

2019 Meteorological and Oceanographic

Summary for the

Bocas del Toro Research Station

Prepared by: Steven Paton

Introduction

This is the 7th 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>

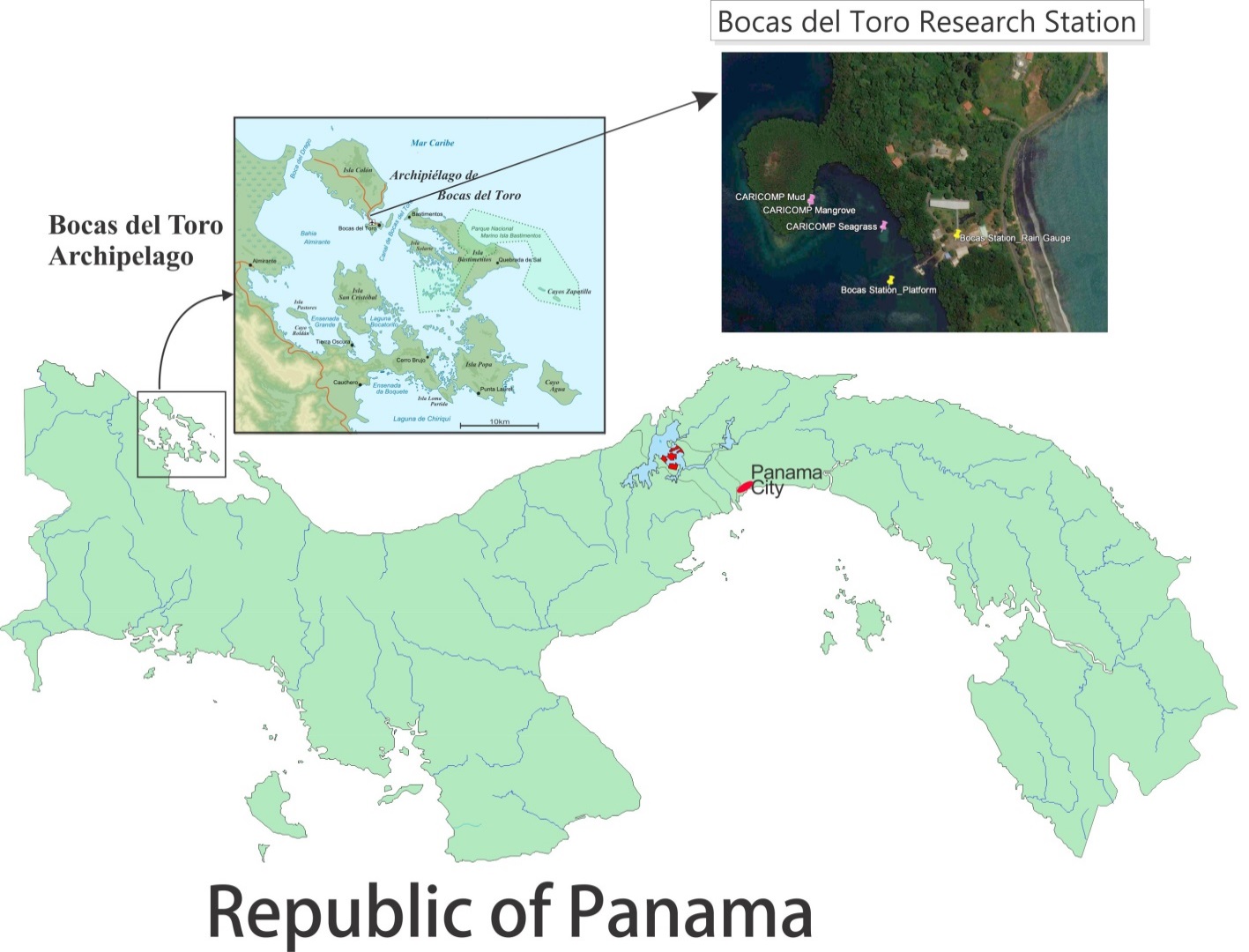
Setting

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.

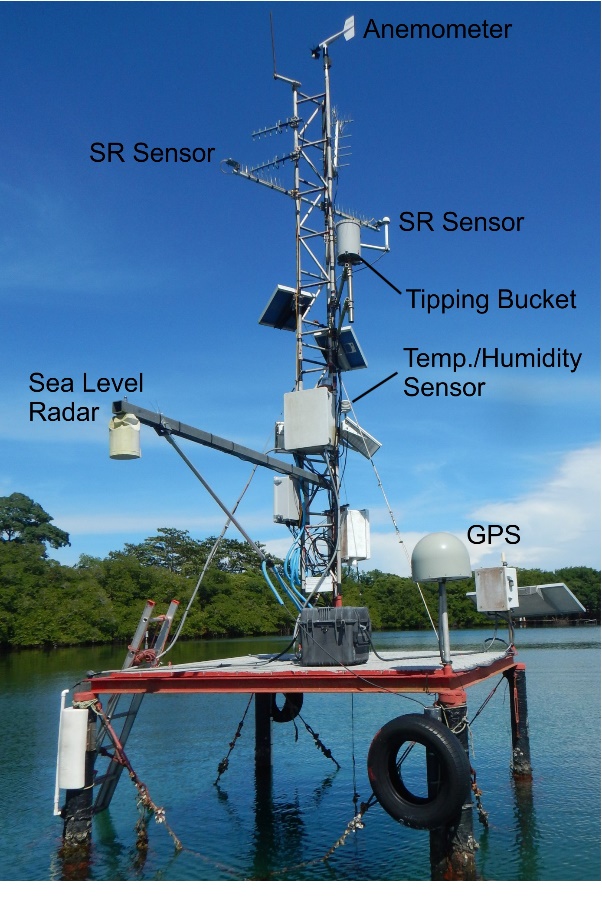


The Mangrove ‘A’, ‘B’, and ‘C’ locations refer to three mangrove census sampling sites located in the mangrove fringe 240m NW of the dock. The Seagrass location refers to the location of the former Seagrass sampling site approximately 90 NW of the dock.

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:

**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

**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 (±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 (MJ m-²), maximum and minimum (J m-² 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, monthy 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**

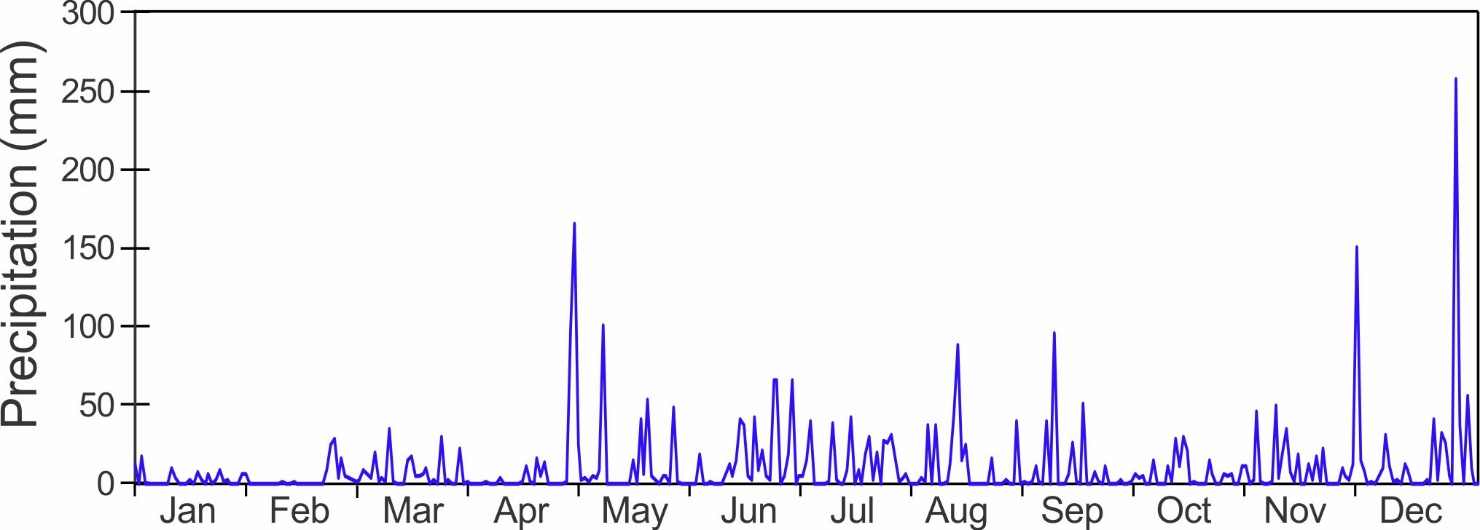
Graphs showing the daily Air Temperature, Relative Humidity, Rainfall, Solar Radiation and Wind Speed averages for 2019 (pages 31 and 32) and monthly averages for the entire period of recorded SST, Salinity, Secchi depth and DO (pages 33 and 34).

**Daily Patterns**

Pages 35and 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 |

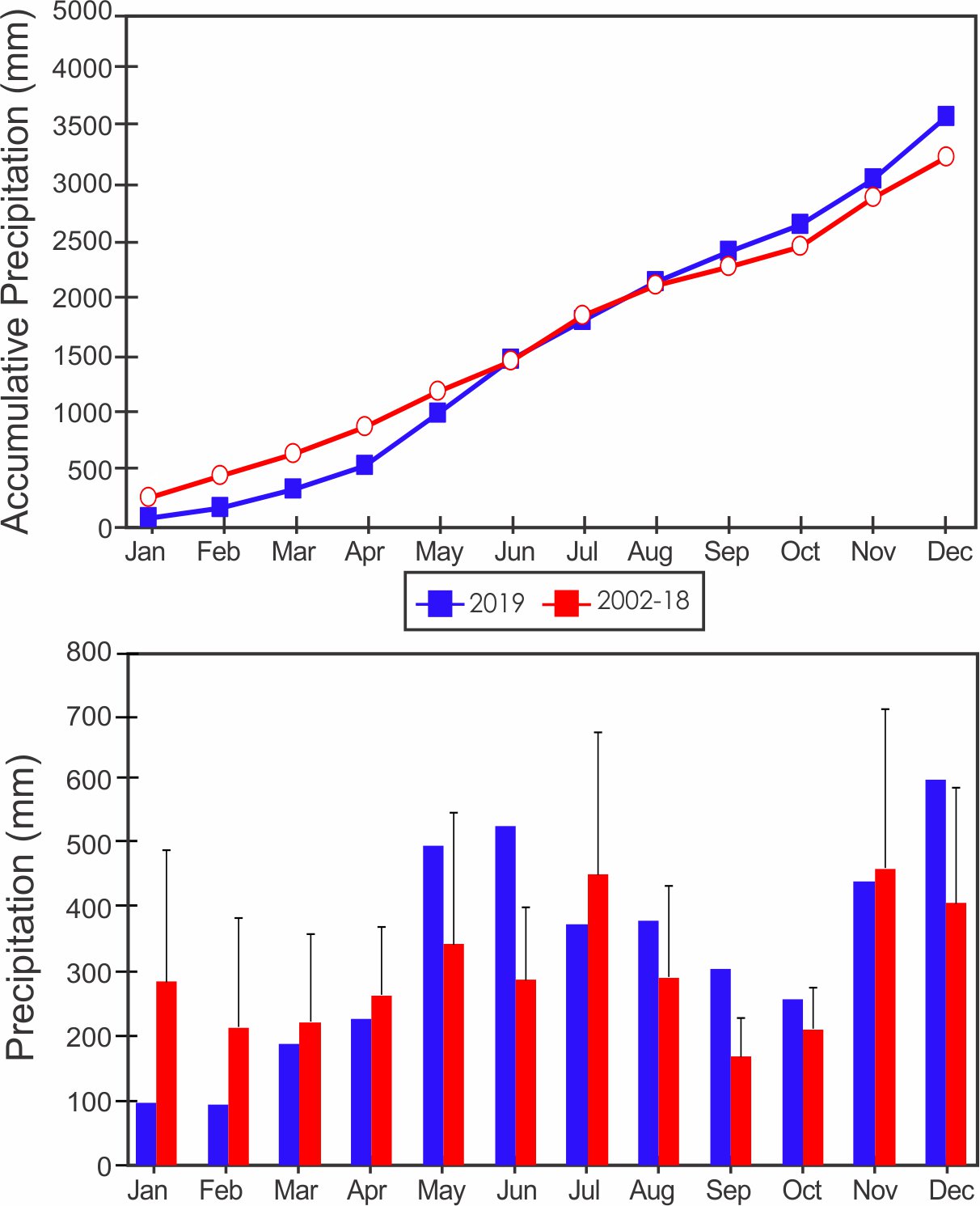


**Monthly Rainfall (mm)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **June** | **July** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Total** |
| **2002** |  |  |  |  | 116.8 | 248.9 | 642.6 | 624.8 | 175.3 | 198.1 | 665.5 | 193.0 |  |
| **2003** | 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 |
| **2004** | 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 |
| **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 | 328.1 | 3473.6 |
| **2007** | 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 |
| **2008** | 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 |
| **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** | 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 |
| **2011** | 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 |
| **2012** | 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 |
| **2013** | 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 |
| **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 | 239.2 | 197.5 | 422.3 | 820.7 | 302.4 | 572.3 | 441.2 | 261.1 | 187.0 | 282.5 | 415.1 | 4621.8 |
| **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 | 650.2 | 3050.1 |
| **2018** | 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 |
| **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 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Mean** | 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 |
| **sd** | 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 |
| **Min** | 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 |
| **Max** | 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 |
| **Rank\*** | 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

