CENTRAL OHIO AIR QUALITY END OF SEASON REPORT 2021

Mid-Ohio Regional Planning Commission
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Highest AQI Days Nov. 2020–Oct. 2021								
100 Ozone	August 24	New Albany	87 Ozone	July 27	New Albany	84 Ozone	June 17	London	81 $PM_{2.5}$	July 20	New Albany

Central Ohio End of Season Report | November 2020–October 2021

The Mid-Ohio Regional Planning Commission (MORPC), which is part of a network of agencies across the country, 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.

Particle pollution concentrations ($PM_{2.5}$) usually peak during overnight hours year-round when strong temperature inversions trap pollutants near the surface. Particle pollution can also be transported over large distances and end up in central Ohio if weather conditions are right. From March through October, ground-level ozone concentrations peak when warm temperatures and sunlight mix with pollutants to enhance the 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 2020-2021 season.

Summary

- For the first time since air quality record-keeping began in 1980, no Unhealthy for Sensitive Groups (USG) AQI days for ozone were observed during the ozone forecast season (Page 3).
- In July, wildfire smoke transported into the Columbus area contributed to 10 Moderate AQI days for $PM_{2.5}$. This represents the highest number of Moderate AQI days recorded in July for $PM_{2.5}$ since 2015.
- Overall, the majority of days in central Ohio were in the Good Air Quality Index (AQI) category. For ozone, 85% of summer days were in the Good AQI category. For $PM_{2.5}$, 87% of all days were in the Good AQI category.

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AIR POLLUTION OVERVIEW

OZONE POLLUTION

MORPC monitors and sends out forecasts and alerts for ground-level ozone pollution levels from March through October. Ground-level ozone pollution is created when emissions from sources such as cars, industry, and lawn equipment react chemically in the presence of sunshine. Concentrations of ground-level ozone peak when temperatures are warm, it is sunny, and winds are light. Ozone is the main ingredient of smog.

PARTICLE POLLUTION

MORPC monitors and sends out forecasts and alerts for particle pollution levels year-round. Fine particle pollution ($PM_{2.5}$) is made of microscopically small solid or liquid particles. Some sources of these fine particles are diesel trucks, buses, power plants, and wood burning fireplaces. Concentrations of $PM_{2.5}$ often peak during overnight hours when cool air is trapped near the ground and pollution levels build in that layer of air. Particle pollution can also be transported into Central Ohio over large distances, such as from distant wildfires, depending on weather conditions.

AIR QUALITY INDEX

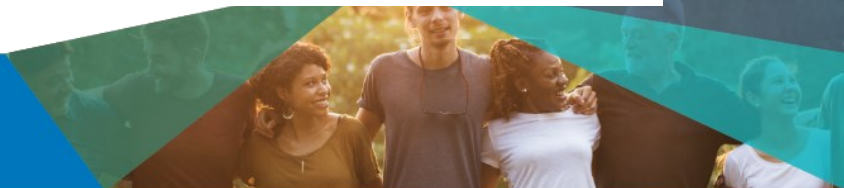
The Mid-Ohio Regional Planning Commission issues daily forecasts and Air Quality Alerts to keep the public informed of local air pollution levels. MORPC uses the Air Quality Index to report pollution levels. The higher the AQI level, the greater the health concern. When air pollution is expected to reach 101 AQI or above, MORPC issues an Air Quality Alert for Central Ohio.

AIR QUALITY INDEX (AQI VALUES)	HEALTH ADVISORY
GOOD 0 - 50	None.
MODERATE 51 - 100	Unusually sensitive people should consider reducing prolonged or heavy exertion.
UNHEALTHY FOR SENSITIVE GROUPS 101 - 150	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
UNHEALTHY 151 - 200	People with heart or lung disease, older adults and children should reduce prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
VERY UNHEALTHY 151 - 200	People with heart or lung disease, older adults and children should reduce prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.

CENTRAL OHIO OZONE AND $PM_{2.5}$ MONITOR LOCATIONS

The Ohio EPA maintains the Ohio air monitoring network as part of its responsibility to regulate air quality to protect public health and the environment in the state of Ohio. The most recent map with locations of Central Ohio monitoring sites for ozone and particle pollution is shown in the map below.

IDENTIFIER	MONITOR	POLLUTANT
1	Delaware	Ozone
2	Centerburg	Ozone
3	Maple Canyon	Ozone, $PM_{2.5}$
4	New Albany	Ozone, $PM_{2.5}$
5	Heath	Ozone
6	Fairgrounds	$PM_{2.5}$
7	Reynoldsburg	Ozone
8	London	Ozone



