

Florida's Ozone and Particulate Matter Air Quality Trends

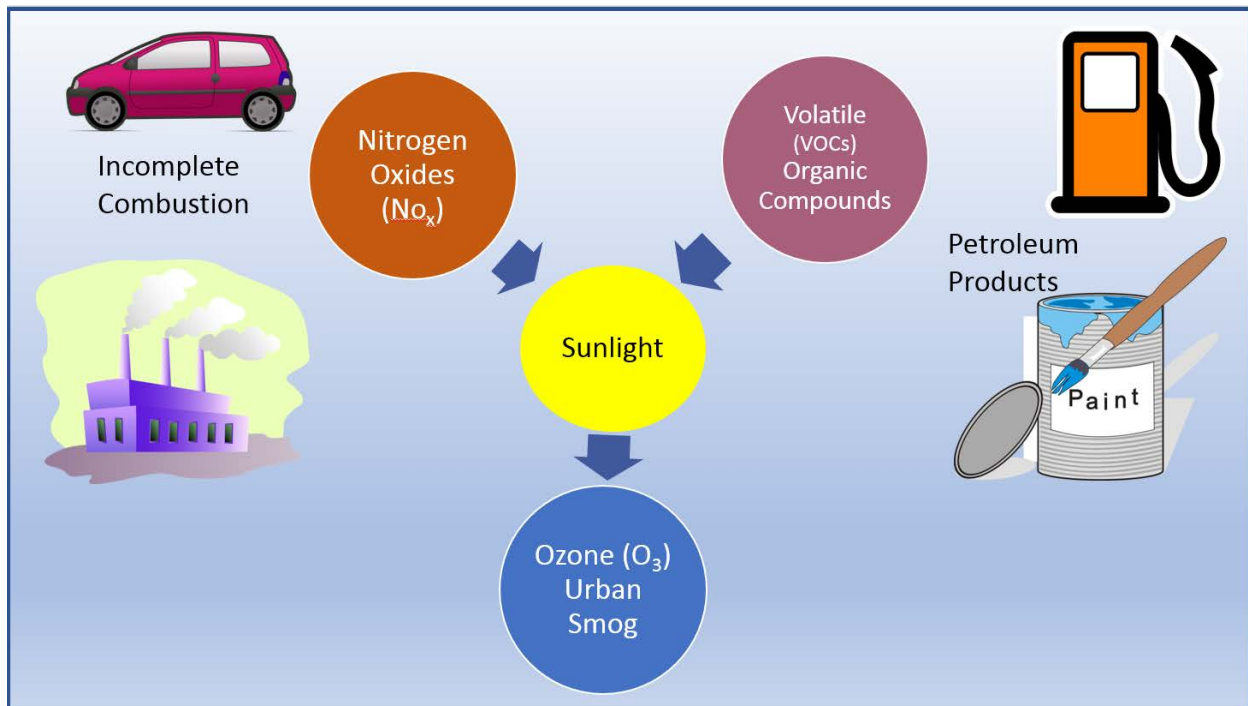
Introduction

Ozone and fine particulate matter are two of the most common and widespread air pollutants. While these pollutants are naturally present in outdoor air, certain areas can have elevated levels that become unhealthy. Fortunately, the air quality across the State of Florida is consistently ranked among the best in the nation with respect to ozone and fine particulate matter. The American Lung Association's 2019 "State of the Air" report ranks 228 cities in 24 counties across Florida as among the cleanest in the country. In addition, all areas in the State meet the air quality standards for these pollutants and levels continue to decrease as they have for many years.

What is ozone?

Ozone is a very reactive gas made of three atoms of oxygen and is the main component of urban smog. Unlike the oxygen we breathe, ozone can be harmful at high levels. Ozone is not directly emitted by any source but is formed when *precursor pollutants*, volatile organic compounds (VOCs) and nitrogen oxides (NO_x), go through a series of complex chemical reactions in the presence of sunlight (**Figure 1**). These reactions are very sensitive to weather conditions. The highest levels of ozone occur when the weather is hot, dry, and sunny and the winds are light. Ozone occurs naturally at low levels but emissions of these precursor pollutants from human activities causes the levels to increase; occasionally to unhealthy levels. Ozone is also found high in the atmosphere where it forms an important protective layer that shields us from the sun's harmful ultraviolet (UV) rays.

Figure 1: Illustration of the formation of ozone.

