

Annual Weather Review 2014

1. Review of Weather Conditions

1.1 Northeast Monsoon Season (January – late March)

The Northeast Monsoon conditions, which started in late November 2013, continued to prevail over the region with low level winds blowing mainly from the north to northeast. A weak monsoon surge affected the region on 5-6 January 2014 and brought moderate to heavy showers to Singapore on 6 January 2014. Around mid-January, the dry phase of the Northeast Monsoon set in as the monsoon rain belt migrated south of the equator away from Singapore. Cross-equatorial and diffluent flow also became more established. The early onset of the dry phase led to fewer rain days and significantly lesser rainfall for January 2014. At the Changi climate station, 75.4mm of rainfall and five rain days were recorded in January 2014, compared to the long-term average rainfall of 242.3mm and 15 rain days respectively. Due to a surge of cold winds from a high pressure system over the northern hemisphere, blowing towards Singapore and the region, January also saw various parts of the island experiencing cooler than normal temperatures with daily minimum temperatures of between 21 and 22 degrees Celsius being recorded.

February 2014 was exceptionally dry and windy. The 27-day dry spell that affected Singapore since 13 January 2015 extended into the first 8 days of February, breaking the previous record of 18 days set in 2008. During the month, there were only seven days of short duration showers between 7 and 19 February 2014, mainly over western parts of Singapore. About half of the 64 rainfall stations, mostly in the southern and eastern areas, recorded monthly rainfall totals below 10.0mm. At the Changi climate station, the rainfall total recorded in February was 0.2mm, setting a new record for the driest month since 1869. Singapore experienced windy conditions in February 2014 with an average daily wind speed of 13.3 km/hr recorded at the climate station, exceeding the previous high of 12.5 km/h in January 1985. The prolonged dry conditions also set another new record for the lowest average daily relative humidity of 74.5%. The previous record low for February and any month of the year was 76.9% (February 1968) and 74.6% (June 2013) respectively.

The dry phase of Northeast Monsoon persisted into the first half of March 2014, with Singapore experiencing a second dry spell from 17 February 2014 to 15 March 2014. Although brief afternoon showers affected a few areas in western Singapore on some days during the period, most parts of the island received little or no rain. The daily maximum temperature in some parts of the island exceeded 33.0 degrees Celsius on most days. On several days between 7 and 15 March 2014, air quality over several parts of Singapore deteriorated in the afternoon and early evening as the prevailing north-easterly winds transported smoke haze from the fires in southern Johor to Singapore. The prolonged dry spell finally ended on 16 March 2014 with widespread and heavy rain as an equatorial band of extensive rainclouds in the southern parts of South China Sea was brought to Singapore and the surrounding region by strong and deep easterly winds.

Despite a wetter second fortnight for March 2014, the overall rainfall in March was below average for most areas of Singapore. The highest rainfall of 208mm to 244mm (15% to 35% above average) was recorded in the northern parts of the island around Sembawang and Yishun. The lowest rainfall of 27mm to 63mm (65% to 85% below average) was recorded over the eastern and western parts of the island around Katong and Jurong.

1.2 First Inter-Monsoon Season (late March –late May)

Northeast monsoon conditions weakened and transitioned to Inter-Monsoon conditions in late March 2014. Low level winds over Singapore became light and variable in direction. Weather conditions were generally warm with daytime temperatures soaring to 35 degrees Celsius on several days of April and May. During the Inter-Monsoon period, Singapore experienced afternoon thundery showers on most days due to convergence of winds and strong convective heating of land areas. Thundery showers on 25 April 2014, 7 May and 16 May 2014 were particularly heavy with maximum hourly rain intensity for some stations exceeding 70mm/hr. Short-duration intense rain also resulted in flash floods over Kaki Bukit on 4 April and around Boon Lay areas on 23 April 2014 and 16 May 2014.

Many parts of Singapore received above average rainfall in April and May 2014. The highest rainfall of 286mm to 312mm (65% to 80% above average) recorded in April was over the north-western and southern parts of the island around Kranji and Jalan Besar. In May, rainfall was highest over the western part of the island around Jurong where 342mm to 400mm (105% to 140% above average) was recorded.

1.3 Southwest Monsoon Season (late May – end October)

Towards end May 2014, with the intensification of the high pressure systems over the Australian landmass, Southwest Monsoon conditions began to set in over the region with low level winds blowing predominantly from the southeast or southwest. For June 2014, Singapore experienced thundery showers mainly in the late morning and afternoon. Several "Sumatra" squalls also affected Singapore on 12, 14, 18, 19 and 25 June 2014 in the early hours and pre-dawn. In particular, the squall on 12 June 2014 brought strong gusty winds up to 103.7 km/h around West Coast Highway. In the third week of the month, relatively warm conditions were experienced between 19 and 21 June 2014 with maximum day-time temperatures peaking at 35 degrees Celsius and night-time temperatures around 28 degrees Celsius. Many parts of Singapore received below average rainfall during the month. The highest rainfall of 203 mm to 234 mm (30% to 50% above average) was recorded around the Bukit Panjang area while rainfall was lowest over the eastern and southern parts of Singapore around Changi and Marina South respectively where 62 mm to 94 mm (40% to 60% below average) was recorded.

Singapore experienced relatively wet conditions in July and August 2014 due to several occurrences of mesoscale convective systems and intense afternoon thunderstorms. Notably, thundery showers, due to convergence of winds over the region, on 5 July 2014 and 12 August 2014 brought wind gusts of 60-69 km/h and around 130-140mm of rainfall over the Tuas and Jurong areas. The afternoon thunderstorm on 29 July 2014, induced by broad scale convergence of winds in the region, also resulted in 95.8 mm of rainfall recorded at Handy Road and led to localised flash floods over the city areas. For both July and August 2014, above normal rainfall was recorded in many parts of the island, particularly the north-western region of Singapore. In July 2014, the highest rainfall of 270 mm to 350 mm (75% to 120% above average) was recorded around the Bukit Panjang area while 280 mm to 320 mm (60% to 90% above average) fell over the Choa Chu Kang area in August.

September 2014 was a relatively dry month for Singapore and the surrounding region as a series of typhoons (Fung-Wong, Kalmaegi and Fengshen) tracked north and north-eastwards into the East China Sea leading to the monsoon trough migrating further north. The drier weather conditions resulted in an increase in hotspot activities with widespread thick smoke haze observed in the southern parts of Sumatra, Kalimantan as well as in the South China Sea. Smoke haze from these areas was blown towards Singapore by the prevailing southwesterly/southeasterly winds, and slight to moderate

hazy conditions affected the island on 14-15, 17-19 and 21-22 September 2014. 24-hr PSI briefly crossed into the low-end of the Unhealthy range on 15, 18 and 19 September 2014.

Southwest Monsoon conditions continued to persist for most parts of October 2014. Thundery showers occurred mostly in the afternoon that month and, in particular, heavy rain in the morning of 4 October 2014 resulted in flash floods over Jalan Boon Lay and Lorong Buangkok. Singapore experienced dry weather condition in October 2014 with many parts of Singapore receiving below average rainfall. In addition, hazy conditions were experienced on 6-7, 8 and 11-12 October as smoke haze from fires in the nearby region was blown in by the prevailing winds towards Singapore. The highest 3-hr PSI and 24-hr PSI recorded for 2014 were 156 at 7pm on 6 October and 125 at 9am on 7 October respectively.

1.4 Second Inter-Monsoon Season (end October – mid-November)

Low level winds began to turn weak and variable in direction towards end October 2014 as Inter-Monsoon conditions set in. The rain band became more established over the equatorial region, resulting in wetter weather over our region. Singapore experienced moderate to heavy thundery showers in the afternoon and early evening on most days of November 2014, due to daytime heating of land areas coupled with convergence of winds. The heavy thundery showers on 13 November led to flash floods over several locations in central and eastern Singapore. Additionally, during the night of 8 November 2014, due to convergence of winds over Singapore and the surrounding vicinity, torrential rain fell over south-western and central Singapore, leading to flood floods at Lorong Kismis in the Bukit Batok area and at Dunearn Road in the Bukit Timah area. Several stations recorded rainfall in excess of 100mm that night with the highest rainfall of 160.8mm recorded near the Clementi area. This amount was also the highest daily rainfall recorded for 2014.

About two thirds of Singapore received above average rainfall during the first fortnight of November 2014. The highest rainfall of 330mm to 370mm (140% to 170% above average) was recorded in the northern part of the island around Woodlands and Sembawang. The lowest rainfall of 40mm to 100mm (30% to 70% below average) was recorded over the western part of the island around Tuas.

Singapore also experienced hazy conditions on 2-3 November 2014 which was rather uncommon during the late Inter-Monsoon season. A developing deep depression that formed in south-central Bay of Bengal induced southerly and south-westerly winds over Singapore on the first few days of November 2014, resulting in smoke haze being transported from southern Sumatra to Singapore.

1.5 Northeast Monsoon Season (mid-November – December)

By mid-November 2014, with the intensification of the high pressure systems over northern Asia, surface winds over Singapore and the surrounding vicinity strengthened and blew predominantly from the northeast and northwest, giving indication of the onset of the Northeast Monsoon. A strengthening of the north-easterly winds over the South China Sea, known as monsoon surge, affected the region around 17-21 November 2014. While this monsoon surge brought torrential rainfall to the north-eastern parts of Peninsular Malaysia, Singapore was only briefly affected in the afternoon of 17 November as the rain bearing cloud clusters shifted further north away from Singapore towards the evening. As such, the island experienced mainly short-duration thundery showers, triggered by daytime heating of land areas and sea breeze convergence, in the afternoon and early evening on most days in the second half of November 2014.

About half of Singapore received above average rainfall in November 2014 with the highest rainfall of 410mm to 460mm (60% to 80% above average) recorded in the northern part of the island around Sembawang and Yishun. The western parts of the island around Lim Chu Kang and the eastern parts of the island around Tampines received the lowest rainfall where 155mm to 205mm (20% to 40% below average) was recorded.

Uncharacteristically, surface winds turned southwest in the first week of December 2014 under the influence of Super Typhoon Hagupit. During this period, Singapore experienced few spells of “Sumatra” Squalls on 1, 4 and 6 December, mainly in the morning. In the second half of December 2014, surface winds over the region began to blow predominantly from the northeast, occasionally strong on most days. As a result, thundery showers, due to sea breeze convergence, occurred mainly over southern and western Singapore in the afternoon.

Severe monsoon surges affected the region in the second half of December 2014 and many parts of Peninsular Malaysia, were hit with some areas recording more than 1,000mm of rainfall over a week period. Due to the absence of strong north-easterly/easterly steering winds, Singapore was not directly affected by these surges. The island, however, still experienced relatively wet weather conditions owing to atmospheric instability induced by the surges. Thundery showers, at times heavy, occurred mostly in the afternoon and early evening on several days. On 17 December 2014, the heavy rain resulted in flash floods in Commonwealth Drive and Enterprise Road in the Jurong area. Additionally, several spells of moderate to heavy thunderstorms affected Singapore throughout the morning and afternoon of 26 December 2014. Many parts of island received rainfall in excess of 50 mm that day with the highest total rainfall of 94.8 mm recorded at Marine Parade.

Approximately two thirds of Singapore received above average rainfall in December 2014. The southern part of the island around Sentosa and Tanjong Pagar recorded the highest rainfall of 567mm to 648mm (110% to 140% above average). The lowest rainfall of 189mm to 270mm (0% to 30% below average) was registered in the eastern and north-eastern parts of the island around Pasir Ris and Punggol.

2. Significant Weather Events

2.1 Prolonged dry spells from mid-January to mid-March and Haze in March 2014

Between mid-January and mid-March 2014, the surface high pressure over Siberia was above normal compared to the climatological average (Figure 1), leading to colder than normal air being blown towards the ASEAN region and the South China Sea and possibly explain why the low level air temperatures were below normal during this period (Figure 2). In addition, the coincident passage of an intense Madden-Julian Oscillation (MJO) dry phase could also have suppressed the convective activities over the region, exacerbating the dry spells.

