



MID-OHIO REGIONAL
MORPC
PLANNING COMMISSION

CENTRAL OHIO AIR QUALITY END OF SEASON REPORT 2023

Mid-Ohio Regional Planning Commission
111 Liberty Street, Suite 100
Columbus, OH 43215

614.228.2663
morpc.org
info@morpc.org



Central Ohio End of Season Report | Nov. 2022–Oct. 2023

The Mid-Ohio Regional Planning Commission (MORPC) is part of a nearly 90-member network of agencies from across the country that issues daily air quality forecasts and notifies the public when ozone and particle pollution levels are considered to be unhealthy for sensitive groups of people.

Fine particle concentrations (PM_{2.5}) 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 2022-2023 season.

Summary

- The majority of days in Central Ohio were in the Good Air Quality Index (AQI) category, but AQI levels were worse compared to 2021-22 season. For ozone, 75 percent of summer days were in the Good AQI category, which was a 9 percent reduction from the last season. For PM_{2.5}, 85 percent of all days were in the Good AQI category, which marked an 11 percent reduction from last season.
- During the 2022-23 season, 11 Air Quality Alerts were issued for the Columbus region. Nine alerts were issued a day in advance of a high-pollution event, and two were issued the day of a high-pollution event. Of the 11 total Air Quality Alerts issued this season, PM_{2.5} was the primary pollutant on 9 occasions.
- Four days with Unhealthy for Sensitive Groups (USG) AQI levels for ozone were observed during the ozone forecast season, which was the most recorded since 2016 (Page 3). For PM_{2.5}, there were two days with USG AQI levels and three days with Unhealthy AQI levels, ending a stretch of 12 consecutive summer seasons (March–October) without USG or higher PM_{2.5} AQI levels.
- Long-range transport of wildfire smoke caused PM_{2.5} to be the primary pollutant on the four days with the highest AQI levels of the season. Two of the season's three days with Unhealthy PM_{2.5} AQI levels occurred from June 28–29. A summary of the conditions on these days is provided on page 8.



