

Air quality in the Upper Hunter: Winter 2021

Air quality in the Upper Hunter was good during winter 2021. 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 99.8% and 99.9% of the time at Muswellbrook and Singleton, respectively. This was the first winter in 10 years PM10 and PM2.5 were both below their respective benchmarks in the Upper Hunter. Regional air quality was improved compared to the last few years, with the region experiencing wetter conditions and closer to average temperatures in 2021.

- Levels of fine particle matter PM10 (particles less than or equal to 10 microns in diameter), PM2.5 (particles less than or equal to 2.5 microns in diameter), nitrogen dioxide (NO₂) and sulfur dioxide (SO₂) were good, remaining below national benchmarks.
- Camberwell recorded the highest PM10 regional daily average during winter 2021, 47 µg/m³ on 28 July. PM10 concentrations at Camberwell were the regional daily maximum for 39% (36 days) of winter 2021. Muswellbrook recorded the highest PM2.5 regional daily average during winter 2021, with 19.7 µg/m³ on 8 July. Merriwa recorded the regional daily maximum for 68% (63 days) of winter 2021.

Annual air quality trends in the Upper Hunter

A comparison of annual average PM10 and PM2.5 levels shows the long-term trends. The national annual average benchmarks are 25 µg/m³ for PM10 and 8 µg/m³ for PM2.5, based on a calendar year. Figure 1 shows the PM10 and PM2.5 **rolling** annual averages¹, based on the 12-month periods to the end of winter, for 2013 to 2021.

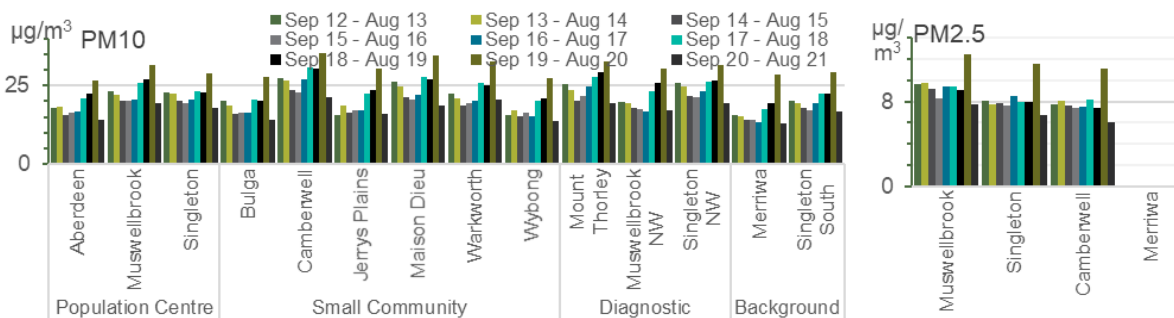


Figure 1 PM10 and PM2.5 rolling annual averages: to the end of winter 2013 to 2021

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles as PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

The comparison in Figure 1 shows significant improvement in particle levels throughout the region during the 12 months to the end of winter 2021 compared to earlier years. All stations recorded their lowest rolling annual average PM10 and PM2.5 particle levels to the end of winter 2021 since the network began, except for Jerrys Plains. By contrast, in the 12 months to the end of winter 2020, all stations recorded their highest rolling annual average PM10 and PM2.5 particle levels since the network began due to intense drought and extensive bushfires.

The improved particle levels resulted from comparatively cooler and wetter conditions in early 2021, reducing dust storm and bushfire activity. At the end of winter 2021, 7% of New South Wales was

¹ 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.

affected by drought (Figure 2), compared to 35% of the state drought declared by the end of winter 2020².

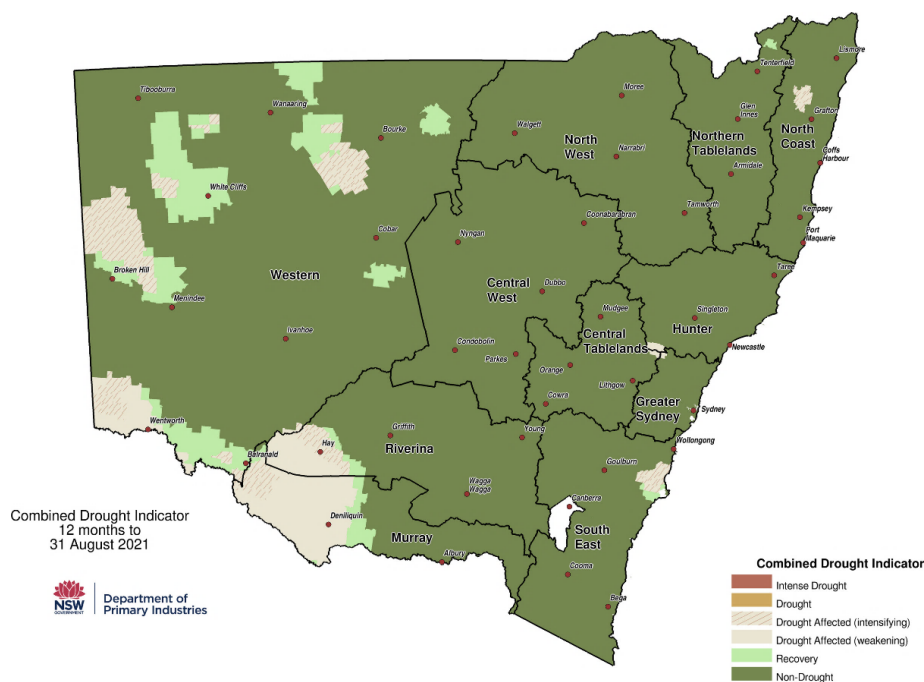


Figure 2 Department of Primary Industries NSW Combined Drought Indicator to 31 August 2021³

Days above benchmark concentrations

PM10 and PM2.5 levels remained below their respective daily benchmark throughout the season.

