2017—2018

Central Ohio Air Quality End of Season Report

Mid-Ohio Regional
Planning Commission
www.MORPC.org

111 Liberty Street, Suite 100
Columbus, OH 43215

918009-2834

Highest AQI Days Nov. 2017–Oct. 2018									
122 Ozone	July 13	Columbus-Maple Canyon Dr.	101 Ozone	July 14	London	101 Ozone	May 25	New Albany	97 Ozone	May 1	Delaware

Air Quality End of Season Report | Nov 2017–Oct 2018

The Mid-Ohio Regional Planning Commission (MORPC) is part of a network of agencies across the country that issues daily air quality forecasts and notifies the public when air pollution levels are considered to be unhealthy for sensitive groups of people. MORPC monitors for two main air pollutants that are a threat to public health in Central Ohio: ground-level ozone pollution and particle pollution (PM2.5). Ozone pollution is more common in the summer and is monitored from March through October. Particle pollution can occur year round. High concentrations of ground-level ozone or particle pollution in the air can affect us all, especially sensitive groups of people. Sensitive groups include children, adults who are active outdoors, people with heart or lung disease (such as asthma) and older adults.

MORPC works with Sonoma Technology, Inc. (STI) to deliver year-round daily air quality forecasts and Air Quality Alerts. This report provides an analysis of the 2017-2018 season for both ozone and particle pollution.

Summary

- The majority of days in central Ohio were in the Good Air Quality Index (AQI) category. For ozone, 81% of summer days were in the Good AQI category. For $PM_{2.5}$, 89% of all days were in the Good AQI category.
- Three Unhealthy for Sensitive Groups (USG) AQI days were observed during the year: once in May, and twice in July. The dominant pollutant on all three days was ozone . There were no Unhealthy for Sensitive Groups days for particle pollution.
- Ozone levels improved from 2016-2017 to 2017-2018 with the percentage of days in the Good AQI category increasing from 68% to 81%. Above average precipitation over the past year, especially in the summer months, reduced ozone formation and led to cleaner air quality conditions despite above average temperatures.
- Over the past 26 years, the number of high ozone days has generally declined in central Ohio. Since 2013, central Ohio has experienced less than 10 high ozone days each year, compared to the average of 30 days per year from 1993 to 2018. A similar decline is seen in other major metropolitan areas in the region.
- Similar to the 2016-2017 season, the season's two highest $PM_{2.5}$ AQI days were both caused by smoke transport from wildfires outside of Ohio. On July 27 and 28, smoke from numerous fires in the Pacific Northwest and western and central Canada impacted Ohio, leading to high-Moderate AQI levels on both days.

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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's 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 (PM2.5) 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 PM2.5 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, if weather conditions are right.

Air Quality Index (AQI)

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 will issue an Air Quality Alert for Central Ohio.

Air Quality Index	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 avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy 201-300	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.