Highest AQI Days
Nov. 2022–Oct. 2023

179 June 28
PM_{2.5} New Albany

171 June 29
PM_{2.5} New Albany

153 July 17
PM_{2.5} Maple Canyon

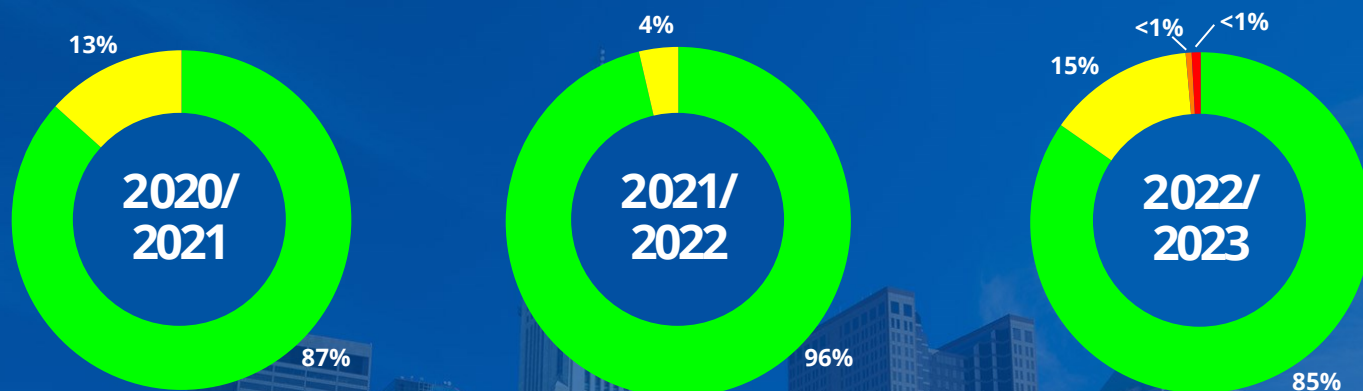
144 June 27
PM_{2.5} New Albany

Central Ohio End of Season Report | Nov. 2022–Oct. 2023

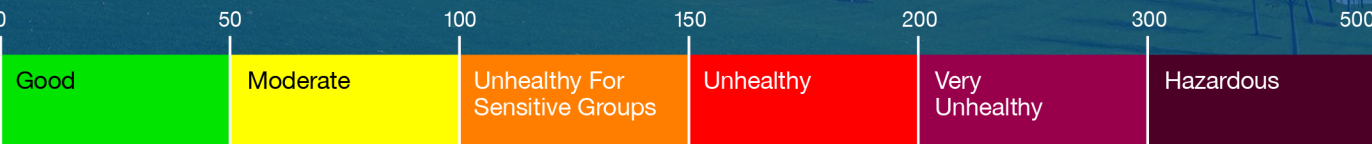
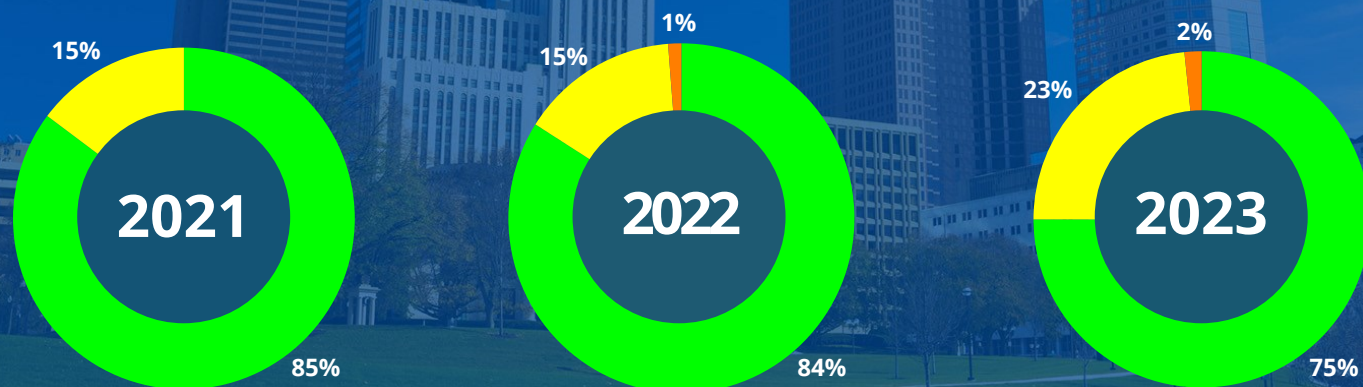
In Central Ohio during the 2022-2023 season, air quality for PM_{2.5} was in the Good AQI category for 85 percent of all days and the Moderate AQI category for a little less than 15 percent of all days. Two days with USG AQI levels and three days with Unhealthy AQI levels were recorded during the season, which accounted for less than 1 percent of days in each AQI category. PM_{2.5} levels were worse than the previous two seasons, due largely to smoke transport into the region. For the first time since August 3, 2010, PM_{2.5} AQI levels reached the USG or higher category, ending a stretch of 12 consecutive summers (March-October) with AQI values below the USG threshold (101 AQI). Nine same- or next-day Air Quality Alerts were issued during the 2022-2023 season for PM_{2.5} due to long-range transport of wildfire smoke.

Air quality for ozone was in the Good AQI category on 75 percent of all days, Moderate AQI category on 23 percent of all days, and USG AQI category on 2 percent of all days. Ozone levels were worse than the previous two seasons. The four days with USG ozone AQI levels in summer 2023 were the most recorded in the Columbus region since 2016. Two Air Quality Alerts (one same-day and one next-day) were issued during the season due to ozone.

Percentage of Days at Each AQI Category—PM_{2.5} (November 2022-October 2023)



Percentage of Days at Each AQI Category—Summertime Ozone (March-October 2023)