Table 1 Number of days above the relevant national benchmarks – winter 2021

| Station type* | Station | PM10 daily [50 µg/m ³ benchmark] | PM2.5 daily [25 µg/m ³ benchmark] | SO ₂ hourly ⁴ [10 pphm benchmark] | SO ₂ daily ⁴ [2 pphm benchmark] | NO ₂ hourly ⁴ [8 pphm benchmark] |
|-------------------|-----------------|---|--|--|---|---|
| Population centre | Aberdeen | 0 | - | - | - | - |
| Population centre | Muswellbrook | 0 | 0 | 0 | 0 | 0 |
| Population centre | Singleton | 0 | 0 | 0 | 0 | 0 |
| Smaller community | Bulga | 0 | - | - | - | - |
| Smaller community | Camberwell | 0 | 0 | - | - | - |
| Smaller community | Jerrys Plains | 0 | - | - | - | - |
| Smaller community | Maison Dieu | 0 | - | - | - | - |
| Smaller community | Warkworth | 0 | - | - | - | - |
| Smaller community | Wybong | 0 | - | - | - | - |
| Diagnostic | Mount Thorley | 0 | - | - | - | - |
| Diagnostic | Muswellbrook NW | 0 | - | - | - | - |
| Diagnostic | Singleton NW | 0 | - | - | - | - |
| 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**

² Sourced from Department of Primary Industries [NSW State seasonal update – August 2021](#) (accessed October 2021).

³ Sourced from Department of Primary Industries [NSW State seasonal update – August 2021](#) (accessed October 2021).

⁴ Note: The [National Environment Protection \(Ambient Air Quality\) Measure \(Air NEPM\)](#) was updated on 18 May 2021. New national benchmarks were introduced for hourly SO₂ (now 10 pphm), daily SO₂ (now 2 pphm) and hourly NO₂ (now 8 pphm).

Pollution roses from hourly particle data

The seasonal pollution rose maps⁵ (Figure 3 and Figure 4) show that hourly PM10 and PM2.5 levels⁶ were predominantly low during the season.

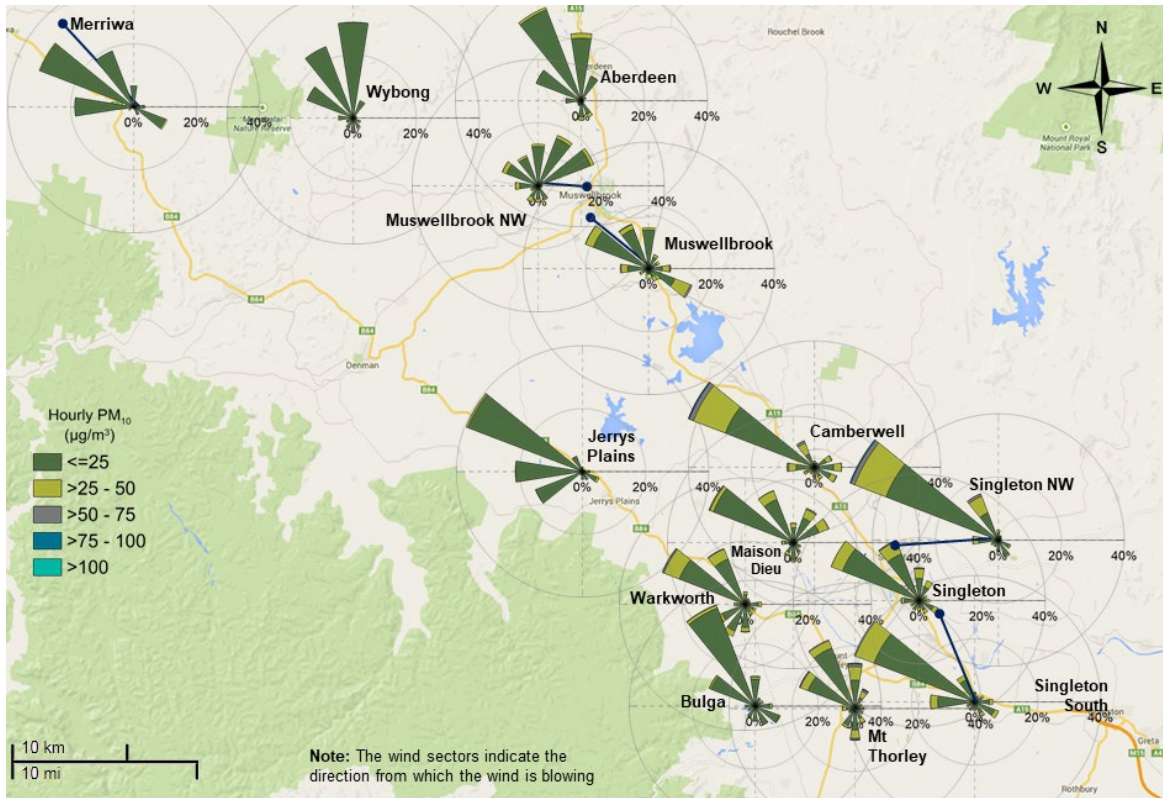


Figure 3 Hourly PM10 pollution rose map for the Upper Hunter region for winter 2021