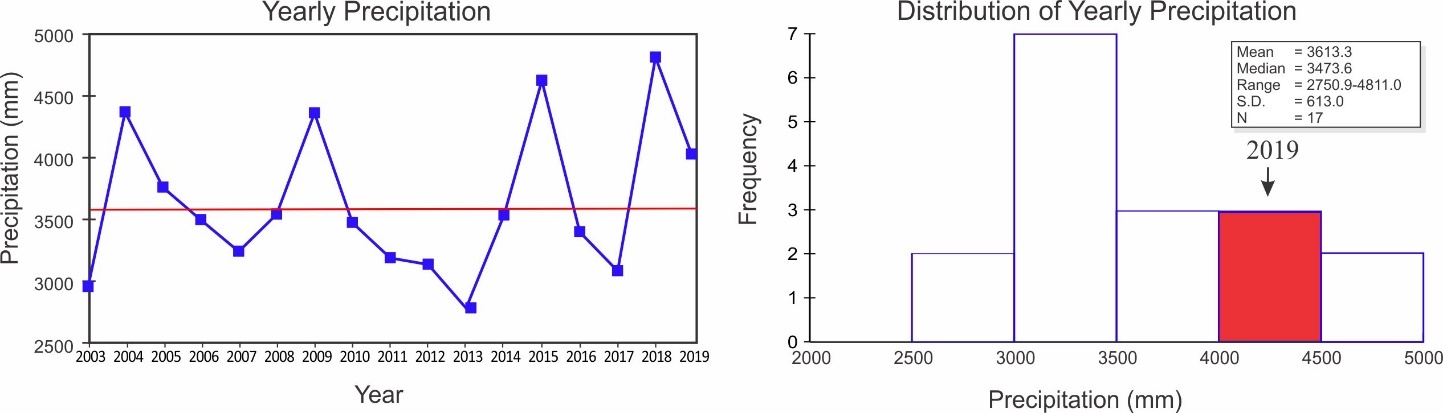
\* Rank of latest year compared to all other years. 1 = wettest

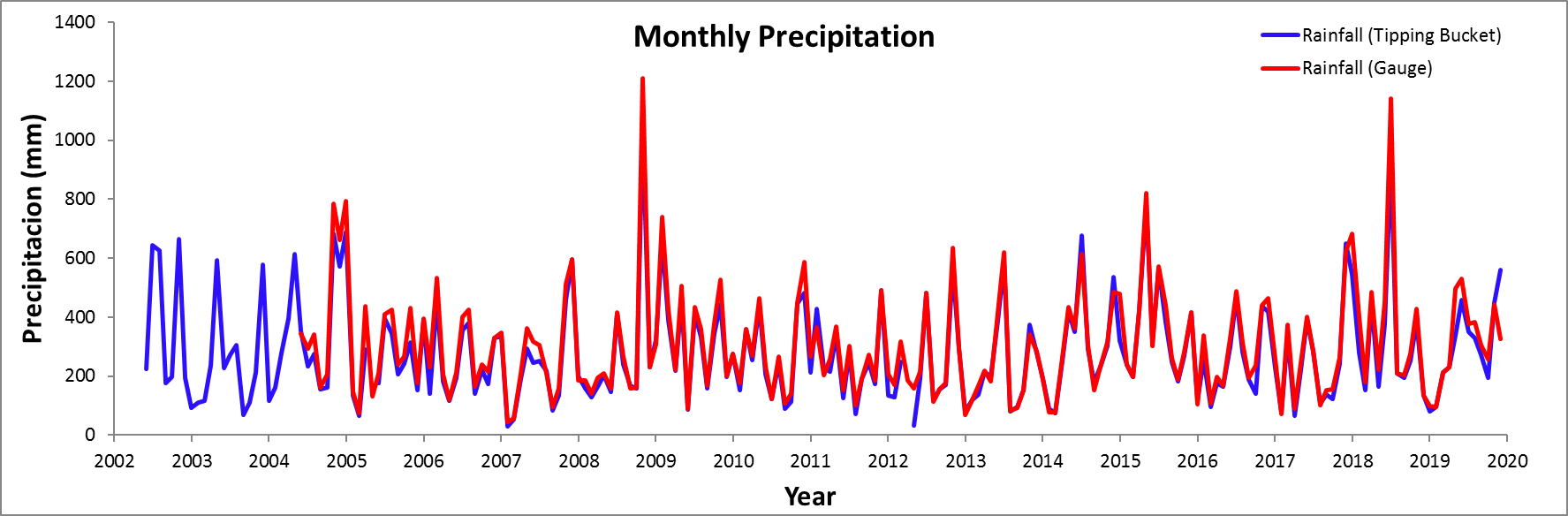


**Yearly Rainfall (mm)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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

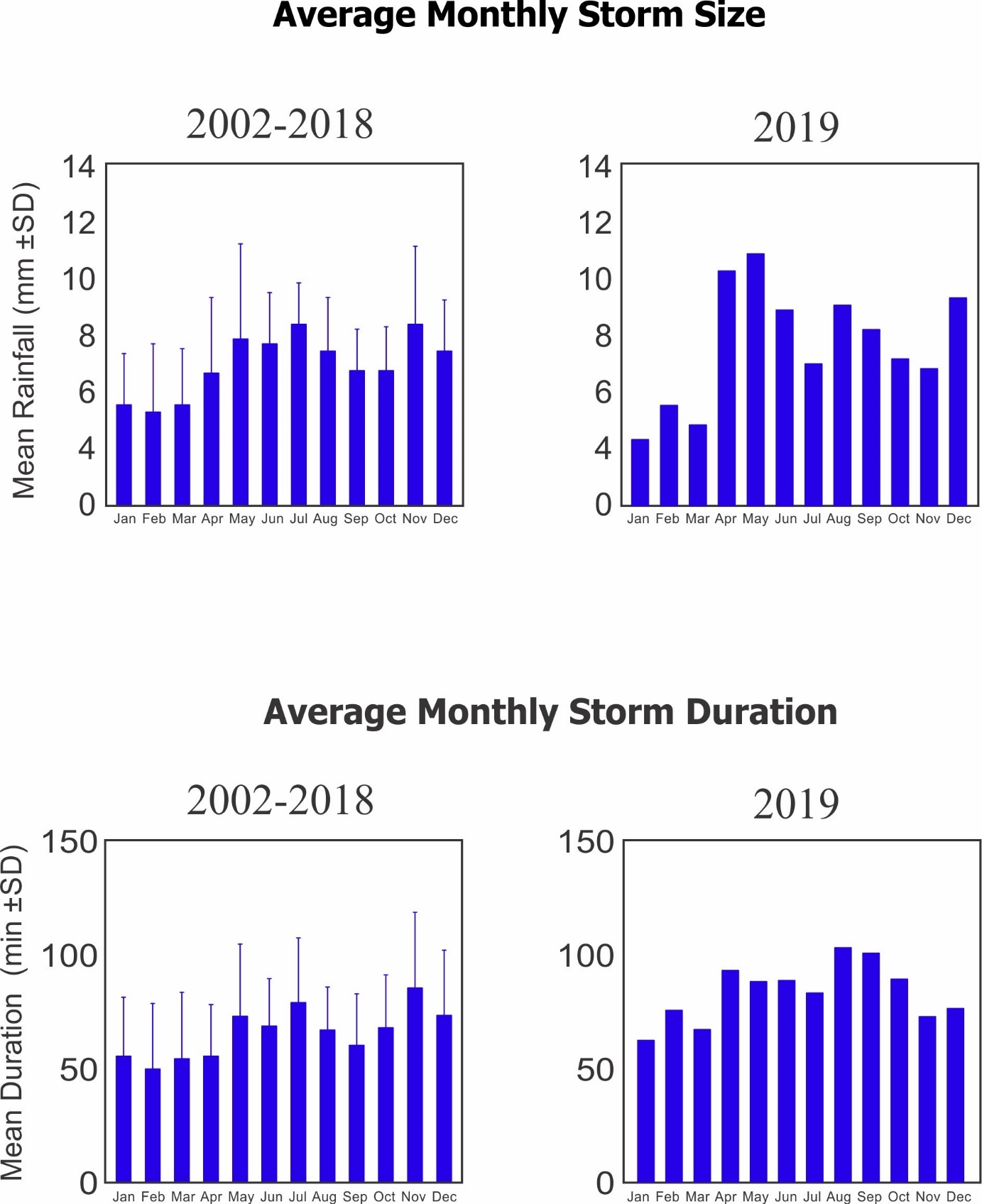




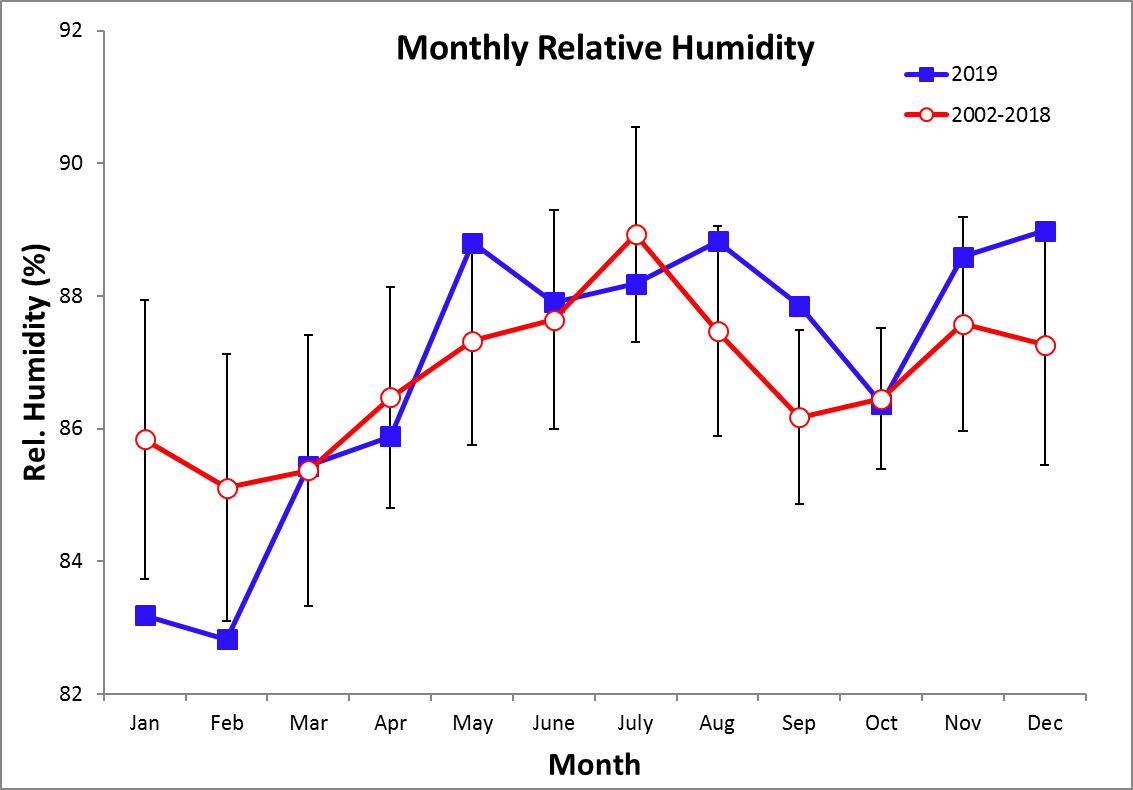
**Storm Analysis**

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

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

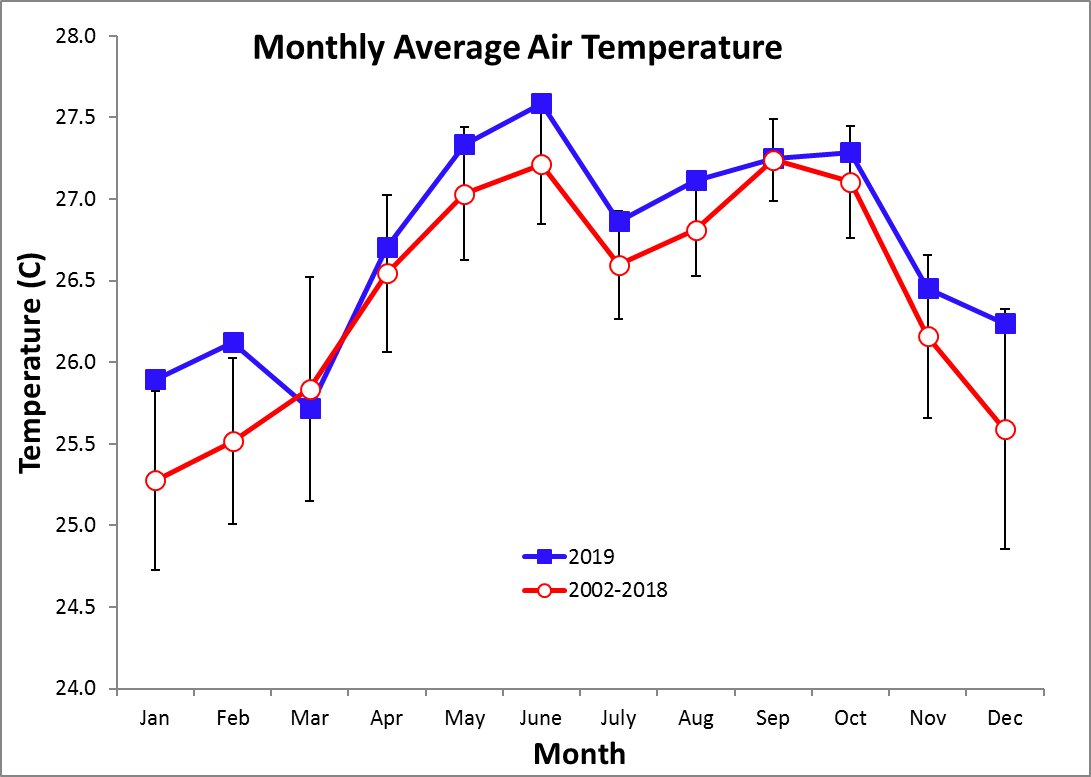
**Relative Humidity (%)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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** |
| **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 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **mean** | 25.3 | 25.5 | 25.8 | 26.5 | 27.0 | 27.2 | 26.6 | 26.8 | 27.2 | 27.1 | 26.2 | 25.6 |
| **sd** | 0.5 | 0.5 | 0.7 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.5 | 0.7 |
| **min** | 24.4 | 24.5 | 24.8 | 25.7 | 26.4 | 26.5 | 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 | 27.2 | 27.6 | 27.6 | 27.1 | 26.9 |

