ARUBA

CLIMATOLOGICAL SUMMARY 2016

PRECIPITATION

The total amount of rainfall recorded at Reina Beatrix International Airport for the year 2016 was **427.9** mm. This is **9.3 %** below normal (Figure 1).

During the first quarter of the year 2016 (January, February, March) a total of **13.8** mm of rainfall was recorded. This is **3.2 %** of the total amount for 2016.

During the second quarter of the year 2016 (April, May, June) a total of **26.6** mm of rainfall was recorded. This is **6.2 %**of the total amount for 2016.

During the third quarter of the year 2016 (July, August, September) a total of **127.7** mm of rainfall was recorded. This is **29.8 %** of the total amount for 2016.

During the fourth quarter of the year 2016 (October, November, December) a total of **259.8** mm of rainfall was recorded. This is **60.7 %** of the total amount for 2016.

The last quarter of the year 2016 which is part of the rainy season was the *wettest* quarter, and the total amount of rain for that quarter was above normal values. Keep in mind though that October was below normal.

The *wettest* month for 2016 was November with a total of **130.8** mm which was above normal values for that month. The *driest* month for 2016 were April and May with a total of **0.0** mm which is below normal for that month.

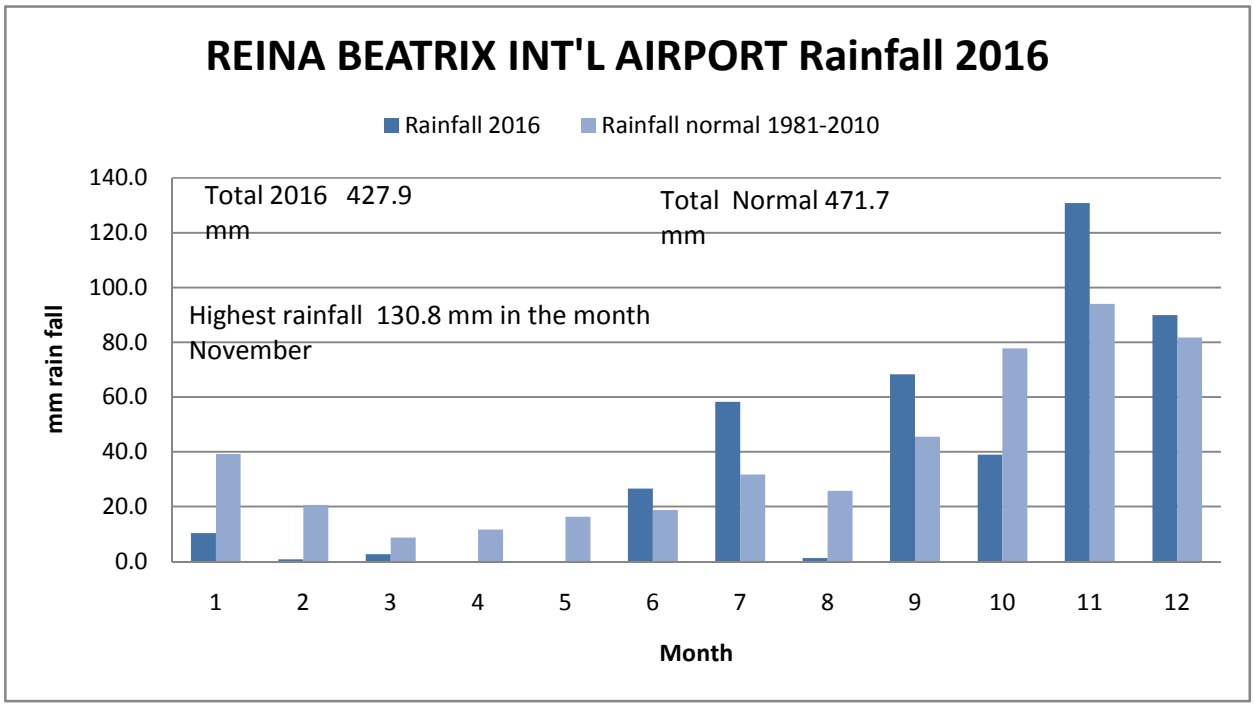

Figure 1. Rainfall 2016 versus 30 year normal (1981-2010) in mm.

TEMPERATURE

The year average air temperature recorded at the Reina Beatrix International Airport Aruba for 2016 was **28.8** ºC (normal value **28.1** ºC), which is a tab above normal. (Figure 2a).

August 2016 with an average of **29.9**ºC and September 2016 with an average of **29.9** ºC, and June 2016 with an average of **29.5**ºC and October 2016 with an average of **29.5** ºC, appear to be the warmest months of the year 2016.

The *warmest* months of 2016 were August and September with an average of **29.9** ºC and the *coldest* month of 2016 was January with an average of **27.2** ºC.