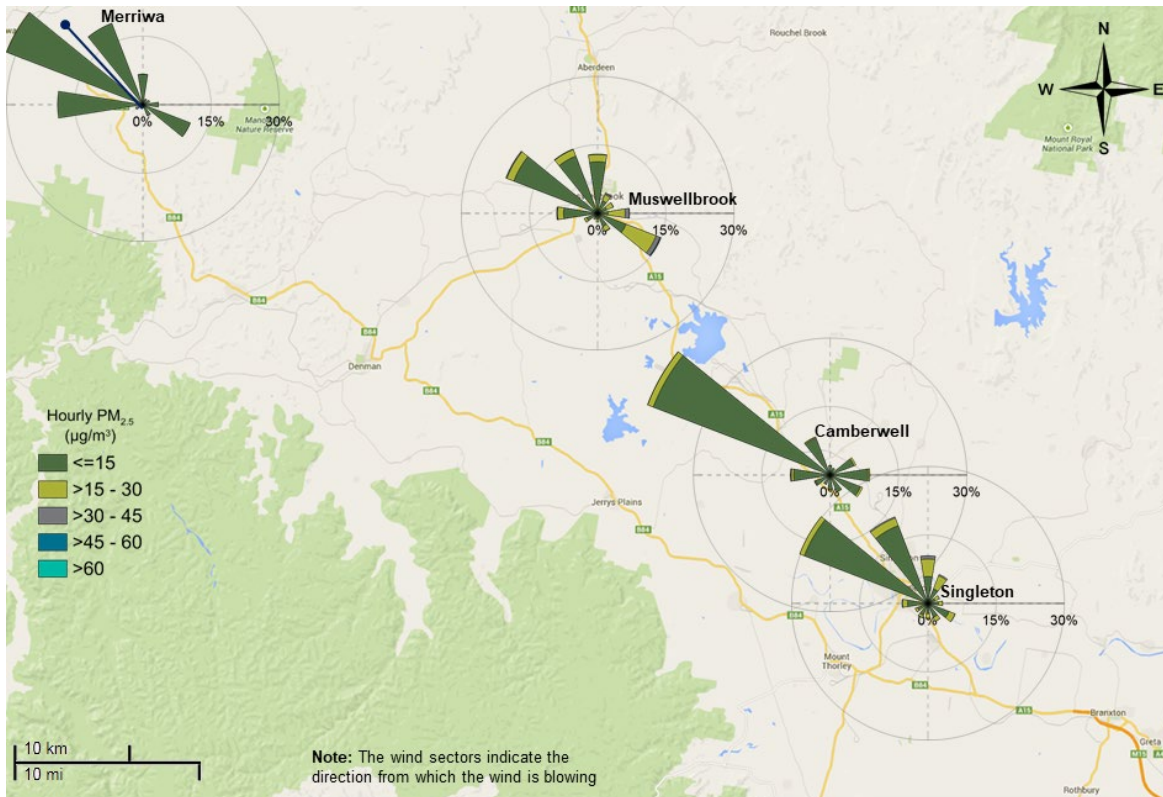


Figure 4 Hourly PM2.5 pollution rose map for the Upper Hunter region for winter 2021

⁵ 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.

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

Daily time series plots

Daily average time series plots for PM₁₀ and PM_{2.5} and daily one-hour maximum plots for NO₂ and SO₂ show the concentrations throughout winter (Figure 5 to Figure 11). PM₁₀, PM_{2.5}, NO₂ and SO₂ remained below the benchmarks.