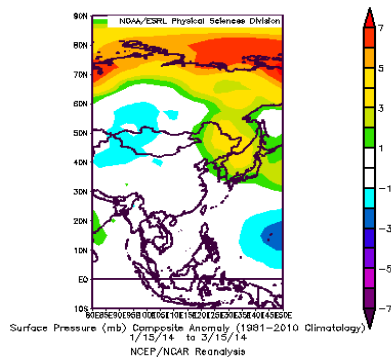


Figure 1: Surface pressure (hPa) composite anomaly (1981-2010 climatology) from 15 January to 15 March 2014 (Source: NCEP reanalysis)

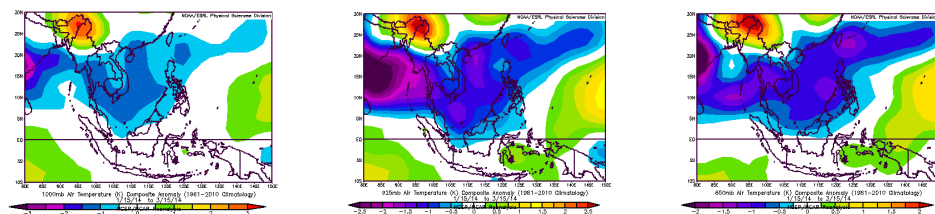


Figure 2: Air temperature composite anomaly (1981-2010 climatology) at 1000hPa, 925hPa and 850hPa from 15 January to 15 March 2014 (Source: NCEP reanalysis)

In the second week of March 2014, the prolonged dry and occasional windy conditions that affected the region subsequently led to an escalation of hotspot activities in Peninsular Malaysia and central Sumatra (Figure 3). Parts of Singapore experienced hazy conditions on several days between 7 and 15 March 2014 as smoke haze caused by the fires in southern Johor was blown towards Singapore by the prevailing north-easterly winds (Figure 4). PSI readings rose to moderate range on a few days with the 3-hr PSI peaking at 84 on 11 March.

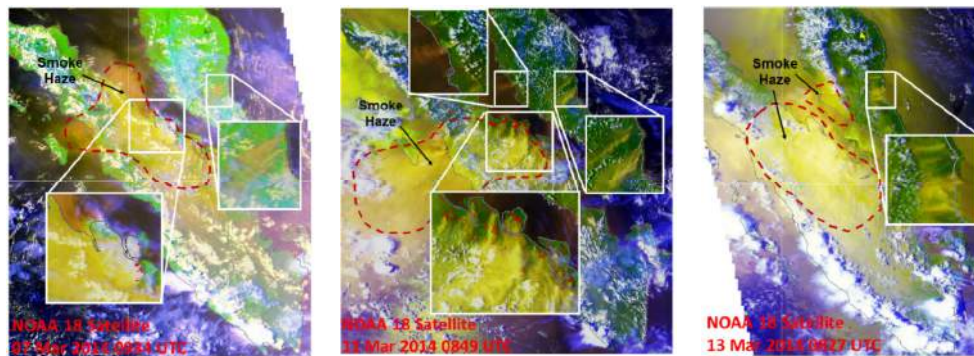


Figure 3: NOAA-18 satellite imagery on 7, 11 and 13 March 2014 showing moderate to dense smoke haze with smoke plumes over central Sumatra and Peninsular Malaysia.

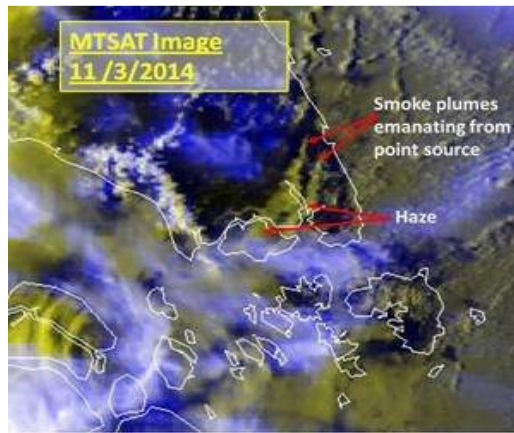


Figure 4: MTSAT imagery on 11 March 2014 showing smoke plumes emanating from hotspots in southern Johore and haze blown towards Singapore.

2.2 Severe Sumatra Squall - 12 June 2014

The Sumatra Squall, that moved across Singapore during the early hours of 12 June 2014 (Figures 5 to 7), was considered one of the most destructive in recent years as the strong gusts from the squall resulted in collapsed roofs, damaged tents, 18 incidences of fallen trees, 30 fallen branches and six snapped trunks. Wind gusts as high as 103.7 km per hour were recorded near West Coast Highway that day (Figure 8).

Due to the intensification of a circulation over the South China Sea, the low-level vertical wind shear was particularly strong that night (Figure 9). Squalls that usually form under such environment tend to be more long lived and severe as the updraft and downdraft are kept separated by the strong vertical wind shear. The passage of the wet phase of an MJO cycle could have also played a part in intensifying the squall.

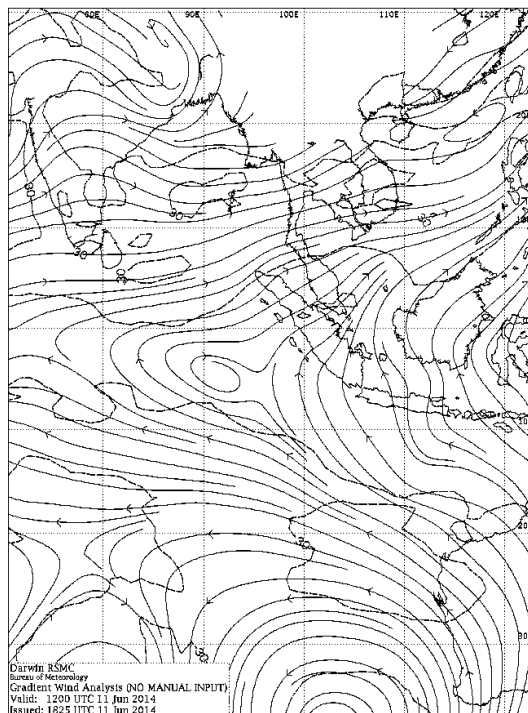


Figure 5: Gradient wind chart (from Bureau of Meteorology, Australia) of synoptic situation in South Asia region on 11 June 2014. South-westerlies with convergence of winds triggered the formation of Sumatra Squall along the Strait of Malacca. The squall subsequently affected Singapore in the early hours of 12 June 2014

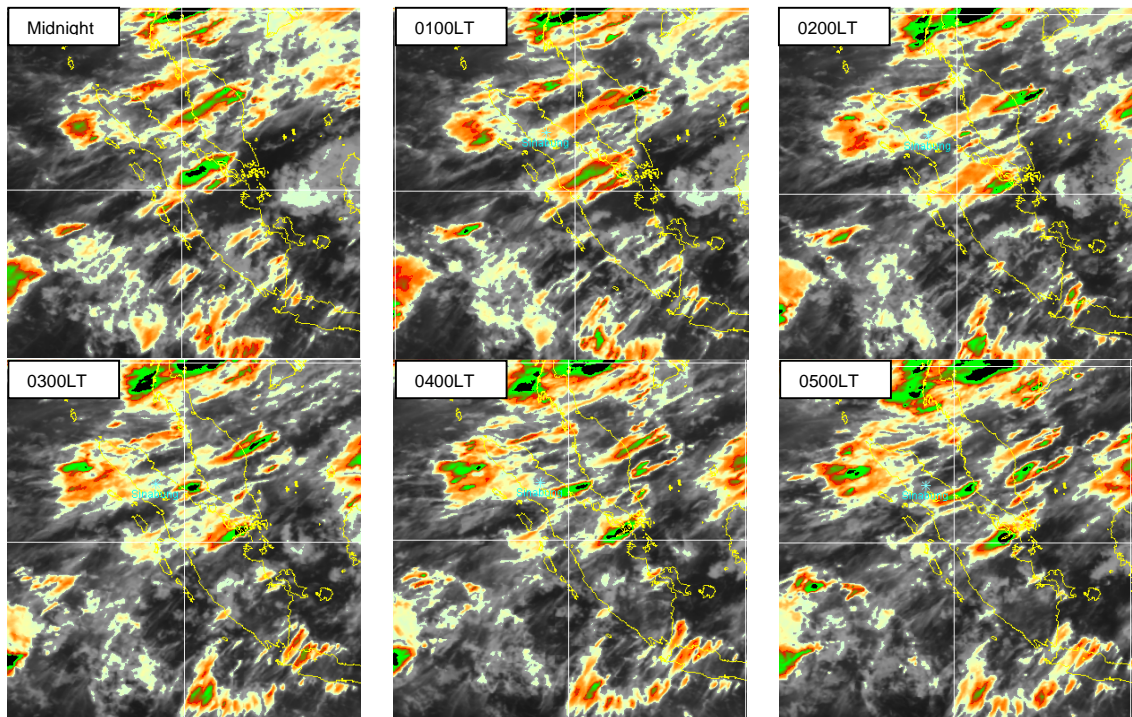


Figure 6: FY2 Infrared channel satellite imagery at hourly intervals between midnight and 0500LT on 12 June 2014 showing the development of the “Sumatra” Squall

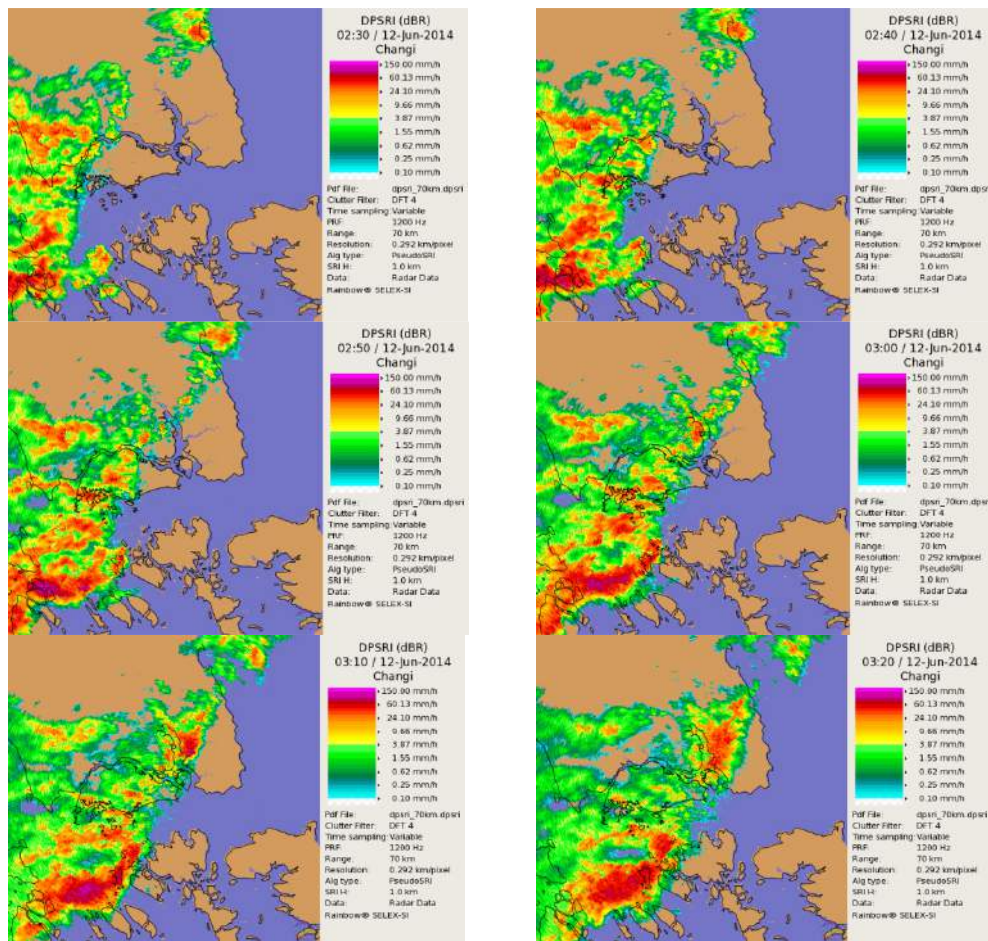


Figure 7: Radar images at 10-min intervals between 0230 – 0320 LT on 12 June 2014 showing a severe “Sumatra” Squall sweeping across the island in less than an hour