Highest AQI Days
Nov. 2020–Oct. 2021

100 Ozone	August 24 New Albany	87 Ozone	July 27 New Albany
84 Ozone	June 17 London	81 $PM_{2.5}$	July 20 New Albany

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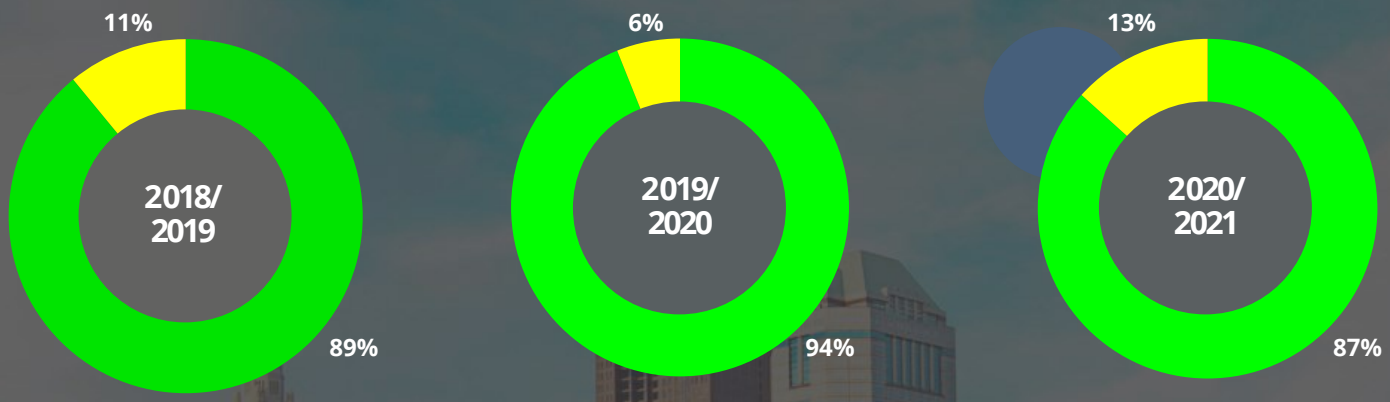
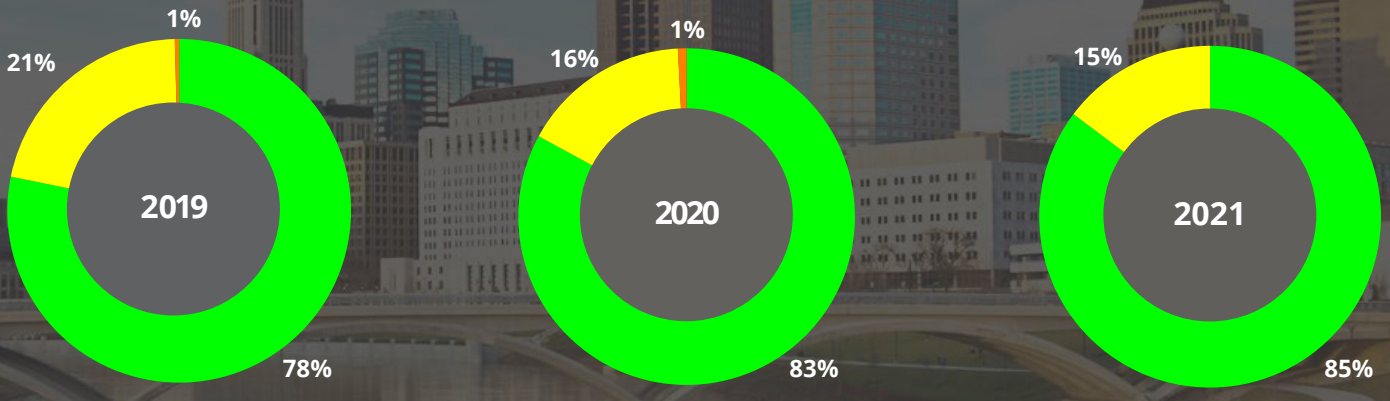
Particle pollution AQI levels did not reach the USG AQI category in central Ohio during this season. In central Ohio during the 2020-2021 season, air quality for particle pollution was in the Good category of the AQI for 87% of all days, and in the Moderate AQI category for 13% of all days.

Ozone AQI levels did not reach the USG AQI category during the summer season. With respect to ozone, the percentage of Good AQI days has gradually increased over the last three years in the Columbus region. Air quality for ozone was in the Good AQI category on 85% of days and in the Moderate AQI category on 15% of days.

Percentage of Days at Each AQI Category—$PM_{2.5}$ (November 2020-October 2021)



Percentage of Days at Each AQI Category—Summertime Ozone (March 2021-October 2021)



