Air quality in Newcastle: Spring 2018

Air quality in Newcastle from 1 September to 30 November 2018 was generally good.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) were all well below benchmark concentrations and assessment goals.
- Daily average levels of fine particulate matter $PM_{2.5}$ (particles less than or equal to 2.5 microns in diameter) were above the 25 micrograms per cubic metre (µg/m^3) benchmark on one day (22 November) at Stockton, due to a large fire in Port Stephens[1] that occurred during a major dust storm.
- Daily average levels of particulate matter PM_{10} (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on 12 days during spring 2018 (15–18, 20 and 30 October, 2, 4, 6 and 21–23 November). This was similar or less than the number of days over the PM_{10} benchmark in earlier years (with 11 to 22 days in the 2013 to 2017 spring seasons). Regional maximum daily PM_{10} levels on these days ranged from 51.0 to 196.6 µg/m^3.
    - Beresfield and Wallsend recorded two days over the benchmark, Newcastle recorded three days, Mayfield recorded four days, Carrington recorded five days and Stockton recorded 12 days.
    - Most of New South Wales continued to be drought-affected (Figure 2), with widespread dust storms continuing[2]. The most extensive events occurred on 21–23 November, being exceptional events due to long-range dust transport and smoke from a large fire in Port Stephens[1]. All sites in the region exceeded the PM_{10} benchmark during this dust event.
        - On 22 November 44 of the 47 air quality monitoring stations in the NSW network recorded PM_{10} levels over the benchmark. A dust storm originated from South Australia and drought-affected regions in New South Wales on 21 November. More information on this event can be found in the New South Wales Annual Air Quality Statement 2018.

Annual air quality trends in the Newcastle region

A comparison of annual average PM_{10} and $PM_{2.5}$ levels shows the long-term trends. The national annual average benchmarks are 25 µg/m^3 for PM_{10} and 8 µg/m^3 for $PM_{2.5}$, based on a calendar year.

Figure 1 shows the PM_{10} and $PM_{2.5}$ annual averages for the 2015 to 2018 calendar years.

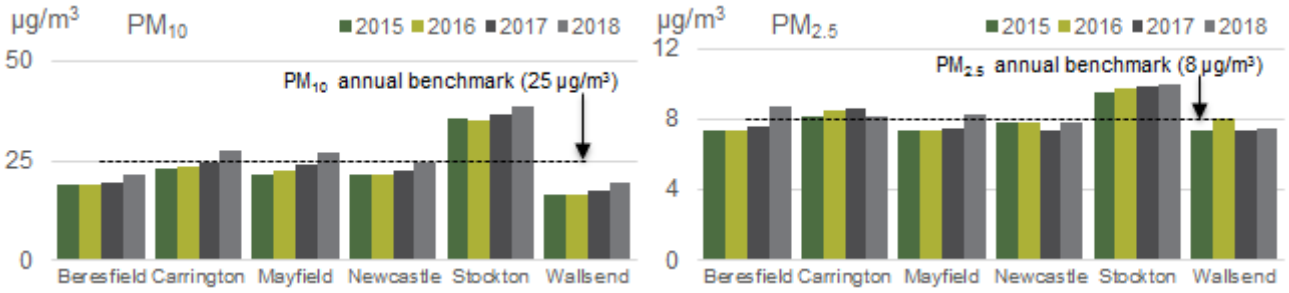

Figure 1 PM_{10} and $PM_{2.5}$ annual averages from 2015 to 2018

The comparison in Figure 1 shows that there was an increase in particle levels in 2018. The majority of New South Wales experienced below average to lowest on record rainfall in 2018 and were drought-affected (Figure 2). Long-range dust from drought-affected areas in New South Wales contributed to the increase in particles observed in the region:

[1] Rural Fire Service (RFS) ICON database: 2007ha 'Richardson Rd, Campvale' fire from 22/11 to 30/11

[2] DustWatch report September 2018 'Dust activity increased in the north-east and south-west NSW', DustWatch report October 2018 'Third dustiest October since 2005', and DustWatch report November 2018 'Second dustiest November in Dust Watch records' and 'Major events occurred around 2 November and 21 November'

- For PM_{10}, annual averages increased in 2018 compared with the three earlier years, with the Carrington, Mayfield and Stockton sites exceeding the PM_{10} annual benchmark in 2018.
- For $PM_{2.5}$, annual averages have remained below the benchmark at Newcastle and Wallsend since 2015. At Beresfield and Mayfield, annual averages increased in 2018, exceeding the benchmark for the first time since 2015. At Carrington and Stockton, annual averages were above the benchmark each year since 2015, with levels remaining fairly consistent (although a steady increase has been seen at Stockton over this time). The overall higher $PM_{2.5}$ annual averages at Stockton is consistent with the Lower Hunter Particle Characterisation Study, which found 40% more $PM_{2.5}$ at Stockton compared to Mayfield, Beresfield and Newcastle. This was found to be due to more sea salt and primary ammonium nitrate at the site (particularly in winter), which is very likely due to Orica's ammonium nitrate manufacturing facility on Kooragang Island.

