

Air quality in Newcastle: Autumn 2023

Air quality in the Newcastle region was generally good during autumn 2023. Daily particle levels were within national benchmarks from 92% of the time at Stockton, 99% at Carrington and Mayfield, and 100% at all other sites. Stockton, Carrington, and Mayfield particle levels are affected by sea salt due to their proximity to the coast. Hourly particle levels were in the good to fair air quality categories from 98.6% to 100% of the time throughout the region.

- Levels of nitrogen dioxide (NO₂), sulfur dioxide (SO₂) and ammonia (NH₃) were good, all remaining below national 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) remained below the 25 micrograms per cubic metre (µg/m³) benchmark.
- Daily average levels of particulate matter PM₁₀ (particles less than or equal to 10 microns in diameter) were above the 50 µg/m³ benchmark on 10 days at Stockton (7, 8, 11, 14, 16-19 March, 19 April, and 24 May) and one day each at Carrington (6 March) and Mayfield (10 March). Regional maximum daily PM₁₀ levels on these days ranged from 50.2 to 62.9 µg/m³.
 - There were no days over the benchmark at Beresfield, Newcastle, and Wallsend.
 - At Stockton, elevated hourly PM₁₀ levels (> 75 µg/m³) predominantly occurred under onshore north-easterly to south-easterly winds (66% of the time that levels were elevated). Stockton particle levels are influenced by sea salt spray transported by onshore winds¹, which prevail during the warmer months. See Stockton section for further details.
- The Newcastle region recorded below-average rainfall and average maximum temperatures during the season.

Annual air quality trends

The national annual average benchmarks are 25 µg/m³ for PM₁₀ and 8 µg/m³ for PM_{2.5}, based on a calendar year. Long-term trends in annual average PM₁₀ and PM_{2.5} levels are compared in Figure 1, showing the PM₁₀ and PM_{2.5} **rolling** annual averages². The rolling annual averages are based on the 12-month periods to the end of autumn, for 2016 to 2023.

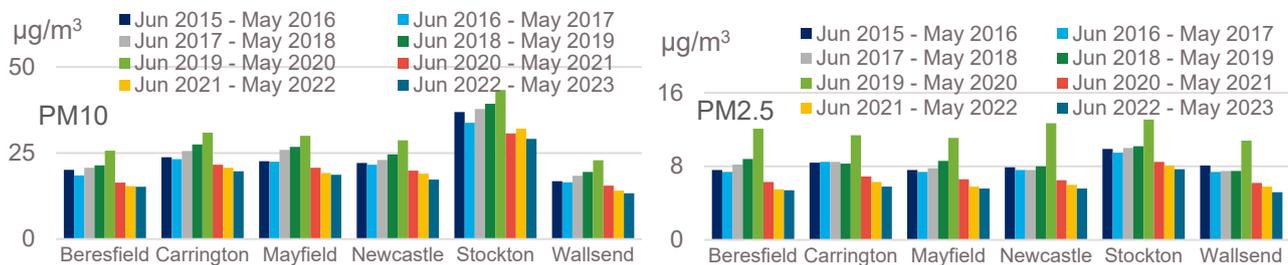


Figure 1 PM₁₀ and PM_{2.5} rolling annual averages to end of autumn – 2016 to 2023

¹ Lower Hunter Particle Characterisation Study

² Rolling averages are not intended to be compared to benchmarks. The rolling annual averages provide a guide to long-term trends, using the most up to date monitoring data.

The comparison in Figure 1 shows that particle levels continued to decrease at most sites in the region during the 12 months to the end of autumn 2023, compared to the same 12-month period in previous years (especially compared to the end of autumn 2020).

Rolling annual average PM10 and PM2.5 levels were below the benchmarks at all sites in the 12 months to the end of autumn 2022, except Stockton PM10. The higher PM10 and PM2.5 annual averages at Stockton were consistent with the Lower Hunter Particle Characterisation Study.

Lower particle levels resulted from the slightly wetter-than-average conditions over the 12-month period. At the end of autumn 2023, greater than 99% of New South Wales remained in the non-drought category³ there were no areas in New South Wales that were drought-affected (Figure 2), compared to 0% at the end of autumn 2022⁴ and 16% at the end of autumn 2021⁵.

