

Air quality in the Upper Hunter: Autumn 2023

Air quality in the Upper Hunter was mostly good during autumn 2023. Daily particle levels were within national benchmarks 100% of the time at Muswellbrook and Singleton. Hourly particle levels were in the good to fair air quality categories more than 99% of the time at Singleton and Muswellbrook.

- Nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) levels were generally good to fair, with one hour at Muswellbrook recorded above the hourly SO₂ national benchmark.
- Daily average levels of PM_{2.5}¹ remained within national benchmarks at all stations.
- Daily average levels of PM₁₀¹ were above the national benchmarks at 5 stations on 14 occasions over 9 days. The highest regional maximum for daily PM₁₀ was 72.5 µg/m³ on 8 March.
- The region experienced average rainfall and above average maximum temperatures during autumn.

Annual air quality trends in the Upper Hunter

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 winter for 2015 to 2023.

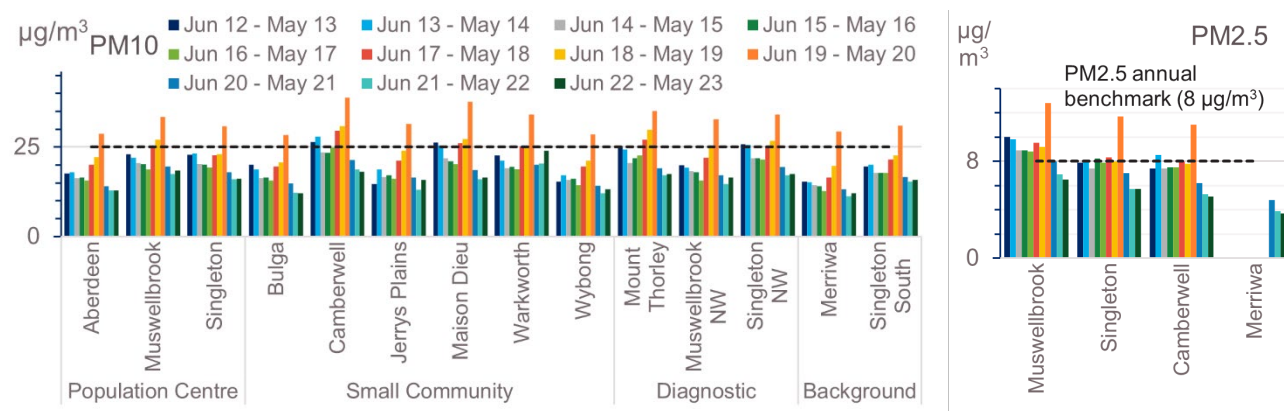


Figure 1 PM₁₀ and PM_{2.5} rolling annual averages: to the end of autumn 2013 to 2023

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM_{2.5}.

¹ PM_{2.5} and PM₁₀ refer to airborne particles, less than or equal to 2.5 and 10 micrometres in diameter, respectively.

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 were very similar or marginally higher at some sites for PM10, while particle levels were slightly lower or the same for PM2.5 for the 12 months to the end of autumn 2023, compared to the 12 months to the end of autumn 2022.

All stations recorded rolling annual average PM10 and PM2.5 levels within the annual benchmarks, with Bulga and Camberwell recording their lowest PM10 levels during this period since the network began operation. PM10 levels at Warkworth continued to increase to the end of autumn 2023 compared to the previous year, with levels similar to those recorded in the 12 months to the end of autumn 2018 and 2019. This is likely due to nearby mining operations, with the United Wambo Joint Venture Open Cut mine starting operations in 2020.

Low particle levels resulted from wetter-than-average conditions and cool to average daytime temperatures. However, average rainfall conditions and drier-than-average daytime temperatures have returned over recent months. At the end of autumn 2023, 1% of New South Wales was drought affected (Figure 2), compared to no areas at the end of autumn 2022³ and 26% at the end of autumn 2021⁴.