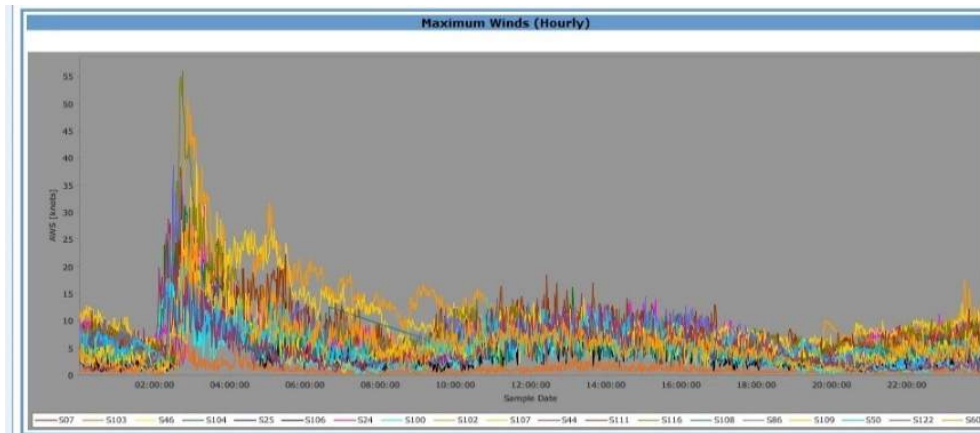


Figure 8: Wind data from automatic weather stations located island wide on 12 June 2014 showing some stations recording maximum wind speed exceeding 30 knots (~55 km/hr) in the early and pre-dawn hours during the passage of the “Sumatra” Squall

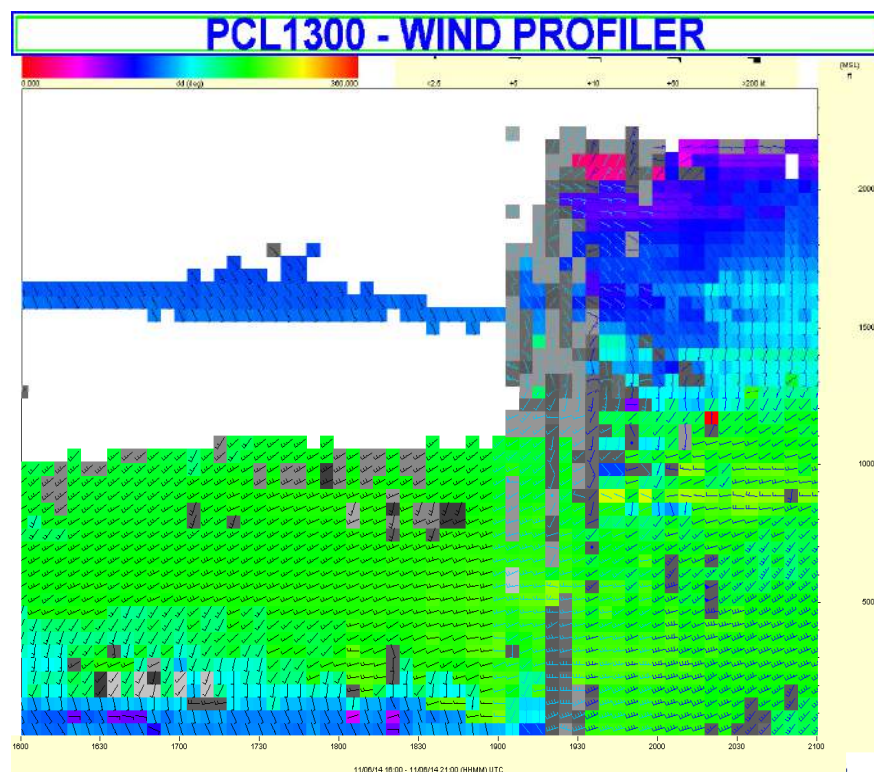


Figure 9: Vertical wind profile from wind profiler located at Changi Airport on 12 June 2014 between midnight and 0500LT. Strong low-level vertical wind shear provided a favourable environment for long-lived and severe squall line. Winds close to surface changed to south-westerly and strengthened significantly (30-40 knots) during the passage of the squall line

2.3 Heavy Rain and Flash Floods - 29 July 2014

The rain-band associated with Tropical Storm Halong (Figures 10- 11) coupled with strong heating of land areas brought unsettled weather conditions over Singapore and the surrounding region on 29 July. Two spells of heavy thunderstorms affected Singapore in the afternoon (Figure 12).

The first spell started around midday where thunderstorms were advected into Singapore from south-western Johor by the north-westerly winds (Figure 13). The gusty winds that accompanied these thunderstorms (Figure 14) resulted in fallen trees and branches.

The second spell developed in the late afternoon. The heavy downpour in southern and central Singapore led to flash floods in a few places such as Mackenzie Road near Little India, Kramat Lane in Orchard Road and Bassein Road in the Novena area. The highest total rainfall of 95.8mm and the maximum hourly rain intensity of 84.8mm/h were recorded at Handy Road near Dhoby Ghaut (Figure 15).

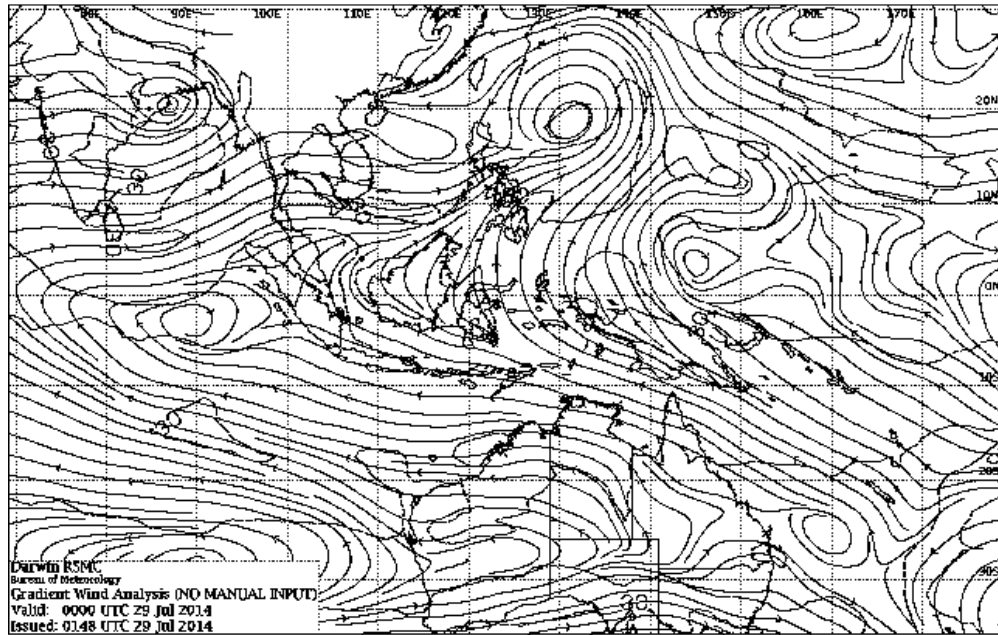


Figure 10: Gradient wind chart (from Bureau of Meteorology, Australia) of synoptic situation in the Asia Pacific region on 29 July 2014. Tropical Storm Halong, located to the east of the Philippines, induced south-westerlies with convergence of winds over the ASEAN region.

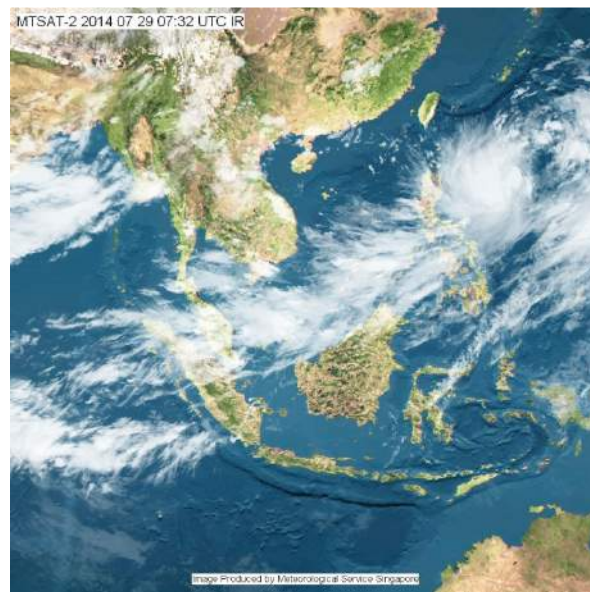


Figure 11: MTSAT colour satellite images at 1532LT on 29 July 2014 showing rain-bands associated with Tropical Storm Halong extending far south from the main system and contributed to wetter conditions over Singapore and the surrounding region

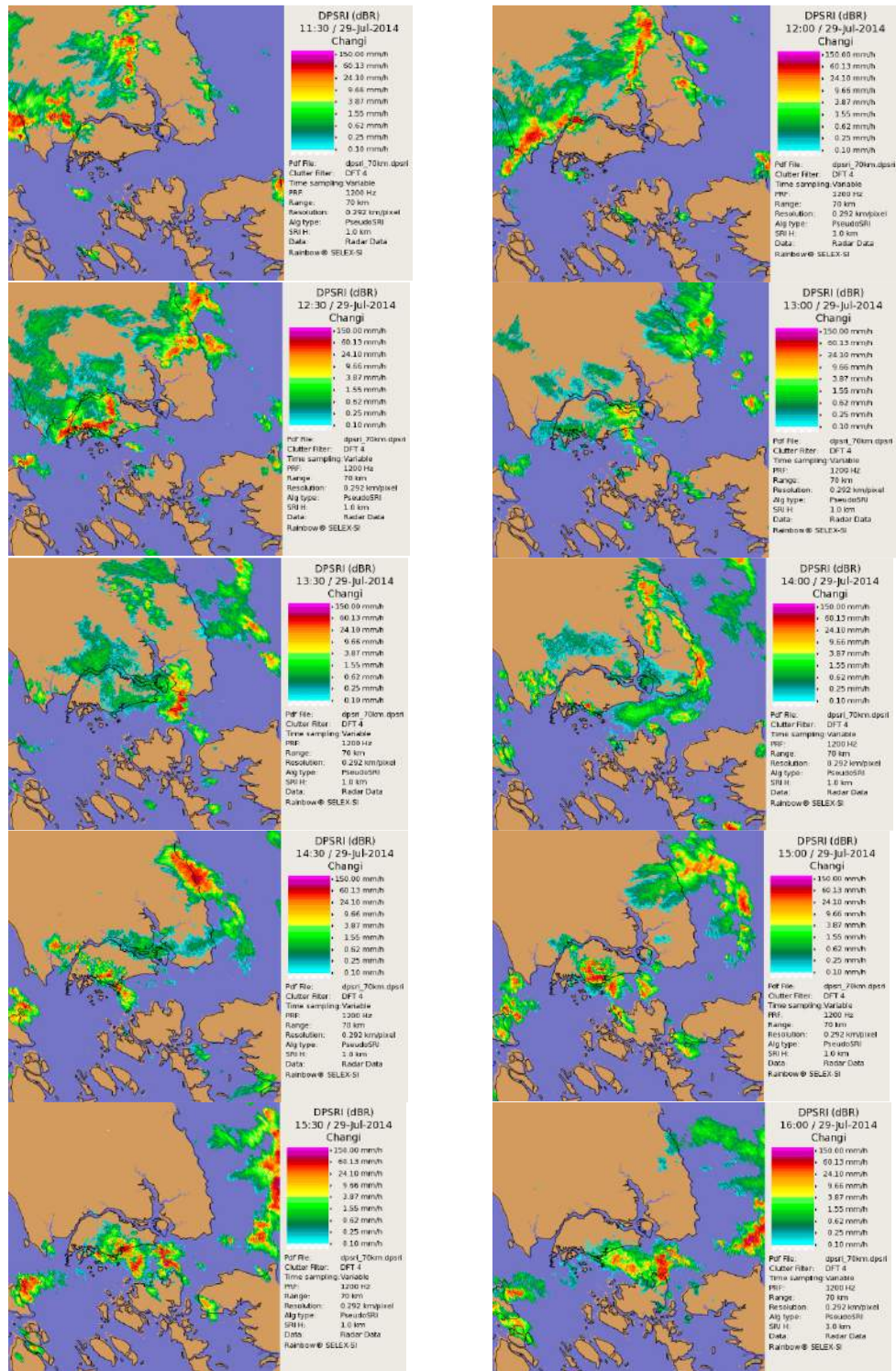


Figure 12: Radar images at 30-min intervals between midday and 1600 LT on 29 July 2014 showing two spells of heavy rain affecting Singapore. The first spell brought heavy rain and gusty winds to many parts of Singapore while the second spell was more intense and localised, confining to southern and central Singapore

