Cracking the AQ Code

ADEQ Arizona Department of Environmental Quality
Air Quality Forecast Team

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Consequences of the New Ozone Standard Change

By: ADEQ Forecast Team

It's early May. You tune into the local news and learn that a high pressure system controls Arizona's weather. The forecast calls for high temperatures in the mid-90s, sunny skies, and light winds. Then you see the words, "Ozone High Pollution Advisory." What does that mean? Does it affect your decision-making? Or do you immediately forget about it? After all, who would be concerned about something you can't see? Surely, if the air looks clean, then the air quality must be alright as well, right? Unfortunately, even though it is invisible, we cannot turn a blind eye to ozone. Ozone is in fact a real thing and it does matter a lot for many people.

In this edition of "Cracking the AQ Code", ozone will be in the spotlight once again (see its first appearance here). However, this time, the recent reduction in the Environmental Protection Agency's (EPA) ozone standard will be the central theme. Ultimately, the topic of this standard change is important to consider because it could likely have ramifications on the overall public perception of air quality.

Ozone's Impact on People

The primary short-term impact ozone has on people's health is that it constricts airways and reduces lung capacity. This can then result in shortness of breath, chest pain, coughing, throat irritation, wheezing, airway inflammation, and the worsening of pre-existing lung diseases (for example, emphysema, bronchitis, and asthma). People that are most at risk for these symptoms include: children, the elderly, people active outdoors, and people with asthma. However, even healthy adults can experience impaired lung function, depending on the rate and duration of their exposure to ozone.

About "Cracking the AQ Code"

In an effort to further ADEQ's mission of protecting and enhancing the public health and environment, the Forecast Team has decided to produce periodic, in-depth articles about various topics related to weather and air quality.

Our hope is that these articles provide you with a better understanding of Arizona's air quality and environment. Together we can strive for a healthier future.

We hope you find them useful!

Upcoming Topics…

- Wildfires
- Air Quality Around the World – PM_{10}
- Tropical Storms

FORECAST DATE	YESTERDAY Mon, 5/2/2016	TODAY Tue, 5/3/2016	TOMORROW Wed, 5/4/2016
NOTICES		Ozone High Pollution Advisory HPA	
AIR POLLUTANT	Highest AQI Reading/Site (*Preliminary data only*)		
O3	108 Phoenix Supersite	105 *Unhealthy for Sensitive Groups*	87 *Moderate*

Figure 1: *Left: A view of downtown Phoenix from South Mountain on May 2, 2016, when ozone exceeded the health standard. Notice how the air quality does not appear adverse, but in fact is, because ozone is invisible. Right: An Ozone High Pollution Advisory (HPA) is issued for Phoenix for May, 3, 2016, because ozone was expected to exceed the federal health standard.*

Ozone's Impact on Plants

Ozone also negatively impacts the environment. Ozone is known to commonly cause unnatural spotting and discoloration of sensitive plant leaves (see Fig. 2). It may also cause leaves to not produce enough chlorophyll, the biomolecule that gives leaves their green color. Reduced chlorophyll leads to reduced photosynthesis (the process in which a plant converts sunlight into energy), which then impedes plant growth. Ozone can also make sensitive plants more susceptible to disease and insect damage. Ponderosa pine, found in northern Arizona, is an example of a plant sensitive to ozone. Ozone can cause abnormally colored spots to appear on needles and leaves to prematurely fall. Furthermore, the negative effects of ozone on individual plants can ultimately result in ecosystem-scale consequences. For further reading on this topic, visit the following links: Ecosystem Effects of Ozone Pollution, Ozone Effects on Vegetation.

Figure 2: *Left: Healthy ponderosa pine needles (top) compared to needles injured by ozone (bottom). Right: Ozone injury is very evident on the tobacco leaf on the right compared to the one on the left. Source: National Park Service, American Phytopathologial Society (see ozone definition).*

The Ozone Standard

Although the concept of a federally recognized ground-level ozone standard dates back to 1971 (see Table 1), it was the 1990 Clean Air Act that paved the way for the declaration of the six criteria pollutants: carbon monoxide, lead, nitrogen dioxide, particle pollution (PM-10 and PM-2.5), and ozone. Because ozone is one of the criteria pollutants, it was assigned a National Ambient Air Quality Standard (NAAQS) by the EPA that must be regularly reviewed.