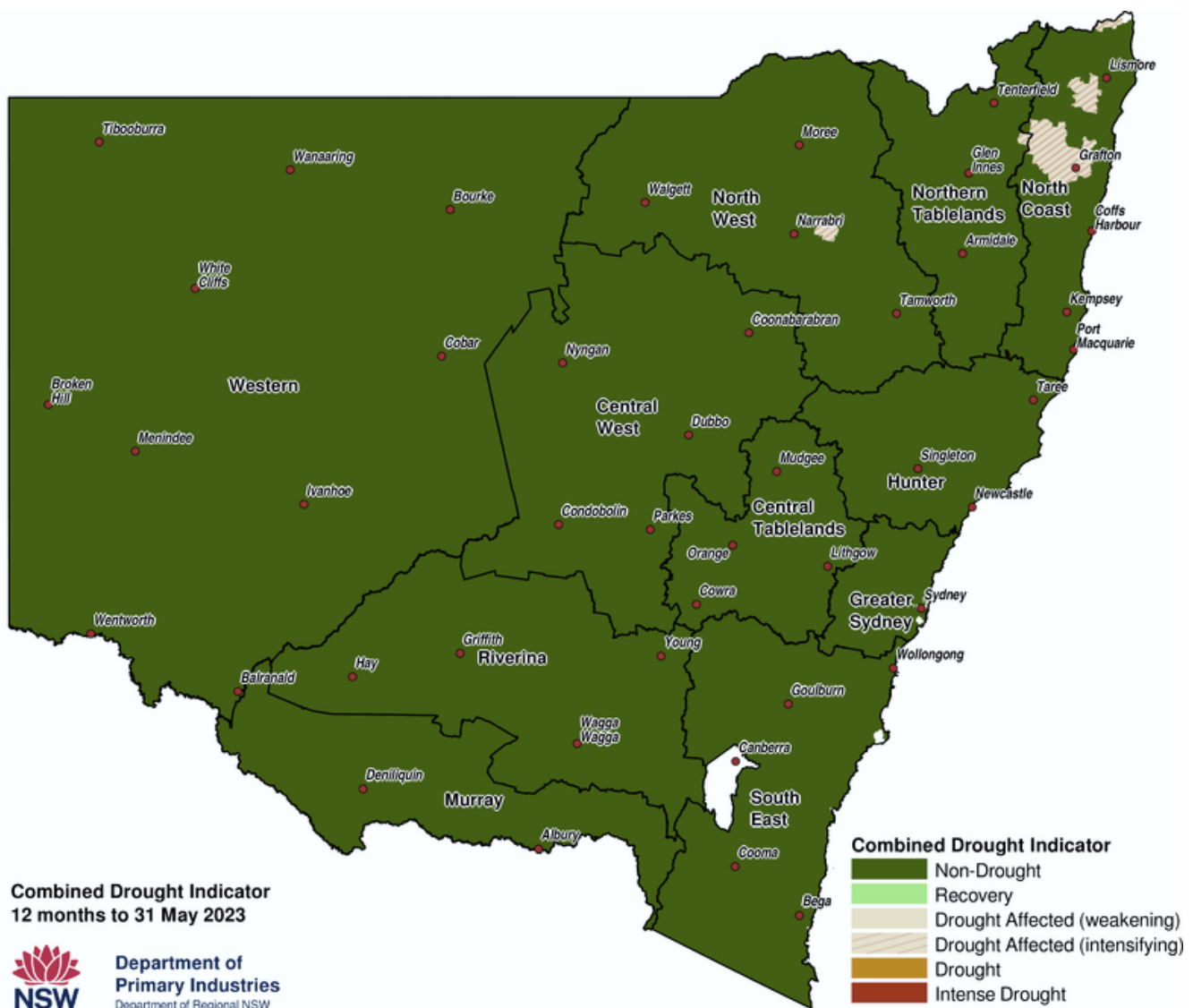


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 May 2023⁵

³ Sourced from Department of Primary Industries NSW State seasonal update – May 2022 (accessed October 2023).

⁴ Sourced from Department of Primary Industries NSW State seasonal update – May 2021 (accessed October 2023).

⁵ Sourced from Department of Primary Industries NSW State seasonal update – May 2023 (accessed October 2023).

Days above benchmark concentrations

Six stations exceeded the PM10 daily benchmark during autumn 2023, with Warkworth (6) and Mount Thorley (5) observing the most exceedances. Aberdeen, Camberwell, Maison Dieu, and Singleton North West all observed one day above the PM10 benchmark. Sulfur dioxide at Muswellbrook was observed above the hourly benchmark of 10 pphm on one occasion during autumn 2023.

All other stations and parameters remained within the national benchmarks throughout the season.

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

Station type*	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]
Population centre	Aberdeen	1	-	-	-	-
Population centre	Muswellbrook	0	0	1	0	0
Population centre	Singleton	0	0	0	0	0
Smaller community	Bulga	0	-	-	-	-
Smaller community	Camberwell	1	0	-	-	-
Smaller community	Jerrys Plains	0	-	-	-	-
Smaller community	Maison Dieu	0	-	-	-	-
Smaller community	Warkworth	6	-	-	-	-
Smaller community	Wybong	0	-	-	-	-
Diagnostic	Mount Thorley	5	-	-	-	-
Diagnostic	Muswellbrook NW	0	-	-	-	-
Diagnostic	Singleton NW	1	-	-	-	-
Background	Merriwa	0	0	0	0	0
Background	Singleton South	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.