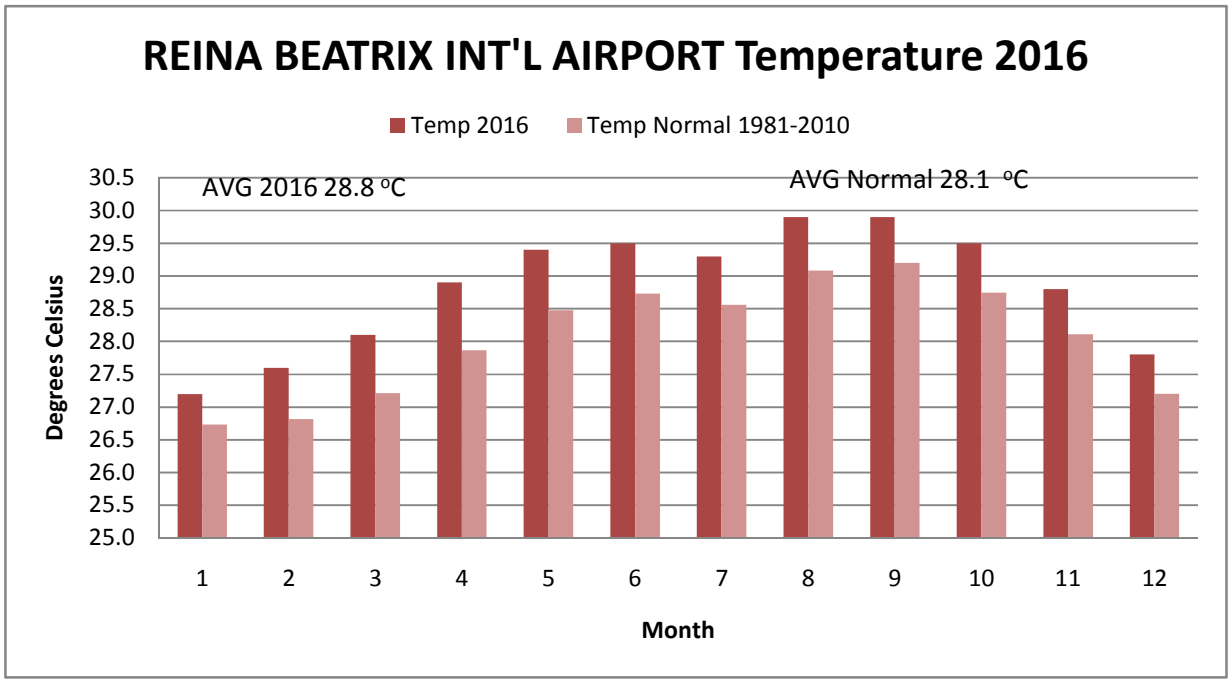

Figure 2a. Temperatures in degrees Celsius 2016.

The average maximum temperature for the year 2016 was **32.2** ºC compared with the normal average maximum temperature **31.5** ºC which is just a tab above normal. (Figure 2b).

The *absolute* maximum temperature was in August 2016 with **35.1** ºC and the *absolute* minimum temperature recorded was **23.4** ºC in November2016.

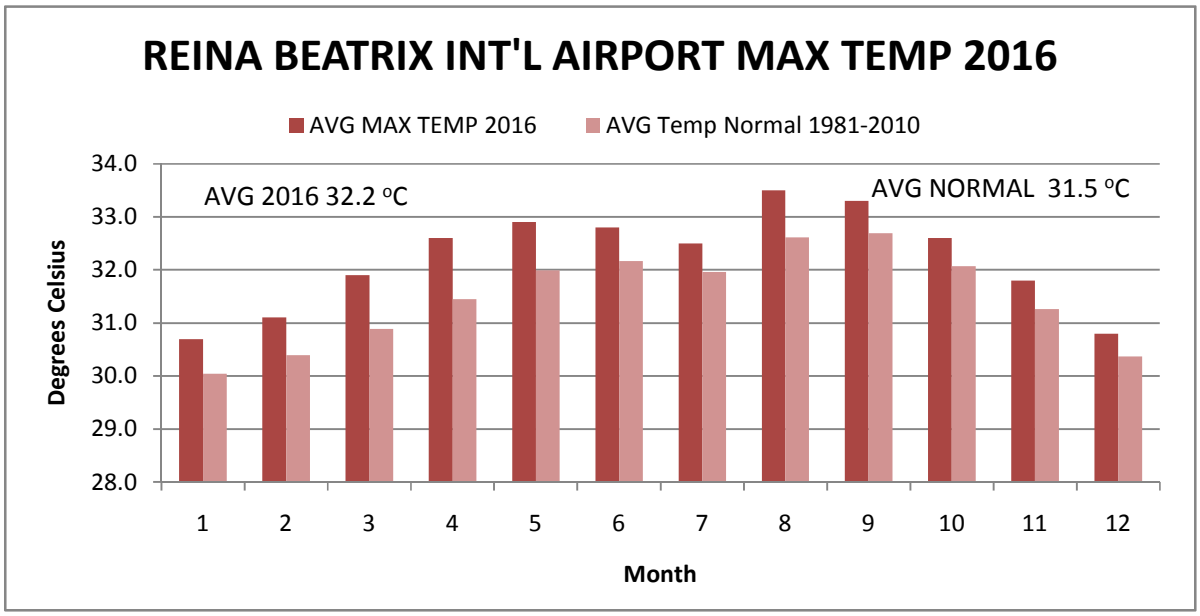

Figure 2b. Maximum temperatures in degrees Celsius 2016.

WINDSPEED

The year average wind-speed at 10 meters height for the year 2016 at the Reina Beatrix International Airport was **7.5 m**/sec (27.0 km/h) compared with the normal value of **7.3** m/sec (26.3 km/h) is just above normal.(Figure 3a).

