

# CENTRAL OHIO AIR QUALITY END OF SEASON REPORT 2024

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## Introduction

The Mid-Ohio Regional Planning Commission (MORPC) is part of a 90-member network comprised of counties, cities, villages, townships, and regional organizations that issue daily air quality forecasts and notify the public when ozone and particle pollution levels are considered to be unhealthy for sensitive groups of people.

Fine particle (PM<sub>2.5</sub>) concentrations typically peak during overnight hours year-round, as strong temperature inversions form and trap pollutants near the surface. Particle pollution can also be transported over large distances, impacting the air quality in central Ohio if weather conditions are right. From March through October, ground-level ozone concentrations peak when warm temperatures and sunlight lead to favorable conditions for pollutant reactions and subsequent formation of ozone. These conditions can create unhealthy levels of air pollution and trigger Air Quality Alerts.

MORPC works with Sonoma Technology to deliver daily air quality forecasts and Air Quality Alerts throughout the year. This report provides an analysis of the 2023-2024 season.

### Summary

- The majority of days in central Ohio were in the Good Air Quality Index (AQI) category, but AQI levels were worse compared with the 2022-2023 season. For ozone, 72% of the days from March through October were in the Good AQI category, which was a 3% reduction from the last season. Abnormally warm and dry conditions aided ozone formation over the summer. For PM<sub>2.5</sub>, 65% of the days from November through October fell in the Good AQI category, which marked a 12% reduction from last season. This decrease in the percentage of days with Good AQI levels was partly due to the threshold for the Moderate category for PM<sub>2.5</sub> decreasing from 12 to 9 µg/m<sup>3</sup> on May 6, 2024, as the United States Environmental Protection Agency (U.S. EPA) updated the National Ambient Air Quality Standards.
- During the 2023-2024 season, only three Air Quality Alerts were issued, compared to 11 Air Quality Alerts for the Columbus region last season. The decrease in Air Quality Alerts was due to a large reduction in the impacts of wildfire smoke over Ohio compared with last season.
- Three days with Unhealthy for Sensitive Groups (USG) AQI levels for ozone were observed during the ozone forecast season (page 5). For PM<sub>2.5</sub>, there were two days with USG AQI levels (page 7).
- An extended period of stagnant weather conditions in October led to this season's highest AQI levels. A summary of the conditions on these days is provided on page 8.

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AIR QUALITY INDEX	Good	Moderate	Unhealthy For Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous		

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October 20

Fairgrounds

Aug. 27, Sept. 5

New Albany

June 13

New Albany

October 19

Fairgrounds

In central Ohio during the 2023-2024 season, air quality for  $PM_{2.5}$  was in the Good AQI category on 65% of days and the Moderate AQI category on 34% of days. USG AQI levels were recorded on two days, which accounted for less than 1% of the days this season. When compared to previous  $PM_{2.5}$  AQI levels included in MORPC's prior end-of-season reports, the percentage of Moderate AQI levels for  $PM_{2.5}$  increased because the U.S. EPA changed the lower threshold of the Moderate AQI category from 12 µg/m<sup>3</sup> to 9 µg/m<sup>3</sup>. Additionally, AQI levels were worse in the Columbus region this season compared with the previous two seasons, partially due to the Fairgrounds monitoring site coming back online. This site is located closer to more emissions sources compared with other  $PM_{2.5}$  monitors in central Ohio. As a result, observed AQI levels there are often higher than at other sites.

Air quality for ozone was in the Good AQI category on 72% of days, the Moderate AQI category on 27% of days, and the USG AQI category on 1% of days. Ozone AQI levels were similar to those in 2023 and worse than those in 2022. Three Air Quality Alerts (two next-day and one same-day) were issued during the season due to ozone.

Percentage of Days at Each AQI Category—PM<sub>2.5</sub> (November 2023-October 2024)



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Over the past 30 years, the number of high ozone days (above 70 ppb for the daily maximum 8-hr average) has declined across Ohio and neighboring states. This decline has been driven mostly by emissions reductions, with the most notable decrease in high ozone days occurring after 2012.