Highest AQI Days
Nov. 2017–Oct. 2018

122 Ozone	July 13 Columbus-Maple Canyon Dr.	101 Ozone	July 14 London
101 Ozone	May 25 New Albany	97 Ozone	May 1 Delaware

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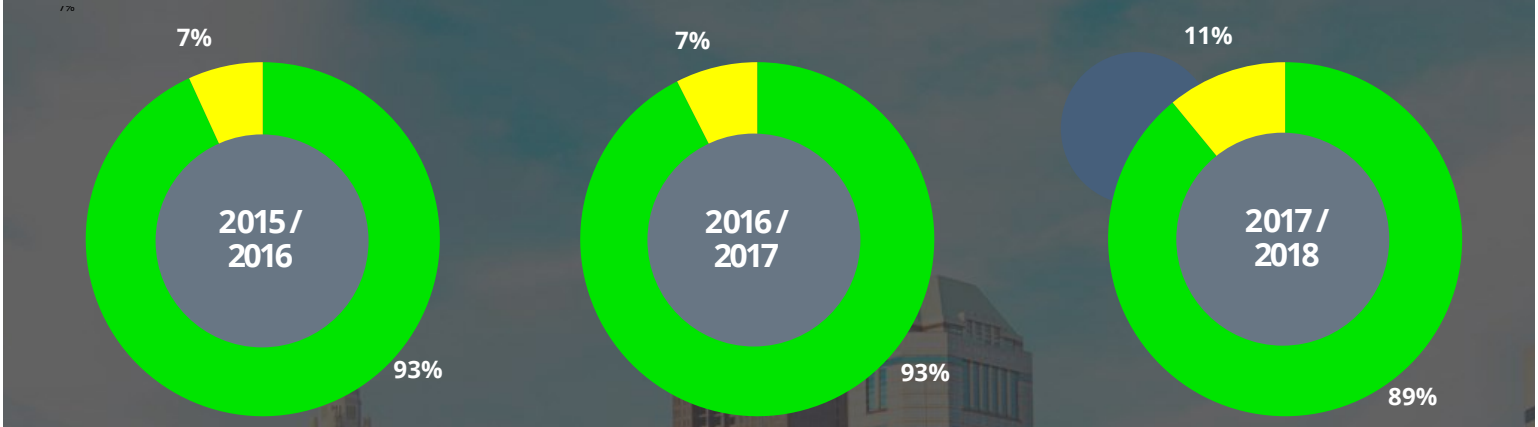
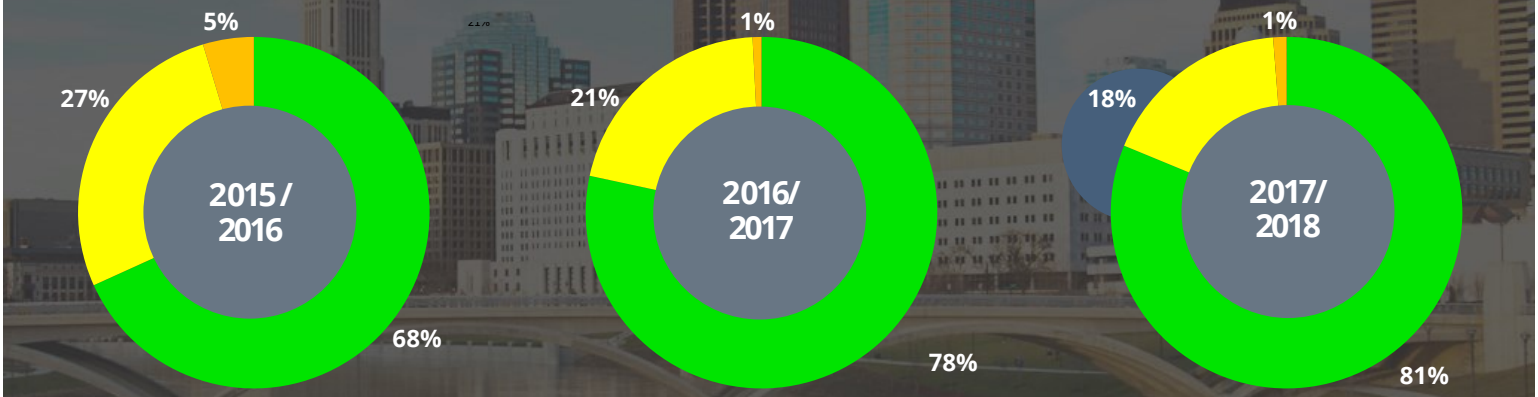
Pollution levels did not reach the Unhealthy for Sensitive Groups (USG) AQI category in the Columbus region during the 2017-2018 season. During this season, air quality for $PM_{2.5}$ was in the Good category of the Air Quality Index (AQI) on 89% of days and in the Moderate AQI category on only 11% of days. The percentage of Good AQI days has remained fairly steady over the last three years, ranging from 93% in 2015-2016 and 2016-2017 to 89% this past year.

Ozone pollution levels have improved over the past few years, and the percentage of days in the Good AQI category has increased from 68% in 2015-2016 to 81% in 2017-2018.

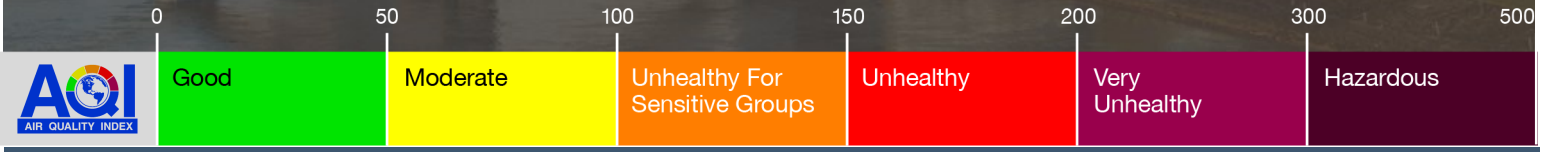
Percentage of Days at Each AQI Category—$PM_{2.5}$ (November through October)



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



*The 2016 ozone season was from April through October. The 2017 and 2018 ozone seasons were from March through October.