* For explanation, refer to the end of the report Definitions: Upper Hunter monitoring station types.

Pollution roses form hourly particle data

The seasonal pollution rose maps⁶ (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels⁷ were generally low during the season.



Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for autumn 2023



Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for autumn 2023

⁶ Pollution roses show 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.

Daily time series plots

Figure 5 to Figure 12 show daily average time series plots for PM10, PM2.5 and SO₂ and daily 1-hour maximum plots for NO₂ and SO₂. PM10 was observed above the daily benchmark 15 times over 6 stations, generally under north-westerly winds, and SO₂ at Muswellbrook exceeded the hourly benchmark under south-easterly winds on one occasion during autumn 2023.

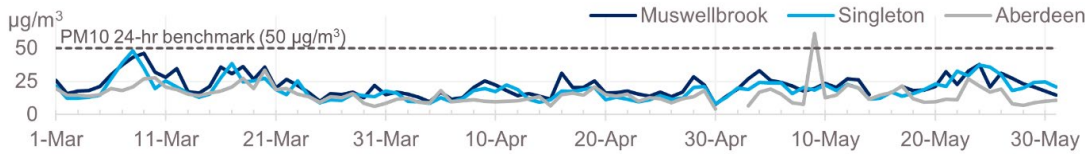


Figure 5 Population centre stations: daily average PM10 – autumn 2023

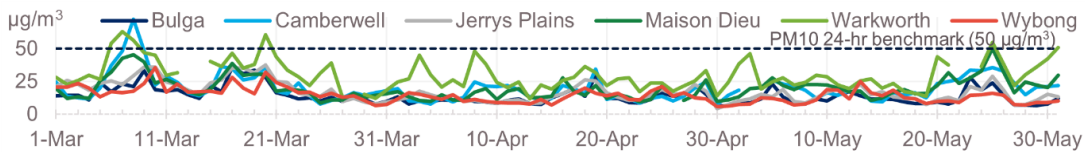


Figure 6 Smaller community stations: daily average PM10 – autumn 2023

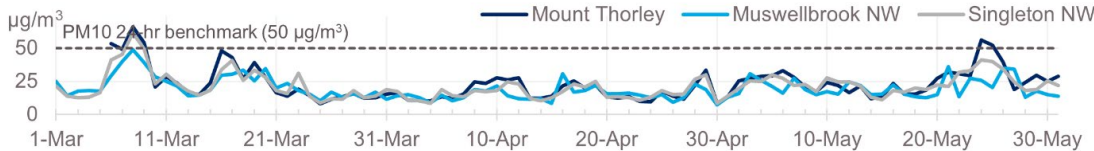


Figure 7 Diagnostic stations: daily average PM10 – autumn 2023

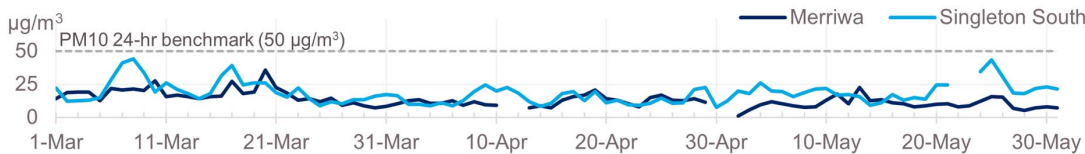


Figure 8 Background stations: daily average PM10 – autumn 2023

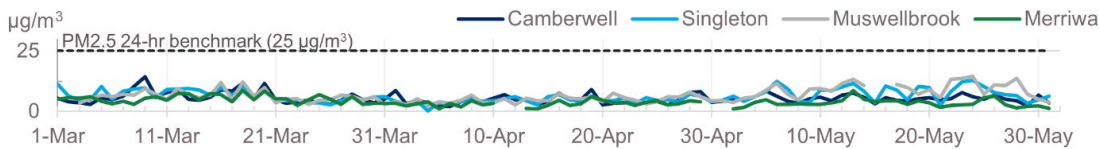


Figure 9 Daily average PM2.5 – autumn 2023

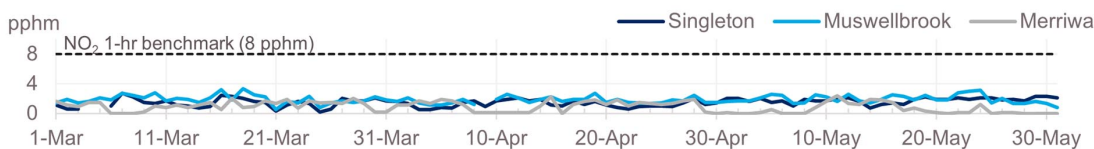