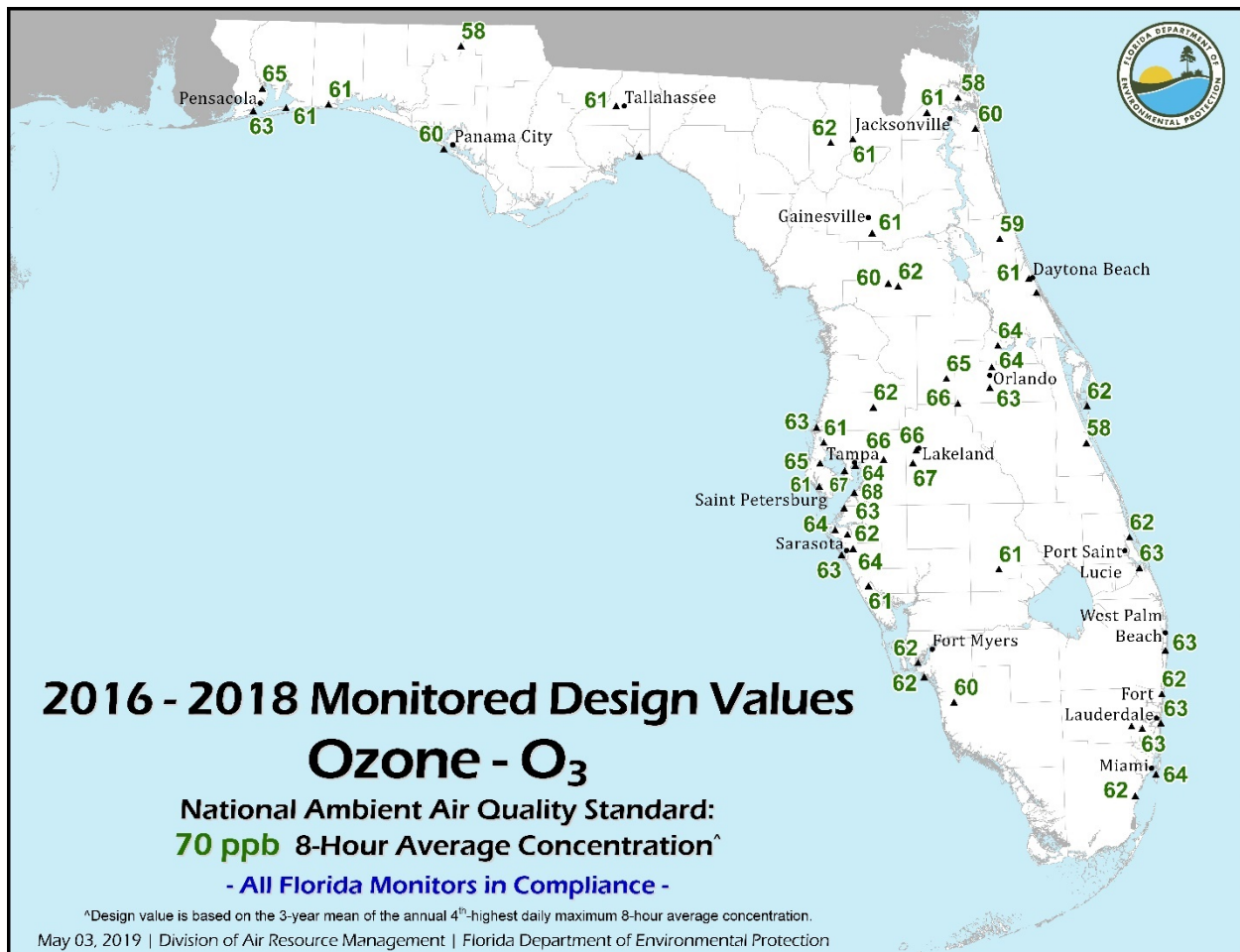


How is Ozone Measured and Reported?

Ozone is measured year-round at 56 monitoring sites in 33 counties across Florida. The monitor locations are shown in **Figure 2**. The monitors are operated by the Florida Department of Environmental Protection (DEP) and nine local government agencies. Florida has approximately 50% more monitors than are required by the U.S. Environmental Protection Agency (EPA). The monitors are operated and maintained under strict national rules to ensure that the data are of the highest quality.

Realtime, hourly ozone data are available on [DEP's Office of Air Monitoring website](#). A variety of other resources including summary reports are also available on the website. Additionally, this information along with local air quality forecasts and ozone data from monitors across the country can be found on EPA's [AirNow website](#). The next day's air quality forecast is available for 23 cities across Florida.

Figure 2: Florida ozone monitors and design values.



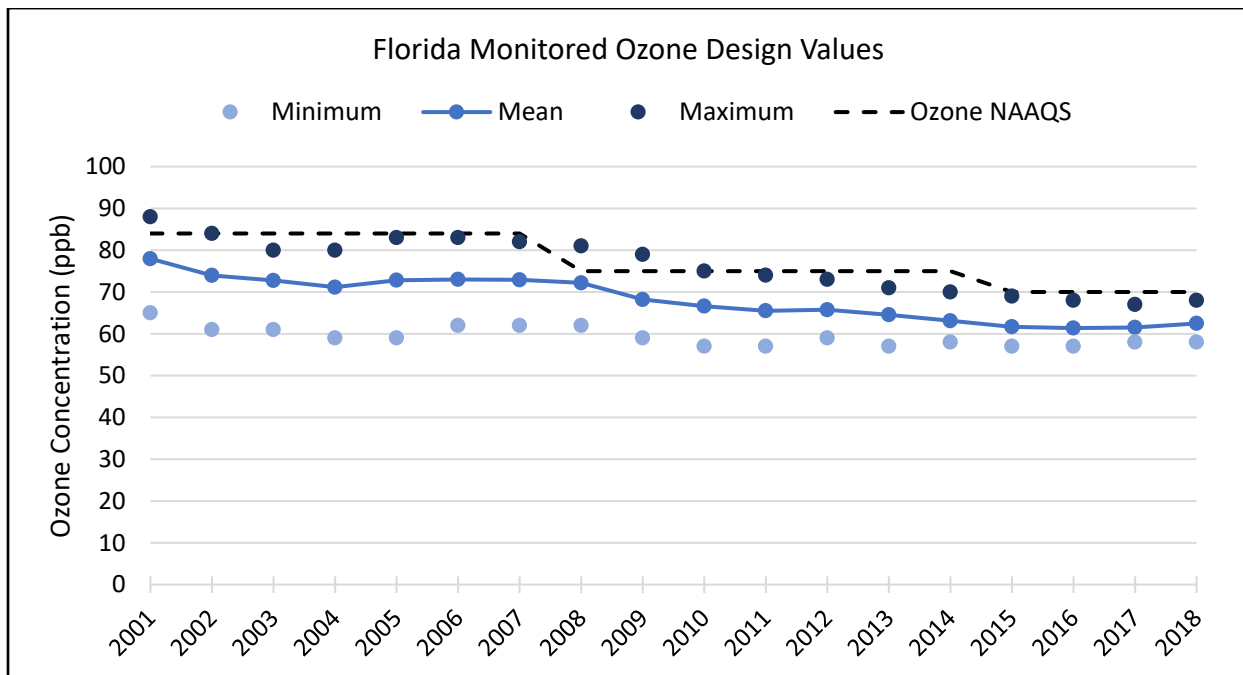
How Do Florida’s Ozone Levels Compare to the Standard?

EPA sets national ambient air quality standards (NAAQS) for a variety of air pollutants. For ozone, the standard is 70 parts per billion (ppb). Compliance with this standard is based on the 3-year average of the annual fourth-high, daily maximum 8-hour concentration. This value, called the design value, is calculated for each monitor in the State and then compared to the standard. As shown in **Figure 2**, all 56 monitors in Florida have a design value lower than 70, and therefore meet this health-based standard.