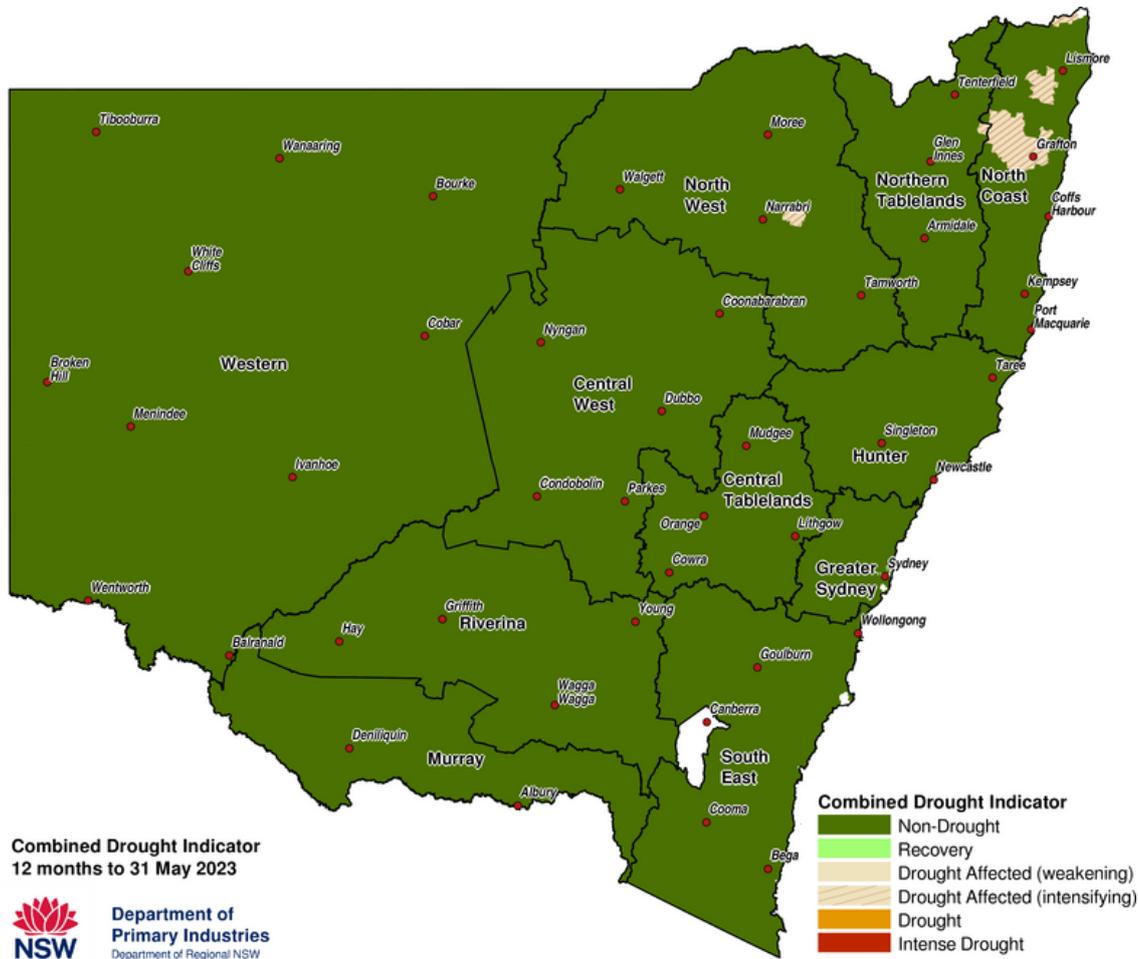


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2023³

Days above benchmark concentrations

There were 12 days over the PM10 daily benchmark in autumn 2023, at Stockton (10), Carrington (1), and Mayfield (1). There were no days over the PM2.5 daily benchmark in autumn 2023.

Concentrations of SO₂, NO₂ and NH₃ remained below relevant benchmarks in autumn 2023.

³ Sourced from Department of Primary Industries NSW State seasonal update – May 2023 (accessed September 2023).

⁴ Sourced from Department of Primary Industries NSW State seasonal update – May 2022 (accessed July 2022).

⁵ Sourced from Department of Primary Industries NSW State seasonal update – May 2021 (accessed July 2022).

Table 1 Number of days above the relevant benchmarks – autumn 2023

Station	PM10 daily [50 µg/m ³ benchmark]	PM2.5 daily [25 µg/m ³ benchmark]	SO ₂ hourly [10 pphm benchmark]	SO ₂ daily [2 pphm benchmark]	NO ₂ hourly [8 pphm benchmark]
Beresfield	0	0	0	0	0
Carrington	1	0	0	0	0
Mayfield	1	0	0	0	0
Newcastle	0	0	0	0	0
Stockton	10	0	0	0	0
Wallsend	0	0	0	0	0

µg/m³ = 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 1–hour maximum plots for NO₂, SO₂ and NH₃ show the concentrations throughout the autumn season (Figure 3 to Figure 7).

Levels of PM2.5, NO₂, SO₂ and NH₃ remained well below the benchmarks and assessment criteria throughout the season.

PM10 levels remained below the benchmark at Beresfield, Newcastle, and Wallsend. Daily PM10 exceeded the daily benchmark (50µg/m³) at Stockton on 10 days, and at Carrington and Mayfield one day each. At Stockton, PM10 levels were likely affected by sea salt on most of these days due to its proximity to the coast. See [Stockton](#) section for further details.