Figure 10 Daily 1-hr maximum NO₂ – autumn 2023

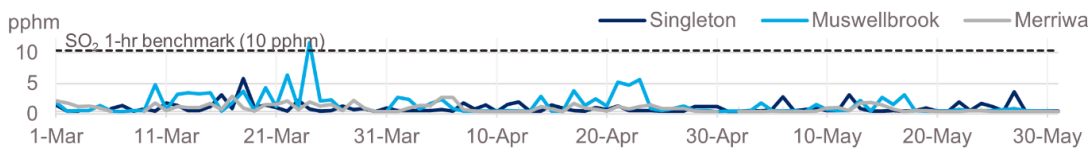


Figure 11 Daily 1-hr maximum SO₂ – autumn 2023

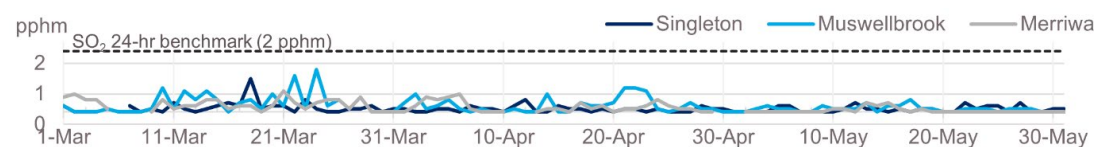


Figure 12 Daily average SO₂ – autumn 2023

Seasonal comparisons

This section compares air quality in autumn 2023 with previous autumn seasons (Figure 13).

There was one day over the SO₂ hourly national benchmarks at Muswellbrook for one hour on 24 April 2023. There were no days over the national benchmarks for NO₂ in autumn 2023. From autumn 2012 to 2021, under the more stringent standards (applied from May 2021 onwards), Muswellbrook would have recorded 14 hours over 13 days above the current hourly SO₂ standard of 10 parts per hundred million (pphm). There would have also been one day above the current daily SO₂ standard of 2 pphm at Muswellbrook. There would not have been any days above the current hourly NO₂ benchmark.

There were 8 days over the PM10 daily benchmark during autumn 2023. This is the highest number of PM10 exceedance days since autumn 2019. From 2012 to 2022, the region recorded between no days (autumn 2022) and 17 days (autumn 2018) over the PM10 benchmark.

There were no days over the PM2.5 daily benchmark during autumn 2023. From 2012 to 2022, the region recorded between no days (autumn 2012–2015 and 2018–2022) and 2 days (autumn 2016) over the PM2.5 benchmark.

Due to severe drought conditions, higher particle levels occurred in autumn 2018 and 2019.