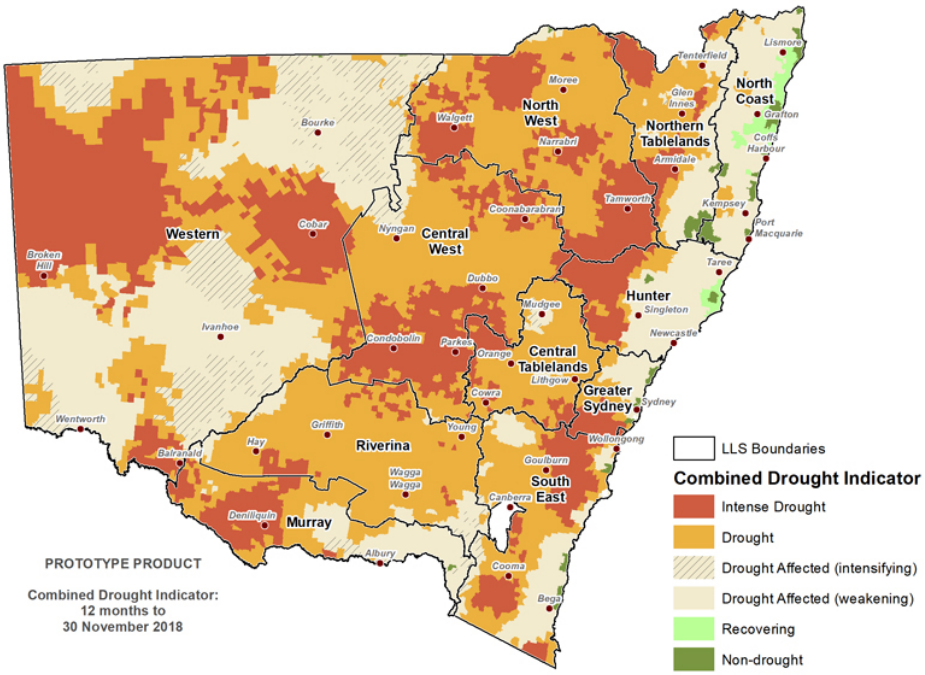

Figure 2 **Department of Primary Industries NSW Combined Drought Indicator to 30 November 2018**[3]

Days above benchmark concentrations

There were 12 days over the PM_{10} daily benchmark in spring 2018, with all sites exceeding the benchmark. At least three of these days were due to the transport of long-range dust into the region. See the Stockton section below for more information on the elevated particle levels at that site.

There was one day over the $PM_{2.5}$ benchmark in spring 2018 at Stockton, due to a bushfire at Port Stephens[1] during a major dust storm event.

Table 1 **Number of days above the relevant benchmarks – spring 2018**

Station	PM_{10} daily [50 µg/m³ benchmark]	$PM_{2.5}$ daily [25 µg/m³ benchmark]	SO_2 hourly [20 pphm benchmark]	SO_2 daily [8 pphm benchmark]	NO_2 hourly [12 pphm benchmark]	NH_3 hourly [46 pphm benchmark]
Beresfield	2	0	0	0	0	-
Carrington	5	0	0	0	0	-
Mayfield	4	0	0	0	0	-
Newcastle	3	0	0	0	0	-
Stockton	12	1	0	0	0	0
Wallsend	2	0	0	0	0	-

µg/m³ = microgram per cubic metre
pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)
- = not monitored

[3] Sourced from Department of Primary Industries NSW State seasonal update - November 2018 (accessed January 2019).

Daily time series plots

Daily average time series plots for PM_{10} and $PM_{2.5}$ and daily one–hour maximum plots for NO_2, SO_2 and NH_3 show the daily concentrations throughout the spring season.

