Air quality in Newcastle: Summer 2020–21

Air quality in the Newcastle region was generally good during summer 2020–21. Daily particle levels were within national benchmarks from 79% of the time at Stockton and 100% at all other sites. Stockton particle levels are affected by sea salt due to its proximity to the coast. Hourly particle levels were in the good to fair air quality categories from 98.1% to 100% of the time throughout the region. Regional air quality was greatly improved compared to summer 2019–20 and earlier years.

- Levels of nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and ammonia (NH_3) were good, all remaining below national benchmark concentrations and assessment goals.
- Daily average levels of fine particulate matter PM2.5 (particles less than or equal to 2.5 microns in diameter) remained below the 25 micrograms per cubic metre (µg/m^3) benchmark.
- Daily average levels of particulate matter PM10 (particles less than or equal to 10 microns in diameter) were above the 50 µg/m^3 benchmark on 19 days (1–3, 14, 16 and 24 December 2020, 16–18, 21–23, 25 and 30 January 2021, 4–5 and 17–19 February 2021), all occurring at Stockton. Regional maximum daily PM10 levels on these days ranged from 50.5 to 72.8 µg/m^3.
- At Stockton, elevated PM10 levels (> 75 µg/m^3) predominantly occurred under onshore north-easterly to south-easterly winds (86% of the time that levels were elevated). Stockton particle levels are influenced by sea salt spray transported by onshore winds[1], which prevail during the warmer months. See Stockton section for further details.
- Elevated PM10 levels also were observed at other sites in the region on 17 January. This was an exceptional event, with highest PM10 levels affected by smoke transported into the region under light north-easterly winds from a bushfire near Myall[2].

Annual air quality trends in the Newcastle region

A comparison of annual average PM10 and PM2.5 levels shows the long-term trends. The national annual average benchmarks are 25 µg/m^3 for PM10 and 8 µg/m^3 for PM2.5, based on a calendar year.

Figure 1 shows the PM10 and PM2.5 **rolling** annual averages, based on the 12-month periods to the end of summer, for 2015–16 to 2020–21.

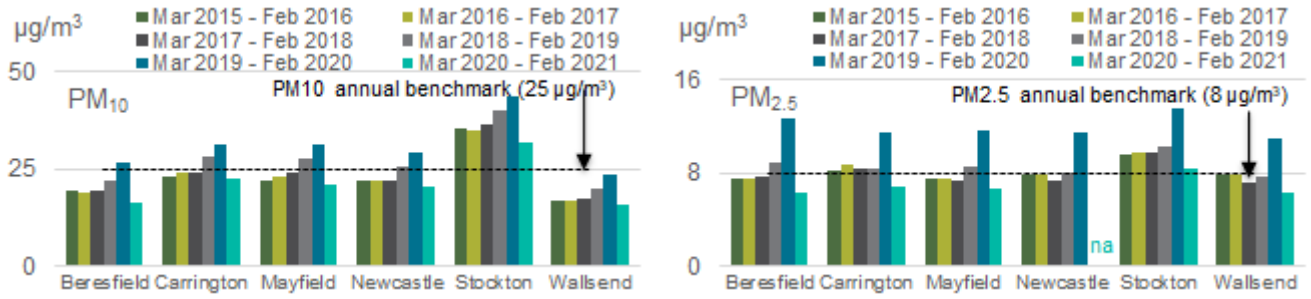

Figure 1 PM10 and PM2.5 annual averages – 2016 to 2021

Note: The Newcastle PM2.5 rolling annual average from March 2020 to February 2021 is not available due to less than 75% data availability

The comparison in Figure 1 shows a large decrease in particle levels throughout the region during the 12-month to the end of summer 2020–21, compared to the same 12-month period in previous years (especially compared to the end of summer 2019–20). Annual average PM10 and PM2.5 levels were below the benchmarks at all sites in the 12 months to the end of summer 2020–21, except Stockton.

[1] Lower Hunter Particle Characterisation Study

[2] Rural Fire Service (RFS) ICON database: 1256.24 ha 'Horse Point Rd, Bungwahl' fire from 16/01 to 24/01.

Greatly improved particle levels resulted from cooler, wetter conditions in 2020 and early 2021, which reduced impact from dust storms and bushfires. At the end of summer 2020–21, 6% of New South Wales was drought affected (Figure 2), compared to 99% of the state drought declared by the end of summer 2019–20[3].

The higher PM10 and PM2.5 annual averages at Stockton were consistent with the Lower Hunter Particle Characterisation Study. This study found two and a half times higher PM10 at Stockton compared to Mayfield, mainly due to fresh sea salt. It also found 40% more PM2.5 at Stockton compared to Mayfield, Beresfield and Newcastle. This was due to more sea salt in onshore winds and primary ammonium nitrate in north-west winds, particularly in winter (and very likely due to Orica's ammonium nitrate manufacturing facility on Kooragang Island).

