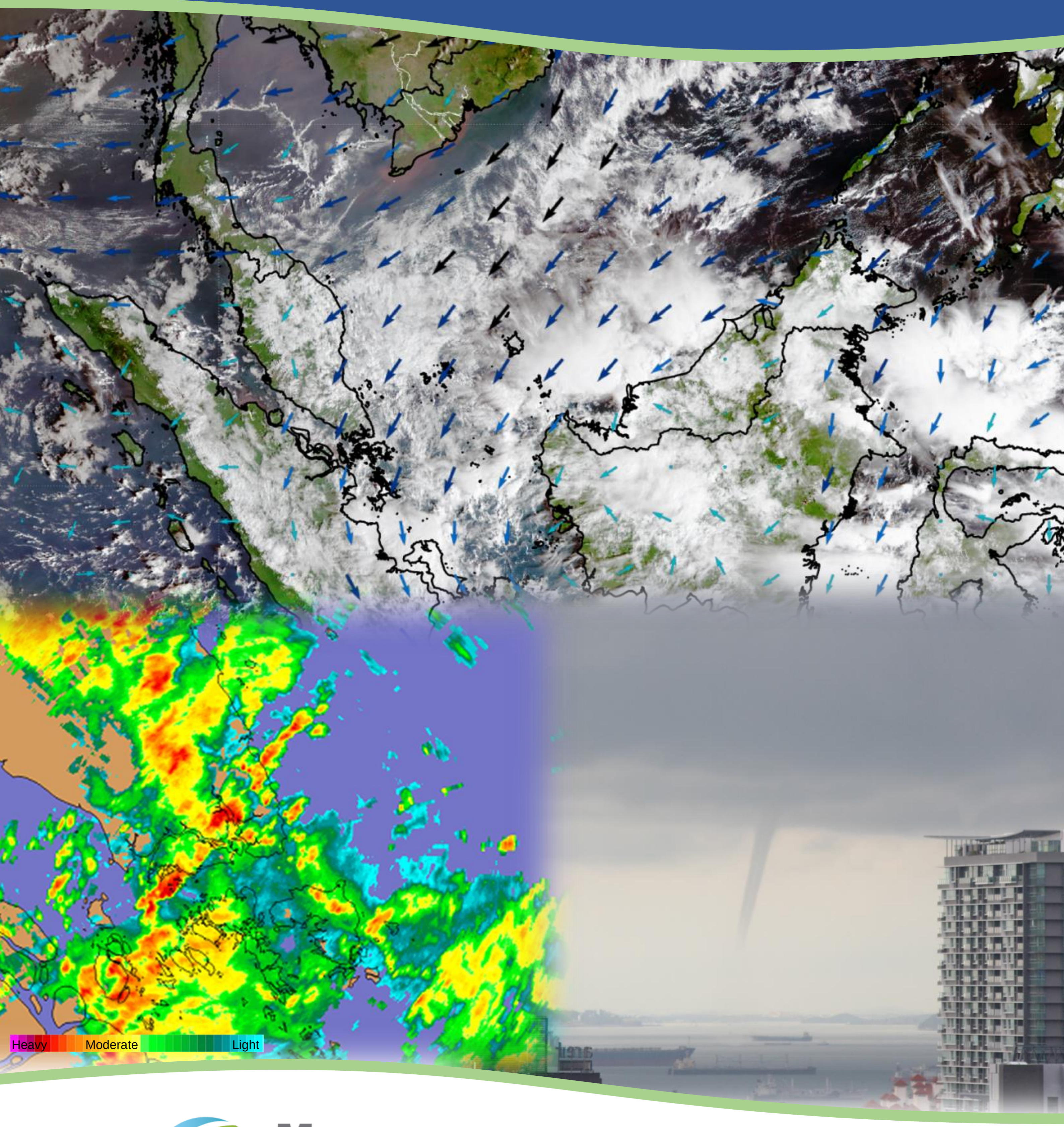
ANNUAL CLIMATE ASSESSMENT 2017
SINGAPORE



Meteorological Service Singapore
Centre for Climate Research Singapore

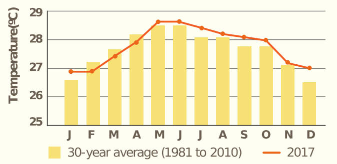
Introduction

The climate influences many aspects of our lives. How today's climate compares with historical records and how it is changing is a topic of interest for many stakeholders.

The Annual Climate Assessment Report provides updates on the climate trends over Singapore and, describes the key climatic features as well as the notable weather events that have affected Singapore during the year. It provides the information needed to understand the state of the current climate of Singapore and place it within a historical perspective.

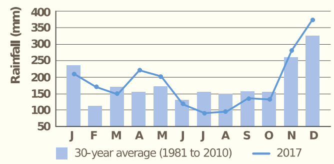
Singapore's Climate in 2017

2017 was the joint 12th warmest year on record since 1929 in Singapore, and the warmest year on record that was not influenced by an El Niño event.



Monthly mean temperatures in 2017 compared with the corresponding long-term average.

The mean annual temperature at 27.7°C was 0.2°C higher than the 1981-2010 long-term average. December 2017 registered the highest temperature anomaly.



Monthly mean rainfall in 2017 compared with the corresponding long-term average.

In 2017, Singapore's annual total rainfall was 2,045.6mm; around 6% below the 1981-2010 long-term average.

EXTREMES IN 2017

	All Available Stations	Climate Station (Changi)	Climate Station Records
Hottest Day	**35.7°C** 15 Mar (Jurong West)	**34.6°C** 18 Oct	**36.0°C** 26 Mar 1998
Coldest Night	**21.7°C** 11 Jan (Tai Seng & Pulau Ubin) 15 Aug (Tuas)	**21.8°C** 11 Jan	**19.4°C** 30 & 31 Jan 1934
Wettest Day	**149.6mm** 31 Dec (Buona Vista)	**69.8mm** 13 Dec	**512.4mm** 2 Dec 1978
Warmest Month	**29.4°C** Jun (Marina Barrage)	**28.5°C** May/Jun	**29.5°C** Mar 1998
Coolest Month	**26.1°C** Feb (Clementi)	**26.9°C** Jan/Feb	**24.2°C** Jan 1934
Wettest Month	**606.0mm** Nov (Sembawang)	**371.2mm** Dec	**818.6mm** Jan 1893
Strongest Wind Gust	**90.0km/h** 20 Sep (Pasir Panjang)	**57.6km/h** 23 Jun	**90.7km/h** 29 Nov 2010

Extremes in 2017 across all available stations and the climate station (refer to the last page for more information on MSS' network of weather stations).
**The non-climate stations complement the measurements at the climate station, including providing indications of local conditions.*

Singapore Climate in 2017

After two successive record warm years in 2015 and 2016, 2017's mean annual temperature of 27.7°C was closer to the 1981-2010 long-term climatological average. This was 0.2°C higher than the long-term average and the joint 12th warmest year on record since 1929. The year 2017 was also Singapore's warmest on record that was not influenced by an El Niño event, which is indicative of the long-term warming that Singapore has been experiencing.

El Niño Southern Oscillation (ENSO[1]), a naturally occurring phenomenon and a major contributor to year-to-year rainfall and temperature variations over Singapore and Southeast Asia, was neutral throughout 2017 except in November and December where it reached borderline La Niña[1] values. Given the influence ENSO has on temperatures, it is not surprising that following the 2015-16 large El Niño[1] event which contributed to 2015 and 2016 being successive record warm years, no temperature record was broken in 2017.

Monthly temperatures in 2017 were mostly slightly above the monthly long-term average. December registered the highest temperature anomaly of +0.6°C (Figure 1).

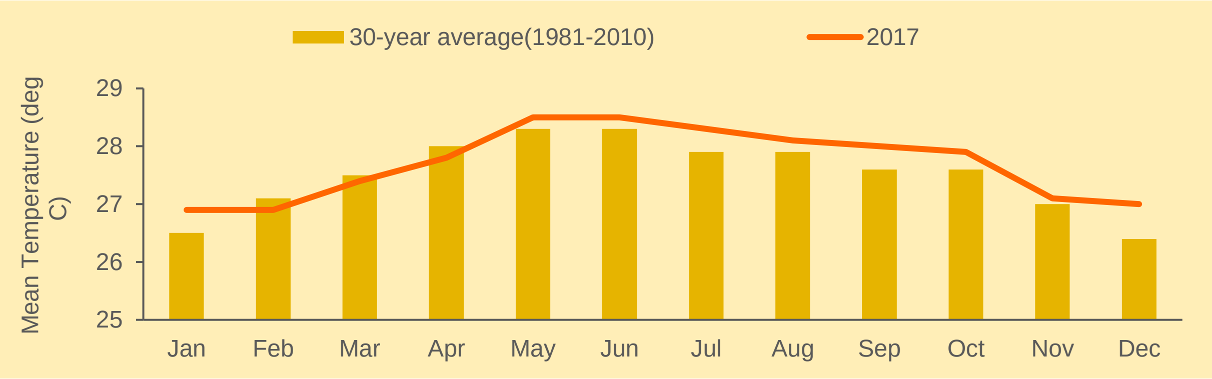


Figure 1: Monthly mean temperatures in 2017 compared with the corresponding long-term average.

For rainfall, there was a mix of above- (wetter) and below-normal (drier) conditions for the individual months in 2017 (Figure 2). Overall, the annual total rainfall was close to normal, which was more likely to occur during a largely neutral ENSO year. The total rainfall of 2,045.6 mm recorded at Changi climate station was around six percent below the 1981-2010 long-term average of 2,165.9 mm.