Driven by the latest scientific research on public health and environmental degradation, multiple standard changes have already resulted since 1990, including for ozone, the first of which became official in 1997. A daily 8-hour concentration average above 0.08 parts per million (ppm) or equivalently, 80 parts per billion (ppb), would have exceeded the NAAQS. It took over a decade in 2008 for a revised standard of 75 ppb to be established. Finally, we have the most current 70 ppb threshold finalized by EPA during late 2015.

Table 1: Historical timeline for ozone standard changes. Source: Environmental Protection Agency (EPA).

History of the NAAQS for Ozone, from 1971 to 2015

Final Rule/Decision	Primary/Secondary	Indicator[1]	Averaging Time	Level[2]	Form
1971 36 FR 8186 Apr 30, 1971	Primary and Secondary	Total photochemical oxidants	1 hour	0.08 ppm	Not to be exceeded more than one hour per year
1979 44 FR 8202 Feb 8, 1979	Primary and Secondary	O_3	1 hour	0.12 ppm	Attainment is defined when the expected number of days per calendar year, with maximum hourly average concentration greater than 0.12 ppm, is equal to or less than 1
1993 58 FR 13008 Mar 9, 1993	EPA decided that revisions to the standards were not warranted at the time				
1997 62 FR 38856 Jul 18, 1997	Primary and Secondary	O_3	8 hours	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008 73 FR 16483 Mar 27, 2008	Primary and Secondary	O_3	8 hours	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2015 80 FR 65292 Oct 26, 2015	Primary and Secondary	O_3	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8 hour average concentration, averaged over 3 years

1. O_3 = ozone

2. Units of measure are in parts per million (ppm)

How are ADEQ Air Quality Forecasts Affected?

The alteration of the ozone standard also means a change to what our air quality forecasts represent. What tends to occur following pollutant standard reductions is a subsequent revision of the range of concentrations that constitutes a particular Air Quality Index (AQI) category (e.g., Good vs. Moderate) (see Table 2).

Particularly, this would come into play when considering the criteria for when the ADEQ Forecast Team will issue a High Pollution Advisory (HPA), which is always governed by the current standard. In other words, if forecasted daily average 8-hour ozone concentrations are expected to exceed the federal health standard of 70 ppb, we will issue an ozone HPA to warn the general public and trigger action to help counter local contribution to ozone formation. The 70 ppb is in contrast to the previous 75 ppb benchmark. This five ppb difference is likely to translate to a greater number of HPAs during a year. A look at Metro

Phoenix's typical ozone values and possible implications to the expected volume of HPAs forecasted are explored in the following section.

Table 2: Comparison of concentration ranges for ozone and associated Air Quality Index (AQI) categories between the 2008 and 2015 ozone National Ambient Air Quality Standards (NAAQS). Source: Environmental Protection Agency (EPA).

AQI Category	Index Values	Breakpoints in the 2008 AQI (ppb, 8-hour average)	Updated Breakpoints (ppb, 8-hour average)
Good	0 - 50	0-59	0-54
Moderate	51 - 100	60-75	55-70
Unhealthy for Sensitive Groups	101 – 150	76-95	71-85
Unhealthy	151 – 200	96-115	86-105
Very Unhealthy	201 – 300	116-374	106-200
Hazardous	301 –500	375 to the Significant Harm Level*	201 to the Significant Harm Level*

**The Significant Harm Level for ozone is 600 ppb, two-hour average*

Changing Air Quality Perceptions

From a forecaster's perspective, a concern we have is that the public will conclude ozone is getting worse because they may notice more HPA's being issued and an increase in the number of days exceeding the federal health standard. However, it's important to keep in mind that creating a stricter ozone standard doesn't inherently have any effect on ozone levels. The purpose of the new standard is to foster measures that will ultimately move ozone to acceptable levels. As we've discussed, the ozone standard has now changed three times since the Clean Air Act was enacted in 1990. Here we will compare the 2008 standard to the most recent 2015 standard and discuss the actual versus perceived changes in ozone levels.