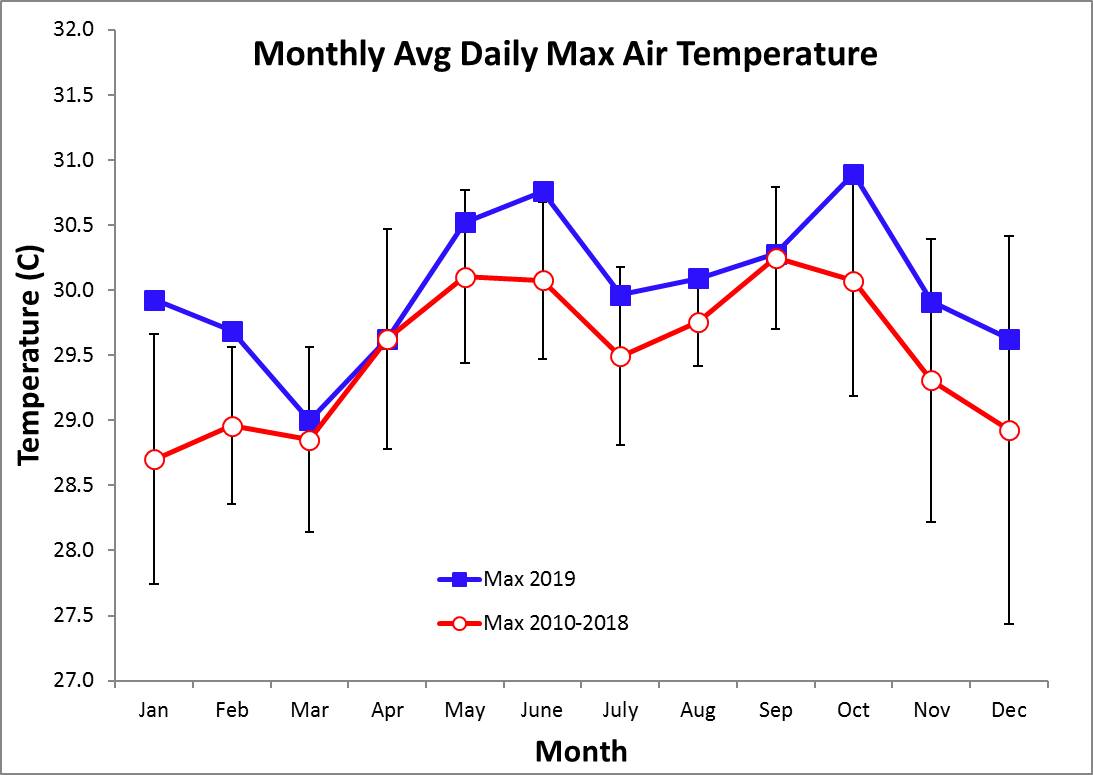
**Monthly Average of Daily Maximum Temperature**

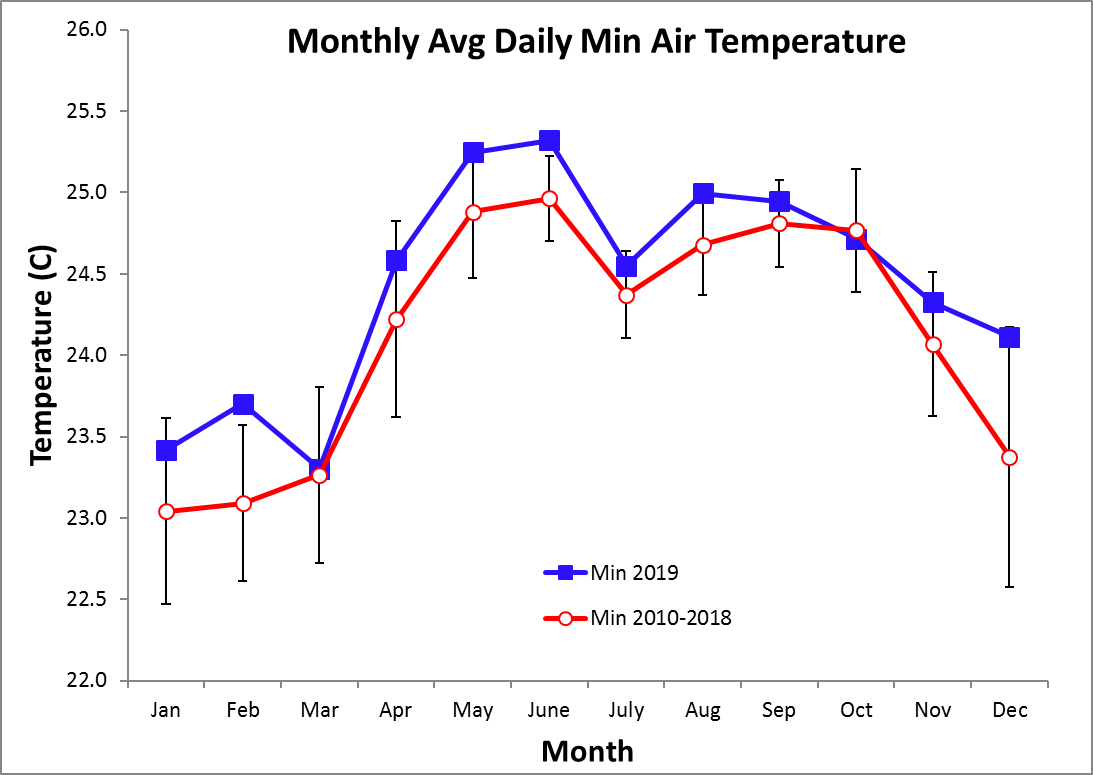
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **June** | **July** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **2010** |  |  |  |  | 29.9 | 29.9 | 29.4 | 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 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **mean** | 28.7 | 29.0 | 28.8 | 29.6 | 30.1 | 30.1 | 29.5 | 29.8 | 30.2 | 30.1 | 29.3 | 28.9 |
| **sd** | 1.0 | 0.6 | 0.7 | 0.8 | 0.7 | 0.6 | 0.7 | 0.3 | 0.5 | 0.9 | 1.1 | 1.5 |
| **min** | 27.6 | 28.3 | 27.6 | 28.5 | 29.2 | 29.0 | 28.5 | 29.1 | 29.5 | 28.8 | 27.8 | 26.1 |
| **max** | 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**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| **mean** | 23.0 | [23.1](mailto:=@average(b2..b26)) | [23.3](mailto:=@average(b2..b26)) | [24.2](mailto:=@average(b2..b26)) | [24.9](mailto:=@average(b2..b26)) | [25.0](mailto:=@average(b2..b26)) | [24.4](mailto:=@average(b2..b26)) | [24.7](mailto:=@average(b2..b26)) | [24.8](mailto:=@average(b2..b26)) | [24.8](mailto:=@average(b2..b26)) | [24.1](mailto:=@average(b2..b26)) | [23.4](mailto:=@average(b2..b26)) |
| **sd** | 0.6 | 0.5 | 0.5 | 0.6 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.8 |
| **min** | 22.2 | 22.2 | 22.6 | 23.3 | 24.3 | 24.5 | 23.9 | 24.1 | 24.4 | 24.2 | 23.2 | 21.8 |
| **max** | 23.8 | 23.7 | 24.4 | 24.9 | 25.5 | 25.3 | 24.9 | 25.0 | 25.4 | 25.4 | 24.8 | 24.6 |

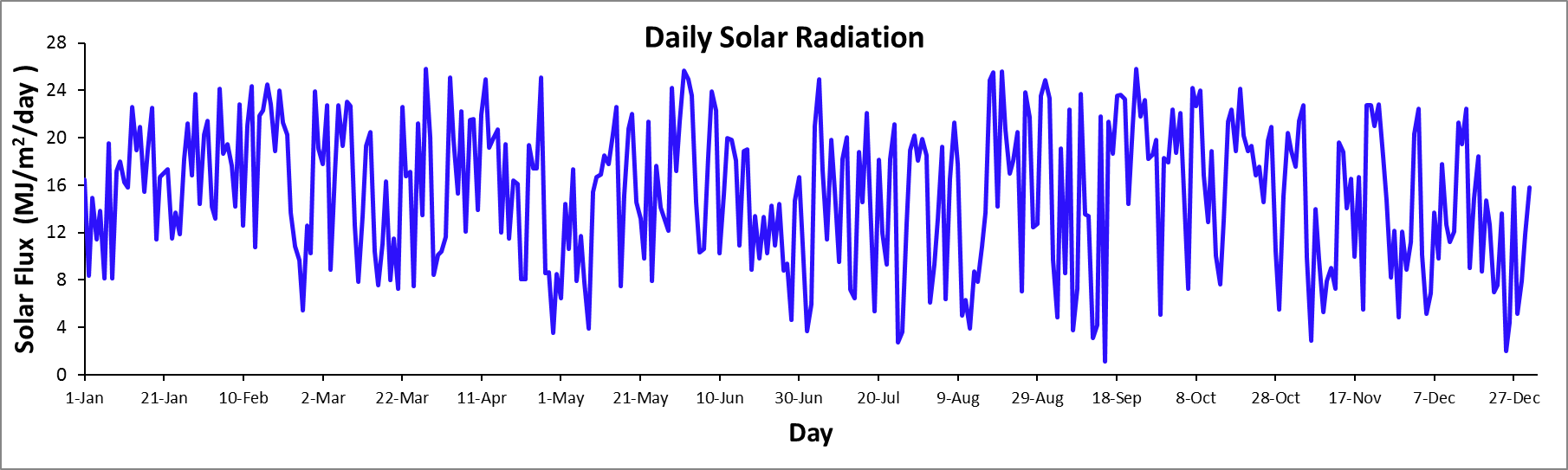
**Monthly Air Temperature (°C)**



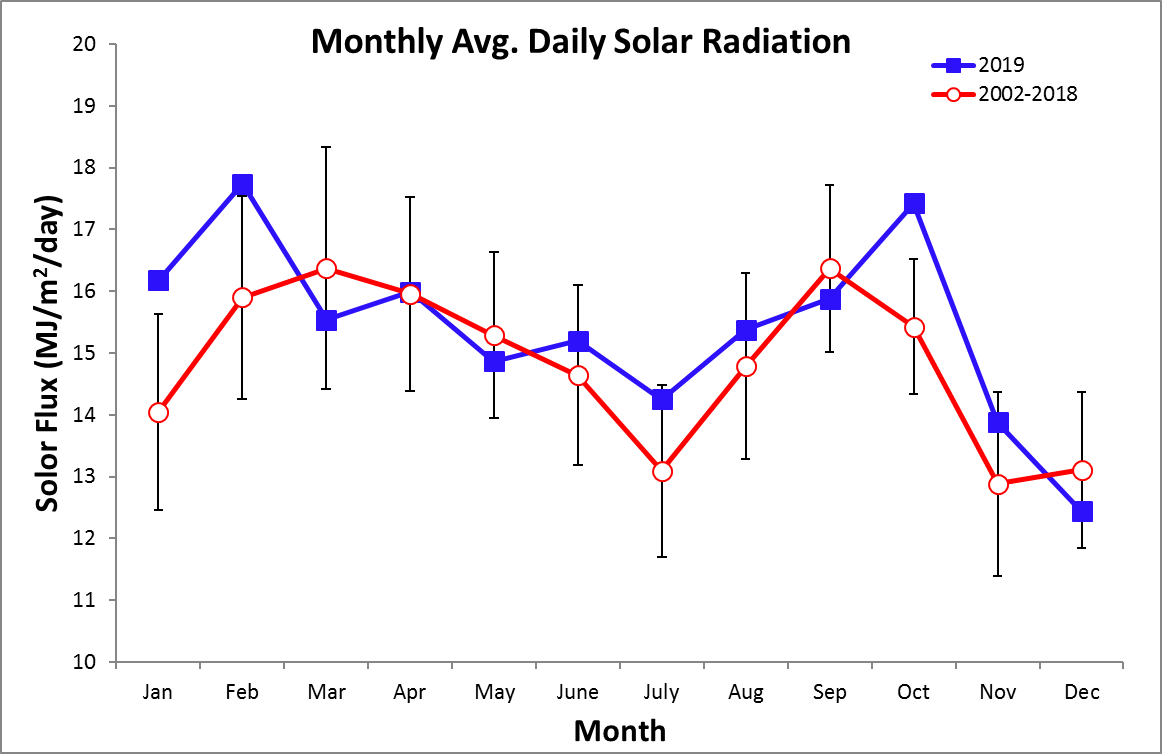


**2019 Daily Total Radiation (MJ m-2 day-1)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 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 |

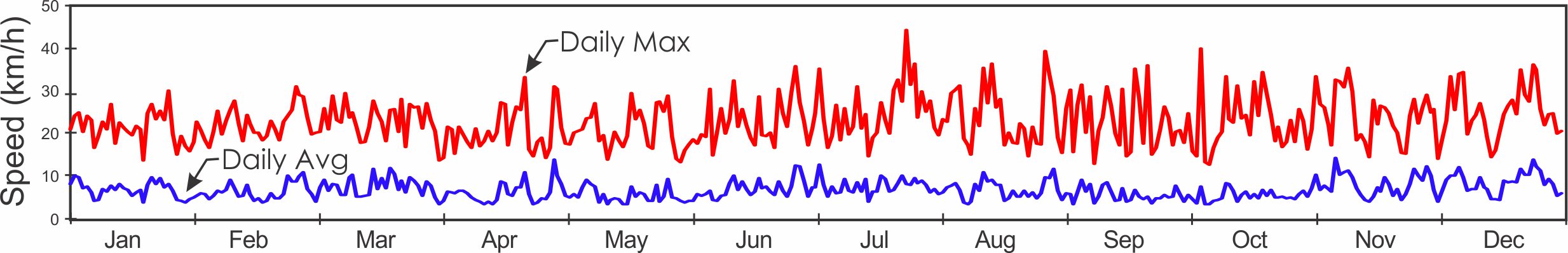
**Monthly Average Total Daily Solar Radiation (MJ m-2 day-1)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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)**