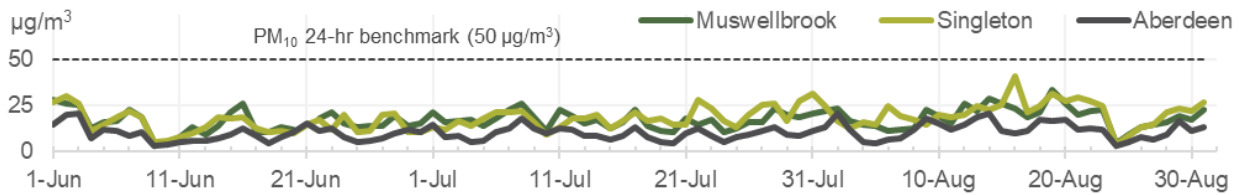


Figure 5 Population centre stations: daily average PM₁₀ – winter 2021

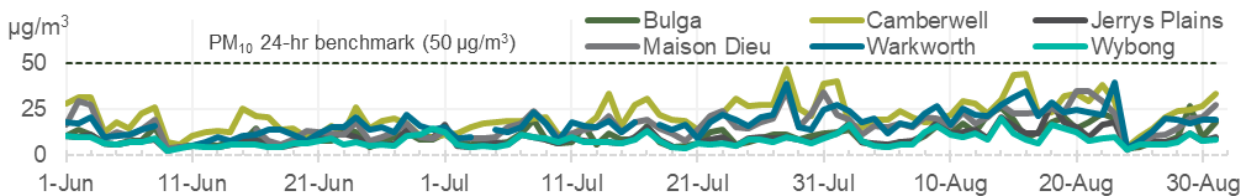


Figure 6 Smaller community stations: daily average PM₁₀ – winter 2021

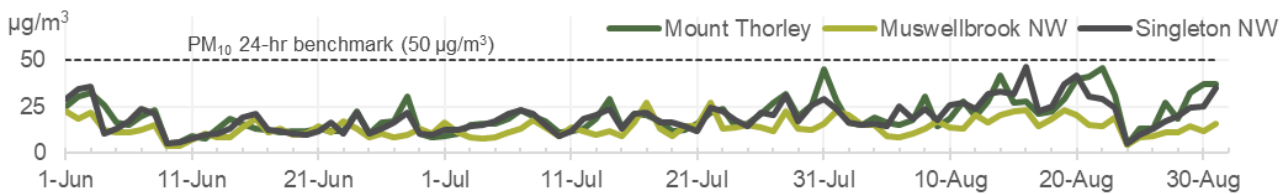


Figure 7 Diagnostic stations: daily average PM₁₀ – winter 2021

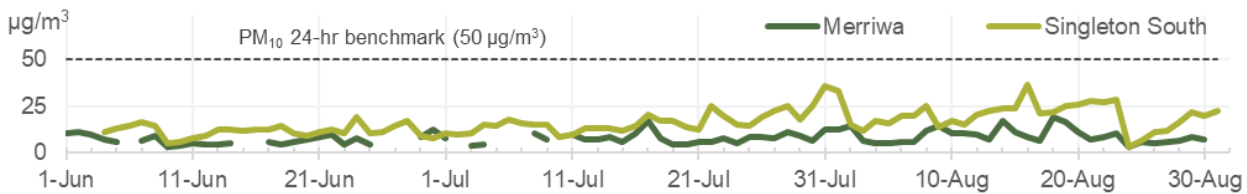


Figure 8 Background stations: daily average PM₁₀ – winter 2021

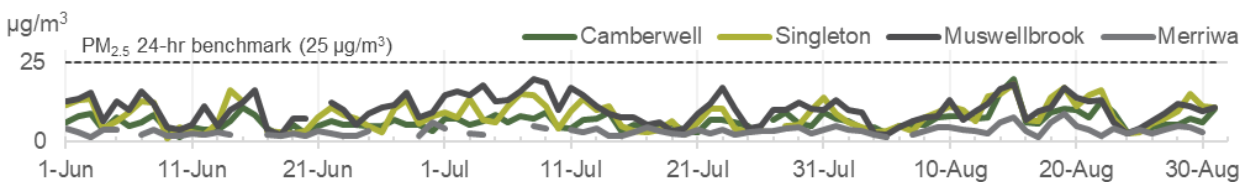


Figure 9 Daily average PM_{2.5} – winter 2021

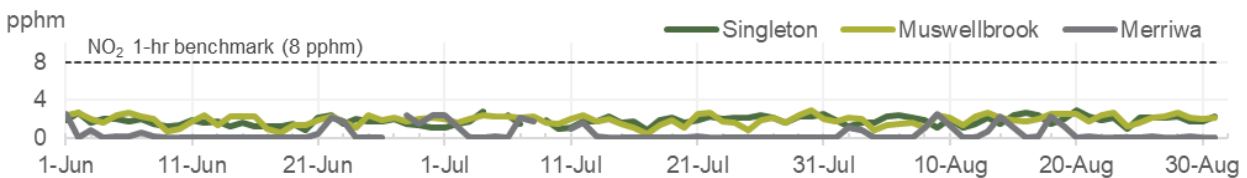


Figure 10 Daily 1-hr maximum NO₂ – winter 2021

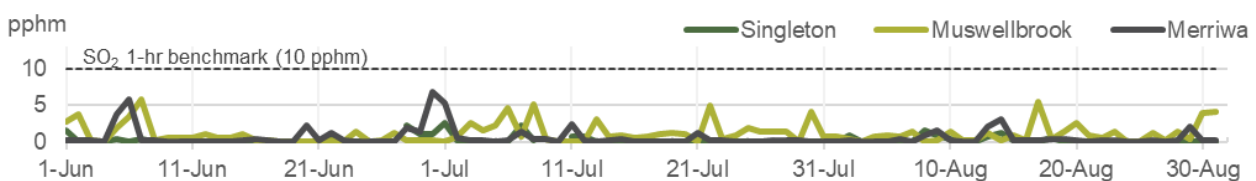


Figure 11 Daily 1-hr maximum SO₂ – winter 2021

Seasonal comparisons

This section compares air quality in winter 2021 with previous winter seasons (Figure 12).

Winter 2021 was the first winter in 10 years that there were no exceedances of either the PM10 or PM2.5 national benchmarks across the region.

All winter days were below national benchmark concentrations for NO₂ and SO₂ over the past 10 years.

All days in winter 2021 were below the daily average PM10 benchmark at all stations. Two days above the benchmark were recorded in winter 2020, compared to 22 days in winter 2019 and 29 days in winter 2018. From 2012 to 2017, days above the PM10 benchmark range from zero (winter 2016) to 10 (winter 2017).

All days in winter 2021 were below the daily average PM2.5 benchmark at all stations, a result also observed in 2013. Days over the PM2.5 benchmark in remaining years ranged from one (winter 2016 and 2017) to 3 (winter 2015 and 2020).