What Are Florida’s Ozone Level Trends?

Since peaking in the late 1990s, ozone levels in Florida have been gradually declining. This trend is illustrated in **Figure 3** showing the range of monitored design values for each year. In addition, the difference between the highest and the lowest design value each year has been getting smaller with the average design value getting closer to the lowest, instead of the highest. This change means that most of the monitors in the State are recording design values closer to the statewide minimum and just a few monitors have design values near the statewide maximum. As shown in **Figure 3**, the ozone standard has been lowered twice since the current form of the standard was introduced in 1997. Despite these changes, Florida has not had a monitor with a design value higher than the standard in nearly a decade.

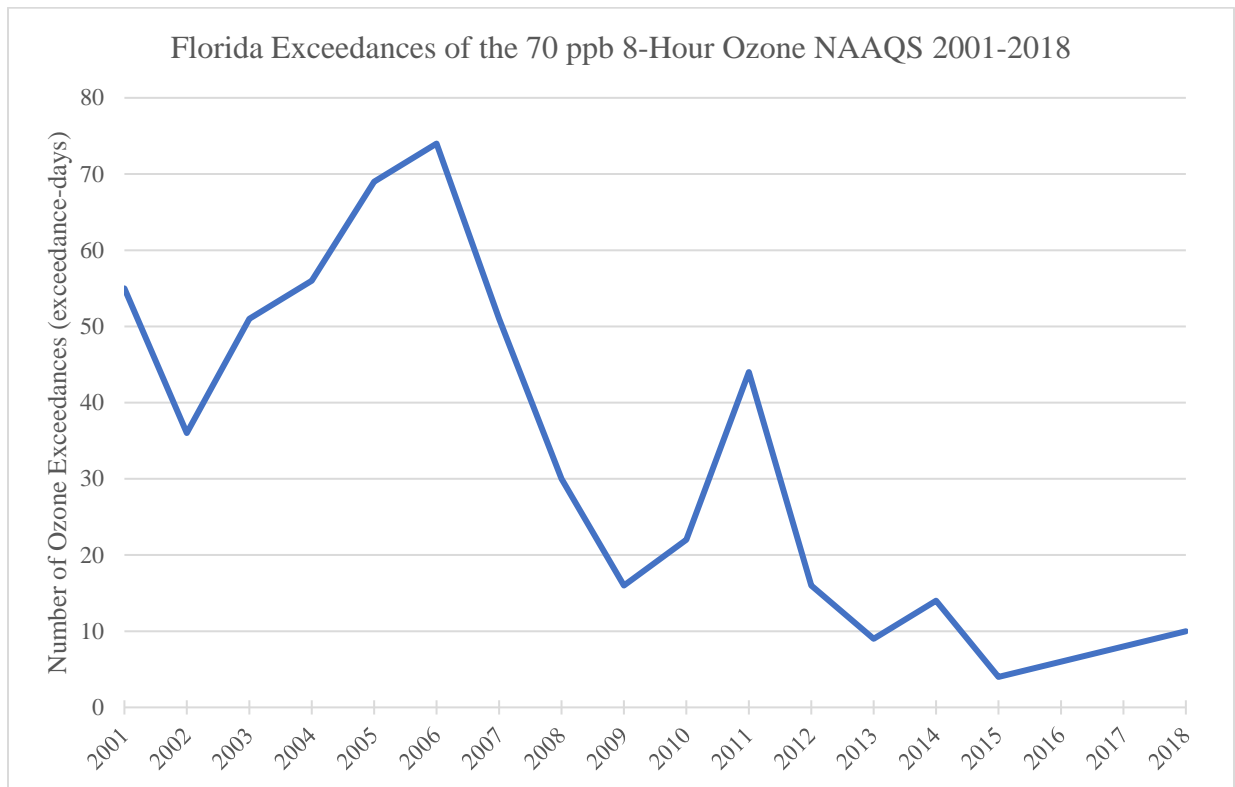
Figure 3: Florida monitored ozone design values.



When considering changes in ozone, the downward trend in design values is only part of the story. The highest levels of ozone only occur during the time of the year when hot, dry, and sunny weather conditions are present. In Florida, exceedances of the ozone standard (days when the 8-hour average level is above 70 ppb) generally occur from about March to October with a peak in

May. The length of time between the first and last exceedance of the ozone standard is getting shorter. Higher ozone levels are appearing later in the spring and ending earlier in the fall, reducing the time that Floridians are exposed to high levels of ozone. There has also been a remarkable decrease in the number of exceedances. **Figure 4** shows the large decrease in monitored ozone levels above the current standard of 70 ppb. In the last ten years, monitored exceedances of the ozone standard have decreased almost 40%.