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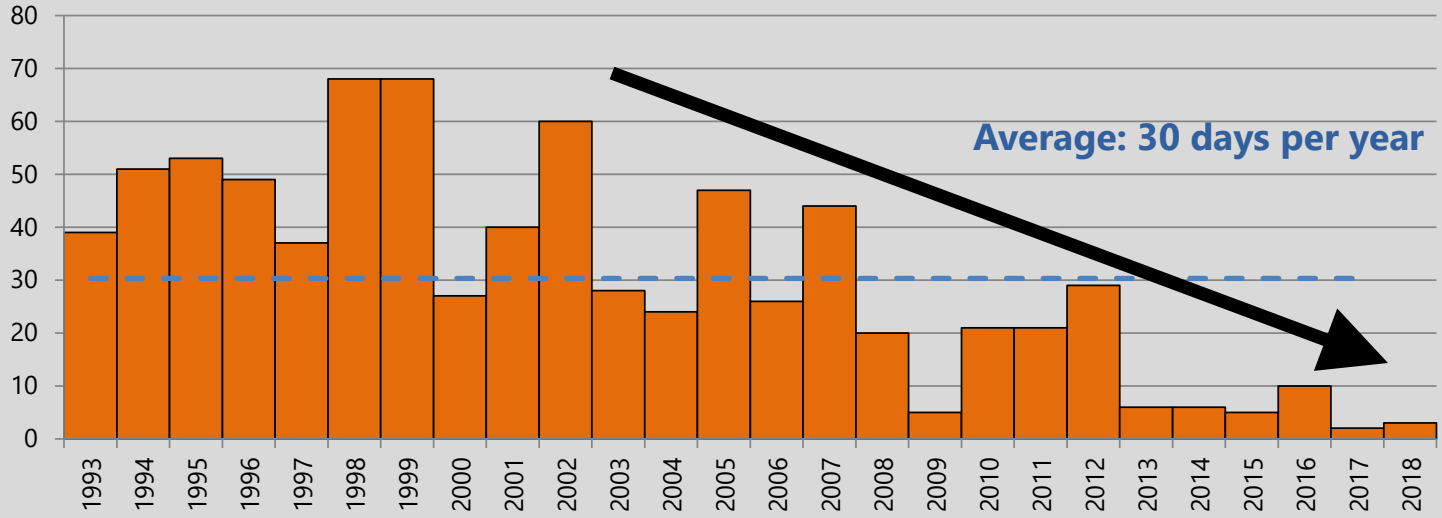
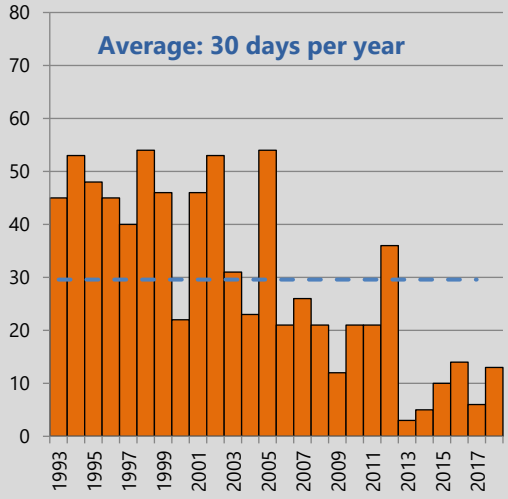
Regional Trends Summary: Ozone Pollution Declining

Over the past 26 years, the number of high ozone days (above 70 ppb for the daily maximum 8-hour average) has generally declined in central Ohio, driven mostly by emissions reductions. However, there is some variation from year to year driven by weather conditions. The charts below indicate the number of high ozone days each year (orange bars) for several major cities throughout the region. The 26-year averages are indicated with the dashed blue line.