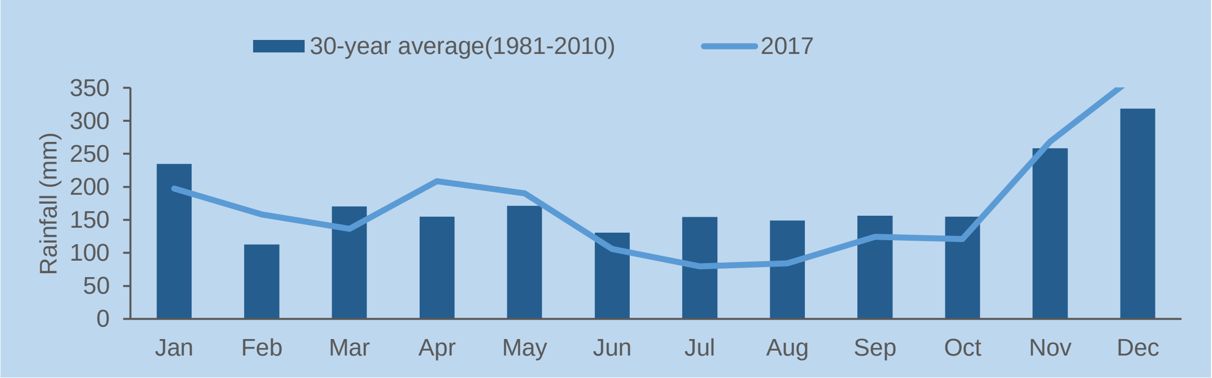


Figure 2: Monthly rainfall in 2017 compared with the corresponding long-term average.

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[1] El Niño Southern Oscillation (ENSO) is a recurring climate pattern caused by interactions between the atmosphere and the ocean in the tropical Pacific. During El Niño, the central-eastern tropical Pacific Ocean is warmer than usual, leading to drier and warmer conditions over Southeast Asia especially during the June to October period. During La Niña, the central-eastern tropical Pacific is cooler than average and the atmosphere over the Southeast Asia region is typically wetter than average. El Niño or La Niña events occur on average once every three to five years.

Large-scale Climate Variability in 2017: ENSO Behaviour

Following the short-lived La Niña conditions in late 2016, ENSO returned to the neutral phase in early 2017. A notable but brief 'coastal' El Niño in the far eastern tropical Pacific followed soon after around March 2017. It led to above-average rainfall conditions but its impact was limited to the coastal regions of north-western South America (Peru, Colombia, and Ecuador) and did not affect the western side of the Pacific Ocean, including Singapore. Up to August 2017, the sea surface temperatures (SSTs) and the atmospheric conditions over the tropical Pacific Ocean were neutral; Singapore's and the nearby region's rainfall and temperature did not show any ENSO-related influence.

As late as August 2017, experts' assessment of the model outlook from the European Copernicus Climate Change Service (C3S) along with the joint Climate Prediction Centre (CPC) and International Research Institute (IRI) indicated neutral conditions to prevail in the tropical Pacific for the rest of 2017. In September 2017, however, the ENSO outlook (Figure 3) changed to favour La Niña over neutral conditions from the September-November season onwards. This was in response to the rapid cooling of sub-surface temperatures over the tropical Pacific from August 2017. The 3-month average Nino3.4 index crossed La Niña thresholds by October 2017 (Figure 4), which is relatively late compared with the typical mid-year onset of ENSO events. The La Niña remained within weak thresholds for the rest of 2017.

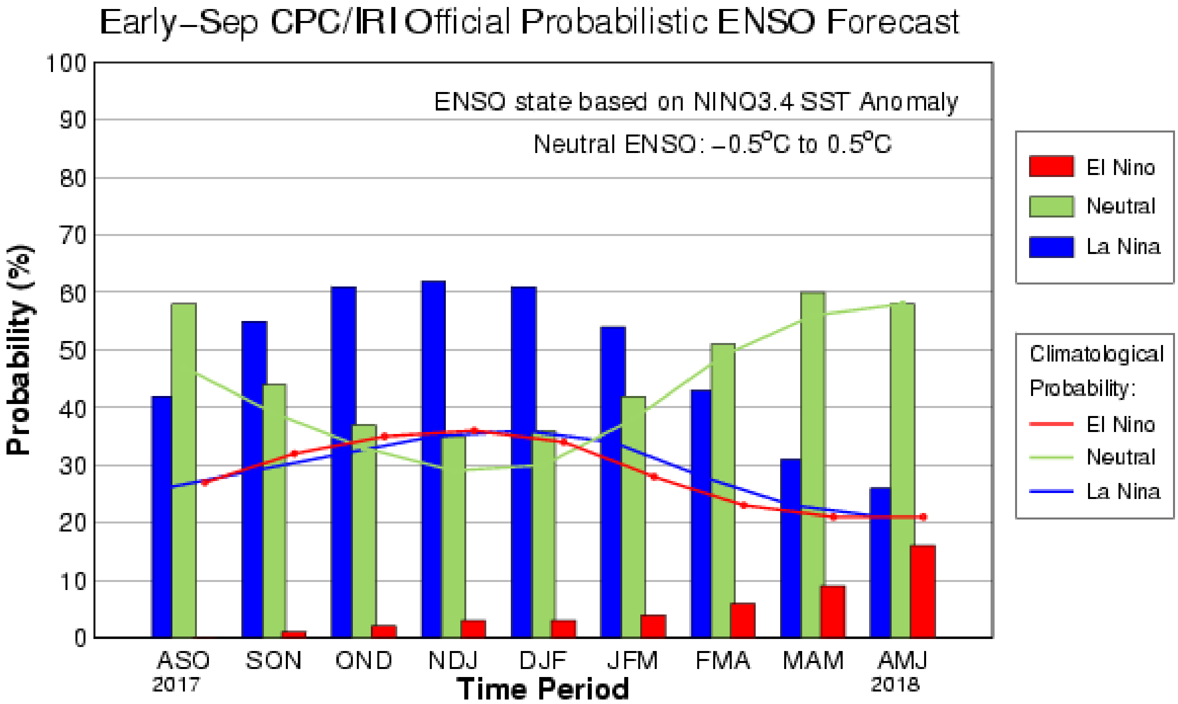


Figure 3: ENSO probabilistic forecast based on the Nino3.4 index which indicated a higher likelihood of La Niña conditions occurring in the later part of 2017. Credit: CPC/IRI.

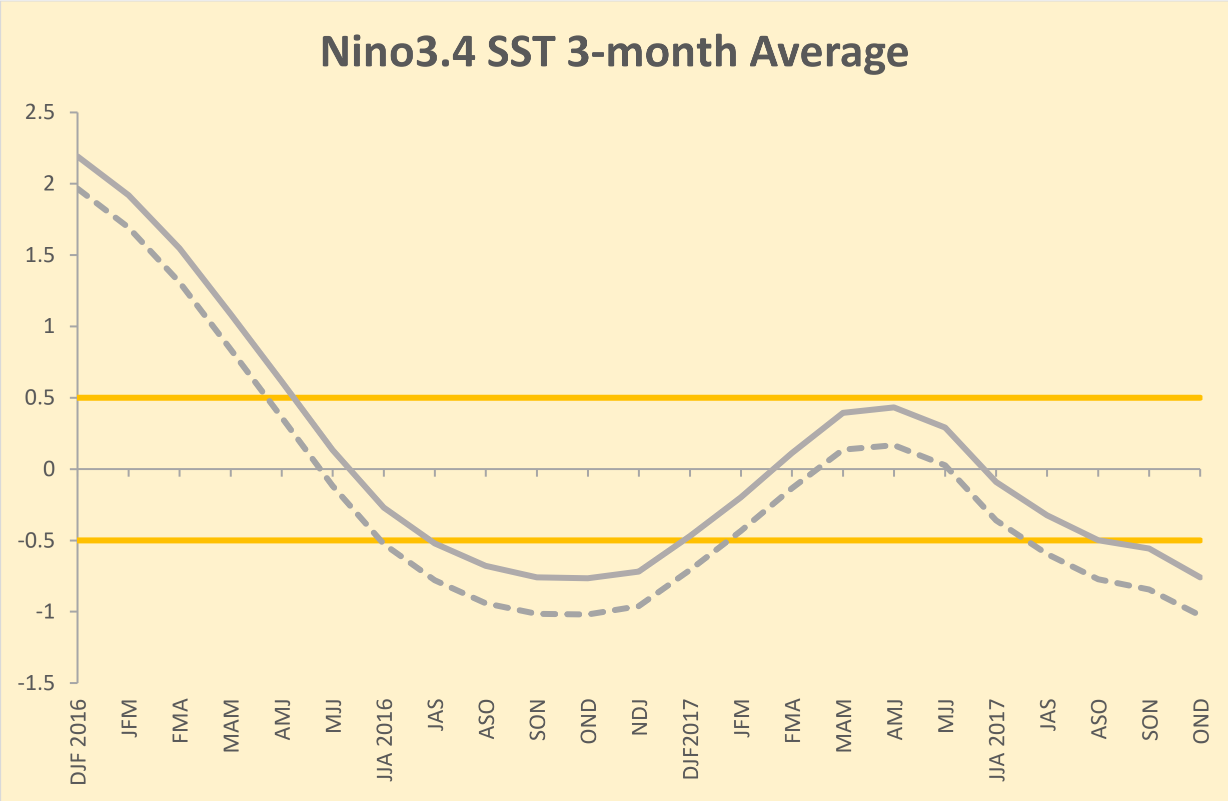


Figure 4: Three-month average Nino3.4 index, centred on month, crossed La Niña threshold by October 2017 (solid line). The dotted line represents detrended Nino3.4 values, to take into account tropical SST warming trend. Data: ERSST version 4. Refer to the "[Annual Climate Assessment 2016]" for the discussion on the detrending of Nino3.4.

As La Niña conditions developed, Southeast Asia experienced above-normal rainfall in many parts of the region during the October-December 2017 season (Figure 5). Despite the wetter conditions, average surface temperatures were either near- or above-normal over many areas (Figure 6).