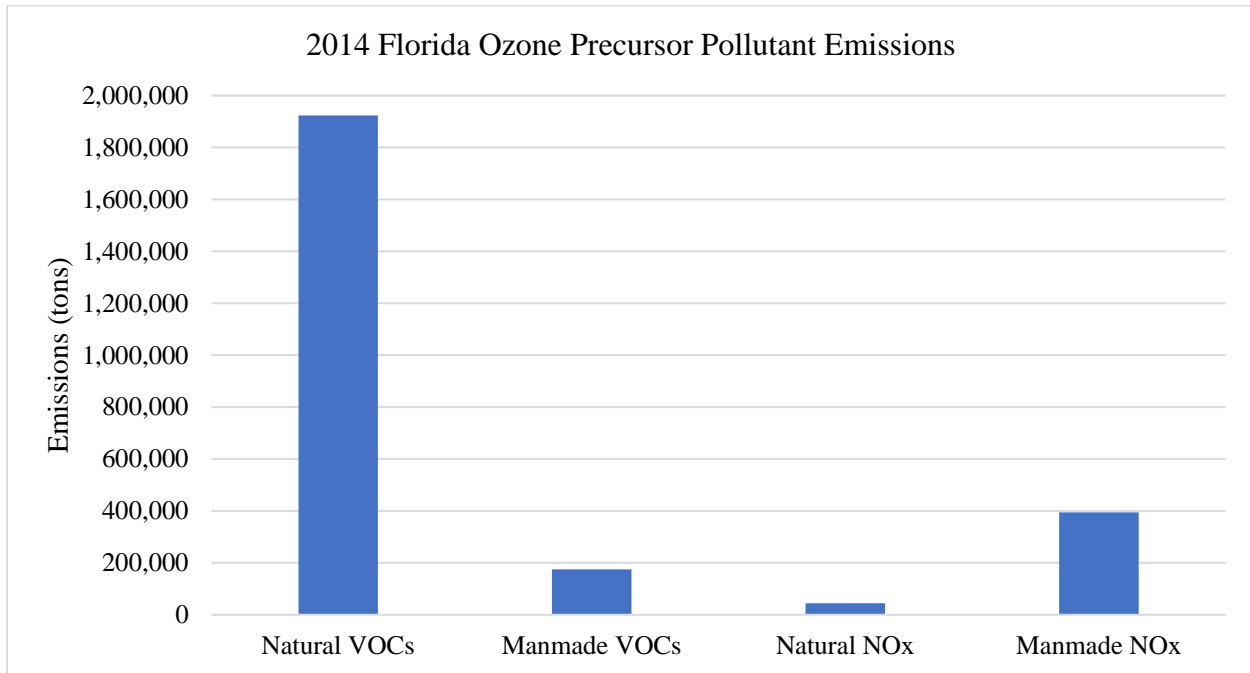
Figure 4: Annual number of monitored ozone levels above the current ozone standard.



What Are Florida's Ozone Precursor Trends?

As previously mentioned, ozone is not emitted directly by pollution sources but is instead created when two types of gases, the precursor pollutants, react in a chemical process powered by the energy of sunlight. The precursor pollutants VOCs and NO_x come from natural and manmade sources. VOCs emitted by plant life are naturally abundant in the Southeastern part of the country and manmade emissions are comparatively insignificant (**Figure 5**). NO_x however, is mostly a manmade pollutant and research has shown that NO_x emitted by human activities is the main driver of ozone formation in the Southeast.

Figure 5: 2014 Florida emissions of VOCs and NO_x by source.



To reduce ozone levels, emissions of the precursor pollutants must be reduced. Since VOCs are mostly from natural sources, reduction efforts have been focused on NO_x emissions. These efforts have produced significant reductions as can be seen in **Figure 6**. On-road sources are emissions from cars and trucks on the highways and they represent the greatest portion of manmade NO_x emissions. Federal vehicle emissions standards have led to significant reductions in emissions from this source category. Industrial facilities are the second largest source of NO_x emissions. These sources, including power plants and manufacturing facilities, have also significantly reduced emissions due to a variety of state and federal rules. Other sources of NO_x include construction equipment, planes, trains and ships, asphalt paving and residential heating.

While less important to ozone formation in Florida, manmade VOC emissions have also been decreasing (**Figure 7**). VOCs are emitted mostly by mobile sources such as cars, trucks, planes, trains, and ships. The long-term downward trend is due to a variety of federal and state emissions and manufacturing standards. Industrial sources are not a significant source by comparison.

Figure 6: Florida NO_x emissions by source category.

