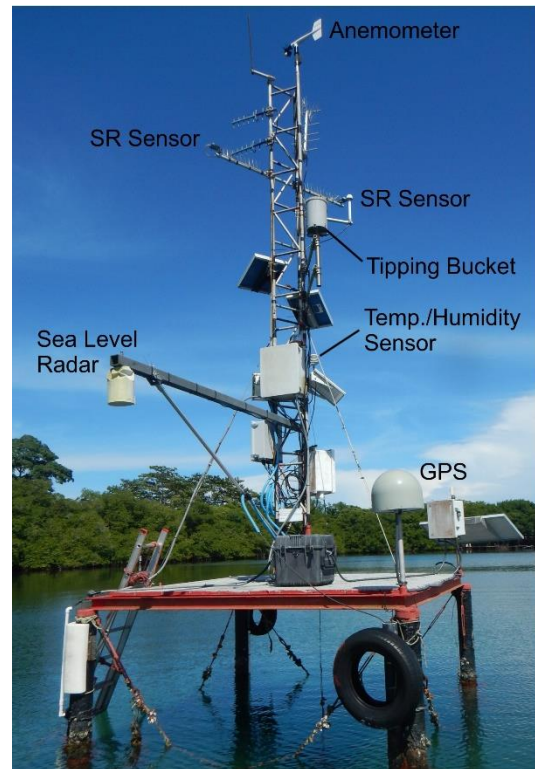
## The Data

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:

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



## Rainfall

Rainfall was collected by a rain gauge near the centre of the station, and 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 2019 are shown on page 7.

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 2018.

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 2018 and for the year 2019.

## **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 16.

## **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 ( $\text{MJ m}^{-2}$ ), maximum and minimum ( $\text{J m}^{-2} \text{s}^{-1}$ ) are collected.

Page 17 shows the Daily Global Radiation values. Page 18 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 19 shows average and maximum daily wind speeds from the Young Anemometer located at the top of the platform tower. Page 20 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. Page 21 shows 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 22 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 23 and 24, 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 25 and 26.

**Water Transparency**

Measured using a standard Secchi Disk at the Coral and Seagrass sites. Monthly averages are shown on page 27 and 28.

**Dissolved Oxygen**

Measured manually at the Dock and the Aquarium using a YSI 2030 Pro sensor. Monthly averages are shown on page 29 and 30.

**Times Series**

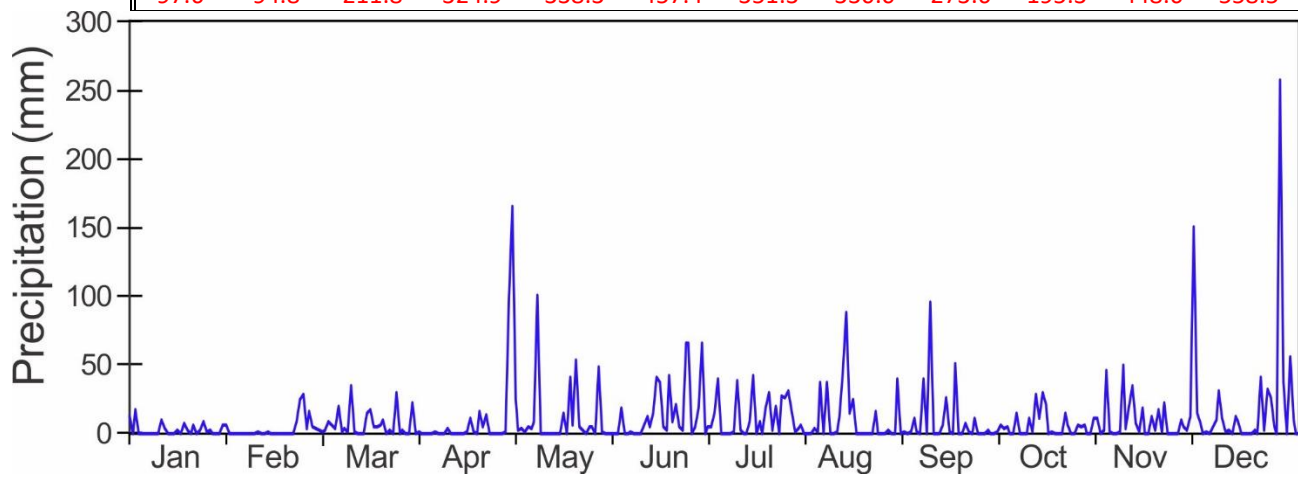
Graphs showing the daily Air Temperature, Relative Humidity, Rainfall, Solar Radiation and Wind Speed averages for 2019 (pages 31 and 32) and monthly averages for the entire period of recorded SST, Salinity, Secchi depth and DO (pages 33 and 34).

**Daily Patterns**

Pages 35 and 36 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.

## 2019 Daily Rainfall (mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	12.9	0.0	3.3	1.8	24.6	0.0	5.8	0.0	1.8	5.3	46.2	0.3
2	0.0	0.0	1.3	0.0	2.8	0.0	15.0	4.1	11.9	0.3	1.0	1.0
3	18.2	0.0	3.1	0.0	4.6	18.5	39.6	1.3	1.5	0.0	0.3	0.0
4	0.0	0.0	9.7	0.3	1.0	0.5	0.0	37.3	0.0	15.5	0.0	5.6
5	0.0	0.0	6.9	0.5	4.8	0.3	0.0	0.0	40.4	0.0	1.5	10.7
6	0.0	0.0	3.6	1.8	4.1	2.0	0.0	37.1	0.0	0.0	50.3	31.0
7	1.0	0.0	20.6	0.3	9.7	0.0	0.3	0.3	95.3	0.0	4.6	11.2
8	0.0	0.0	2.0	0.0	101.4	0.0	1.0	0.3	0.3	11.9	19.8	1.0
9	0.0	0.0	3.8	0.0	0.0	0.5	38.9	1.0	0.3	1.0	35.1	2.5
10	0.0	1.0	1.8	4.6	0.0	6.4	2.3	12.2	0.0	29.0	7.9	0.0
11	10.7	0.0	34.8	0.0	0.0	12.7	0.0	45.0	6.4	11.4	1.3	13.0
12	3.8	0.0	1.0	0.0	0.0	4.8	0.0	88.4	26.9	30.0	18.8	9.1
13	0.0	1.0	0.0	0.0	0.0	14.7	9.4	14.7	1.8	21.8	0.0	0.8
14	0.7	0.0	0.0	0.0	0.0	41.4	42.9	25.1	0.0	0.5	0.0	0.0
15	0.0	0.0	0.0	0.3	0.0	38.1	0.3	0.8	50.8	1.8	12.4	0.0
16	3.1	0.0	15.0	1.3	15.2	5.6	9.4	0.0	0.3	0.0	3.3	0.0
17	0.0	0.0	17.3	11.4	0.0	3.0	0.0	0.0	0.0	0.0	17.8	2.8
18	7.5	0.0	5.8	1.5	40.9	42.7	19.3	0.0	7.4	0.0	1.3	0.0
19	2.3	0.0	5.3	0.0	6.6	9.4	30.2	0.0	1.5	14.7	22.9	41.1
20	0.0	0.0	6.4	16.3	53.8	21.6	2.3	0.0	0.3	7.1	0.0	2.8
21	6.7	0.0	9.9	5.6	5.3	4.8	20.6	17.0	11.9	0.0	0.0	32.0
22	0.0	8.6	0.0	14.2	2.3	3.0	0.8	0.0	0.0	0.0	0.0	25.9
23	3.1	25.4	3.1	0.0	0.0	65.8	27.7	0.0	0.0	6.9	0.0	5.8
24	9.1	28.7	0.0	0.0	5.3	65.8	25.9	0.0	0.0	5.6	9.9	0.8
25	1.8	3.8	30.2	0.0	5.3	0.3	31.5	2.5	3.3	6.1	5.6	256.8
26	2.5	16.8	0.8	0.0	0.8	4.8	16.0	0.0	0.0	0.5	3.0	37.3
27	0.0	5.1	2.8	0.3	48.3	18.5	1.0	0.0	0.0	0.3	12.2	0.8
28	0.0	4.3	0.3	1.0	1.5	66.3	4.1	40.4	1.8	10.9	150.9	56.4
29	0.0		0.8	98.6	0.0	0.3	6.6	0.5	6.1	11.9	15.0	9.9
30	7.1		22.4	165.4	0.0	5.6	0.5	2.0	3.8	0.5	7.6	0.0
31	7.1		0.3		0.0			0.0		2.3		0.0
	97.6	94.8	211.8	324.9	338.3	457.4	351.3	330.0	273.6	195.3	448.6	558.5

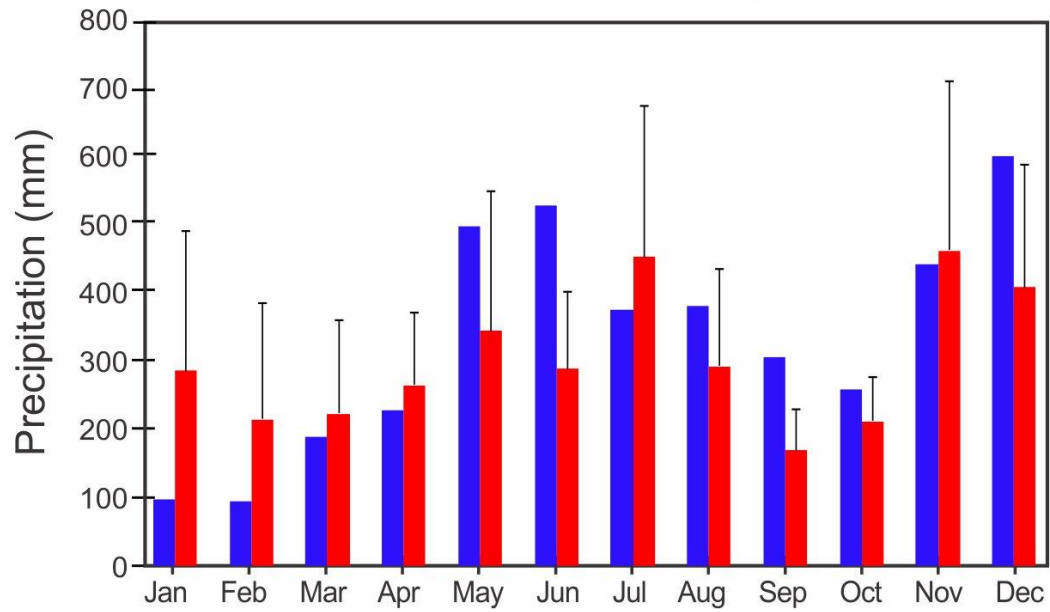
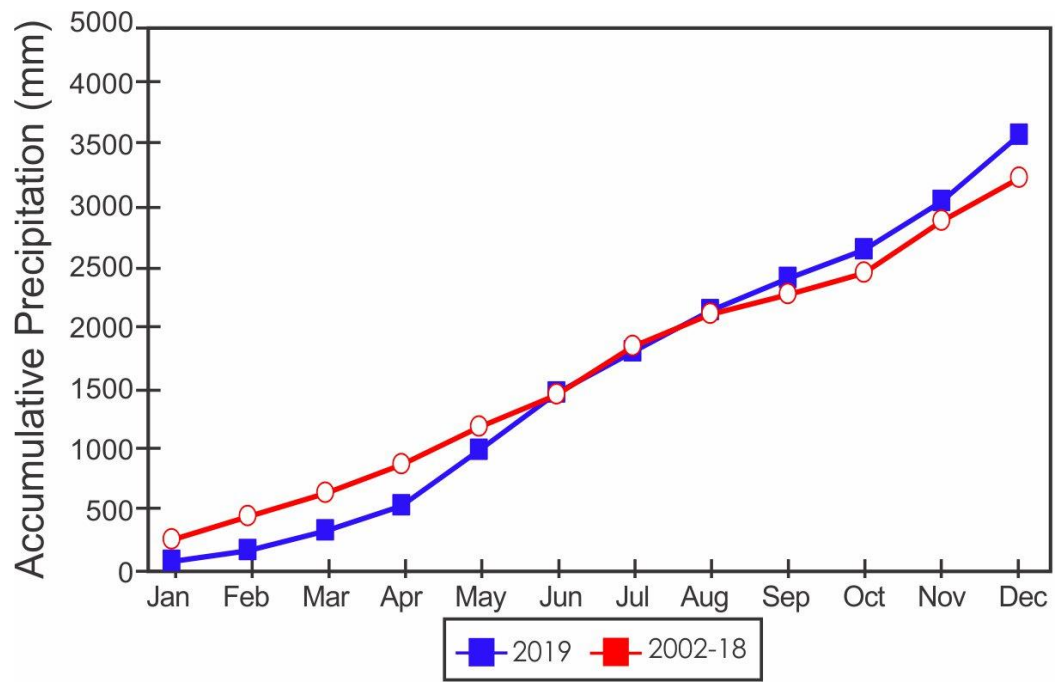


## Monthly Rainfall (mm)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
<b>2002</b>					116.8	248.9	642.6	624.8	175.3	198.1	665.5	193.0	
<b>2003</b>	94.0	109.2	116.8	236.2	591.8	226.1	271.8	304.8	68.6	111.8	213.4	576.6	2921.0
<b>2004</b>	116.8	160.0	279.4	396.2	614.7	344.3	292.9	342.6	160.8	205.0	783.3	662.8	4358.9
<b>2005</b>	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
<b>2006</b>	393.6	231.7	534.1	206.8	120.4	213.4	400.9	426.0	165.1	238.4	215.1	328.1	3473.6
<b>2007</b>	345.7	45.4	57.5	208.2	361.6	315.8	306.5	209.5	96.9	159.7	510.6	595.1	3212.5
<b>2008</b>	185.1	185.5	141.0	193.6	208.5	159.3	416.3	267.4	158.7	162.1	1209.2	231.6	3518.3
<b>2009</b>	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
<b>2010</b>	274.8	175.3	358.4	268.7	463.2	233.7	123.5	267.6	107.0	140.0	450.2	586.0	3448.4
<b>2011</b>	267.3	366.0	203.9	258.1	369.4	152.1	301.7	100.4	190.8	272.7	185.0	491.4	3158.8
<b>2012</b>	207.2	171.0	316.6	185.2	158.2	214.6	480.7	114.1	155.3	176.7	633.8	293.4	3106.8
<b>2013</b>	69.6	118.7	168.3	218.2	183.0	417.3	620.6	84.3	93.9	151.1	341.2	284.7	2750.9
<b>2014</b>	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
<b>2015</b>	480.4	239.2	197.5	422.3	820.7	302.4	572.3	441.2	261.1	187.0	282.5	415.1	4621.8
<b>2016</b>	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
<b>2017</b>	258.7	70.9	375.2	90.0	244.8	401.7	285.2	102.8	152.4	154.3	263.9	650.2	3050.1
<b>2018</b>	683.8	400.2	178.2	485.6	221.3	451.9	1140.9	210.8	203.2	275.0	427.0	133.1	4811.0
<b>2019</b>	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
<b>Mean</b>	286.3	215.7	223.6	265.6	345.0	289.0	454.4	293.5	169.4	211.8	463.2	409.3	3613.3
<b>sd</b>	205.5	170.2	137.0	106.0	205.4	115.4	221.0	142.8	59.6	65.2	248.4	181.0	613.0
<b>Min</b>	69.6	45.4	57.5	90.0	116.8	89.3	123.5	84.3	68.6	111.8	185.0	133.1	2750.9
<b>Max</b>	792.2	739.3	534.1	485.6	820.7	530.4	1140.9	624.8	306.3	378.6	1209.2	662.8	4811.0
<b>Rank*</b>	15	14	9	9	5	1	12	5	1	5	8	3	5