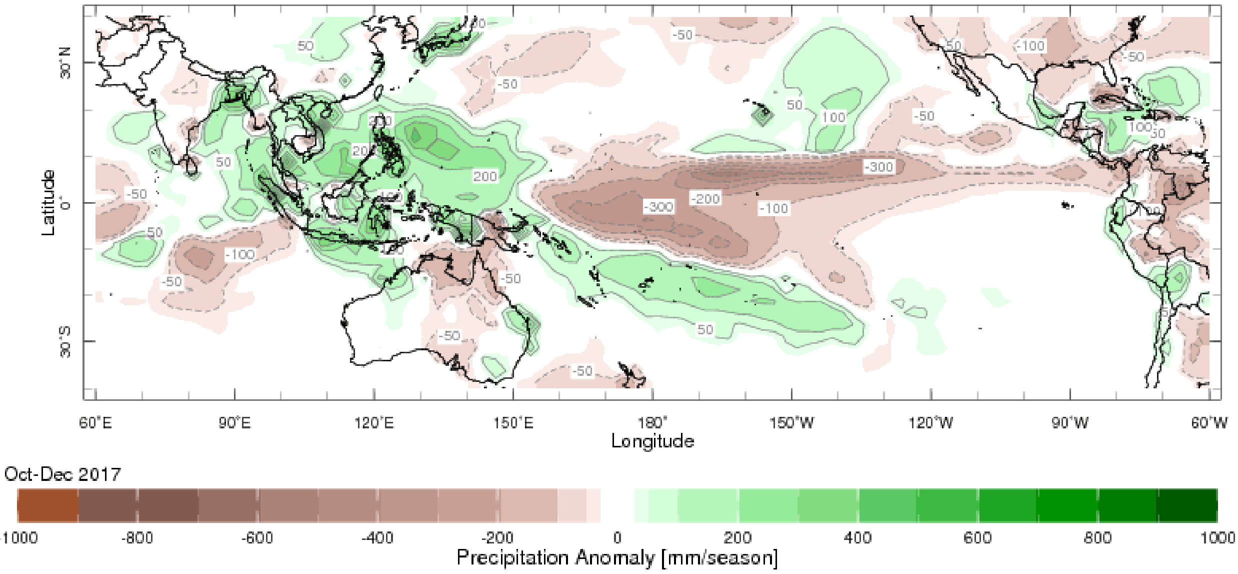


Figure 5: October-December 2017 seasonal average rainfall anomaly (mm/season) over the Pacific and the eastern Indian Ocean showing large scale wet anomalies (green shades) over Southeast Asia. (Credit: IRI Maproom.)

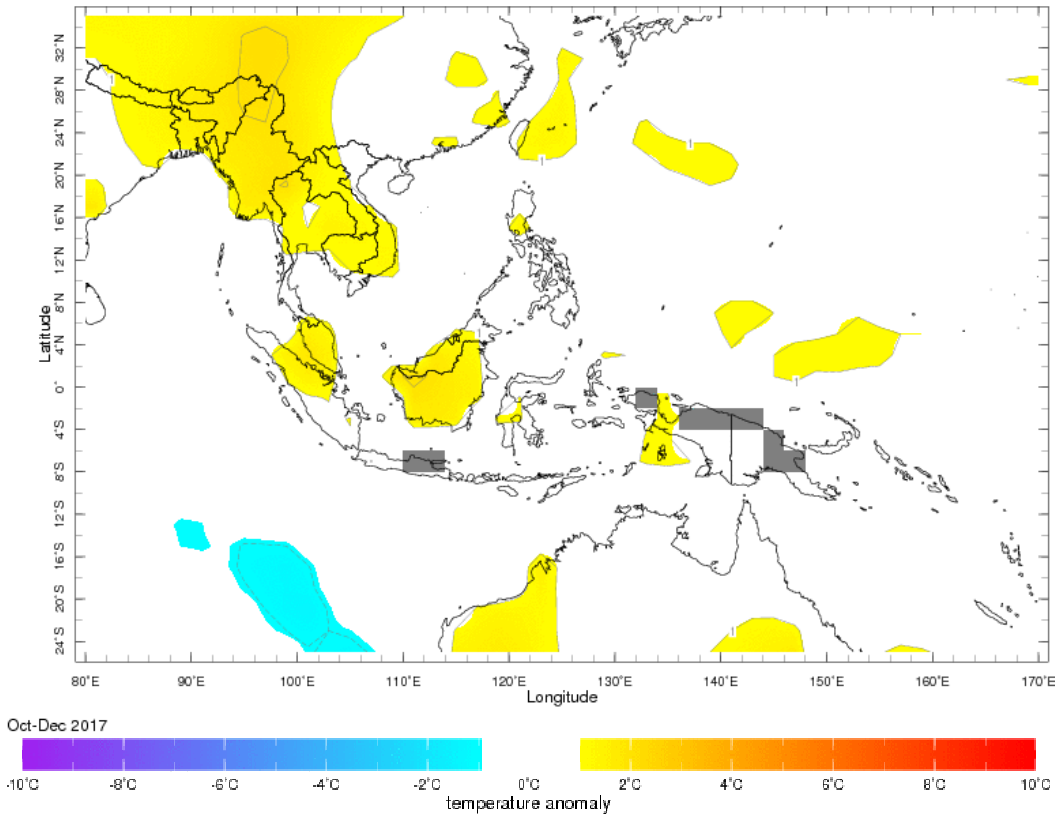


Figure 6: October-December 2017 seasonal average surface temperature anomaly (˚C) showing warmer conditions over mainland Southeast Asia and central parts of the Maritime Continent (Kalimantan, Peninsular Malaysia, and central-north Sumatra). (Credit: IRI Maproom.)

Intra-seasonal Climate Variability in 2017

ENSO is not the sole mode of large-scale climate variability impacting Southeast Asia that is monitored in order to understand on-going climate anomalies. While an ENSO event's duration is typically of the order of a year, other phenomena can play an important role on shorter timescales. One such phenomenon is the Madden-Julian Oscillation (MJO), an intra-seasonal phenomenon (i.e. the duration of a typical MJO event is less than a calendar season; see inset for details). The MJO is important to monitor as it is known to influence week-to-week variations of rainfall and temperature over Southeast Asia.

In 2017, the MJO was active earlier in the year, in January and February, and later in October and December. In particular, during February, October, and December 2017, a strong MJO was active over the Maritime Continent (phase 5) and the Western Pacific and Western Hemisphere regions (phases 6-8).

Significance of the Madden-Julian Oscillation

The MJO is a major fluctuation in tropical weather on weekly to monthly timescales. It is characterised by an eastward moving pulse of cloud and rainfall along the equatorial region from the Indian Ocean to the western Pacific. Each cycle typically lasts about 30 to 60 days. Research into the MJO is important because of its potential impacts on the intra-seasonal rainfall and temperature variations over Singapore and the Maritime Continent.

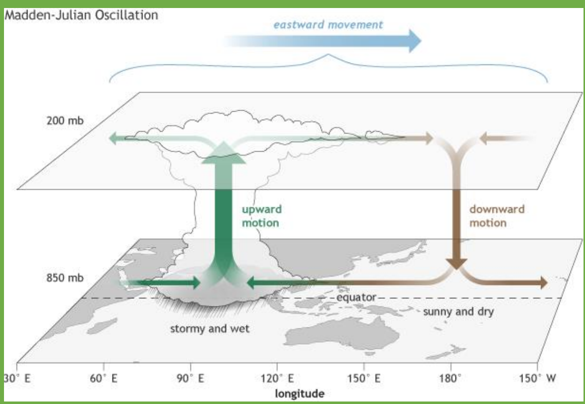


Figure 7: The MJO vertical structure which has an upward motion section (enhanced rainfall) and a downward motion section (suppressed rainfall). In this instance it is in a particular phase over the Indian Ocean. Credit: NOAA Climate.

The MJO is known to be more active from November to March. In studies done, the MJO has been found to enhance rainfall during cold surges of the Northeast Monsoon season, bringing much wetter conditions to Singapore and the surrounding region.

The MJO's path along the equatorial region is divided into sub-geographical locations, called *phases*, marked by the position of its upward motion (Figure 7). These are phases 2-3 (Indian Ocean), phases 4-5 (Maritime Continent), phases 6-7 (Western Pacific) and phases 8 and 1 (Western Hemisphere and Africa). When the MJO is active over the Indian Ocean and Maritime Continent in phases 2-4, it tends to bring enhanced rainfall over our region. Conversely, it can bring drier conditions while in phases 6-8.

Indeed, during the third week of October (see "Notable Weather Events in 2017" section for details), warmer conditions were experienced in Singapore at the time when a strong MJO was transitioning from the Maritime Continent to the Western Pacific. The cloudiness over our region was low as depicted in the longwave radiation anomalies plot in Figure 8, a typical signature during the propagation of an active MJO. The clearer skies resulted in stronger solar heating and hence warmer conditions on average over the region.