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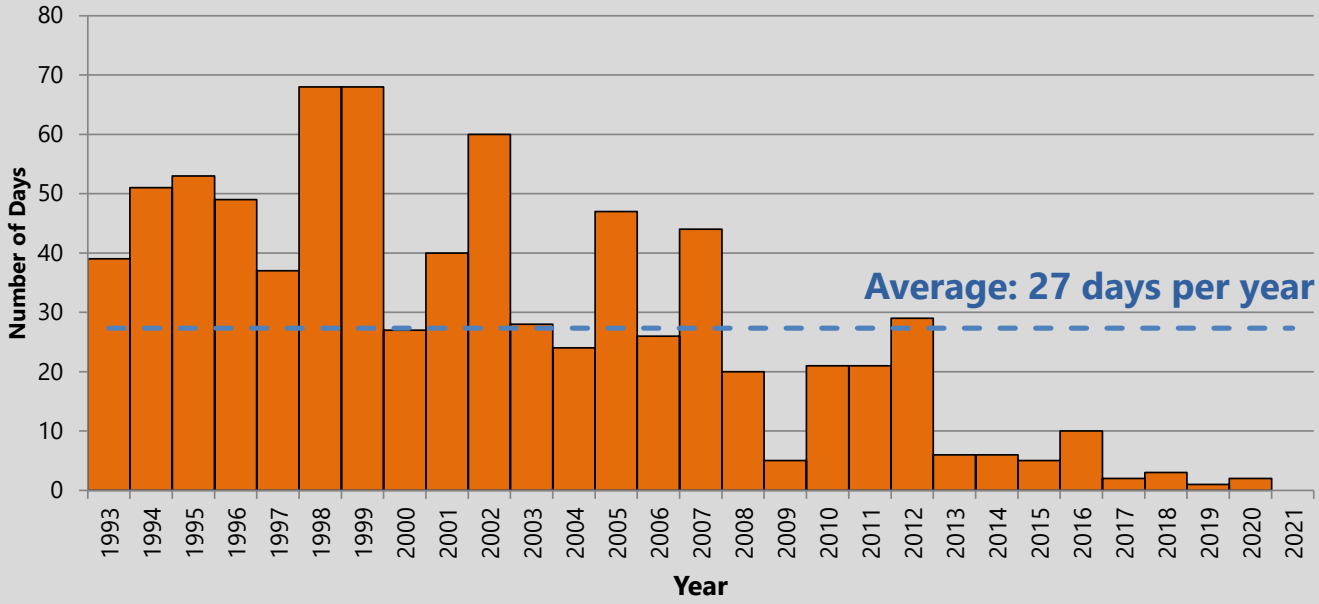
Regional Counts of High Ozone Days

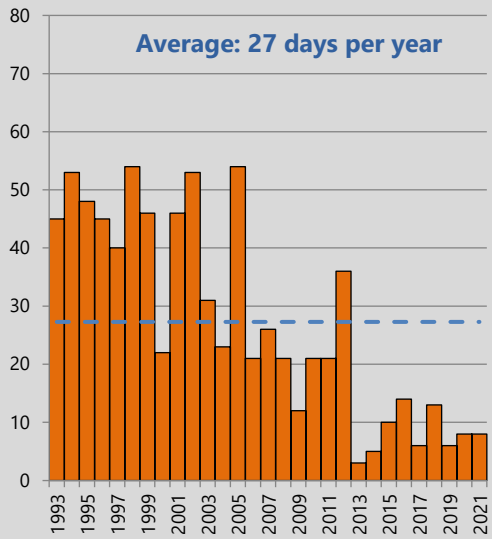
Over the past 29 years, the number of high ozone days each year has generally declined in central Ohio, driven mostly by emissions reductions. Dating back to the start of air quality record keeping in 1980, summer 2021 marked the first time that no Unhealthy for Sensitive Groups ozone days were recorded in the Columbus area.

However, there are variations from 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, 29-year averages are indicated with the dashed blue lines.