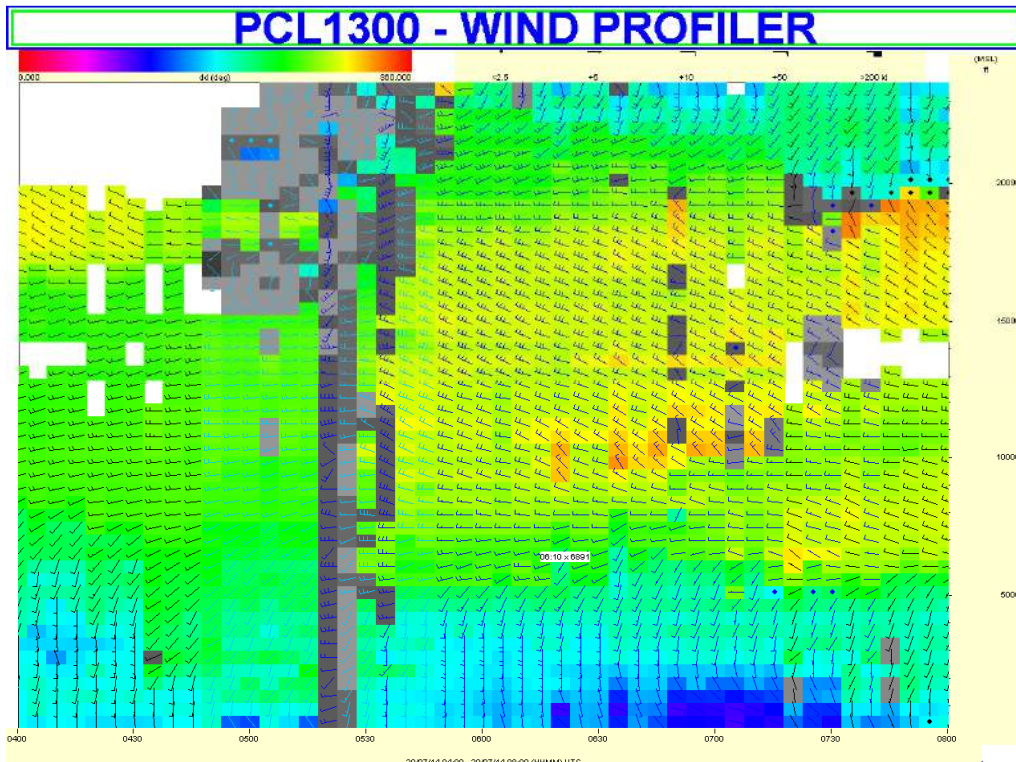


Figure 13: Vertical wind profile from wind profiler located at Changi Airport on 29 July 2014 between midday and 1600LT. Strong west-northwesterly steering winds predominated throughout the whole period. The strong low-level vertical wind shear facilitated the development of gusty winds

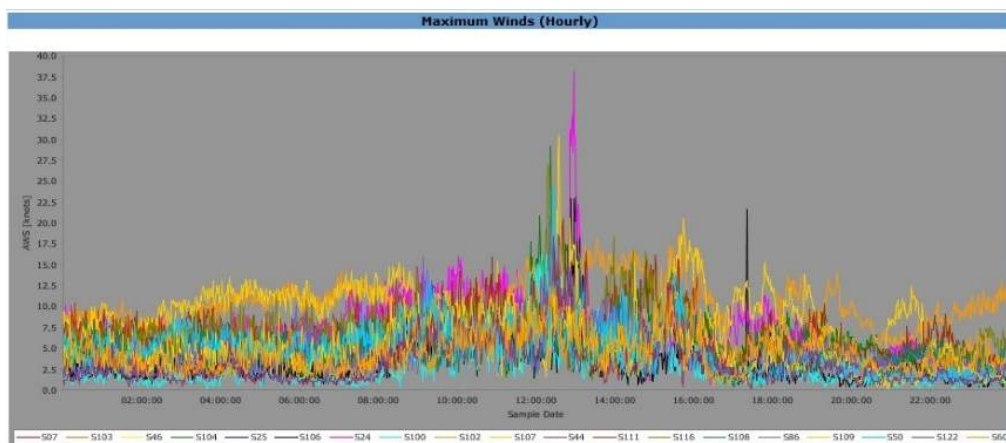


Figure 14: Wind data from automatic weather stations located island wide on 29 July 2014 showing a spike in maximum wind speed around 1200-1300 LT

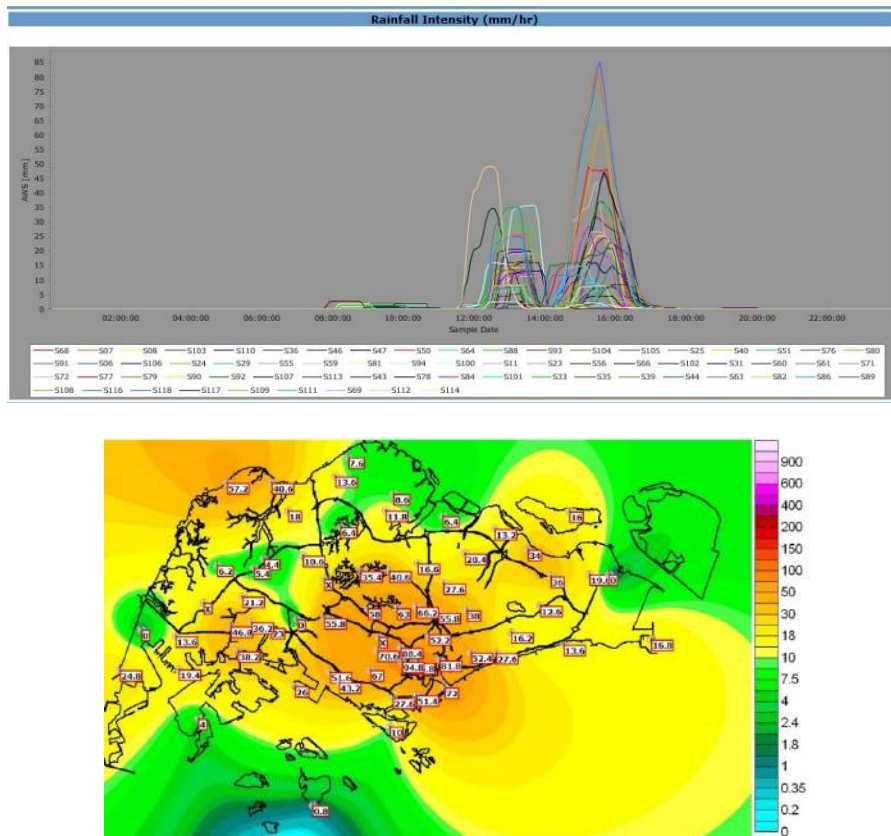


Figure 15: Rainfall data from the automatic weather stations located island wide on 29 July 2014. Rainfall intensity (top) and total rainfall (bottom) for the day

2.4 Haze in September and October 2014

Drier weather conditions prevailed in for the southern ASEAN region in September and October 2014 as the monsoon rain belt was located further north, away from the equator. During this period, the drier conditions led to an escalation of hotspot activities in Sumatra and Kalimantan. Widespread smoke haze was occasionally observed emanating from hotspot clusters and the smoke haze was carried by the prevailing low level winds to affect parts of Peninsular Malaysia and Singapore. Singapore experienced a total of six haze episodes in September and October. Three episodes occurred on 14-15, 17-19 and 21-22 September 2014 while another three episodes on 6-7, 8 and 11-12 October 2014. These six haze episodes that affected Singapore were generally diffused upon reaching Singapore's shores. The highest 3-hr PSI and 24-hr PSI recorded were 156 at 7pm on 6 October 2014 and 125 at 9am on 7 October 2014 respectively (Figure 16). Satellite image in Figure 17 shows haze in the region on 6 October 2015.

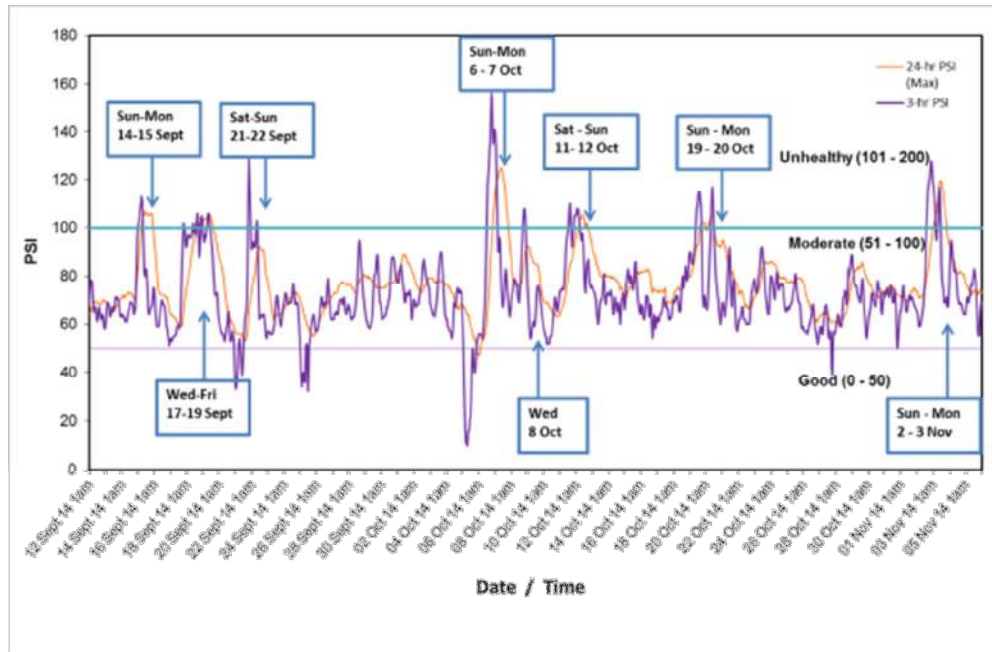


Figure 16: PSI value for Singapore from September to November 2014.

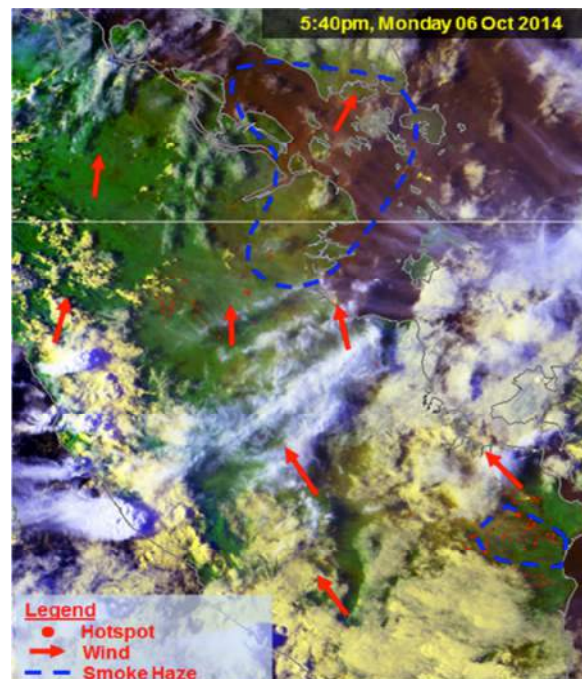


Figure 17: NOAA18 satellite image on 6 October 2014 showing moderate haze moving from eastern Riau across the Malacca Strait to affect Singapore

2.5 Heavy rain and hail over Bukit Timah - 14 October 2014

In the afternoon of 14 October 2014, light winds coupled with solar heating of land areas led to intense thunderstorms with gusty winds over central, northern and western Singapore (Figures 18-22). Trees at many locations fell during the heavy rain. Hailstones were also sighted in the Bukit Timah area and there were reports of damage a roofs at the former Turf Club grounds.