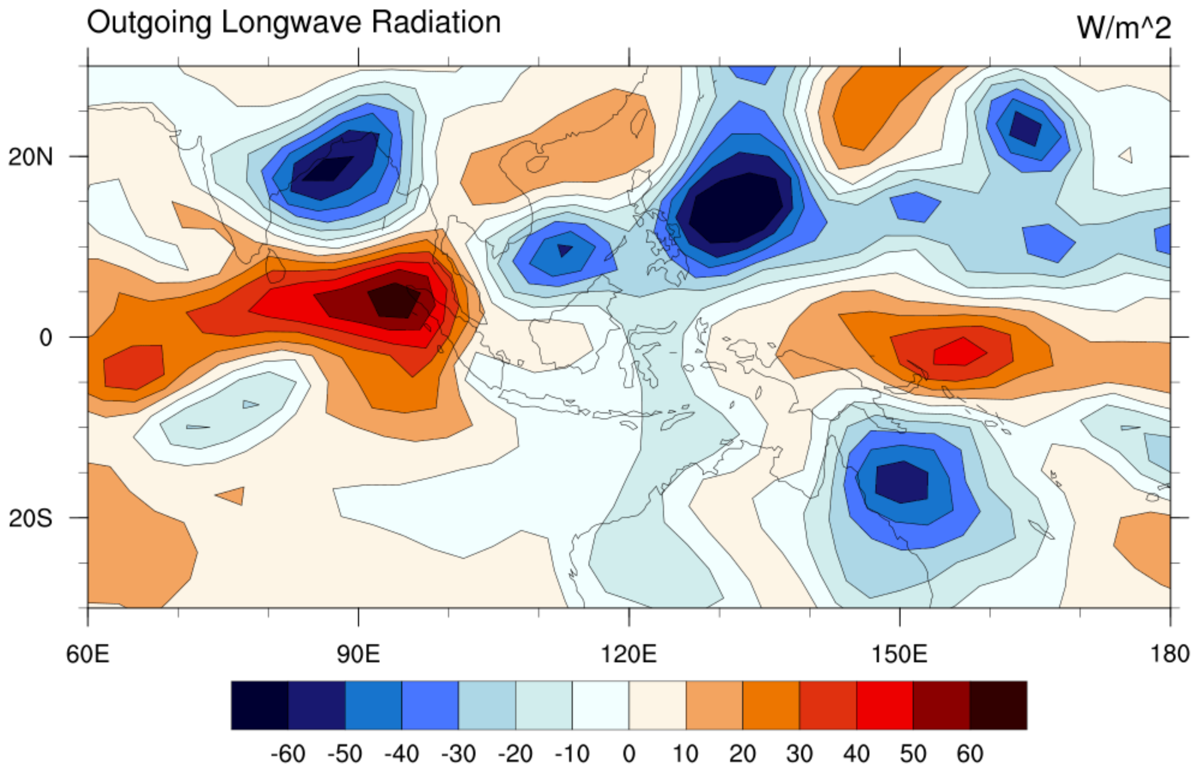
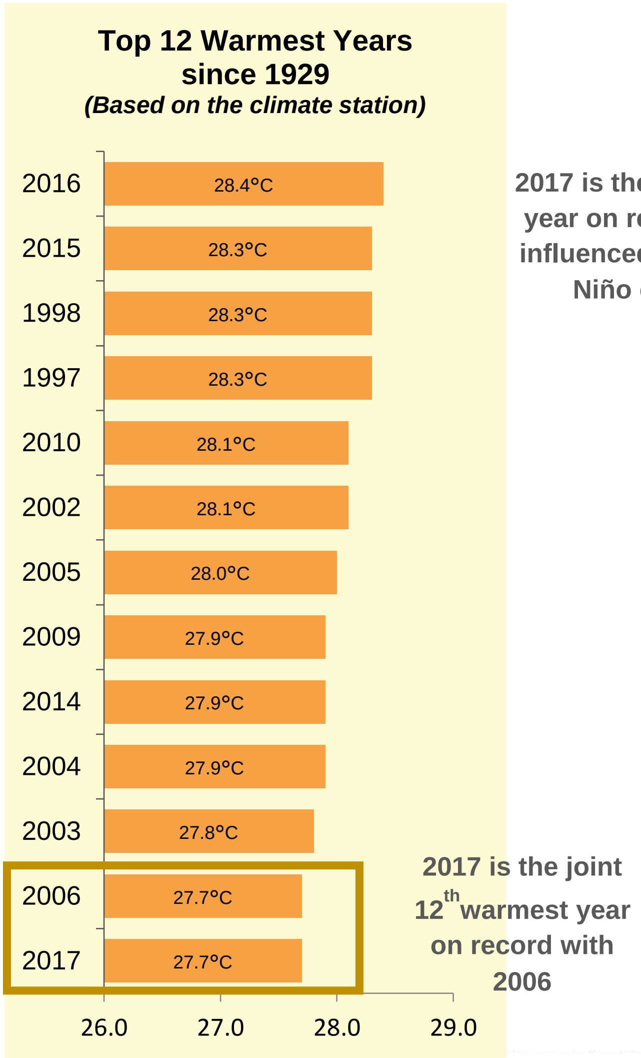
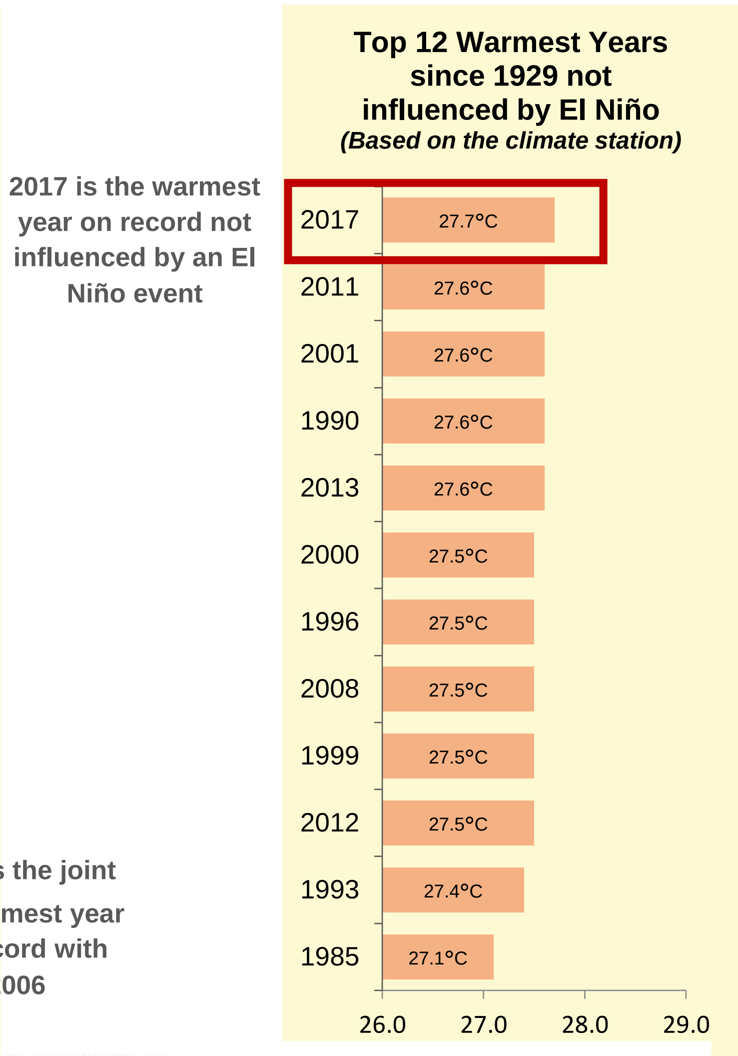


Figure 8: Outgoing longwave radiation (OLR; and indicator of cloudiness) anomalies (against 1981-2010 climatology) in Watts per square meter (W/m^2) between 17 and 22 October 2017. The positive anomalies (red shades) show the skies over the Peninsular and Northern Sumatra during that week being much clearer than normal, which coincided with the MJO leaving the Maritime Continent. It led to drier and warmer conditions over the region. (Data: NOAA Interpolated OLR.)

Temperature in 2017





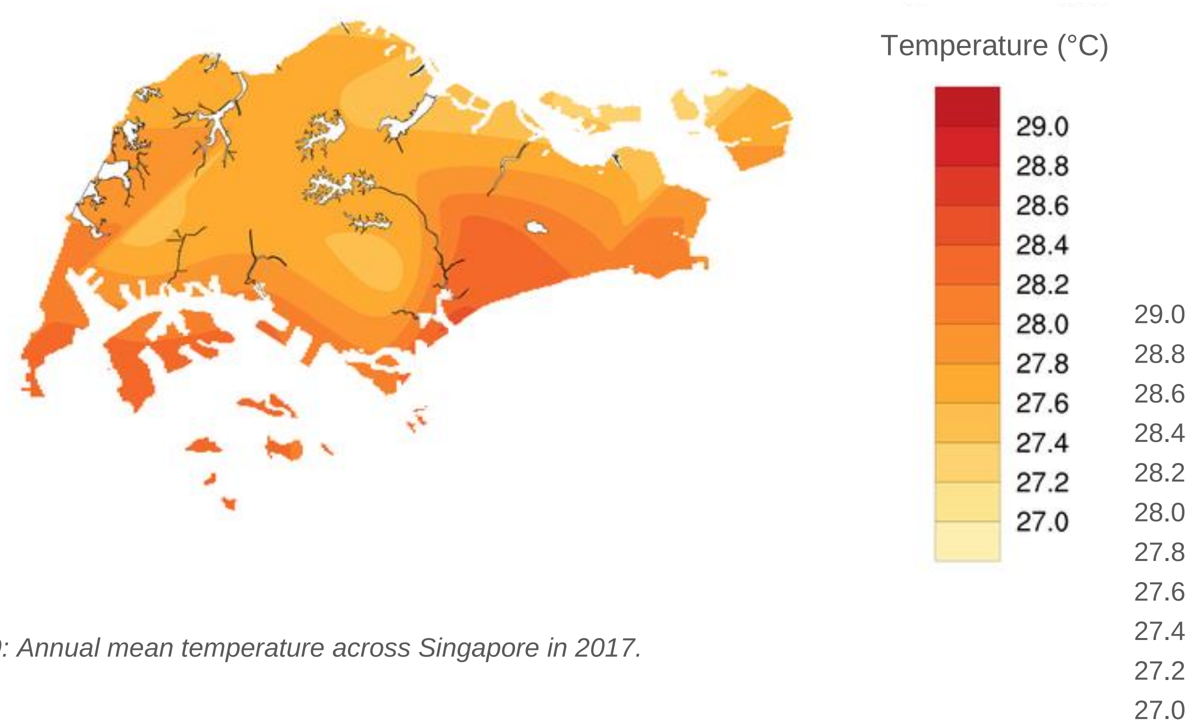


Figure 9: Annual mean temperature across Singapore in 2017.