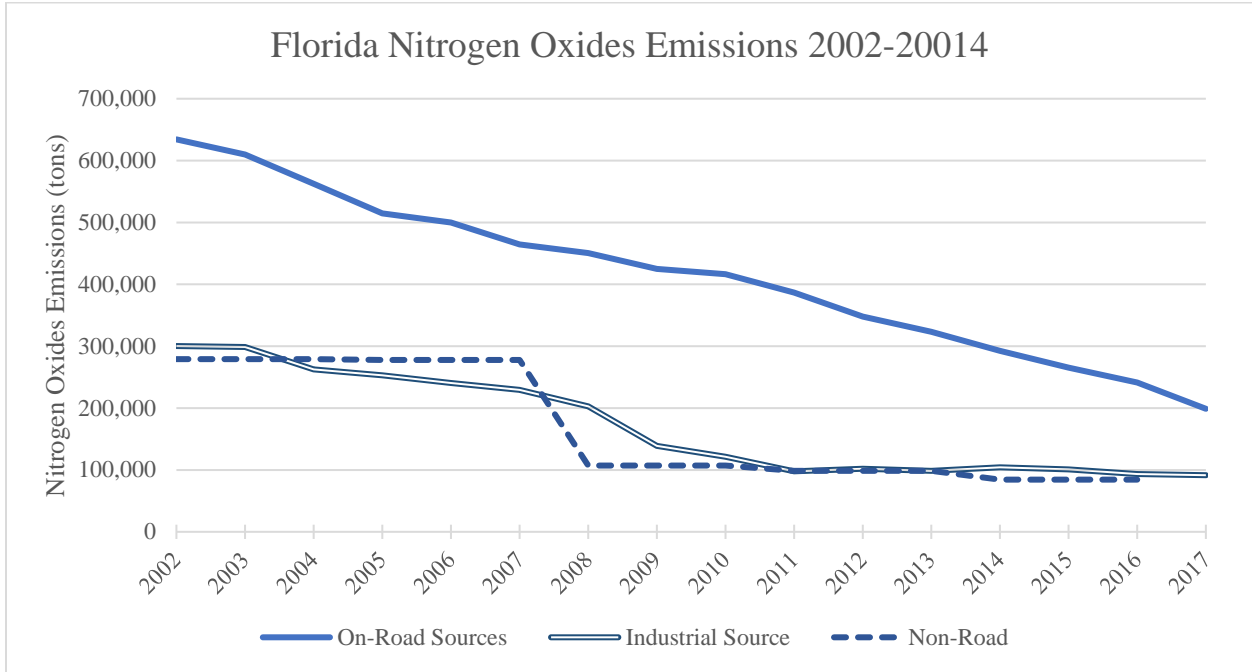
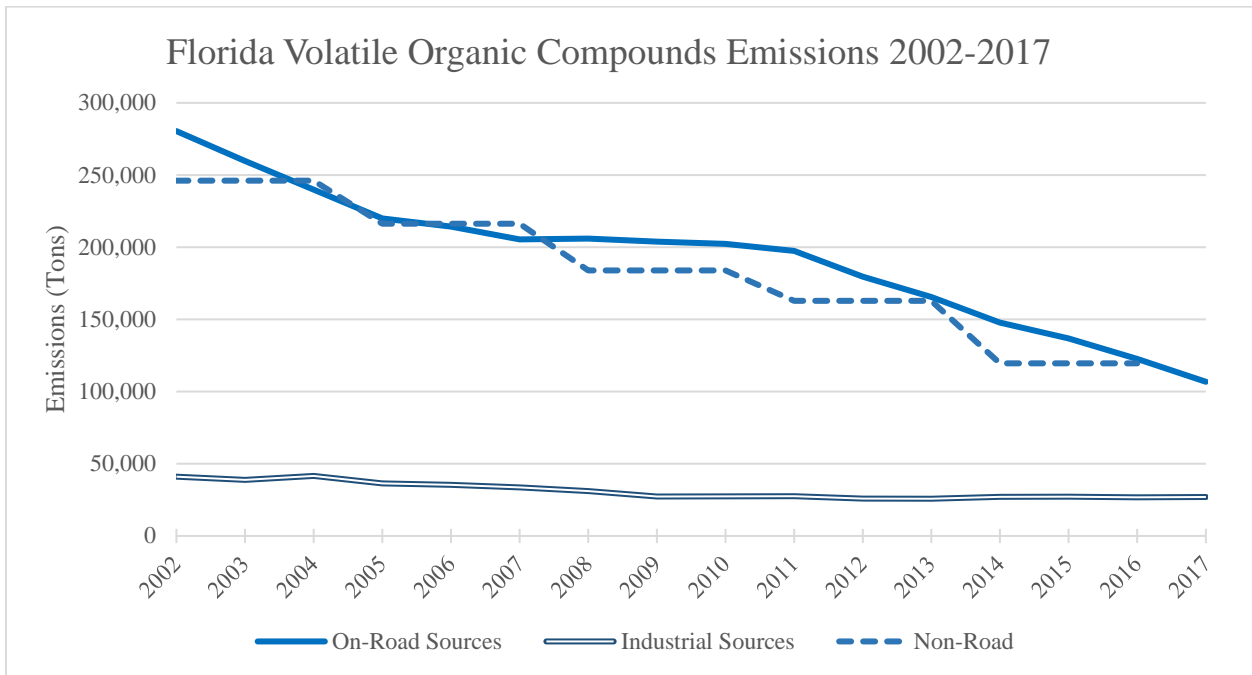


Figure 7: Florida VOC emissions by source category.

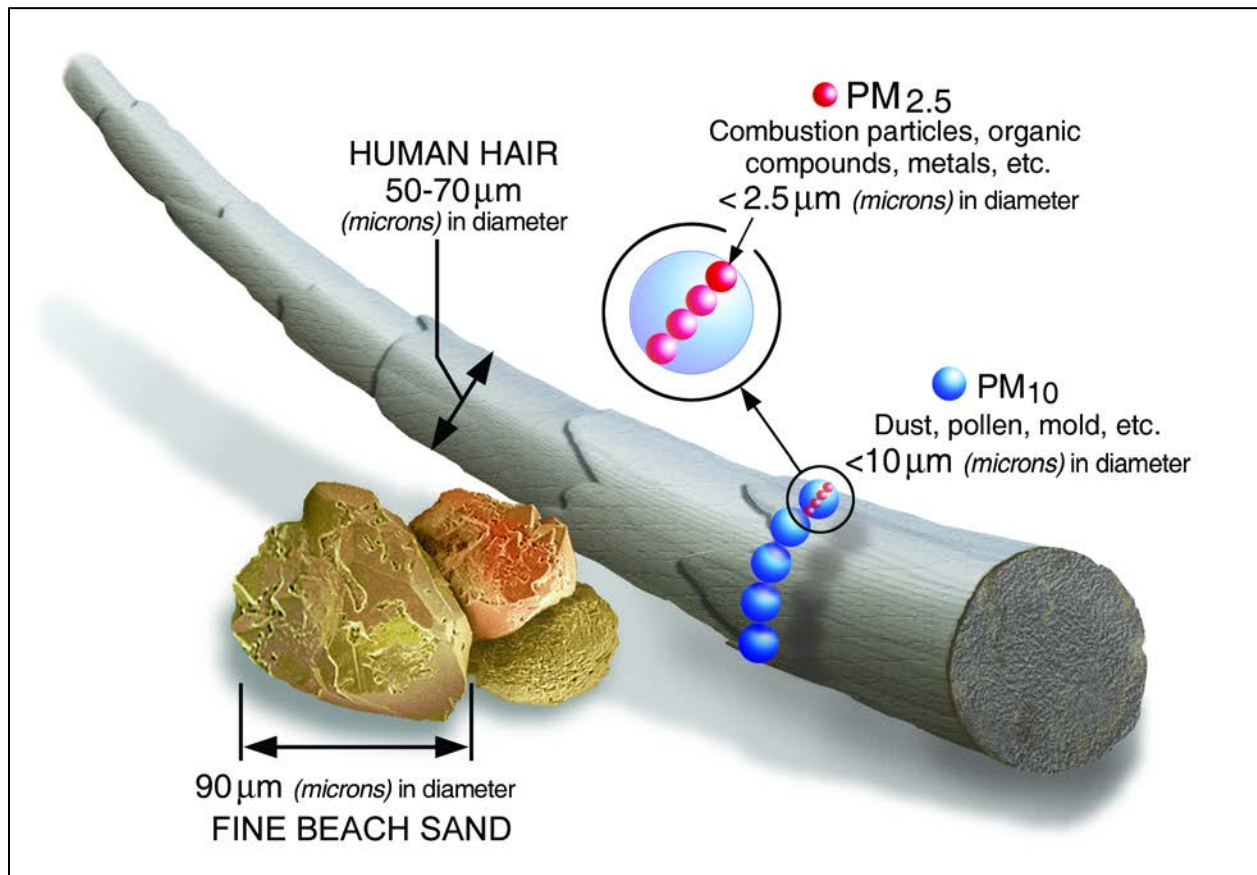


What is Particulate Matter?