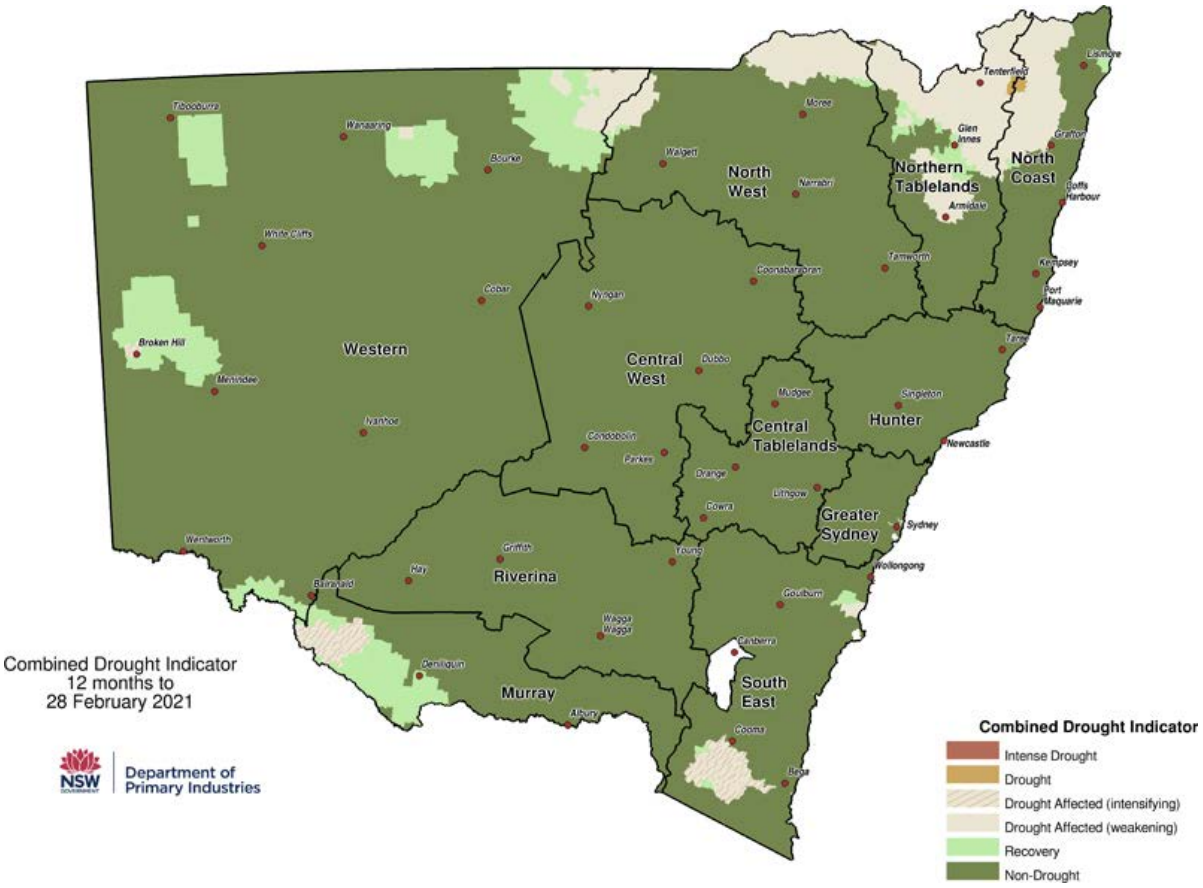

Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 28 February 2021[4]

[3] Sourced from Department of Primary Industries NSW State seasonal update – February 2020 (accessed May 2021)

[4] Sourced from Department of Primary Industries NSW State seasonal update – February 2021 (accessed March 2021)

Days above benchmark concentrations

There were 19 days over the PM10 daily benchmark in summer 2020–21, all occurring at Stockton. There were no days over the PM2.5 daily benchmark in summer 2020–21.

Table 1 Number of days above the relevant benchmarks – summer 2020–21

Station	PM10 **daily** [50 µg/m^3 benchmark]	PM2.5 **daily** [25 µg/m^3 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	0	0	0	0	0	-
Carrington	0	0	0	0	0	-
Mayfield	0	0	0	0	0	-
Newcastle	0	0	0	0	0	-
Stockton	19	0	0	0	0	0
Wallsend	0	0	0	0	0	-

µg/m^3 = micrograms per cubic metre
pphm = parts per hundred million by volume (i.e. parts of pollutant per hundred million parts of air)
- = not monitored

Daily time series plots

Daily average time series plots for PM10 and PM2.5 and daily one–hour maximum plots for NO_2, SO_2 and NH_3 show the concentrations throughout the summer season (Figure 3 to Figure 7).

Levels of PM2.5, NO_2, SO_2 and NH_3 remained below the benchmarks and assessment criteria throughout the season.

PM10 levels remained below the benchmark at most sites, except for 19 days at Stockton. Stockton PM10 levels were most likely affected by sea salt on many of these days due to its proximity to the coast. See Stockton section for further details.

Elevated PM10 levels were also observed at other sites in the region on 17 January. This was an exceptional event, affected by smoke from a bushfire near Myall Lakes under light north-easterly winds.