2017 was the joint 12th warmest year in Singapore with an annual mean temperature of 27.7°C. This value was 0.7°C lower than the warmest year on record set in the previous year in 2016 and 0.2°C above the 1981-2010 long-term average. While the annual mean temperature was closer to the 1981-2010 long-term average, 2017 is still the warmest year since 1929 that was not influenced by an El Niño event. Warmer temperatures are generally experienced across our region during an El Niño and the impact on Singapore's temperature tends to be felt across two years.

According to the World Meteorological Organization, the year 2017 was also globally the warmest without an El Niño, indicative of the long-term global warming that the world is experiencing. The globally-averaged temperature for 2017 was about 0.46°C above the 1981-2010 long-term average of 14.3°C and about 1.1°C above the pre-industrial era[2]. Most parts of the world experienced above-average temperatures and record warmth was observed over some parts of the world, mostly over the ocean (see Figure 10).

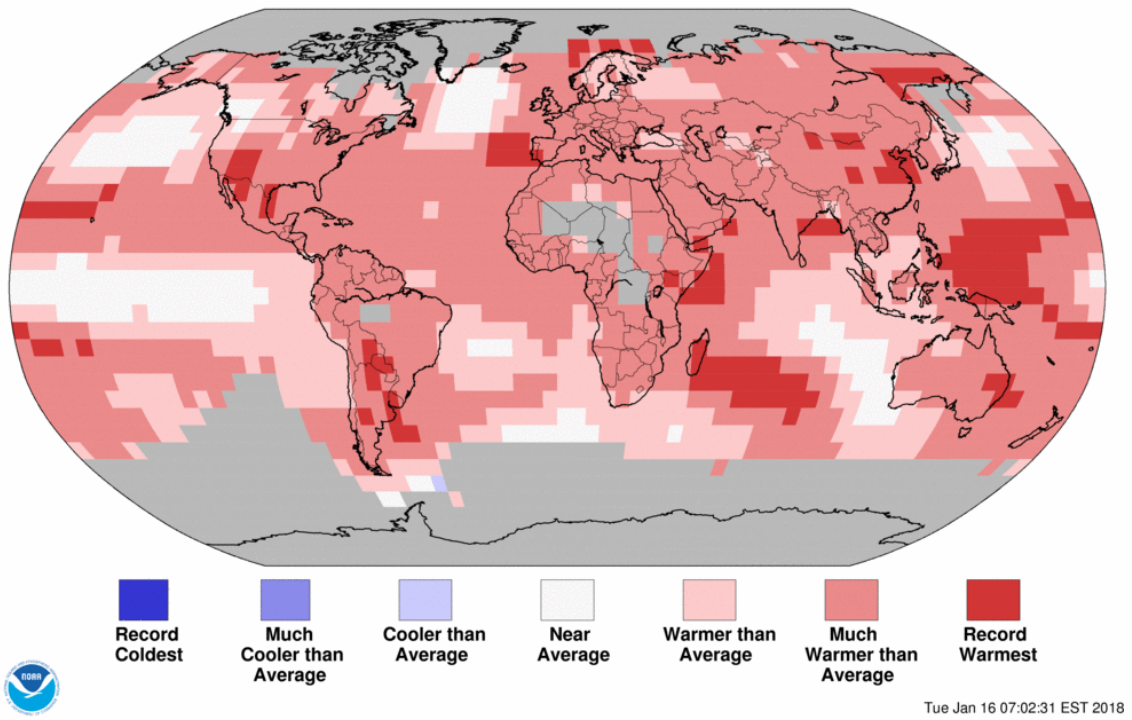


Figure 10: Global annual temperature percentiles map showing regions with record warmth in 2017. (Source: NOAA, GHCN-M version 3.3.0 & ERSST version 4.0.0)

[2] The period 1880-1900 is used as a reference period for pre-industrial conditions. In the Paris Agreement on climate change, countries agreed to work to limit global temperature rise this century to below 2°C above pre-industrial levels and to pursue efforts to limit the increase even further to 1.5°C.

Rainfall in 2017

Globally, there was a mix of wetter and drier conditions in 2017, with extreme precipitation and drought events occurring across different parts of the world.

Locally over Singapore, the annual total rainfall recorded at the Changi climate station in 2017 was close to the 1981-2010 long-term average while other parts of the island recorded slightly above-average rainfall (Figure 11 and Figure 12).

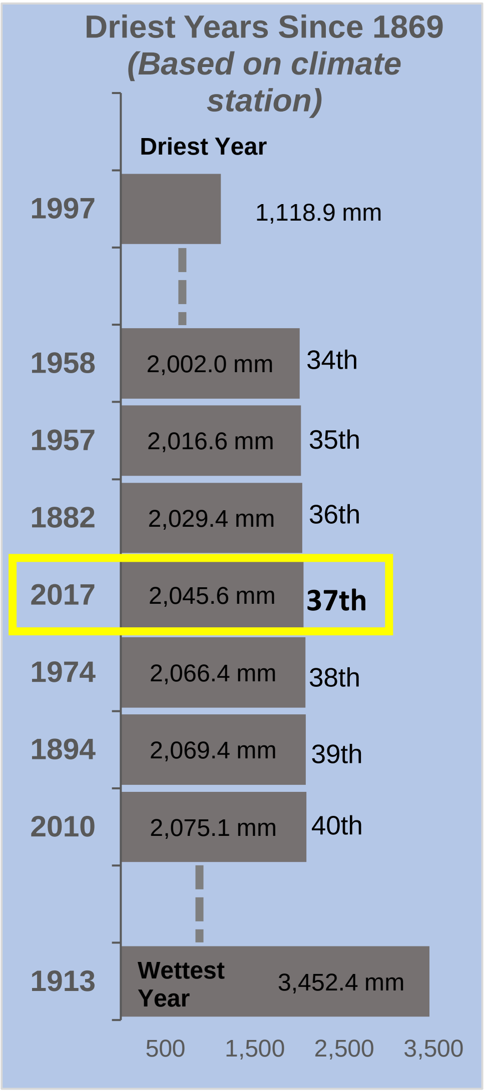


Figure 11: Annual total rainfall distribution across Singapore in 2017.

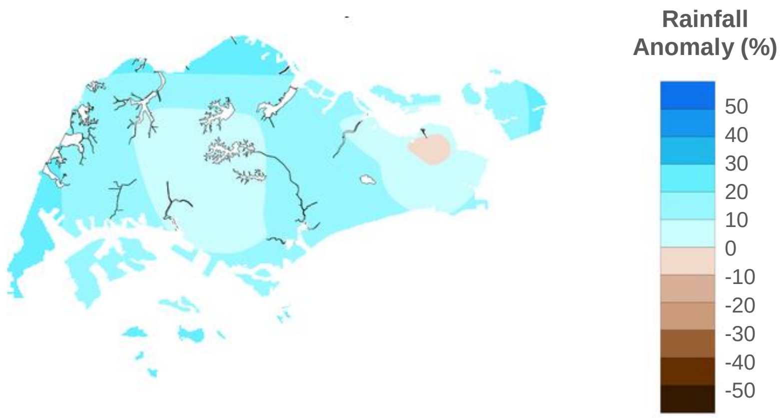


Figure 12: Annual rainfall anomalies across Singapore (relative to the 1981-2010 average) in 2017.

Monthly rainfall anomalies were also near average (Figure 13). The most notable months were July and August when most parts of the island recorded below-average rainfall. The rainfall at the Changi climate station was 40-50% below the average for these two months.

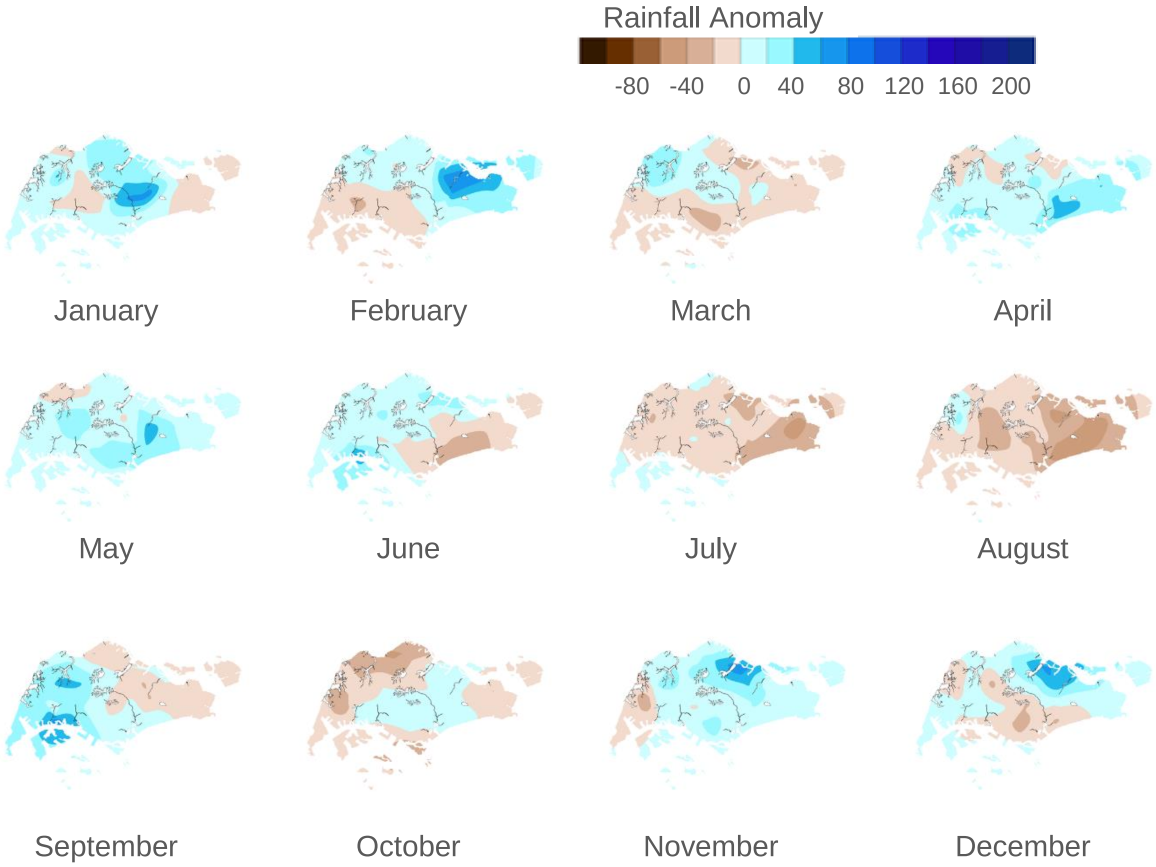


Figure 13: Monthly rainfall anomaly maps for 2017.