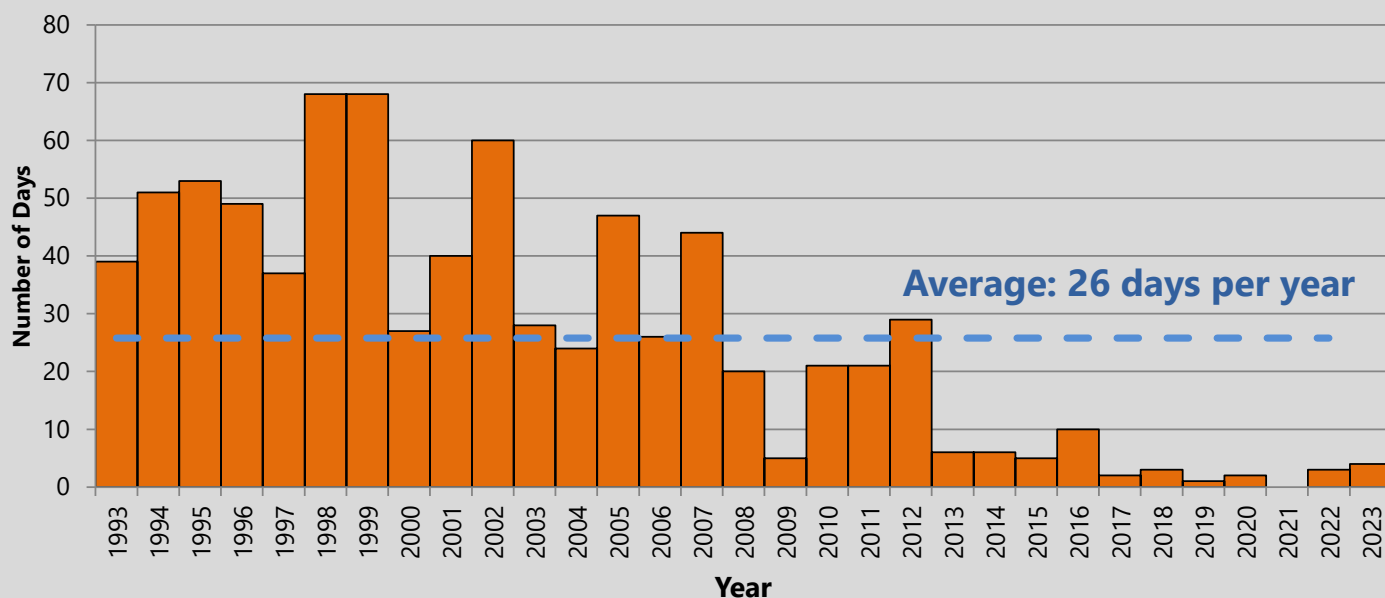


REGIONAL COUNTS OF HIGH OZONE

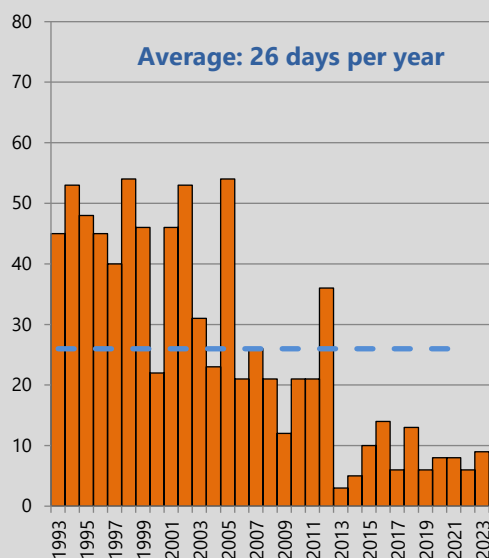
Over the past 30 years, the number of high ozone days (above 70 ppb for the daily maximum 8-hr average) has declined across Ohio and neighboring states. This decline has been driven mostly by emissions reductions, with the most notable decrease in high ozone days occurring after 2012.

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-year averages are indicated with dashed blue lines.

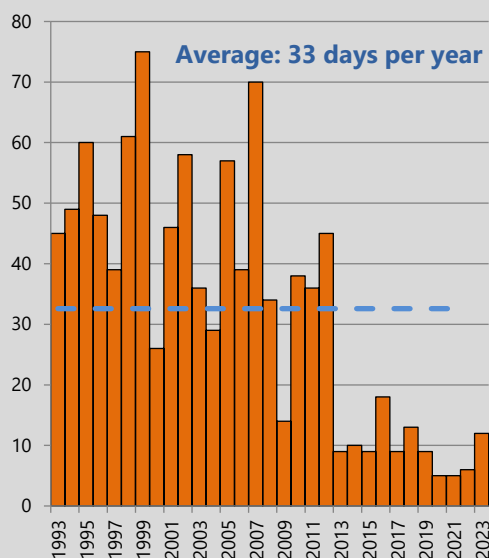
Columbus



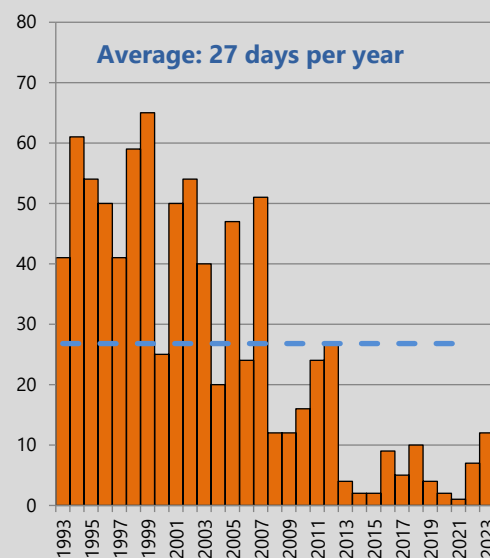
Cleveland



Cincinnati

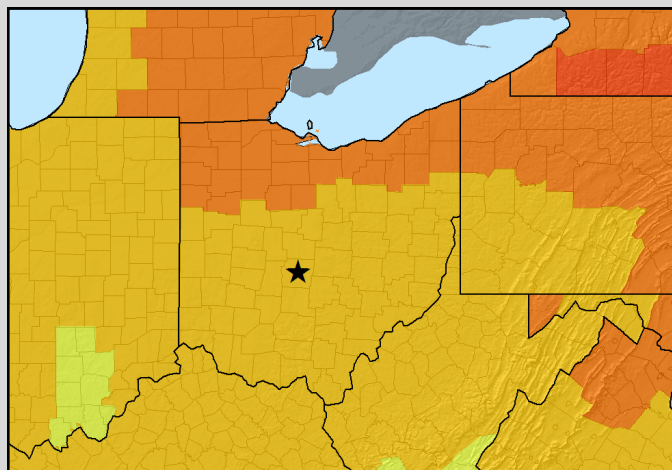
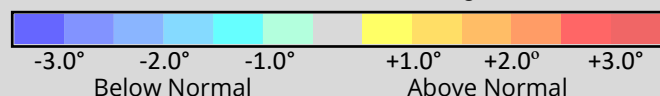