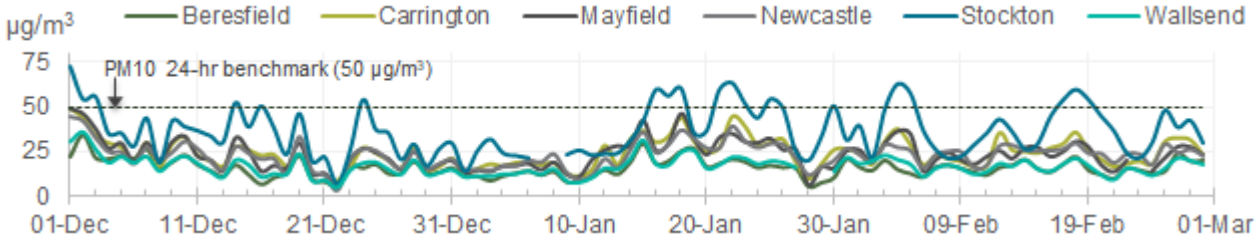

Figure 3 **Daily average PM10 during summer 2020–21**

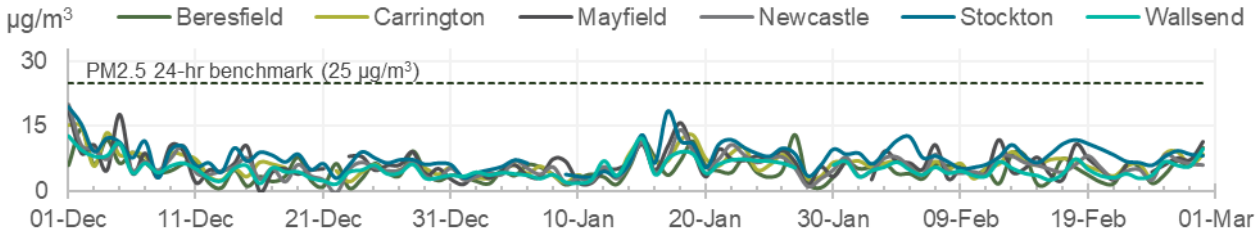

Figure 4 **Daily average PM2.5 during summer 2020–21**

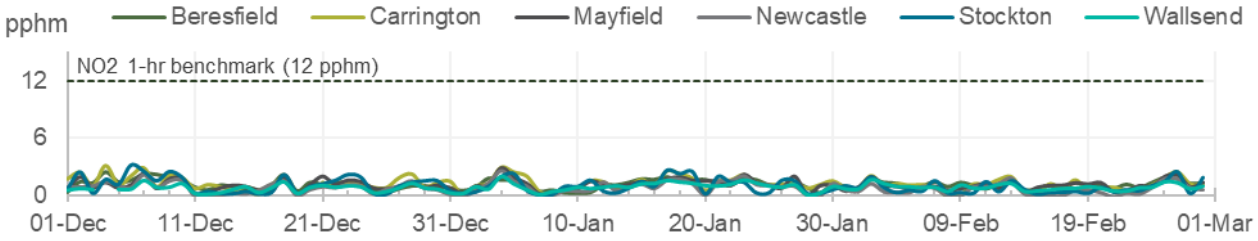

Figure 5 **Daily maximum 1-hr NO_2 during summer 2020–21**

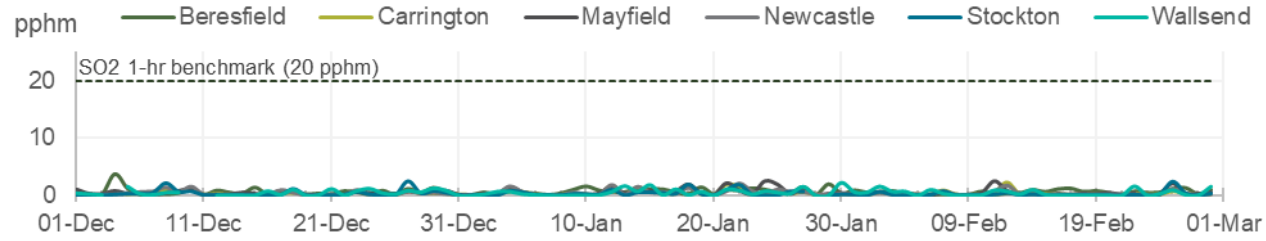

Figure 6 **Daily maximum 1-hr SO_2 during summer 2020–21**

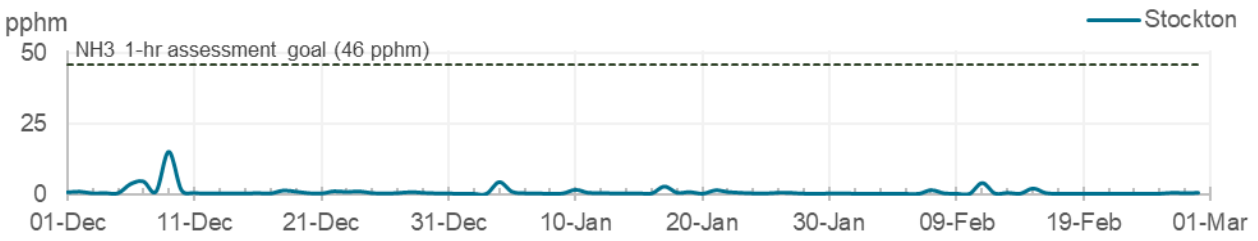

Figure 7 **Daily maximum 1-hr NH_3 during summer 2020–21**

Pollution roses from hourly particle data

The seasonal pollution rose maps[5] (Figure 8 and Figure 9) show that hourly[6] PM10 and PM2.5 levels generally remained low during the season. Stockton recorded some elevated hourly PM10 levels under north-east winds, due predominantly to sea salt (see Stockton section below for more detail).