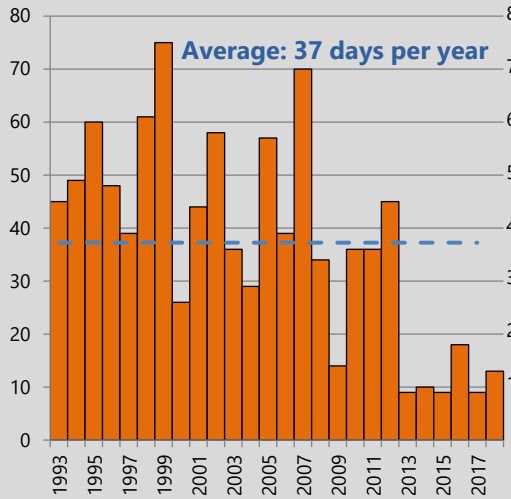
Columbus



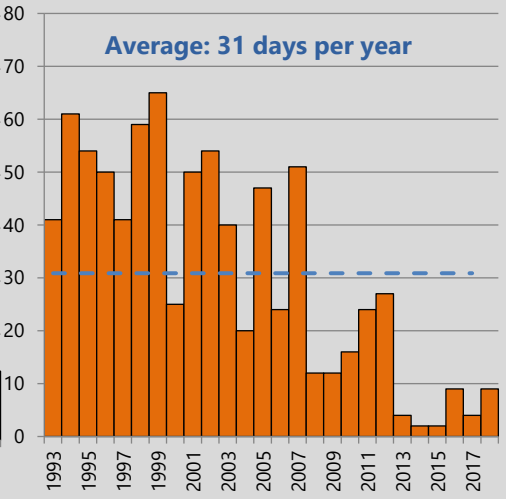
Cleveland



Cincinnati



Indianapolis



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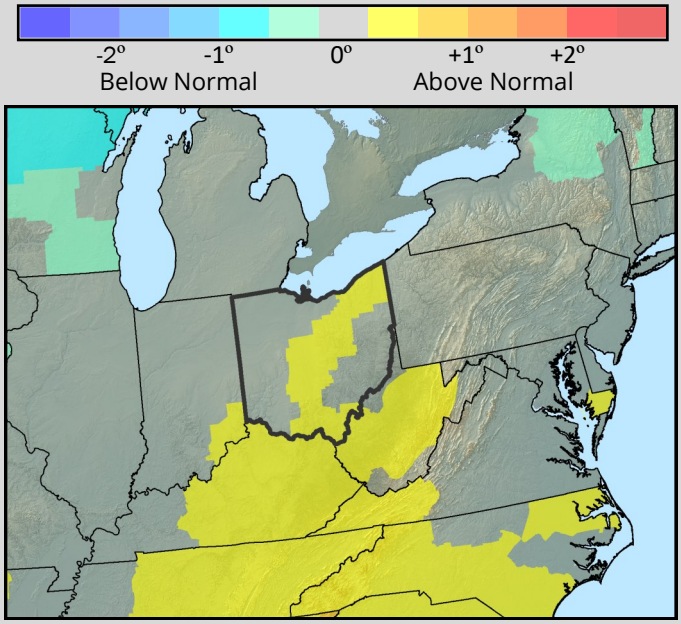
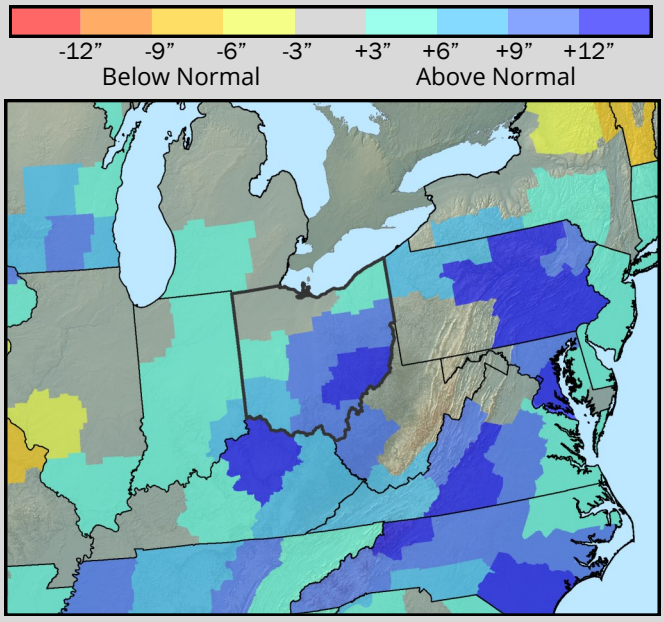
Seasonal Weather Summary

Temperature Anomalies (°F)
November 2017-October 2018
Versus 2007-2016 Average



Precipitation Anomalies (inches)
November 2017-October 2018
Versus 2007-2016 Average



Weather patterns can have a strong impact on air quality in central Ohio. Temperatures were slightly higher than average during the 2017-18 forecast season, and were especially warm in the summer months. These conditions would normally enhance ozone formation. However, precipitation in central Ohio was also above normal during this period. These conditions indicate increased storm activity, which typically enhances atmospheric mixing and aids pollutant dispersion. In addition, increased rainfall and the associated cloud cover can reduce the formation of ozone. As a result, air quality was in the Good AQI category for most of the 2017-18 season.

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	-0.8	+1.5	2	--
December	-2.3	-1.2	6	--
January	-2.3	-0.34	8	--
February	+6.0	+3.0	6	--
March	-3.4	-0.1	0	0
April	-5.4	+1.8	1	6
May	+9.2	+0.4	1	16
June	+2.4	+2.7	3	10
July	+0.8	+0.7	5	6
August	+1.9	+0.9	8	5
September	+4.9	+3.7	0	3
October	+1.5	0.0	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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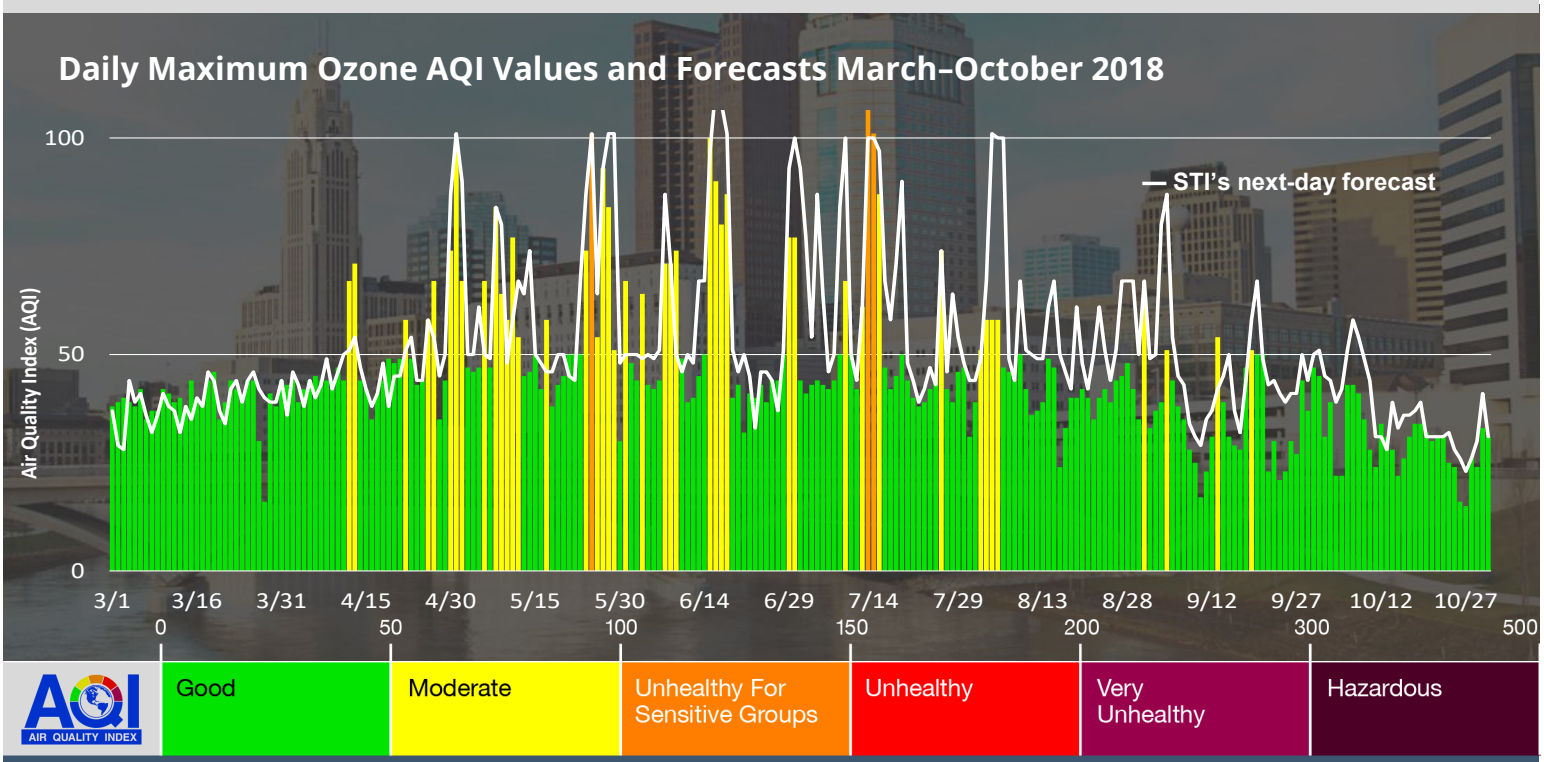
Ozone Summary and Highest AQI Days—2018

