MID-OHIO REGIONAL
MORPC
PLANNING COMMISSION

CENTRAL OHIO AIR QUALITY END OF SEASON REPORT 2022

Mid-Ohio Regional Planning Commission
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Highest AQI Days
Nov. 2021–Oct. 2022

143 Ozone	June 21 New Albany	108 Ozone	June 25 New Albany
105 Ozone	June 29 London	100 Ozone	June 22 New Albany

Central Ohio End of Season Report | Nov. 2021– Oct. 2022

The Mid-Ohio Regional Commission (MORPC) is the regional council for more than 80 local governments and community partners. MORPC 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 also can 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 2021-2022 season.

Summary

- Overall, the majority of days in Central Ohio were in the Good Air Quality Index (AQI) category. For ozone, 84 percent of summer days were in the Good AQI category. For $PM_{2.5}$, 96 percent of all days were in the Good AQI category.
- Three days with Unhealthy for Sensitive Groups (USG) AQI levels for ozone were observed during the ozone forecast season, which was the most recorded since 2018 (Page three).
- On June 21, the daily ozone AQI value reached 143, which was the highest ozone day in the Columbus region since 2012. A summary of the conditions present on this day are provided on page six.
- Despite some month-to-month variation, temperatures and precipitation were above average in the Columbus region over the past year.

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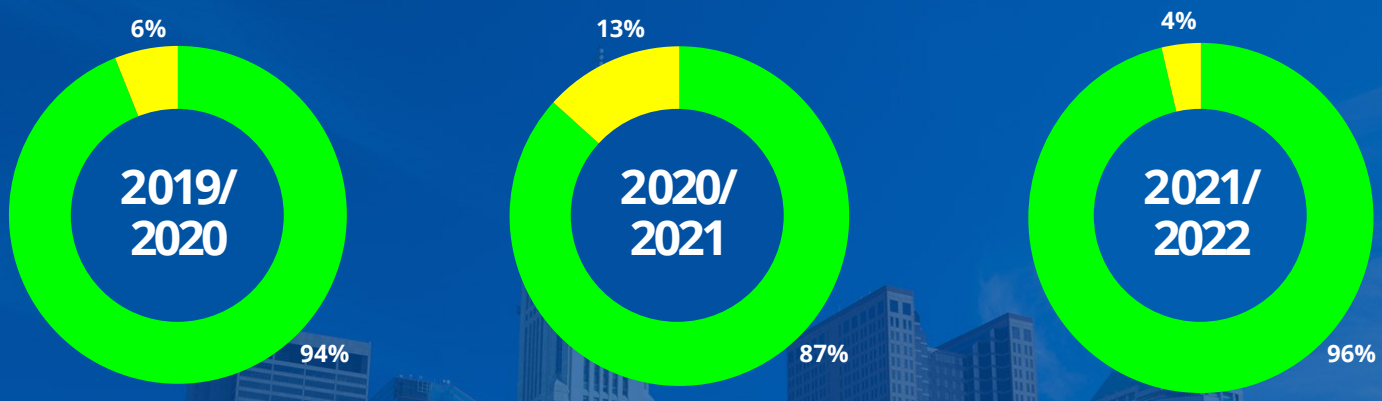
Highest AQI Days Nov. 2021–Oct. 2022	143 Ozone	June 21 New Albany	108 Ozone	June 25 New Albany	105 Ozone	June 29 London	100 Ozone	June 22 New Albany

Central Ohio End of Season Report | Nov. 2021– Oct. 2022

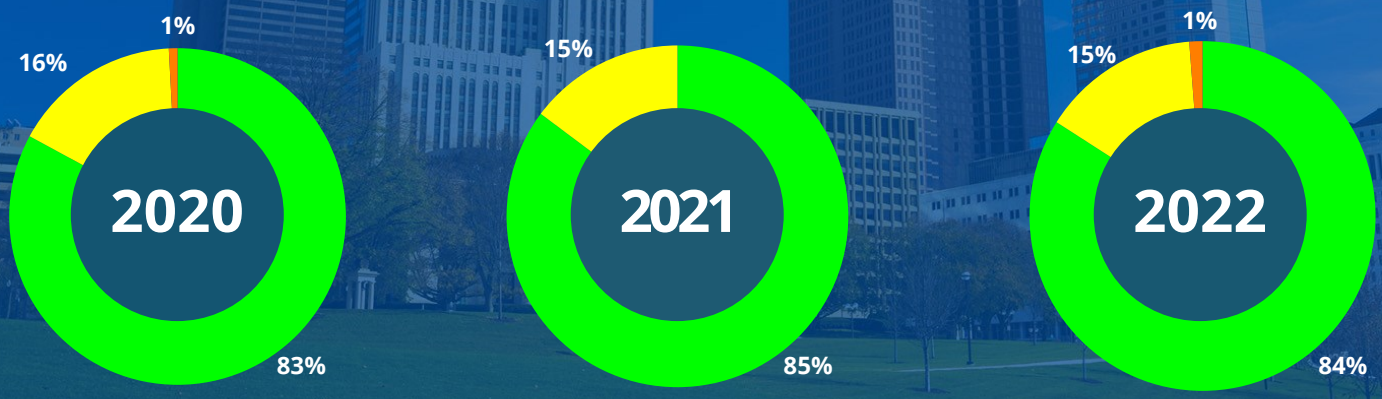
In central Ohio during the 2021-2022 season, air quality for $PM_{2.5}$ was in the Good AQI category for 96 percent of all days, and the Moderate AQI category for 4 percent of all days. The 2021-2022 period marks the 12th consecutive season without USG $PM_{2.5}$ levels. **The last USG $PM_{2.5}$ day was recorded on August 3, 2010.**