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

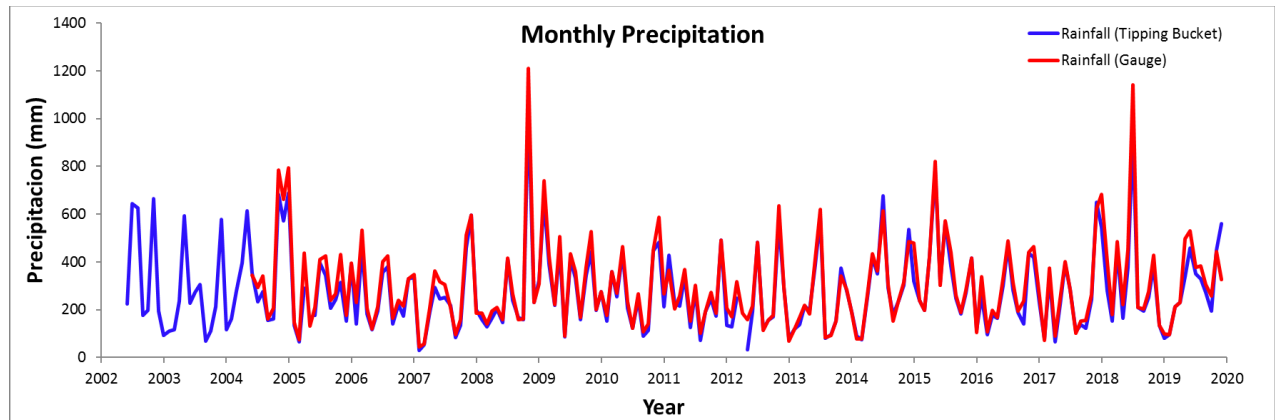
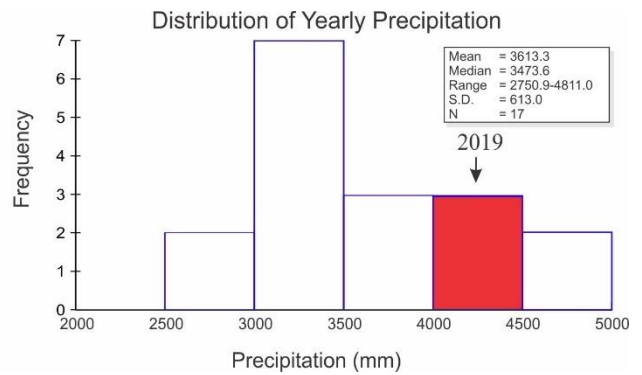
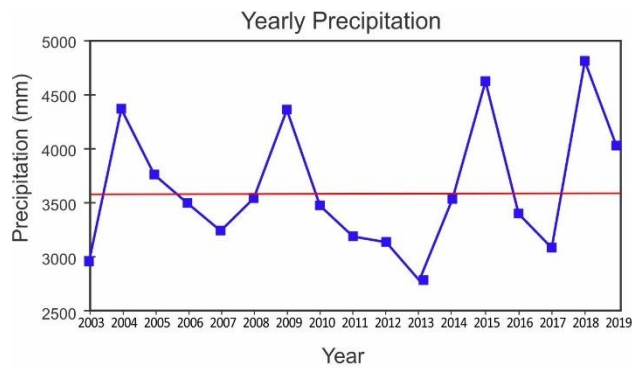
\* Rank of latest year compared to all other years. 1 = wettest



## Yearly Rainfall (mm)

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

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

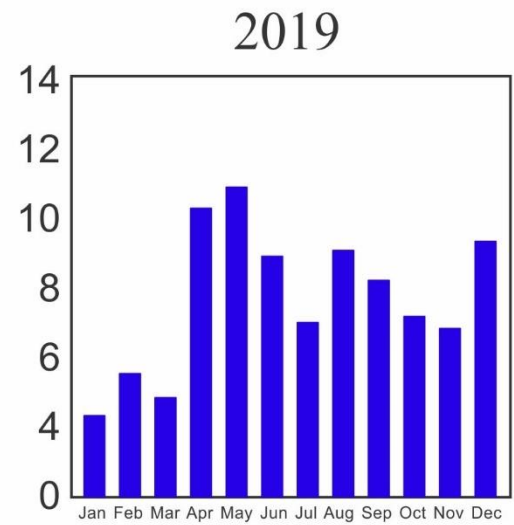
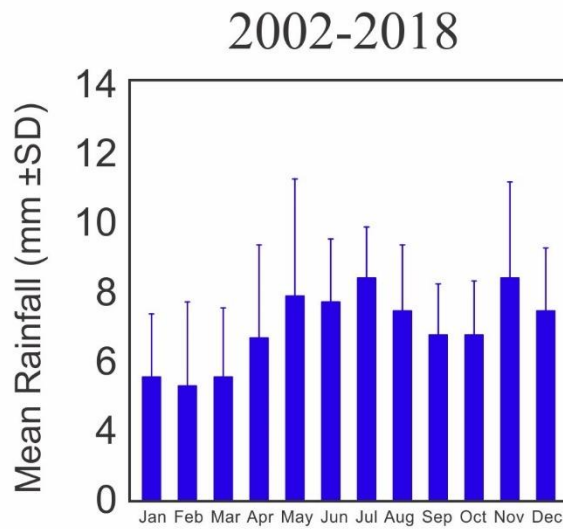


## Storm Analysis

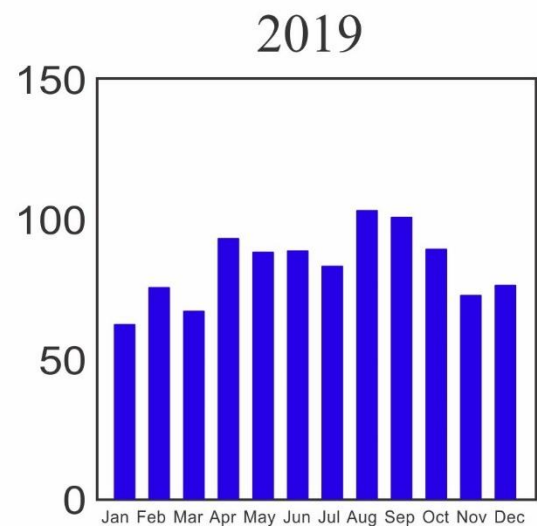
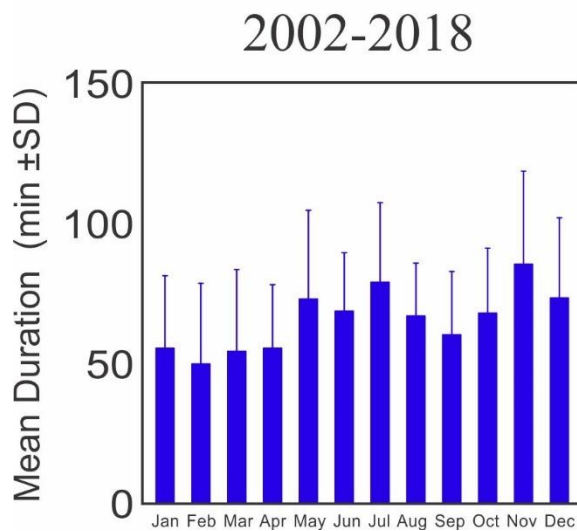
	Max. Rainfall per Storm (mm)			Storm Duration (min.)		
	2002-2018		2019	2002-2018		2019
	Mean	S.D.		Mean	S.D.	
<b>January</b>	46.4	33.4	<b>10.2</b>	61.0	26.6	<b>62.1</b>
<b>February</b>	36.6	37.4	<b>28.7</b>	51.5	26.2	<b>75.3</b>
<b>March</b>	41.3	37.9	<b>23.6</b>	55.7	26.6	<b>66.9</b>
<b>April</b>	41.2	27.3	<b>92.7</b>	59.1	22.5	<b>92.8</b>
<b>May</b>	51.2	38.9	<b>101.1</b>	72.8	33.2	<b>87.9</b>
<b>June</b>	59.9	31.8	<b>65.5</b>	73.8	25.0	<b>88.4</b>
<b>July</b>	69.6	38.4	<b>38.6</b>	82.2	28.1	<b>82.9</b>
<b>August</b>	52.7	22.5	<b>105.2</b>	67.9	17.7	<b>102.8</b>
<b>September</b>	38.4	12.8	<b>75.4</b>	63.6	21.9	<b>100.4</b>
<b>October</b>	42.9	17.4	<b>48.0</b>	72.1	28.6	<b>89.0</b>
<b>November</b>	71.0	57.2	<b>123.7</b>	87.0	31.4	<b>72.5</b>
<b>December</b>	62.7	37.0	<b>255.8</b>	72.5	27.2	<b>76.1</b>

	Av. Rainfall per Storm (mm)		
	2002-2018		2019
	Mean	S.D.	
<b>January</b>	4.3	2.1	<b>2.7</b>
<b>February</b>	3.8	2.7	<b>4.1</b>
<b>March</b>	4.1	2.2	<b>3.3</b>
<b>April</b>	5.6	3.1	<b>9.6</b>
<b>May</b>	6.7	3.8	<b>10.3</b>
<b>June</b>	6.8	2.2	<b>8.0</b>
<b>July</b>	7.8	2.1	<b>5.8</b>
<b>August</b>	6.2	2.2	<b>8.2</b>
<b>September</b>	5.8	1.9	<b>7.2</b>
<b>October</b>	5.7	2.0	<b>6.0</b>
<b>November</b>	7.5	3.1	<b>5.6</b>
<b>December</b>	6.1	2.2	<b>8.5</b>

## Average Monthly Storm Size

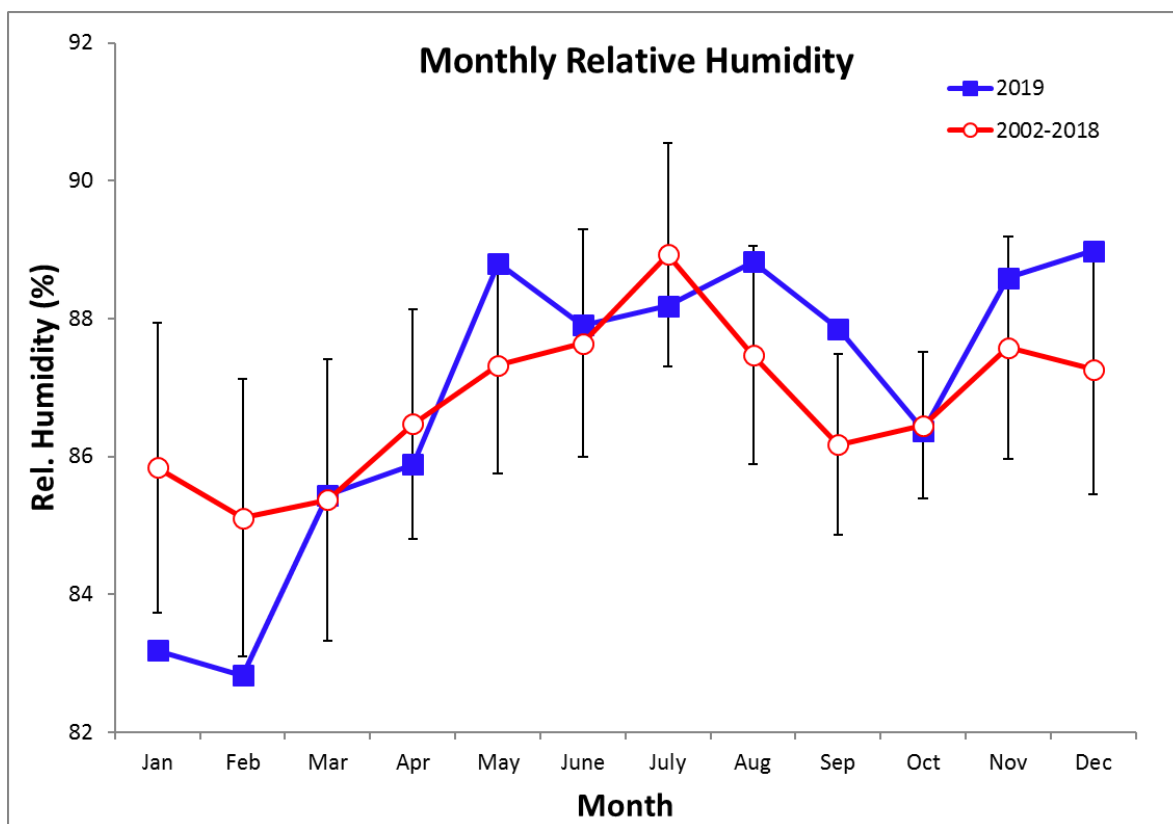


## Average Monthly Storm Duration



## Relative Humidity (%)

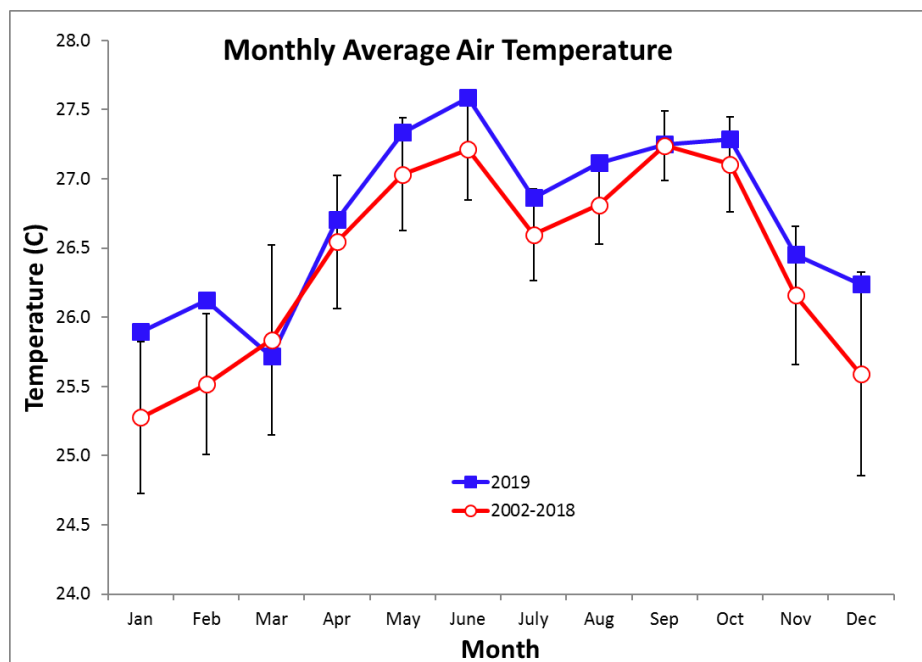
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2009								83.7	81.6	83.6	85.5	83.0
2010	83.0	87.4	87.5	87.4	87.8	86.3	87.2	87.6	85.8	85.5	87.3	89.2
2011	88.3	86.0	84.3	86.1	87.8	87.1	88.8	86.9	86.9	87.3	88.2	89.4
2012	87.1	85.8	87.3	88.5	85.7	86.0	88.4	86.7	86.6	86.5	90.1	88.6
2013	85.6	85.6	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
mean	85.8	85.1	85.4	86.5	87.3	87.6	88.9	87.5	86.2	86.5	87.6	87.3
sd	2.1	2.0	2.0	1.7	1.6	1.7	1.6	1.6	1.3	1.1	1.6	1.8
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
<b>2002</b>						26.9	26.3	26.2	27.6	26.9	26.4	
<b>2003</b>	25.7	26.2	27.1	27.3	27.1	27.2	26.7	26.6	27.6	27.6	26.9	25.4
<b>2004</b>	25.6	25.8	25.8	26.5	26.4	26.8	26.4	26.5	27.4	27.4	25.6	25.1
<b>2005</b>	24.4	25.0	27.3	26.3		28.2	27.5	27.0	27.1	27.5	25.9	25.9
<b>2006</b>	25.5	25.3	25.2	26.3	27.1	27.3	26.9	27.0	27.1	27.3	26.3	26.1
<b>2007</b>	25.3	26.1	26.5	27.0	27.2	27.3	26.8	27.1	27.1	27.2	25.9	25.3
<b>2008</b>	25.1	25.3	25.6	26.2	26.8	26.9	26.3	26.9	27.5	27.1	25.6	25.1
<b>2009</b>	25.0	24.5	24.9	26.2	26.7	27.2	26.5	26.7	27.5	26.9	26.1	26.2
<b>2010</b>	25.6	26.0	26.0	26.9	27.2	27.2	27.0	26.9	27.1	26.5	25.2	23.7
<b>2011</b>	24.6	25.1	25.2	25.7	26.8	27.2	26.5	27.0	26.9	26.4	25.6	24.7
<b>2012</b>	24.5	25.1	24.8		27.6	27.5	26.4	27.2	27.0	27.0	25.6	25.8
<b>2013</b>	25.9	25.7	25.8	26.7	26.8	26.8	26.5	27.0	27.6	27.2	26.6	26.0
<b>2014</b>	25.5	25.6	25.9	26.1	26.5	26.5	26.1	26.3	26.8	26.7	26.3	25.5
<b>2015</b>	25.2	25.6	25.7	26.5	26.6	27.2	26.4	26.8	27.1	27.6	27.1	26.9
<b>2016</b>	26.1	25.7	26.6	27.3	27.8	27.4	26.4	26.9	27.1	27.3	26.4	25.8
<b>2017</b>	25.5	26.0	25.7	27.1	27.6	27.3	26.4	27.1	27.5	27.3	26.5	25.1
<b>2018</b>	24.4	24.7	25.6	25.9	27.0	27.3	26.9	26.5	27.2	26.9	26.5	26.2
<b>2019</b>	25.9	26.1	25.7	26.7	27.3	27.6	26.9	27.1	27.3	27.3	26.5	26.2
<b>mean</b>	25.3	25.5	25.8	26.5	27.0	27.2	26.6	26.8	27.2	27.1	26.2	25.6
<b>sd</b>	0.5	0.5	0.7	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.5	0.7
<b>min</b>	24.4	24.5	24.8	25.7	26.4	26.5	26.1	26.2	26.8	26.4	25.2	23.7
<b>max</b>	26.1	26.2	27.3	27.3	27.8	28.2	27.5	27.2	27.6	27.6	27.1	26.9