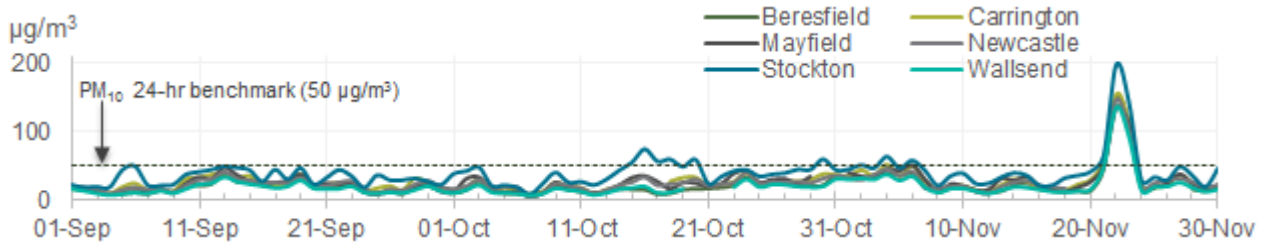

Figure 3 Daily average PM_{10} during spring 2018

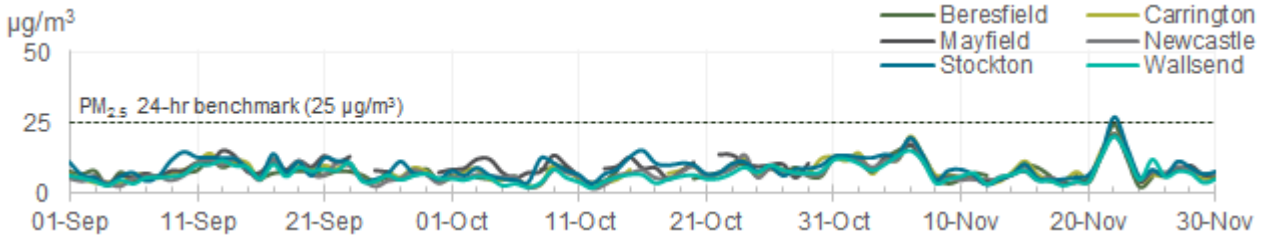

Figure 4 Daily average $PM_{2.5}$ during spring 2018

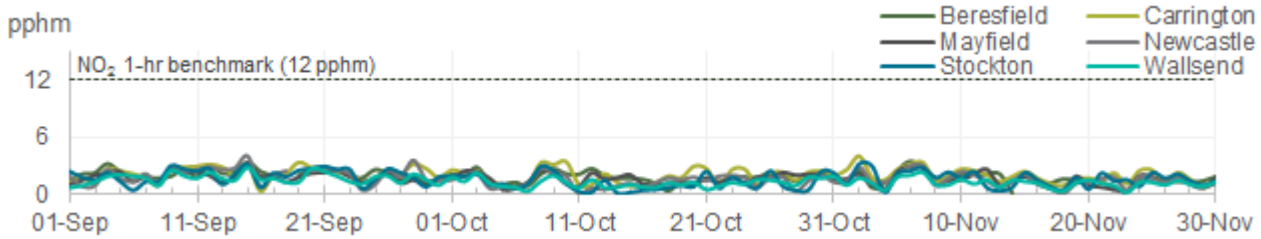

Figure 5 Daily maximum 1-hr NO_2 during spring 2018

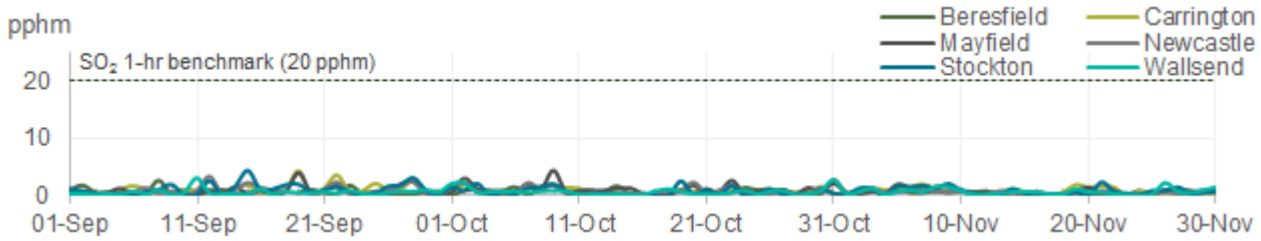

Figure 6 Daily maximum 1-hr SO_2 during spring 2018

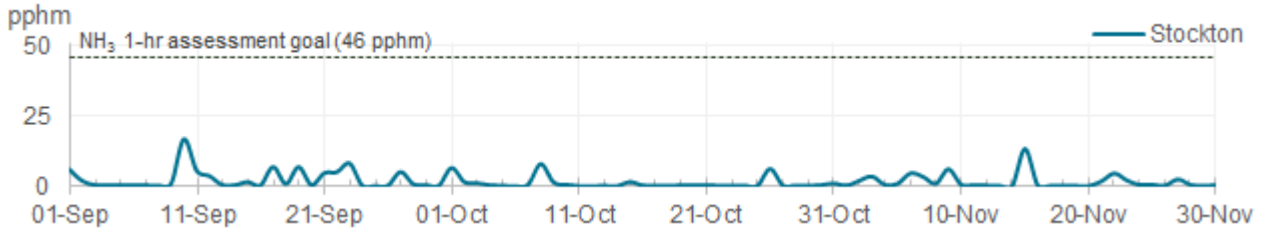

Figure 7 Daily maximum 1-hr NH_3 during spring 2018

Pollution roses

The seasonal pollution rose maps[4] show that hourly[5] PM_{10} and $PM_{2.5}$ levels generally remained low during spring. Some elevated hourly PM_{10} levels in the region were experienced under north-west winds, predominantly during the 21–23 November dust storm event. Stockton also recorded elevated hourly PM_{10} levels under north-east winds, due predominantly to sea salt (see Stockton section below for more detail).