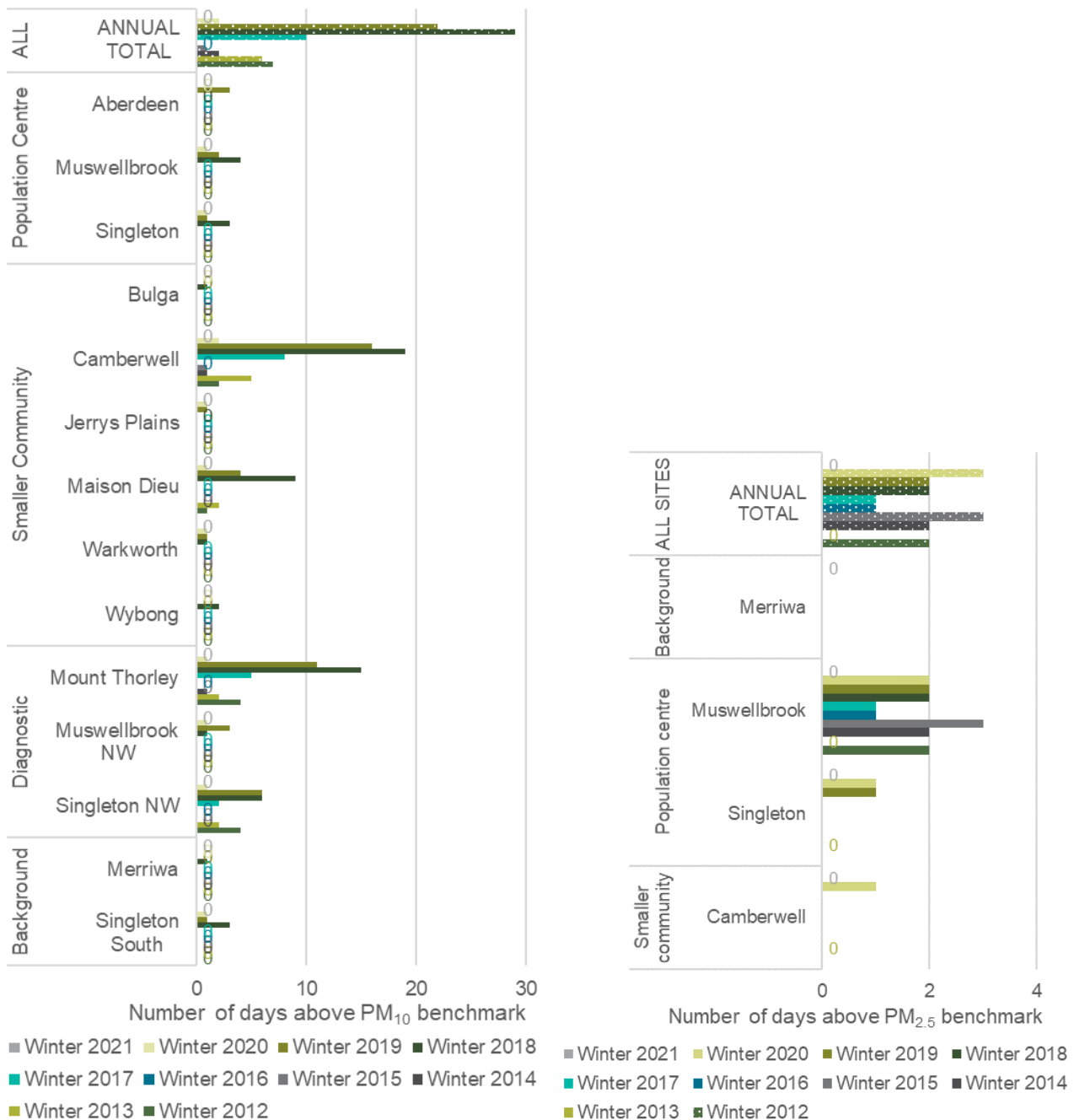


Figure 12 Number of days above the PM10 and PM2.5 daily benchmarks: winter 2013 to 2021

Note: The Merriwa background air quality monitoring station was upgraded in July 2020 to monitor particles as PM2.5, visibility, ozone, nitrogen oxides, carbon monoxide and sulfur dioxide.

Particle air quality trends in the Upper Hunter

Figure 13 and Figure 14 show daily average PM10 levels during winter 2021, compared to the daily maximum and minimum levels (i.e. shaded range) for winter seasons from 2011 to 2020, at Singleton and Muswellbrook. Daily PM10 levels were within or below the historical range throughout the season. Regional rainfall levels were average during winter 2021, with good falls at Singleton towards the end of August 2021 (Figure 15).