To start off let's take a look at how ozone has behaved over the past several years (see Fig. 3). As you can see, no two years are the same. Weather conditions have a strong influence over ozone levels, and some years will simply have more days that are conducive for ozone formation than others. For example, years with a less active monsoon season would mean less cloud cover and lighter winds, resulting in higher than normal ozone levels. This is not to say limiting ozone is completely out of our control though.

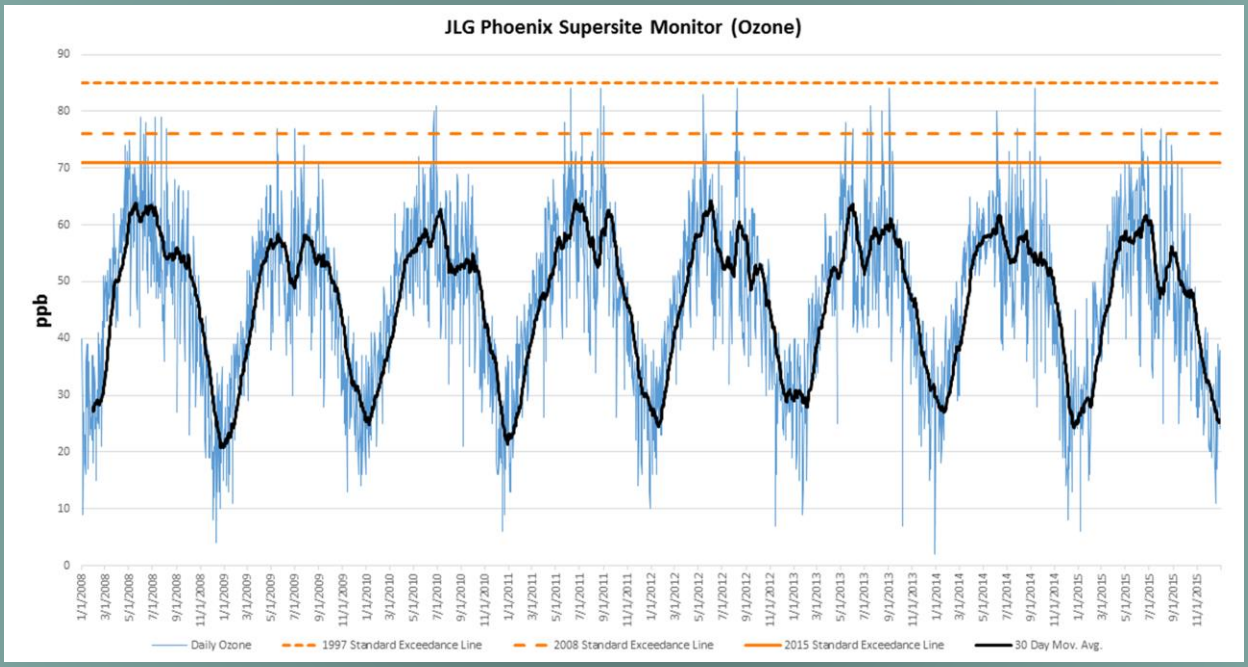


Figure 3: *Daily 8-hr maximum ozone concentrations (blue lines) from ADEQ's JLG Phoenix Supersite monitor going back to the year 2008. The black line indicates the rolling 30-day average ozone concentration, while the various orange lines correspond to the concentrations needed to exceed the last three federal ozone standards (small dash = 1997 standard; large dash = 2008 standard; solid line = new 2015 standard).*

ADEQ works with federal, state, tribal, and local governments, as well as the public, to curb ozone formation by limiting ozone precursors, such as NOx and VOCs. Even so, the new standard will have a noticeable change in the amount of exceedances that occur (see Table 3). Moving from one standard to a stricter one can give the perception of worsening air quality. For example, we will look at 2015 using the three most recent standards set in place by the EPA: the current standard of 70 ppb, the 2008 standard of 75 ppb, and 1997 standard of 80 ppb. If the 1997 standard of 80 ppb was in effect for 2015, there wouldn't have been any exceedances. On the other hand, if 75 ppb was in effect, then the Phoenix metropolitan area would have seen seven exceedance days in 2015. Finally, looking at 2015 with the newly set standard of 70 ppb, there would have been 28 recorded ozone exceedance days. Therefore, the perception of air quality could appear degraded when comparing the 2015 standard versus previous ozone standards.