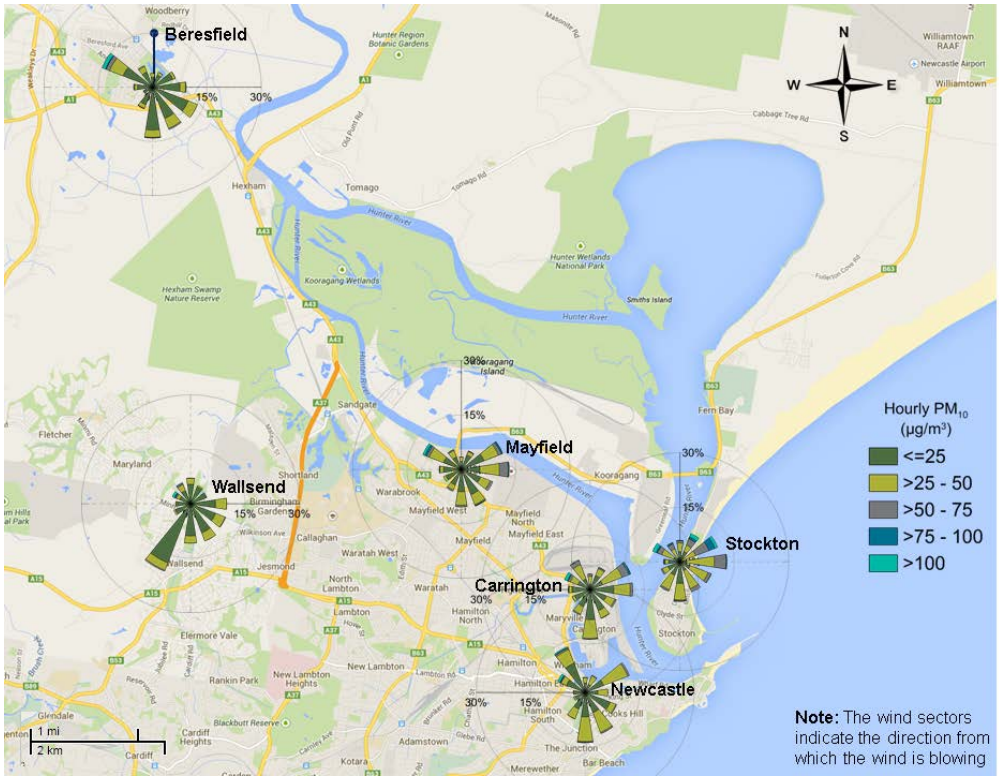

Figure 8 Hourly PM_{10} pollution roses for the Newcastle region for spring 2018

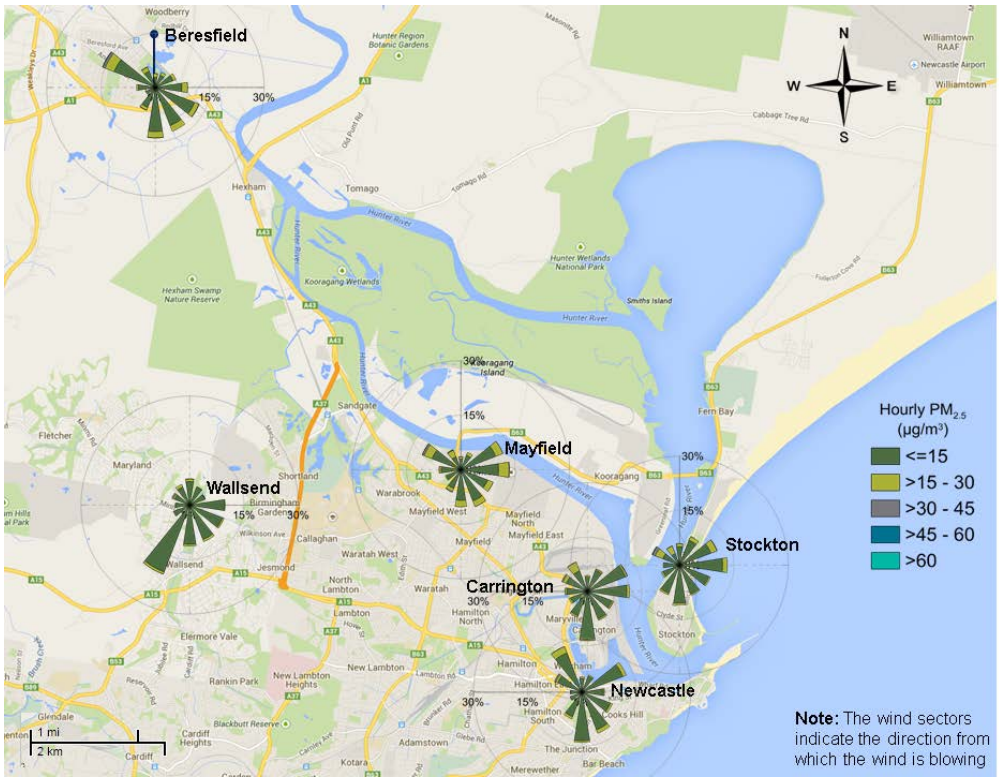

Figure 9 Hourly $PM_{2.5}$ pollution roses for the Newcastle region for spring 2018

[4] Pollution roses show the wind direction and particle levels at a location. The length of each bar around the circle shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate categories of particle levels.

[5] Note: There are no standards for hourly PM_{10}/$PM_{2.5}$ in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).

Seasonal comparisons

This section compares air quality levels in spring 2018 with previous spring seasons, where data were available. Monitoring at Stockton commenced in October 2012[6] and at Mayfield and Carrington in August 2014. Monitoring of $PM_{2.5}$ at Newcastle commenced in December 2013.