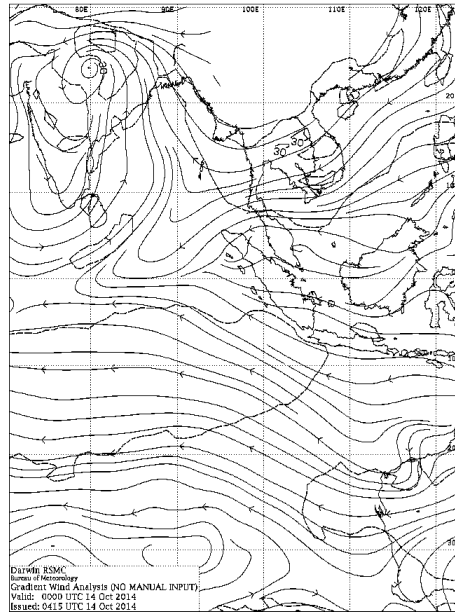


Figure 18: Gradient wind chart (from Bureau of Meteorology, Australia) of synoptic situation in South Asia region on 14 October 2014. Light winds coupled with land heating led to the development of intense afternoon thundery showers

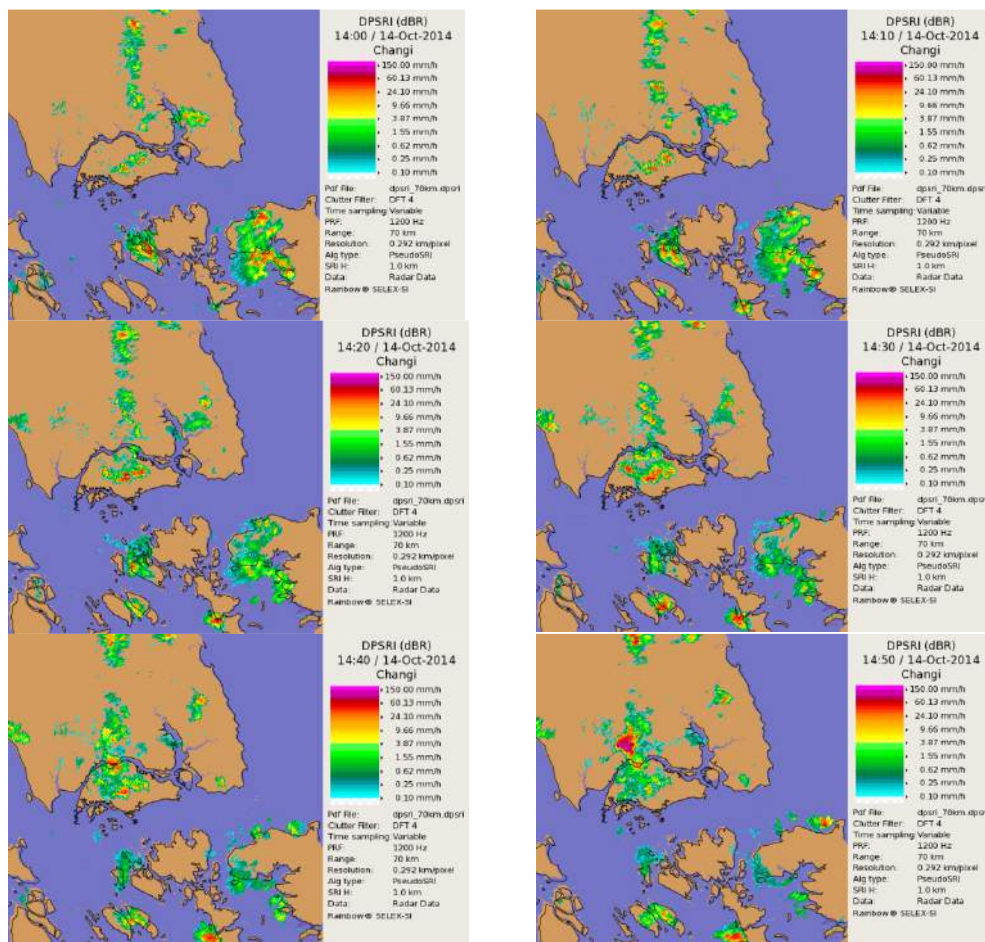


Figure 19: Radar images at 10-min intervals between 1400 and 1450 LT on 14 October 2014 showing the development of intense thunderstorm cells over central, northern and western Singapore

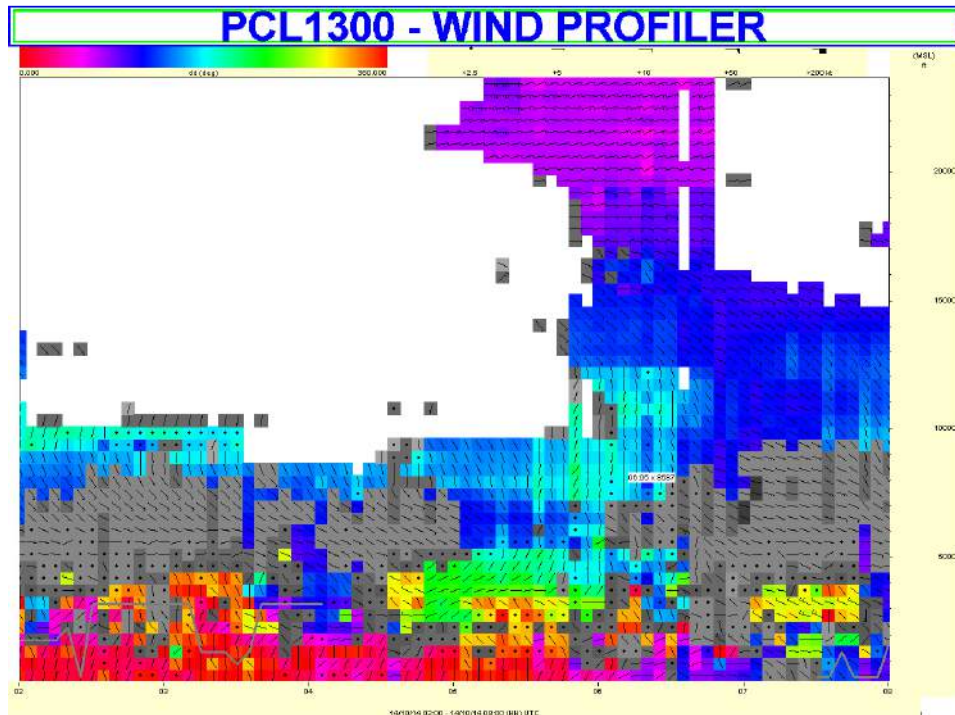


Figure 20: Vertical wind profile from wind profiler located at Changi Airport on 14 October 2014 between 1000LT and 1600LT. Light and variable winds predominated throughout the whole period, providing a favourable environment in developing an intense thunderstorm in the afternoon

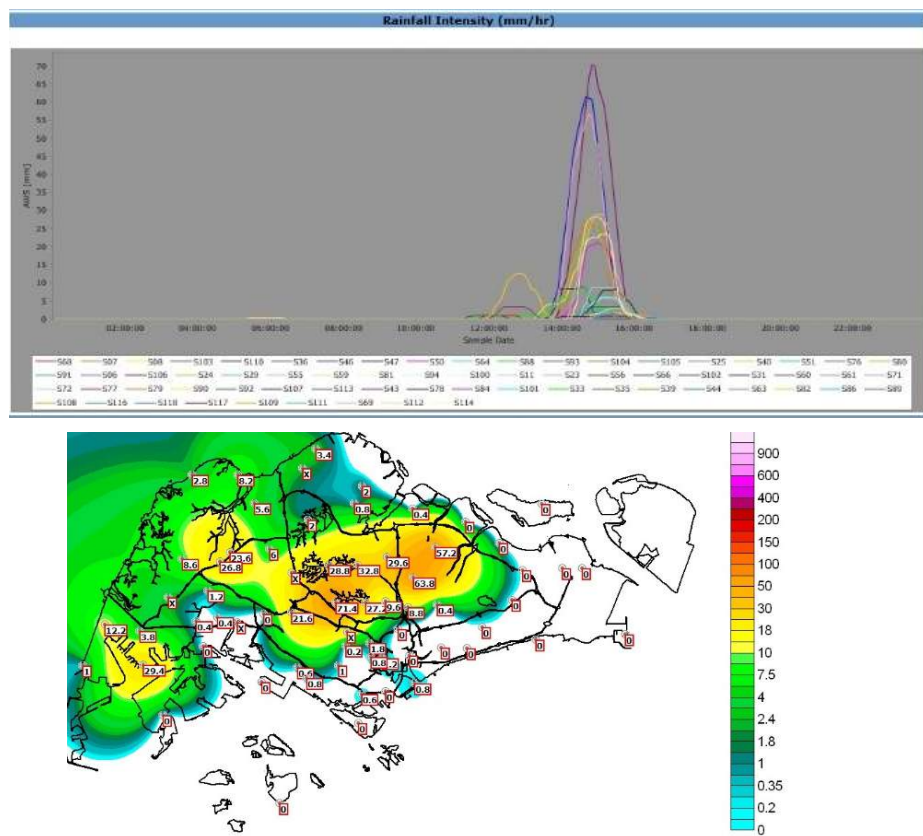


Figure 21: Rainfall data from the automatic weather stations located island wide on 14 October 2014. Rainfall intensity (top) and total rainfall (bottom) for the day

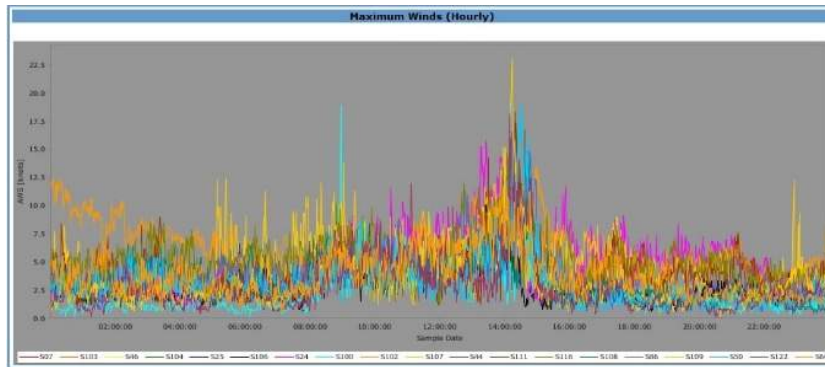


Figure 22: Wind data from automatic weather stations located island wide on 14 October 2014 showing a spike in maximum wind speed around 1400-1500 LT

2.6 Haze in early November 2014

On 2-3 November 2014, Singapore experienced hazy conditions due to the low-level southerly and south-westerly winds induced by the deep depression developed over the south-central Bay of Bengal. The 3-hr PSI in Singapore started to increase rapidly in the afternoon of 2 November and reached a high of 128 at 9 pm. The air quality persisted in the Unhealthy range throughout the night. This haze episode was rather short-lived as changing wind direction to south-easterly helped mitigate the situation with air quality returning to the Moderate range in the afternoon the next day.

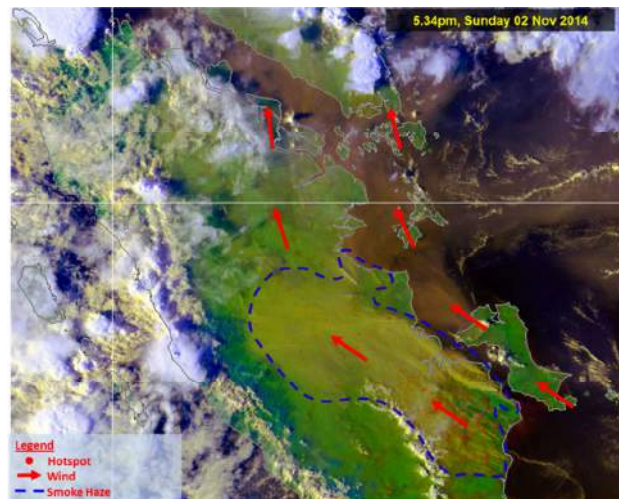


Figure 23: NOAA 18 satellite image on 2 November 2014 showing extensive haze patch over southern Sumatra.