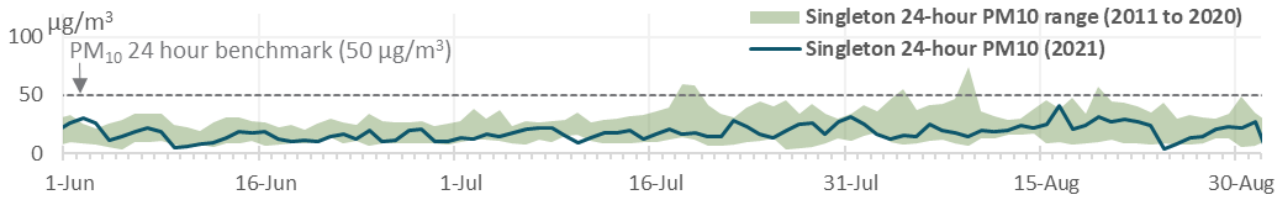


Figure 13 Singleton daily average PM10 during winter 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020

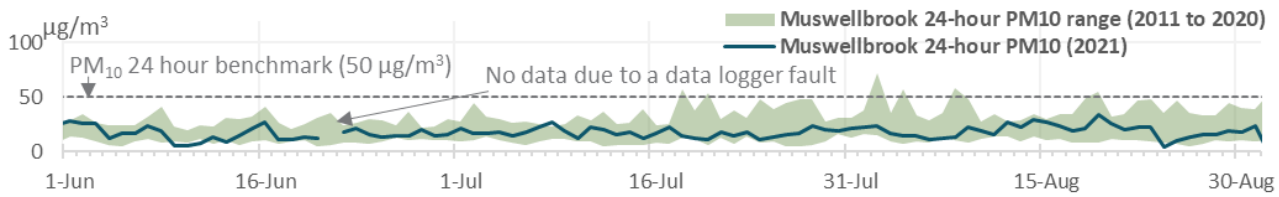


Figure 14 Muswellbrook daily average PM10 during winter 2021 plotted against the daily maximum and minimum PM10 levels from 2011 to 2020

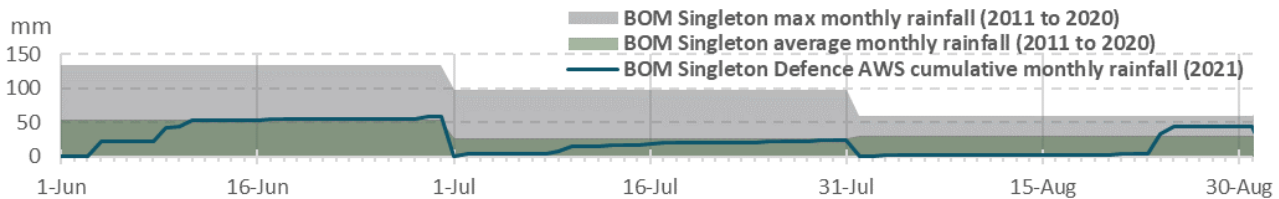


Figure 15 Bureau of Meteorology Singleton Defence AWS⁷ cumulative monthly rainfall in winter 2021 against maximum and average monthly rainfall from 2011 to 2020⁸

Figure 16 and Figure 17 show daily average PM2.5 levels during winter 2021, compared to the daily maximum and minimum levels (shaded range) for winter periods from 2012 to 2020, at Singleton and Muswellbrook. Daily PM2.5 levels were generally within or below the historical range throughout the season.

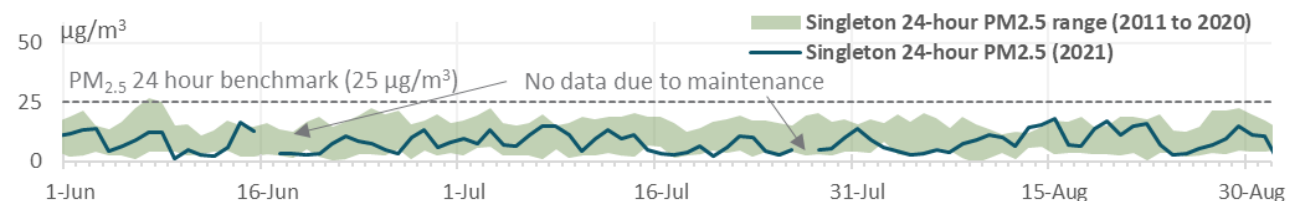


Figure 16 Singleton daily average PM2.5 during winter 2021 plotted against the daily maximum and minimum PM2.5 levels from 2011 to 2020

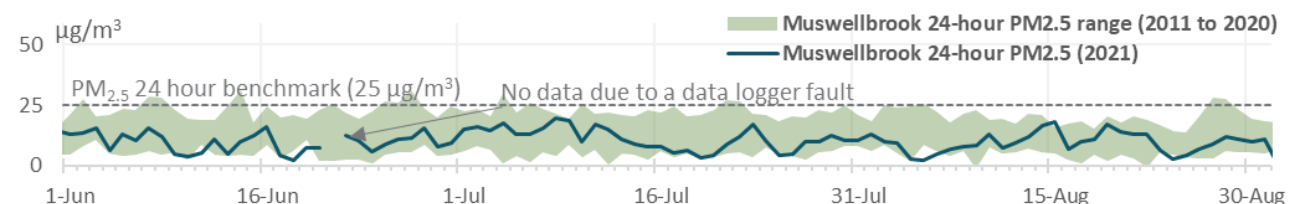


Figure 17 Muswellbrook daily average PM2.5 during winter 2021 plotted against the daily maximum and minimum PM2.5 levels from 2012 to 2020

⁷ Data obtained from the Bureau of Meteorology [Singleton Defence AWS monthly rainfall data](#) (accessed October 2021).

⁸ 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 October 2021) from January 2011 to March 2017 and [Singleton Defence AWS monthly rainfall data](#) from April 2017.

Meteorological summary

Rainfall and temperature⁹

The Upper Hunter experienced average to below average rainfall during winter 2021 (Figure 18). There was 25 to 100 millimetres more rainfall in winter 2020 compared to winter 2021. Winter 2021 was wetter than winters in 2019 and 2018 by up to 100 millimetres throughout most of the Upper Hunter.