Table 3: Comparison of the amount of days the Phoenix area monitoring network would have recorded a federal health exceedance using the last three ozone standards established by the Environmental Protection Agency (EPA).

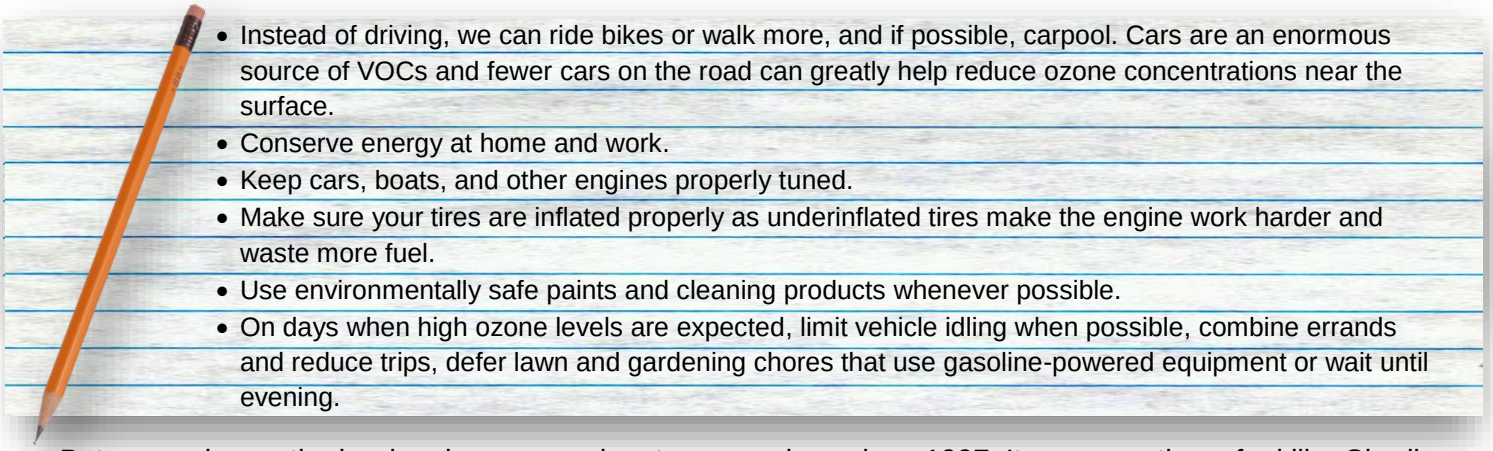
Exceedance Days:	1997 Standard	2008 Standard	New Standard
2015	0	7	28
2014	1	11	27
2013	1	13	39
2012	3	28	55
2011	2	18	46
2010	1	10	25

Once again, as a reminder, the data does not change, only the cut-off value for an exceedance. That is why it is important to be informed about the updated standard. Thus, as we move forward with the newly set ozone standard, expect more ozone exceedances this year. In addition to more exceedances, the

period of the year with elevated ozone levels will be extended. For instance, the first and last ozone exceedances have typically occurred around early May and late August, respectively; however, it is quite possible now to observe exceedances as early as April and as late as October. The perception of air quality, which seemed better in recent years, may now be appearing to get worse. Just remember, it's the new standard causing the sudden change, not the air itself. The key is that, although an increased frequency of HPAs are going to occur based on a lower EPA standard, they should still merit the same recognition as years prior since they now reflect the latest research on ozone and its adverse effects upon public health and the environment.

So What Can We Do?

Now that we have established the technical side of the ozone standard change, let's answer the real question: What can we do to help improve Arizona's air? First of all, we'd like to extend a heart-felt appreciation for the work that has already been done to improve the state's air over the past two decades. When the 1997 standard was rolled out, it seemed like an impossible bar to overcome. Through extensive collaboration between local, county and state government agencies, we have since had multiple years where Phoenix has met the standard. Changes in seasonal gasoline blends, improved public relations and coordinated messaging, and better outreach and education have been key factors in helping to reach that goal. Changes in public behavior such as people teleworking and using public transit on High Pollution Advisory days have contributed to reducing precursors to ozone as well. Here are some additional actions the public can take to mollify ozone production near the surface.