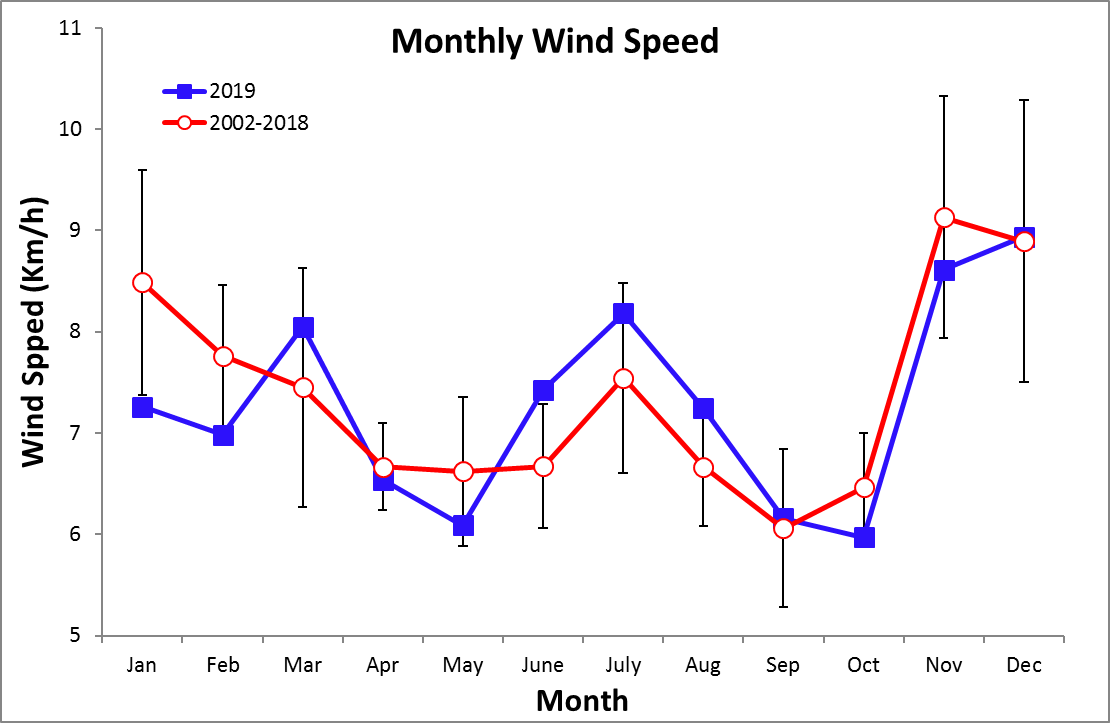
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Jan. | | Feb. | | | 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 |
|  | | | | | | | | | | | | | | |

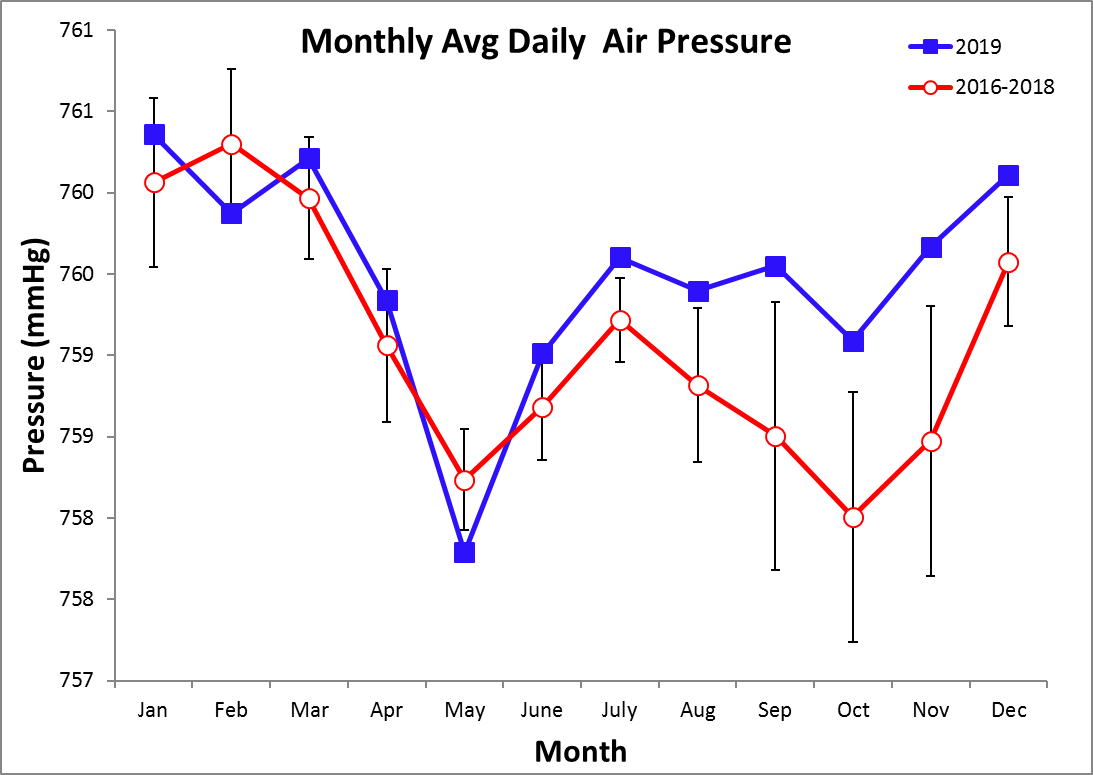
Average Monthly Wind Speed (km/h) and Direction (°)

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



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 |



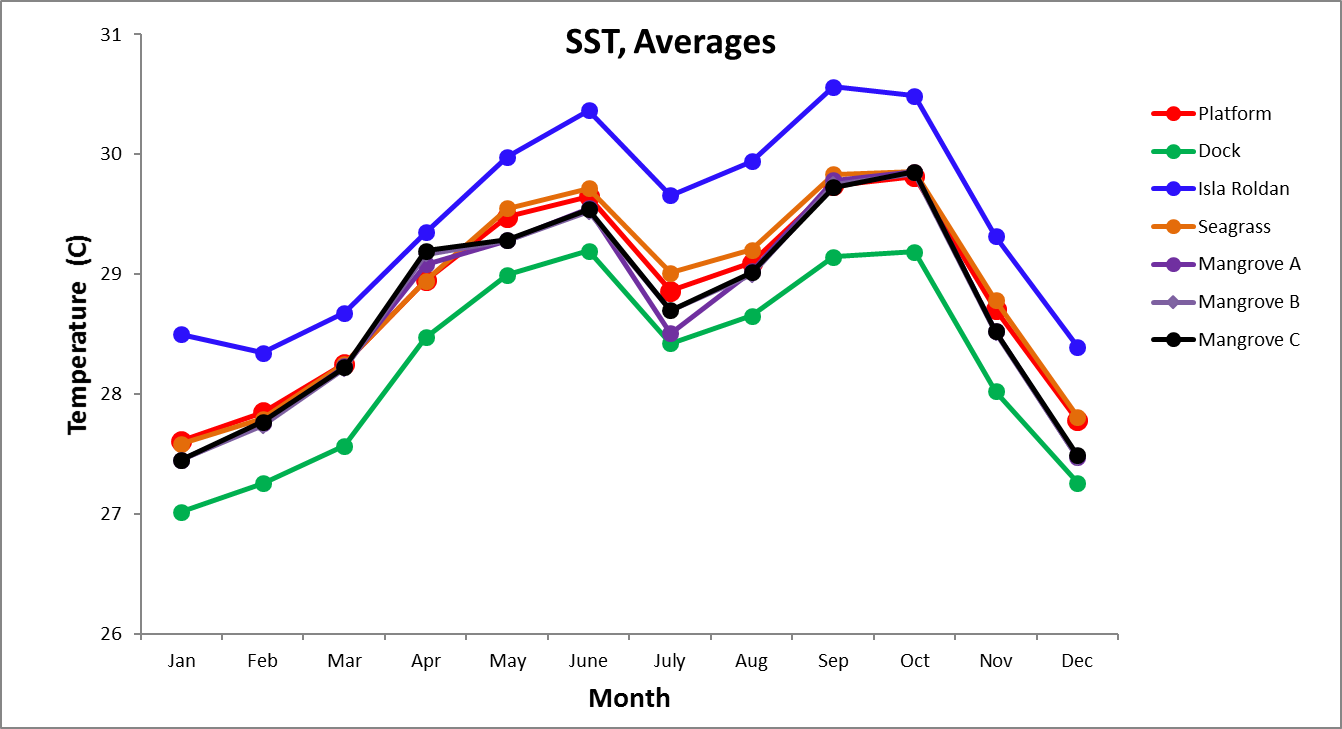
Average Sea Surface Temperature (°C)

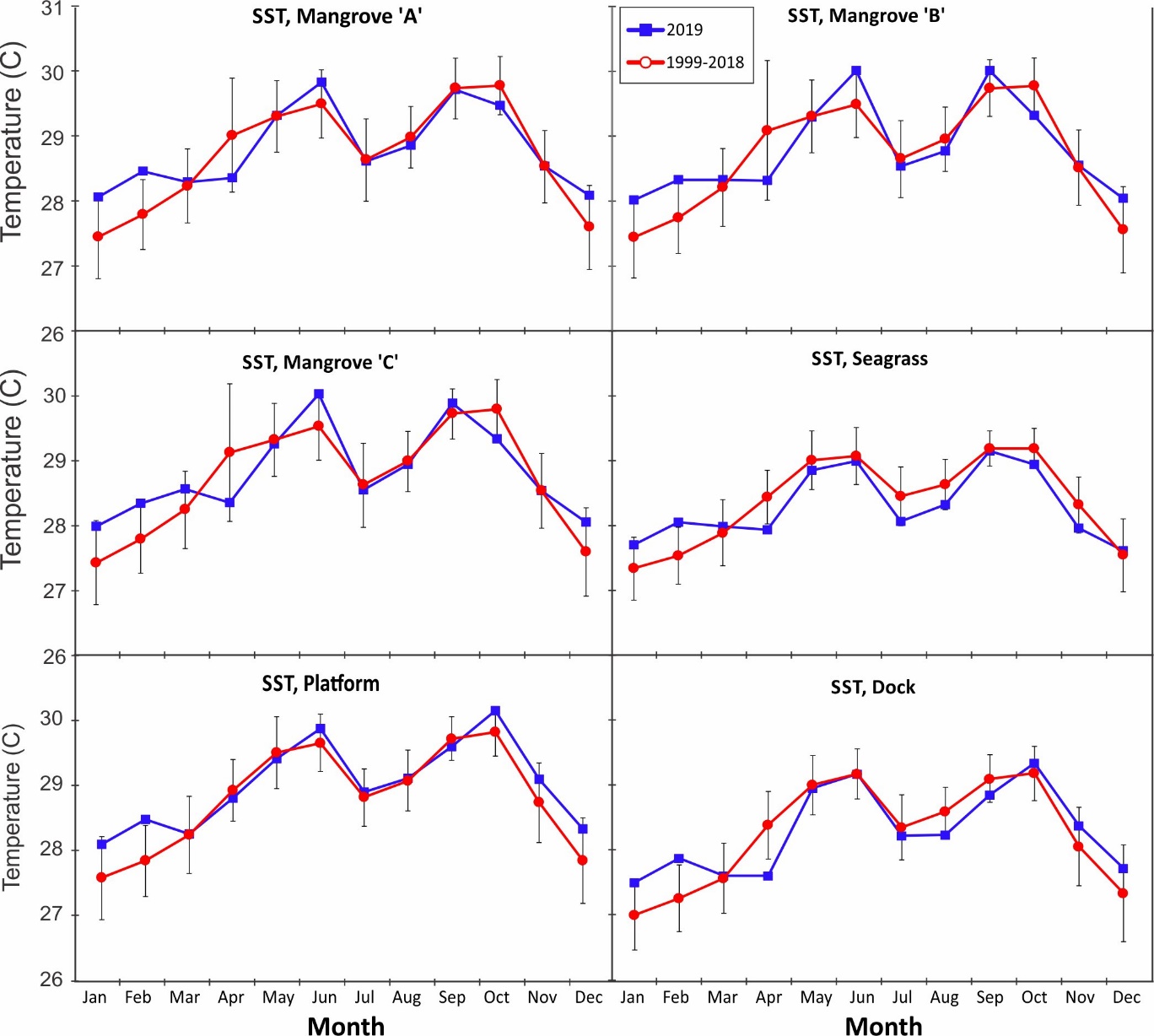
**Long-term Average Monthly Temperatures (1999-2018)**