However, there are year-to-year variations in the number of high ozone days due to fluctuating weather conditions. The charts below indicate the number of high ozone days each year (orange bars) for several major cities throughout the region. The long-term, 30-yr averages are indicated with dashed blue lines.



**Columbus** 





Cincinnati



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## **Seasonal Weather Summary**

Temperature Anomalies (°F)



Weather patterns can have a strong impact on air quality in central Ohio. During the 2023-2024 forecast season, temperatures were above normal and precipitation was below normal.

Weather conditions over the summer matched the seasonal trends, with abovenormal temperatures and below-normal precipitation. The warm and dry conditions enhanced ozone development, with the bulk of Moderate-or-higher ozone AQI levels occurring during peak ozone season, from late spring through the summer. In addition, while wildfire smoke did not reach the levels observed during the summer of 2023, satellites detected thin smoke over central Ohio on numerous days. This aloft smoke occasionally mixed down to the surface and contributed to ozone precursors.

The peak months for PM<sub>2.5</sub> AQI levels this season were February, July, and October. Below-normal precipitation was a factor during each of these months as the dry conditions reduced atmospheric mixing and allowed pollutants to carry over from day to day. Additional factors leading to the elevated PM<sub>2.5</sub> AQI levels were regional smoke in July, and abnormally light winds in February and October.

## November 2023-October 2024 Versus 1991-2020 Average -19" -13" -7" -1 +5" +11" +17" Below Normal Above Normal

Precipitation Anomalies (inches)



Columbus, Ohio	Temperature departure from normal (°F)	Precipitation departure from normal (inches)	Moderate-or- higher PM <sub>2.5</sub> days	Moderate-or- higher ozone days
November	+0.6	-0.90	16	
December	+7.3	+0.12	12	
January	+2.1	+1.81	11	
February	+8.0	-1.18	17	
March	+4.9	-0.96	6	1
April	+3.8	+2.02	4	4
May	+4.8	+0.85	9	13
June	+2.3	-3.07	10	14
July	+1.5	-2.84	17	12
August	+2.2	-1.76	13	11
September	+4.5	-0.68	7	8
October	+3.3	-2.63	23	5

Red: warmer-than-normal temperatures. Blue: colder-than-normal temperatures. Green: wetter-than-normal conditions. Brown: drier-than-normal conditions.

Meteorological data courtesy of the National Weather Service, <u>w2.weather.gov/climate/index.php</u>.

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## **Ozone Summary and Highest AQI Days - 2024**

The table below shows observed ozone AQI levels on days with forecast AQI levels of 100 or higher or observed AQI levels of 90 or higher. Three Air Quality Alerts for ozone were issued during the year (June 16, June 20, and August 26). Brief descriptions of weather conditions on selected high-AQI-level days (indicated in bold in the table below) are provided on the following page.

Date	Next-Day Forecast	Same-Day Forecast	Observed Ozone AQI	Peak Monitor
5/20	90	90	90	New Albany
6/12	71	90	93	New Albany
6/13	87	90	101	New Albany
6/16	101	101	74	London
6/17	97	100	58	New Albany
6/20	101	101	71	Maple Canyon
6/21	84	97	100	London, New Albany
6/22	90	97	97	New Albany
8/24	87	100	93	New Albany
8/26	97	101	80	New Albany
8/27	93	100	105	New Albany
9/5	77	74	105	Delaware
9/20	87	77	97	London

Sonoma Technology meteorologists were generally able to predict the trend of observed air quality levels with their next-day forecasts. The chart below lists daily observed AQI levels (colored bars) and next-day forecasts (white line) for ozone. No bars are shown for days with missing observed AQI values.