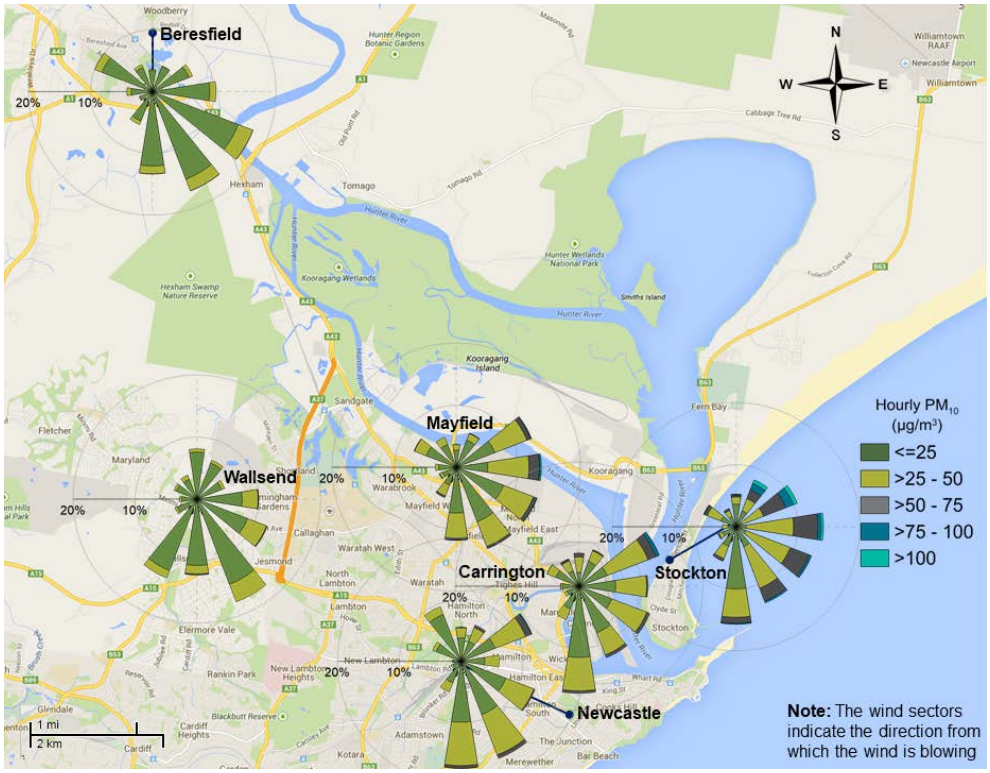

Figure 8 **Hourly PM10 pollution roses for the Newcastle region for summer 2020–21**

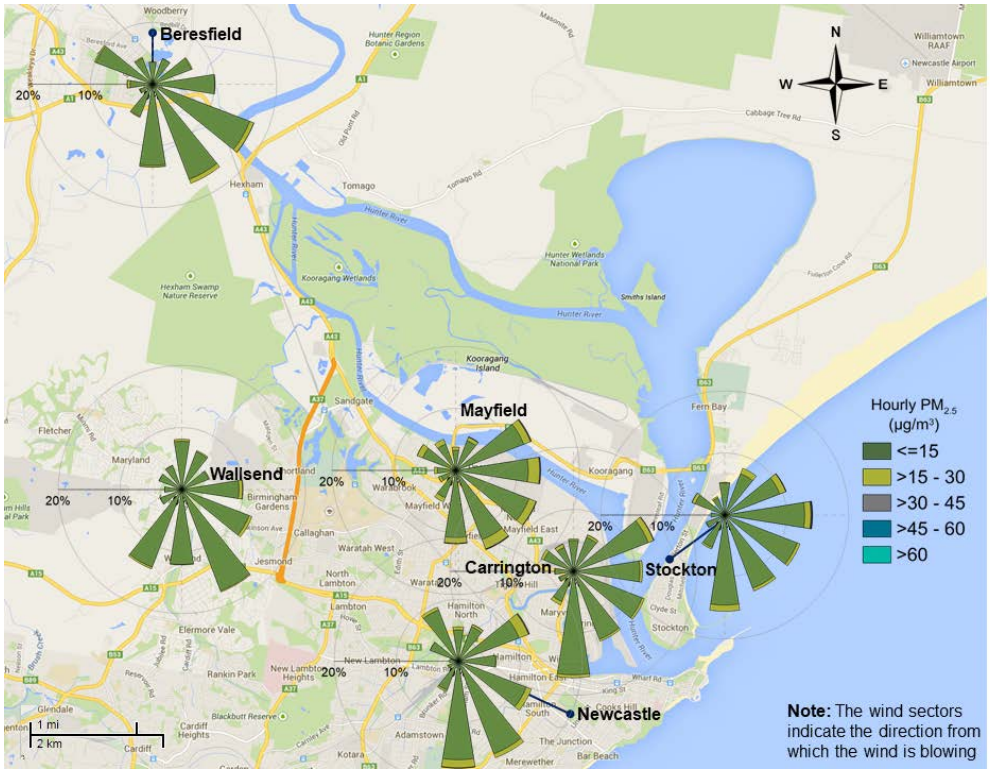

Figure 9 **Hourly PM2.5 pollution roses for the Newcastle region for summer 2020–21**

[5] 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.