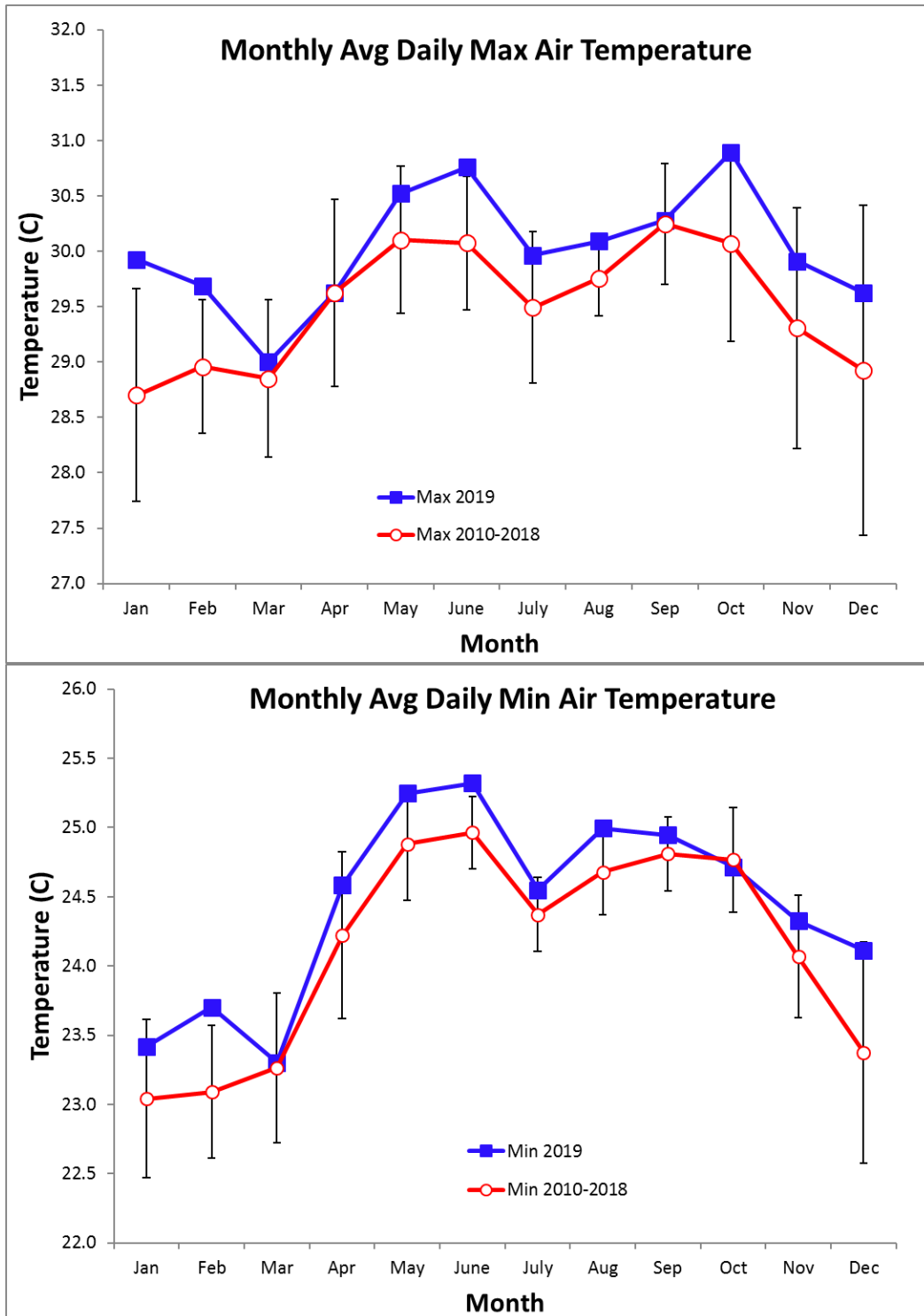
**Monthly Average of Daily Maximum Temperature**

<b>Year</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>July</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>2010</b>					29.9	29.9	29.4	29.5	29.9	29.0	27.8	26.1
<b>2011</b>	27.6	28.4	28.0	28.5	29.3	29.7	29.0	29.6	29.6	28.8	28.1	27.4
<b>2012</b>	27.6	28.3	27.6		30.4	30.2	29.1	29.9	29.7	29.7	27.9	28.5
<b>2013</b>	29.0	28.6	28.6	29.4	29.4	29.3	28.9	29.6	30.3	29.8	29.5	29.0
<b>2014</b>	28.3	28.5	28.7	28.7	29.2	29.0	28.5	29.1	29.5	29.2	28.9	28.3
<b>2015</b>	28.5	29.6	29.7	30.4	29.8	30.4	29.8	30.2	30.6	31.4	30.9	31.3
<b>2016</b>	30.2	29.5	29.7	31.0	31.1	30.6	30.0	29.8	31.0	30.8	30.0	29.8
<b>2017</b>	29.2	29.5	29.4	30.2	30.9	30.5	29.4	30.2	30.9	30.8	29.7	29.0
<b>2018</b>	27.9	28.7	28.9	29.1	30.5	30.5	30.9	29.7	30.7	30.4	30.3	30.4
<b>2019</b>	29.9	29.7	29.0	29.6	30.5	30.8	30.0	30.1	30.3	30.9	29.9	29.6
<b>mean</b>	28.7	29.0	28.8	29.6	30.1	30.1	29.5	29.8	30.2	30.1	29.3	28.9
<b>sd</b>	1.0	0.6	0.7	0.8	0.7	0.6	0.7	0.3	0.5	0.9	1.1	1.5
<b>min</b>	27.6	28.3	27.6	28.5	29.2	29.0	28.5	29.1	29.5	28.8	27.8	26.1
<b>max</b>	30.2	29.7	29.7	31.0	31.1	30.8	30.9	30.2	31.0	31.4	30.9	31.3

**Monthly Average of Daily Minimum Temperature**

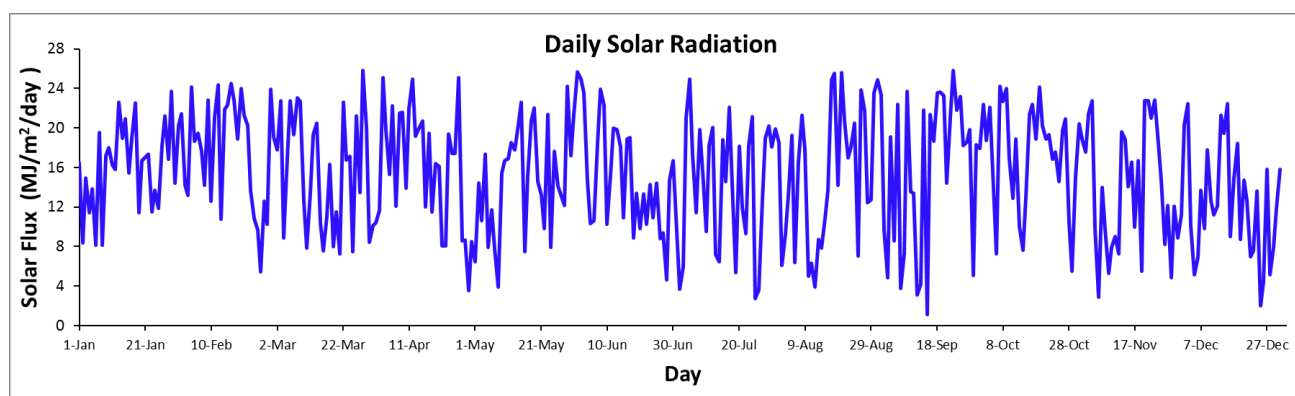
<b>Year</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>June</b>	<b>July</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
<b>2010</b>					24.9	24.9	24.9	24.7	24.9	24.3	23.2	21.8
<b>2011</b>	22.5	22.6	22.6	23.3	24.7	24.9	24.4	24.9	24.6	24.2	23.7	22.8
<b>2012</b>	22.2	22.8	22.6		25.3	25.2	24.1	24.8	24.7	24.7	23.8	23.8
<b>2013</b>	23.5	23.4	23.6	24.6	24.7	24.6	24.3	25.0	25.4	25.1	24.2	23.6
<b>2014</b>	23.4	23.1	23.4	24.0	24.3	24.5	24.4	24.1	24.4	24.5	24.3	23.4
<b>2015</b>	23.1	23.1	23.2	24.2	24.4	25.1	24.3	24.6	24.7	25.4	24.8	24.6
<b>2016</b>	23.8	23.3	24.4	24.8	25.5	25.2	23.9	24.7	24.7	25.1	24.2	23.6
<b>2017</b>	23.1	23.6	23.2	24.9	25.2	25.0	24.4	24.8	25.1	25.0	24.0	22.7
<b>2018</b>	22.4	22.2	23.2	23.4	24.6	24.9	24.5	24.1	24.7	24.6	24.2	23.5
<b>2019</b>	23.4	23.7	23.3	24.6	25.2	25.3	24.5	25.0	24.9	24.7	24.3	24.1
<b>mean</b>	23.0	23.1	23.3	24.2	24.9	25.0	24.4	24.7	24.8	24.8	24.1	23.4
<b>sd</b>	0.6	0.5	0.5	0.6	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.8
<b>min</b>	22.2	22.2	22.6	23.3	24.3	24.5	23.9	24.1	24.4	24.2	23.2	21.8
<b>max</b>	23.8	23.7	24.4	24.9	25.5	25.3	24.9	25.0	25.4	25.4	24.8	24.6

## Monthly Air Temperature (°C)



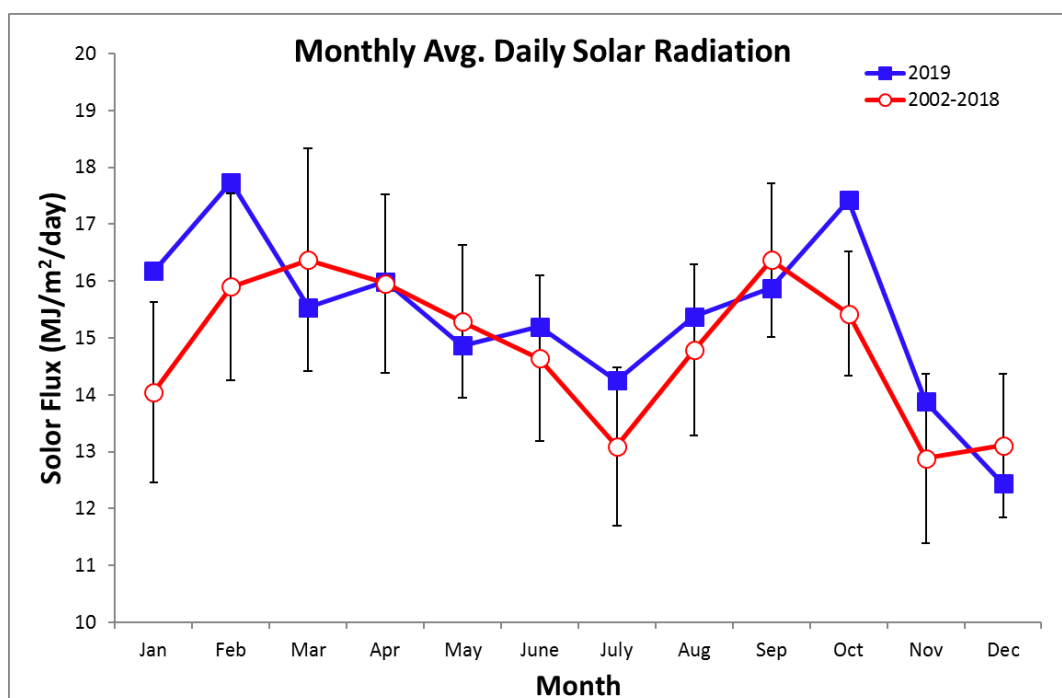
## 2019 Daily Total Radiation (MJ m<sup>-2</sup> day<sup>-1</sup>)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	16.4	21.5	19.1	10.4	6.4	25.6	11.0	18.5	23.3	17.9	18.9	11.2
2	8.4	14.2	17.8	11.6	14.4	24.9	3.7	6.1	9.7	22.3	17.6	20.4
3	14.9	13.2	22.7	25.1	10.6	23.6	6.0	9.3	4.9	18.7	21.4	22.4
4	11.5	24.1	8.9	19.8	17.3	14.6	21.0	13.1	19.1	22.1	22.7	10.1
5	13.9	18.7	17.0	15.3	7.9	10.3	24.9	19.3	8.5	15.5	9.9	5.1
6	8.1	19.4	22.7	22.2	11.7	10.6	17.3	6.4	22.4	7.2	2.9	6.9
7	19.5	17.6	19.3	12.1	7.7	18.5	11.4	16.5	3.8	24.2	14.0	13.7
8	8.1	14.2	23.1	21.5	3.9	23.9	19.9	21.3	7.3	22.7	9.8	9.8
9	17.2	22.8	22.7	21.6	15.5	22.3	15.6	17.8	23.7	24.0	5.3	17.7
10	18.0	12.6	12.6	13.9	16.7	10.3	9.5	5.0	13.5	16.8	7.9	12.7
11	16.2	21.1	7.8	22.0	16.9	15.2	18.2	6.3	13.4	12.9	9.0	11.2
12	15.8	24.4	13.4	25.0	18.5	20.0	20.0	3.9	3.1	18.8	7.2	12.0
13	22.6	10.7	19.3	19.2	17.8	19.8	7.2	8.7	4.2	10.0	19.6	21.3
14	18.9	21.8	20.5	20.0	20.3	18.1	6.5	7.8	21.8	7.6	18.8	19.5
15	20.9	22.3	10.4	20.7	22.6	10.9	18.8	10.8	1.1	13.1	14.0	22.5
16	15.4	24.5	7.5	12.0	7.5	18.9	14.5	13.7	21.3	21.4	16.5	9.0
17	18.9	22.8	11.1	19.4	15.2	19.0	22.1	24.8	18.7	22.4	10.0	14.9
18	22.6	18.9	16.3	11.5	20.8	8.9	14.4	25.5	23.6	18.9	16.7	18.4
19	11.4	24.0	8.0	16.4	22.0	13.4	5.3	14.2	23.6	24.2	5.5	8.7
20	16.7	21.3	11.5	16.1	14.5	9.8	18.1	25.6	23.3	20.2	22.8	14.7
21	17.0	20.3	7.3	8.0	13.2	13.3	11.9	20.7	14.4	18.8	22.8	12.7
22	17.3	13.7	22.6	8.1	9.8	10.2	9.3	17.0	21.1	19.3	21.0	7.0
23	11.5	10.8	16.8	19.4	21.4	14.2	18.2	18.1	25.8	16.9	22.8	7.5
24	13.7	9.7	17.2	17.4	7.9	10.9	21.2	20.5	21.8	17.6	18.5	13.6
25	11.9	5.5	7.5	17.4	17.6	14.4	2.8	7.1	23.2	14.6	14.7	2.0
26	18.3	12.6	21.2	25.1	14.2	8.8	3.6	23.8	18.3	19.7	8.2	4.4
27	21.2	10.2	13.5	8.6	13.3	9.4	12.7	21.7	18.6	20.9	12.2	15.8
28	16.9	23.9	25.8	8.7	12.1	4.6	18.9	12.5	19.8	10.4	4.8	5.1
29	23.7		20.1	3.5	24.2	14.7	20.2	12.7	5.1	5.5	12.0	7.9
30	14.4		8.4	8.5	17.2	16.7	18.1	23.5	18.3	15.1	8.9	11.8
31	20.2		10.1		21.4		19.9	24.9		20.4		15.8