The *highest* average wind-speed of **9.3** m/sec (33.5 km/h) was recorded during the month of June 2016. The *lowest* average wind-speed during the month of November 2016 with a **3.9** m/sec (14.0 km/h).

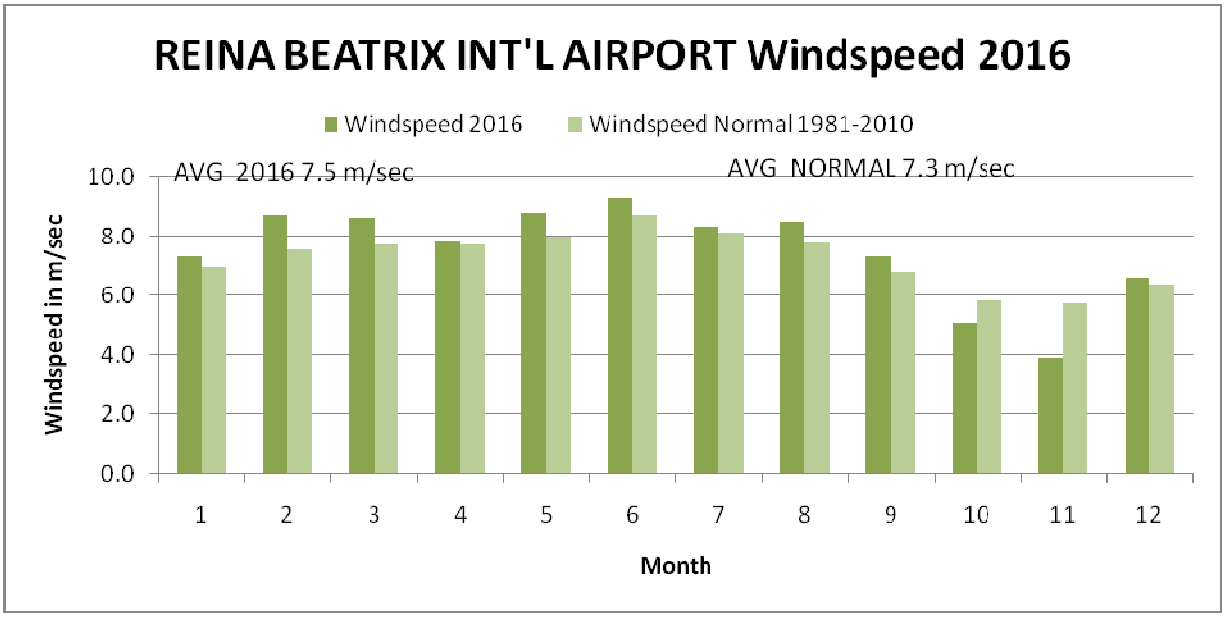

Figure 3a. Wind-speed 2016 in m/sec.

The average maximum wind-speed for the year 2016 was **15.1** m/sec (54.4 km/h) ,compared to the normal value of **14.5** m/sec (52.2 km/h), which is a tab above normal. (Figure 3b).

The *absolute* maximum wind-speed of **22.6** m/sec (81.4km/h) was recorded during the month of June2016.