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

**Average Monthly Temperatures (2019)**

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



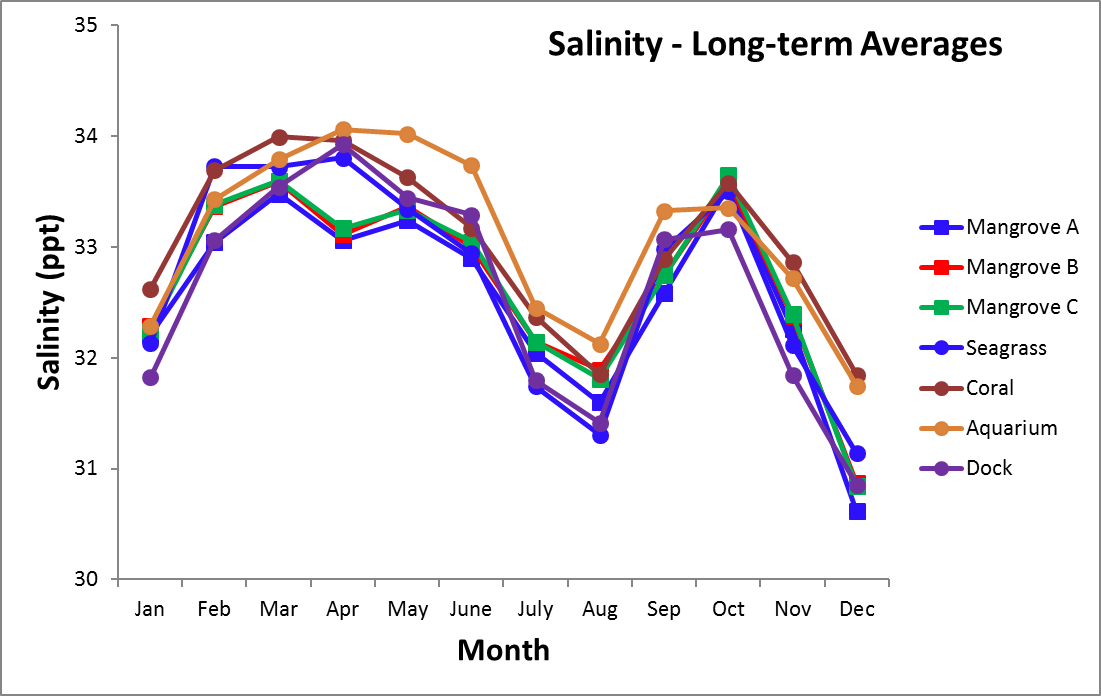
Average Salinity (ppt)

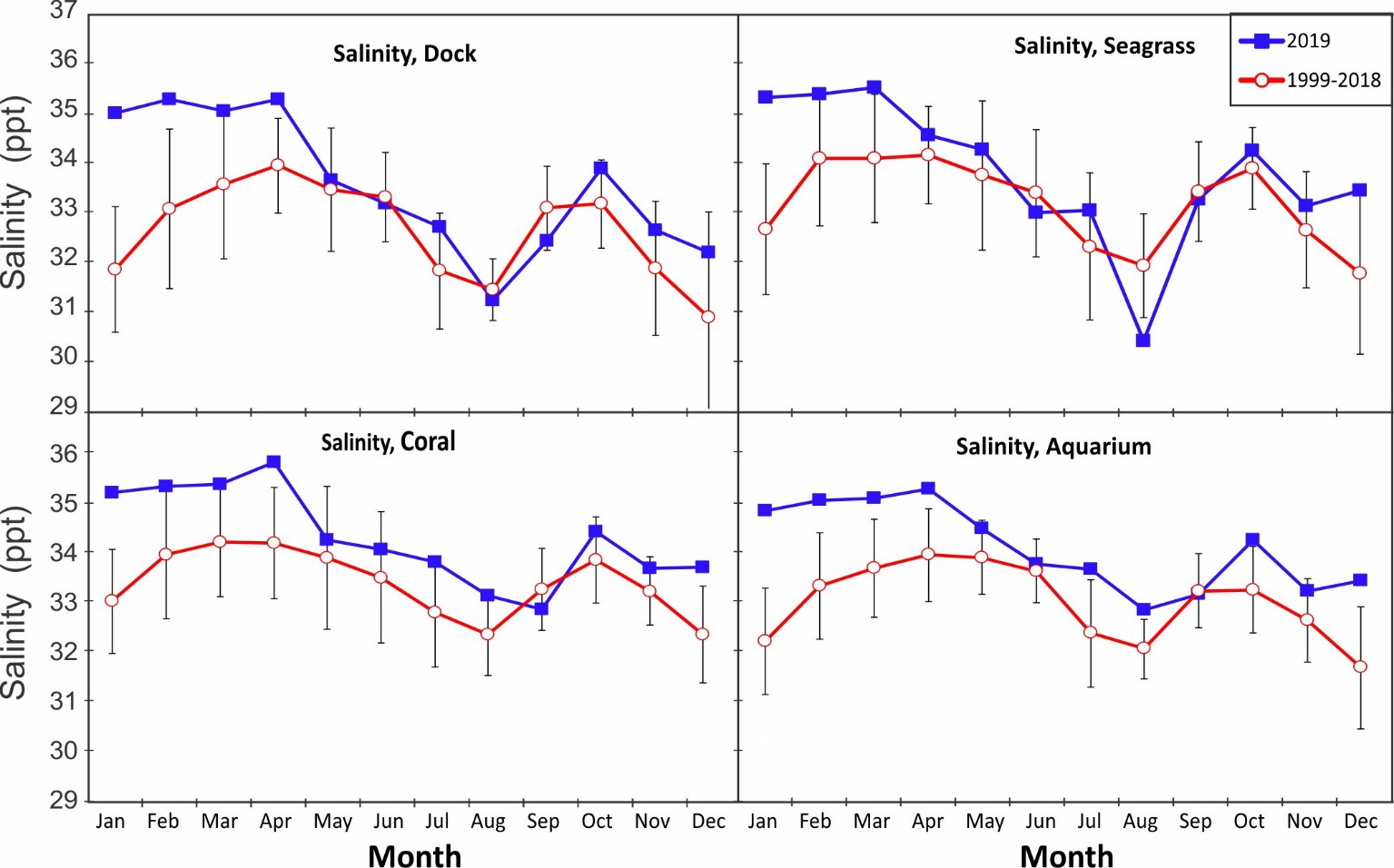
**Long-term Average Monthly Salinity (1999-2018)**

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

**Average Monthly Salinity (2019)**

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

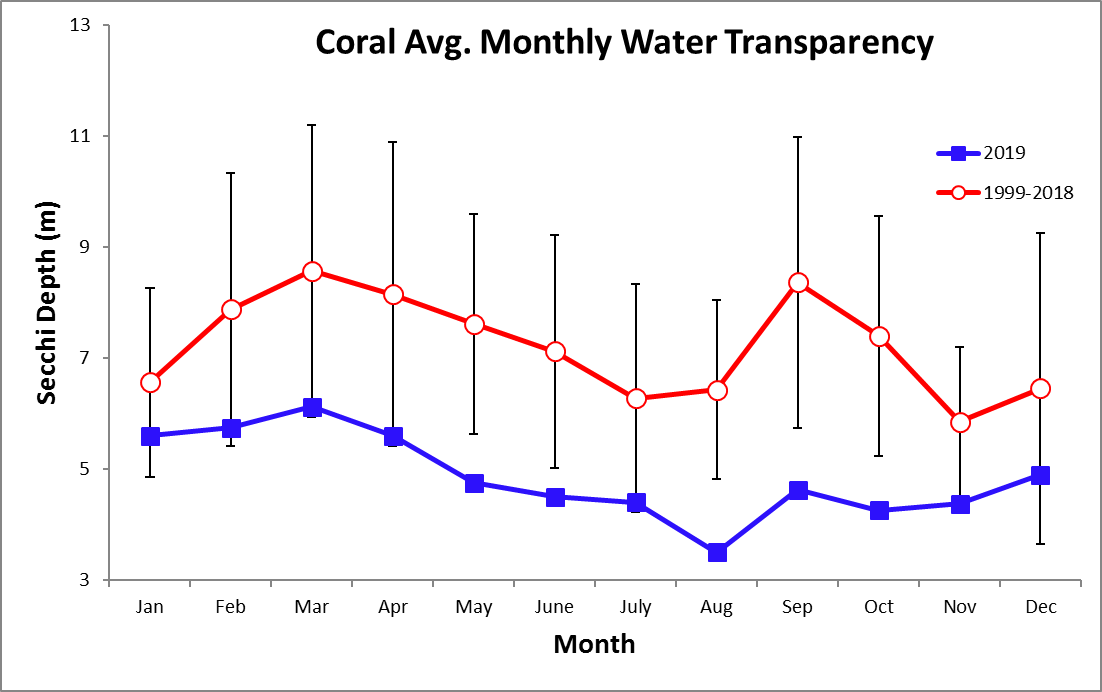




Average Water Transparancy (Secchi depth)

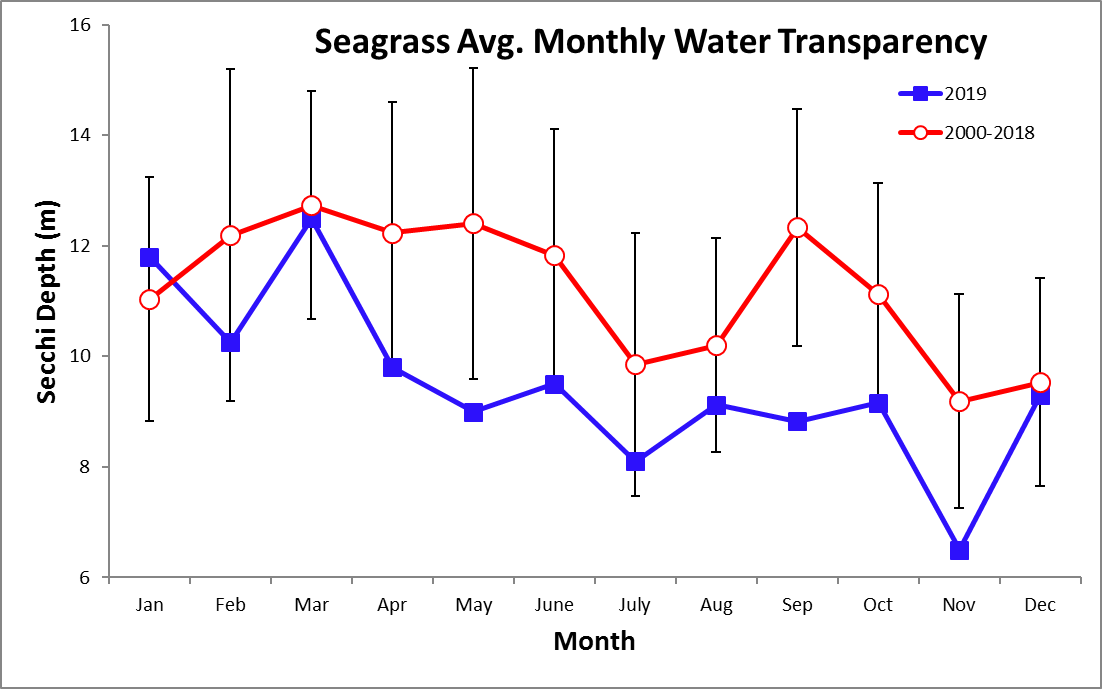
**Coral**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |

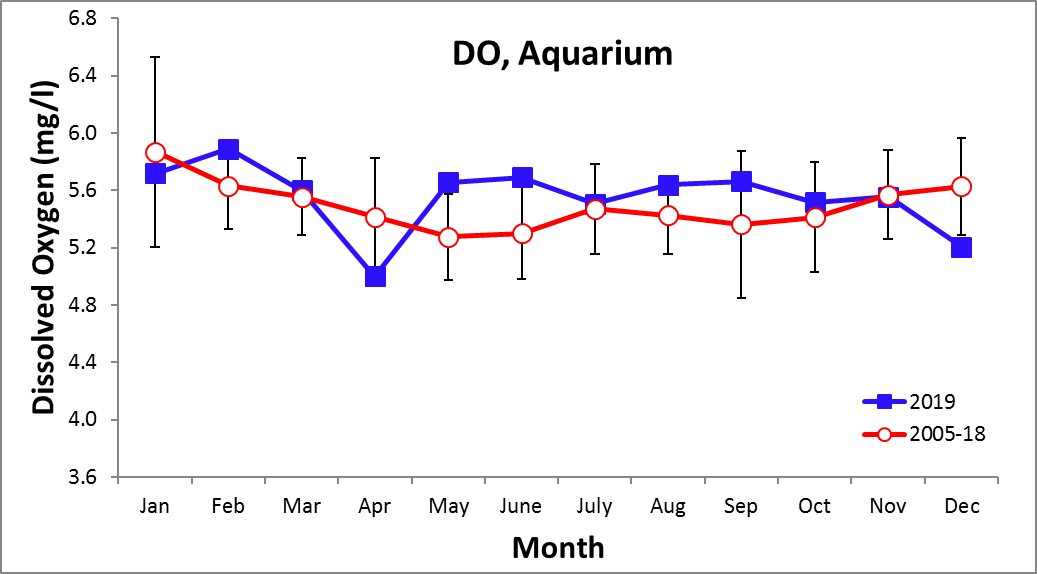
Average Disolved Oxygen (mg/l)