2.7 Heavy rain and Flash Floods - 8 November 2014

A low pressure circulation affected northern Peninsular Malaysia on 8 November 2014. This induced a large scale wind convergence over Singapore and the surrounding vicinity (Figure 24) and resulted in the development of scattered thunderstorms over the sea areas around Singapore in the early evening that day (Figure 25). Steered by the southerly winds, the thunderstorms affected Singapore around 2030LT and intensified over the south-western and central part of the island (Figures 26-27). Heavy rain fell that evening with several stations in those areas recording rainfall in excess of 100mm (Figure 28). The heavy rainfall led to flash floods in Bukit Batok and the Bukit Timah areas. The highest total rainfall of 160.7mm and the maximum hourly rain intensity of 104.6mm/h were recorded at Old Toh Tuck Road near Clementi. These

figures were also the highest daily rainfall and maximum hourly rain intensity recorded for 2014.

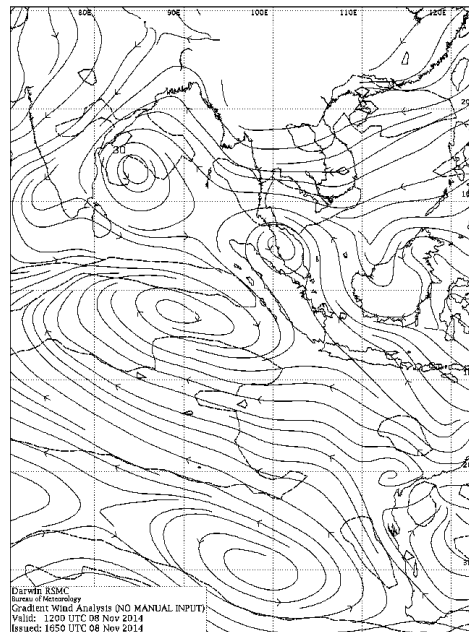


Figure 24: Gradient wind chart (from Bureau of Meteorology, Australia) of synoptic situation in South Asia region on 08 November 2014. The circulation over northern Peninsular Malaysia led to strong convergence of winds over the region and hence unstable weather conditions that night

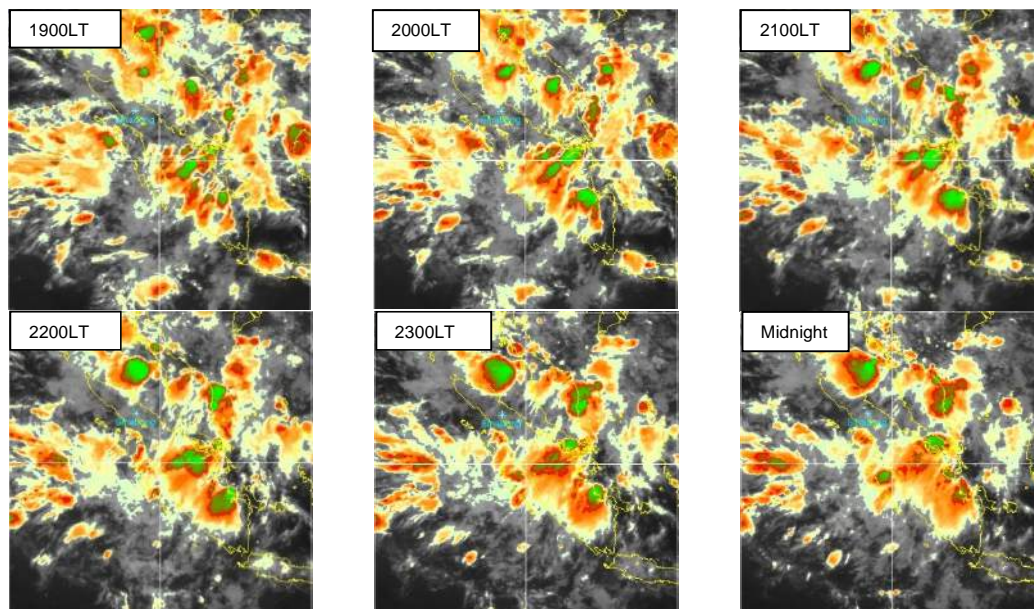


Figure 25: FY2 Infrared channel satellite imagery at hourly intervals between 1900LT and midnight on 08 November 2014 showing intense thunderstorm development over Singapore and the surrounding vicinity

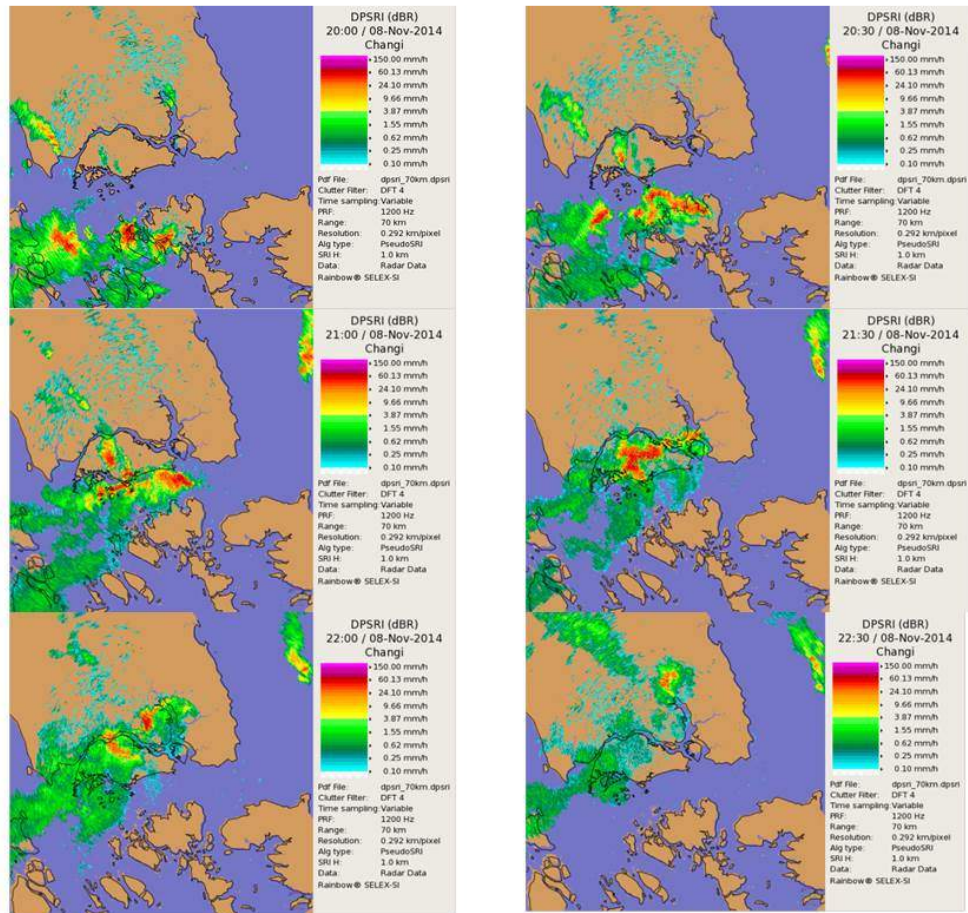


Figure 26: Radar images at half-hourly intervals between 2000LT and 2230 LT on 8 November 2014 showing the development of severe thunderstorms over Singapore. The storms affected south-western Singapore first before spreading to other parts of the island

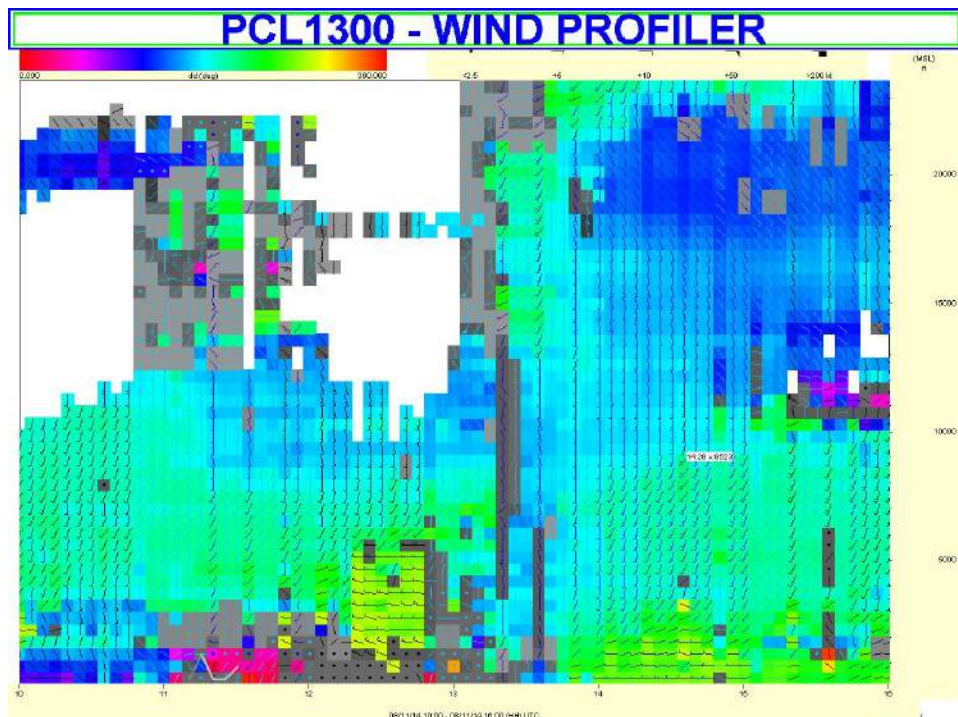


Figure 27: Vertical wind profile from wind profiler located at Changi Airport on 08 November 2014 between 1800LT and midnight. The southerly winds were responsible for steering the intense thunderstorms towards Singapore

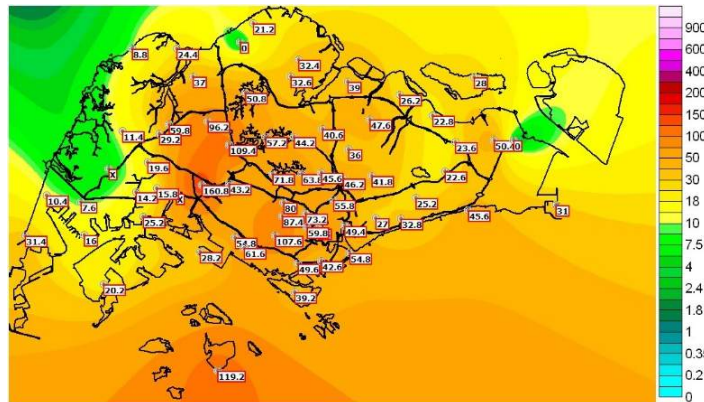
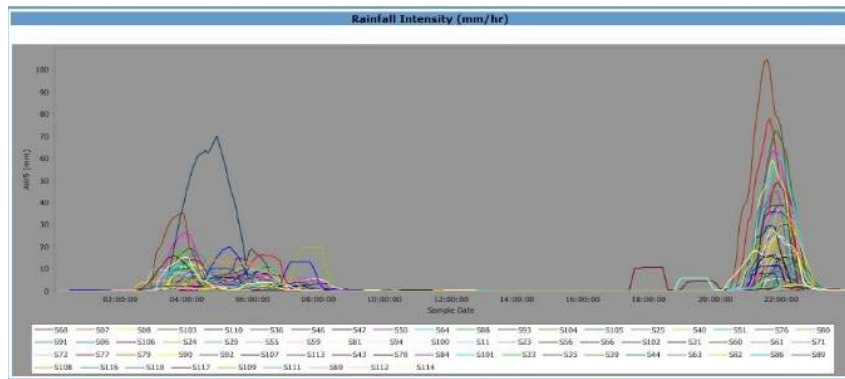


Figure 28: Rainfall data from the automatic weather stations located island wide on 08 November 2014. Rainfall intensity (top) and total rainfall (bottom) for the day

2.8 Heavy rain and Flash Floods / Waterspout at Pulau Tekong - 17 November 2014

Thundery showers affected most parts of Singapore on 17 November 2014 due to strong solar heating of land areas and convergence of winds (Figures 29-30). The thunderstorms were advected into Singapore around midday by the steering easterly winds (Figures 31-32). Heavy rain fell over many parts of Singapore, particularly in the Tampines area (Figure 31). The nearest rainfall station, located in the Paya Lebar area, recorded 53.2mm of rain within a short time span of 30 minutes. Flash floods also affected the Serangoon, Macpherson and Hougang areas. A waterspout associated with cloud clusters off the east coast of Peninsular Malaysia was sighted around Pulau Tekong in that afternoon.