The table below shows the forecast and observed ozone AQI levels on days with forecast or observed AQI levels above 100. On days when an alert was issued (forecasted AQI levels over 100), the observed ozone levels were, on average, 81 AQI. 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
5/1/18	101	101	97	Delaware
5/25/18	**101**	**122**	**101**	**New Albany**
5/28/18	101	112	84	London
5/29/18	101	101	51	Delaware
6/16/18	112	101	90	London
6/17/18	108	108	80	Delaware
6/18/18	101	101	87	Heath
7/13/18	**100**	**100**	**122**	**Columbus-Maple Canyon Dr.**
7/14/18	100	100	101	London
8/4/18	101	101	58	New Albany

STI 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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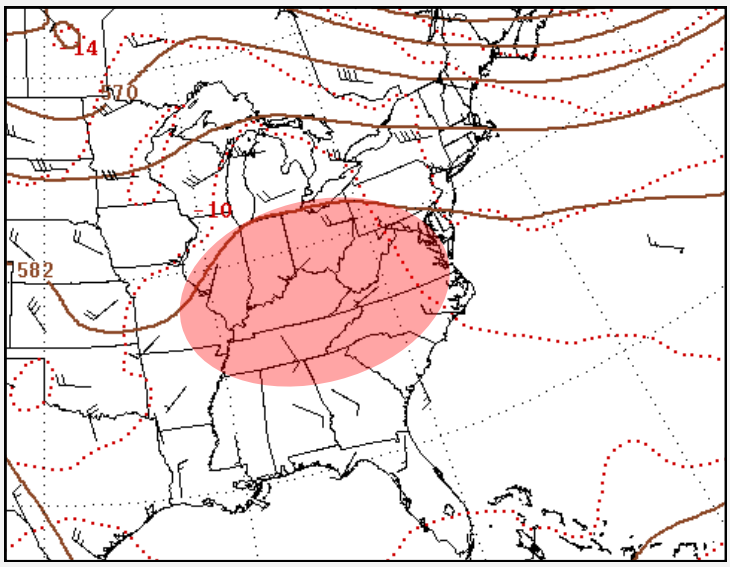
Highlighted Days—Ozone

May 25, 2018: 101 AQI

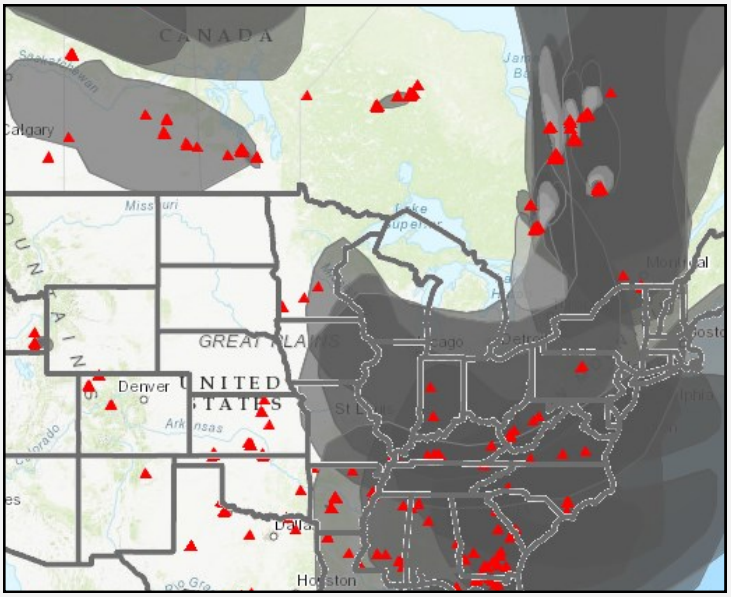
Ozone levels on this day reached 101 AQI. High pressure over Ohio reduced atmospheric mixing and led to sunny skies and temperatures in the mid– to upper-80s. Also, calm winds and a strong temperature inversion through the morning hours limited mixing and dispersion, allowing pollutants to accumulate in central Ohio. These conditions created more ground-level ozone. In the afternoon, light southwesterly winds developed and gradually transported additional pollutants from southwestern Ohio into the Columbus region. These conditions led to ozone levels that were Unhealthy for Sensitive Groups.