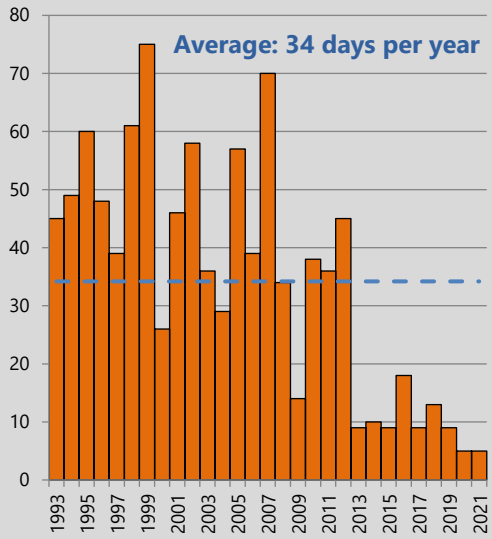
Columbus



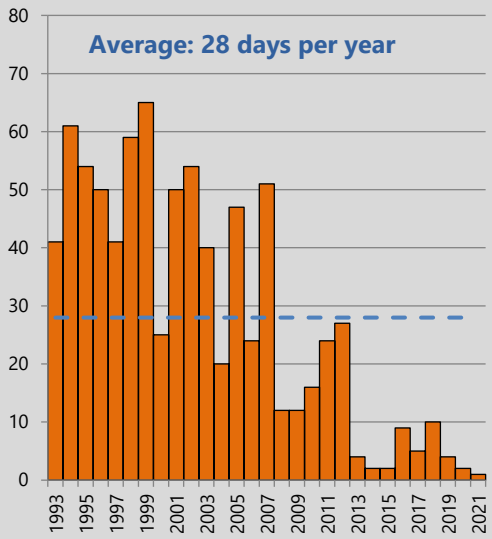
Cleveland



Cincinnati



Indianapolis



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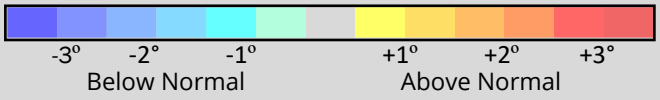
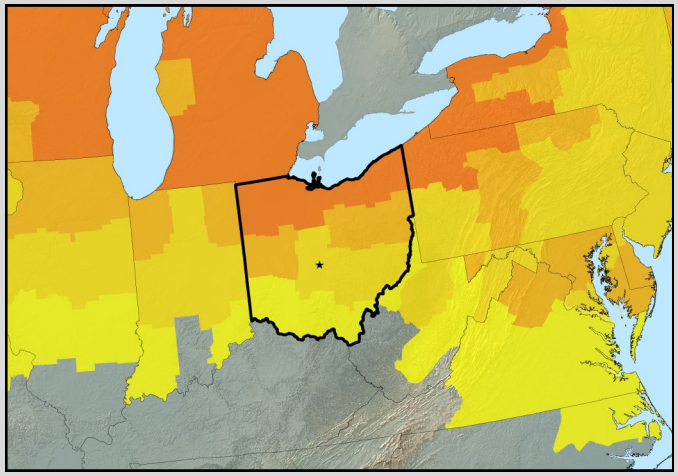
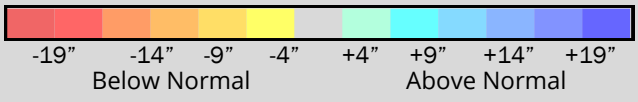
Seasonal Weather Summary

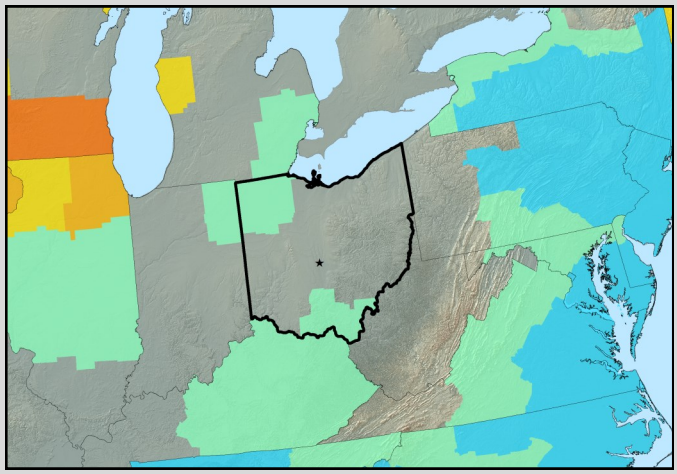
Temperature Anomalies (°F)
November 2020-October 2021
Versus 2007-2016 Average





Precipitation Anomalies (inches)
November 2020-October 2021
Versus 2007-2016 Average





Weather patterns can have a strong impact on air quality in central Ohio. During the 2020-2021 forecast season, temperatures were higher than average and precipitation was below average.

For $PM_{2.5}$, most days during the forecast season featured Good AQI levels. February featured the most Moderate AQI days for $PM_{2.5}$. Despite persistent upper-level low pressure that aided vertical mixing, colder-than-normal temperatures generated frequent morning inversions, trapping pollutants near the ground. Occasional fog and mist enhanced particle formation, further increasing AQI levels.

The ozone forecast season runs from March to October. During this period in 2021, 36 Moderate AQI days for ozone concentrations were recorded. May and August each featured eight Moderate ozone days, which tied for the most of any month during the 2021 forecast season. On many of these days, afternoon temperatures in the mid-80s to low-90s promoted ozone formation, while light southerly to southwesterly winds transported regional pollutants into central Ohio. In August, long-range transport of wildfire smoke likely enhanced ozone production on all Moderate days.

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	+3.0	+0.15	2	--
December	+1.1	-0.73	5	--
January	+2.5	-0.48	5	--
February	-5.6	-0.02	12	--
March	+5.0	-0.17	4	1
April	+0.1	-0.12	4	4
May	-2.7	-0.53	1	8
June	+2.3	-1.75	1	5
July	-0.2	-0.03	10	6
August	+2.7	+3.42	3	8
September	+1.7	-1.16	0	4
October	+7.0	+0.67	0	0