Maximum and minimum temperatures were above average (Figure 19) during winter 2021.

New South Wales rainfall deciles 1 June to 31 August 2021

Australian Gridded Climate Data

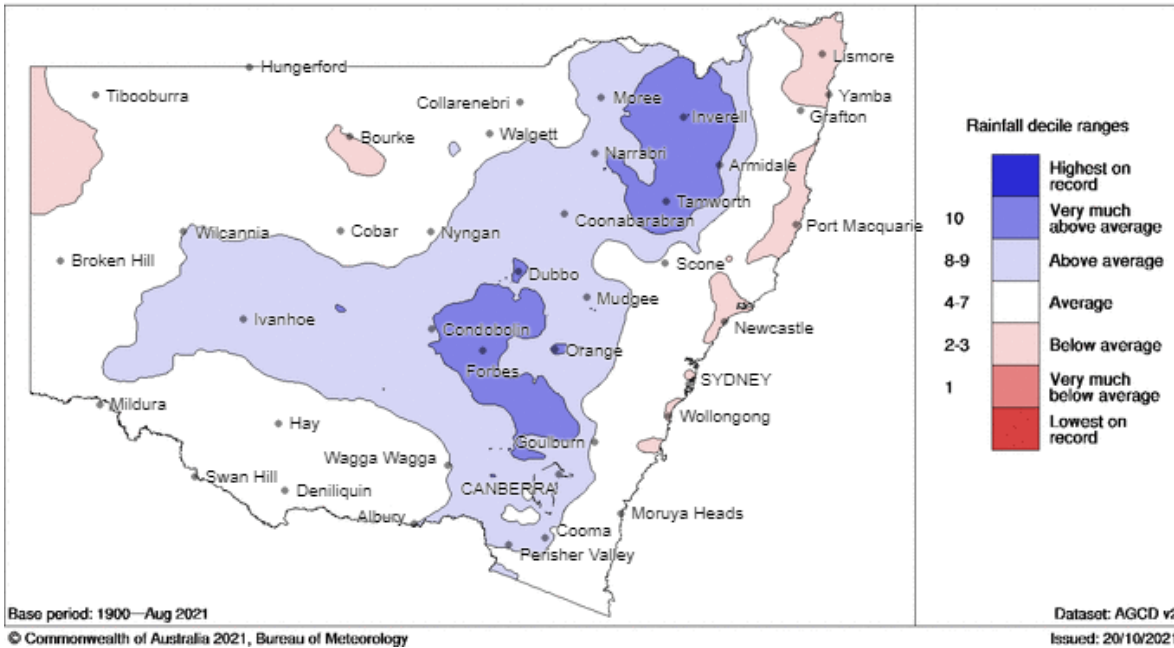


Figure 18 NSW rainfall deciles – winter 2021

Maximum Temperature Deciles 1 June to 31 August 2021

Distribution Based on Gridded Data
 Australian Bureau of Meteorology

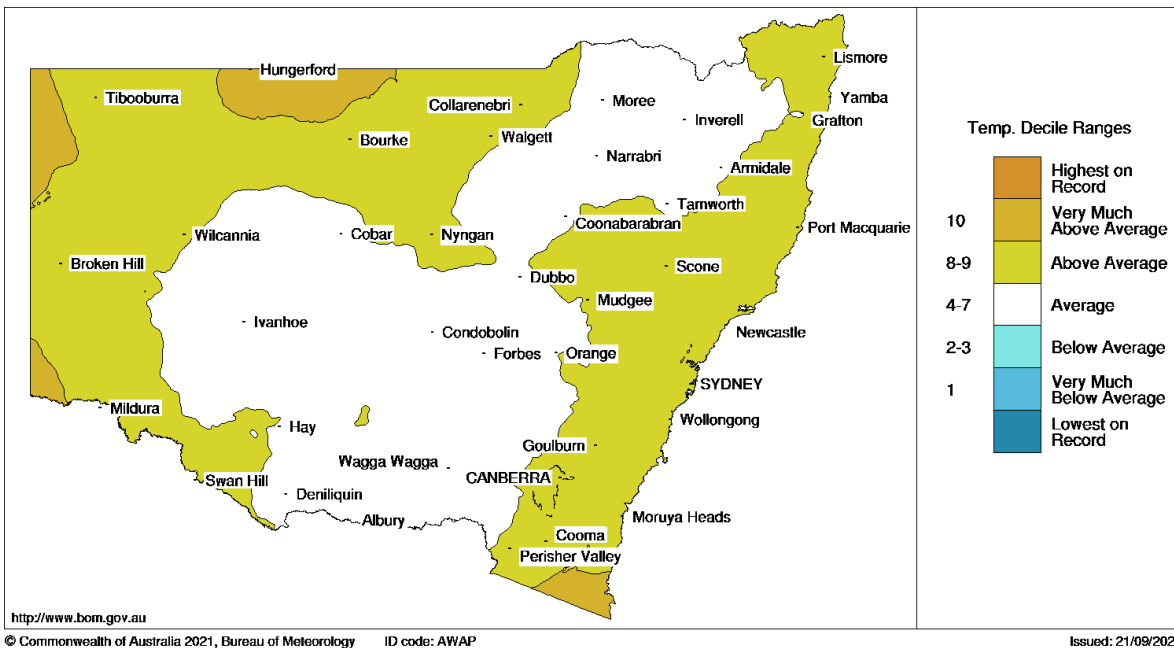


Figure 19 NSW maximum temperature deciles – winter 2021

⁹ Rainfall and temperature information is from the Bureau of Meteorology [New South Wales winter 2021 climate statement](#) (access October 2021) and [climate maps](#) (accessed October 2021).