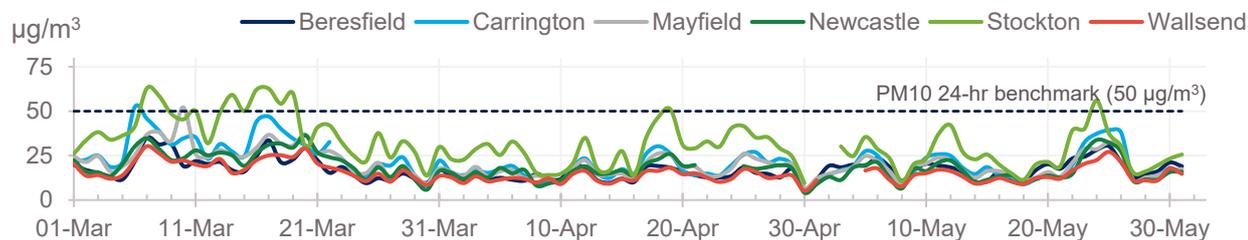


Figure 3 Daily average PM10 during autumn 2023

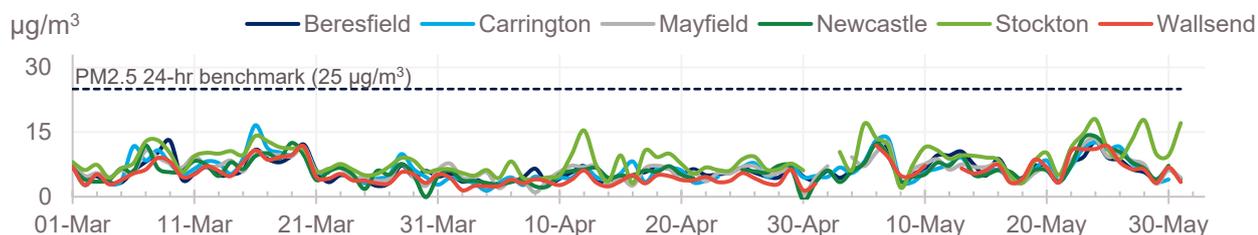


Figure 4 Daily average PM2.5 during autumn 2023

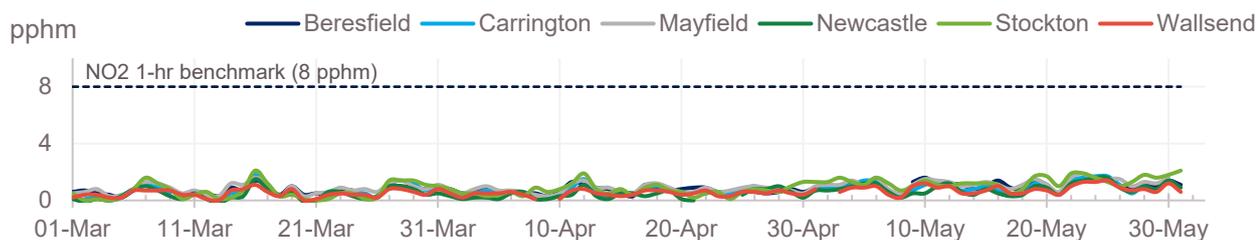


Figure 5 Daily maximum 1-hr NO₂ during autumn 2023

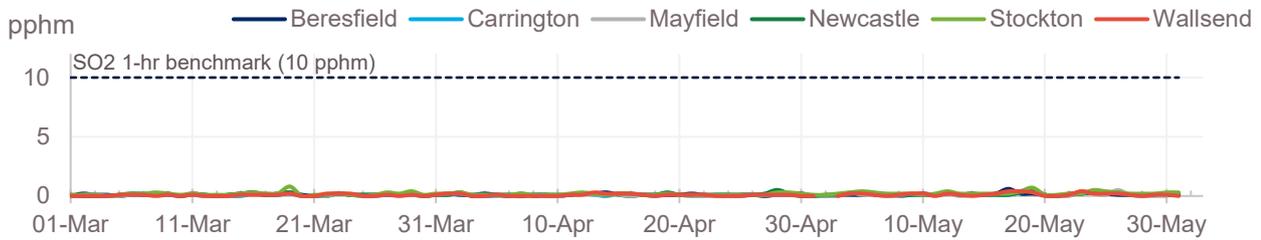


Figure 6 Daily maximum 1-hr SO₂ during autumn 2023

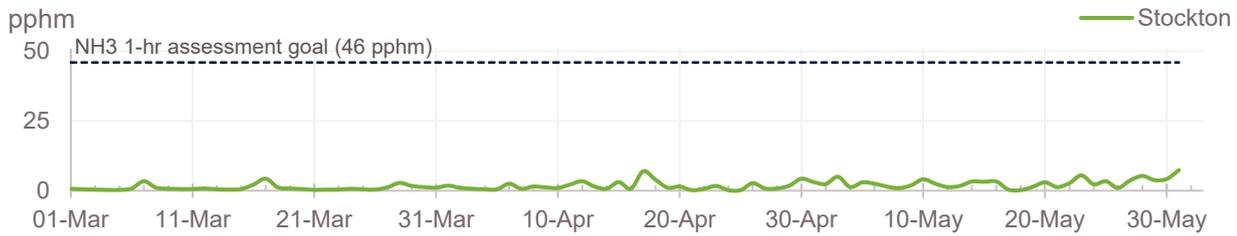


Figure 7 Daily maximum 1-hr NH₃ during autumn 2023

Pollution roses from hourly particle data

The seasonal pollution rose maps⁶ (Figure 8 and Figure 9) show that hourly⁷ PM10 and PM2.5 levels generally remained low during the season. Stockton recorded some elevated hourly PM10 levels under easterly winds, due predominantly to sea salt (see Stockton section below for more detail).