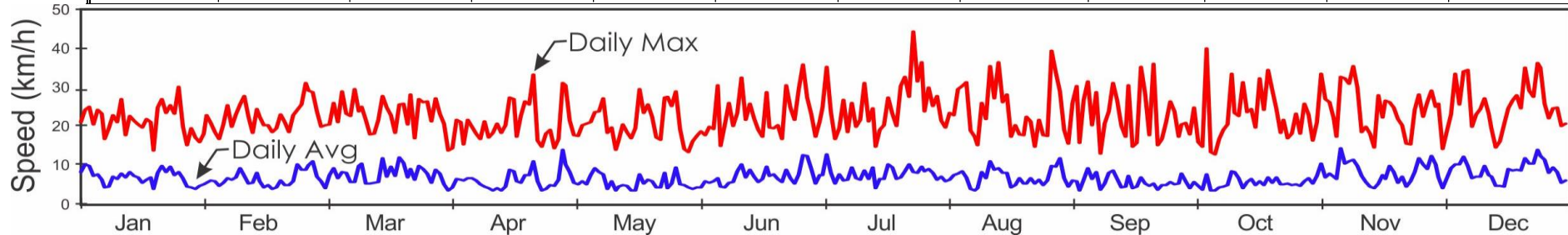
## Monthly Average Total Daily Solar Radiation ( $\text{MJ m}^{-2} \text{ day}^{-1}$ )

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
mean	14.0	15.9	16.4	16.0	15.3	14.6	13.1	14.8	16.4	15.4	12.9	13.1
sd	1.6	1.6	2.0	1.6	1.3	1.5	1.4	1.5	1.4	1.1	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	16.3	18.0	19.9	18.8	17.6	17.9	15.8	17.8	18.3	17.4	15.9	15.9



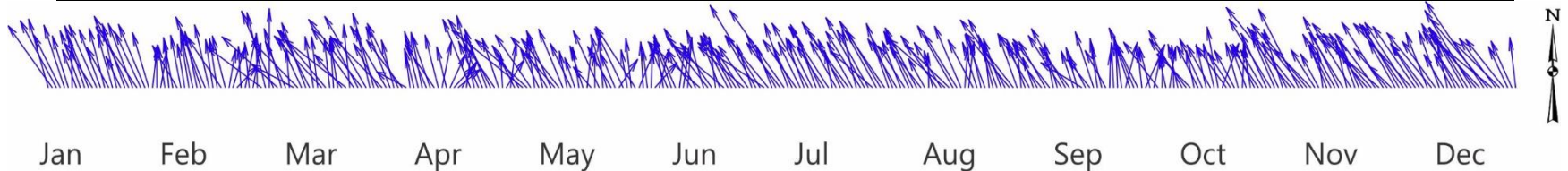
## 2019 Daily Average Wind Speed (km/h)

	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	8.7	21.3	6.0	23.1	6.4	20.1	3.9	14.1	8.7	21.8	4.8	17.8	7.9	21.6	6.3	19.9	6.4	26.2	6.0	25.0	10.8	33.6	4.6	14.6
2	10.6	24.4	6.5	21.2	4.5	20.6	4.8	14.6	5.9	18.0	4.8	18.9	7.8	25.0	6.7	23.7	6.3	30.5	5.1	16.2	7.3	27.2	7.1	18.9
3	10.1	25.3	6.3	18.7	7.8	20.8	6.9	21.9	5.4	17.9	6.3	18.0	13.1	35.3	7.8	23.1	3.9	16.1	4.1	15.2	8.2	26.5	9.7	23.4
4	7.7	20.8	5.2	17.1	9.6	26.2	6.7	21.3	6.3	20.6	6.0	20.2	8.5	23.8	8.2	29.7	6.8	26.9	8.0	40.2	7.5	22.4	10.7	33.6
5	8.1	24.6	5.9	20.7	7.1	21.4	6.5	15.6	5.6	20.9	6.2	19.7	5.8	17.1	8.9	30.6	9.6	31.7	4.0	13.8	6.8	17.6	10.6	25.8
6	6.6	23.5	7.1	25.6	8.6	29.1	7.0	21.9	7.9	21.3	7.0	30.8	8.0	19.8	7.2	31.5	7.0	20.5	3.9	13.2	14.7	32.9	12.6	34.2
7	4.8	17.0	6.8	20.2	8.4	23.6	7.1	20.1	9.7	23.9	4.9	15.3	6.5	27.0	4.4	19.2	8.5	28.9	4.8	17.0	10.9	32.5	10.3	34.6
8	5.0	19.8	7.2	23.2	6.1	22.8	6.5	18.4	8.7	24.0	4.7	20.6	6.6	18.9	4.0	17.7	4.2	13.4	4.9	19.4	11.5	31.2	7.2	20.2
9	7.5	23.1	9.7	25.8	6.0	29.7	5.6	17.1	8.0	27.5	5.9	26.3	9.8	26.2	4.5	15.4	5.7	21.0	5.3	20.7	11.7	35.7	7.5	23.3
10	6.8	21.3	7.7	27.9	10.3	24.0	5.0	21.6	4.4	18.6	6.1	20.3	7.0	20.1	8.7	26.1	8.4	24.1	8.8	33.7	10.2	30.1	7.4	24.7
11	8.3	27.2	5.7	22.7	10.8	25.3	4.6	17.4	6.3	19.9	8.8	23.6	6.8	22.0	7.0	22.1	9.1	31.3	8.6	23.6	7.7	18.8	10.1	27.4
12	7.3	18.1	5.8	18.5	5.8	22.0	4.0	18.6	3.9	14.3	10.5	32.7	9.0	31.3	11.4	35.5	7.0	26.8	7.0	23.0	6.1	20.2	7.9	23.4
13	8.7	22.9	8.4	24.7	5.7	18.3	4.4	21.0	4.8	16.6	7.3	21.9	6.8	21.5	9.2	27.3	4.8	20.4	4.5	31.5	5.0	18.4	7.5	19.6
14	7.7	21.7	6.4	22.6	5.9	18.3	4.0	18.6	5.3	20.8	9.2	26.1	9.9	24.8	9.5	36.5	5.0	17.7	6.1	23.9	4.5	15.0	5.1	14.9
15	7.4	20.8	4.6	20.6	6.1	21.8	5.0	20.6	5.1	18.8	7.5	22.4	4.5	15.0	8.4	26.4	7.7	30.8	6.9	24.6	5.8	28.3	5.2	16.4
16	6.0	20.0	5.3	20.5	12.2	27.9	9.3	27.6	3.9	17.3	6.0	19.5	7.0	19.3	8.5	28.3	4.6	15.0	5.3	20.0	7.9	22.4	4.9	20.7
17	6.7	22.2	4.3	18.8	7.4	25.1	8.9	27.2	4.0	19.8	6.9	17.6	6.8	20.5	4.7	17.5	5.0	16.1	6.4	32.5	6.9	26.8	9.5	24.8
18	7.3	21.3	4.8	19.8	10.1	23.1	6.4	17.5	8.0	29.6	10.0	28.9	10.6	27.6	5.4	20.5	7.2	35.3	5.4	24.4	10.3	26.5	9.1	26.8
19	4.4	14.2	6.4	23.3	7.7	18.6	6.0	22.9	5.8	23.6	7.6	19.9	9.9	23.5	7.0	18.3	5.8	28.6	7.3	34.7	8.7	25.1	9.2	28.1
20	8.4	25.0	5.3	21.3	12.3	25.9	7.8	26.6	6.8	25.9	8.1	19.7	6.9	20.4	5.8	18.0	5.2	18.1	5.9	29.5	5.8	22.1	8.9	24.9
21	10.3	27.2	5.3	18.8	11.0	25.9	7.8	25.9	6.3	22.8	6.9	20.5	7.2	30.5	5.7	22.7	5.6	36.2	7.2	24.6	7.4	20.5	12.2	35.2
22	8.6	23.6	6.3	23.1	7.3	20.7	11.4	33.4	4.7	17.4	6.1	17.0	8.9	32.9	7.1	21.5	4.1	15.4	5.6	18.7	4.9	16.0	10.8	29.3
23	10.1	25.5	10.6	24.5	9.4	28.3	6.4	16.7	4.6	16.8	9.3	30.8	10.6	27.8	5.7	15.0	5.2	17.0	5.5	21.9	6.3	15.7	10.8	27.9
24	7.9	23.4	9.3	25.8	6.7	17.3	3.9	15.1	8.5	27.5	7.1	25.1	8.7	44.3	6.6	22.0	5.2	21.3	5.6	17.2	8.6	24.5	14.3	36.3
25	8.7	30.2	9.2	31.2	10.2	27.2	4.4	18.4	4.5	27.8	5.7	21.9	8.4	31.6	5.2	18.1	6.1	26.6	5.2	18.3	12.2	28.3	12.8	35.3
26	7.0	20.4	10.5	29.4	9.5	26.3	5.3	19.3	5.8	25.4	8.1	29.8	10.1	36.7	6.4	17.9	5.6	24.1	5.6	23.6	10.5	22.8	11.8	26.0
27	5.0	15.6	11.4	29.0	8.2	26.7	5.2	14.8	9.9	29.2	13.0	36.1	8.8	24.1	10.2	39.6	5.8	17.5	5.2	18.4	9.4	26.5	8.5	22.4
28	4.7	19.8	7.5	24.0	5.9	21.5	6.7	17.0	5.6	19.5	12.8	27.7	9.5	30.2	9.9	34.1	8.2	20.7	6.3	26.0	12.7	29.4	9.9	24.9
29	4.3	17.5			9.2	27.4	14.2	31.3	5.3	14.6	9.5	23.3	8.4	25.4	12.2	29.1	6.3	21.1	7.0	23.3	10.5	25.2	8.7	25.0
30	5.0	16.2			8.3	23.4	10.6	30.8	4.7	13.8	5.7	17.5	6.6	28.0	7.1	19.4	4.5	18.1	5.8	16.6	7.3	25.9	5.8	20.3
31	5.6	18.4			5.5	20.9			4.3	16.4			7.6	21.7	5.0	15.8			7.7	21.3			6.5	21.0



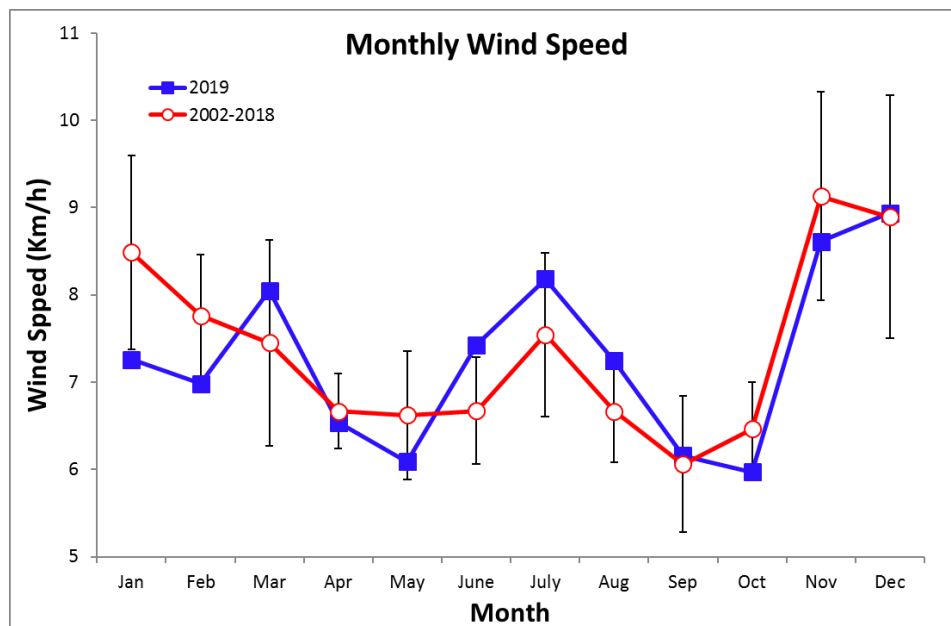
## 2019 Average Daily Wind Direction (°)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	336.1	344.3	326.4	348.0	314.4	53.6	319.7	328.8	329.5	34.2	317.5	302.3
2	312.5	318.6	353.0	339.4	347.0	21.2	311.4	316.2	319.8	338.3	326.7	318.9
3	320.4	343.6	289.7	340.0	324.5	345.9	313.3	326.2	332.0	18.2	324.9	318.3
4	322.3	345.4	303.9	343.0	338.5	328.0	330.8	322.6	320.0	311.0	333.8	313.9
5	333.2	346.6	324.5	327.8	318.6	330.6	324.6	321.2	309.7	2.6	320.6	315.2
6	334.8	341.4	330.8	332.1	326.9	327.1	313.3	310.5	319.0	341.7	309.3	306.1
7	358.3	342.0	322.2	314.2	307.1	11.8	323.6	319.3	311.1	12.3	310.1	313.7
8	330.8	333.0	345.8	339.2	310.4	12.3	330.8	358.0	342.4	355.3	322.4	315.2
9	331.4	327.9	349.8	16.8	327.9	7.4	319.7	339.9	335.5	340.8	309.3	311.7
10	333.7	340.9	305.6	340.4	342.9	315.6	323.2	313.4	315.9	318.4	308.5	329.6
11	329.7	346.8	308.2	34.7	324.4	321.2	330.6	317.9	318.8	310.8	304.5	309.0
12	316.3	346.9	350.9	54.1	332.6	300.2	324.4	299.6	311.3	303.6	316.3	312.6
13	326.4	314.3	353.7	61.4	346.3	336.0	314.6	302.6	332.8	341.9	320.8	331.1
14	330.9	339.6	346.5	40.6	334.7	309.8	315.6	319.0	336.8	322.3	347.4	318.1
15	338.6	15.0	308.8	12.3	10.6	313.2	343.1	317.1	291.8	324.9	327.4	341.1
16	320.7	23.8	297.2	328.7	307.3	349.1	319.3	327.1	321.5	341.0	321.4	322.4
17	337.0	55.5	351.4	339.8	359.2	330.6	325.0	6.5	309.6	320.4	320.0	321.2
18	340.6	354.2	312.8	326.7	325.3	299.0	315.5	9.2	333.4	339.3	322.7	315.4
19	324.1	17.6	321.1	327.5	352.4	322.1	312.6	321.6	346.9	344.5	317.2	319.5
20	331.6	351.2	310.1	330.6	335.0	321.5	319.6	334.0	339.6	29.7	340.2	316.6
21	323.8	14.7	318.8	322.9	318.8	317.1	339.7	339.8	319.5	312.3	317.2	317.5
22	330.0	358.4	340.6	314.1	327.3	316.0	316.8	330.3	2.4	315.8	331.9	309.8
23	314.3	296.2	336.7	333.4	45.3	300.7	320.2	350.6	355.7	320.8	328.2	305.0
24	324.8	339.6	320.1	354.8	324.1	312.8	320.2	336.9	356.5	337.1	316.6	314.4
25	327.7	0.1	304.0	44.1	346.6	331.9	299.5	331.4	347.3	4.3	307.6	308.4
26	335.9	327.7	318.8	10.7	350.6	318.1	319.9	331.2	21.4	330.6	306.5	298.7
27	9.4	301.1	329.1	322.3	315.5	317.3	318.3	320.9	333.1	346.4	311.8	311.6
28	359.7	336.1	338.2	316.4	31.7	294.0	314.0	309.5	327.9	323.0	299.2	303.1
29	14.6		323.8	298.0	354.9	309.1	332.5	310.2	323.3	314.9	316.2	309.8
30	346.4		311.4	301.4	350.2	329.9	327.7	331.7	351.0	318.5	307.6	324.7
31	351.2		289.2		2.7		318.0	351.3		324.8		326.1