Indianapolis

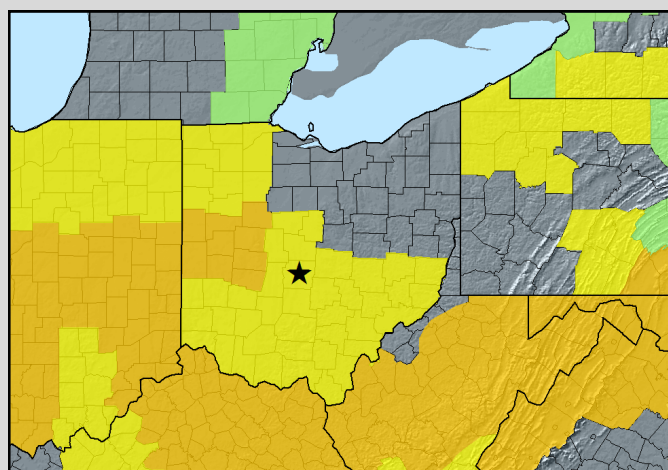


SEASONAL WEATHER SUMMARY

Temperature Anomalies (°F)
November 2022-October 2023
Versus 1991-2020 Average



Precipitation Anomalies (inches)
November 2022-October 2023
Versus 1991-2020 Average



Weather patterns can have a strong impact on air quality in Central Ohio. During the 2022-2023 forecast season, temperatures were above normal and precipitation was below normal.

For PM_{2.5}, 5 of the 6 days with Moderate AQI levels during the winter season occurred in November and December. On most of these days, light winds hindered dispersion, while fog and high humidity enhanced particle production. Cold temperatures in the 20s and 30s, combined with the aforementioned light winds, produced inversions on some days that trapped pollutants at the surface. Temperatures in January and February were much warmer than normal, resulting in weaker inversions and only one day with Moderate PM_{2.5} AQI levels.

During the summer, long-range transport of smoke from numerous wildfires in Canada impacted air quality in the Columbus region. Between June and August, 43 days with Moderate or higher PM_{2.5} AQI values were recorded. This accounted for 80% of the season's Moderate or higher PM_{2.5} AQI values. The presence of smoke also enhanced ozone formation, leading to 14 days with Moderate or higher ozone AQI values for both June and July.

Columbus, Ohio	Temperature departure from normal (°F)	Precipitation departure from normal (inches)	Moderate or higher PM _{2.5} days	Moderate or higher ozone days
November	+1.7	-0.45	2	--
December	+0.1	-1.11	3	--
January	+7.8	+1.16	1	--
February	+8.6	-0.79	0	--
March	+0.8	+1.60	0	0
April	+0.7	-0.68	1	10
May	-0.7	-0.32	1	10
June	-2.6	-0.62	17	14
July	+0.3	+1.73	12	14
August	-1.0	+0.74	14	6
Septem-	+1.7	-2.37	3	4
October	+2.4	+0.21	0	3

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, w2.weather.gov/climate/index.php.

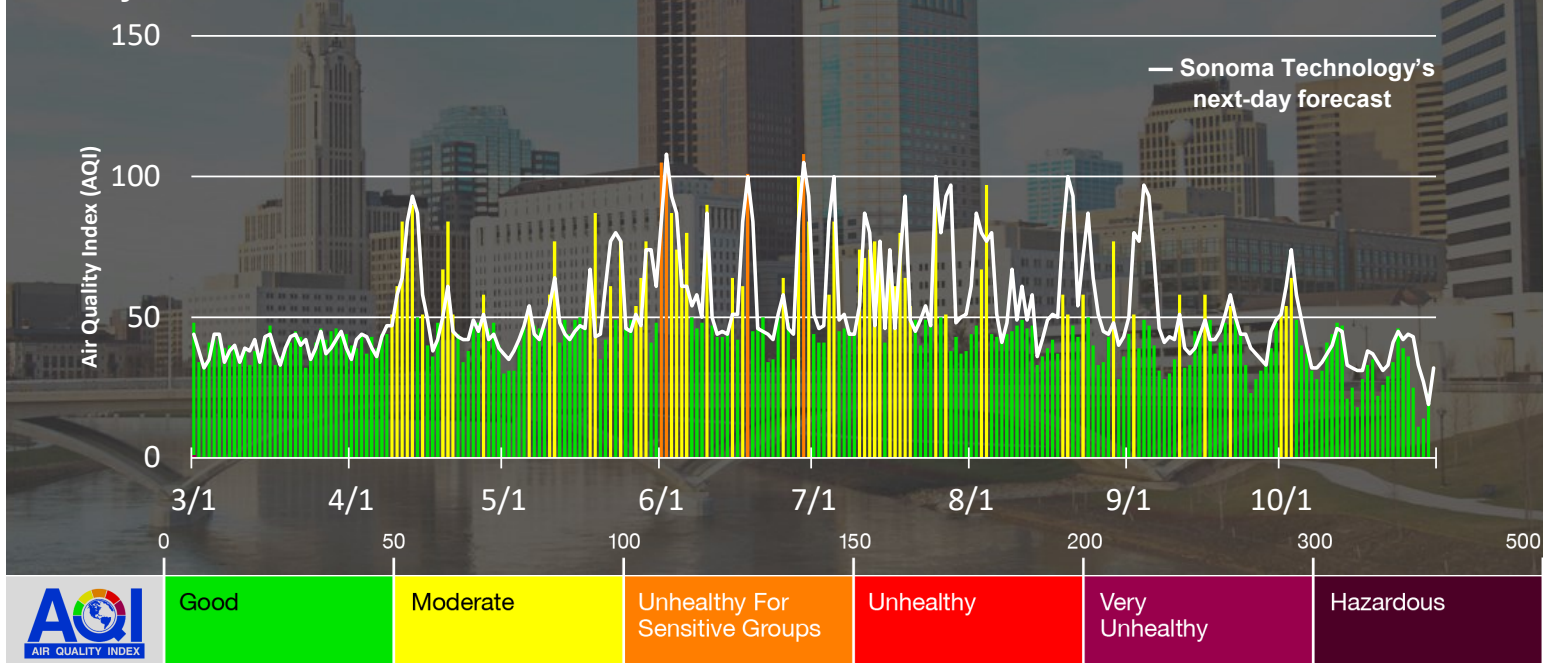
OZONE SUMMARY AND HIGHEST AQI DAYS - 2023