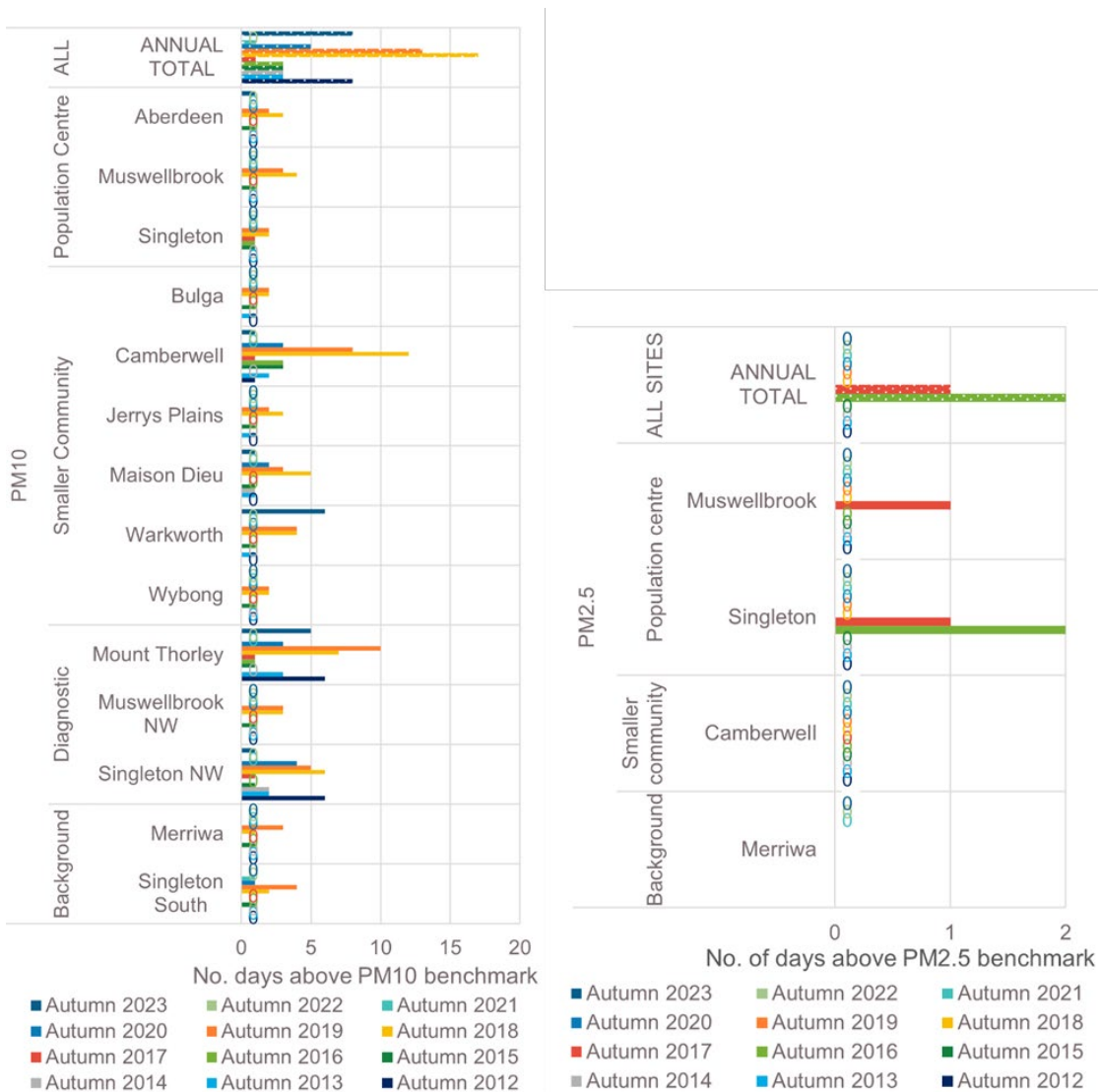


Figure 13 Number of days above the PM10 and PM2.5 daily benchmarks: autumn 2012 to 2023

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to also monitor PM2.5

Particle air quality trends in the Upper Hunter

Figure 14 and Figure 15 show daily average PM10 levels during autumn 2023, compared to the daily maximum and minimum levels (i.e. shaded range) for autumn periods from 2011 to 2022, at Singleton and Muswellbrook. Daily PM10 levels were generally within the historical range throughout the season. Regional rainfall levels were below average for the season (Figure 16).

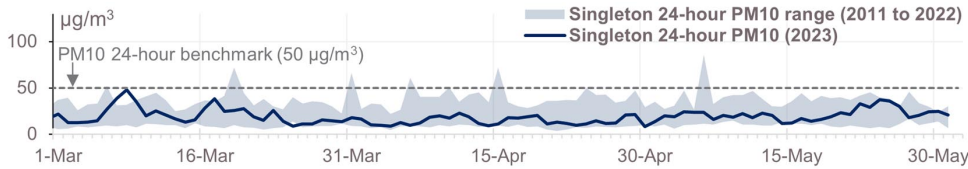


Figure 14 Singleton daily average PM10 during autumn 2023 plotted against the daily maximum and minimum PM10 levels from 2011 to 2022

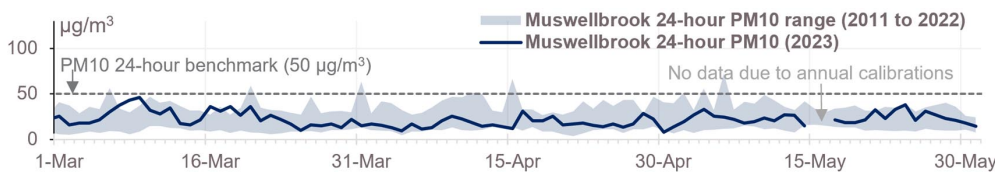


Figure 15 Muswellbrook daily average PM10 during autumn 2023 plotted against the daily maximum and minimum PM10 levels from 2011 to 2022