[6] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).

Seasonal comparisons

This section compares air quality levels in summer 2020–21 with previous summer seasons, where data were available[7].

All days were below benchmark concentrations for NO_2 and SO_2 in summer during the past nine 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 summer during the past nine years.

There were large decreases in the number of days over the particle benchmarks in summer 2020–21, especially compared to summer 2019–20 (Figure 10).

- There were 19 days over the PM10 daily benchmark during summer 2020–21, all occurring at Stockton. In summer 2019–20, the region recorded 44 days over the PM10 benchmark due to intense drought conditions and extreme bushfires, ranging from 15 days at Wallsend to 43 days at Stockton. From 2012–13 to 2018–19, the region recorded between 9 days (summer 2013–14) and 40 days (summer 2018–19) over the PM10 daily benchmark.
- There were no days over the PM2.5 daily benchmark during summer 2020–21. In summer 2019–20, the region recorded 20 days over the PM2.5 benchmark, mainly due to extreme bushfires and dust storms. From 2012–13 to 2018–19, the region recorded between zero and one day (summer 2015–16) over the PM2.5 daily benchmark.

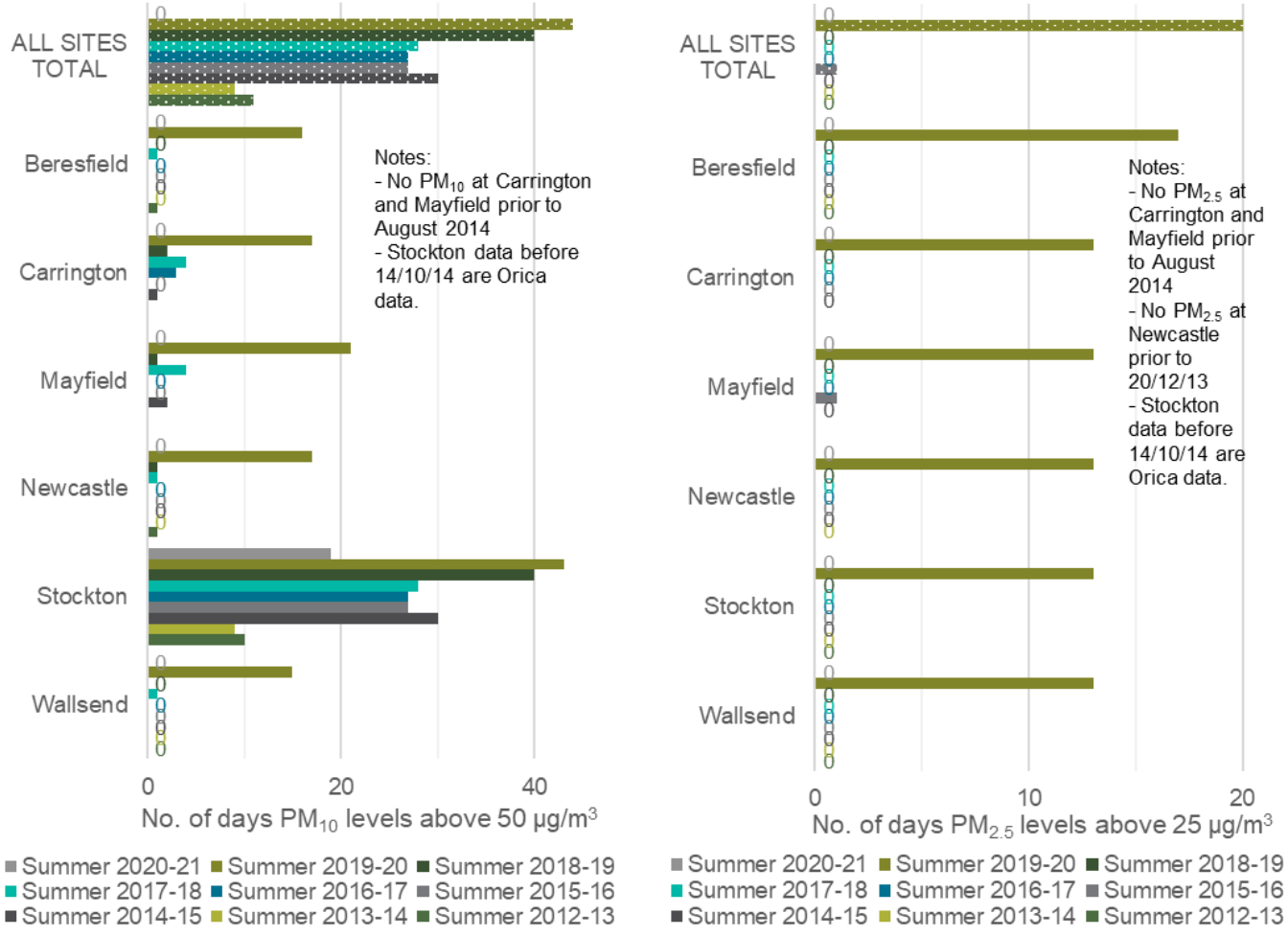

Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: summer 2013 to 2021

[7] Monitoring at Stockton commenced in October 2012 and at Mayfield and Carrington in August 2014. Monitoring of PM2.5 at Newcastle commenced in December 2013. Stockton air quality monitoring was undertaken by Orica from October 2012 to October 2014. From October 2014 it was undertaken by the NSW government 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 PM10 during summer 2020–21, compared to the daily maximum and minimum PM10 levels (i.e. shaded range) from summer 2012–13 to 2019–20, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season, and often at the lower levels. Rainfall in Newcastle was above average during summer, with a very wet December (refer to the Meteorological summary section)[8]. Variability during the season may also reflect the relatively low number of years of historical data available for comparison.