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. Two Air Quality Alerts for ozone were issued during the year (June 1 and 2), which were verified by observations on both occasions. Brief descriptions of weather conditions on selected high-AQI level days (shown in bold in the table below) are provided on the following page.

Date	Next-Day Forecast	Same-Day Forecast	Observed Ozone AQI	Peak Monitor
4/13/23	93	90	90	New Albany
6/1/23	84	101	105	London
6/2/23	108	108	105	London
6/10/23	87	100	90	London
6/18/23	100	100	101	Maple Canyon
6/28/23	84	90	100	New Albany
6/29/23	105	105	108	Delaware
7/25/23	100	90	93	New Albany
8/4/23	77	97	97	Reynoldsburg

Sonoma Technology meteorologists were generally able to capture the trend of observed air quality levels with their next-day forecasts. The chart below shows daily observed AQI levels (colored bars) and next-day forecasts (white line) for ozone.

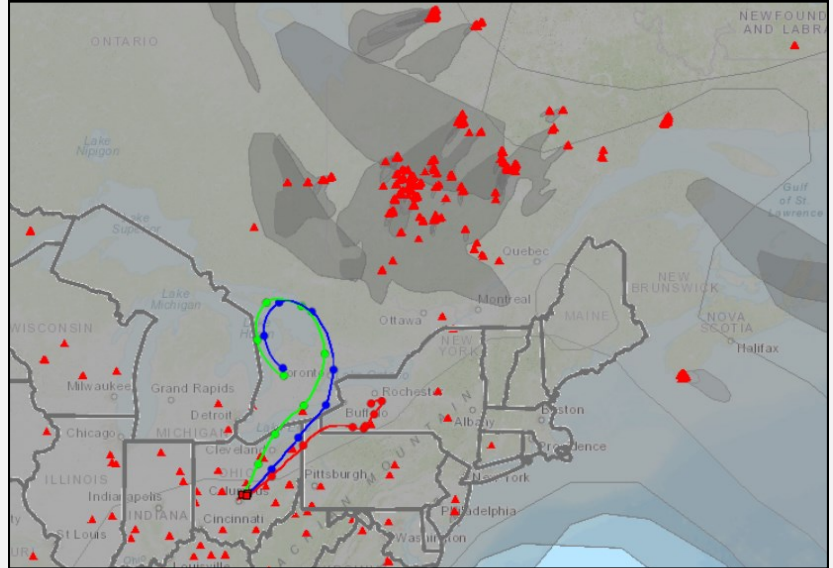
Daily Maximum Ozone AQI Values and Forecasts March–October 2023



HIGHLIGHTED DAYS—OZONE

June 1-2, 2023: 105 AQI

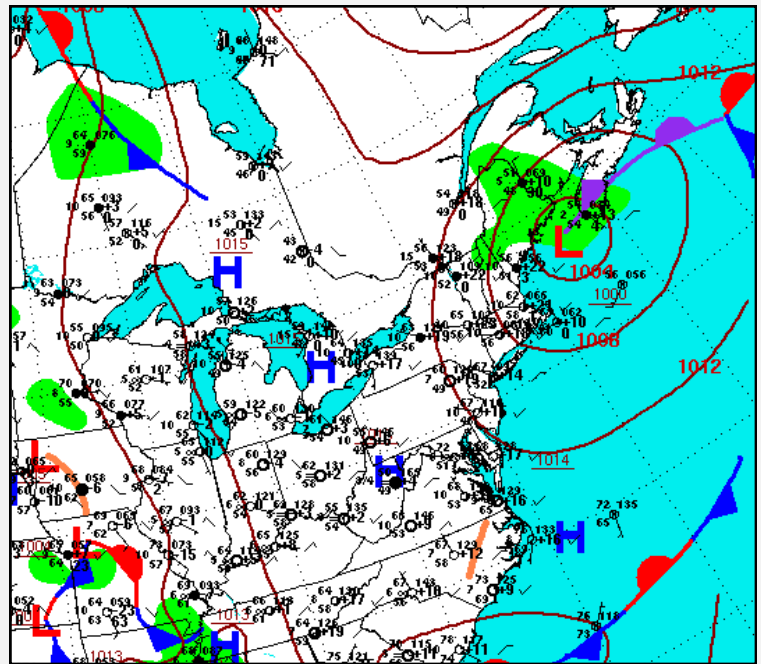
The two ozone Air Quality Alerts issued this season were on June 1 and 2. During this period, upper-level high pressure over the Great Lakes inhibited vertical mixing over the Columbus region. At the surface, high pressure north of Ohio produced light northerly to northeasterly winds. These winds reduced dispersion and gradually transported smoke from Canadian wildfires into Central Ohio, which enhanced ozone formation. Furthermore, high temperatures in the upper-80s to low-90s each day and mostly sunny skies promoted ozone development. These conditions, combined with day-to-day carryover, led to a daily AQI value at the London monitoring site of 105 on both days, which is in the USG