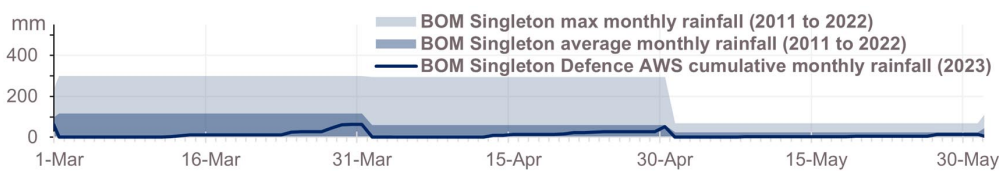


Figure 16 Bureau of Meteorology Singleton Defence AWS⁸ cumulative monthly rainfall in autumn 2023 against maximum and average monthly rainfall from 2011 to 2022⁹

Figure 17 and Figure 18 show daily average PM2.5 levels during autumn 2023, compared to the daily maximum and minimum levels (shaded range) for autumn periods from 2011 to 2022, at Singleton and Muswellbrook. Daily PM2.5 levels were within or below the historical range in the season.

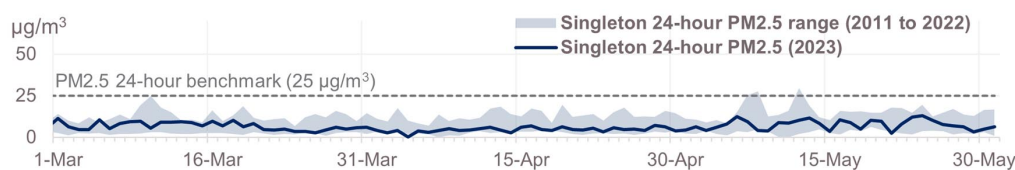


Figure 17 Singleton daily average PM2.5 during autumn 2023 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2022

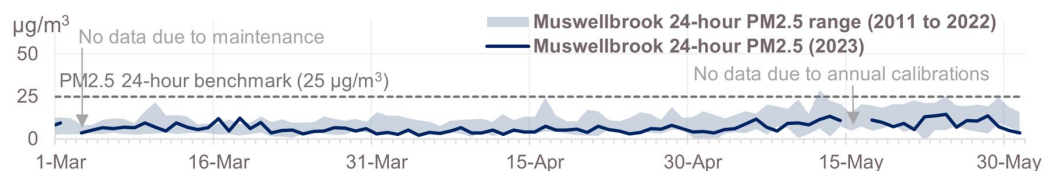


Figure 18 Muswellbrook daily average PM2.5 during autumn 2023 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2022

⁸ Data obtained from the Bureau of Meteorology [Singleton Defence AWS monthly rainfall data](#) (accessed October 2023).
⁹ The Bureau of Meteorology STP station was decommissioned in January 2019. Therefore, statistics have been calculated from a combination of the [Singleton STP monthly rainfall data](#) (accessed March 2020) from January 2011 to March 2017 and [Singleton Defence AWS monthly rainfall data](#) from April 2017.

Meteorological summary

Rainfall and temperature¹⁰

The Upper Hunter experienced average rainfall during autumn 2023 (Figure 19). Autumn 2023 was drier than autumn 2022, with 200 to 400 millimetres less rain. The season was drier than autumn 2021, with 100 to 400 millimetres less rain, similar to autumn 2020, with 25 millimetres more in western parts of the Hunter and 25 millimetres closer to the coast in autumn 2023 compared to autumn 2020.

Maximum temperatures were above average (Figure 20), and minimum temperatures were average during the season.