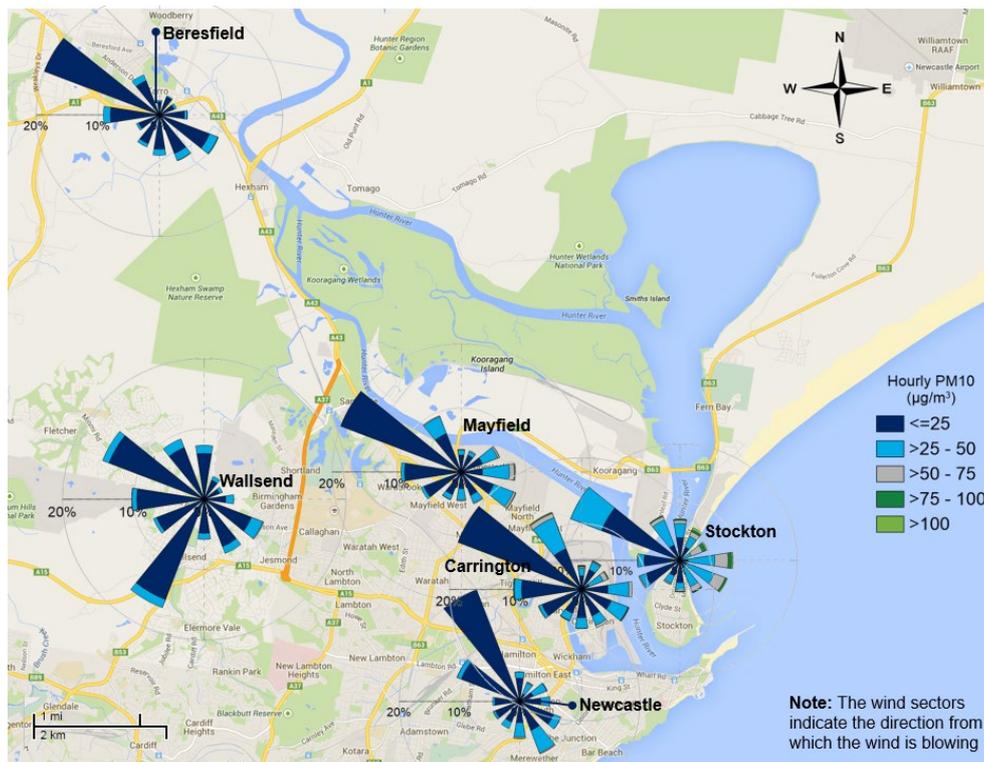


Figure 8 Hourly PM10 pollution roses for the Newcastle region for autumn 2023

⁶ 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.

⁷ There are no standards for hourly PM10 or PM2.5 in the National Environment Protection (Ambient Air Quality) Measure (Air NEPM).



Figure 9 Hourly PM2.5 pollution roses for the Newcastle region for autumn 2023

Seasonal trends

This section compares air quality levels in autumn 2023 with previous autumn seasons, where data were available⁸.

All days were below benchmark concentrations for NO₂ and SO₂ in autumn during the past 10 years at Beresfield, Newcastle, Stockton, and Wallsend, and since monitoring began at Carrington and Mayfield.

For NH₃ at Stockton, there were no days over the assessment criterion in autumn during the past 10 years.

There were no days over the PM2.5 daily benchmark during autumn 2023. The daily PM2.5 benchmark has not been exceeded during autumn since 2013 at Wallsend (1 day).

There were 10 days over the PM10 daily benchmark at Stockton, and one day each at Carrington and Mayfield, during autumn 2023. This is 4 days more than autumn 2022. From 2013 to 2022, the region recorded between one day (autumn 2013) and 21 days⁹ (autumn 2016) over the PM10 daily benchmark.

⁸ 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.

⁹ A historical error was found regarding the number of days above the PM10 daily benchmark at Stockton in autumn 2016. Previously, 20 days above the benchmark was reported however, it is 21 days.