June 2: NOAA Hazard Mapping System fire detections (red triangles), NOAA smoke analysis (grey contours), and 48-hr back trajectories (green - 50 m above ground level [AGL], blue - 500 m AGL, red - 1,500 m AGL) ending at 11 p.m. on June 2. Northeasterly winds carried smoke from several eastern Canadian wildfires into the Columbus area, which enhanced ozone development. *Image from AirNow-Tech.*

June 18, 2023: 101 AQI

Canadian wildfire smoke also influenced ozone formation on June 18. As a surface low pressure system departed New England and high pressure resided over eastern Ohio, calm-to-light easterly to southeasterly winds limited dispersion. These winds allowed smoke and associated ozone precursors from the previous days to linger across the Columbus region, enhancing ozone production. Additionally, mostly sunny skies and high temperatures in the low-80s supported ozone development. As a result, the daily AQI value at the Maple Canyon monitoring site reached 101.



June 18: Surface high pressure east of Columbus, combined with a departing surface low off the Maine coast, led to calm-to-light winds in central Ohio. These winds allowed Canadian wildfire smoke from the previous days to linger in the Columbus region, which enhanced ozone production. *Image from wpc.ncep.noaa.gov.*



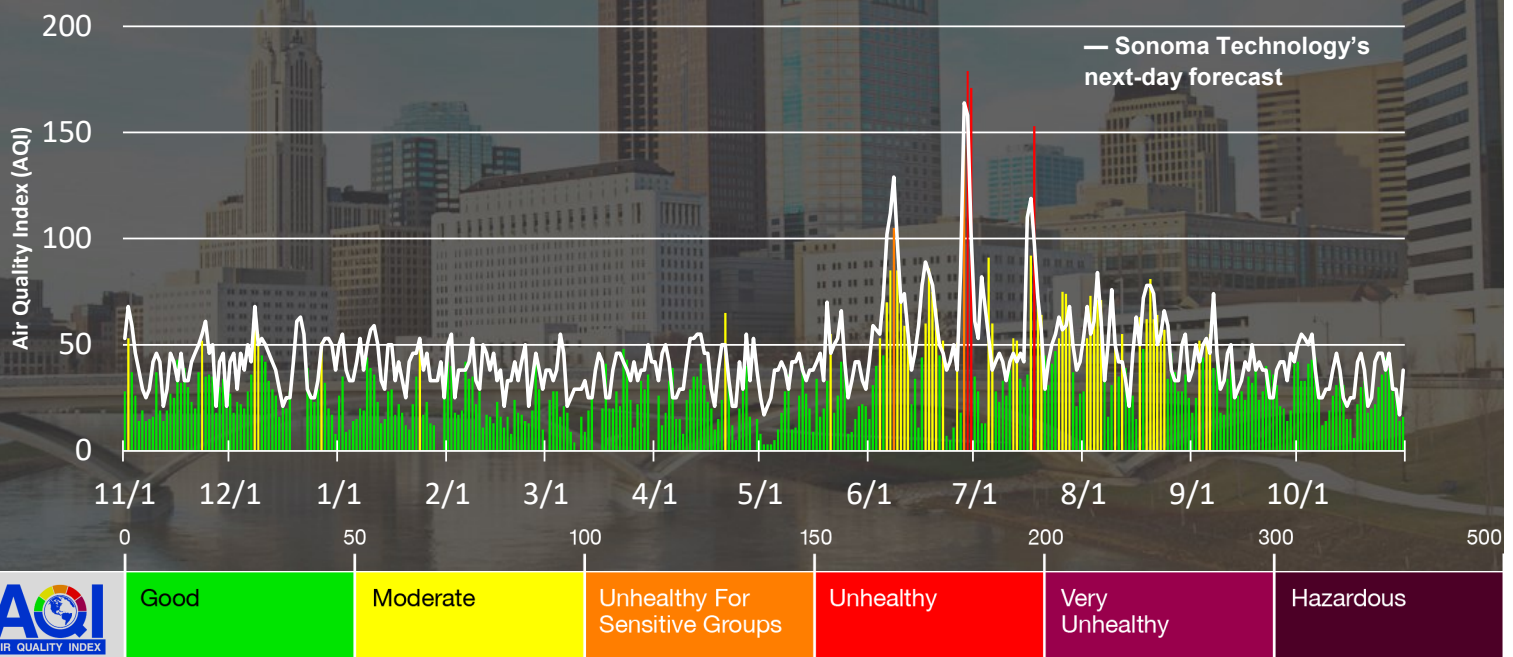
PM_{2.5} SUMMARY AND HIGHEST AQI DAYS — 2022-2023

The table below shows PM_{2.5} AQI levels on days with next-day forecast AQI levels above 100 or observed AQI levels above 84. Nine Air Quality Alerts were issued for PM_{2.5}, which were verified by observations on five occasions. 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 PM2.5 AQI	Peak Monitor
6/6/23	102	102	85	New Albany
6/7/23	112	144	105	New Albany
6/8/23	129	105	85	New Albany
6/17/23	89	97	86	New Albany
6/27/23	84	112	144	New Albany
6/28/23	164	187	179	New Albany
6/29/23	158	174	171	New Albany
6/30/23	102	67	35	New Albany
7/4/23	68	55	91	New Albany
7/16/23	110	105	92	Maple Canyon
7/17/23	119	137	153	Maple Canyon

Sonoma Technology meteorologists were generally able to capture the trend of observed air quality levels with their next-day forecasts. The chart below shows daily observed AQI levels (colored bars) and next-day forecasts (white line) for PM_{2.5}. No bars are shown for days with missing observed AQI values.