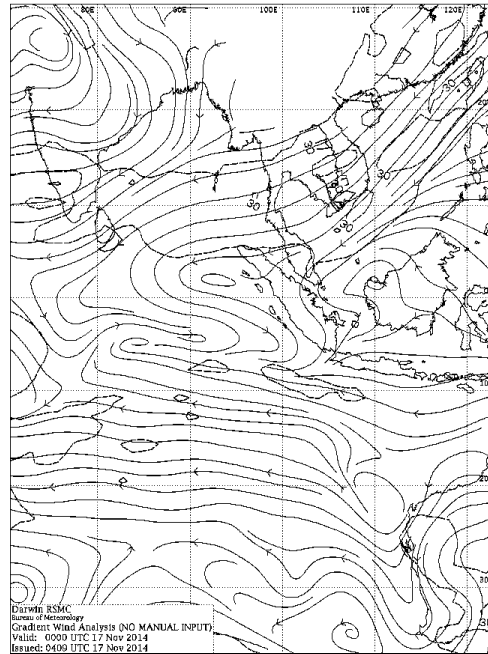


Figure 29: Gradient wind chart (from Bureau of Meteorology, Australia) of synoptic situation in South Asia region on 17 November 2014. A monsoon surge brought northeasterly winds of 30 knots or more over the South China Sea. Strong speed convergence over the sea northeast of Singapore led to continuous build-up of intense thunderstorms over the region

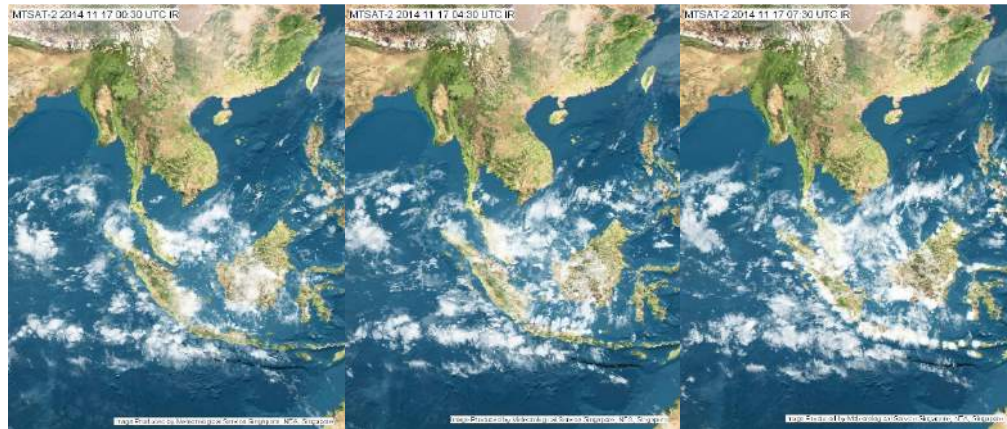


Figure 30: MTSAT colour satellite images at 0830LT, 1230LT and 1530LT on 17 November 2014 showing the large rain bearing cloud clusters affecting the east coast of Peninsular Malaysia in the morning and then Singapore in the afternoon

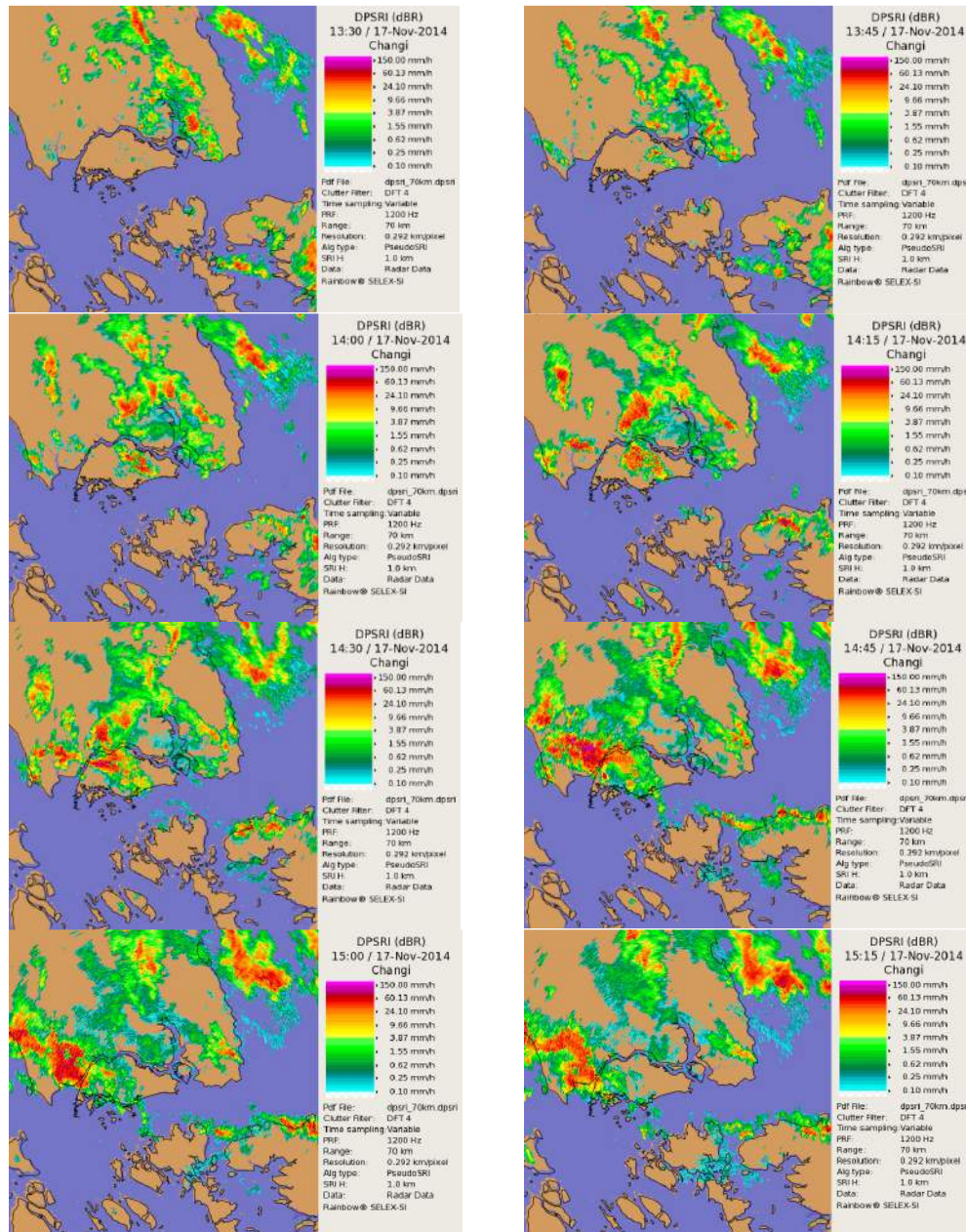


Figure 31: Radar images at 15-minute intervals between 1330LT and 1515LT on 17 November 2014 showing thunderstorms being advected into Singapore from the South China Sea

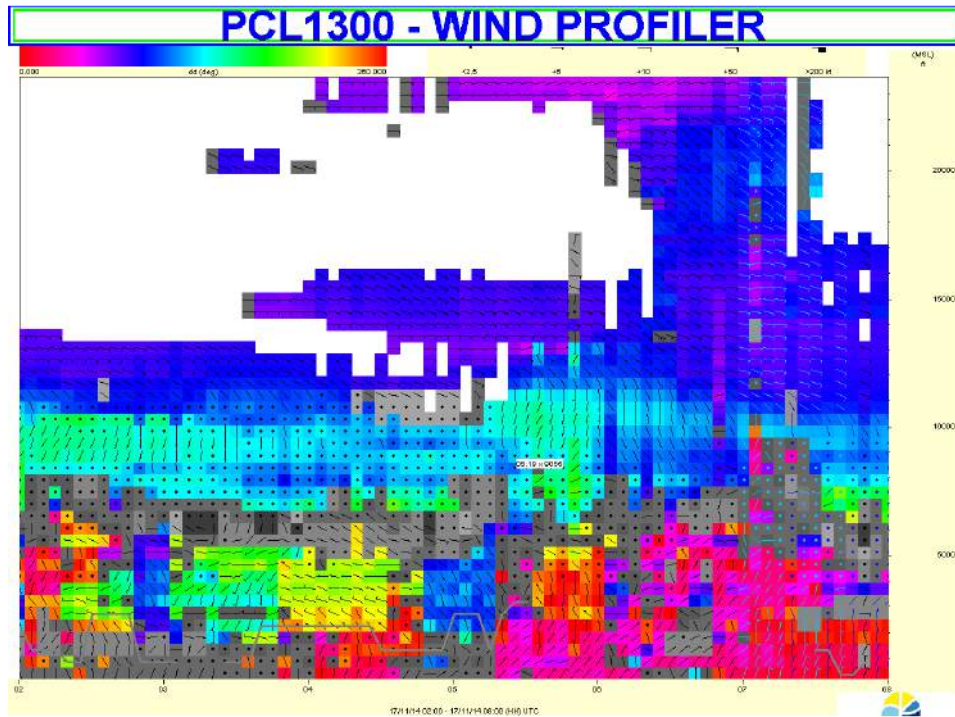


Figure 32: Vertical wind profile from wind profiler located at Changi Airport on 17 November 2014 between 1000LT and 1600LT. The easterly winds at around 10,000ft (~3km) steered the thunderstorms from the South China Sea to Singapore.

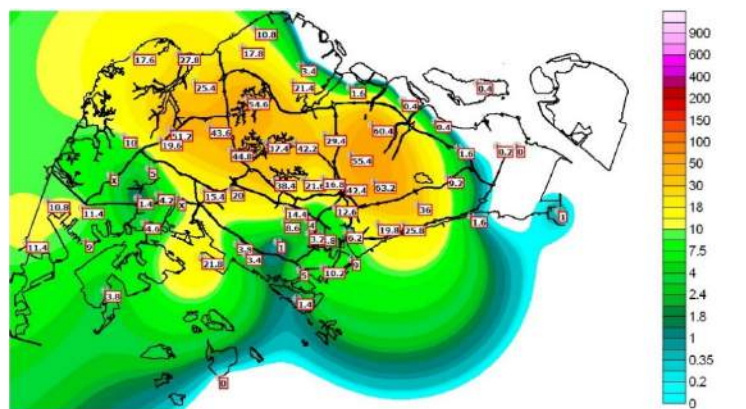
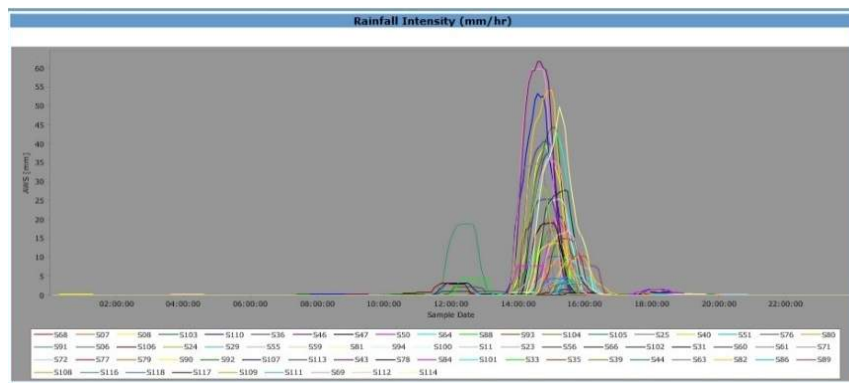


Figure 33: Rainfall data from the automatic weather stations located island wide on 17 November 2014. Rainfall intensity (top) and total rainfall (bottom) for the day.