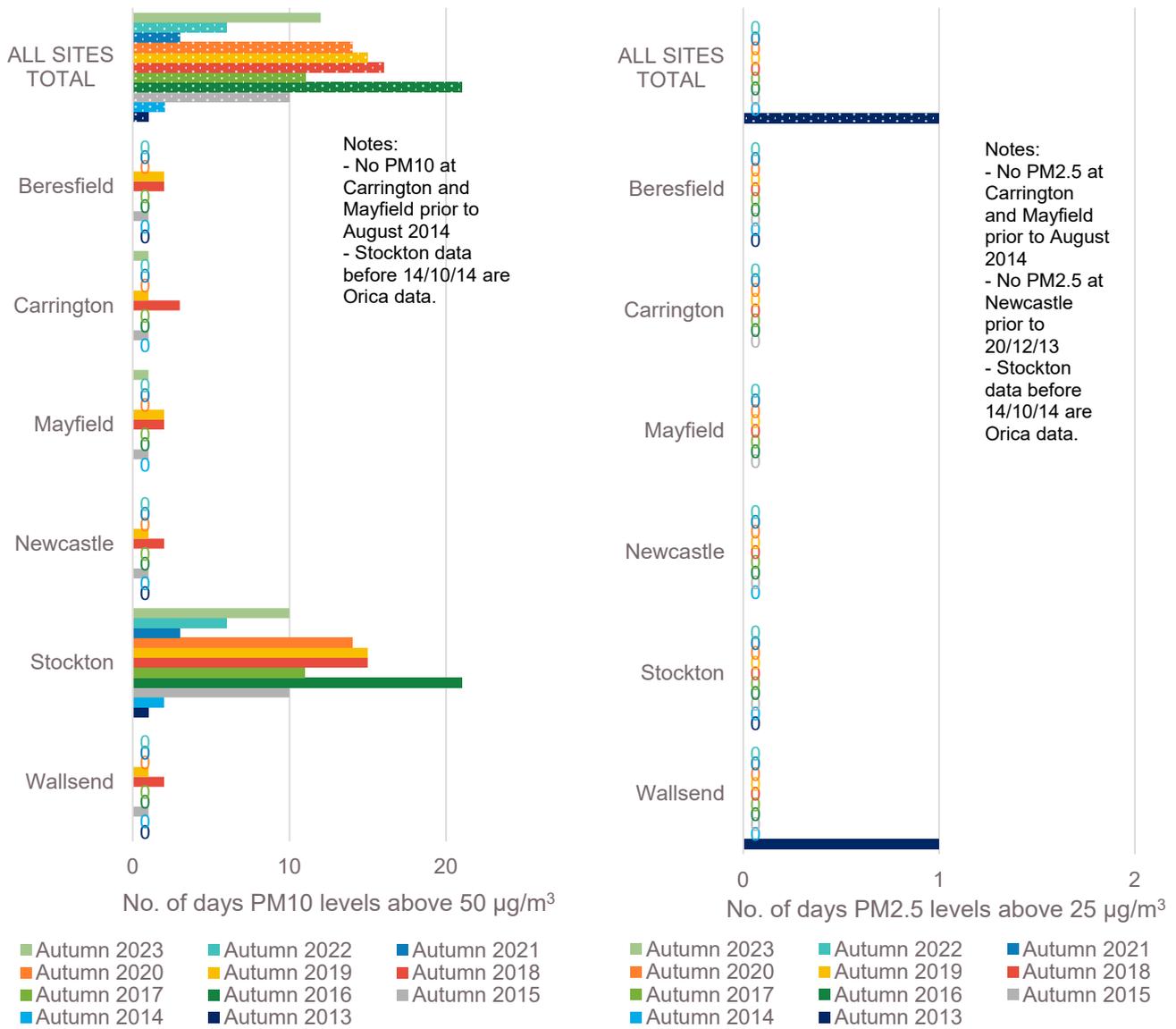


Figure 10 Number of days above the PM10 and PM2.5 daily benchmarks: autumn 2013 to 2023

Particle air quality trends

Figure 11 and Figure 12 show daily average PM10 during autumn 2023, compared to the daily maximum and minimum PM10 levels (shaded range) from autumn 2013 to 2022, at Stockton and Newcastle. Daily PM10 levels were generally within the historical range throughout the season.

Rainfall in Newcastle was slightly below average during most of autumn (Figure 13).

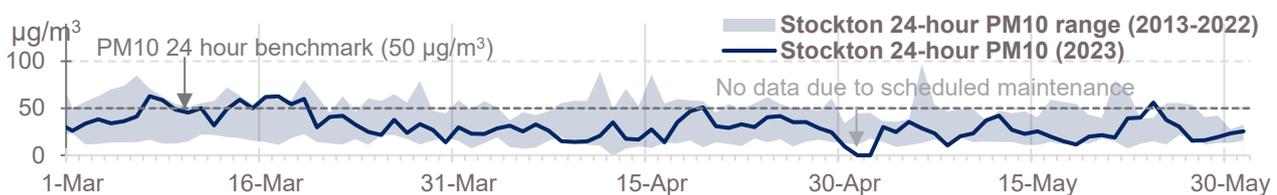


Figure 11 Stockton daily average PM10 during autumn 2023 plotted against the daily maximum and minimum PM10 levels from 2013 to 2022

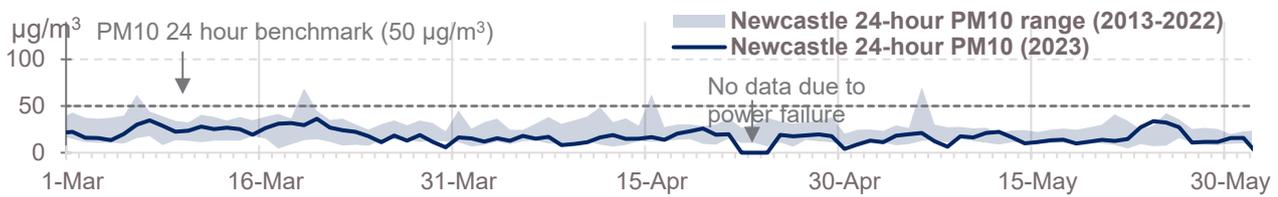


Figure 12 Newcastle daily average PM10 during autumn 2023 plotted against the daily maximum and minimum PM10 levels from 2013 to 2022

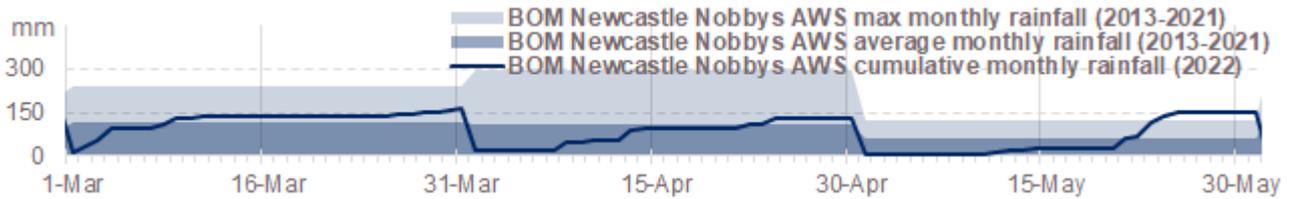


Figure 13 Bureau of Meteorology Newcastle Nobbys Signal Station AWS¹⁰ cumulative rainfall during autumn 2023 plotted against maximum and average rainfall from 2013 to 2022

Figure 14 and Figure 15 show daily average PM2.5 during autumn 2023, compared to the daily maximum and minimum PM2.5 levels (shaded range) from 2014 to 2022, at Stockton and Newcastle. Daily PM2.5 levels were generally within the historical range throughout the season, and often at the lower levels.