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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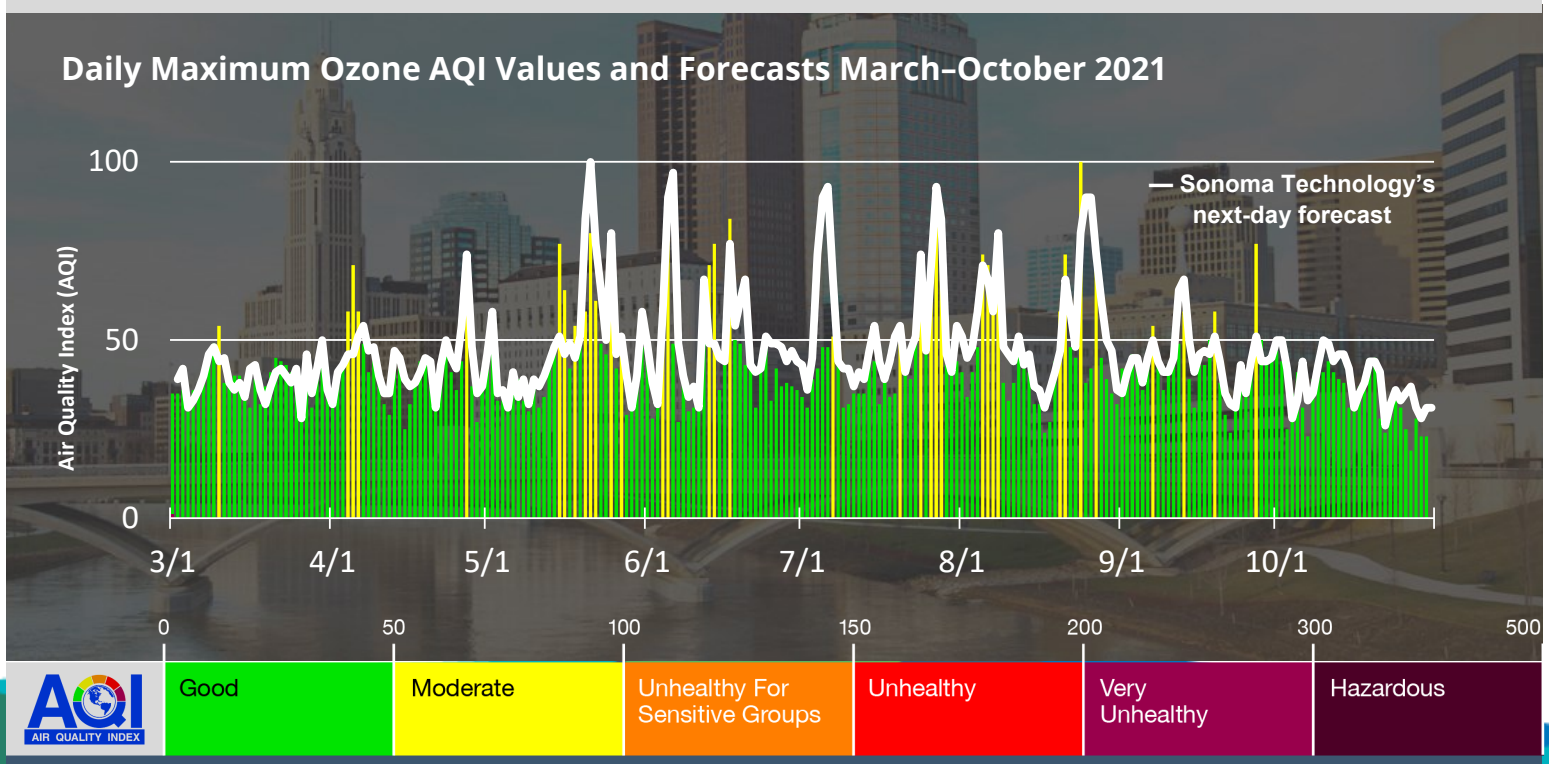
Ozone Summary and Highest AQI Days—2021

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. No Air Quality Alerts were issued during the year. For the first time in recorded history, ozone AQI levels did not reach the USG category in the Columbus region over the forecast year. Brief descriptions of weather conditions on selected high-AQI 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
6/17/21	**77**	**74**	**84**	**London**
7/27/21	93	100	87	New Albany
8/24/21	**80**	**74**	**100**	**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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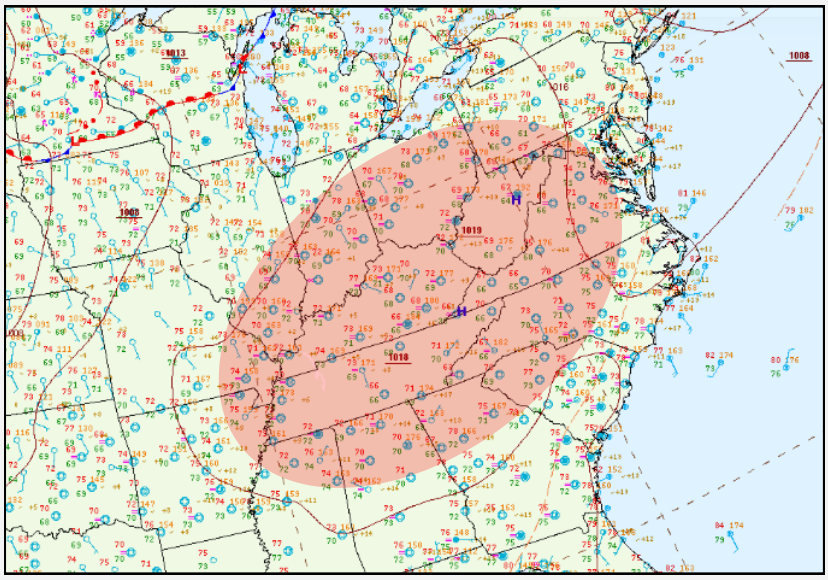
Highlighted Days—Ozone