Air quality for ozone was in the Good AQI category on 84 percent of days, Moderate AQI category on 15 percent of days, and USG AQI category on 1 percent of days. Four Air Quality Alerts were issued during the summer 2022 ozone forecasting season. The three USG ozone days in summer 2022 were the most recorded in the Columbus region in four years.

Percentage of Days at Each AQI Category—$PM_{2.5}$ (November 2021-October 2022)



Percentage of Days at Each AQI Category—Summertime Ozone (March-October 2022)



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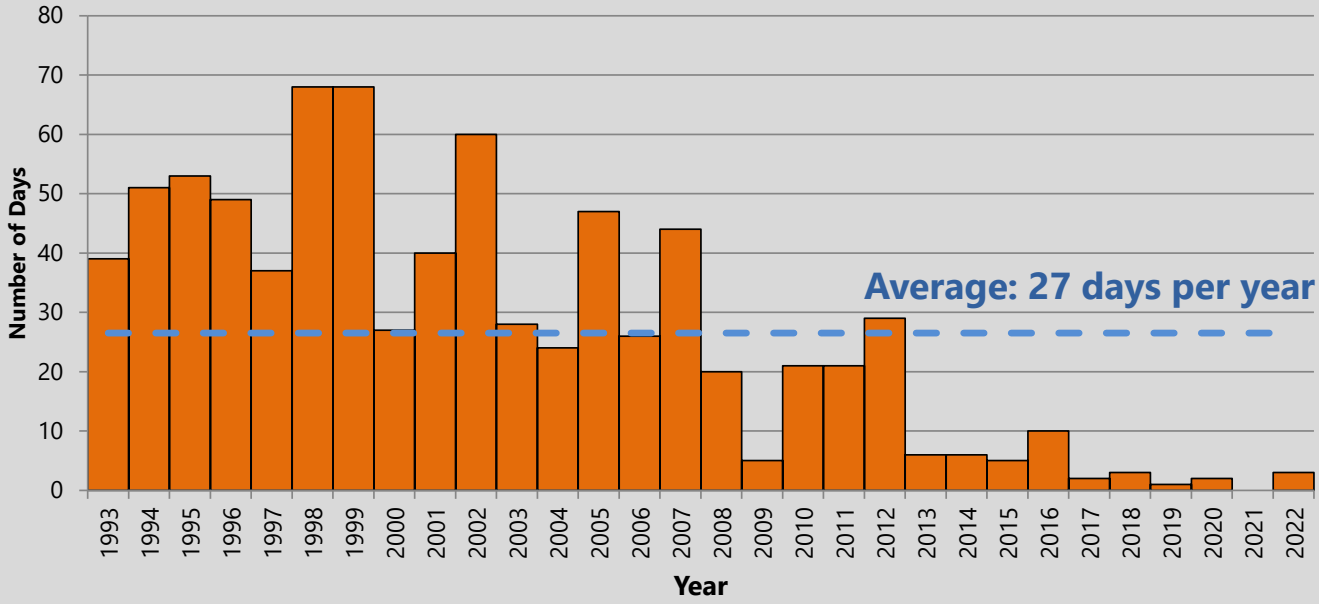
Regional Counts of High Ozone Days

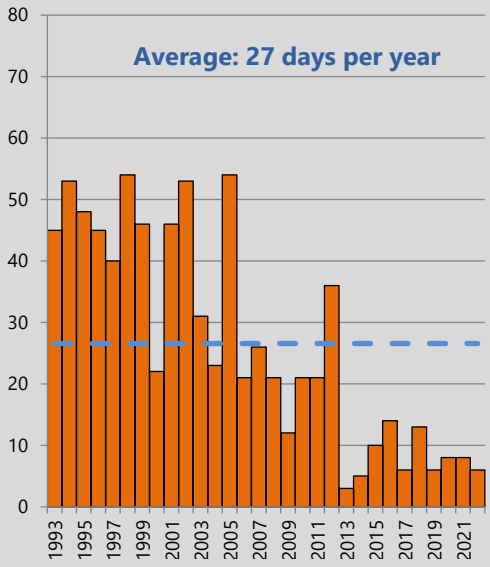
Over the past 30 years, the number of high ozone days (above 70 ppb for the daily maximum eight-hour average) has declined across Ohio and neighboring states. This decline has been driven mostly by emissions reductions, with the most notable decrease in high ozone days occurring after 2012.