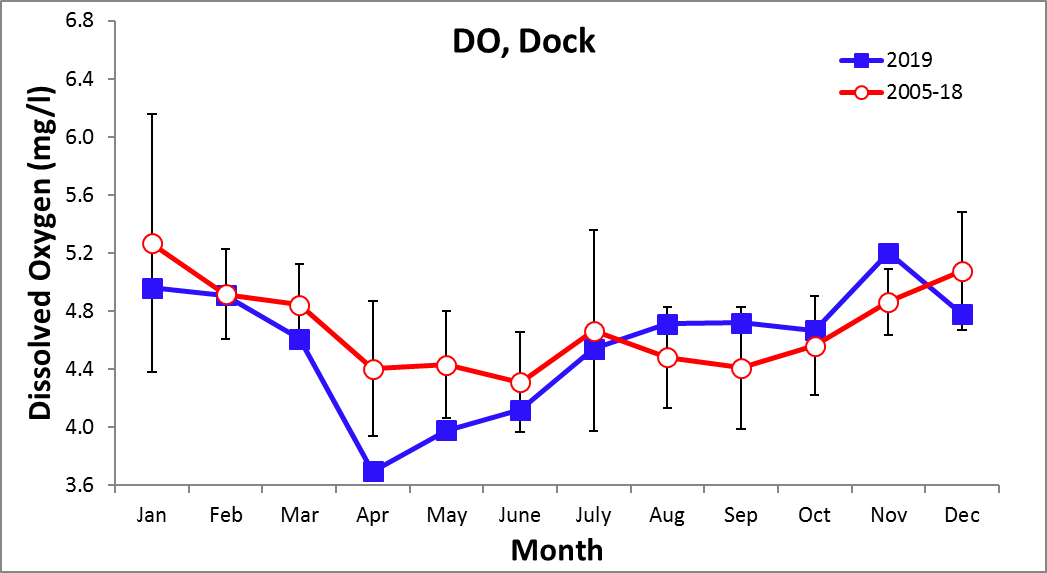
**Aquarium**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |

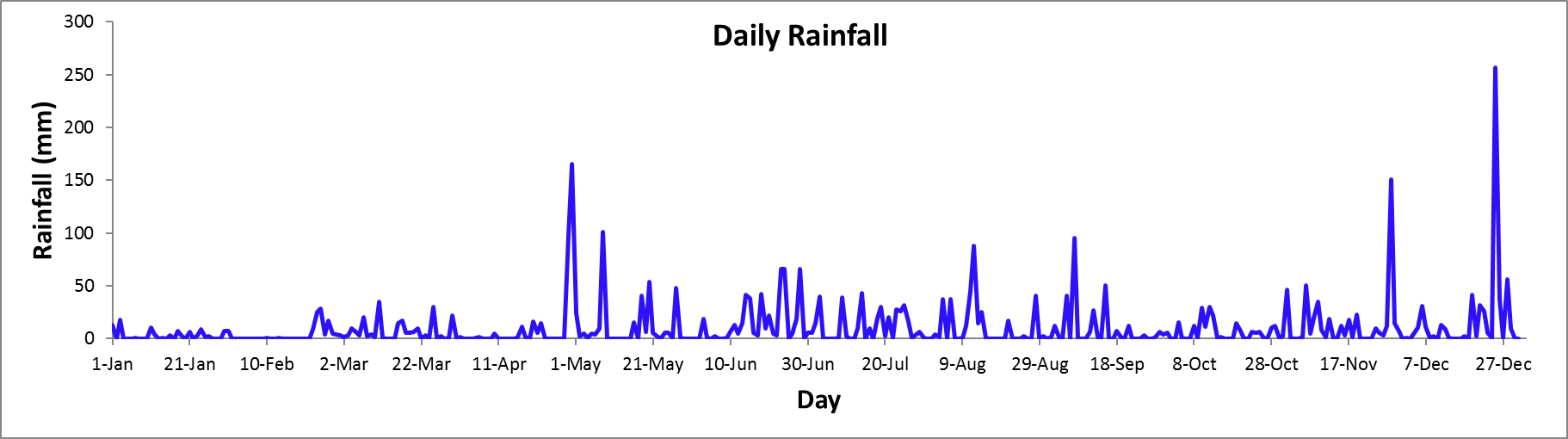
**Dock**

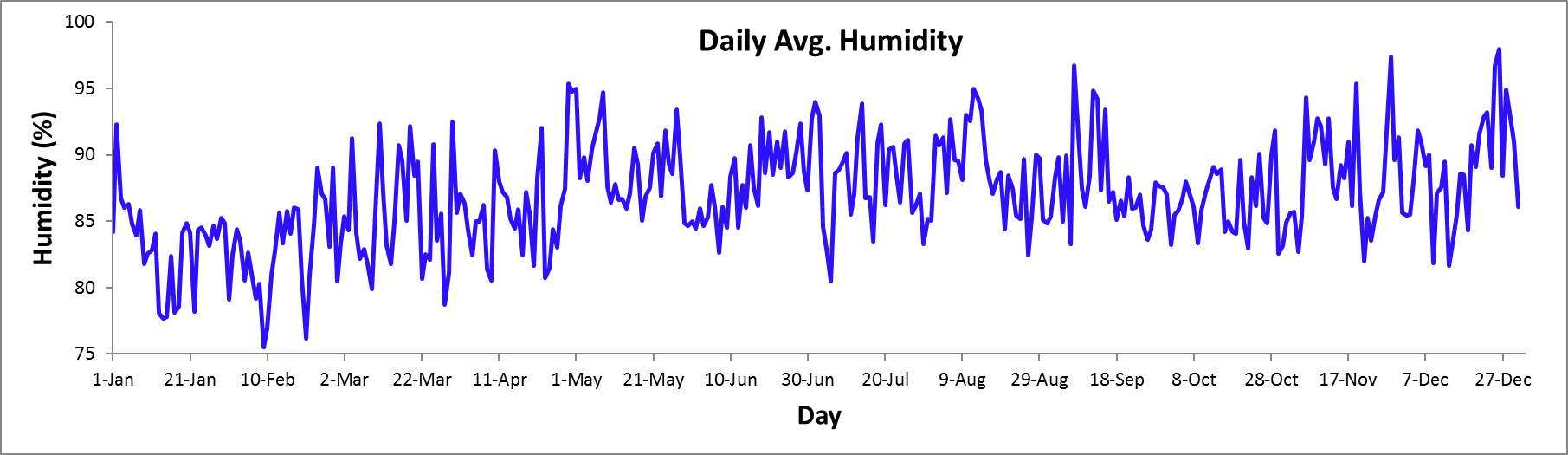
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **June** | **July** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** |
| **2005** |  |  |  |  | 4.4 | 4.3 | 3.7 | 4.6 | 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 |