August 24, 2021: 100 AQI

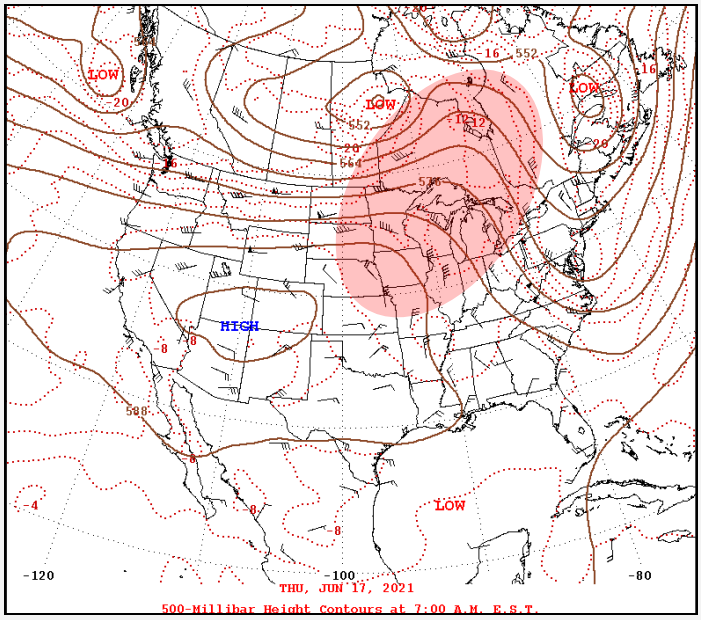
The summer's highest AQI day for ozone occurred on August 24, when a large area of upper-level high pressure extending from the Southern Plains to Ohio inhibited vertical mixing. At the surface, ozone production was promoted by partly sunny skies and high temperatures in the low-90s. Furthermore, light winds (averaging less than 5 mph) that were associated with surface high pressure located south of the Ohio Valley hindered dispersion throughout the day. It is also likely that ozone development was enhanced by long-range transport of remnant smoke that originated from wildfires in southern Canada and the western United States. The daily ozone AQI value reached 100 because of these conditions, which is in the high-Moderate category.



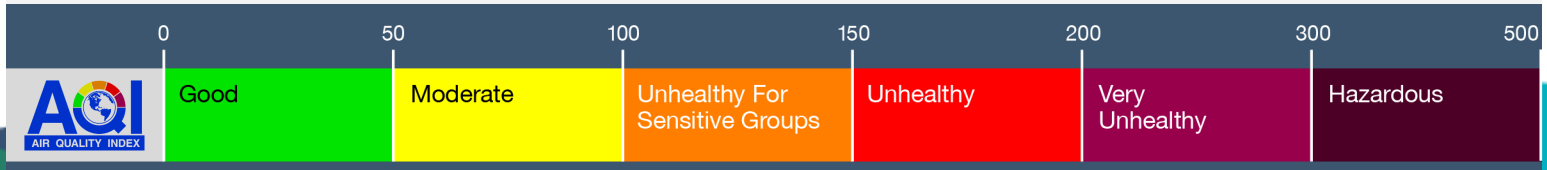
August 24: Surface weather map valid 8 a.m., showing high pressure south of the Columbus region (denoted by red shading). *Image from https://www.wpc.ncep.noaa.gov.*

June 17, 2021: 84 AQI

High ozone levels were recorded on this date despite the absence of wildfire smoke. The aloft weather pattern indicated an upper-level ridge of high pressure over the Great Lakes region, which reduced vertical mixing in the lower levels of the atmosphere in central Ohio. At the surface, periods of light southerly to southwesterly winds in the Columbus area limited pollutant dispersion. Additionally, sunny skies and afternoon temperatures in the mid-80s supported the formation of ground-level ozone. Therefore, despite little pollutant carryover, the daily AQI value peaked at 84, which is high-Moderate.



June 17: 500 mb map valid 8 a.m., showing an upper-level ridge of high pressure over the Great Lakes region (red shading). This upper-level pattern indicated limited atmospheric mixing downwind in central Ohio. *Image from https://www.wpc.ncep.noaa.gov.*



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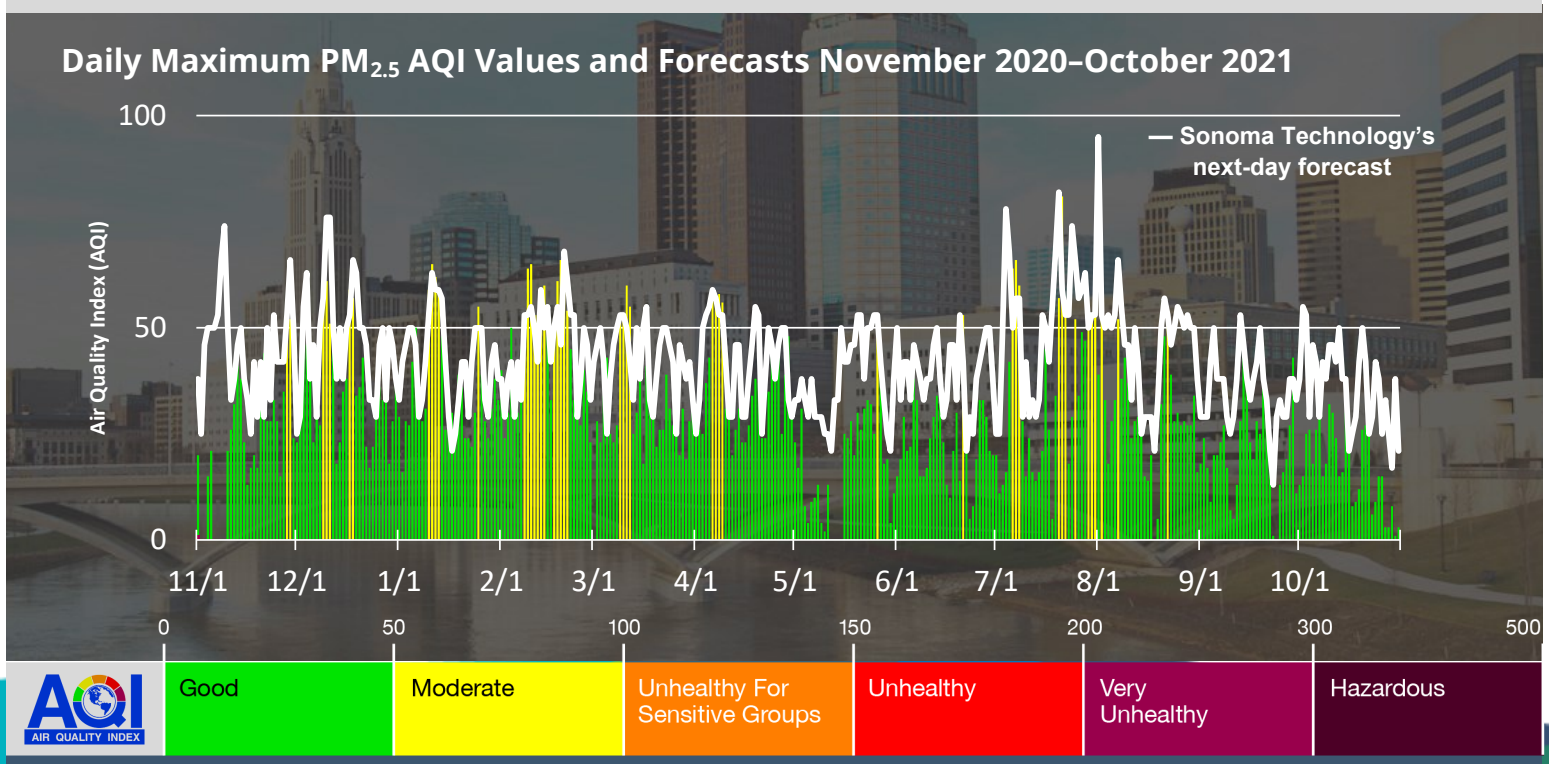
$PM_{2.5}$ Summary and Highest AQI Days—2020-2021