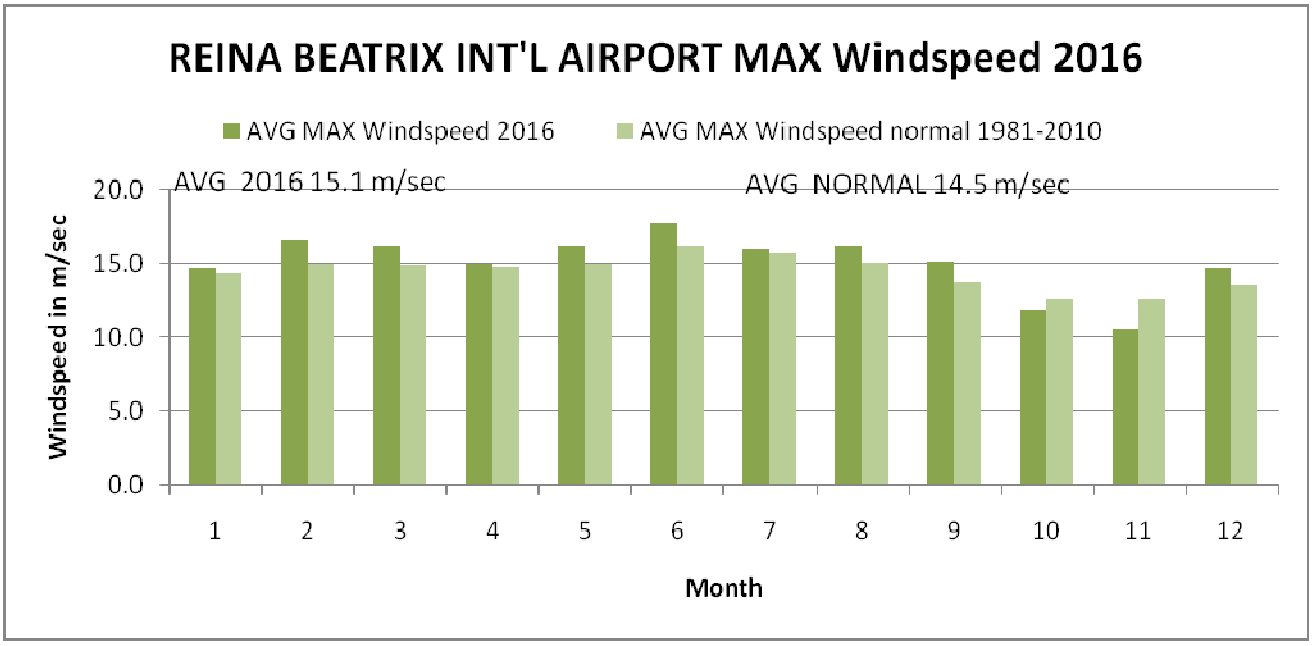

Figure 3b. Maximum wind-speed 2016 in m/sec.

The wind-rose figure indicates that for **66.6**% of the time the wind was between 11-17 knots. The wind was **16.7**% of the time between7-11 knots and was **16.7** % of the time between 17-21 knots (Figure 3c).

The wind was **75**% of the time from the East and **16.7**% of the time from the East-Northeast and **8.2**% from the East-Southeast.

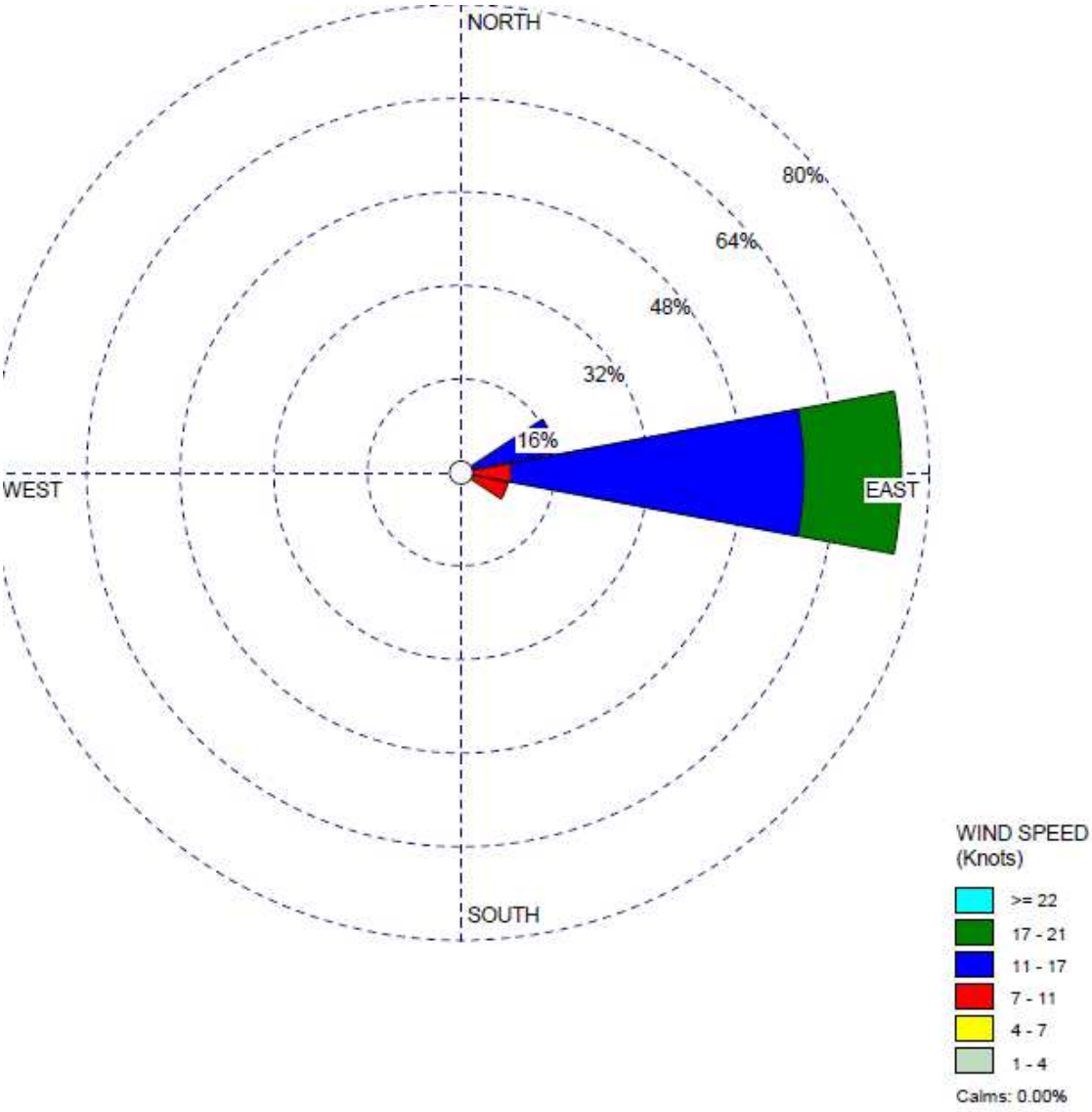

Figure 3c. Wind-rose data 2016 in knots.

ATMOSPHERIC PRESSURE

The average atmospheric pressure for 2016 recorded at the Reina Beatrix International Airport was **1011.7**hPa compared with the normal value of **1011.8**hPa which is around normal (Figure 4).