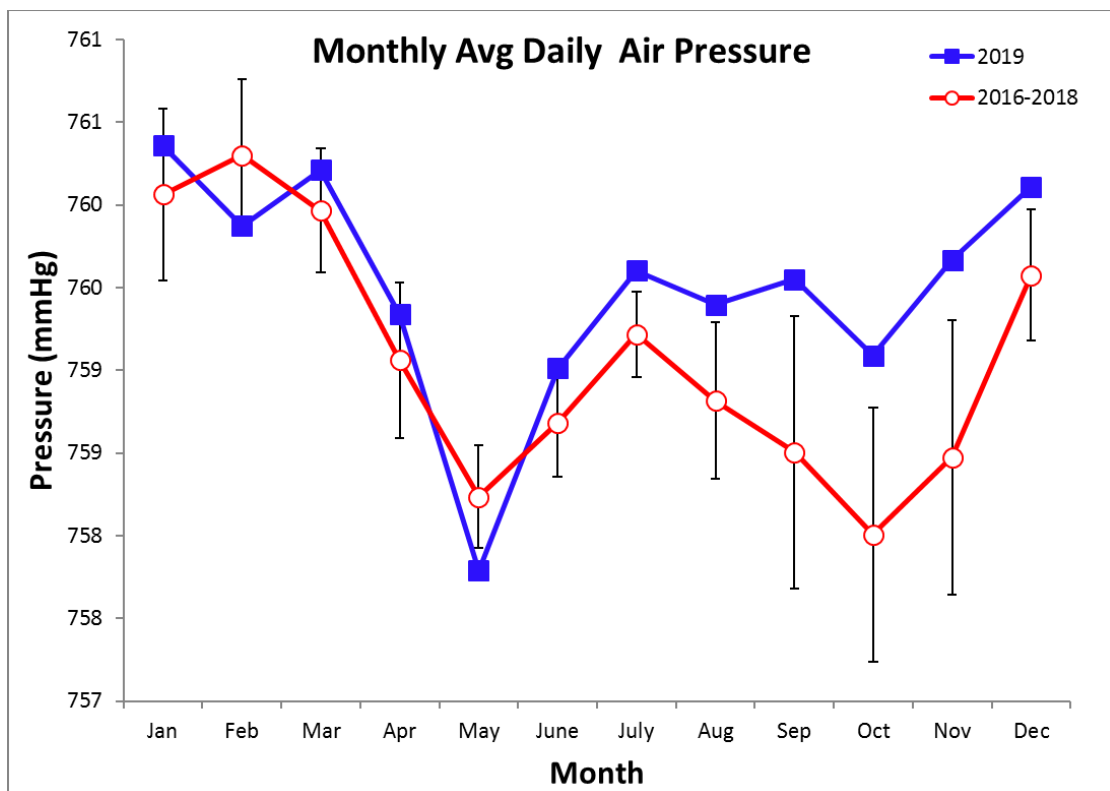
## Average Monthly Wind Speed (km/h) and Direction (°)

	Long-term Av.			2019		
	Speed	Sp max	Dir.	Speed	Sp max	Dir.
<b>January</b>	8.5	24.0	324.6	<b>7.3</b>	<b>21.7</b>	<b>333.0</b>
<b>February</b>	7.8	23.3	330.1	<b>7.0</b>	<b>22.9</b>	<b>343.7</b>
<b>March</b>	7.5	23.0	333.9	<b>8.0</b>	<b>23.6</b>	<b>324.4</b>
<b>April</b>	6.7	21.8	337.7	<b>6.5</b>	<b>20.9</b>	<b>342.4</b>
<b>May</b>	6.6	22.3	333.4	<b>6.1</b>	<b>21.0</b>	<b>332.2</b>
<b>June</b>	6.7	22.9	333.7	<b>7.4</b>	<b>23.0</b>	<b>325.5</b>
<b>July</b>	7.5	24.4	329.6	<b>8.2</b>	<b>25.6</b>	<b>320.8</b>
<b>August</b>	6.7	23.2	330.5	<b>7.2</b>	<b>23.9</b>	<b>326.3</b>
<b>September</b>	6.1	22.7	334.4	<b>6.2</b>	<b>23.2</b>	<b>328.2</b>
<b>October</b>	6.5	22.9	331.8	<b>6.0</b>	<b>23.0</b>	<b>333.1</b>
<b>November</b>	9.1	26.3	321.6	<b>8.6</b>	<b>24.9</b>	<b>318.4</b>
<b>December</b>	8.9	25.3	320.7	<b>8.9</b>	<b>25.3</b>	<b>315.2</b>



## 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
mean	760.1	760.3	760.0	759.1	758.2	758.7	759.2	758.8	758.5	758.0	758.5	759.6
sd	0.5	0.5	0.4	0.5	0.3	0.3	0.3	0.5	0.8	0.8	0.8	0.4
min	759.5	759.9	759.6	758.6	757.8	758.2	759.0	758.3	757.7	757.4	757.8	759.2
max	760.4	760.8	760.4	759.6	758.5	759.0	759.6	759.4	759.5	759.1	759.7	760.1



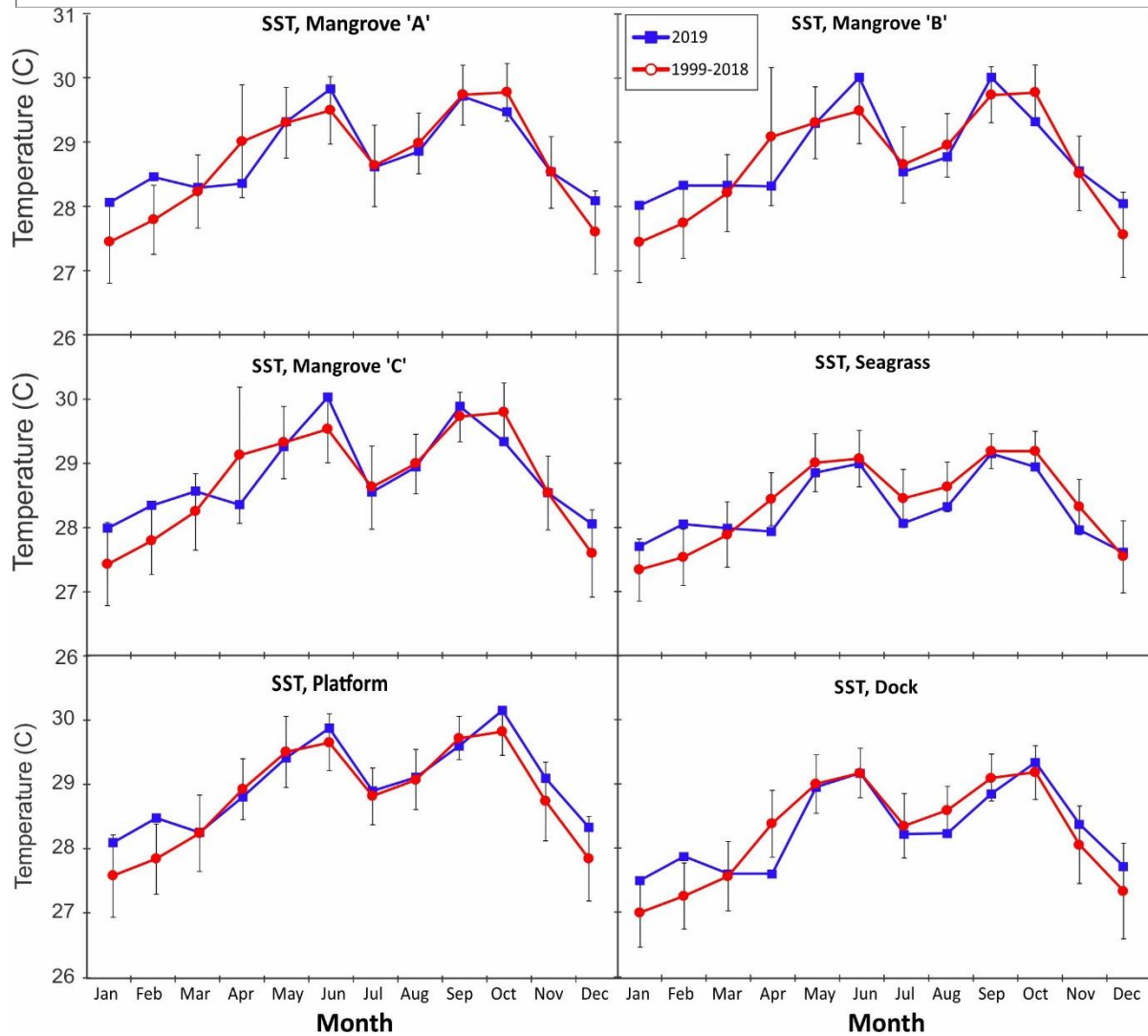
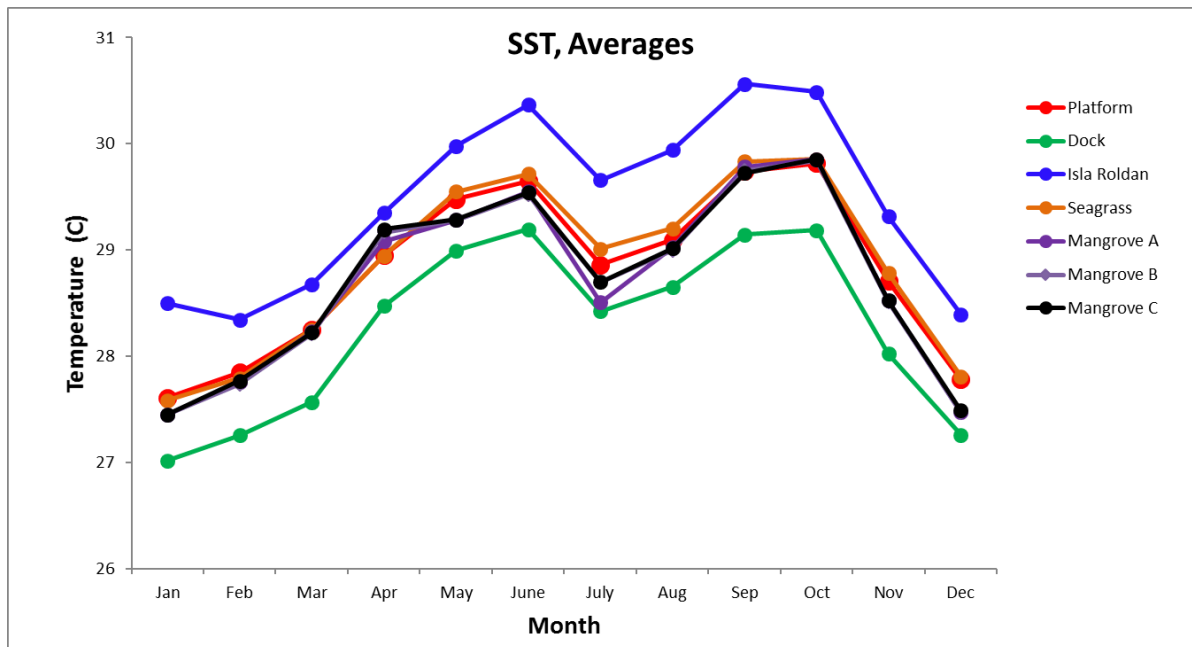
## Average Sea Surface Temperature (°C)

Long-term Average Monthly Temperatures (1999-2018)

	Mangrove			Sea grass	Platform	Dock
	'A'	'B'	'C'			
<b>January</b>	27.4	27.4	27.4	27.5	27.6	27.0
<b>February</b>	27.7	27.7	27.7	27.8	27.8	27.2
<b>March</b>	28.2	28.2	28.2	28.2	28.2	27.6
<b>April</b>	29.1	29.1	29.2	28.9	28.9	28.4
<b>May</b>	29.3	29.3	29.3	29.6	29.5	29.0
<b>June</b>	29.5	29.5	29.5	29.7	29.6	29.2
<b>July</b>	28.6	28.7	28.6	28.9	28.8	28.4
<b>August</b>	29.0	29.0	29.0	29.2	29.1	28.6
<b>September</b>	29.8	29.7	29.7	29.8	29.7	29.1
<b>October</b>	29.8	29.8	29.8	29.8	29.8	29.2
<b>November</b>	28.5	28.5	28.5	28.8	28.7	28.0
<b>December</b>	27.5	27.5	27.5	27.8	27.8	27.3

Average Monthly Temperatures (2019)

	Mangrove			Sea grass	Platform	Dock
	'A'	'B'	'C'			
<b>January</b>	28.0	28.0	28.0	28.0	28.1	27.5
<b>February</b>	28.5	28.3	28.3	28.4	28.5	27.9
<b>March</b>	28.3	28.3	28.6	28.4	28.3	27.6
<b>April</b>	28.3	28.3	28.3	28.3	28.8	27.6
<b>May</b>	29.3	29.3	29.3	29.4	29.4	29.0
<b>June</b>	29.9	30.0	30.0	29.6	29.9	29.2
<b>July</b>	28.6	28.5	28.5	28.4	28.9	28.2
<b>August</b>	28.9	28.8	28.9	28.8	29.1	28.2
<b>September</b>	29.7	30.0	29.9	29.8	29.6	28.9
<b>October</b>	29.5	29.3	29.3	29.5	30.1	29.3
<b>November</b>	28.5	28.6	28.5	28.3	29.1	28.4
<b>December</b>	28.1	28.0	28.0	27.9	28.3	27.7