The table below shows particle pollution 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 particle pollution, and no days with an AQI above 100 were observed. Brief descriptions of weather conditions on selected high-AQI days (shown in bold in the table below) are provided on the following page.

Date	Next-Day Forecast	Same-Day Forecast	Observed $PM_{2.5}$ AQI
12/10/20	76	74	61
12/11/20	76	63	51
1/11/21	63	66	65
2/10/21	55	63	65
2/19/21	**46**	**63**	**66**
7/4/21	78	74	42
7/6/21	50	68	66
7/20/21	**82**	**82**	**81**
8/1/21	95	89	60

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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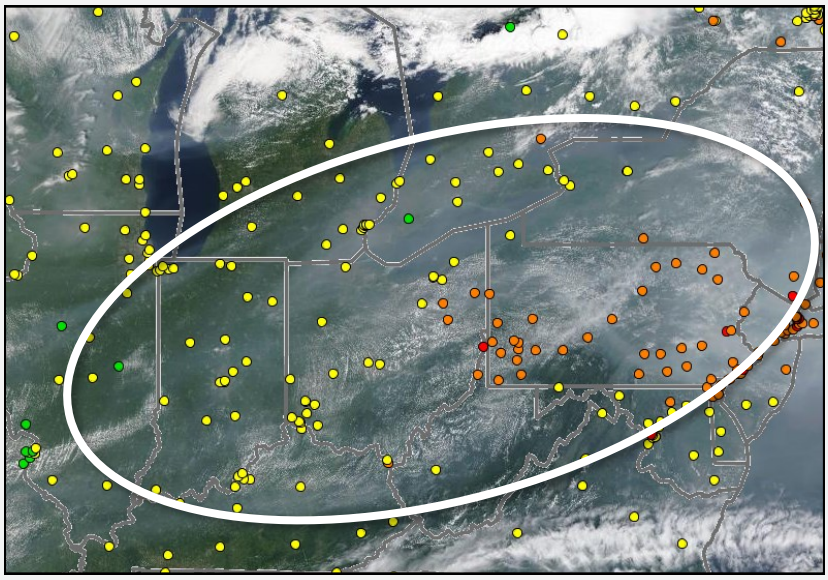
Highlighted Days—$PM_{2.5}$

July 20, 2021: 81 AQI

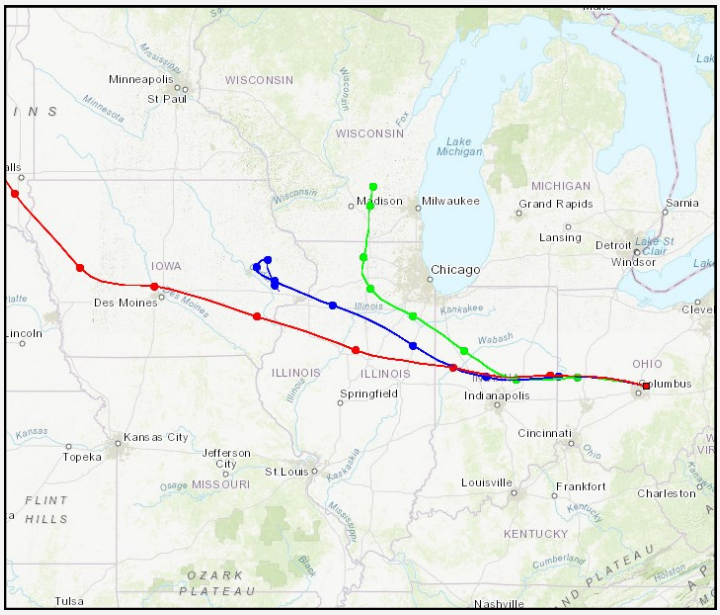
The year's highest particle pollution AQI day was recorded on July 20. On this day, northwesterly winds at the surface and aloft transported a thin plume of smoke from wildfires in southern Canada into central Ohio. Daytime heating also allowed smoke aloft to mix down and reach the surface, while wind speeds that were less than 5 mph throughout the day hindered dispersion. These conditions, along with pollutant carryover from the previous day, yielded an observed AQI value of 81, which is in the Moderate category.