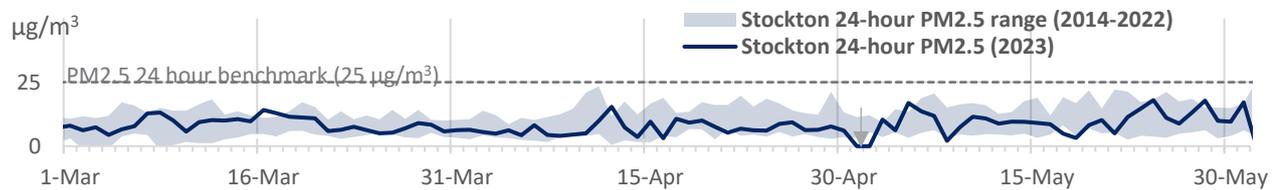


Figure 14 Stockton daily average PM2.5 during autumn 2023 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2022

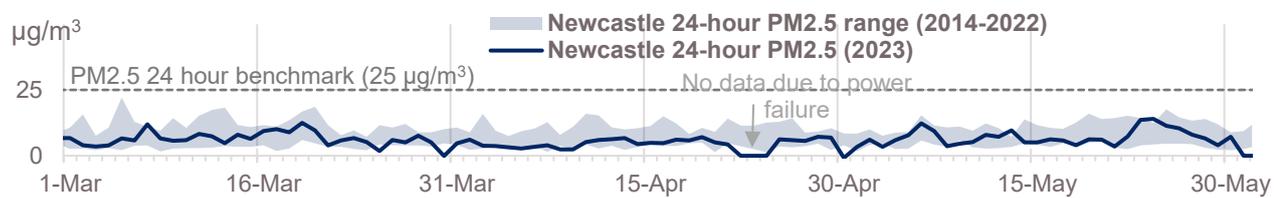


Figure 15 Newcastle daily average PM2.5 during autumn 2023 plotted against the daily maximum and minimum PM2.5 levels from 2014 to 2022

¹⁰ Data from Bureau of Meteorology [Newcastle Nobbys Signal Station AWS monthly rainfall](#) page (accessed July 2022).

Meteorological summary

Rainfall¹¹

The Newcastle region experienced slightly below average rainfall during autumn 2023 with 323.8 mm, compared to the long-term (1862-2023) average of 349.7 mm (Figure 16).

Rainfall in autumn 2023 was drier than autumn 2022 (441.8 mm), but wetter than autumns 2020 and 2021 with 50 mm more rain.

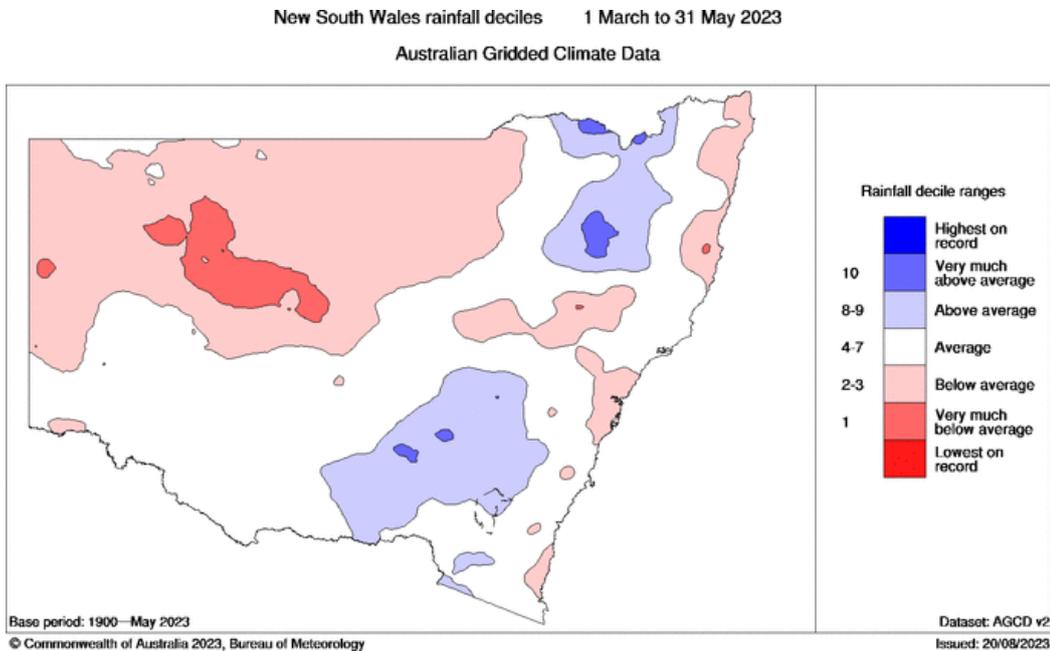


Figure 16 NSW rainfall deciles – autumn 2023

Temperatures¹¹

Maximum temperatures were above average during the season (Figure 17), while minimum temperatures were average.