All days were below benchmark concentrations for NO_2 and SO_2 in spring during the past six years at Beresfield, Newcastle, Stockton and Wallsend and since monitoring began at Carrington and Mayfield.

For NH_3 at Stockton, there were no days over the assessment criterion in spring during the past six years.

There was one day above the $PM_{2.5}$ benchmark at Stockton during spring 2018, due to bushfire smoke along with dust from the 21–23 November major dust storm event. This was similar to previous years, except for spring 2013 when eight days were recorded over the $PM_{2.5}$ benchmark in the region.

There were 12 days above the PM_{10} benchmark in the region during spring 2018, with at least three affected by the long-range transport of dust into the region from severely drought-affected areas. Beresfield and Wallsend recorded two days over the PM_{10} benchmark, Newcastle recorded three days, Mayfield recorded four days, Carrington recorded five days and Stockton recorded 12 days. This was lower than spring 2017 and similar or lower than previous spring seasons, with 11 days above the benchmark in spring 2016, 14 days each in 2013 and 2014, 20 days in 2015 and 22 days in spring 2017.

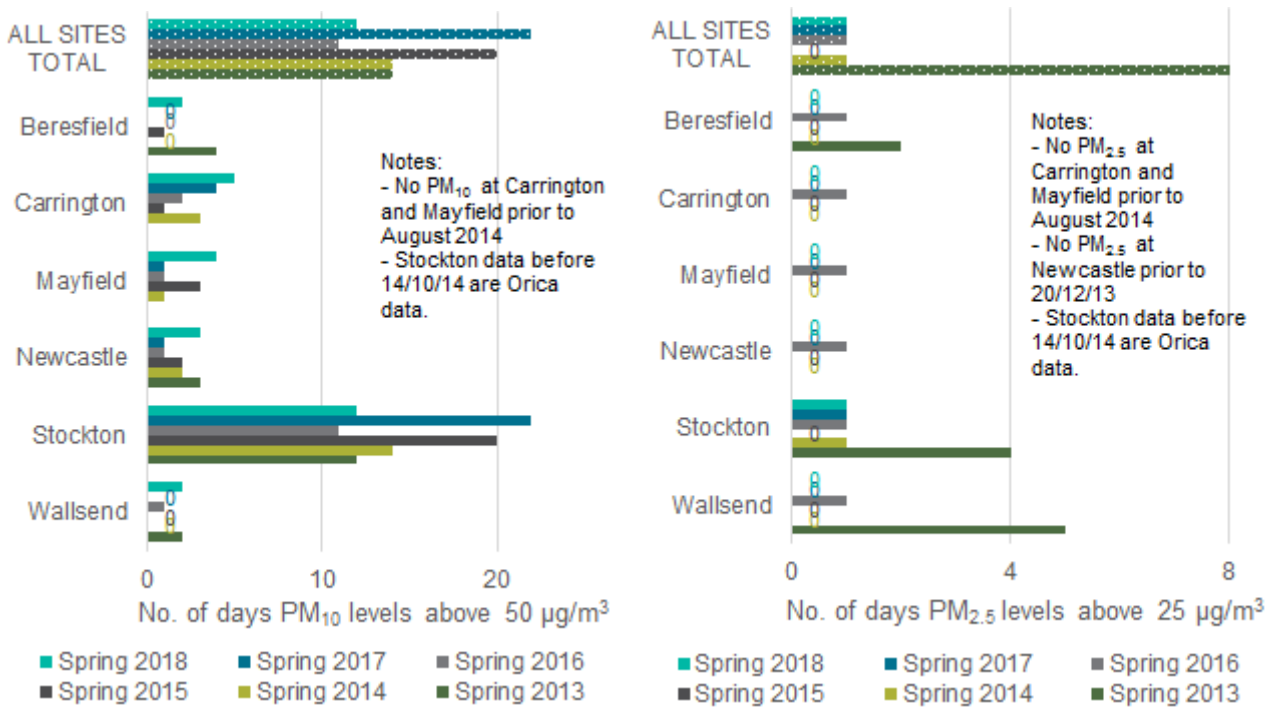

Figure 10 Number of days above the PM_{10} and $PM_{2.5}$ benchmarks: spring 2013 to spring 2018

[6] Stockton air quality monitoring was undertaken by Orica from October 2012 to October 2014. From October 2014 it was undertaken by the Office of Environment and Heritage as part of the Newcastle Local Air Quality Monitoring Network.

Particle air quality trends in the Newcastle region

Figure 11 and Figure 12 show daily average PM_{10} during spring 2018, compared to the daily maximum and minimum (i.e. shaded range) of PM_{10} levels for the spring periods from 2013 to 2017, at Stockton and Newcastle. These show that daily PM_{10} levels were generally within the range of earlier years throughout the season, except for the large peak on 22 November during the extensive dust storm. Rainfall totals were amongst the highest since spring 2013 for September and October, returning to dry conditions in November (Figure 13). Variability during the season may also be partly due to the low number of years of historical data available for comparison.