May 25: 500 mb weather map showing an upper-level ridge of high pressure over the Ohio (denoted by the red shading). *Image from https://www.wpc.ncep.noaa.gov*

July 13, 2018: 122 AQI

Ozone levels on this day reached 122 AQI, the highest observed levels for the year. Light and variable winds throughout the day limited pollutant dispersion, and sunny skies and very warm temperatures increased ozone production. Also, on the previous few days, a large smoke plume originating from numerous fires in Manitoba, Ontario, and Quebec, Canada, was transported over the region (see smoke plume analyses, right). This smoke further enhanced ozone formation, leading to AQI levels that were in the middle of the Unhealthy for Sensitive Groups range.



July 13: Hazard Mapping System smoke plumes (gray shading) and fire detections (red triangles) on July 12, one day prior to the highest observed ozone AQI levels for the year. *Data from AirNow-Tech and https://www.ospo.noaa.gov/Products/land/hms.html*

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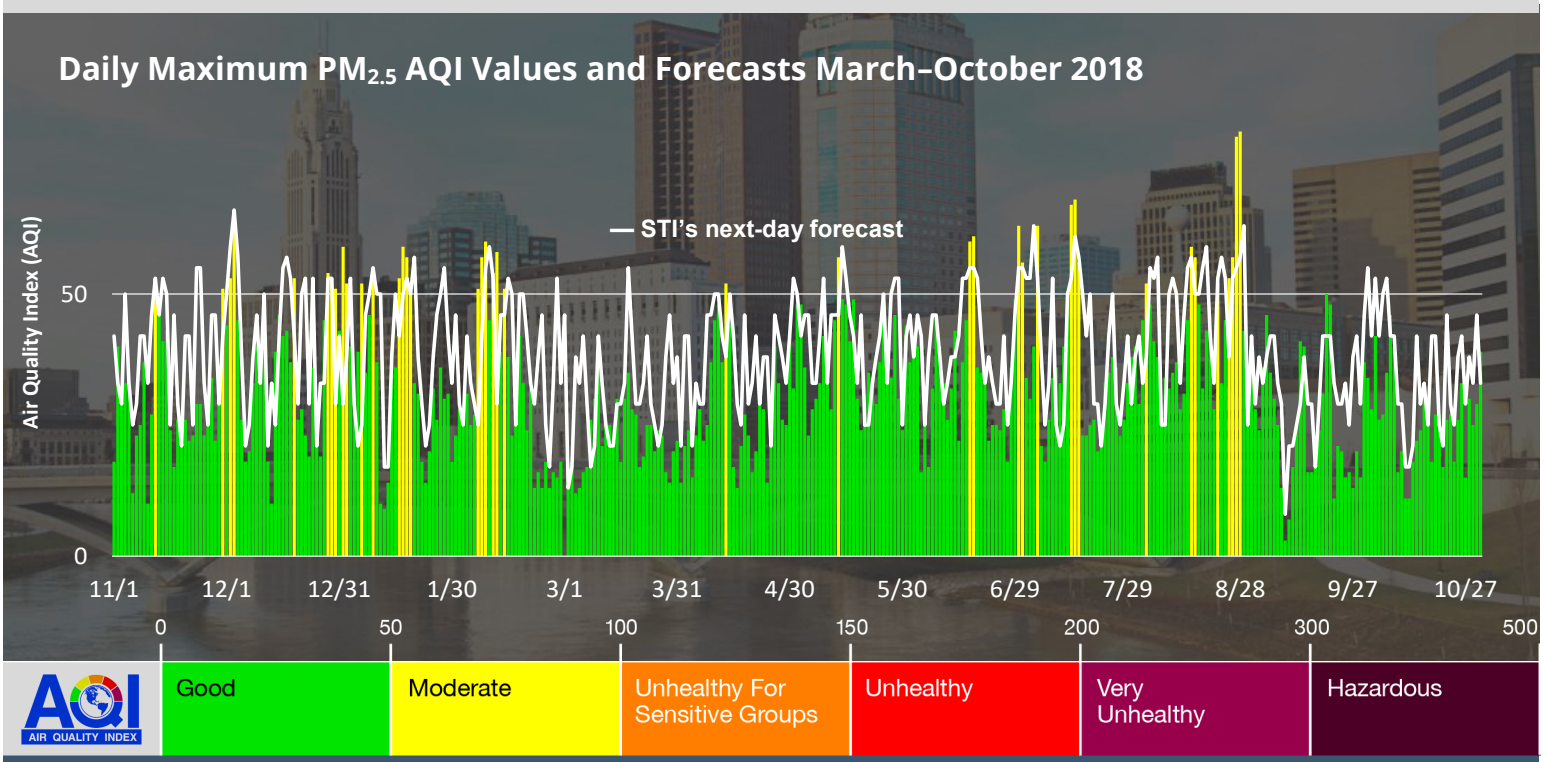
$PM_{2.5}$ Summary and Highest AQI Days—2018