However, there are variations year to year due to 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 the dashed blue lines.

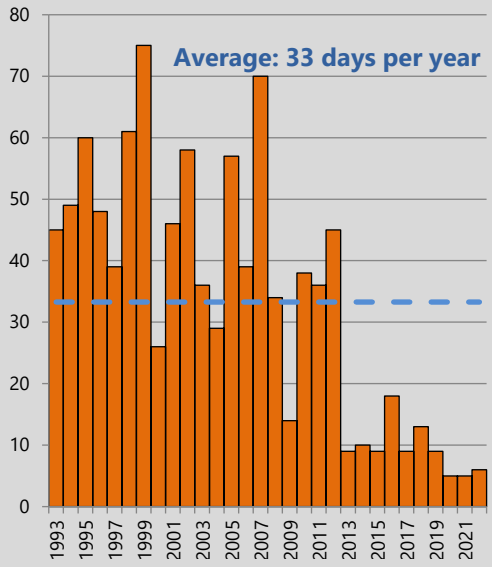
Columbus



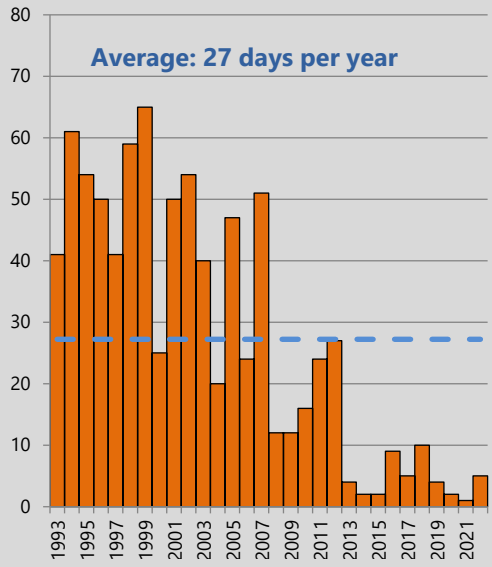
Cleveland



Cincinnati



Indianapolis



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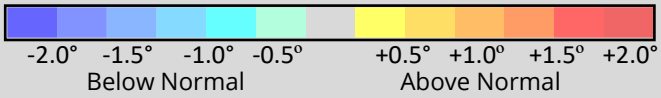
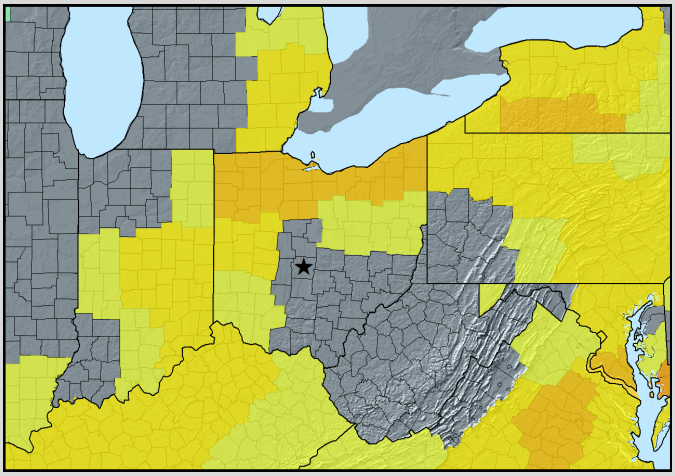
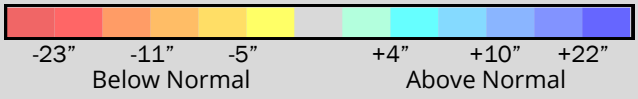
Seasonal Weather Summary

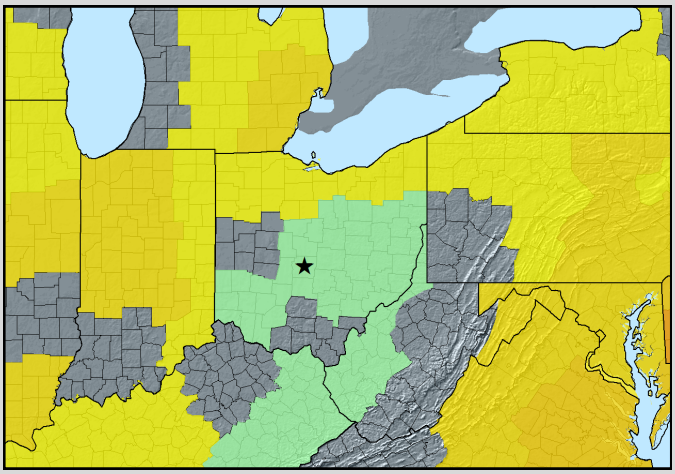
Temperature Anomalies (°F)
November 2021-October 2022
Versus 1991-2020 Average





Precipitation Anomalies (inches)
November 2021-October 2022
Versus 1991-2020 Average





Weather patterns can have a strong impact on air quality in Central Ohio. During the 2021-2022 forecast season, temperatures and precipitation were above normal.