Particulate matter (PM) is a mixture of solid particles and liquid droplets found in the air that are small enough to be inhaled deep into the lungs. The particles are grouped into two categories based on their size. The larger particles are called PM₁₀ and they have a diameter of 10 micrometers or smaller. The smaller particles are called PM_{2.5} or fine particles, and have a diameter of 2.5 micrometers or less. The illustration in **Figure 8** provides some perspective on the relative sizes of these particles.

There are many sources of PM. Most of the particles are formed in the atmosphere as the result of complex chemical reactions involving the *precursor pollutants* nitrogen oxides (NO_x) and sulfur dioxide (SO₂). These pollutants are mostly manmade and are emitted by industrial sources and mobile sources. PM can also be directly emitted from these sources. High levels of PM are typically found in smoke emitted by wildfires and other fires. A few times each year, Florida and the Caribbean receive some dust blown across the Atlantic Ocean from the Saharan Desert that contains both PM_{2.5} and PM₁₀. Saharan dust crossing the Atlantic has been documented for centuries. These dust clouds do not typically increase the PM to unhealthy levels, but they do enhance the colors of sunrises and sunsets. PM_{2.5} is also the main cause of reduced visibility and haze in many parts of the country.

Figure 8: Illustration of the relative sizes of PM₁₀ and PM_{2.5} particles.

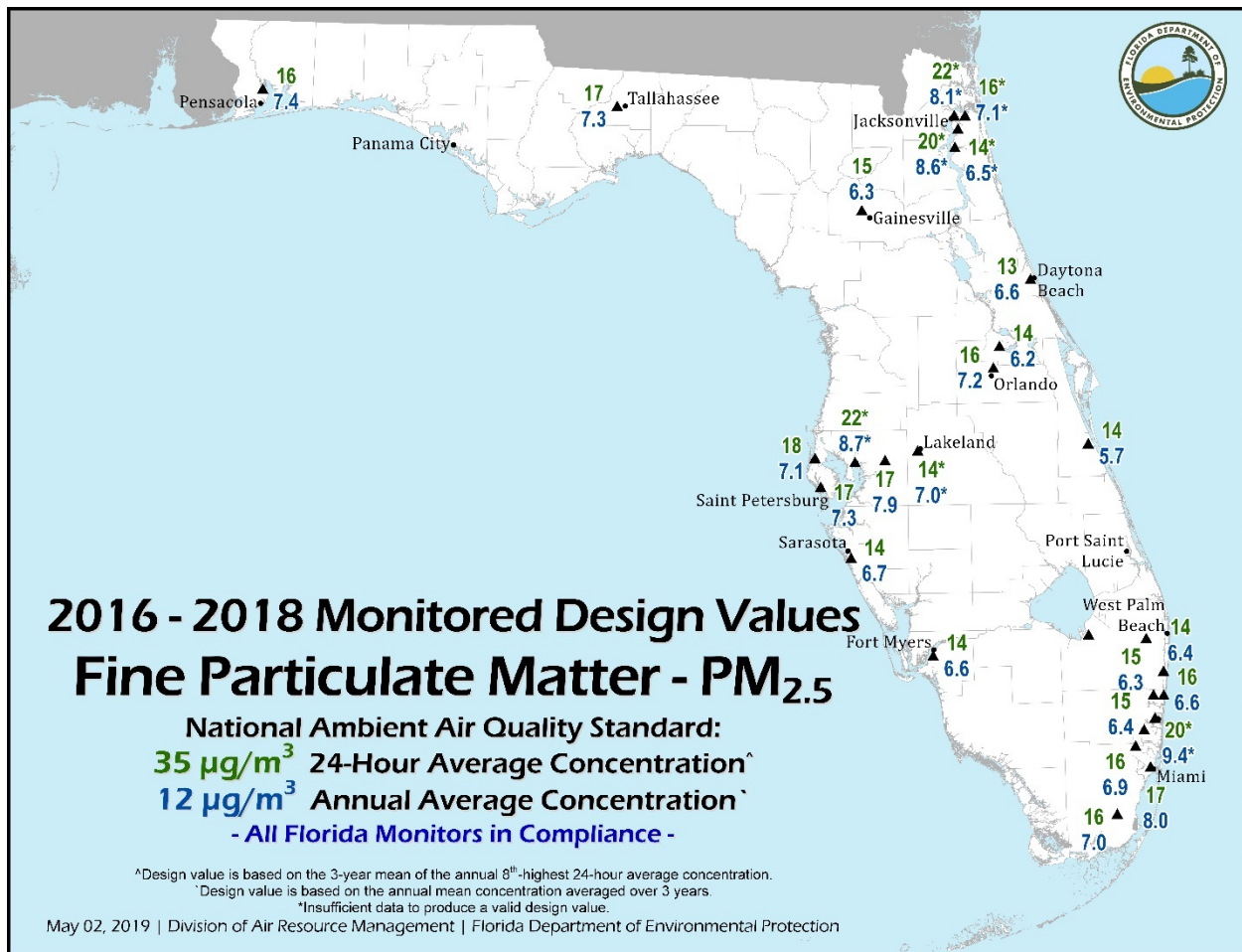


How is Particulate Matter Measured and Reported?

PM₁₀ is monitored at 20 sites statewide and PM_{2.5} at 28 sites (**Figure 9**). Many of these monitors utilize the traditional PM measurement method involving the use of a individual filter. This method is very manpower intensive and involves physically replacing the filter and weighing the collected PM every 24 hours. As newer systems using various automated electronic systems to produce not one reading per day, but one per hour are becoming more reliable and accurate, they are beginning to replace the older filter-based systems. There are also many non-regulatory PM monitors in Florida that provide real-time monitoring of PM to alert the public of rapidly changing levels due to events such as fires.