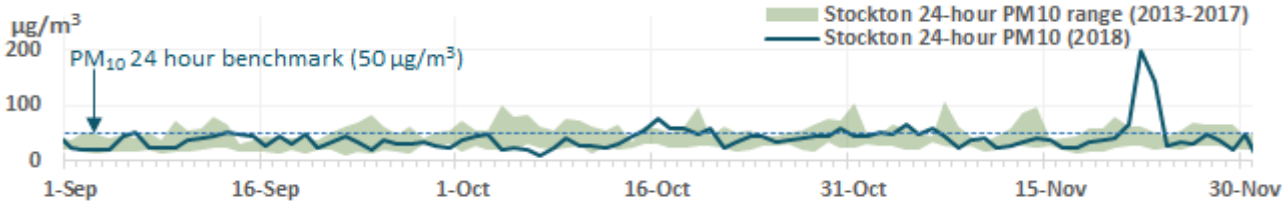

Figure 11 **Stockton daily average PM_{10} during spring 2018 plotted against the daily maximum and minimum PM_{10} levels recorded from spring 2013 to 2017**

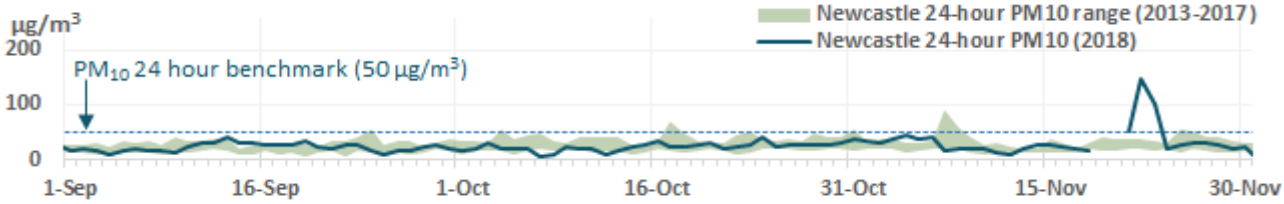

Figure 12 **Newcastle daily average PM_{10} during spring 2018 plotted against the daily maximum and minimum PM_{10} levels recorded from spring 2013 to 2017**

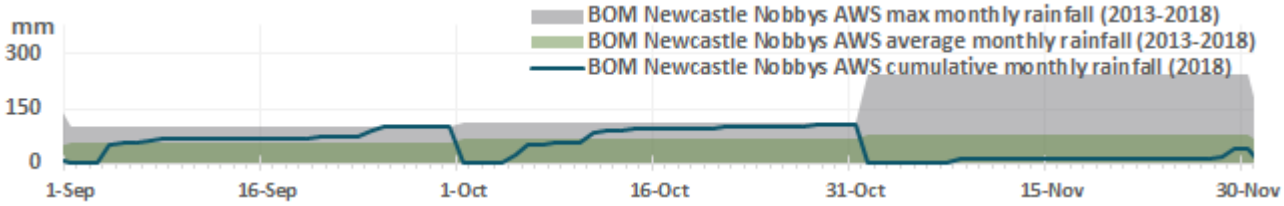

Figure 13 **Bureau of Meteorology Newcastle Nobbys Signal Station AWS[7] cumulative rainfall during spring 2018 plotted against the monthly maximum and average rainfall from 2013 to 2018**

Figure 14 and Figure 15 show daily average $PM_{2.5}$ during spring 2018, compared to the daily maximum and minimum levels (shaded range) from spring 2014 to 2017, at Stockton and Newcastle. These show that daily $PM_{2.5}$ levels were similar to earlier years. The peak at Stockton on 22 November was due to a large fire in Port Stephens[1], occurring during the extensive dust storm event. Variability during the season may also be partly due to the low number of years of historical data available for comparison.

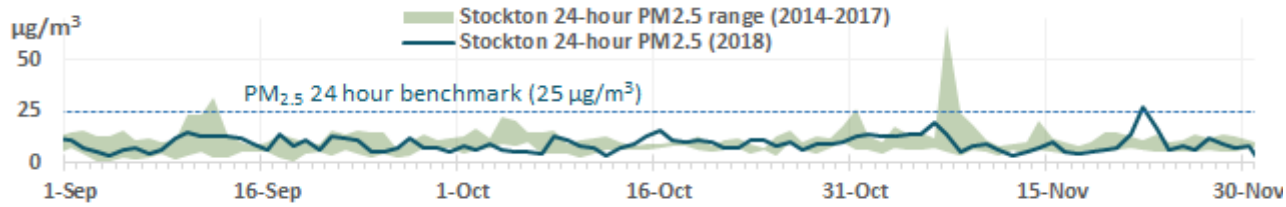

Figure 14 **Stockton daily average $PM_{2.5}$ during spring 2018 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from spring 2014 to 2017**