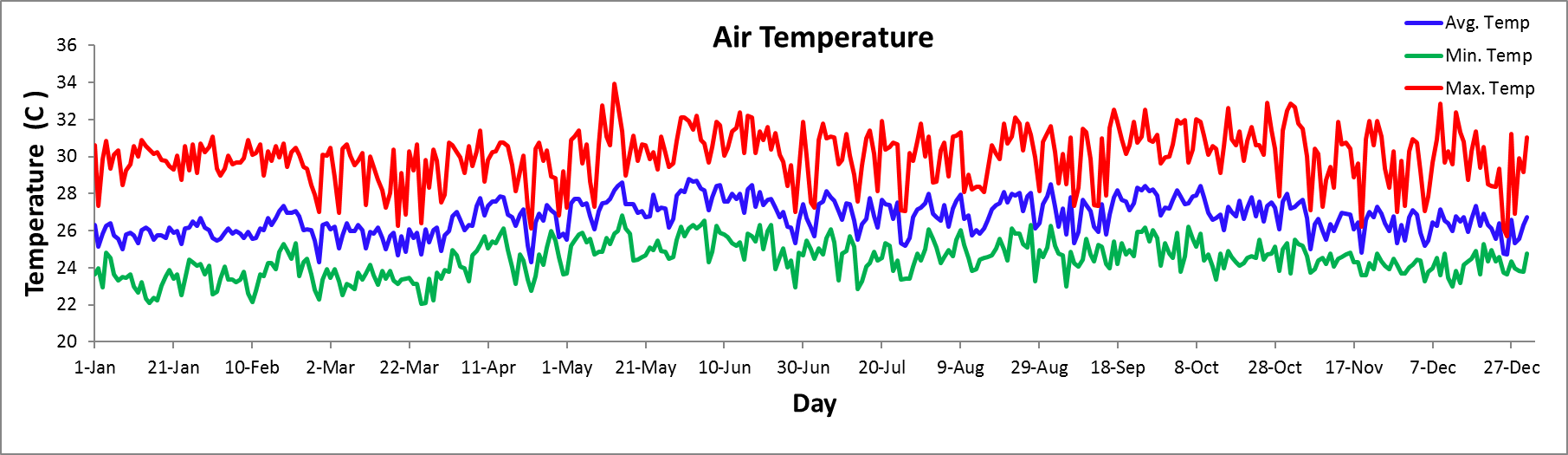


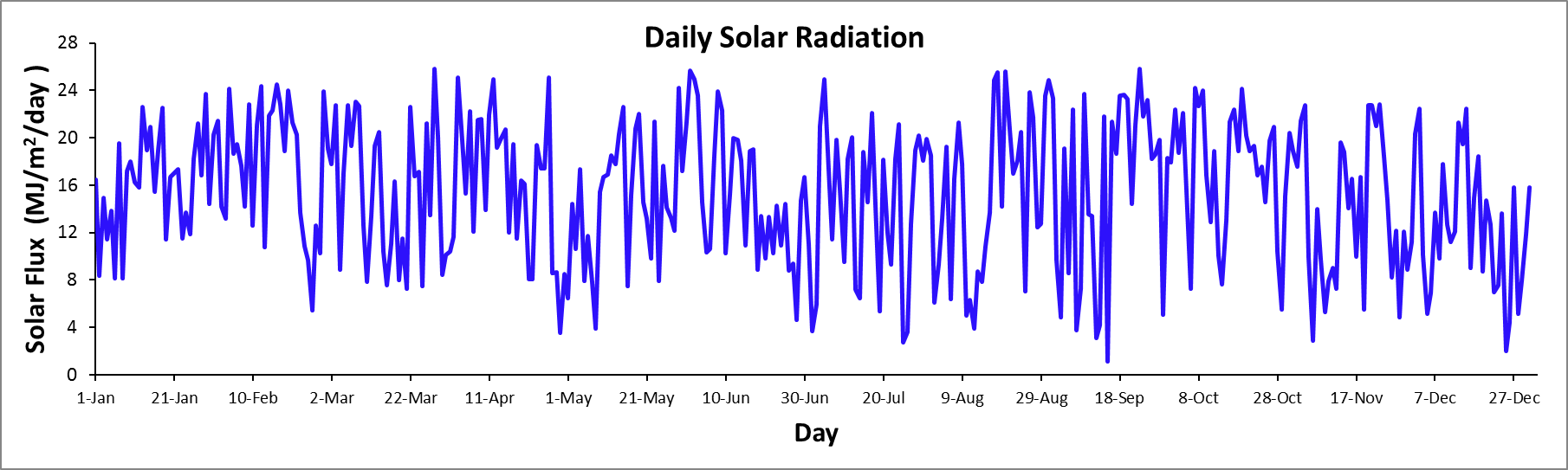


**Time Series – Daily, 2019**

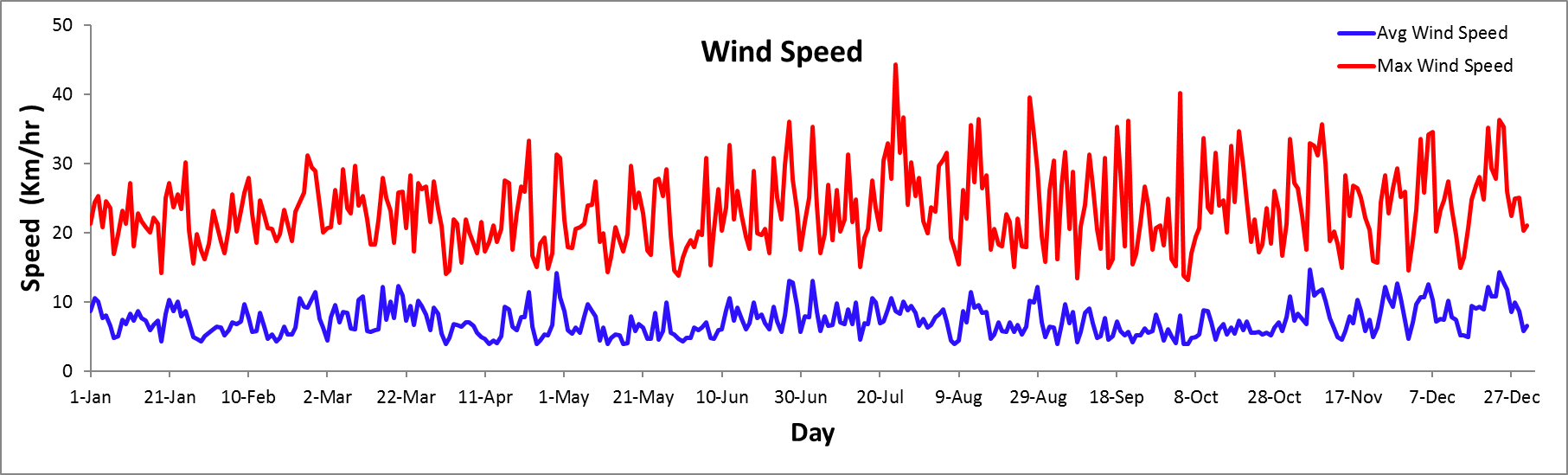


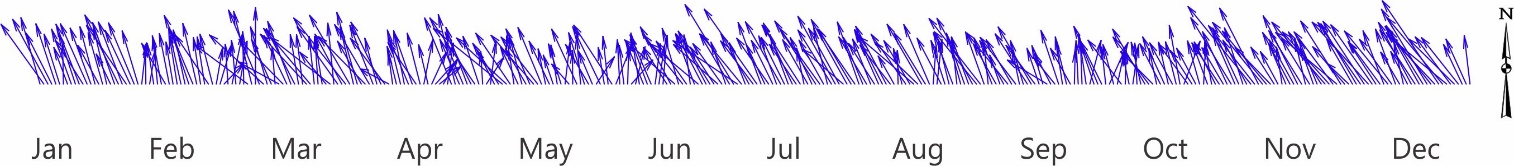


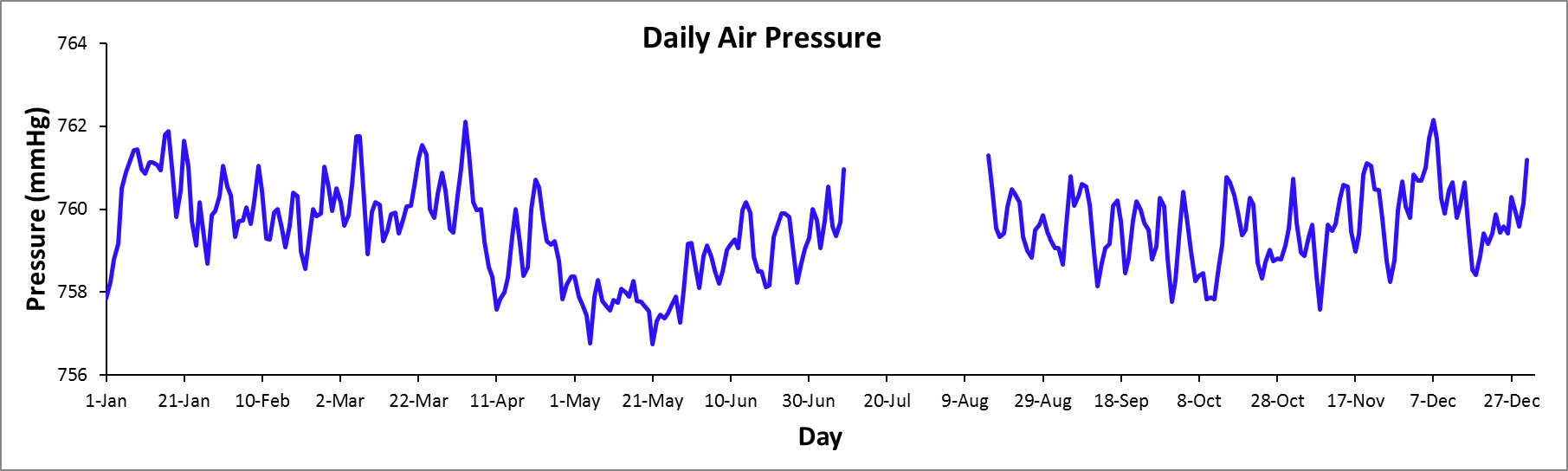


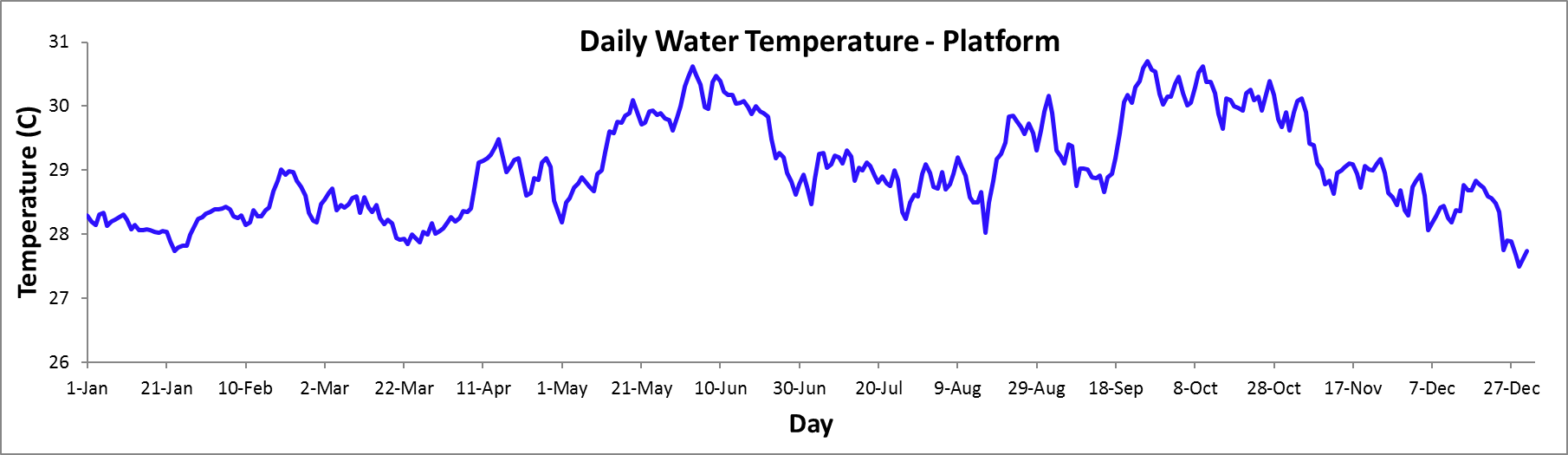


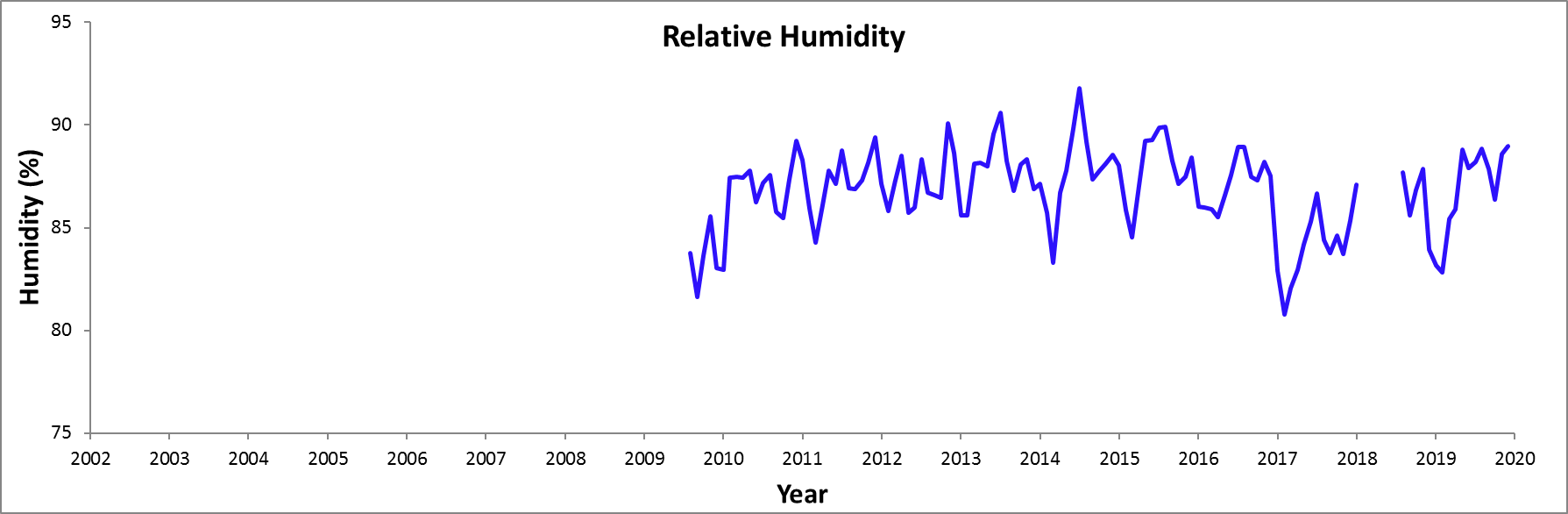
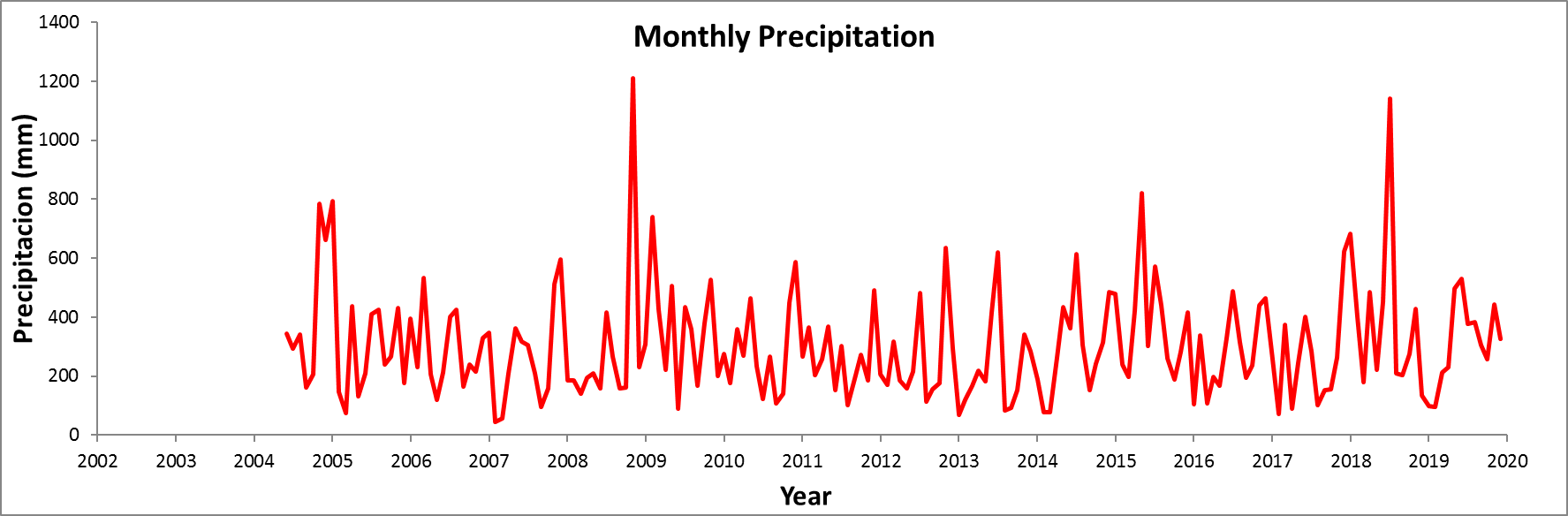
**Time Series – Daily, 2019**