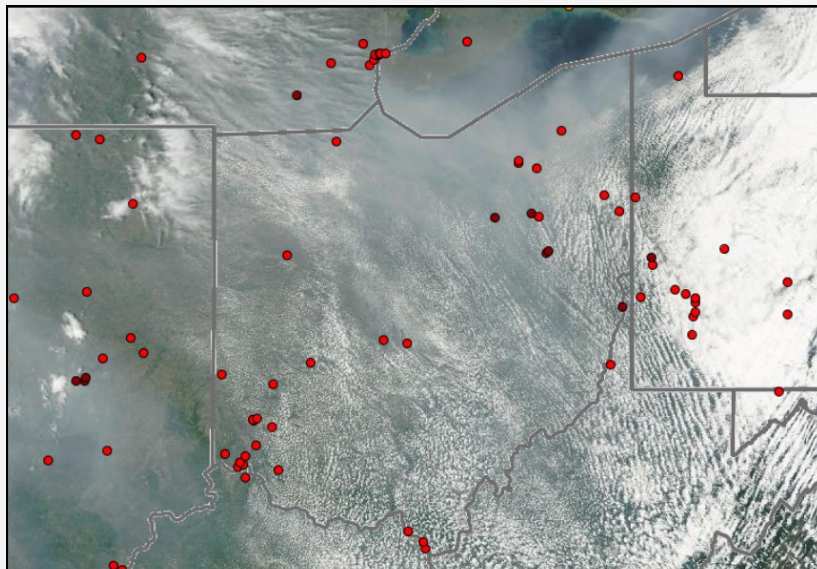
Daily Maximum PM_{2.5} AQI Values and Forecasts November 2022–October 2023



HIGHLIGHTED DAYS—PM_{2.5}

June 28-29, 2023: **179, 171 AQI**

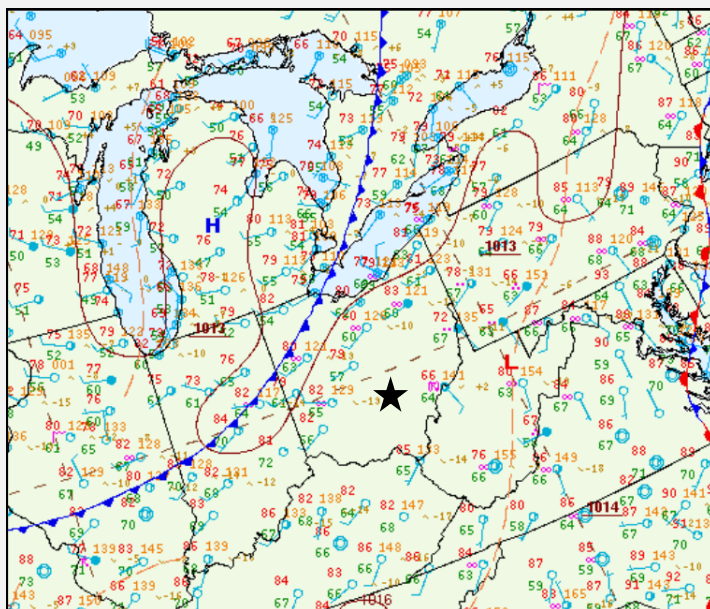
The season's two days with the highest PM_{2.5} AQI values were recorded June 28-29. This event was well predicted by Sonoma Technology meteorologists, who issued Air Quality Alerts in advance of the high pollution levels. On June 28, surface high pressure over the Great Lakes produced light westerly to northwesterly winds, which carried dense smoke from Canadian wildfires into Central Ohio. The following day, as the surface high departed the Buckeye State, winds shifted to southerly to southeasterly. These winds recirculated dense smoke into the Columbus region, keeping particle concentrations high. As a result, both days recorded a daily AQI value in the Unhealthy category, including a season-high AQI of 179 on June 28. This day marked the highest daily PM_{2.5} AQI level in the Columbus region since October 14, 1999 (208 AQI). It was also Central Ohio's first Unhealthy PM_{2.5} AQI day since August 14, 2003.