Regulatory PM data and the real-time, hourly PM data are available on [DEP's Office of Air Monitoring website](#). A variety of other resources including summary reports are also available on the website. Additionally, this information along with local air quality forecasts and PM data from monitors across the country can be found on EPA's [AirNow website](#). The next day's air quality forecast is available for 23 cities across Florida.

Figure 9: Florida PM_{2.5} monitors and design values.



How Do Florida’s Particulate Matter Levels Compare to the Standard?

EPA also sets NAAQS for both PM₁₀ and PM_{2.5}. There are two standards for PM_{2.5}, an annual average standard set at 12.0 micrograms per cubic meter (µg/m³) and a 24-hour average standard set at 35 µg/m³. Compliance with the annual standard is based on the 3-year average of the annual average concentration. Compliance with the 24-hour standard is based on the 3-year average of the annual eighth-high concentrations. These design values are calculated for every monitor in the State and compared to the standard. As can be seen in **Figure 9**, every monitor in the state meets both standards.

PM₁₀ has a 24-hour average standard of 150 µg/m³. Compliance with this standard is based on the number of exceedances of the standard. The standard is not to be exceeded more than once per year on average over three years. All of Florida is designated as attaining the PM₁₀ standard.

What Are Florida’s Particulate Matter Level Trends?

PM_{2.5} and PM₁₀ levels are gradually decreasing across the State. **Figure 10** shows that since monitoring began for PM_{2.5} in 2001, design values for both the annual and 24-hour standards have decreased. Even though EPA has lowered both standards since they were introduced, Florida has never had a monitor with a design value exceeding either standard. The trend in PM₁₀ levels is shown in **Figure 11**. As can be seen, the levels of PM₁₀ in Florida are well below the standard, averaging less than 30% of the standard.

Figure 10: Florida monitored PM_{2.5} design values.