3. Climatic Features

Neutral (neither El Niño nor La Niña) conditions prevailed in the tropical Pacific Ocean for 2014. Towards late 2014, the oceanic and atmospheric anomalies began to border on El Niño thresholds, indicating some signs of a weak coupling between the atmosphere and the ocean might be occurring.

The Indian Ocean Dipole Mode Index (DMI), an indicator that focuses on convective anomalies over the Indian Ocean, was mostly negative for the first three quarters of 2014 before turning positive in October and November 2014 (Figure 34). In general, DMI displayed better correlation with the percentage of 2014 monthly rainfall difference from mean for the climate station (Figure 35) towards the second half of the year and especially so when the signal was stronger such as in July and August. The slightly enhanced negative DMI, during these two months, could have contributed to wetter weather conditions over the Maritime Continent.

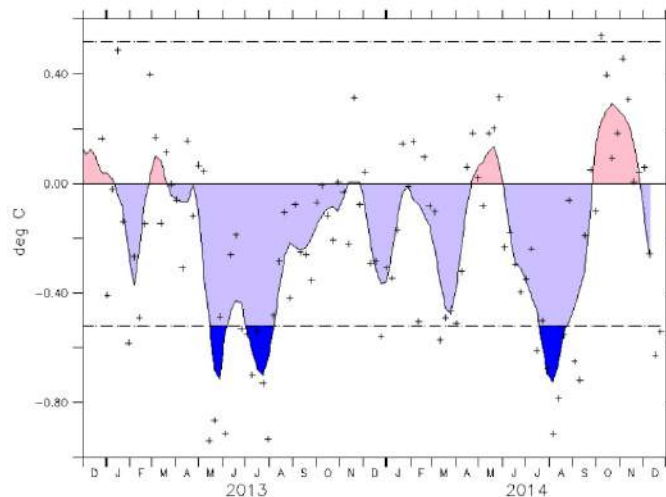


Figure 34: The Indian Ocean Dipole Mode Index (source: JAMSTEC). Positive (red) indicates warmer anomalies in the western Indian Ocean and cooler anomalies in the eastern Indian Ocean. Negative (blue) indicates cooler anomalies in the western Indian Ocean and warmer anomalies in the Eastern Indian Ocean

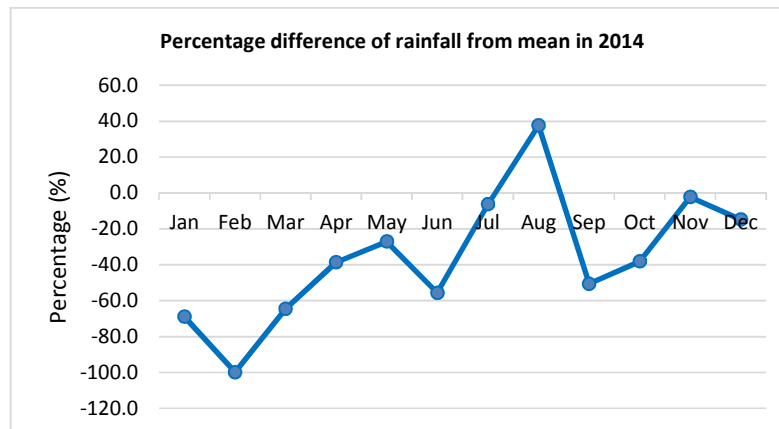


Figure 35: Percentage difference of 2014 monthly rainfall from the mean (1869-2013) for the climate station at Changi

The impact of Madden-Julian Oscillation (MJO) (Figure 36) on the monthly rainfall for the climate station was more pronounced in the earlier part of 2014. The coincident passage of an intense MJO dry phase during this period could have exacerbated the two dry spells experienced between mid-January and mid-March, resulting in monthly rainfall to be significantly lower than the long-term average. For other periods of 2014,

MJO's correlation with the percentage of 2014 monthly rainfall difference from the mean for the climate station was weak.

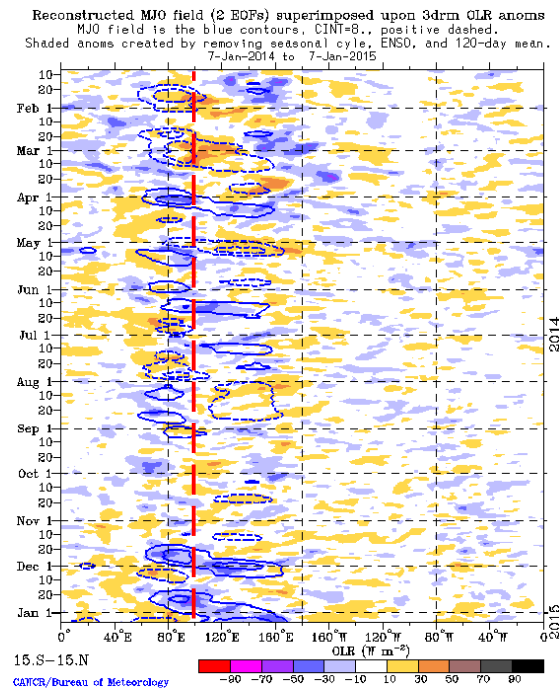


Figure 36: MJO fields (bold and dotted lines) superimposed on Outward Long wave Radiation (OLR) anomalies. Bold blue lines indicate a wet phase of MJO while dotted lines indicate a dry phase of MJO. Blue contours indicate negative OLR anomalies while orange contours indicate positive OLR anomalies

Apart from October 2014 which indicated an easterly anomalies, the 2014 anomalous 850-hPa zonal wind averaged 5°N and 5°S (Figure 37) generally did not show any significant anomalies. As such, the 850-hPa zonal wind had a weak influence on the Southwest and Northeast Monsoons in 2014.

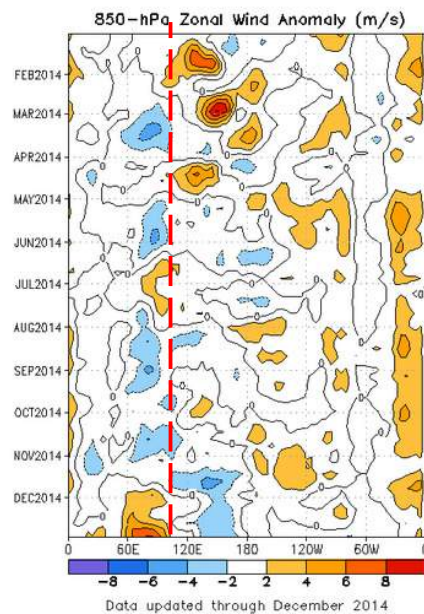


Figure 37: Time-longitude section of anomalous 850-hPa zonal wind averaged between 5°N - 5°S (source: CDAS/Reanalysis). Contour interval is 2 ms^{-1} . Anomalies are departures from the 1981-2010 base period pentad means. The data are smoothed temporally by using a 3-point running average. Blue shading and dashed contours indicate easterly anomalies. Orange shading and solid contours indicate westerly anomalies. Singapore is located at approximately 100°E .

For year 2014, the annual rainfall over most parts of the island was below average. The highest rainfall of more than 2450mm (5-10% above average) fell mainly over the northern part of Singapore while the lowest rainfall of 1350mm to 1570 mm (35% to 45% below average) was recorded over the eastern part of the island (Figures 38-39). A total rainfall of 1538.4mm was recorded at the climate station, which was 34.4% below the long-term average of 2344.0mm. August, November and December were wettest with monthly rainfall around 240-250mm while February was the driest with only 0.2mm of rainfall recorded (Figure 40).

RAINFALL DISTRIBUTION 2014

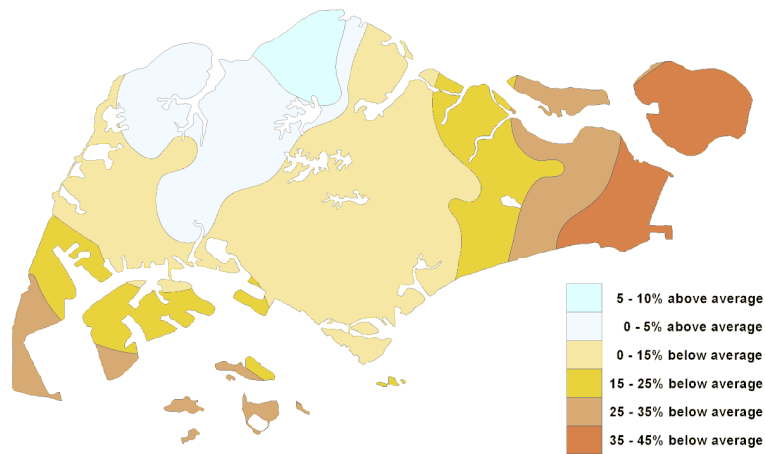


Figure 38: Percentage difference of annual rainfall in 2014 from the long-term means for Singapore

TOTAL RAINFALL (MM) 2014

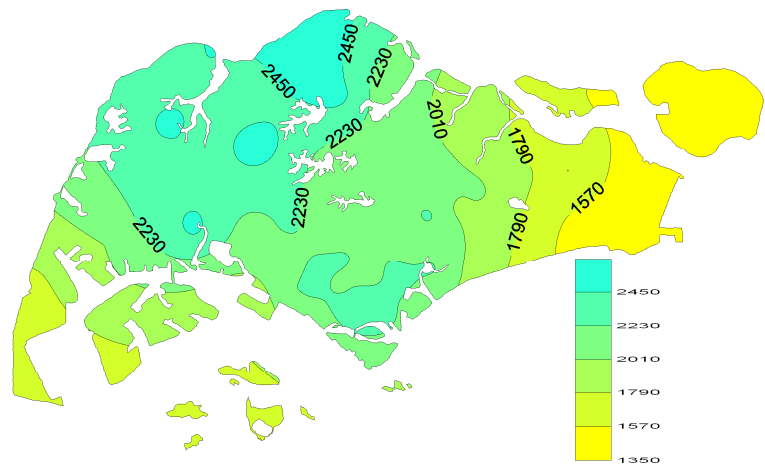


Figure 39: Isohyets of annual rainfall in 2014 for Singapore

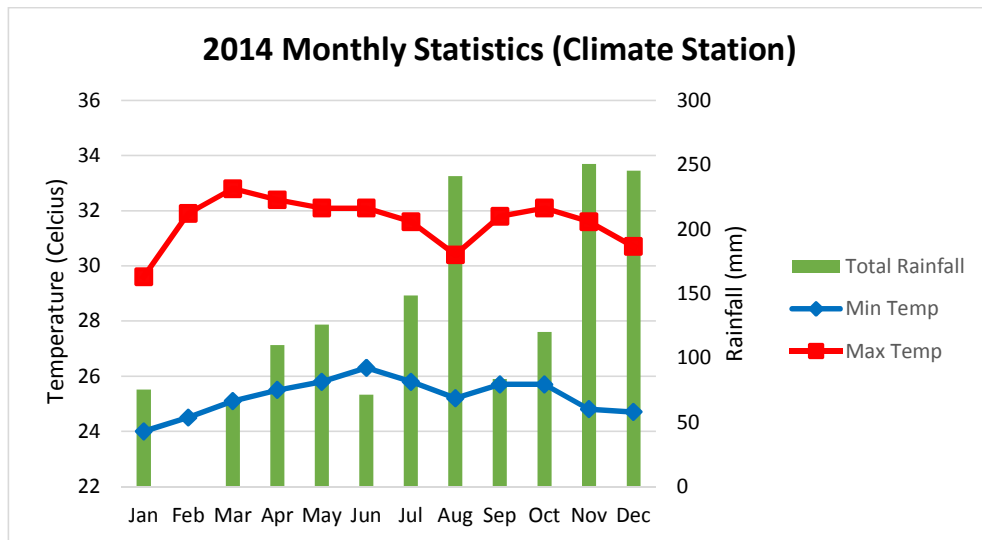


Figure 40: Monthly statistics of rainfall, maximum and minimum temperatures at the climate station located at Changi