The *highest* monthly average atmospheric pressure of **1013.2**hPa was recorded during March2016 with the *lowest* during October2016 of **1009.1**hPa.

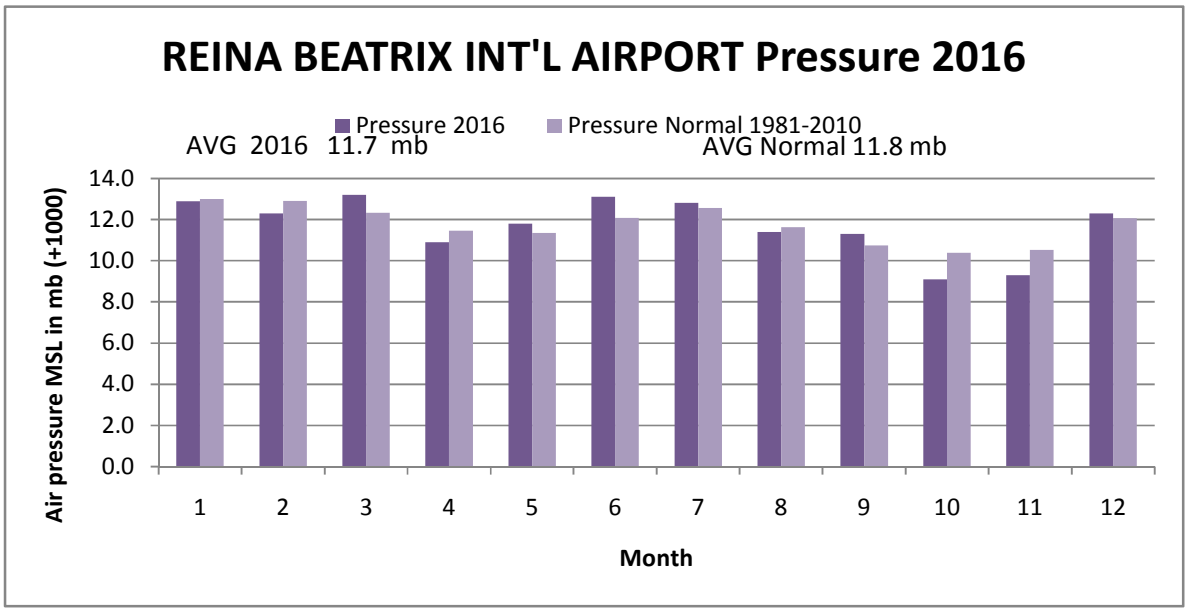

Figure 4. Atmospheric Pressure at MSL, (Mean Sea Level) in hPa (+1000) 2016.

CLOUD COVERAGE

The average cloud coverage in 2016 was **60.8** % compared with the normal value of **47.3**% which is a tab above normal. (Figure 5).

Highest average cloud coverage in 2016wasobserved during November(**74.1**%) with the *lowest* during the month of February(**47.5**%).

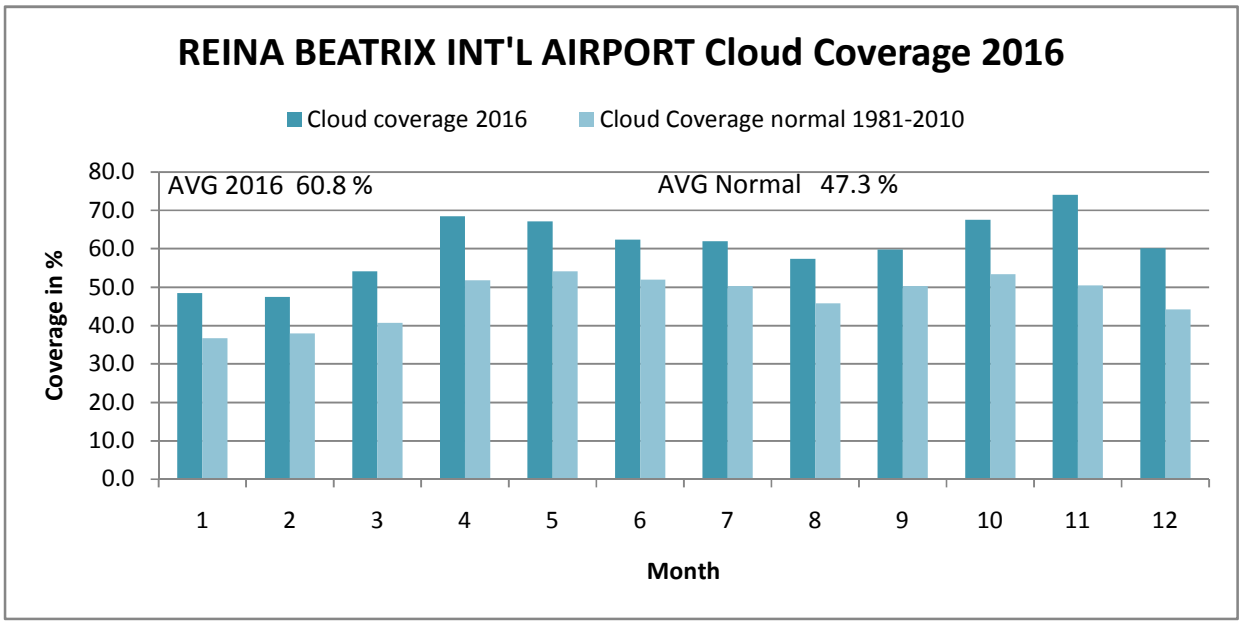

Figure 5. Total cloud cover in percentage 2016.