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## **Highlighted Days—Ozone**

### August 27, 2024: 105 AQI

As a late-summer ridge of high pressure aloft crossed over the Buckeye State, warm air in the mid-levels of the atmosphere produced stable conditions in the Columbus region. As a result, clear skies and light winds allowed a temperature inversion to develop early in the day, confining pollutants near the surface. In addition, partly sunny skies and high temperatures in the upper-90s during the day enhanced ozone formation. Furthermore, light winds hindered dispersion, allowing regional smoke to linger over central Ohio, which contributed to ozone precursors. These conditions resulted in some of the highest AQI levels of the year, with ozone concentrations reaching the USG category at the New Albany monitor.

### September 5, 2024: **105 AQI**

Just over a week after the USG ozone AQI levels on August 27, another ridge of high pressure traversed the Ohio Valley. The ridge aloft limited atmospheric mixing over Ohio. In addition, despite forecast models predicting southeasterly winds strong enough to disperse pollutants, winds ended up lighter than anticipated. The persistent but light winds carried regional pollutants from the Columbus metro area toward the Delaware monitoring site. Furthermore, sunny and warm conditions combined with thin-density smoke to enhance ozone production. Therefore, despite a next-day ozone forecast in the Moderate AQI category, the daily observed ozone AQI level reached 105 at the Delaware site, while the rest of the central Ohio monitoring sites recorded Moderate ozone AQI levels for the day.



August 27: Mid-afternoon ozone concentrations (ppb). Light southwesterly winds transported regional pollutants, including smoke into central Ohio, resulting in hourly ozone concentrations in the mid-70s ppb in the Columbus region during the mid-afternoon hours. Image from AirNow-Tech.



September 5: Visible satellite imagery on September 5 shows sunny skies, which enhanced ozone formation across the Columbus region as a ridge of high pressure aloft traversed Ohio. Image from star.nesdis.noaa.gov.

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AIR QUALITY INDEX	Good	Moderate	Unhealthy For Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous
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The table below lists  $PM_{2.5}$  AQI levels on days with observed AQI levels at or above 75. No Air Quality Alerts were issued for  $PM_{2.5}$  this season. Brief descriptions of weather conditions on high-AQI days (in bold in the table below) are provided on the following page.

Date	Next-Day Forecast	Same-Day Forecast	Observed PM <sub>2.5</sub> AQI	Peak Monitor
11/5/23	59	68	84	Fairgrounds
12/15/23	87	84	75	Fairgrounds
2/22/24	46	68	77	Fairgrounds
10/17/24	50	73	84	Fairgrounds
10/18/24	68	96	99	Fairgrounds
10/19/24	94	97	117	Fairgrounds
10/20/24	84	99	115	Fairgrounds
10/21/24	94	99	94	Fairgrounds
10/22/24	88	79	75	Fairgrounds
10/29/24	62	75	77	Fairgrounds

Sonoma Technology meteorologists were generally able to predict the trend of observed air quality levels with their next-day forecasts. The chart below lists daily observed AQI levels (colored bars) and next-day forecasts (white line) for PM<sub>2.5</sub>. No bars are shown for days with missing observed AQI values.



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## Highlighted Days—PM<sub>2.5</sub>

#### November 5 and 6, 2023: 84, 72 AQI

As a surface ridge of high pressure moved across the Buckeye State on November 5, light northwesterly winds recirculated thindensity smoke into the Columbus region. The smoke emanated from widespread agricultural fires and wildfires across the southeastern United States that occurred over several days leading up to November 5. The smoke combined with other regional emissions to produce maximum hourly PM<sub>2.5</sub> concentrations up to 55 µg/m<sup>3</sup>. On November 6, winds shifted to the southwest ahead of an approaching cold front, allowing additional smoke to enter central Ohio. These conditions, combined with temperature inversions each morning, resulted in mid-Moderate AQI levels in central Ohio.

#### Oct. 19 and 20, 2024: 117, 115 AQI

A strong and slow-moving surface highpressure system remained nearly stationary over Ohio from October 15-22. Average wind speeds during this period were only 3 mph in the Columbus region, which allowed pollutants to accumulate and carry over from day to day. In addition, the calm conditions combined with clear skies to produce the strongest morning temperature inversions of October, confining pollutants near the surface. Furthermore, this period of stagnant weather occurred during the annual All American Quarter Horse Congress near the Fairgrounds PM<sub>2.5</sub> monitor, with campfires and dust likely contributing to elevated particle levels. As a result, the highest AQI levels of the year occurred on October 19 and 20, with USG AQI values recorded at the Fairgrounds monitor on both days.