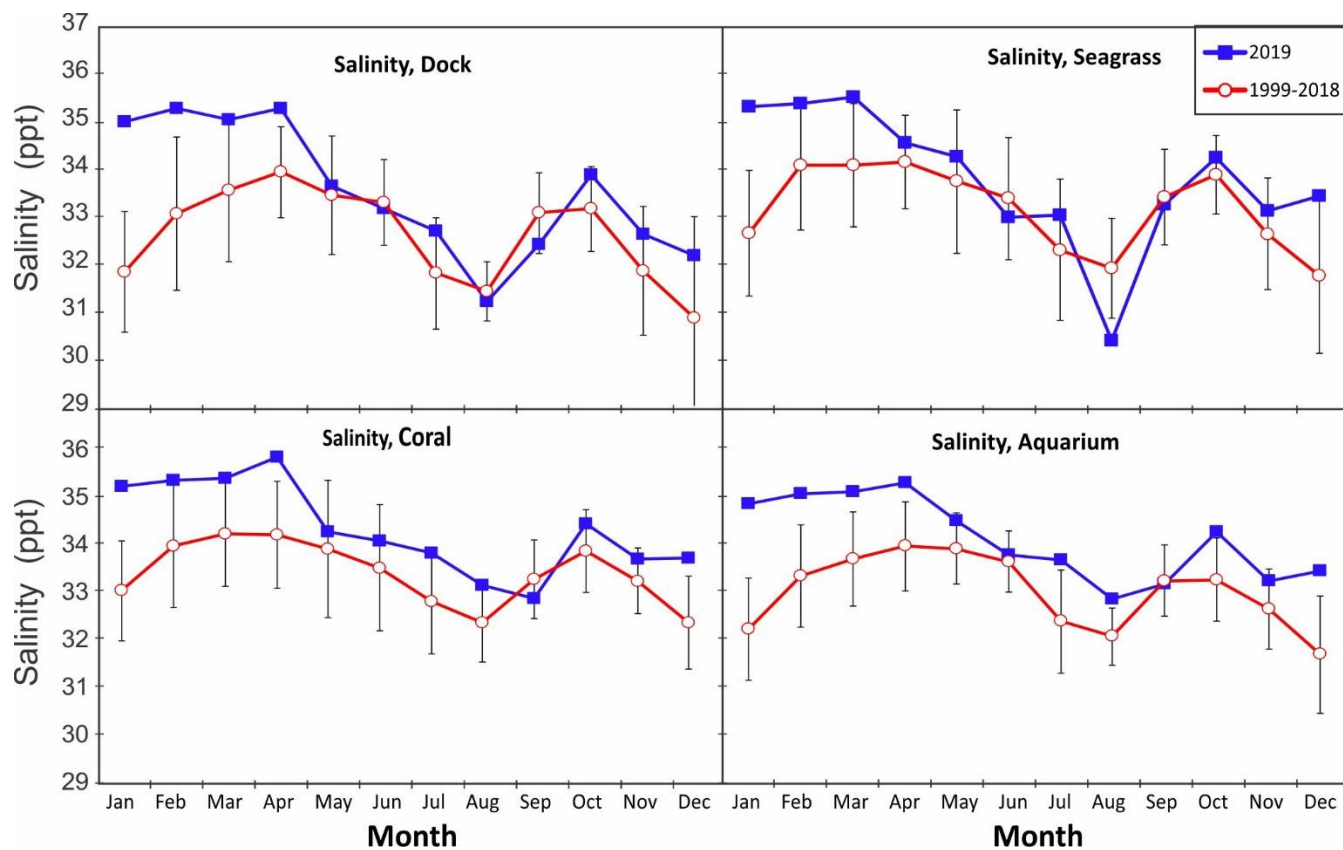
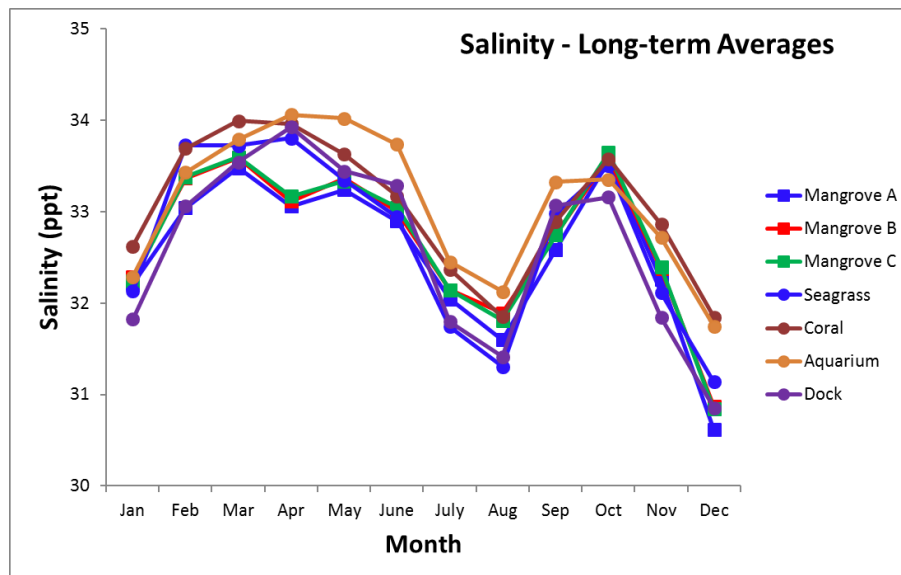
## Average Salinity (ppt)

### Long-term Average Monthly Salinity (1999-2018)

	Mangrove			Aquarium	Coral	Dock	Seagrass
	'A'	'B'	'C'				
<b>January</b>	32.2	32.1	32.5	31.6	32.0	32.1	31.6
<b>February</b>	33.0	33.3	33.6	32.9	33.7	33.3	32.9
<b>March</b>	33.5	33.6	33.9	33.4	33.6	33.6	33.4
<b>April</b>	33.1	33.9	33.8	33.8	33.7	33.9	33.8
<b>May</b>	33.2	34.0	33.6	33.4	33.3	34.0	33.4
<b>June</b>	32.9	33.7	33.1	33.3	32.9	33.7	33.3
<b>July</b>	32.0	32.5	32.4	31.8	31.9	32.5	31.8
<b>August</b>	31.6	32.1	31.8	31.4	31.4	32.1	31.4
<b>September</b>	32.6	33.4	33.0	33.2	33.0	33.4	33.2
<b>October</b>	33.6	33.3	33.6	33.2	33.5	33.3	33.2
<b>November</b>	32.3	32.7	32.9	31.8	32.1	32.7	31.8
<b>December</b>	30.6	31.5	31.6	30.6	30.9	31.5	30.6

### Average Monthly Salinity (2019)

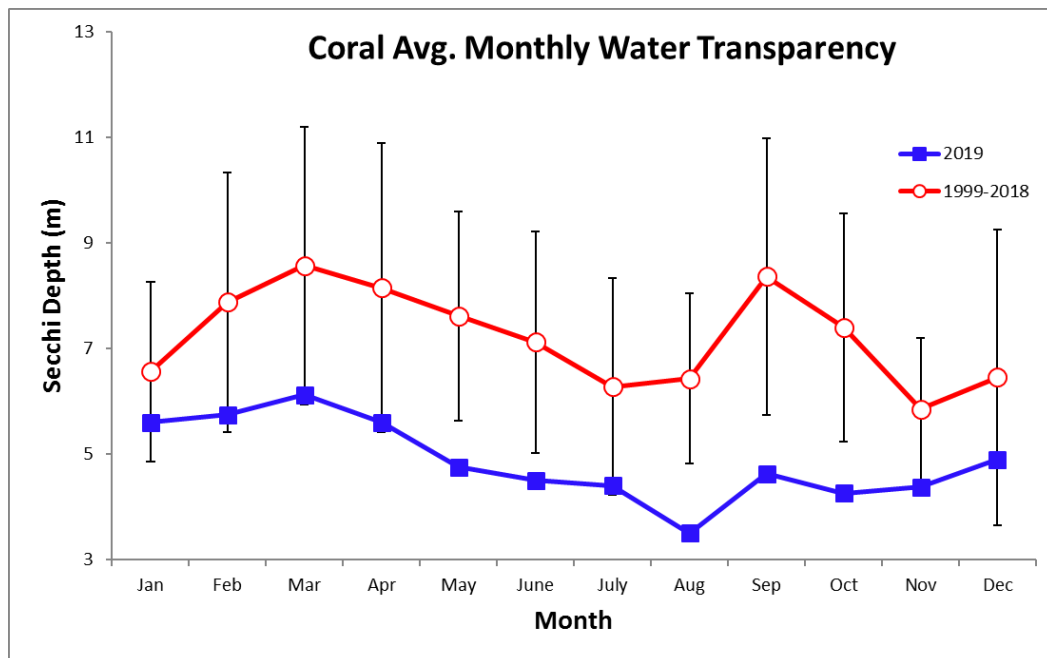
	Sea grass	Coral	Aquarium	Dock
<b>January</b>	31.5	31.9	32.1	31.2
<b>February</b>	33.1	33.4	33.2	32.7
<b>March</b>	34.2	34.3	34.4	34.2
<b>April</b>	34.4	34.5	34.6	34.1
<b>May</b>	34.0	34.1	34.1	34.1
<b>June</b>	33.7	33.6	33.6	33.2
<b>July</b>	28.1	30.8	31.4	30.0
<b>August</b>	31.3	32.1	31.9	31.2
<b>September</b>	32.2	32.1	32.5	32.4
<b>October</b>	32.5	32.4	32.7	32.5
<b>November</b>	31.2	31.9	32.2	31.5
<b>December</b>	33.6	33.8	33.5	33.4



## Average Water Transparency (Secchi depth)

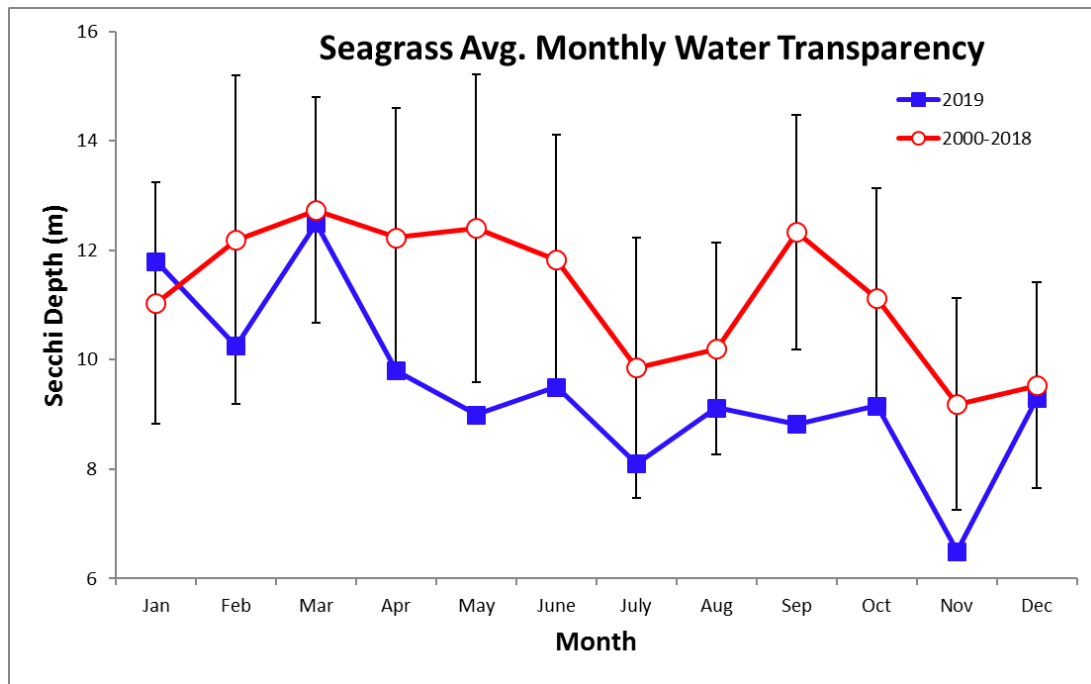
### Coral

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
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	9.7
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
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



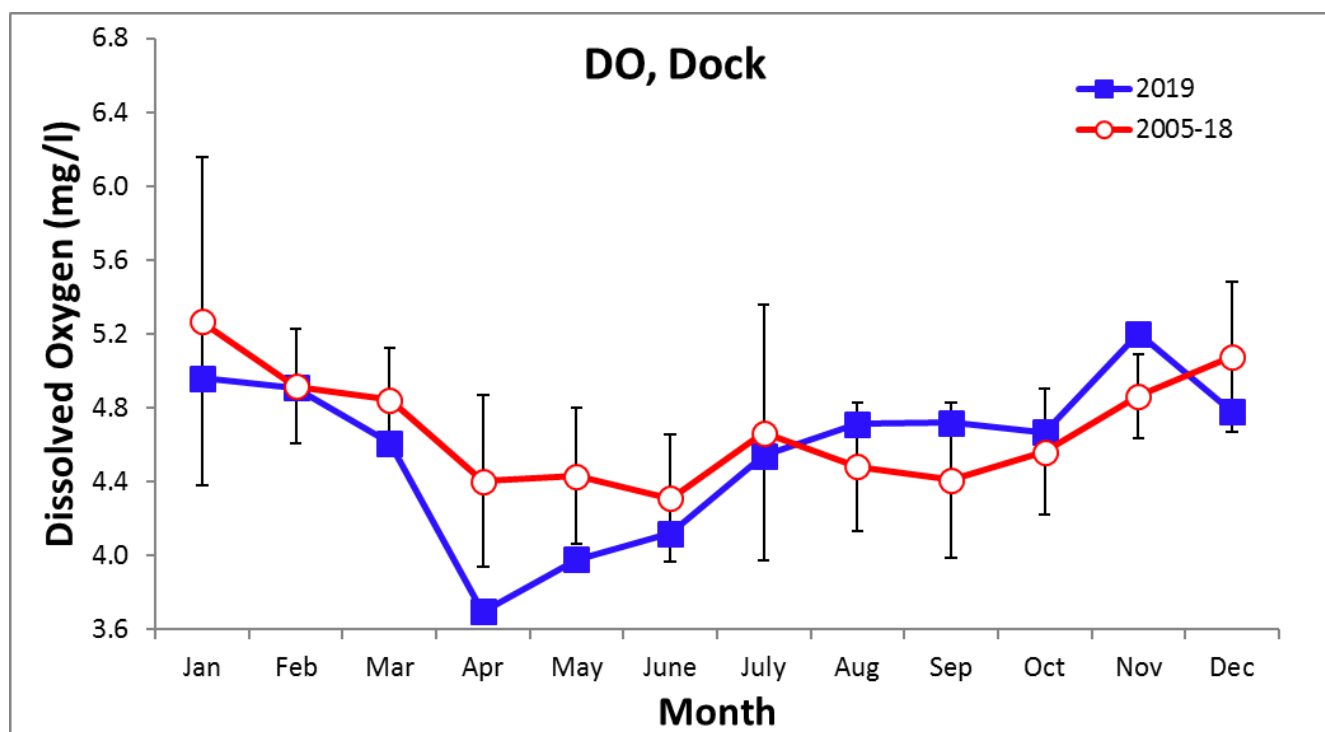
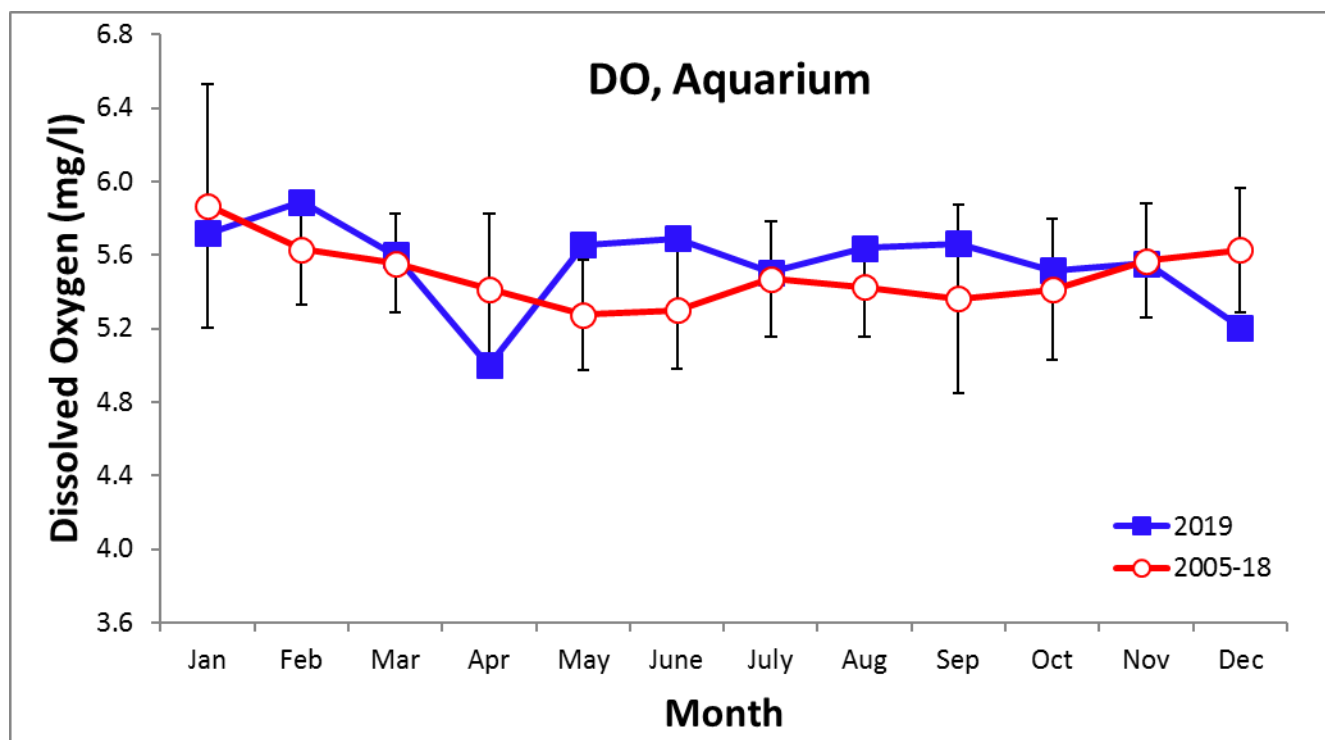
## Average Disolved Oxygen (mg/l)