RELATIVE HUMIDITY

The average relative humidity of 2016 was **75.8**% compared to the normal value of **77.4**%, which is a tab below normal. (Figure 6). The months February and March were exceptionally dry compared to the climate normal.

Highest monthly average relative humidity of **79.1**% was recorded during the September2016with a *lowest* monthly average of **71.5%** during the month of March 2016.

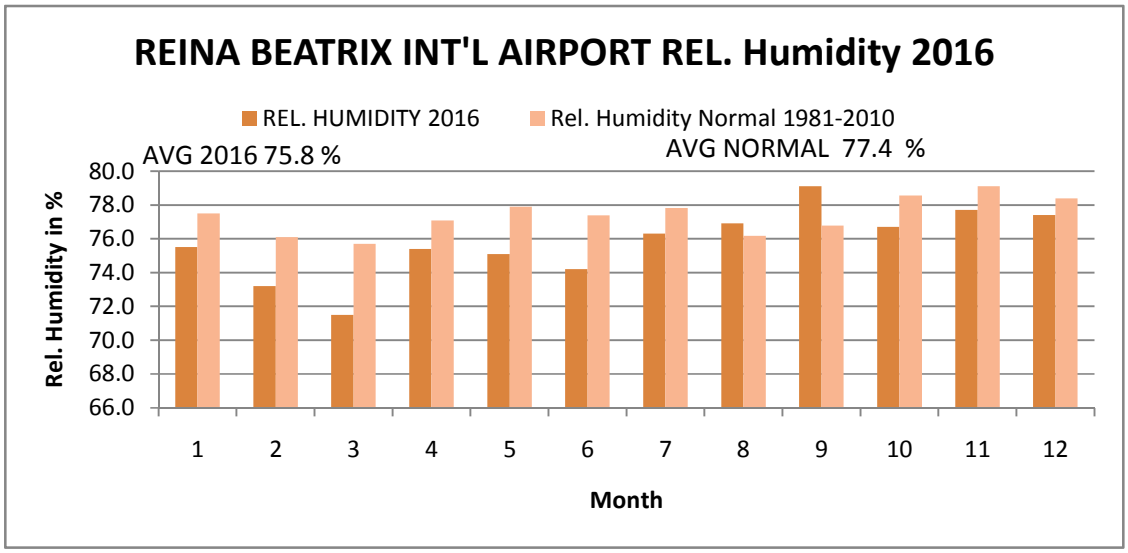

Figure 6. Relative humidity in percentage 2016.

SPECIAL OCCURRENCE (EVENTS) DURING THE YEAR 2016

SEISMIC ACTIVITIES:

There were about 9 earthquake events near Aruba recorded and felt by humans in the year 2016 of which the strongest earthquake was on Oct 1 2016 at 4:16 AM local time and had a magnitude of 3.8 with epicenter at latitude 11.79 degrees north and longitude 70.54 degrees west, which is about 98 kilometers southwest of Aruba and a depth of 18.5 kilometers.

EARTHQUAKES NEAR ARUBA YEAR 2016

Date	Local Time	Latitude North	Longitude West	Magnitude	Depth
	(AM/PM)	(degrees)	(degrees)		(km)
Nov 2 2016	1:06 PM	12.50	70.70	2.9	35.7
Oct 26 2016	9:20 PM	13.02	70.65	3.0	35.5
Oct 14 2016	3:35 AM	12.11	70.04	3.0	18.6
Oct 1 2016	4:16 AM	11.79	70.54	3.8	18.5
Jul 25 2016	3:54 AM	11.73	69.28	2.7	28.3
May 16 2016	11:50AM	12.80	70.49	2.7	14.6
Mar 24 2016	2:12 AM	11.81	69.22	3.3	33.9
Feb 3 2016	1:32 AM	12.30	69.98	2.5	3.6
Jan 3 2016	8:08 PM	11.84	70.27	2.5	21.1

Table 1. Earthquakes near Aruba year 2016.

SEVERE BAD WEATHER:

- **HURRICANE MATTHEW**

  Matthew formed out of an area of disturbed weather near the windward islands on the morning of the 28th of September, about 55 km...(35 mi) SE of St Lucia or 55 km…(35 mi) ENE of St. Vincent. The system moved initially towards the west and approached the local region later on Thursday becoming a hurricane, at about 300 km east of Curacao. Matthew strengthened into a category 2 hurricane by early Friday and in the meanwhile a tropical storm watch was in effect for Aruba as the system was moving north of the island still in a westward motion. Matthew strengthened rapidly over the Caribbean Sea to a category 3, major hurricane, while moving west- southwestward...and became a powerful category 5 hurricane, the same day, near 80 mi...125 km northwest of Punta Gallinas, Colombia.