Wind

Winds were predominantly from the north-west during winter 2021 (Figure 20), which is typical for this time of year. Regional wind speeds in winter 2021 were lower compared to winter 2020.

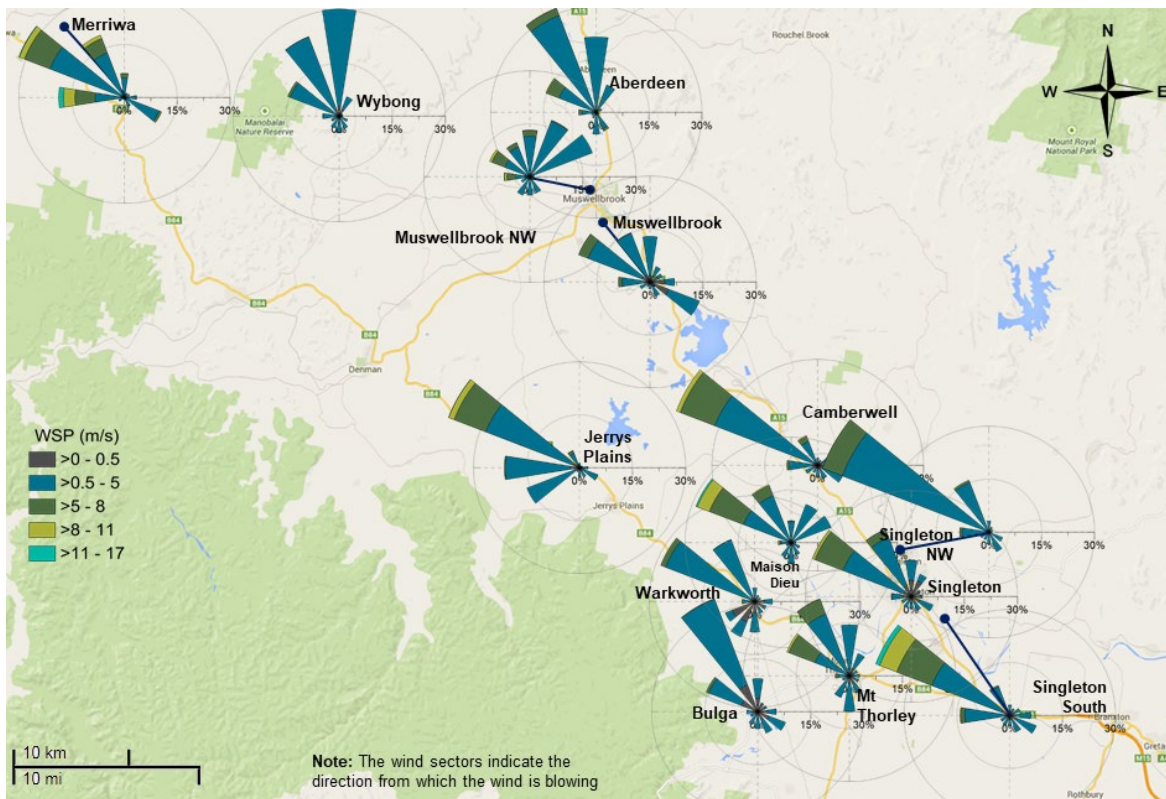


Figure 20 Wind rose map¹⁰ for the Upper Hunter region for winter 2021

¹⁰ Wind roses show the wind direction and speed at a location. The length of each bar around the circle show 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. The maximum online time that can be attained for NO₂ and SO₂ is 96% due to daily calibrations.

Table 2 Online performance (%) during winter 2021

| Station | Particles PM10 daily | Particles PM2.5 daily | Gases SO ₂ hourly | Gases NO ₂ hourly | Meteorology Wind hourly |
|-----------------|----------------------|-----------------------|------------------------------|------------------------------|-------------------------|
| Aberdeen | 100 | - | - | - | 100 |
| Bulga | 100 | - | - | - | 100 |
| Camberwell | 100 | 99 | - | - | 100 |
| Jerrys Plains | 99 | - | - | - | 100 |
| Maison Dieu | 96 | - | - | - | 95 |
| Merriwa | 88 | 87 | 87 | 87 | 93 |
| Mount Thorley | 100 | - | - | - | 100 |
| Muswellbrook | 99 | 99 | 95 | 95 | 99 |
| Muswellbrook NW | 100 | - | - | - | 100 |
| Singleton | 100 | 98 | 95 | 90 | 100 |
| Singleton NW | 100 | - | - | - | 99 |
| Singleton South | 98 | - | - | - | 95 |
| Warkworth | 96 | - | - | - | 100 |
| Wybong | 100 | - | - | - | 100 |

- = not monitored

The overall reduced online times were mainly due to:

- Merriwa PM10 – instrument fault (10 days) and scheduled maintenance (one day)
- Merriwa PM2.5 – instrument fault (11 days) and scheduled maintenance (one day)
- Merriwa gases - instrument fault (11 days) and scheduled maintenance (2 days)
- Merriwa wind – instrument fault (10 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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