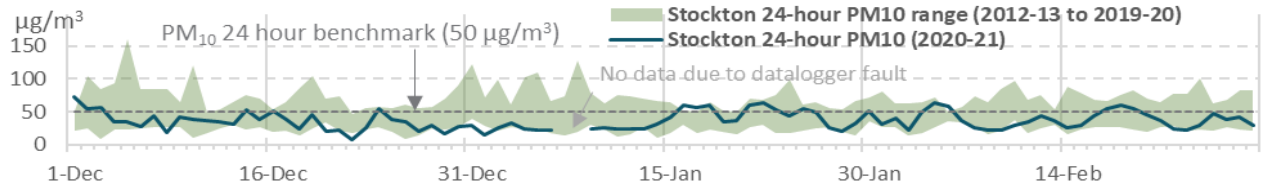

Figure 11 **Stockton daily average PM10 during summer 2020–21 plotted against the daily maximum and minimum PM10 levels from 2013 to 2020**

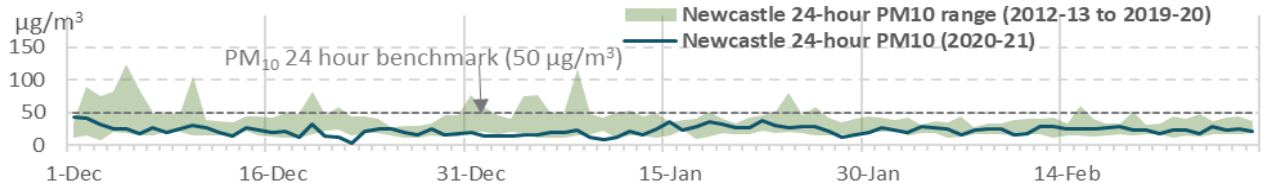

Figure 12 **Newcastle daily average PM10 during summer 2020–21 plotted against the daily maximum and minimum PM10 levels from 2013 to 2020**

Figure 13 and Figure 14 show daily average PM2.5 during summer 2020–21, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2013–14 to 2019–20, at Stockton and Newcastle. Daily PM2.5 levels were low and generally within the historical range throughout the season, and often at the lower levels. Variability during the season may also reflect the relatively low number of years of historical data available for comparison.

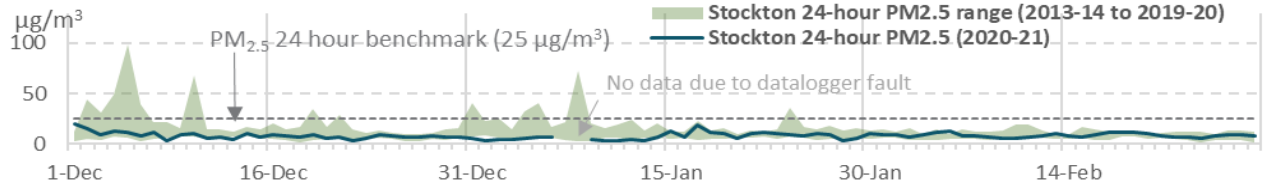

Figure 13 **Stockton daily average PM2.5 during summer 2020–21 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2020**

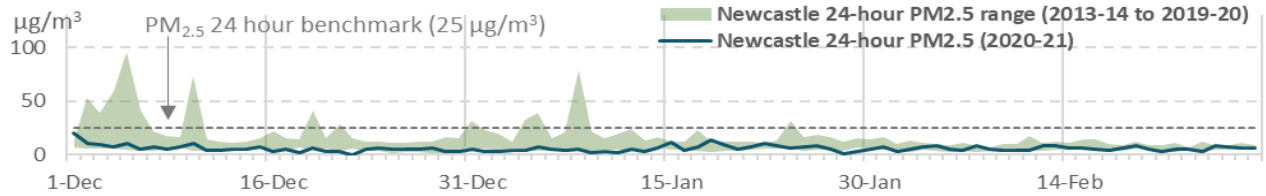

Figure 14 **Newcastle daily average PM2.5 during summer 2020–21 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2020**

[8] Note: The Bureau of Meteorology Newcastle Nobbys Signal Station AWS cumulative rainfall graph was not included in this seasonal newsletter as a result of a large amount of missing rainfall data during summer 2020–21.

Meteorological summary

Rainfall and temperature[9]

The Newcastle region experienced above average rainfall overall during summer 2020–21 compared to long-term records (Figure 15), with very much above average rainfall during December 2020.

Summer 2020–21 was wetter than the three previous summers, with 100 to 200 millimetres more rain than summer 2019–20 and 200 to 400 millimetres more rain than summers 2018–19 and 2017–18.