The table below shows the forecast and observed $PM_{2.5}$ AQI levels on days with observed AQI levels above 60. No air quality alerts were issued for $PM_{2.5}$, and no days with an AQI above 100 were observed. Brief descriptions of weather conditions on selected high moderate 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
12/3/17	66	72	63	New Albany
6/18/18	55	59	61	Columbus-Fairgrounds
6/30/18	55	63	63	New Albany
7/5/18	**53**	**63**	**63**	**Columbus-Fairgrounds**
7/14/18	53	63	67	New Albany
7/15/18	61	68	68	New Albany
8/27/18	**55**	**61**	**80**	**Columbus-Fairgrounds**
8/28/18	**57**	**68**	**81**	**Columbus-Fairgrounds**

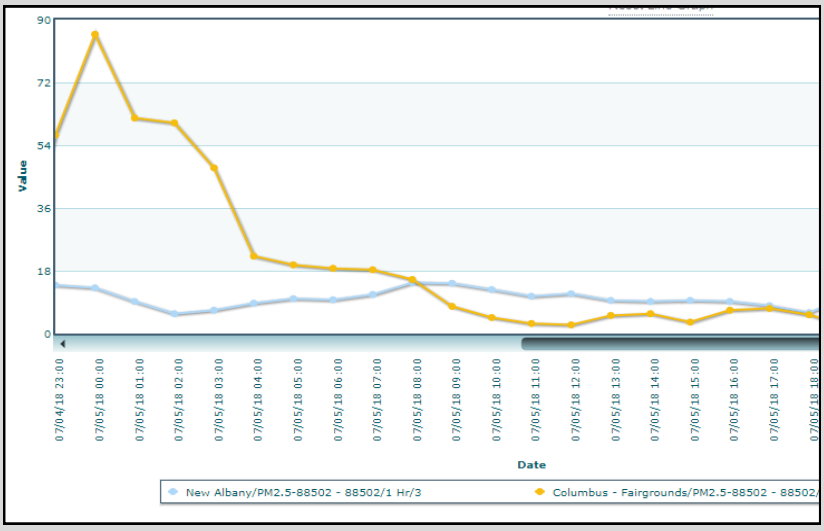
STI meteorologists were generally able to capture the trend of observed air quality levels with their next-day forecasts. The chart below shows daily observed AQI levels (colored bars) and next-day forecasts (white line) for $PM_{2.5}$.



Highlighted Days—$PM_{2.5}$

July 5, 2018: 63 AQI

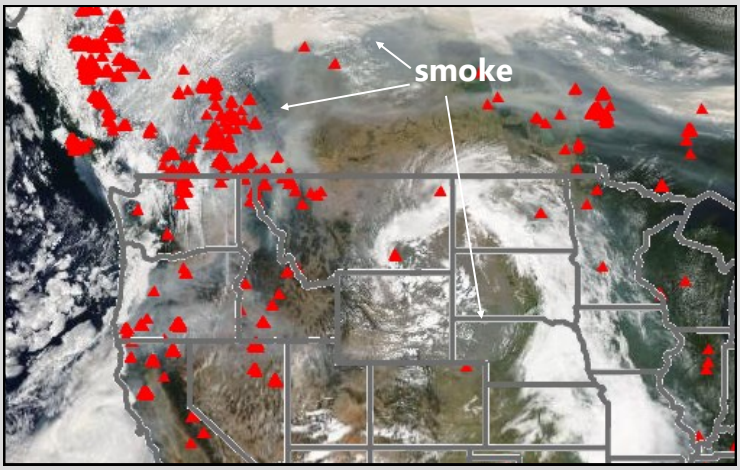
On July 4, particle levels were Good for the majority of the day. However, fireworks associated with the 4th of July holiday drastically increased $PM_{2.5}$ levels late in the evening. Hourly concentrations peaked at 85.8 µg/m^3 at the Columbus-Fairgrounds monitor in the early morning hours of July 5. Although $PM_{2.5}$ concentrations gradually decreased to the single digits by the afternoon (see time series, right), the high $PM_{2.5}$ through the morning hours pushed the AQI levels for the day into the mid-Moderate category.



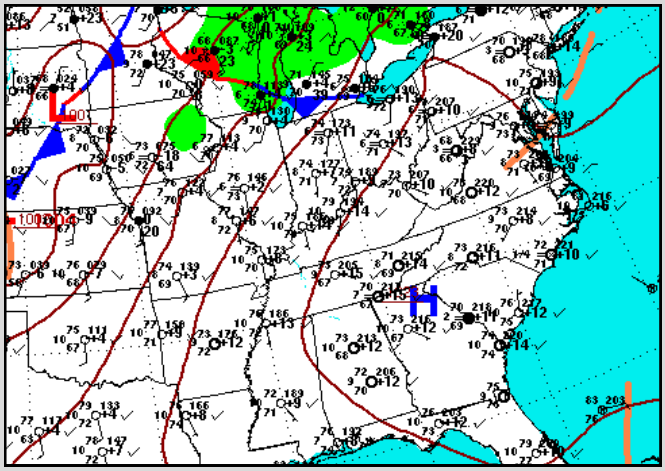
July 5: Hourly $PM_{2.5}$ concentrations at two central Ohio monitoring stations. Particle levels spiked early in the day on July 5 due to fireworks displays the night before.