Past Temperature and Rainfall Trends

Temperature

Annual mean temperature analysis at the climate station showed an average rise of 0.25ºC per decade from 1948 to 2017. This is comparable to the trend observed for the more recent period between 1984 and 2017, the average rise recorded at Changi climate station is 0.26°C per decade (refer to the last page for more information on Singapore's climate station).

Singapore's climate is characterised by two monsoon seasons separated by two inter-monsoon periods. The Northeast Monsoon occurs from December to early March and the Southwest Monsoon from June to September. The Northeast Monsoon comprises an initial wet phase, usually from December to January, and a dry phase from February to early March.

Over the long-term period from 1984 to 2017, rising mean temperature trends were observed throughout the year (Figure 14) at Changi climate station. Notably, the normally cooler months of December and January recorded the highest rise compared to the other months.

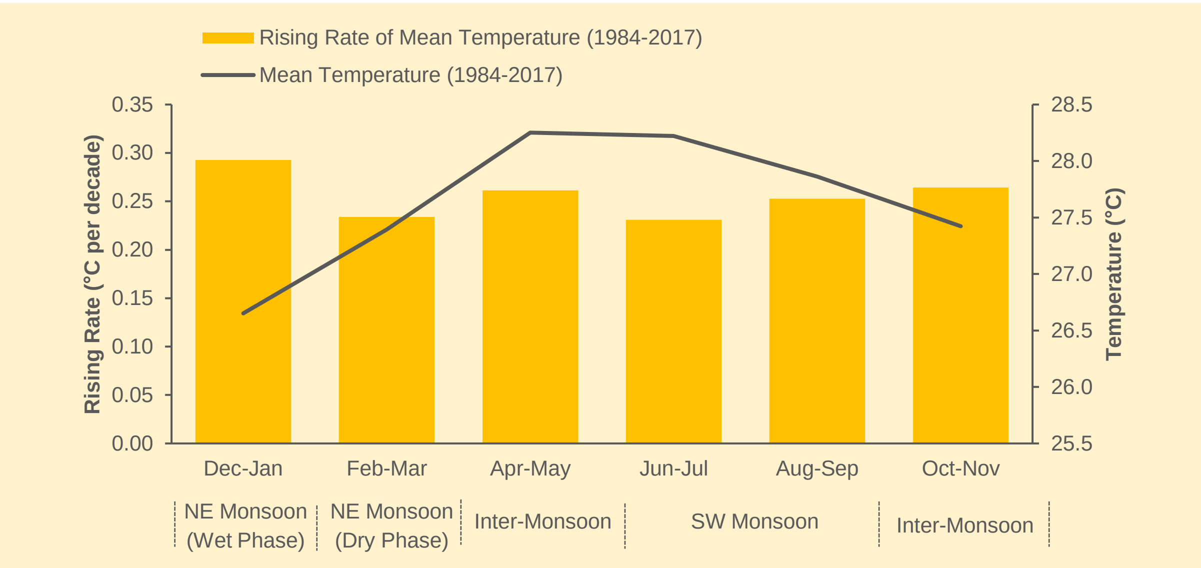


Figure 14: Rising rate of mean temperature at the climate station (yellow bars; left axis) and the long-term average from 1984 to 2017 (black line; right axis).

The extreme temperature also showed similar trends for December and January. Both the mean daily maximum temperatures[3] and the highest daily maximum temperatures[4] showed the highest rate of increase in the two-month period (Figure 15) and are statistically significant (i.e. a strong trend, 0.19°C and 0.31°C per decade respectively). At Changi climate station, the highest daily maximum temperature recorded in the December-January period was 33.1°C in the 1980s (1984-1989) and 35.2°C in this decade (2010-2017). The differences in trends for extreme temperatures across the different periods are more distinct compared to that for mean temperatures (Figure 14).

[3] The daily maximum temperatures averaged for all days within each of the 2-month periods.
[4] The highest daily maximum temperature of all days within each of the 2-month periods.

Consistent with the rising trends in extreme temperatures, the number of warm (cool) days[5] were also observed to increase (decrease) at the strongest rate for December and January (Figure 16).

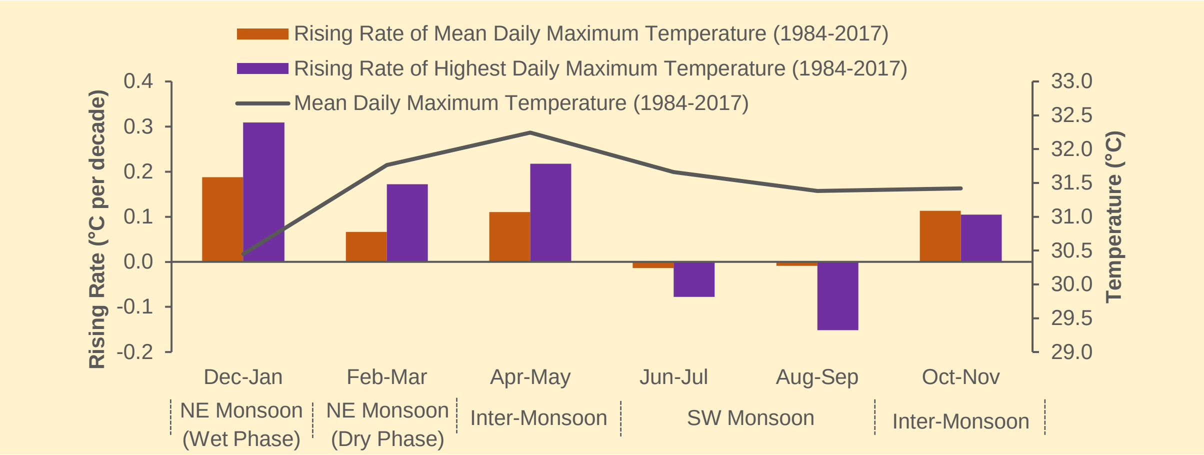


Figure 15: Rising rates of mean daily maximum temperature and the highest daily maximum temperature recorded at the climate station (red and purple bars respectively; left axis) and the mean daily maximum temperature (black line; right axis) for the different 2-month periods from 1984 to 2017. Both extreme temperatures showed the highest rate of increase in December and January.

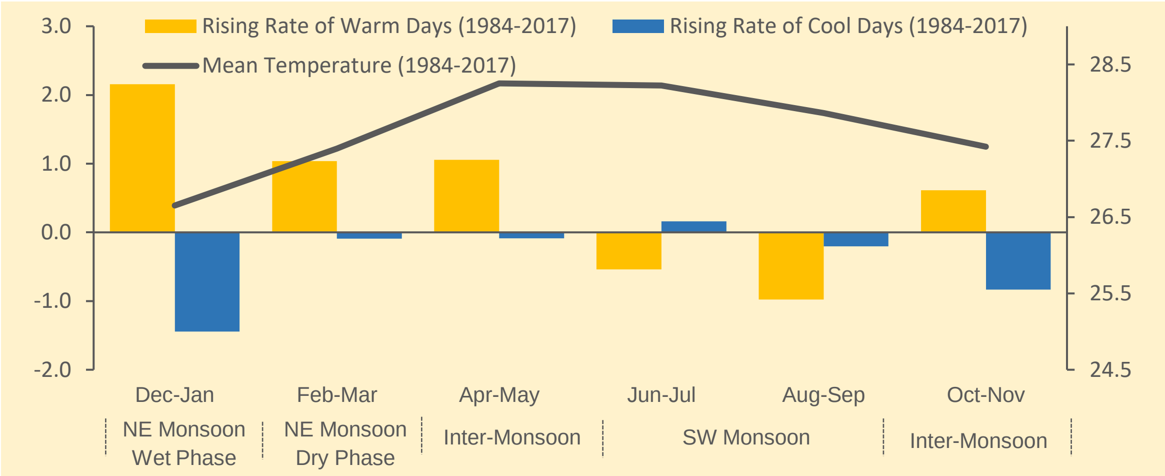


Figure 16: Rising rates of number of warm and cool days at the climate station(yellow and blue bars respectively; left axis) and mean temperature (black line; right axis) for the different 2-month periods from 1984-2017.

In summary, the temperature trends from 1984 to 2017 varied across different periods of the year. In particular, the wet phase of the Northeast Monsoon in December and January, which is climatologically the cooler period of the year, showed more prominent increasing trends in extreme warm temperatures and warm days, as well as decreasing trends for cool days. These trends indicate that the gap in extreme warm temperatures between the cooler and warmer months of the year is narrowing. The reasons for these trends is an area that requires further studies and research.

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[5] *Based on temperature records at the Changi climate station with continuous observations since 1984.*

Each calendar day of a year has its own thresholds for warm day and cool day which are based respectively on the 90th and 10th percentile value of the daily maximum temperatures within a 5-day window centred on the calendar day, over the climatological period 1981-2010. For Changi climate station, the range of daily thresholds are 33.0-33.7°C (warm days) and 29.5-30.9°C (cool days) for June; 31.6-32.6°C (warm days) and 26.7-29.4°C (cool day) for December.