### Aquarium

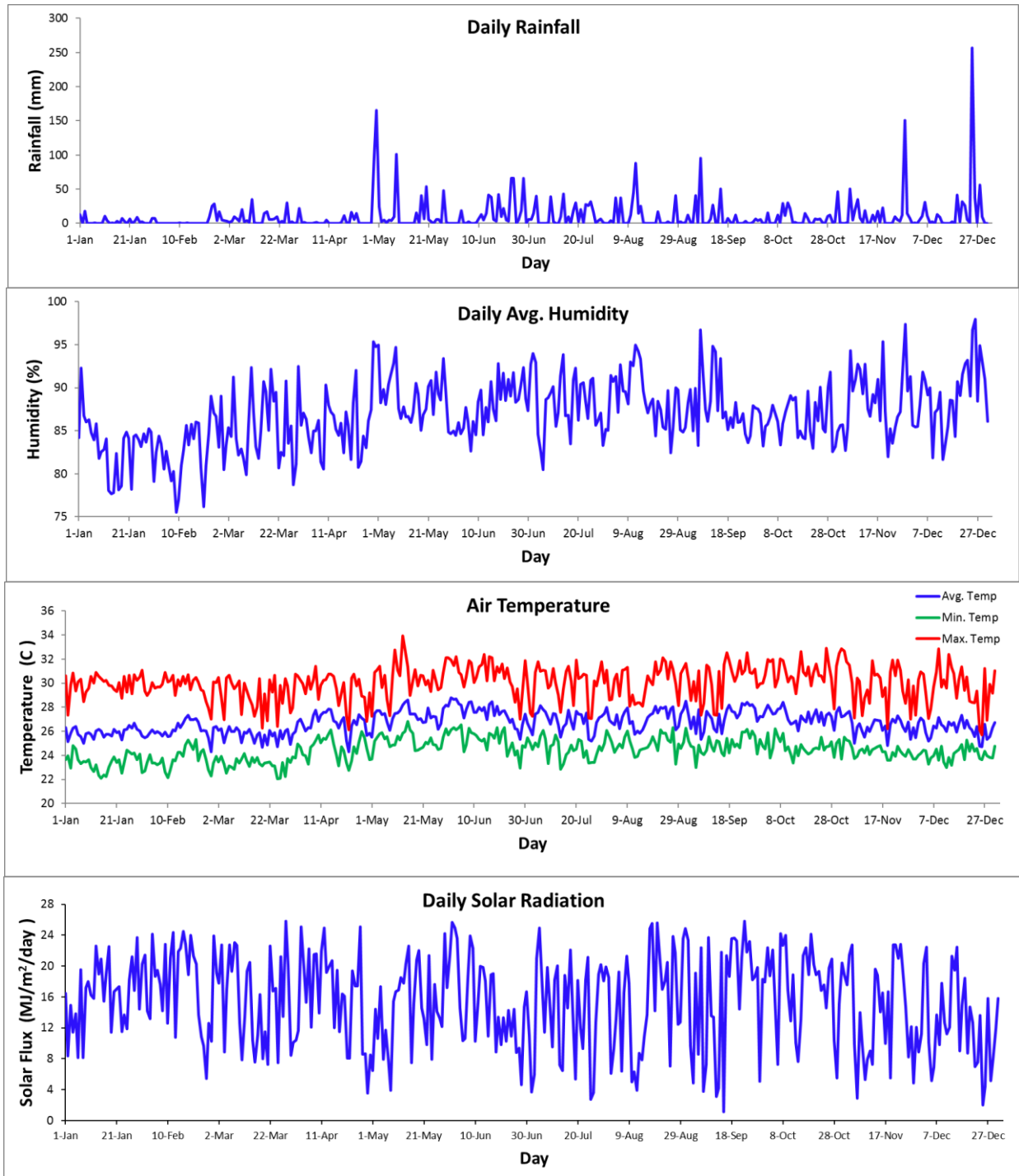
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2005					5.6	5.9	5.0	5.7	6.8	6.1	6.0	5.8
2006	6.5	5.5	5.8	5.6	5.3	4.6	5.1	4.8	4.5	4.7	5.9	5.9
2007	5.5	5.2	5.0	4.9	4.9	5.4	5.4	5.3	5.3	5.8	5.7	6.1
2008	7.7	5.5	5.5	5.5	5.5	5.5	5.8	5.4	5.4	4.9	5.0	5.1
2009	5.1	5.4	5.2	5.0	4.7	5.3	5.0	5.3	5.0	5.0	5.6	5.3
2010		5.2	5.5	5.4	5.4	5.3	5.5	5.5	5.4	5.3	5.6	5.8
2011	5.8	5.8	5.5	6.2	4.8	5.0	5.2	5.2	5.0	5.7	5.6	6.0
2012	6.4	6.2	6.0	6.0	5.4	5.5	5.7	5.9	5.5	5.7	5.8	6.2
2013	5.8	5.6	5.6	5.4	5.3	5.6	5.8	5.2	5.6	5.7	5.8	5.6
2014	5.6	5.7	5.6	5.1	5.6	5.0	5.8	5.4	4.7	5.0	5.2	5.2
2015	5.3	5.5	5.7	5.0	5.1	5.0	5.1	5.4	5.4	5.3	5.0	5.3
2016	5.4	5.4	5.3	5.5	5.3	5.3	5.6	5.6	5.5	5.6	5.6	5.6
2017	5.6	5.8	5.5	5.2	5.3	5.2	5.8	5.8	5.6	5.5	5.6	5.6
2018	5.9	6.1	6.0	6.0	5.5	5.5	5.6	5.3	5.1	5.6	5.7	5.8
2019	5.7	5.9	5.6	5.0	5.7	5.7	5.5	5.6	5.7	5.5	5.6	5.2
mean	5.9	5.6	5.5	5.4	5.2	5.3	5.4	5.4	5.3	5.4	5.6	5.7
sd	0.8	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.6	0.4	0.3	0.4
min	5.1	5.2	5.0	4.9	4.7	4.6	5.0	4.8	4.5	4.7	5.0	5.1
max	7.7	6.2	6.0	6.2	5.6	5.9	5.8	5.9	6.8	6.1	6.0	6.2

### Dock

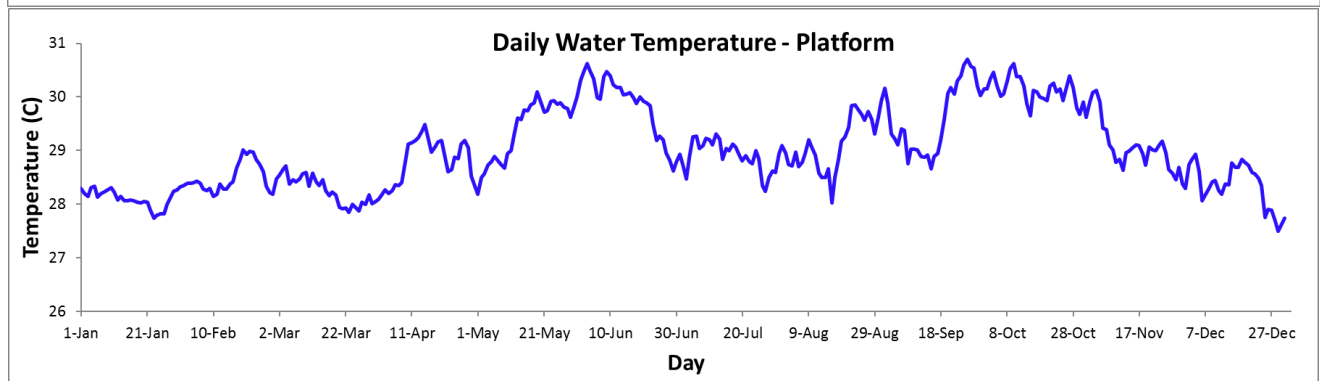
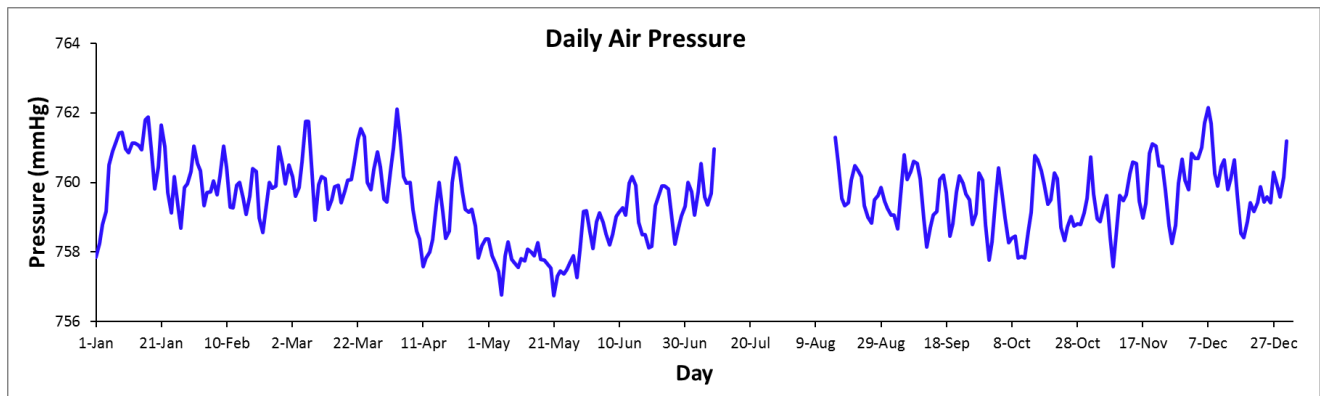
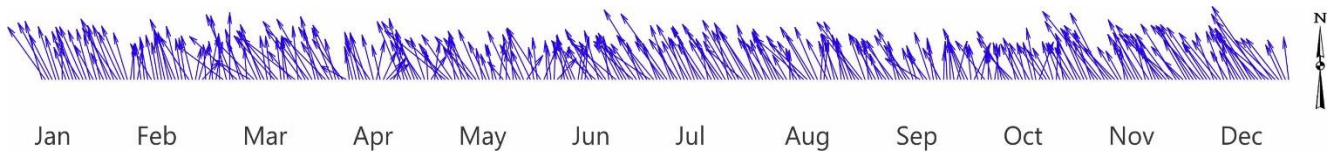
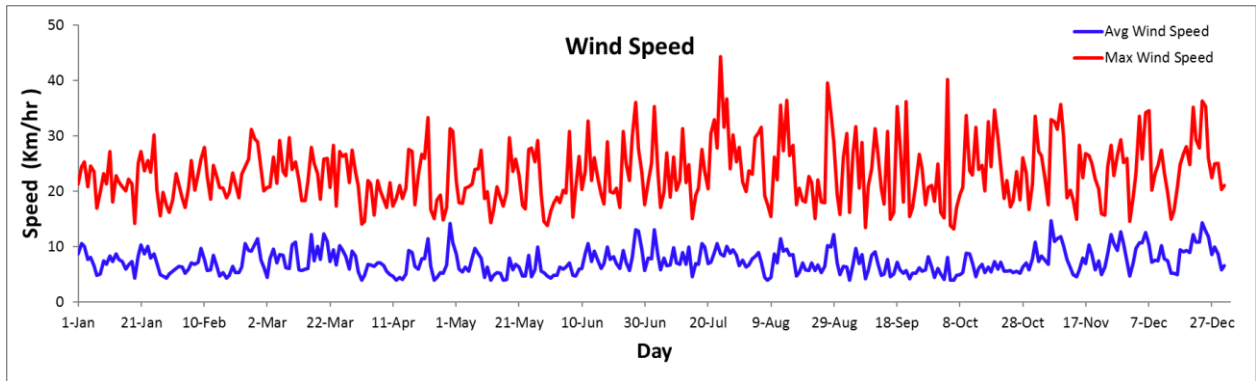
Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2005					4.4	4.3	3.7	4.6	4.7	4.8	4.8	5.1
2006	8.0	5.0	5.2	5.0	4.1	4.2	4.5	4.3	3.7	4.3	4.9	5.6
2007	5.1	4.4	4.5	3.4	4.3	4.1	4.0	3.8	4.3	5.0	4.8	4.8
2008	5.0	4.5	4.7	4.7	4.0	4.3	4.8	4.2	3.5	4.5	4.8	6.0
2009	4.7	5.5	5.0	4.8	4.5	4.3	6.7	4.4	4.1	4.7	5.1	5.2
2010		4.8	4.8	4.2	4.7	4.3	3.9	4.3	4.6	4.2	4.6	5.0
2011	5.3	5.0	4.8	4.1	4.1	3.6	4.6	4.1	4.3	4.8	5.0	5.3
2012	5.9	4.7	5.0	5.0	4.8	4.8	4.6	5.0	4.5	4.7	5.0	5.4
2013	4.6	5.1	5.3	4.5	4.9	4.7	4.7	4.3	5.0	4.7	5.0	4.7
2014	4.9	5.3	5.3	4.5	5.0	4.3	5.3	5.0	4.8	4.8	5.0	5.6
2015	5.1	5.2	4.9	4.8	5.0	5.0	5.0	4.9	4.6	4.5	4.3	4.6
2016	4.3	4.7	4.5	4.4	4.2	4.5	4.8	4.6	4.6	4.1	4.8	4.7
2017	5.3	4.9	4.8	4.1	4.6	4.3	4.4	4.3	4.0	3.8	4.7	4.8
2018	5.4	4.9	4.5	4.5	4.0	3.9	4.5	4.7	4.8	4.9	5.1	4.8
2019	5.0	4.9	4.6	3.7	4.0	4.1	4.5	4.7	4.7	4.7	5.2	4.8
mean	5.3	4.9	4.9	4.5	4.5	4.3	4.7	4.5	4.4	4.6	4.8	5.1
sd	0.9	0.3	0.3	0.4	0.4	0.4	0.7	0.4	0.4	0.3	0.2	0.4
min	17.5	6.6	5.7	9.7	8.0	8.2	15.3	7.9	9.7	7.7	4.5	8.1
max	4.3	4.4	4.5	3.4	4.0	3.6	3.7	3.8	3.5	3.8	4.3	4.6