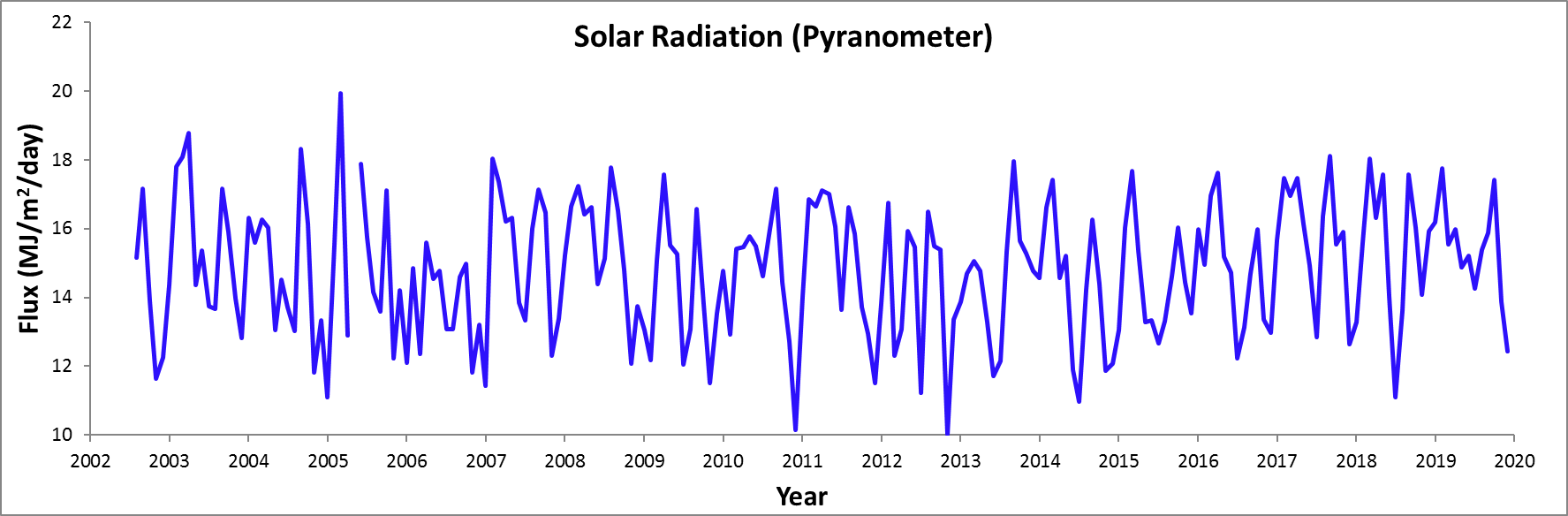
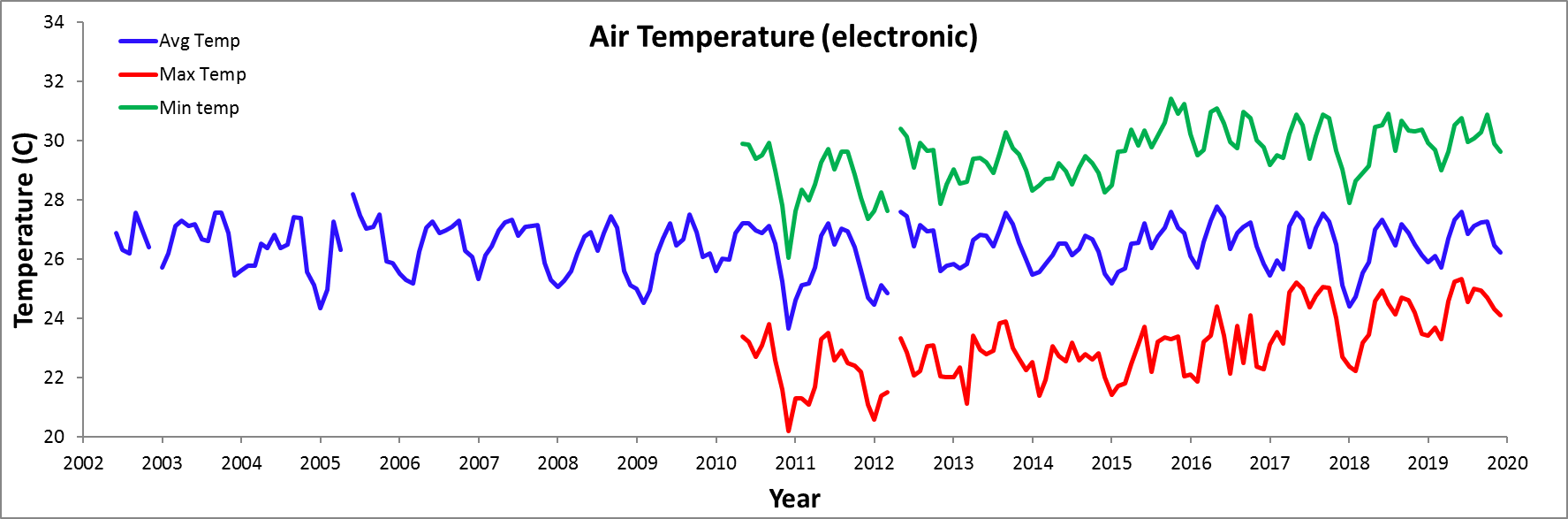
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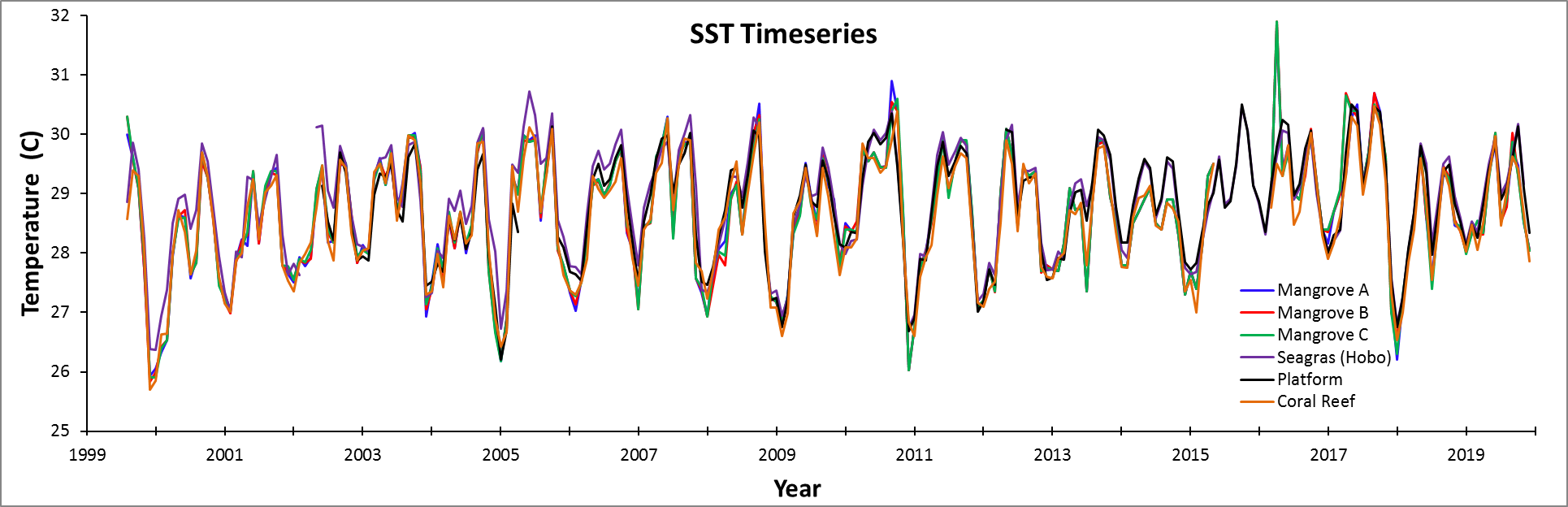
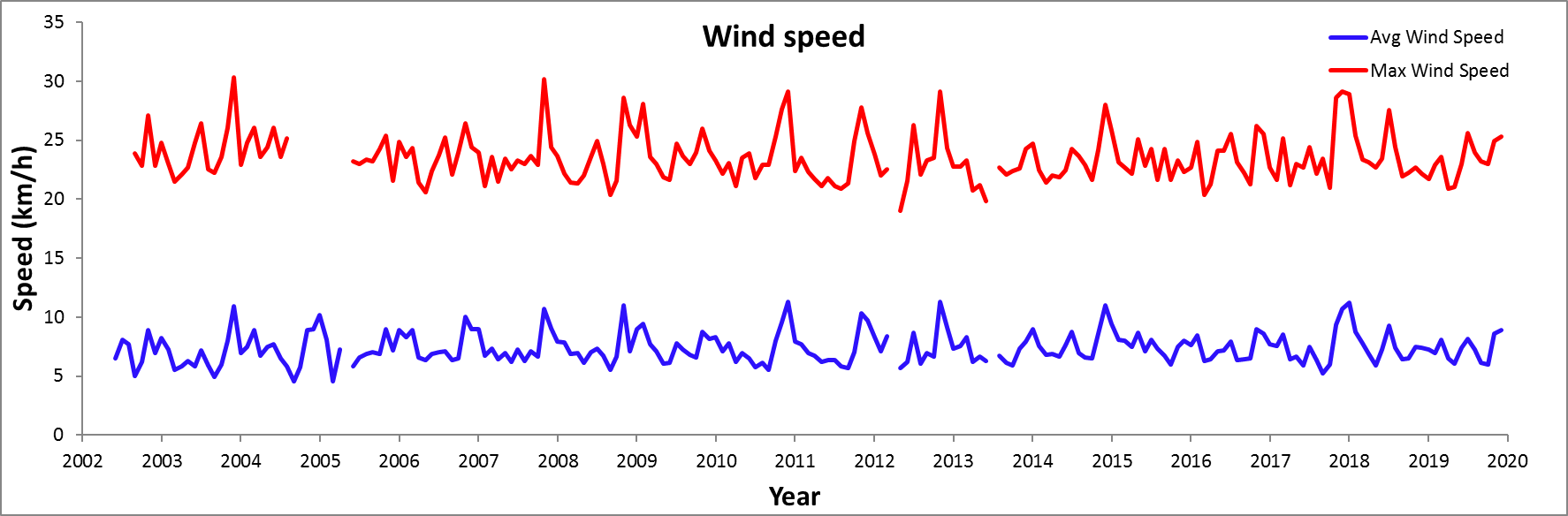


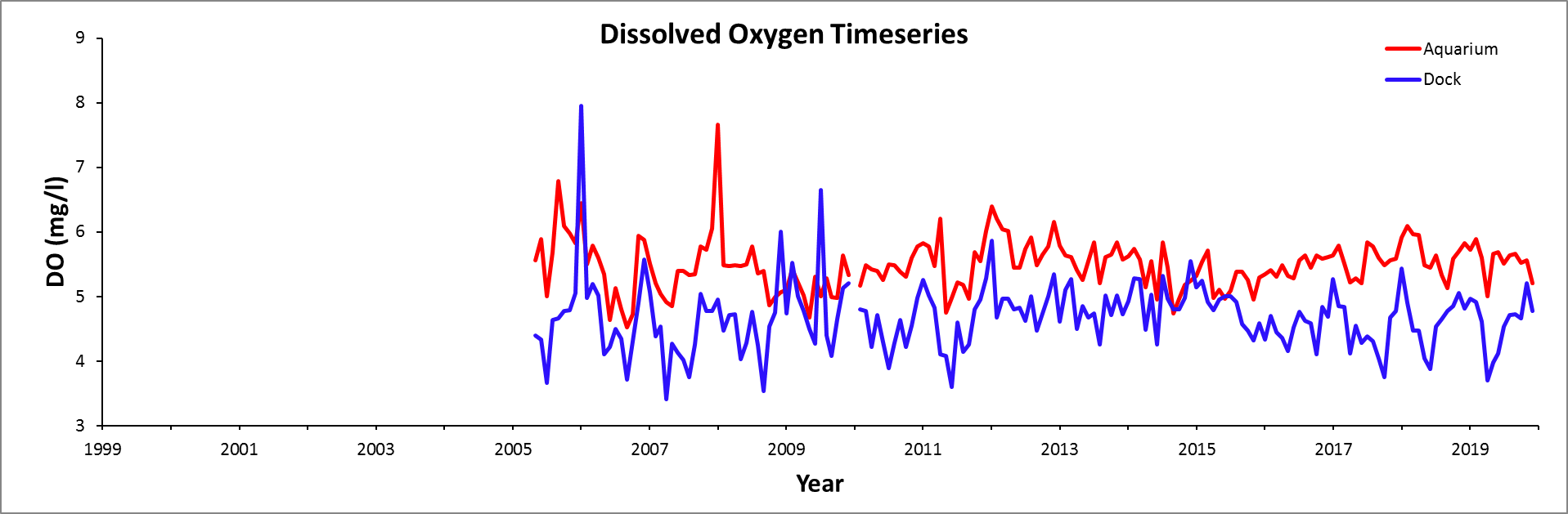


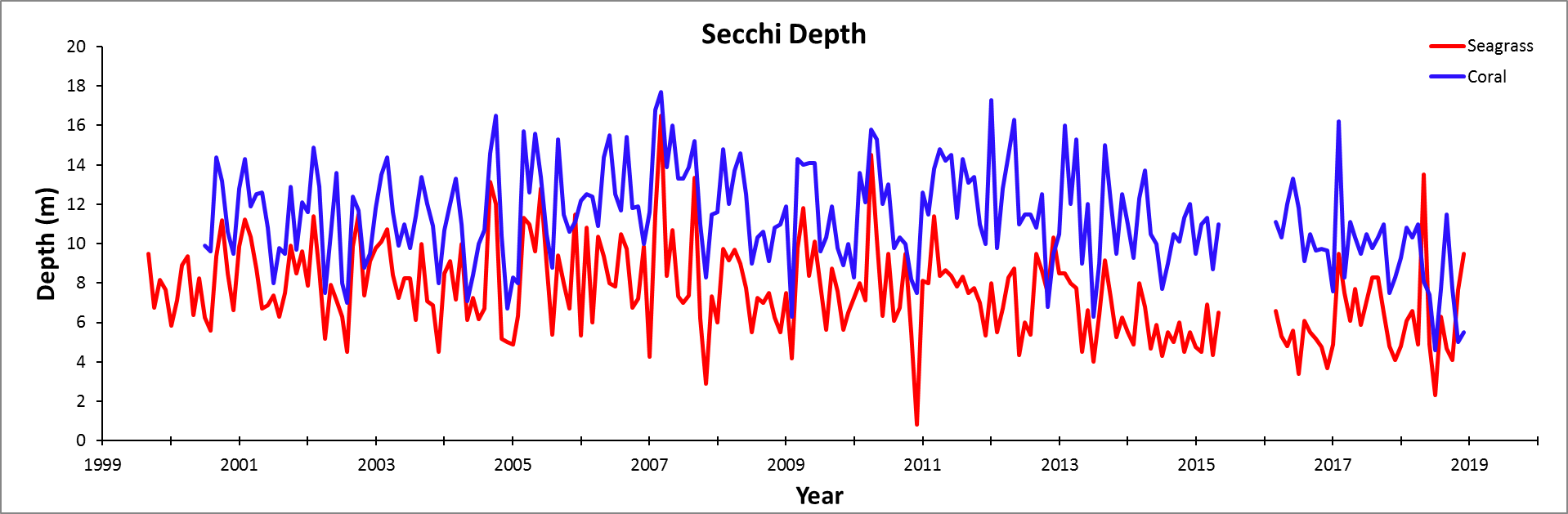
**Time Series – Monthly**

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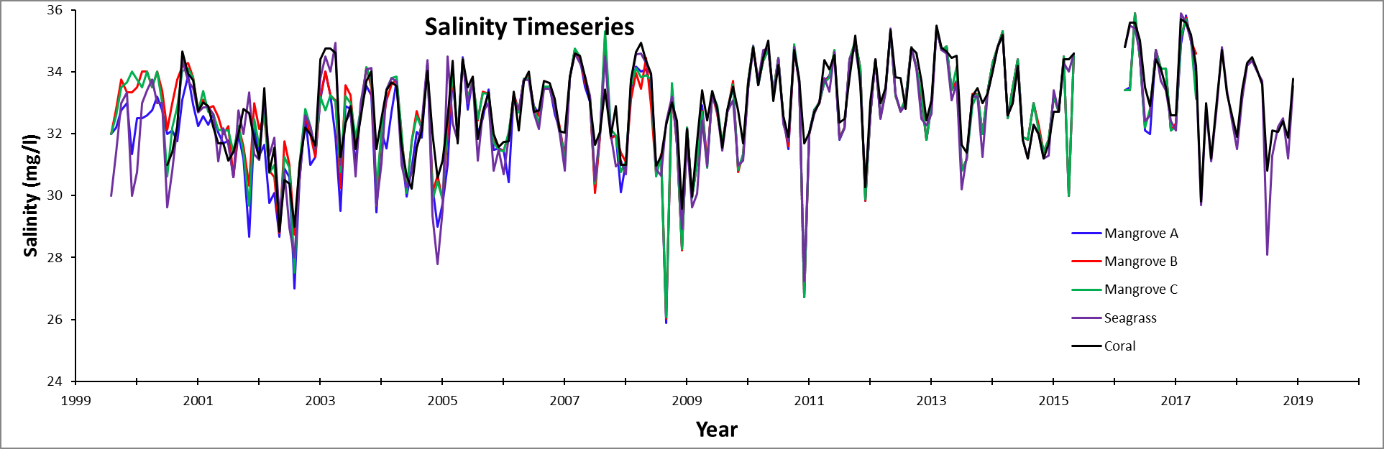
**Time Series – Monthly**

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**Time Series – Monthly**

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