Hot spots and fire detections (red triangles) and smoke (gray areas) detected by satellite on November 2, 2023. The map shows widespread agricultural burning and wildfires across the southeastern United States three days prior to this event. Back-trajectory analysis (green - 10 meter, blue - 500 meter, 72-hour back-trajectories) from November 5 indicates smoke from these fires contributed to particle levels in the Columbus region. *Image courtesy: AirNow-Tech.* 



**October 19**: Surface weather map valid at 2:00 p.m. A strong high-pressure system was analyzed across Ohio, which caused light winds and limited dispersion. *Image courtesy: wpc.ncep.noaa.gov.* 

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Sonoma Technology provides same-day, next-day, and extended AQI daily forecasts for central Ohio. A statistical summary of same-day and next-day forecasting performance at the Good-to-Moderate AQI threshold (51 AQI) is shown in the charts on the right and described below.

There were 242 next-day ozone forecasts issued in the Good or Moderate AQI categories, with 197 being correct at the Good-to-Moderate threshold, leading to a Percent Correct (PC) of 81%. Of the 68 days with observed Moderate-or-higher ozone AQI levels, 51 were correctly predicted by the next-day forecast. These numbers resulted in a Probability of Detection (POD) of 75%, compared with 84% in the 2023 summer ozone forecast season. The False Alarm Rate (FAR) for the nextday ozone forecasts was 35%, compared with 41% in the 2023 summer ozone forecast season. The average bias for next-day ozone forecasts was +2.1 ppb compared with +2.7 ppb during the 2023 season.

There were 364 next-day PM<sub>2.5</sub> forecasts issued in the Good or Moderate AQI categories, with 300 being correct at the Good-to-Moderate threshold. These numbers resulted in a PC of 82%. Of the 127 days with observed Moderate-or-higher PM<sub>2.5</sub> AQI levels, 90 were correctly predicted in the next-day forecast, resulting in a POD of 71%. The FAR for PM<sub>2.5</sub> next-day forecasts during the 2023-2024 forecast season was 24%, compared with 48% during the 2022-2023 forecast season. On average, next-day PM<sub>2.5</sub> forecasts had no bias this season.

The table below lists the forecast statistics for the Columbus region for the 2023-2024 season.

#### Good-to-Moderate Ozone Forecast Statistics, March–Oct. 2024



Good-to-Moderate PM<sub>2.5</sub> Forecast Statistics, Nov. 2023–Oct. 2024



Pollutant	Good-to-Moderate Threshold										
		Sa	Same Day				Next Day				
	Percent Correct	Probability of Detection	False Alarm Rate	Bias	MAE	Percent Correct	Probability of Detection	False Alarm Rate	Bias	MAE	
PM <sub>2.5</sub>	92	87	11	+0.3 μg/m <sup>3</sup>	$1.5 \mu\text{g/m}^3$	82	71	24	$0.0 \ \mu g/m^3$	$2.6  \mu g/m^3$	
Ozone	90	88	22	+1.3 ppb	3.9 ppb	81	75	35	+2.1 ppb	5.4 ppb	

#### Statistical Definitions

**Percent Correct:** The percentage of forecasts that correctly predicted whether observations would be above or below a certain threshold.

**Probability of Detection:** The ability to correctly predict high-pollution events at or above a certain threshold.

False Alarm Rate: The percentage of cases for which a forecast of high pollution was incorrect at or above a certain threshold.

**Bias:** The average difference between forecast and observed concentrations. A positive bias indicates that the forecast concentrations tended to be higher than observed concentrations. A negative bias indicates that the forecast concentrations tended to be lower than observed.

**Mean Absolute Error (MAE):** Indicates the average absolute difference between forecast and observed concentrations. A low MAE suggests that forecasts tend to be fairly accurate.

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