For $PM_{2.5}$, the majority of the forecast season featured Good AQI levels. Six of the winter season's 10 Moderate $PM_{2.5}$ days occurred in late January and early February. On most days, upper-level high pressure reduced atmospheric mixing, while light surface winds hindered dispersion. Furthermore, many days had morning temperatures in the single digits and teens. Along with clear skies and light winds, these cold temperatures resulted in strong inversions, trapping pollutants near the ground.

The ozone forecast season runs from March to October. During this period in 2022, 39 moderate or higher AQI days for ozone were recorded. June featured 15 moderate or higher ozone AQI days, which was the most of any month during the ozone forecasting season. June temperatures were above normal, with partly to mostly sunny skies on most days that supported ozone formation. Additionally, 11 of the 15 days with moderate or higher ozone AQI levels in June featured long-range transport of smoke, which enhanced ozone production and further increased AQI levels.

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	-1.8	-0.89	1	--
December	+7.3	+1.38	0	--
January	-4.3	-0.39	4	--
February	0.0	+3.71	5	--
March	+3.7	-1.33	1	2
April	-2.7	-0.53	0	1
May	+2.9	+4.70	0	3
June	+1.2	-1.83	2	15
July	+1.0	+3.26	0	8
August	-0.1	-0.52	0	2
September	+0.1	0.00	0	4
October	-1.1	-2.30	0	4

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.

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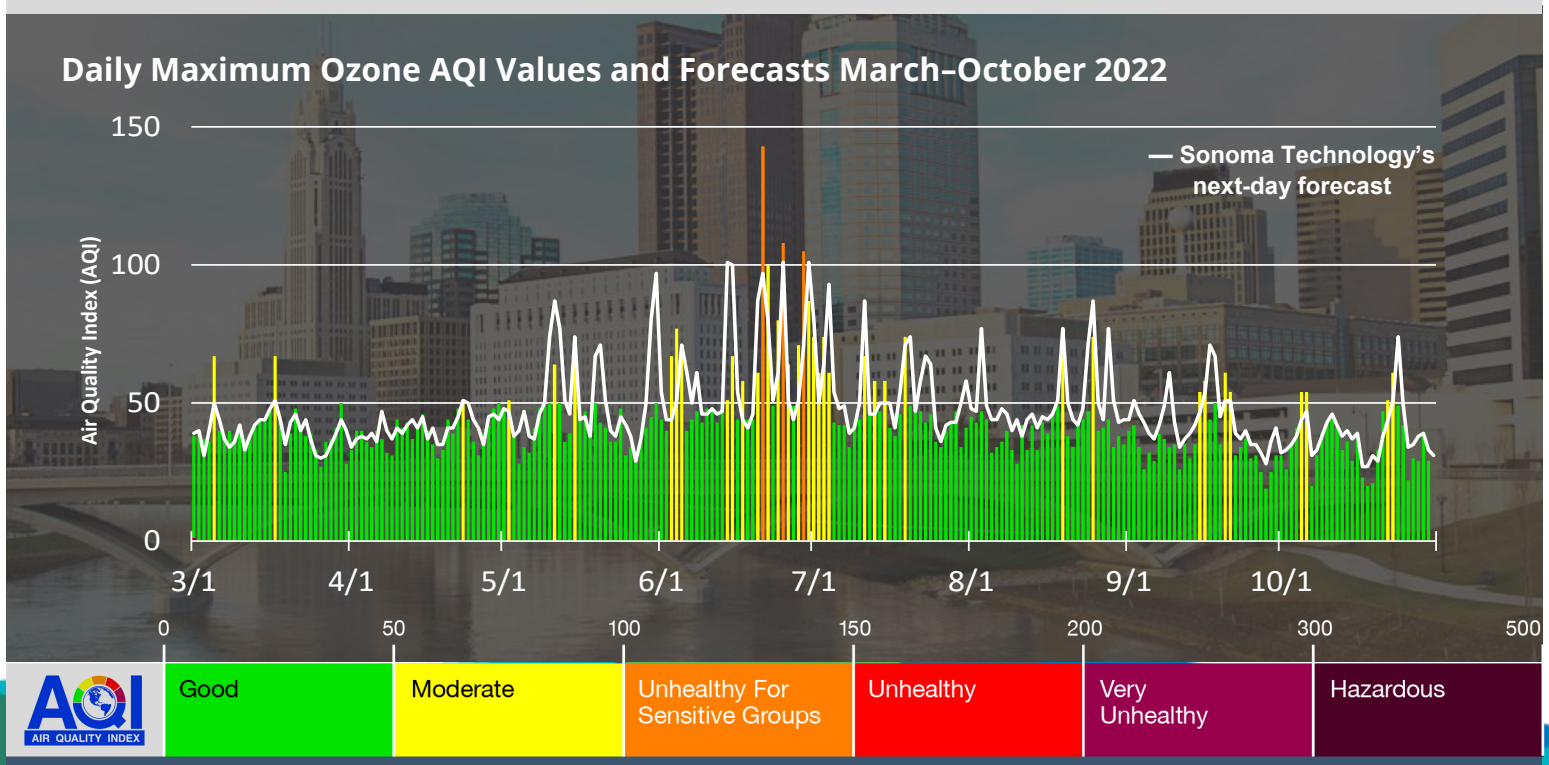
Ozone Summary and Highest AQI Days - 2022