Maximum temperatures were average to below average during the season (Figure 16), while minimum temperatures were above average.

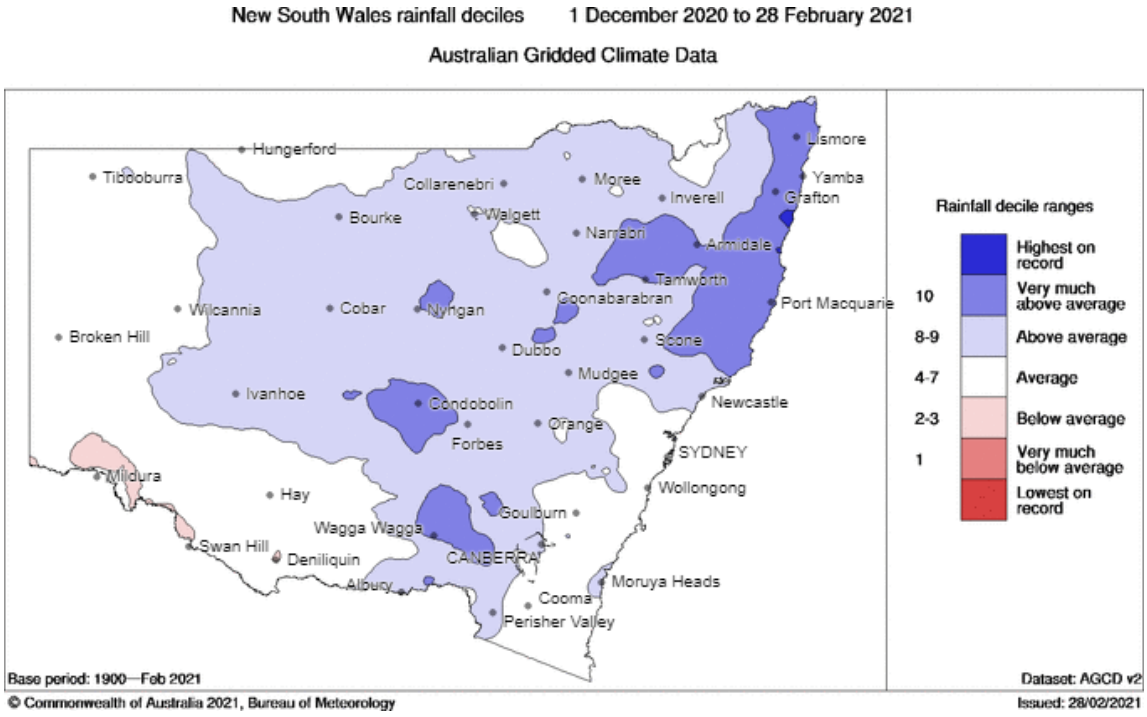

Figure 15 NSW rainfall deciles – summer 2020–21

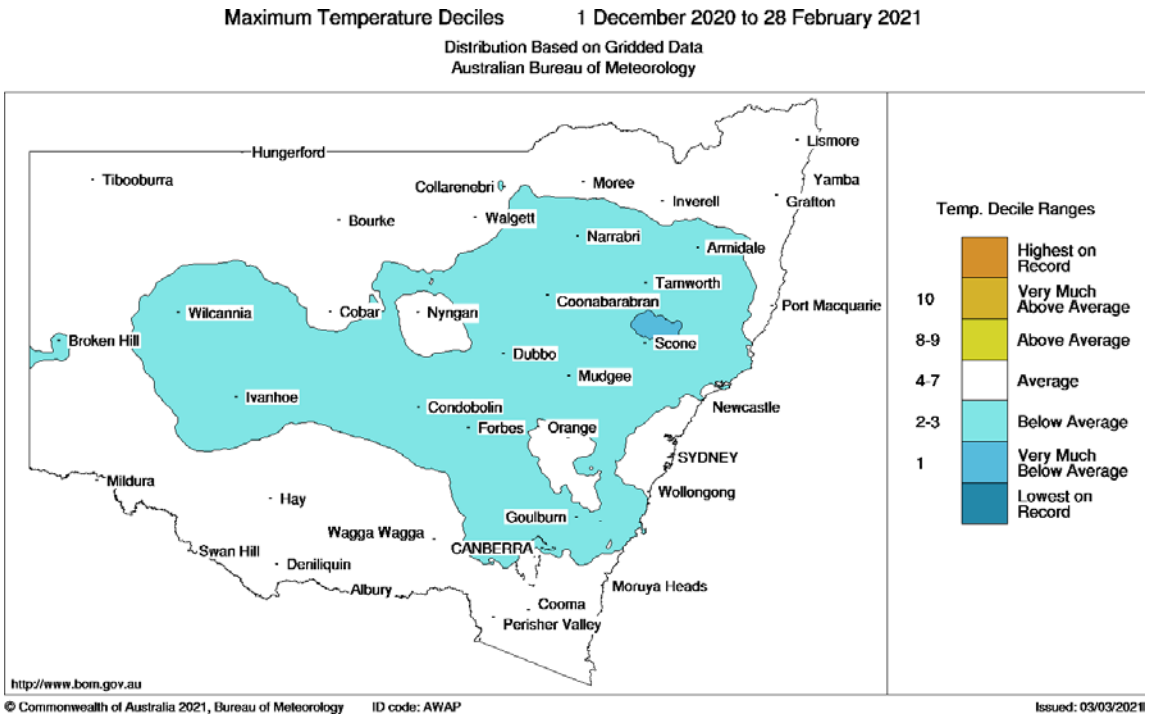

Figure 16 NSW maximum temperature deciles – summer 2020–21

[9] Rainfall and temperature information is from the Bureau of Meteorology New South Wales summer 2020-21 climate statement (access March 2021) and climate maps (accessed March 2021)