Rainfall

Using data from 1984 (the same period as that used for the temperature trends analyses in the preceding section), the mean annual cycle of precipitation for 1984-2017 is presented here and shows considerable variability (Figure 17).

In terms of trends, Singapore experienced a minimal rise in total yearly rainfall over the period 1984-2017 (~4.6 mm/year or 46 mm/decade)[6] that is not statistically significant (i.e. the trend is not strong and is dominated by year-to-year variations). Decomposing the annual trend into 2-month periods, the slight upward trend is primarily driven by increased rainfall during the wetter months of the year (i.e. October-November and April-May, the inter-monsoon months; and December-January, the wet phase of the Northeast Monsoon season). A relatively smaller increase is observed for June-July during the Southwest Monsoon. In contrast, the traditional dry phase of the Northeast Monsoon (February-March) shows a considerable decrease in decadal rainfall. While the trends are not statistically significant, they indicate that the wetter periods are getting wetter and the drier periods getting drier.

The increase and decrease in rainfall during the wetter and drier periods respectively is a subject of ongoing research. This is pertinent given that the December-January period also shows the largest rise in extreme temperature indicators. The notion of higher maximum daytime temperatures and increased rainfall is consistent with a warmer atmosphere being able to hold more moisture, which can then lead to higher rainfall amounts from more severe rain events when they occur. Indeed, an analysis of December hourly rainfall shows that the amount of rainfall occurring just past the warmest time of the day (around 1-3 pm) has increased over the decades.

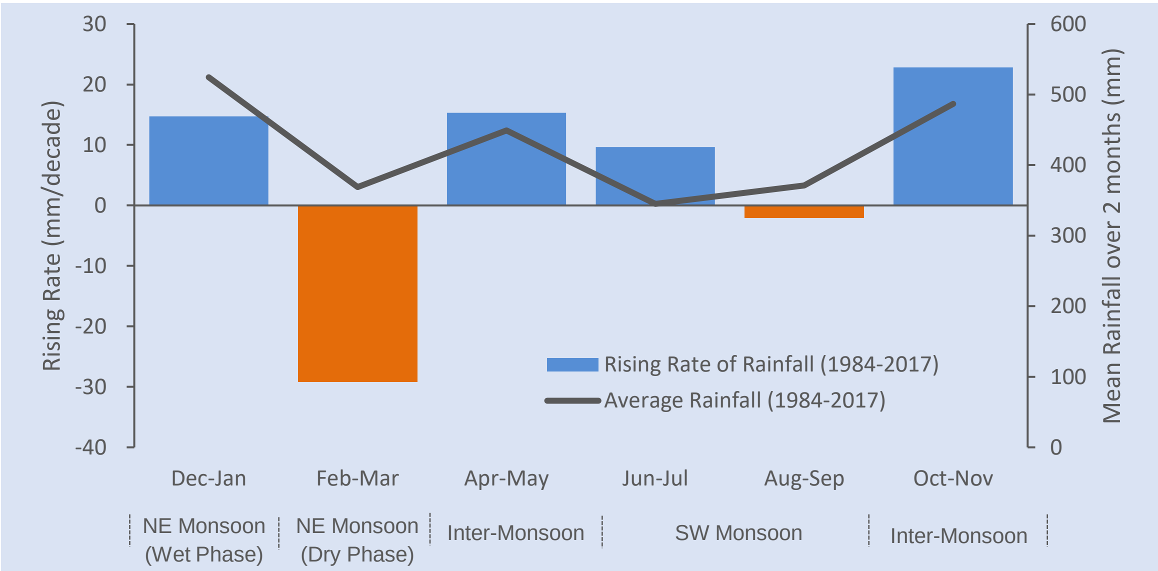


Figure 17: Rising rates in decadal rainfall (blue and orange bars; left axis) and mean rainfall (black line; right axis) for the different 2-month periods from 1984-2017.

[6] The average increase from 1980 to 2017, using available observations from the island-wide network of up to 28 rain gauges since 1980, was ~10 mm/year (or 100 mm/decade) but is not statistically significant.

Notable Weather Events in 2017

Northeast Monsoon Surges

The early part of the year saw two occurrences of monsoon surges in the South China Sea that brought windy conditions and widespread rain to Singapore. The first occurrence brought heavy downpour on 23 January that led to flash floods over several areas including Tanjong Pagar. The daily total rainfall of 106.0 mm recorded at Kallang on that day was the highest for January 2017. The second occurrence in February, a normally dry month, brought periods of rain showers from 12 to 15 February. These episodes contributed to a total of 15 rain days in February 2017, almost twice the average number for the month.

The year ended on a wet note as the island experienced widespread intermittent rain (Figure 18) on the last two days of December (the last wet New Year's Eve in Singapore was in 2012). The rainy weather was due to a monsoon surge coupled with the presence of a vortex (a large-scale atmospheric circulation) that developed over the sea to the east of Singapore (Figure 19). On 31 December, the 63.4 mm of rainfall recorded at the Changi climate station raised the month's total to 371.2 mm, 17 percent above the long-term average for December. Based on all rainfall stations, the year's highest daily total rainfall of 149.6 mm (at Buona Vista) was also recorded on that day.

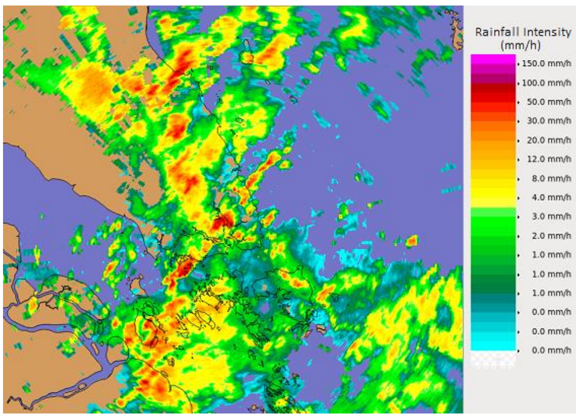


Figure 18: Weather radar image at 12.45 pm on 31 December 2017 showing widespread rain over Singapore and the surrounding region.

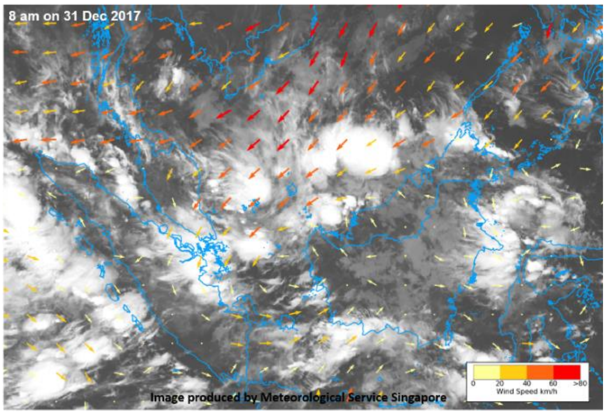


Figure 19: Satellite image at 8 am on 31 December 2017 showing extensive cloudiness in the region due to the development of a monsoon surge.

Intense Localised Thunderstorms

Localised thunderstorms are common in Singapore, arising from strong solar heating of land areas. When combined with the convergence of winds over Singapore, intense thunderstorms can develop, such as on 13 December 2017 (Figure 20) when the Changi climate station recorded daily total rainfall of 69.8 mm, the highest for the year. In another episode, strong wind convergence over Singapore under the remote influence of a tropical cyclone in the region on 18 April 2017 triggered intense thunderstorms that led to flash floods in the central and southern parts of the island (Figure 21).

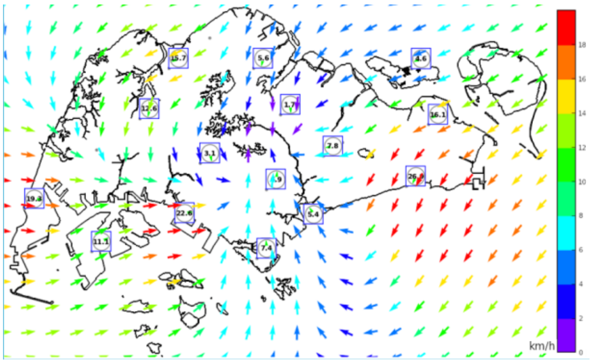


Figure 20: Strong solar heating and wind convergence over Singapore triggered intense afternoon thunderstorms on 13 December 2017.

Figure 21: A heavy downpour left cars stranded in flood waters in the Orchard Road area on 18 April 2017. (Photo credit: Stomp)

The highest recorded 60-minute rainfall (92 mm at Tuas) during the year resulted from intense localised thunderstorms on 10 June 2017.

On 18 June 2017, a large waterspout, associated with intense thunderstorm clouds that developed over the sea areas south of Singapore, was observed at around 9.10am (Figure 22).

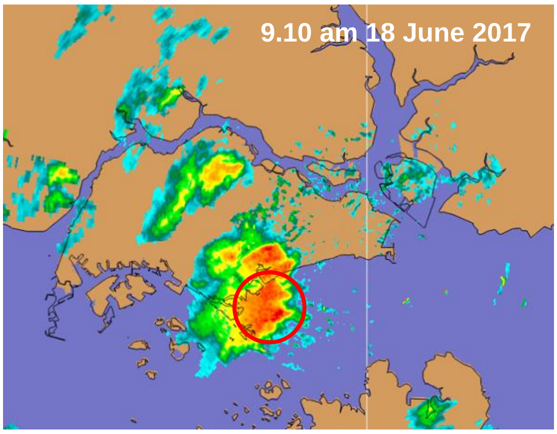


Figure 22: Weather radar image on the morning of 18 June 2017 (left) showing intense thunderstorms (circled) off the southern coast of Singapore that triggered the development of a large waterspout (right). (Photo credit: Harkiran Kaur Grewal)

In 2017, the Changi climate station recorded 181 lightning days, close to the long-term annual average of 185 days. Lightning from a thunderstorm struck SMRT's trackside equipment near the Bedok MRT Station on 20 November.