  After a brief southern motion, Matthew began to move in the so long anticipated northwest to north directions and this motion brought the system south southwest of Port-au Prince and southeast of Kingston by Saturday morning. On this position the system began to induce dangerous swells into the Caribbean Sea as was foreseen by the Meteorological Department Aruba (DMA); Advisories and warnings were previously issued by the DMA. Swells that reached Aruba (see pictures) made considerable damage to the southern coastal region of the island. Finally, Matthew dissipated in the late afternoon of October 09 at about 200 mi…320 km east of Cape Hatteras, North Carolina.

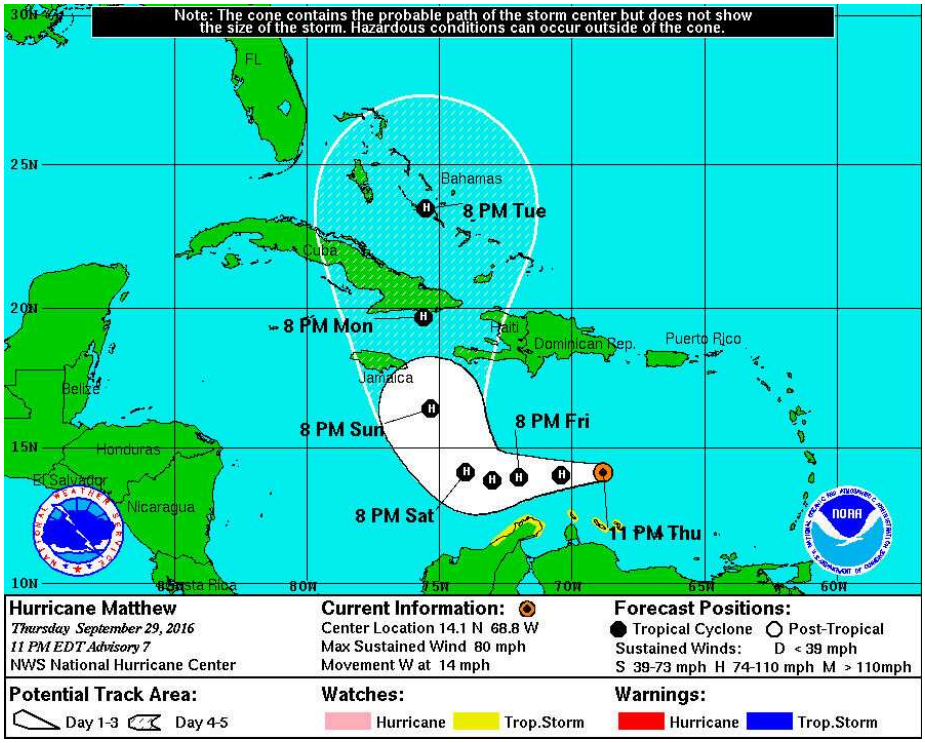

Figure 7. Path of Hurricane Matthew.

Figure 8a. Swells

Figure 8b. Swells

Figure 8c. Swells

- **THE EXTREME RAINFALL EVENT OF NOVEMBER 20**

  After a few days of upper level troughing in the south- central Caribbean, finally on Sunday the Inter Tropical Convergence Zone, ITCZ, activated over the ABC islands. For a couple of days, the DMA forecasted the rainfall event in the weather forecasts. Periods with thundershowers between 5 AM and 2 PM on Sunday, characterized this event as a total of 110 mm fell at the Reina Beatrix Airport. This was well above the 94 mm monthly average of November. At other stations as Hadicurari a total of 99.5 mm was registered and at Westpunt, 265.5 mm. This abundant rainfall was too much to handle at that moment and this event caused flashfloods that eventually caused damage to infrastructure, homes and a lot of “drowned” cars.

Figure 9a. Aruba flooding.

Figure 9b. Oranjestad, Aruba flooding.

CLIMATE ANOMALY:

2016 began with a strong El Niño event in place. The 2015-16 El Niño event ranks amongst the three strongest since 1950, along with 1982-83 and 1997-98. It declined steadily through the early months of 2016, following the typical breakdown pattern of El Niño, and most indicators had fallen below El Niño thresholds by May.

Global temperatures for January to September 2016 were 0.88 °C (1.58 °F) above the average for the 1961-90 reference period and approximately 1.2 °C above pre-industrial levels. They were especially warm in the early months of the year, with monthly anomalies of +1.12 °C (+2.02 °F) in February and +1.09 °C (+1.96 °F) in March, the largest monthly anomalies ever recorded.
The very warm ocean temperatures contributed to significant coral bleaching in some tropical waters.

In the early months of 2016, precipitation in many parts of the world was strongly influenced by El Niño. Precipitation for the 12 months from July 2015 to June 2016 was well below average in many areas which typically show a dry signal during El Niño, such as Indonesia and the islands of the tropical western Pacific, much of southern Africa, and the northern half of South America along with parts of Central America and the Caribbean. The Caribbean region suffered the harsh consequences of prolonged drought: in Haiti, for instance, over 1.5 million people were found to be severely food insecure owing in part to drought-related impacts.

Conditions cooled slightly from May as the influence of the declining El Niño event decreased, but all months were still at least 0.7 °C above the 1961-90 average.
Since May, sea surface temperatures in the equatorial central and eastern Pacific Ocean have been near or slightly below average. As of early November, they have not yet fallen below La Niña thresholds, although some climate model forecasts are indicating the possibility of weak La Niña conditions in the final weeks of 2016.