Wind

The winds were predominately from north-east to south in the region during summer 2020–21, which was typical for this warmer season. As an example, Figure 17 shows that at Stockton, winds with an easterly component prevailed 54% of the time, with moderate or stronger winds (above five metres per second) occurring 9% of the time.

Figure 17 Wind rose map[10] for the Newcastle region for summer 2020–21

[10] 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

Particles at Stockton in summer 2020–21

The Stockton monitoring site recorded 19 days over the PM10 daily benchmark during summer 2020–21 (1–3, 14, 16 and 24 December 2020, 16–18, 21–23, 25 and 30 January 2021, 4–5 and 17–19 February 2021). There were significantly fewer days over the PM10 daily benchmark in summer 2020–21 compared to summer 2019–20, when there were 43 days over the benchmark during the extreme drought and bushfire period. From 2012–13 to 2018–19, Stockton recorded between nine days (summer 2013–14) and 40 days (summer 2018–19) over the PM10 daily benchmark (Figure 10).

In summer 2020–21, elevated hourly PM10 levels (>75 µg/m^3)[11] were recorded at Stockton 5.9% of the time (Figure 18). These occurred under:

- onshore north-easterly to south-easterly winds 85.6% of the time (107 hours, 5.0% total for summer)
- north-westerly winds 2.4% of the time (3 hours, 0.1% total for summer).

Elevated PM10 levels under predominant onshore winds at Stockton indicate the potential contribution of sea salt under. The Lower Hunter Particle Characterisation Study found sea salt was a major contributor of particles at the site under onshore winds.

Elevated PM10 levels under light north-easterly winds occurred on 17 January 2021, resulting in an exceptional event due to smoke associated with a bushfire near Myall Lakes[2].

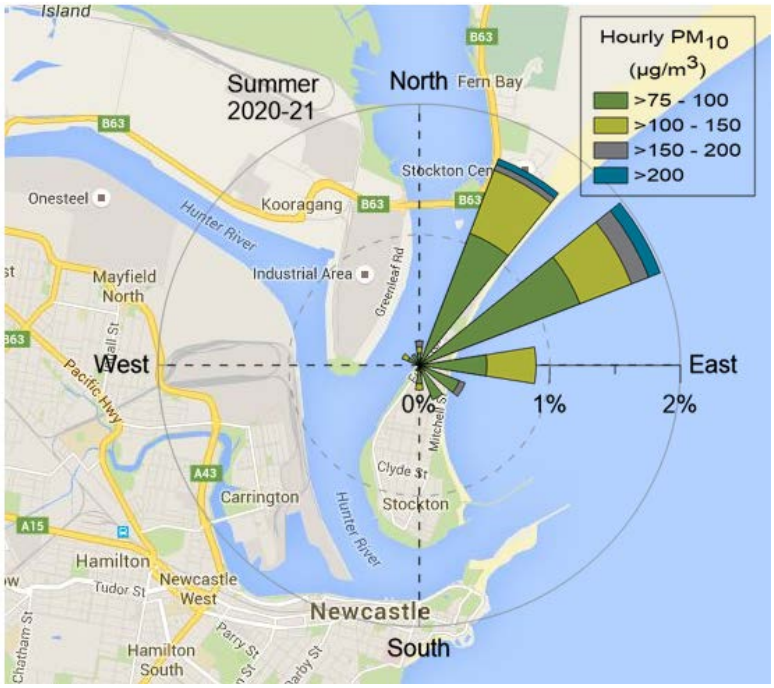

Figure 18 Stockton summer 2020–21 PM10 pollution rose – proportion of hourly averaged PM10 levels >75 µg/m^3 by wind direction

The Stockton monitoring site did not record any days over the PM2.5 daily benchmark during summer 2020–21. This was significantly fewer days than summer 2019–20, when there were 13 days over the PM2.5 daily benchmark, during the extreme drought and bushfire period (Figure 10). Elevated hours of PM2.5 (>40 µg/m^3)[11] were observed at Stockton 0.2% of the time (5 hours), with the majority (60%) occurring under north-easterly winds.

[11] There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure.

Network performance

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

Table 2 Online performance (%) during summer 2020–21

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO_2 hourly	Gases NO_2 hourly	Gases NH_3 hourly	Meteorology Wind hourly
Beresfield	100	100	94	95	-	100
Carrington	97	97	89	91	-	97
Mayfield	99	97	94	95	-	100
Newcastle	100	100	95	94	-	100
Stockton	98	98	93	94	94	99
Wallsend	98	98	90	93	-	97

- = not monitored

The reduced online times were mainly due to:

- Carrington SO_2 – instrument fault following power outage (six days).

This document was prepared by Sean Watt and reviewed by Loredana Warren.

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