Sumatra Squalls

A total of around 40 Sumatra squall events affected the island during the year. Although Sumatra squalls usually develop in the Southwest Monsoon and inter-monsoon periods, five squalls hit the island in the Northeast Monsoon months of January and February 2017.

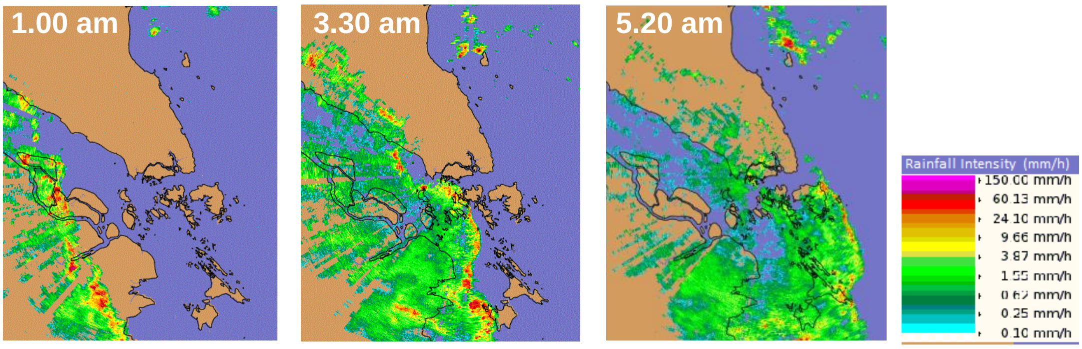


Figure 23: Sequence of weather radar images showing the passage of a Sumatra squall moving across Singapore in the early hours and predawn on 4 January 2017.

Sumatra squalls on 23 June and 20 September were accompanied by wind gusts of up to around 90 km/h (25 m/s) at Pasir Panjang, the strongest gusts recorded for the year based on all wind stations.

On 14 November, strong winds from a Sumatra squall uprooted a few trees in the Geylang area. The heavy rains from the Sumatra squall also produced the highest daily total rainfall for November 2017 based on all rainfall stations (130.6 mm at East Coast Parkway).

Very Warm Days

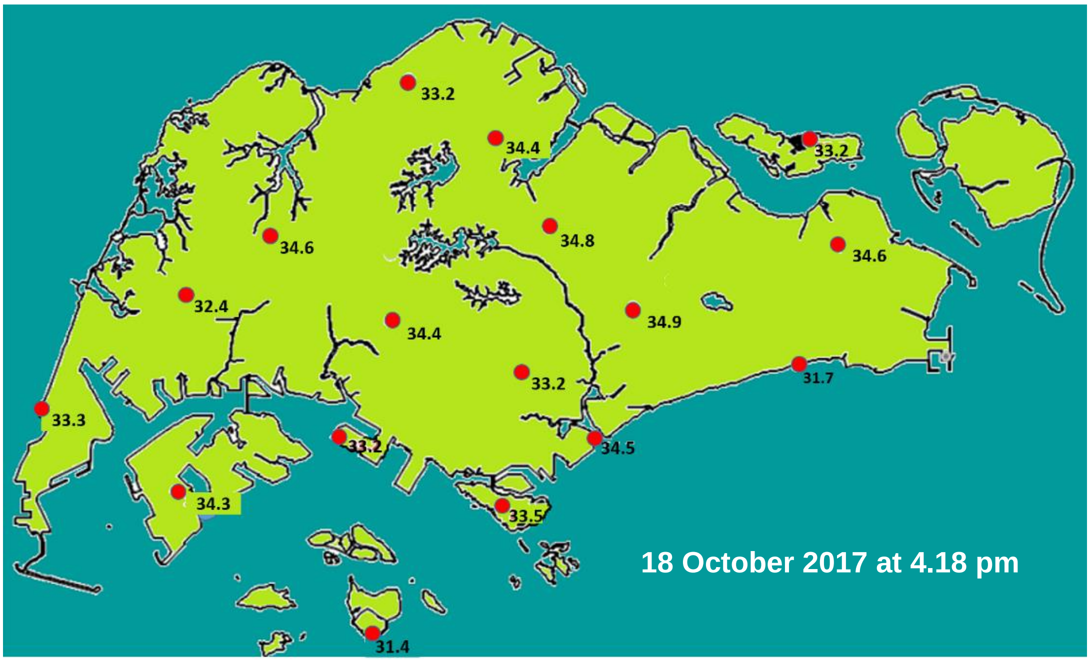


Figure 24: Very warm temperatures (deg C) across the island on 18 October 2017, the hottest day in 2017.

Despite 2017 not being an El Niño year, there were still some very warm days in certain months. October 2017, in particular, was warm as temperatures soared to above 35°C at some stations across the island between 17 and 22 October. This was due to the passage of a dry air mass moving from the Indian Ocean to the surrounding region. The hottest day in 2017 was on 18 October 2017, when a daily maximum temperature of 34.6°C was recorded at the Changi climate station. This also tied the record for the highest daily maximum temperature for October, last set on 11 October 2016. January and December, normally the cooler months of the year, saw temperatures exceeding 34°C at some stations in the early part of both months this year.

General Climate of Singapore

Singapore has a tropical climate which is warm and humid, with abundant annual rainfall of about 2,200 mm. Generally, the eastern parts of Singapore receive less rainfall compared to other parts of the island. The winds are generally light but with a diurnal variation due to land and sea breezes.

The temperature variation throughout the year is relatively small compared to the mid-latitude regions. The daily temperature range has a minimum usually not falling below 23-25ºC during the night, and a maximum usually not rising above 31-33ºC during the day.

Singapore's climate is traditionally classified into four periods according to the average prevailing wind direction:

a) Northeast Monsoon (December to early March).

b) Inter-monsoon (Late March to May).

c) Southwest Monsoon (June to September).

d) Inter-monsoon (October to November).

Average Annual Rainfall (1981-2010)
(based on 28 rainfall stations)

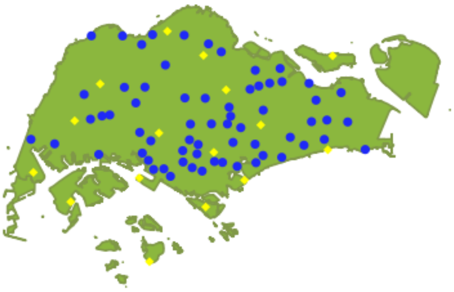
The transitions between the monsoon seasons occur gradually, generally over a period of two months (the inter-monsoon periods). The winds during the inter-monsoon periods are usually light and tend to vary in direction. The three main rain-bearing weather systems that affect Singapore are the Northeast Monsoon surges, "Sumatra" squalls and convective showers/thunderstorms. Convective showers/thunderstorms occur throughout the year. "Sumatra" squalls commonly occur during the Southwest Monsoon and inter-monsoon periods, while the monsoon surges occur during the Northeast Monsoon season.

Sea Breeze Induced Thunderstorms: Sea breezes are winds formed as a result of temperature differences between the land and the adjoining sea. The sea breeze, carrying a large amount of moisture from the sea, blows inland during the day where the moist air mixes with the rising warm land air and, under unstable conditions, form rain clouds in the afternoon. During the inter-monsoon periods, when winds are light, sea breezes are more common.

"Sumatra" Squalls: A "Sumatra" squall is an organised thunderstorm line that develops over Sumatra or the Straits of Malacca, often overnight, and then moves eastward to affect Peninsular Malaysia and Singapore. In a typical event, the squall line can bring about one to two hours of thundery showers. Often this happens in the predawn or morning hours. Some Sumatra squalls are also accompanied by wind gusts with speeds up to 80 km/h (22 m/s) which are strong enough to uproot trees.

Northeast Monsoon Surges: A Northeast Monsoon surge is a surge of cold air from Central Asia. During the period December through early March, the heartland of Asia including Siberia, experiences very low, cold temperatures. From time to time, this cold air rushes out of Central Asia leading to an abrupt increase in northeasterly winds over the South China Sea blowing towards the warm tropics. The sea warms and moistens the overlaying air and the wind eventually converges to bring about widespread rain in the tropical regions. December and January are usually the wettest months of the year in Singapore and a few heavy rain spells, caused by surges of Northeast Monsoon winds, contribute significantly to the rainfall in these months. A typical rain spell generally lasts for a few days.

Network of Automatic Weather Stations as of Dec 2017



Legend
- Stations measuring rainfall only
- Stations measuring rainfall and other elements including temperature, winds & relative humidity

Manned Weather Stations

About the Meteorological Service Singapore (MSS)

The MSS is Singapore's national authority on weather and climate. It is a division under the National Environment Agency (NEA).

MSS currently operates a network of five manned observation stations, one upper air observatory and around 80 automatic weather stations. All the automatic weather stations measure rainfall and more than one-fifth of them measure other meteorological elements including temperature, relative humidity, pressure, and wind. This observation network serves as the main source of climate data for this report.

The manned observation station at Changi is our designated climate station. The climate station, first located at Outram in 1869, has undergone a number of relocations over the years due to changes in local land use, before shifting to its current site at Changi. The climate station serves as the reference station where its records are used for tracking the national long-term climate trends. The oldest climate station records are for monthly rainfall (starting from 1869) and temperature (starting from 1929, with a break from 1942 to 1947).

The installation of the automatic weather station network from 2009 greatly expanded the coverage of weather observations across Singapore. Prior to this, there were around 40 manual rainfall stations and just a few temperature stations in Singapore. For the purpose of analysing long-term climate trends and establishing climatological averages, only stations with continuous long-term (at least 30 years) records can be used. This limits the number of stations available for such purpose to 28 stations for rainfall and three stations for temperature.

Further Information
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