The table below shows the forecast and observed ozone AQI levels on days with forecast AQI levels at or above 100 or observed AQI levels above 80. Four Air Quality Alerts were issued during the year. 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
6/14/22	**101**	**101**	**51**	**New Albany**
6/21/22	**97**	**101**	**143**	**New Albany**
6/22/22	80	90	100	New Albany
6/25/22	101	105	108	New Albany
6/29/22	71	97	105	Heath
6/30/22	101	101	87	New Albany

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.



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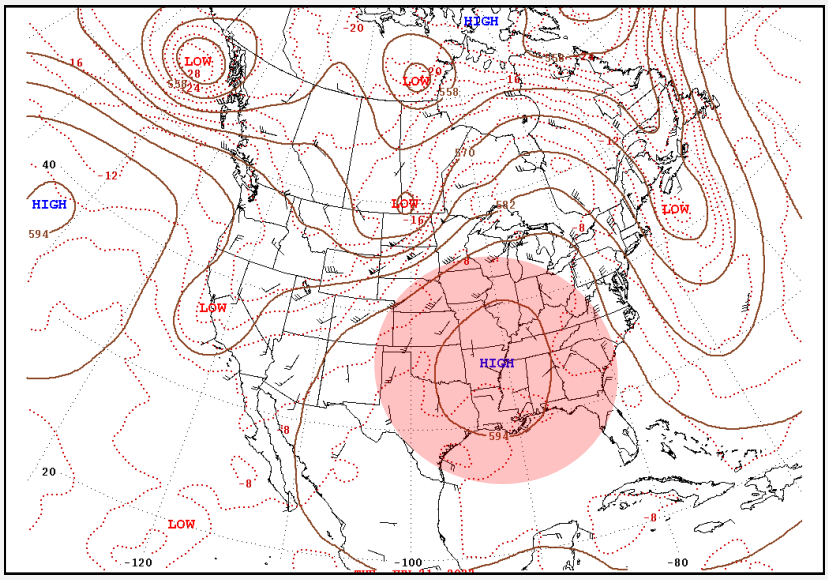
Highlighted Days—Ozone

June 21, 2022: 143 AQI

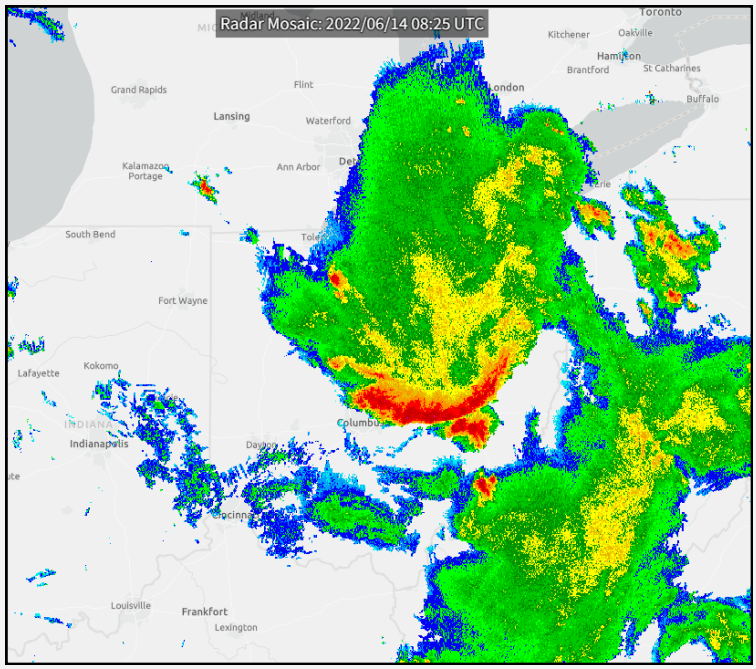
The summer's highest ozone AQI day occurred on June 21. On this day, strong upper-level high pressure over the southern Mississippi River Valley reduced atmospheric mixing and generated sunny skies with temperatures in the mid-90s, promoting ozone formation. At the surface, west-southwesterly winds carried smoke from fires across the southwestern and south-central U.S. into the Columbus region, which enhanced ozone production. These conditions, combined with pollutant carryover from the previous day, led to an observed AQI value at the New Albany monitoring site of 143, which is the highest ozone AQI recorded in the Columbus region since July 2, 2012.