August 27-28, 2018: 80-81 AQI

On the days leading up to this episode, a large swath of wildfire smoke blanketed almost the entire continental U.S. This smoke originated from numerous fires in the Pacific Northwest and western and central Canada (below, left). On August 26-28, an upper-level ridge of high pressure moved over Ohio, reducing vertical mixing in the atmosphere. In addition, surface high pressure centered over the Carolinas (below, right) produced light-to-moderate southwesterly winds, gradually transporting smoke and other regional pollutants into central Ohio. As a result, $PM_{2.5}$ AQI levels reached their highest values of the year and exceeded 80 AQI on both August 27 and 28. On both days, AQI levels were correctly forecast in the Moderate category.



August 23: MODIS satellite imagery showing smoke plumes, overlaid with fire locations (red triangles) in the Pacific Northwest and Canada. *Data from AirNow-Tech and https://www.ospo.noaa.gov/Products/land/hms.html*



August 27: Surface weather map, showing surface high pressure over the Carolinas, which produced southwesterly winds and transported smoke and other pollutants into the Columbus region. *Image from https://www.wpc.ncep.noaa.gov*

Forecast Statistics

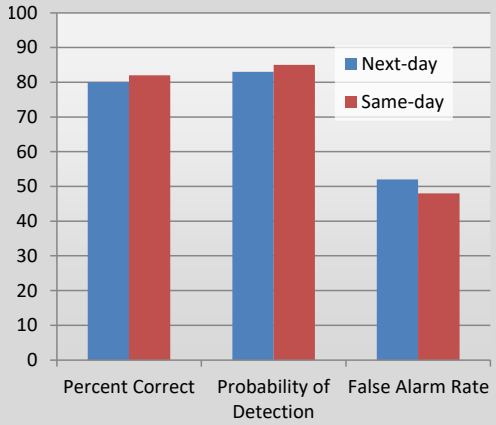
Sonoma Technology, Inc. provides same-day, next-day, and extended AQI daily forecasts for central Ohio. A statistical summary of same-day and next-day forecasting performance at the Good-to-Moderate AQI threshold (51 AQI) is shown in the charts on the right and described below. These statistics assess the accuracy of the forecasts in determining if air quality pollution levels would be in the Good AQI range or in the Moderate or higher ranges. All forecast statistics discussed in this summary are described at the bottom of this page.

Of the 245 next-day ozone forecasts issued, 196 were correct at the Good-to-Moderate threshold, resulting in a Percent Correct (PC) of 80%. Of the 46 days with observed AQI levels of at least Moderate, 38 were correctly predicted in the next-day forecast, resulting in a Probability of Detection (POD) of 83%. The False Alarm Rate (FAR) for the next-day forecasts was 52%.

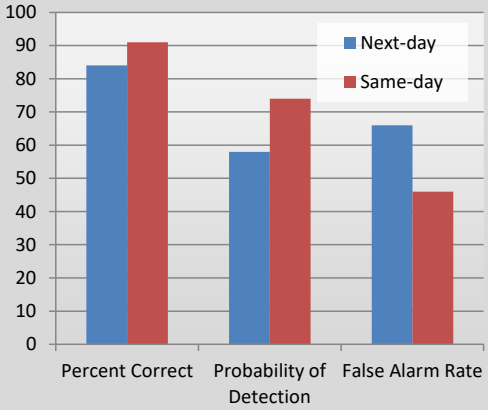
USG ozone AQI levels were observed on three days in central Ohio during summer 2018. The next-day or same-day forecasts called for USG AQI levels on one of these three days, and the average forecast ozone levels on these days was 100 AQI. Air Quality Alerts (next-day or same-day forecasts above 100 AQI) were issued on eight days during summer 2018; of these days, USG ozone AQI levels were observed on one day. Moderate ozone AQI levels were observed on the other seven days, and five of these Moderate days had AQI levels of at least 80.

Of the 365 next–day $PM_{2.5}$ forecasts issued, 307 were correct at the Good-to-Moderate threshold, resulting in a PC of 84%. Of the 40 days with observed AQI levels of Moderate, 23 were correctly predicted in the next-day forecast, resulting in a POD of 58%. The FAR for the next-day forecasts was 66%.

Good-to-Moderate Ozone Forecast Statistics, March–Oct. 2018



Good-to-Moderate $PM_{2.5}$ Forecast Statistics, Nov. 2017–Oct. 2018



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
$PM_{2.5}$	91	74	46	+1.2 µg/m^3	1.8 µg/m^3	84	58	66	+1.5 µg/m^3	2.7 µg/m^3
Ozone	82	85	48	+4.1 ppb	5.9 ppb	80	83	52	+5.1 ppb	7.0 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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