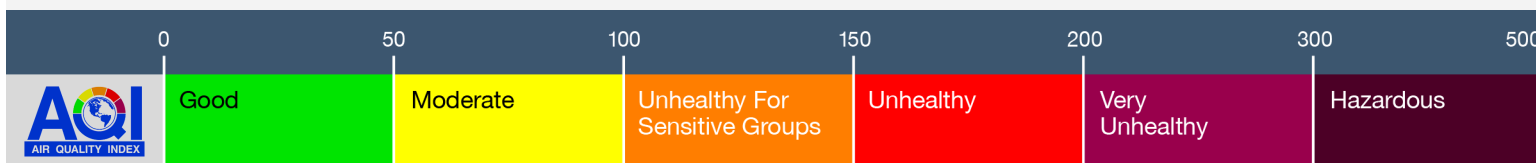
June 28: MODIS-Terra satellite imagery and 24-hour observed PM_{2.5} AQI levels. Hazy areas depict dense smoke from Canadian wildfires over Ohio. This smoke resulted in AQI levels ranging from Unhealthy (red dots) to Very Unhealthy (dark purple dots) across Ohio, Indiana, Michigan, and Pennsylvania. *Image courtesy: AirNow-Tech.*

July 17, 2023: **153 AQI**

Unhealthy PM_{2.5} AQI levels returned to the Columbus region in mid-July. On July 16, a cold front slowly moved toward the Buckeye State, aiding vertical mixing. However, westerly to southwesterly winds ahead of the frontal boundary carried Canadian wildfire smoke into the Columbus region by the afternoon of July 16, with the densest smoke arriving on July 17. Furthermore, wind speeds on July 17 averaged less than 10 mph, hindering dispersion of smoke from the prior day. As a result, the daily AQI value on July 17 reached 153 at the Maple Canyon monitoring site.



July 17: Surface weather map valid at 5 p.m. A cold front across central Indiana and northwestern Ohio produced westerly to southwesterly winds, which transported dense wildfire smoke into the Columbus region. *Image courtesy: wpc.ncep.noaa.gov.*



FORECAST STATISTICS

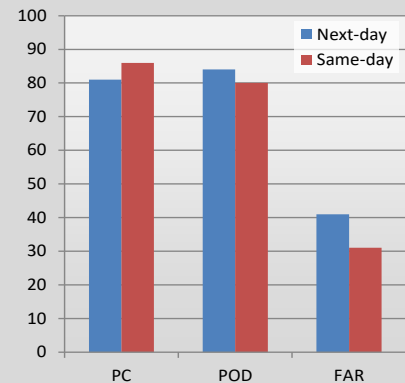
Sonoma Technology provides same-day, next-day, and extended AQI daily forecasts for Central Ohio. A statistical summary of same-day and next-day forecasting performance at the Good-to-Moderate AQI threshold (51 AQI) is shown in the charts on the right and described below.

There were 240 next-day ozone forecasts issued in the Good or Moderate AQI categories, with 194 being correct at the Good-to-Moderate threshold, leading to a Percent Correct (PC) of 81%. Of the 61 days with observed Moderate or higher ozone AQI levels, 51 were correctly predicted by the next-day forecast. This resulted in a Probability of Detection (POD) of 84%, compared to 72% in the 2022 Summer ozone forecast season. The False Alarm Rate (FAR) for the next-day ozone forecasts was 41%, compared to 52% in the 2022 Summer ozone forecast season. The average bias for next-day ozone forecasts was +2.7 ppb.

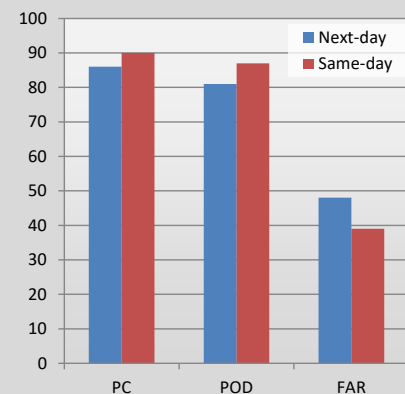
There were 351 next-day PM_{2.5} forecasts issued in the Good or Moderate AQI categories, with 301 being correct at the Good-to-Moderate threshold. This resulted in a PC of 86%. Of the 54 days with observed Moderate or higher PM_{2.5} AQI levels, 44 were correctly predicted in the next-day forecast, resulting in a POD of 81%. The FAR for PM_{2.5} next-day forecasts during the 2022-23 forecast season was 48%, compared to 79% during the 2021-22 forecast season and was the lowest next-day PM_{2.5} FAR since the 2014-15 forecast season. On average, the bias for next-day PM_{2.5} forecasts was +3.2 µg/m³.

The table below shows the forecast statistics for the Columbus region.

**Good-to-Moderate Ozone
Forecast Statistics, March–Oct. 2023**



**Good-to-Moderate PM_{2.5} Forecast
Statistics, Nov. 2022–Oct. 2023**



Pollutant	Good-to-Moderate Threshold									
	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 _{2.5}	90	87	39	+2.5	3.0 µg/m ³	86	81	48	+3.2 µg/m ³	4.2 µg/m ³
Ozone	86	80	31	+1.5 ppb	4.3 ppb	81	84	41	+2.7 ppb	5.8 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.

FOR MORE INFORMATION VISIT:

www.morpc.org/airquality

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MAURO DIAZ-HERNANDEZ

Air Quality and Sustainability Program Coordinator

Mid-Ohio Regional Planning Commission

mdiazhernandez@morpc.org

T: 614.233.4130 | **C:** 740.249.5783



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