June 21: 500-mb map valid 8 a.m., showing an upper-level ridge of high pressure over the southern Mississippi River Valley (red shading). This upper-level pattern limited atmospheric mixing downwind in Central Ohio. *Image from www.wpc.ncep.noaa.gov.*

June 14, 2022: 51 AQI

Due to the potential for USG ozone levels, Sonoma Technology meteorologists issued an Air Quality Alert for June 14. On this day, upper-level high pressure west of the state generated partly sunny skies, while high temperatures in the low-90s promoted ozone formation. Furthermore, smoke from seasonal fires in the Mississippi River Valley was carried into the Columbus region, which enhanced ozone production. Despite these conditions, strong thunderstorms moved across central Ohio during the early morning hours, aiding mixing and reducing ozone precursors, which limited ozone development. As a result, the observed AQI value on this day reached 51, which is in the low-Moderate category.



June 14: Doppler radar imagery, valid 4:25 a.m. Strong morning thunderstorms moving across Central Ohio aided mixing and dispersed ozone precursors, which led to lower-than-forecast ozone AQI levels later in the day. *Image from www.ncei.noaa.gov/maps/radar/.*

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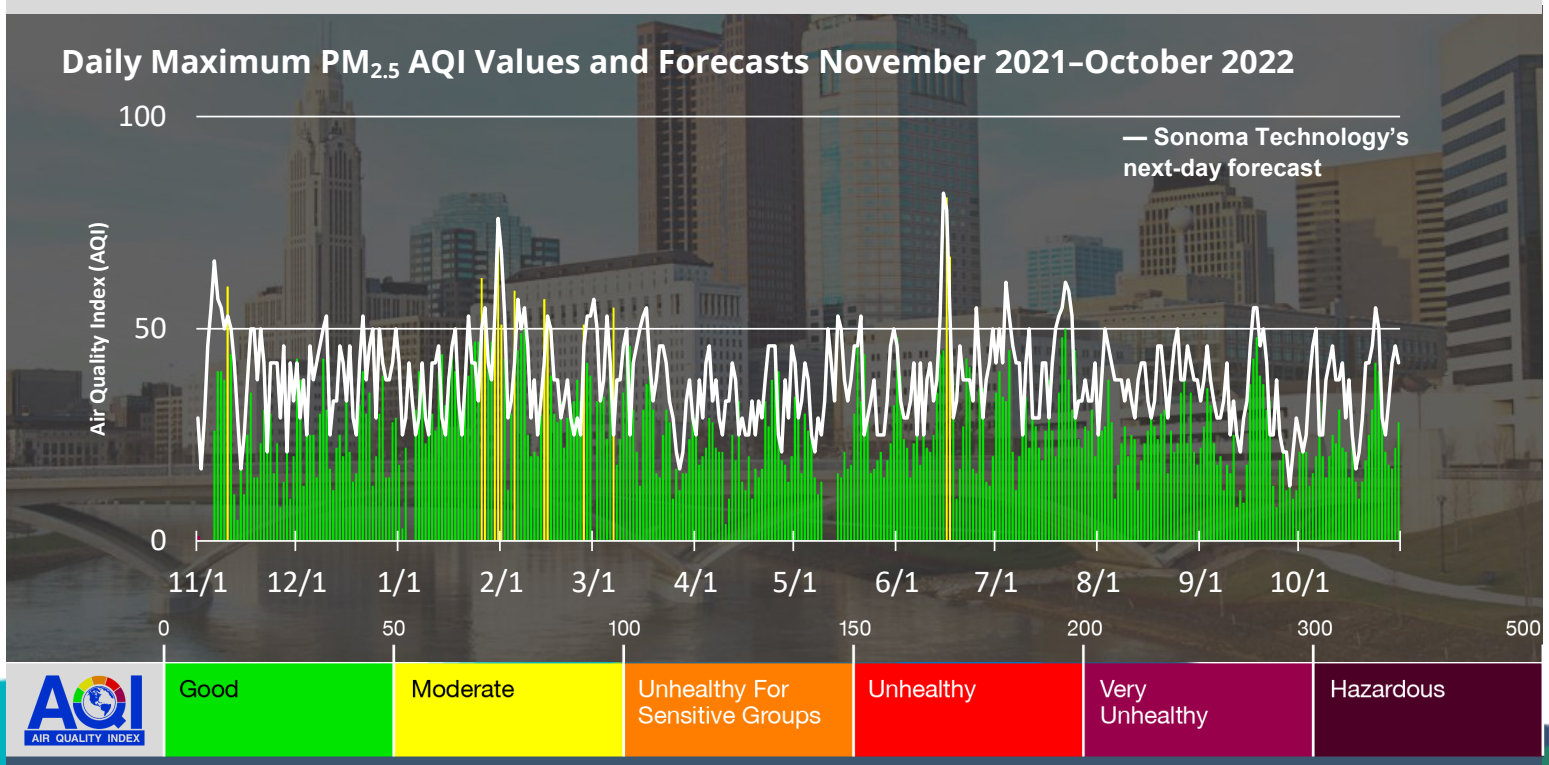
$PM_{2.5}$ Summary and Highest AQI Days—2021-2022