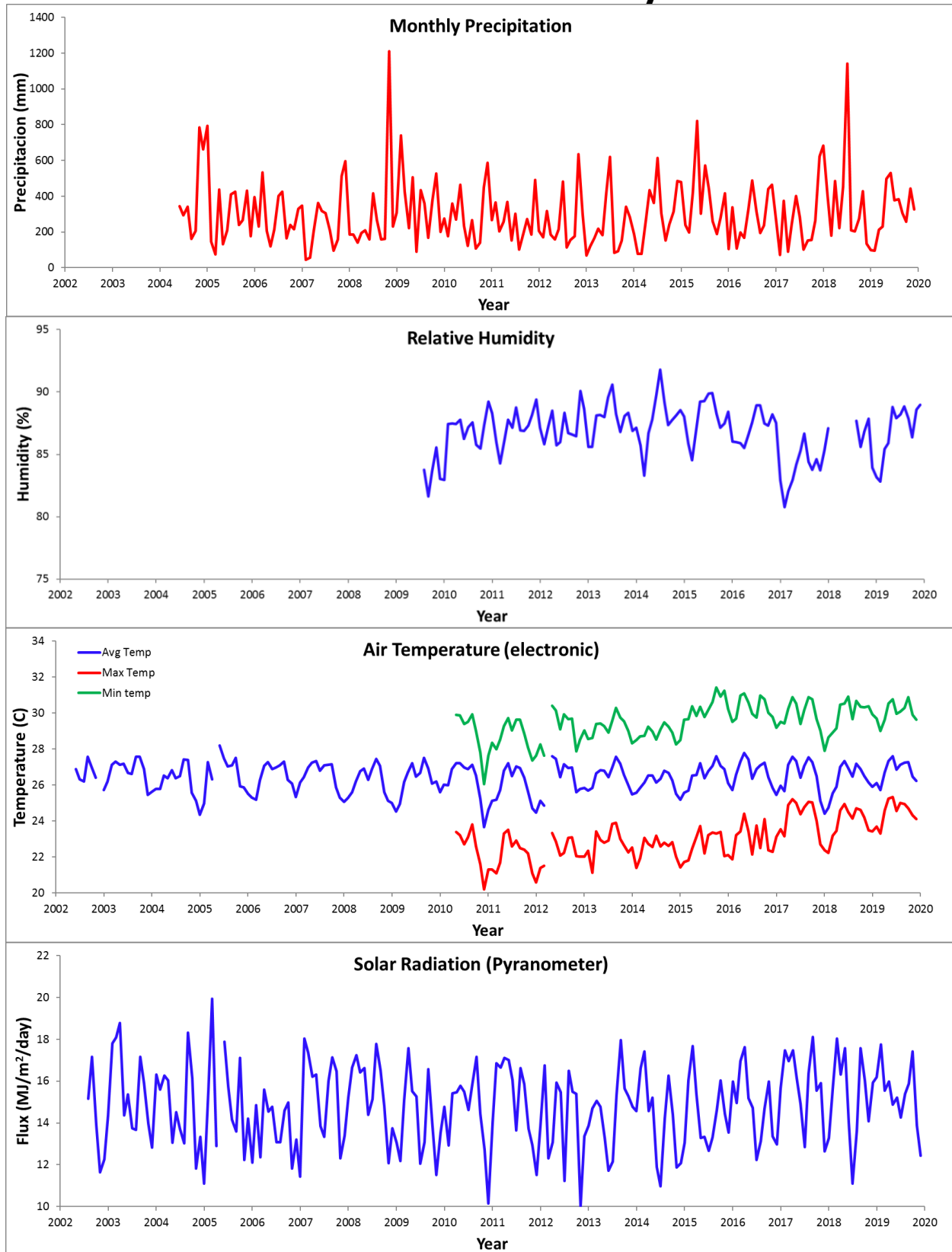
## Time Series – Daily, 2019



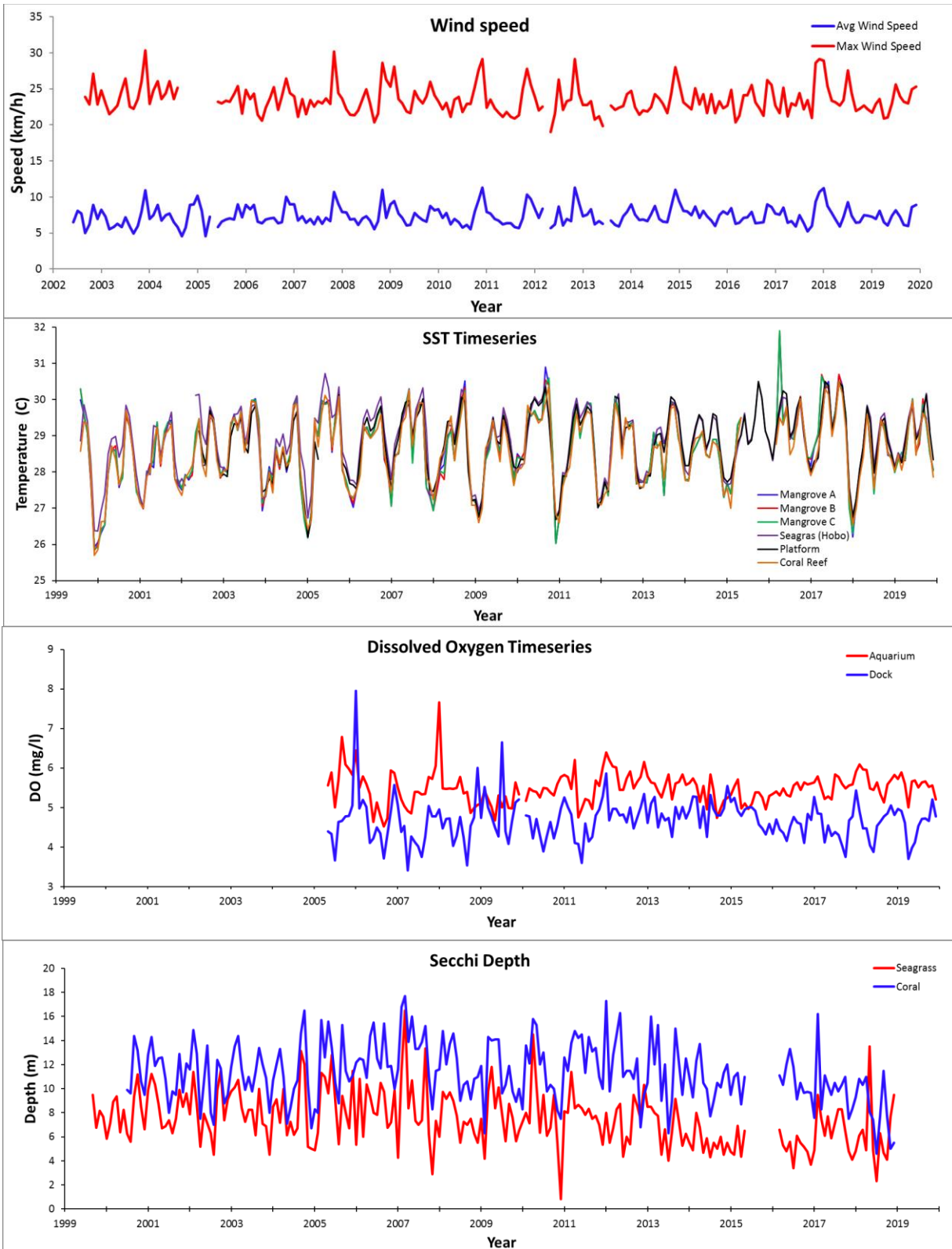
## Time Series – Daily, 2019



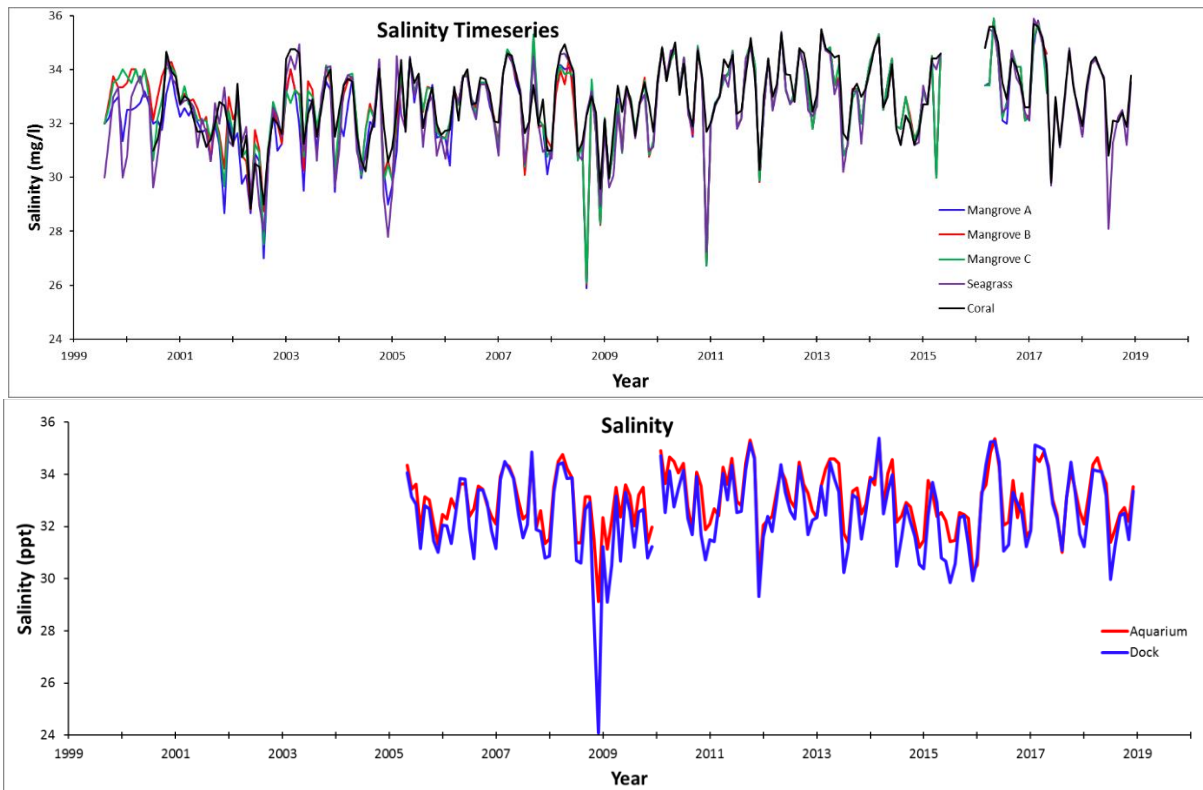
## Time Series – Monthly



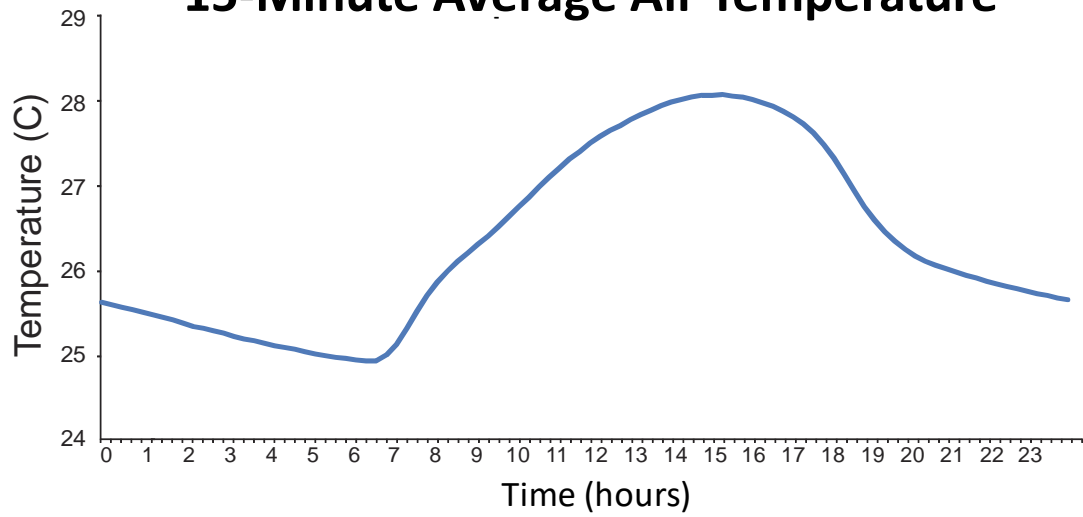
## Time Series – Monthly



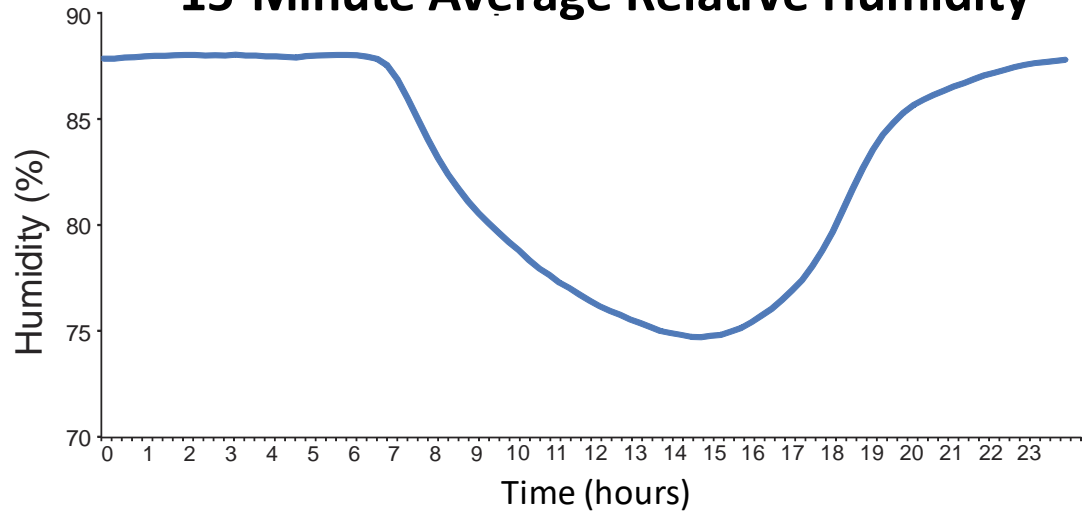
## Time Series – Monthly



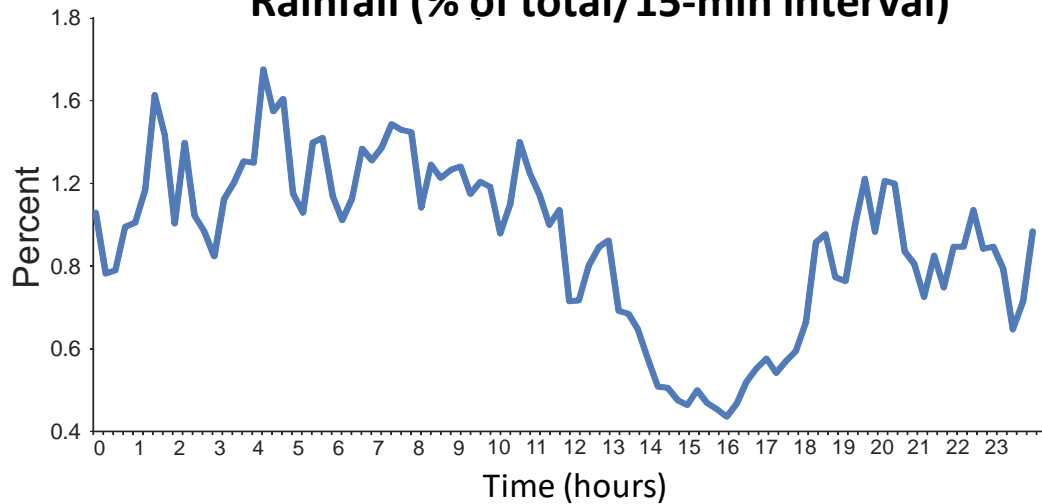
### 15-Minute Average Air Temperature



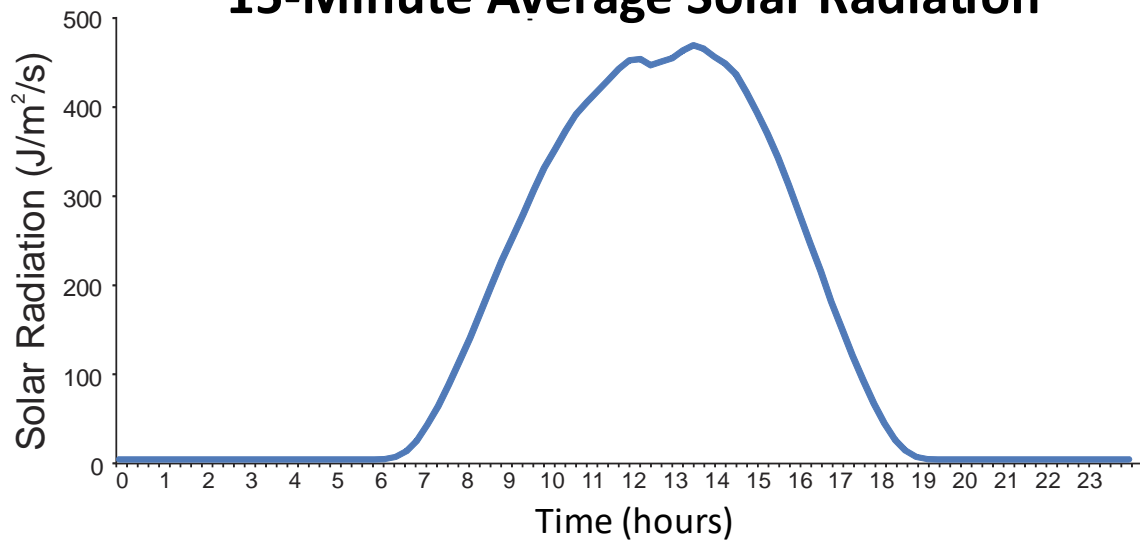
### 15-Minute Average Relative Humidity



### Rainfall (% of total/15-min interval)



## 15-Minute Average Solar Radiation



## 15-Minute Average Wind Speed