It is important to note that El Niño and La Niña are not the only factors that drive global climate patterns. For example, the state of the Indian Ocean (the Indian Ocean Dipole), or the Tropical Atlantic Sea Surface Temperature, are also capable of affecting the climate in the adjacent land areas. Northern hemisphere winter conditions are influenced by the so-called Arctic and North Atlantic Oscillations.

TROPICAL CYCLONE ACTIVITIES:

For the 2016 season, 15 named storms formed, of which 7 became hurricanes, and 3 became major hurricanes. One unnamed depression also formed in the basin. The number of named storms and hurricanes in 2016 was above the long-term averages of 12 and 6, respectively. The season total of major hurricanes matched the long-term average of 3.

One named storm, Otto, which became a hurricane, formed in the Atlantic basin in November. Based on a 30-year (1981-2010) climatology, a named storm forms in the basin in November in about 7out of 10 years, with a hurricane forming about once every other year.

In terms of Accumulated Cyclone Energy (ACE), which measures the combined strength and duration of tropical storms and hurricanes, activity in the basin for 2016 was above normal. Overall, the ACE for the season was about 40 percent above the 1981-2010 median value. It is noteworthy that just three cyclones, Matthew, Gaston, and Nicole, produced more than 70 percent of the seasonal ACE, while many of this year's other cyclones were relatively weak and/or short lived.

Name	Dates	Max Wind (mph)
H Alex	12-15 Jan	85
TS Bonnie	27 May- 4 Jun	45
TS Colin	5- 7 Jun	50
TS Danielle	19-21 Jun	45
H Earl	2-6 Aug	80
TS Fiona	16-23 Aug	50
MH Gaston	22 Aug- 3 Sep	120
TD Eight	28 Aug- 1 Sep	35
H Hermine	28 Aug- 3 Sep	80
TS Ian	12-16 Sep	60
TS Julia	14-18 Sep	40
TS Karl	14-25 Sep	70
TS Lisa	19-25 Sep	50
MH Matthew	28 Sep- 9 Oct	160
MH Nicole	4-18 Oct	130
H Otto	21-26 Nov	110

Table 2. Hurricanes 2016.

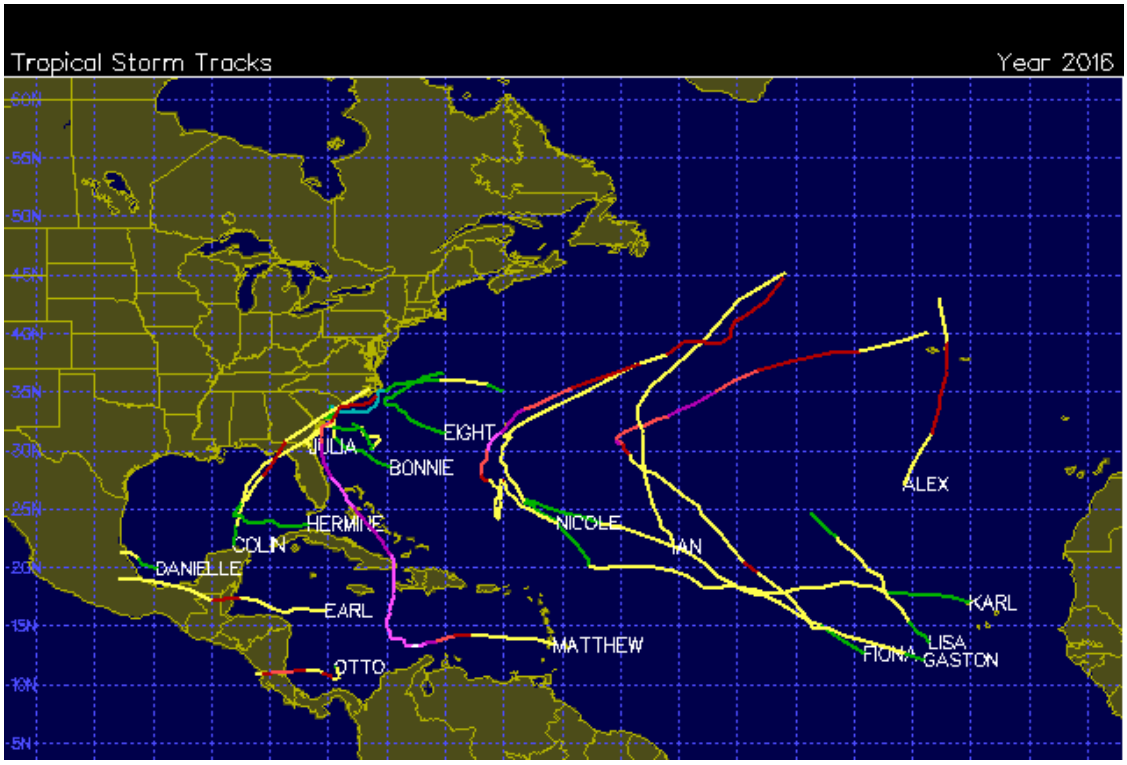

Figure 10. Storm tracks Atlantic Basin 2016.

In figure 7 we can see the storm tracks. Major-hurricane Matthew was the closest to Aruba but was no major threat.

For the year 2017 a near-normal hurricane season is forecasted.
Keep in mind that these are extreme long-term forecasts and therefore changes can occur.

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