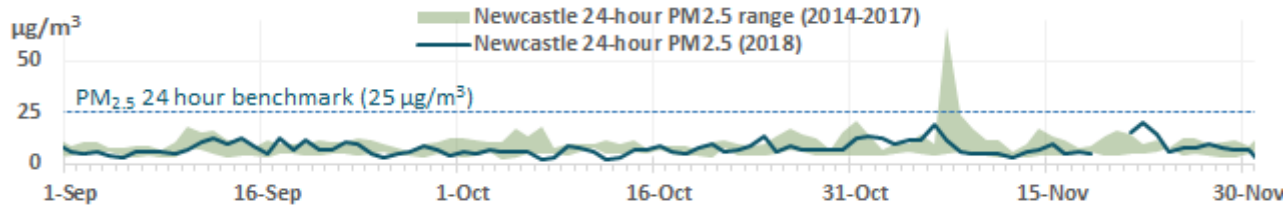

Figure 15 **Newcastle daily average $PM_{2.5}$ during spring 2018 plotted against the daily maximum and minimum $PM_{2.5}$ levels recorded from spring 2014 to 2017**

[7] Data from Bureau of Meteorology Newcastle Nobbys Signal Station AWS monthly rainfall page (accessed January 2019)

Meteorological summary

Rainfall and temperature[8]

The Newcastle region experienced above average rainfall during spring 2018 compared to long-term records. September and November recorded average rainfall, while rainfall was very much above average in October. Spring 2018 was wetter than the three previous spring seasons, with 100 to 200 millimetres more rain than springs 2016 and 2017, and 50 to 100 millimetres more rain than spring 2015.

Maximum temperatures in Newcastle were average and minimum temperatures were very much above average during the season.

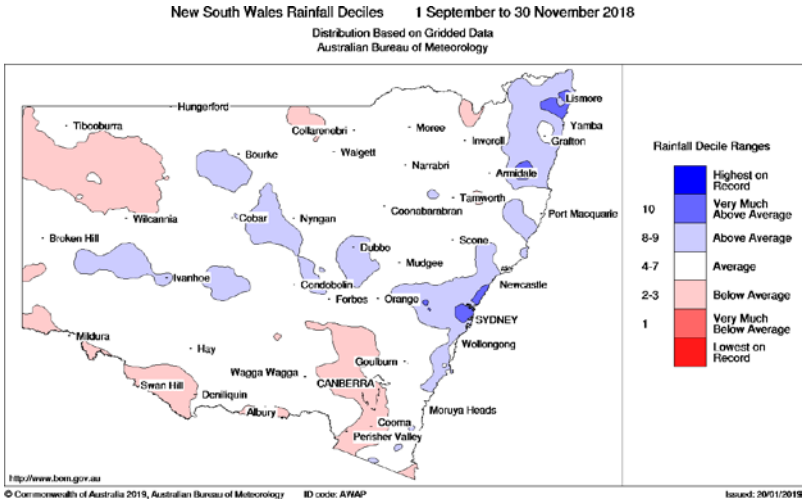

Figure 16 NSW rainfall deciles – spring 2018

Wind

The winds were variable in the region during spring 2018, which was typical for this transitional season, where predominant winds change from north-westerly in winter to south-easterly in summer. As an example, Figure 17 shows that at Stockton, north-west winds prevailed 10% of the time, with moderate or stronger (above five metres per second) north-west winds occurring 4% of the time.

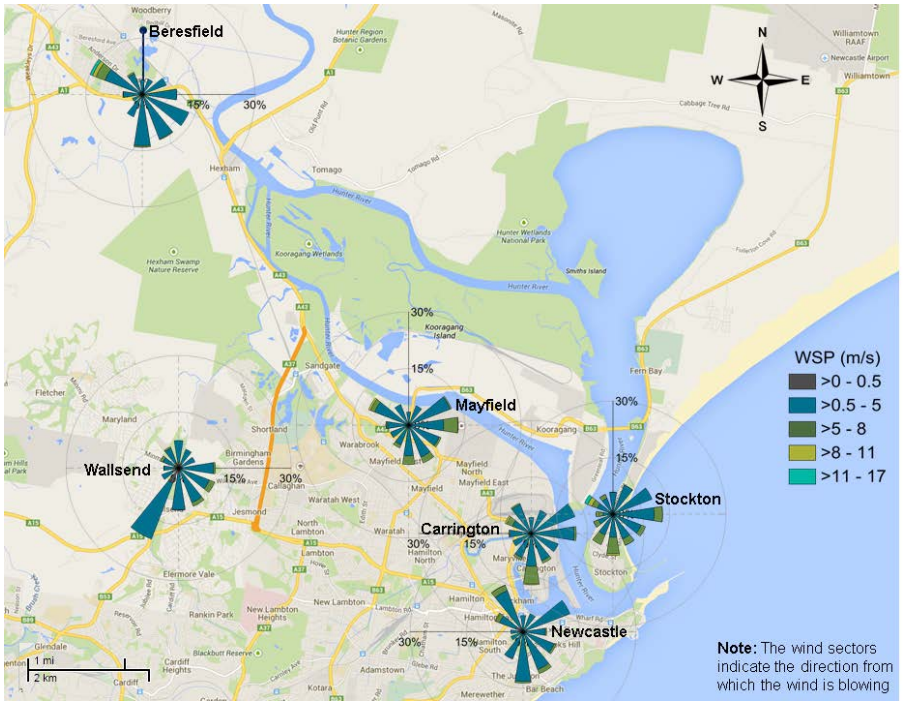

Figure 17 Wind rose map[9] for the Newcastle region for spring 2018

[8] Rainfall and temperature information are from the Bureau of Meteorology New South Wales spring 2018 climate statement and climate maps (accessed January 2019).