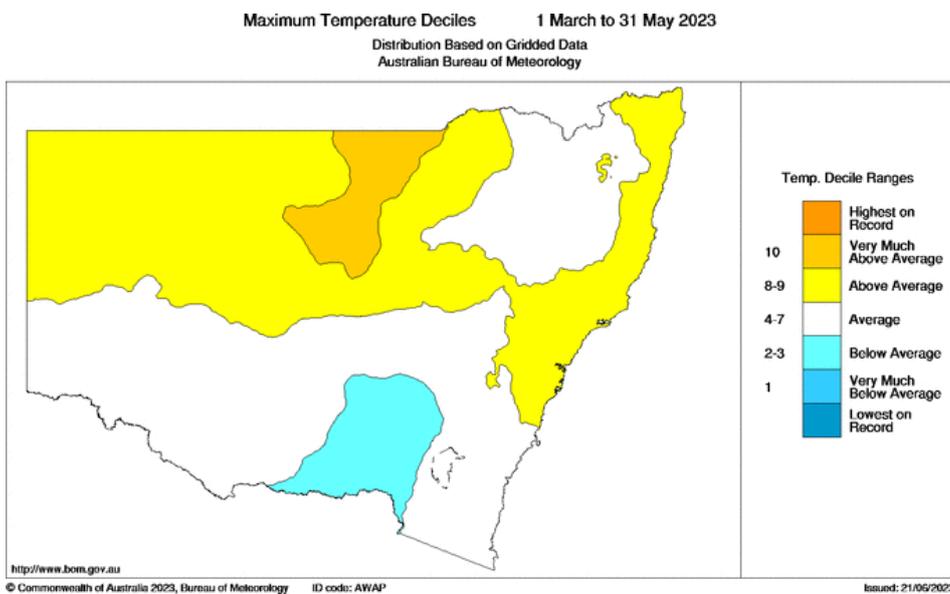


Figure 17 NSW maximum temperature deciles – autumn 2023

¹¹ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales autumn 2022 climate statement](#) (accessed July 2022) and [climate maps](#) (accessed September 2023).

Winds

The winds were variable during autumn 2023 (Figure 18), with an increasing percentage of north-westerly winds. Winds typically shift from onshore easterly flows during the warmer months to offshore westerly flows as temperatures cool.