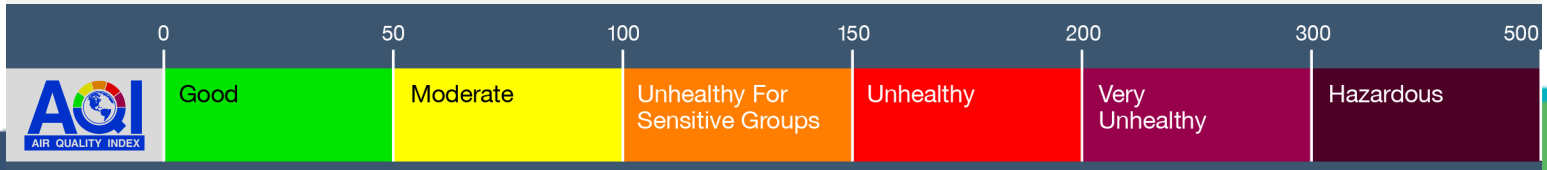
July 20: MODIS Terra satellite imagery and 24-hour observed $PM_{2.5}$ AQI levels (dots). Smoke from wildfires (area under the oval) increased particle levels in the Columbus region on this day. *Image courtesy: AirNow-Tech.*

February 19, 2021: 66 AQI

The highest AQI day of the winter season occurred on February 19. As an upper-level trough of low pressure moved toward the Buckeye State, a cold air mass generated strong temperature inversions during the morning and evening hours, which trapped pollutants near the ground. In addition, fog and mist in the Columbus region enhanced particle formation, and westerly to northwesterly winds transported additional pollutants from the Great Lakes region into the Columbus area. These conditions, combined with carryover of pollutants from the previous days, resulted in Moderate AQI values.



February 19: 48-hour backward trajectories ending at 11 p.m. on February 19 show low-level westerly to west-northwesterly transport, allowing regional pollutants from the Upper Midwest to enter the Columbus area. Trajectories are shown for elevations of 100 m (green), 250 m (blue), and 500 m (red) above ground level. *Image courtesy: AirNow-Tech.*



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Forecast Statistics

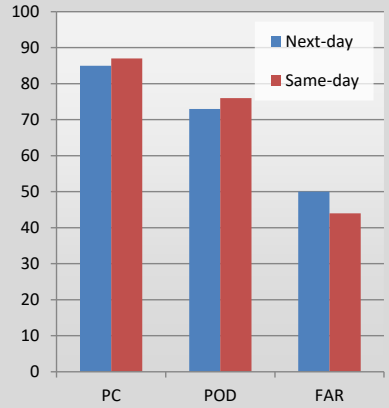
Sonoma Technology provides same-day, next-day, and extended AQI daily forecasts for central Ohio. A statistical summary of same-day and next-day forecasting performance at the Good-to-Moderate AQI threshold (51 AQI) is shown in the charts on the right and described below.

Of the 244 next-day ozone forecasts issued, 207 were correct at the Good-to-Moderate threshold, resulting in a Percent Correct (PC) of 85%. Of the 36 days with observed Moderate ozone AQI levels, 26 were correctly predicted in the next-day forecast, resulting in a Probability of Detection (POD) of 72%. The False Alarm Rate (FAR) for the next-day ozone forecasts was 50%.

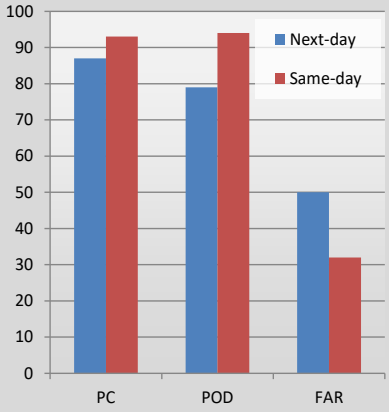
Of the next-day particle pollution forecasts issued when valid data were measured (355 days), 309 were correct at the Good-to-Moderate threshold, resulting in a PC of 87%. Of the 47 days with observed Moderate AQI levels, 37 were correctly predicted in the next-day forecast, resulting in a POD of 79%. The FAR for the next-day forecasts was 50%, with an average bias of +3.1 µg/m^3 for next-day forecasts.

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

Good-to-Moderate Ozone Forecast Statistics, March–Oct. 2021



Good-to-Moderate $PM_{2.5}$ Forecast Statistics, Nov. 2020–Oct. 2021



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
$PM_{2.5}$	93	94	32	+2.4 µg/m^3	2.6 µg/m^3	87	79	50	+3.1 µg/m^3	3.7 µg/m^3
Ozone	87	76	44	+1.4 ppb	4.2 ppb	85	72	50	+3.0 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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