[9] Wind roses show the wind direction and speed at a location. The length of each bar around the circle in these wind roses shows the percentage of time the wind blows from a particular direction. The colours along the bars indicate the wind speeds.

Stockton

The Stockton monitoring site recorded a higher number of days over the PM_{10} benchmark (12 days) compared to other sites in the region (two to five days).

In spring 2018, elevated hourly PM_{10} levels (>75 µg/m^3) [10] were recorded at Stockton 6.9% of the time (Figure 18). These occurred under:

- onshore easterly winds 63% of the time (94 hours, 4.3% in total for spring). This indicates the potential contribution of sea salt (especially on 15–18, 20 and 30 October, 4 and 6 November), with the Lower Hunter Particle Characterisation Study finding sea salt to be a major contributor of particles at the site.
- north-westerly winds 21% of the time (32 hours, 1.5% in total for spring), mainly as a result of the extensive dust storm on 21–23 November (at least 26 hours) and a nearby fire[11] on 2 November (2 hours).

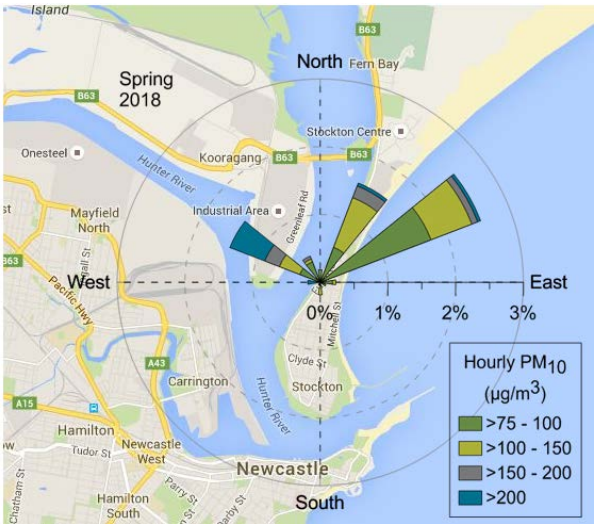

Figure 18 Stockton spring 2018 pollution rose - proportion of hourly averaged PM_{10} levels >75 µg/m^3 by wind direction

Elevated hourly $PM_{2.5}$ levels (>40 µg/m^3) occurred 0.5% of the time (10 hours) during spring, as a result of a large fire in Port Stephens[1] that occurred during the 21–23 November major dust storm event.

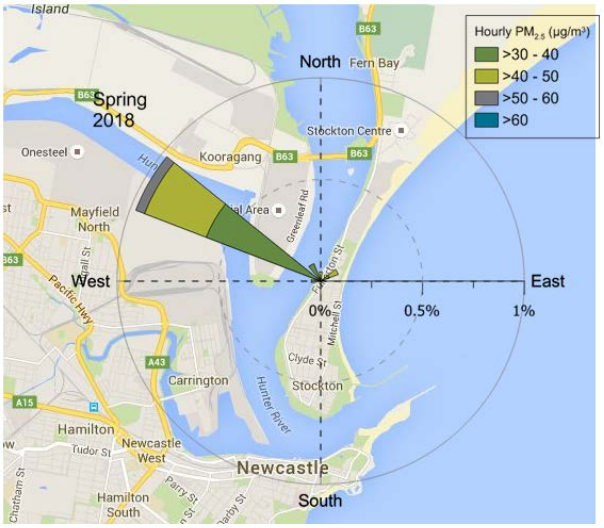

Figure 19 Stockton spring 2018 pollution rose – proportion of hourly averages $PM_{2.5}$ levels >30 µg/m^3 by wind direction

[10] Note: There are no standards for hourly PM_{10}/$PM_{2.5}$ in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM)

[11] RFS ICON database: 15ha 'Haul road, Stockrington' fire from 2 November to 5 November

Network performance

The target network performance is at least 95% available data for all parameters. For NO_2, SO_2 and NH_3, due to daily calibrations, the maximum online time that can be attained is 96%.

Table 2 Online performance (%) during spring 2018

Station	Particles PM_{10} daily	Particles $PM_{2.5}$ daily	Gases SO_2 hourly	Gases NO_2 hourly	Gases NH_3 hourly	Meteorology Wind hourly
Beresfield	98	89	93	88	-	99
Carrington	98	98	95	95	-	100
Mayfield	98	92	95	95	-	100
Newcastle	98	98	93	94	-	99
Stockton	100	100	95	95	95	100
Wallsend	97	100	95	95	-	100

- = not monitored

The reduced online times were mainly due to:

- Beresfield $PM_{2.5}$ – scheduled maintenance and calibrations (three days) and intermittent negative values (seven days)
- Beresfield NO_2 – scheduled maintenance and calibrations (four days) and instrument fault (three days)
- Mayfield $PM_{2.5}$ – scheduled calibrations (two days) and intermittent negative values (five days).

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