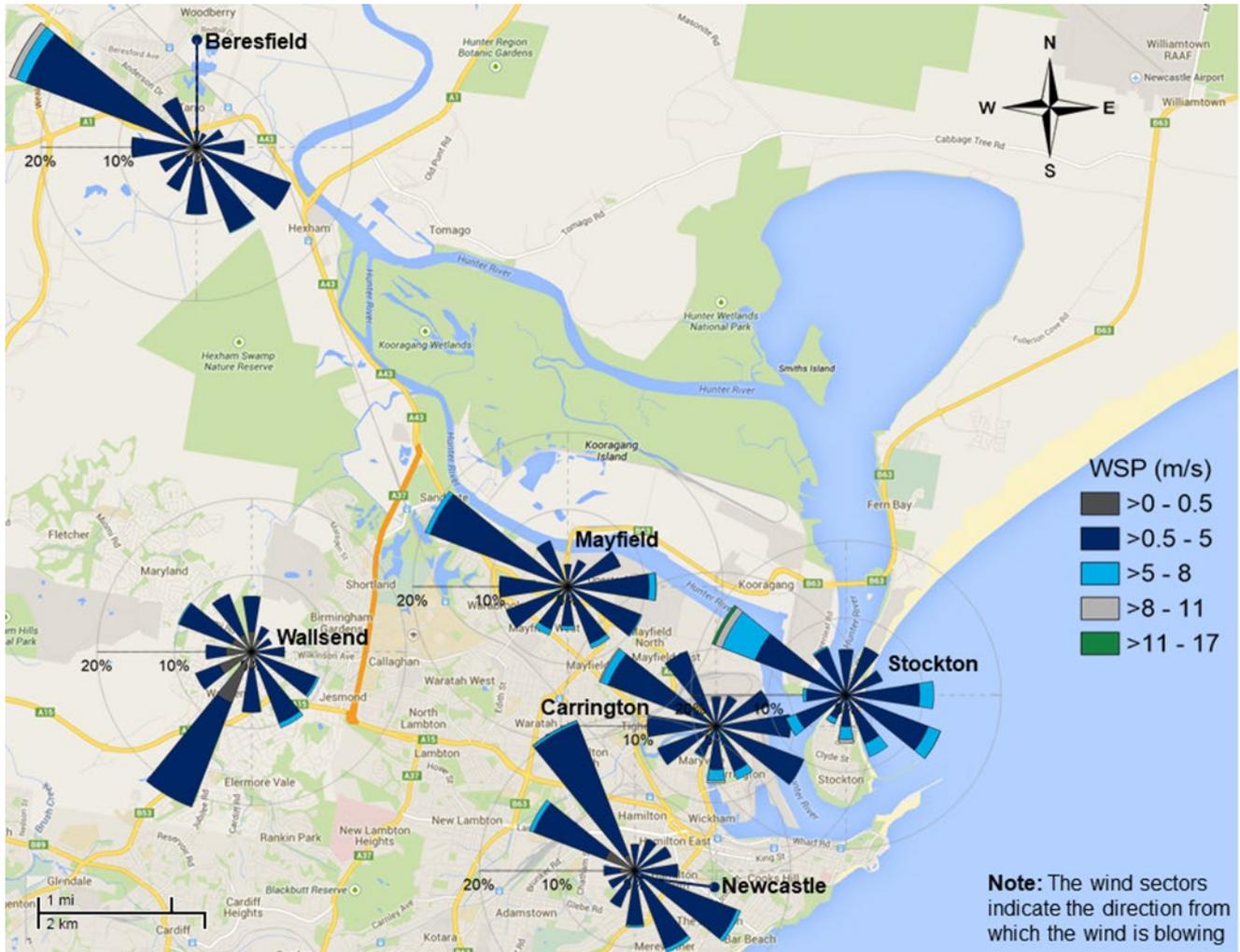


Figure 18 Wind rose map¹² for the Newcastle region for autumn 2023

¹² 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 autumn 2023

The Stockton monitoring site recorded 10 days over the PM10 daily benchmark during autumn 2023 (7, 8, 11, 14, 16-19 March, 19 April, and 24 May). This is 4 days more than autumn 2022. From 2013 to 2022, Stockton recorded between 1 day (autumn 2013) and 21 days (autumn 2016) over the PM10 daily benchmark (Figure 10).

In autumn 2023, elevated hourly PM10 levels ($>75 \mu\text{g}/\text{m}^3$)¹³ were recorded at Stockton 4.1% of the time (Figure 19). These occurred under onshore (north north-easterly to south south-easterly winds) 65.9% of the time (59 hours, 2.7% total for autumn). Elevated PM10 levels under predominant onshore winds at Stockton indicate the potential contribution of sea salt. The Lower Hunter Particle Characterisation Study found sea salt was a major contributor of particles at the site under onshore winds.

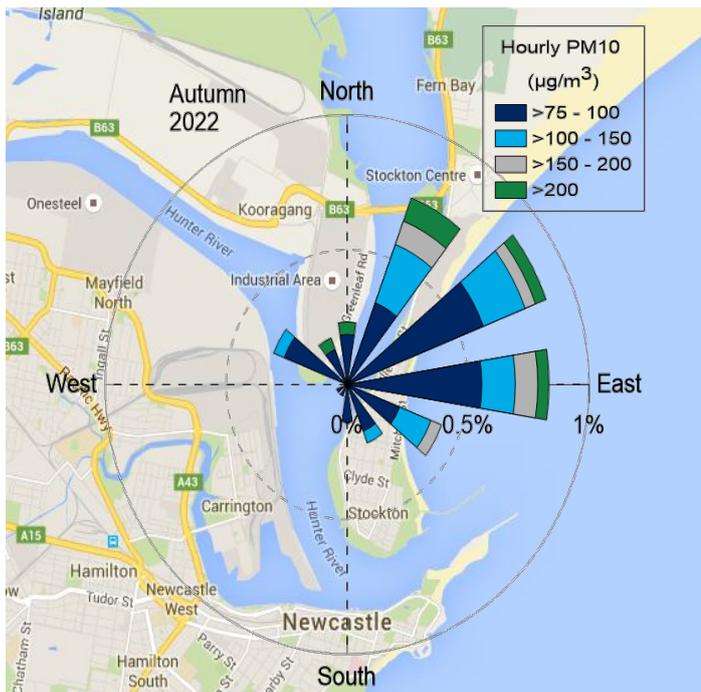


Figure 19 Stockton autumn 2023 PM10 pollution rose – proportion of hourly averaged PM10 levels $>75 \mu\text{g}/\text{m}^3$ by wind direction

The Stockton monitoring site did not record any days over the PM2.5 daily benchmark during autumn 2023. This was the same as all previous years during autumn (Figure 10). There were 2 hours of elevated PM2.5 ($>40 \mu\text{g}/\text{m}^3$)¹³ observed at Stockton during autumn 2023.

¹³ 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 NO₂, SO₂ and NH₃, the maximum online time that can be attained is 96% due to calibrations.

Table 2 presents online performance of Newcastle local monitoring stations during autumn 2023:

- all stations met online targets for monitoring of meteorology and particles (PM10 and PM2.5)
- Stockton and Mayfield met online targets for all gas monitoring
- Beresfield, Carrington, Newcastle, and Wallsend did not meet online targets for SO₂ and NO₂.

Table 2 Online performance (%) during autumn 2023

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	92	-	100
Carrington	97	97	93	87	-	95
Mayfield	100	99	95	95	-	100
Newcastle	97	96	90	92	-	97
Stockton	98	98	96	96	96	100
Wallsend	98	95	95	94	-	99

- = not monitored

The reduced online times were mainly due to:

- Beresfield SO₂ and NO₂ – annual maintenance and instrument fault
- Carrington SO₂ and NO₂ – instrument malfunction
- Newcastle SO₂ and NO₂ – power failure and instrument malfunction
- Wallsend NO₂ – scheduled maintenance.

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