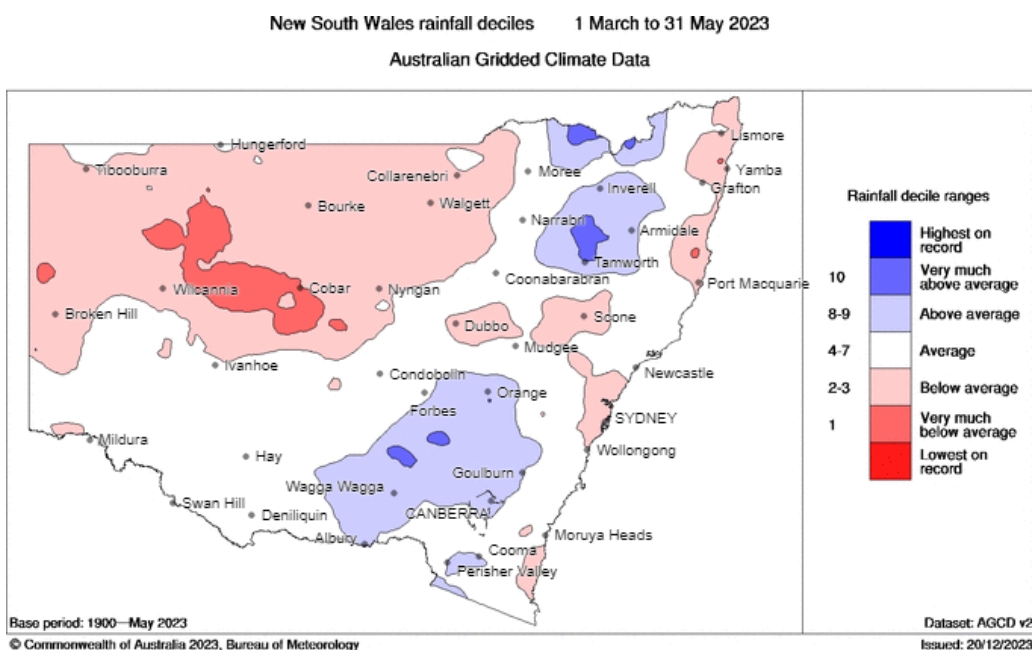


Figure 19 NSW rainfall deciles – autumn 2023

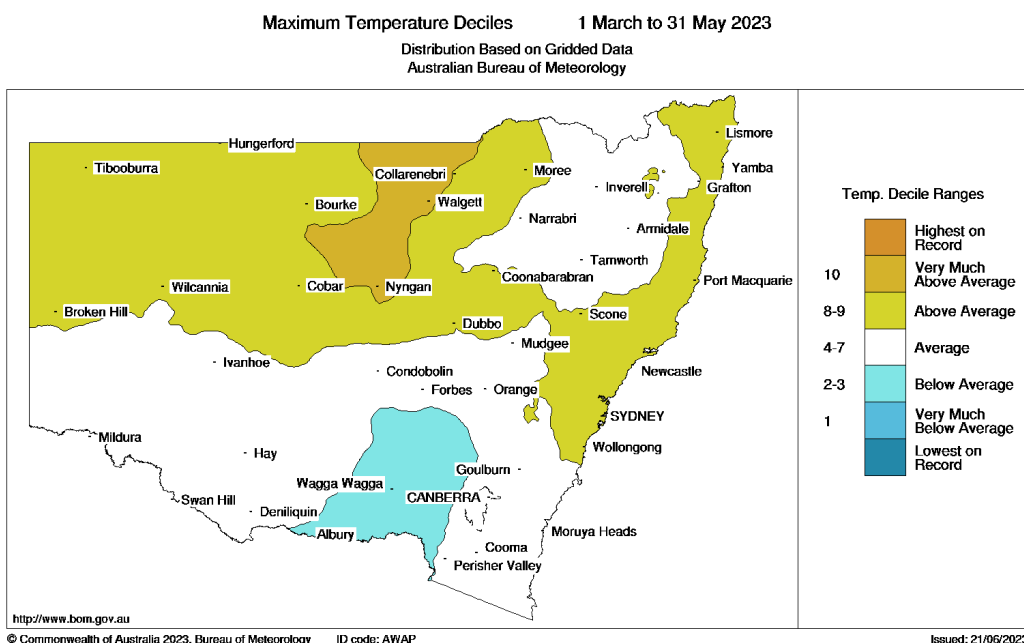


Figure 20 NSW maximum temperature deciles – autumn 2023

¹⁰ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales autumn 2023 climate statement](#) (accessed October 2023) and [climate maps](#) (accessed October 2023).

Wind

The winds were variable in the region during autumn 2023 (Figure 21), which was typical for this transitional season. Winds typically change from north-westerly in winter to south-easterly in summer.