The table below shows $PM_{2.5}$ AQI levels on days with next-day forecast AQI levels above 75 or observed AQI levels of 65 or higher at the New Albany monitoring site. No Air Quality Alerts were issued for $PM_{2.5}$, and no days with an AQI level above 100 were observed. Brief descriptions of weather conditions on days with high AQI levels are provided on the following page.

Date	Next-Day Forecast	Same-Day Forecast	Observed $PM_{2.5}$ AQI
1/31/22	76	76	72
6/15/22	82	99	81
6/16/22	78	74	67

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.



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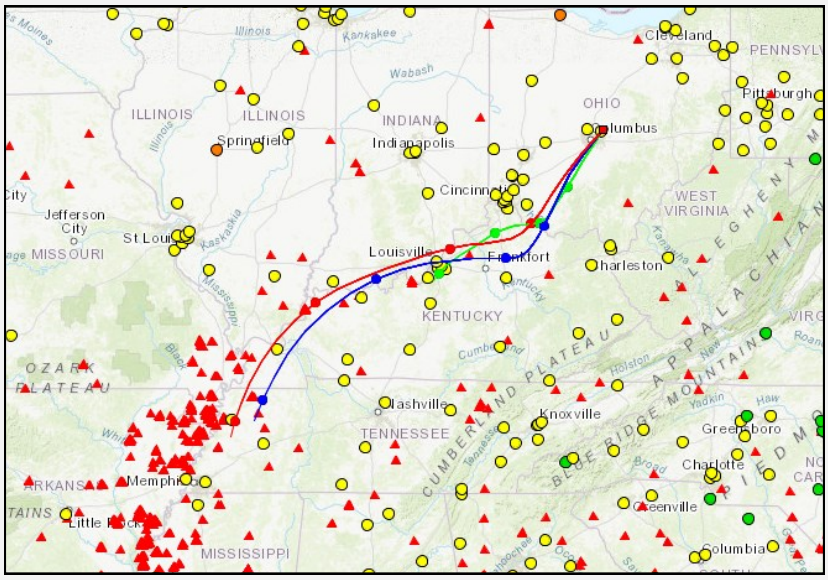
Highlighted Days—$PM_{2.5}$

June 15-16, 2022: 81, 67 AQI

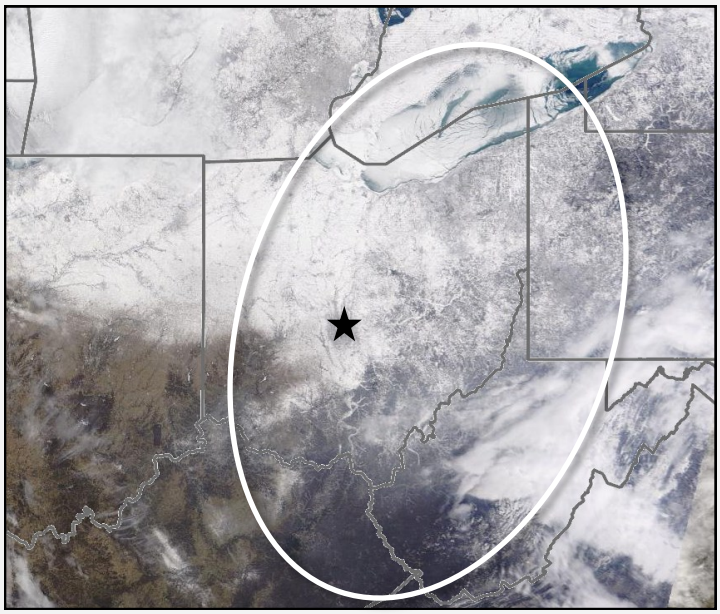
Two of the year's highest $PM_{2.5}$ AQI days were recorded on June 15 and 16. During this two-day period, surface high pressure east of the Buckeye state produced light to moderate southwesterly winds. These winds carried smoke from fires in the Mississippi River Valley into the Columbus region, increasing particle concentrations. Furthermore, high pressure aloft over the Ohio Valley reduced mixing, allowing pollutants to accumulate. These conditions, combined with carryover from the previous days, led to an observed AQI level of 81 on June 15, which was the highest $PM_{2.5}$ AQI value of the year. Southwesterly winds persisted on June 16, allowing additional smoke to reach Central Ohio, resulting in an observed AQI level of 67.