- Instead of driving, we can ride bikes or walk more, and if possible, carpool. Cars are an enormous source of VOCs and fewer cars on the road can greatly help reduce ozone concentrations near the surface.
- Conserve energy at home and work.
- Keep cars, boats, and other engines properly tuned.
- Make sure your tires are inflated properly as underinflated tires make the engine work harder and waste more fuel.
- Use environmentally safe paints and cleaning products whenever possible.
- On days when high ozone levels are expected, limit vehicle idling when possible, combine errands and reduce trips, defer lawn and gardening chores that use gasoline-powered equipment or wait until evening.

But, as we know, the bar has been moved on two occasions since 1997. It can sometimes feel like Charlie Brown trying to kick that football. Just as he (we) gets enough confidence that he can finally kick the ball (we can finally reach that standard), Lucy pulls the ball away (the standard gets more stringent). It's important for everyone to keep doing their part regardless of the changing standards. It's even more important to realize that we have made a difference by our actions, giving us confidence that we can continue to do so in the future.

For our next topic, the ADEQ Forecast Team will look at Wildfires.

Thanks for reading!

Sincerely,
ADEQ Forecast Team
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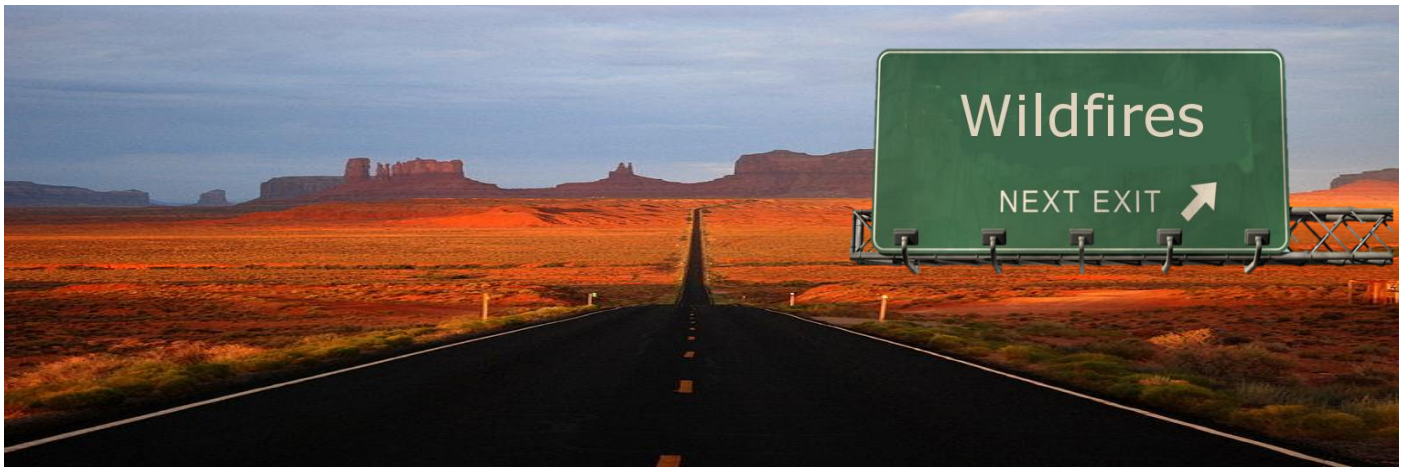
If you haven't already, click HERE to start receiving your Daily Air Quality Forecasts (Phoenix, Yuma, Nogales)

In case you missed the previous Issues…

June 2015: Tools of the Air Quality Forecasting Trade: Capturing Dust Storms on Doppler Radar
July 2015: Ozone: An Invisible Irritant
Sept 2015: North American Monsoon
Oct 2015: The Genesis of a Thunderstorm: An Arizona Perspective
Dec 2015: Temperature Profiles, Inversions, and NO BURN DAYS
Jan 2016: El Niño Southern Oscillation
Feb 2016: All About Fog
April 2016: Jet Streams and Fronts



Here's a look at what we'll be discussing in the near future…

-Wildfires
-Air Quality Around the World – PM_{10}
-Tropical Storms

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