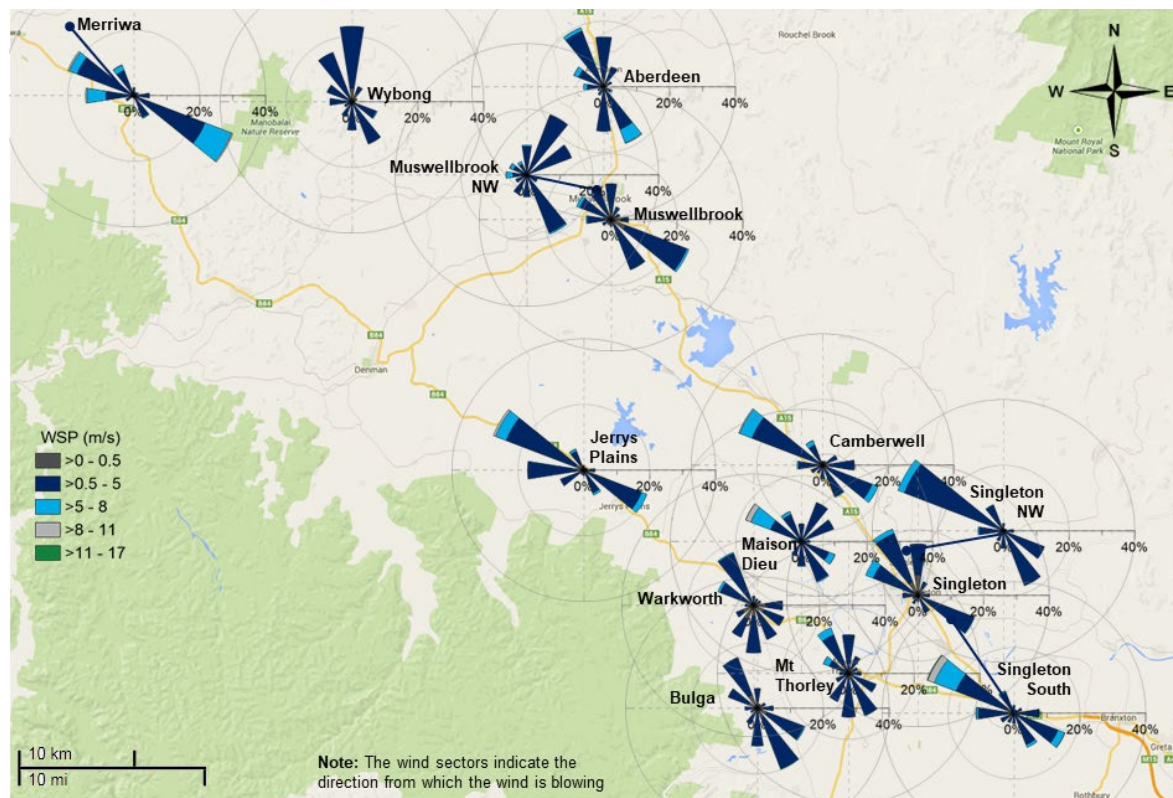


Figure 21 Wind rose map¹¹ for the Upper Hunter region for autumn 2023

¹¹ Wind roses show the wind direction and speed at a location. The length of each bar around the circle shows the percentage of time that the wind blows from a particular direction. The colours along the bars indicate the wind speed categories.

Network performance

The target network performance is at least 95% available data for all parameters. Due to daily calibrations, the maximum online time that can be attained for NO₂ and SO₂ is 96%.

Table 2 Online performance (%) during autumn 2023

Station	Particles PM10 daily	Particles PM2.5 daily	Gases SO ₂ hourly	Gases NO ₂ hourly	Meteorology Wind hourly
Aberdeen	98	-	-	-	100
Bulga	100	-	-	-	100
Camberwell	98	98	-	-	100
Jerrys Plains	100	-	-	-	100
Maison Dieu	99	-	-	-	100
Merriwa	96	96	90	92	97
Mount Thorley	97	-	-	-	98
Muswellbrook	98	97	93	94	100
Muswellbrook NW	100	-	-	-	83
Singleton	100	100	92	89	99
Singleton NW	100	-	-	-	100
Singleton South	98	-	-	-	100
Warkworth	95	-	-	-	98
Wybong	100	-	-	-	100

- = not monitored

The overall reduced online times were mainly due to:

- Merriwa NO₂ and SO₂ – 6-month calibrations and maintenance (2 days), data logger issue (2 days) and planned power outage (1 day)
- Muswellbrook NO₂ – calibrations (1 day)
- Muswellbrook SO₂ – 6-month calibrations and maintenance (2 days)
- Singleton NO₂ and SO₂ – communications issue (2 days)
- Muswellbrook NW wind – instrument damage and replacement (16 days)

Definitions: Upper Hunter monitoring station types

The 14 monitoring stations in the Upper Hunter serve different purposes:

Larger population: stations near the larger population centres monitor the air quality in these centres.

Smaller communities: stations near smaller communities monitor the air quality at those locations.

Diagnostic: provide data that can help diagnose the likely sources and movement of particles across the region as a whole; they do not provide information about air quality at population centres.

Background: the stations near Merriwa and Singleton South are at both ends of the valley and provide background data, measuring the quality of air entering and leaving the Upper Hunter Valley under predominant winds (south-easterlies and north-westerlies).

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