June 15: 24-hour observed $PM_{2.5}$ AQI levels (dots), NOAA HMS satellite fire detections (red triangles), and back trajectory analysis (green - 100 m, blue - 500 m, red - 1000 m above ground level) ending at 11 p.m. Transport of smoke from seasonal fires in the Mississippi River Valley increased particle levels in the Columbus region. *Image courtesy: AirNow-Tech.*

January 31, 2022: 72 AQI

The day with the highest AQI level of the winter season occurred on January 31. Morning low temperatures in the teens generated a strong inversion, trapping pollutants near the ground. In the afternoon, sunny skies and temperatures in the mid-30s promoted snow melt across Central Ohio. Due to melting snow, relative humidity increased, and the added moisture enhanced particle production, producing haze over central and eastern Ohio. Furthermore, surface high pressure passing over the region reduced dispersion, allowing pollutants to accumulate. These conditions, combined with pollutant carryover from the previous day, yielded an observed AQI level of 72, which is in the mid-moderate category.



January 31: MODIS Terra satellite image, indicating haze (circled in white) across Central and eastern Ohio. This haze was a byproduct of snow melt, with the increase in low-level moisture enhancing particle production across the region. *Image courtesy: AirNow-Tech.*

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Forecast Statistics

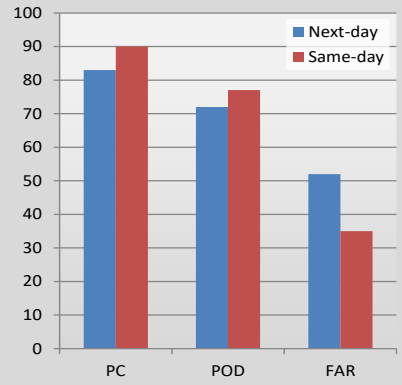
Sonoma Technology provides same-day, next-day, and extended AQI daily forecasts for Central Ohio. A statistical summary of same-day and next-day forecasting performance at the good-to-moderate AQI threshold (51 AQI) is shown in the charts on the right and described below.

Of the 245 next-day ozone forecasts issued, 203 were correct at the good-to-moderate threshold, resulting in a Percent Correct (PC) of 83 percent. Of the 39 days with observed, moderate or higher ozone AQI levels, 28 were correctly predicted by the next-day forecast, resulting in a Probability of Detection (POD) of 72 percent. The False Alarm Rate (FAR) for the next-day ozone forecasts was 52 percent.

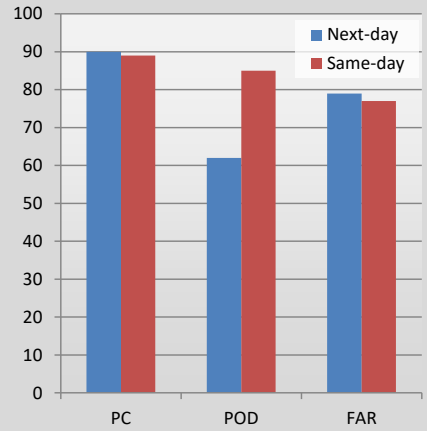
Of the next-day $PM_{2.5}$ forecasts issued when valid data were measured (354 days), 319 were correct at the good-to-moderate threshold, resulting in a PC of 90 percent. Of the 13 days with observed moderate $PM_{2.5}$ AQI levels, 8 were correctly predicted in the next-day forecast, resulting in a POD of 62 percent. While the FAR for $PM_{2.5}$ next-day forecasts was 79 percent, the average bias for next-day forecasts was +2.7 μg/m^3.

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

Good-to-Moderate Ozone Forecast Statistics, March–Oct. 2022



Good-to-Moderate $PM_{2.5}$ Forecast Statistics, Nov. 2021–Oct. 2022



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
$PM_{2.5}$	89	85	77	+2.1 μg/m^3	2.2 μg/m^3	90	62	79	+2.7 μg/m^3	3.1 μg/m^3
Ozone	90	77	35	+1.7 ppb	4.2 ppb	83	72	52	+3.1 ppb	5.8 ppb

Statistical Definitions

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

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

False Alarm Rate (FAR): 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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