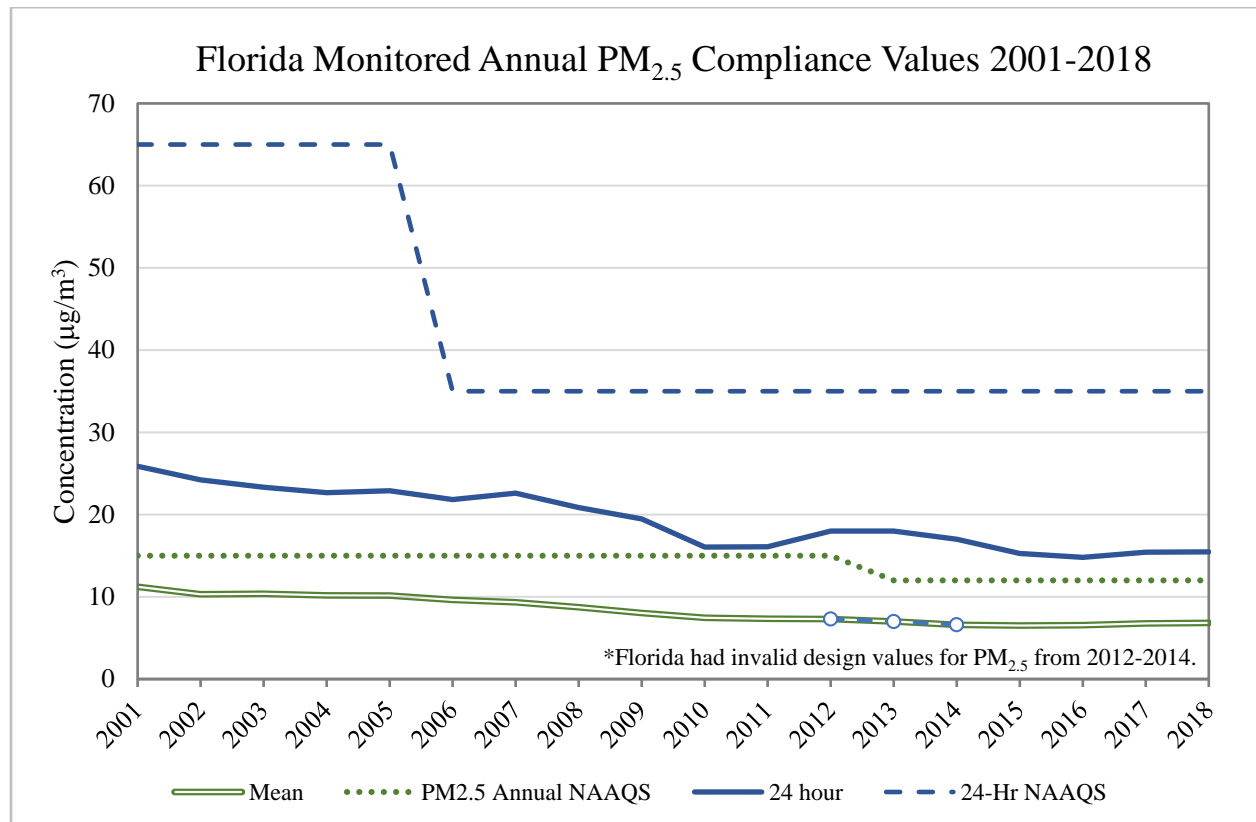
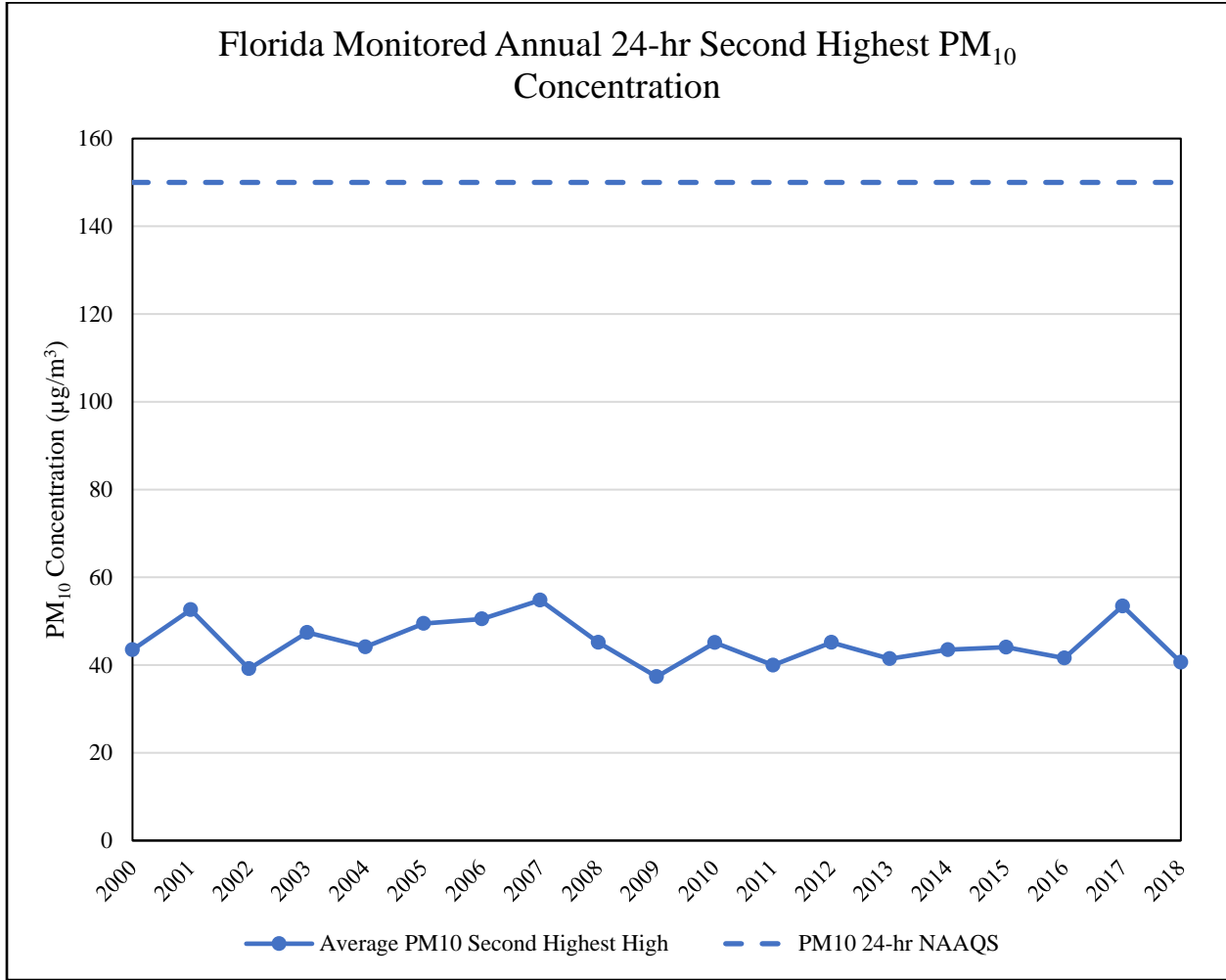
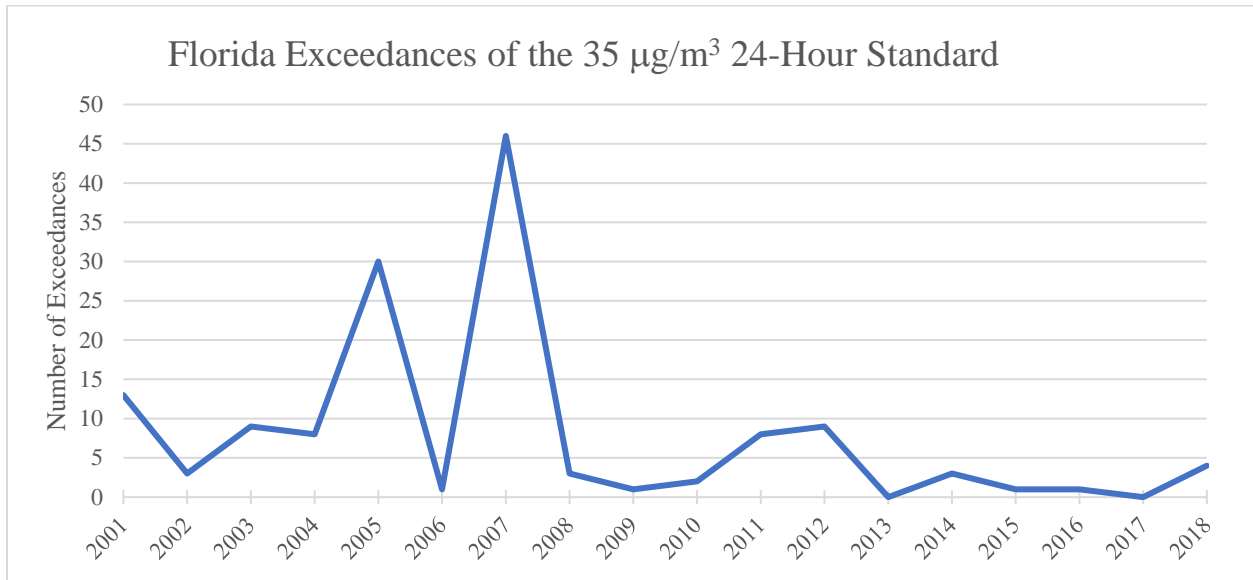


Figure 11: Florida monitored PM₁₀ levels.



In addition to the decreasing design values, the total number of exceedances of the 24-hour standard (days when the average level is above 35 µg/m³) has been declining as well (**Figure 12**). The numbers can fluctuate from year-to-year based on the number of monitors there were in each year and if there were any major wildfires. Wildfires have historically been the most common cause of PM_{2.5} exceedances in Florida, and years with many fires often have a correspondingly large number of exceedances. For example, the Bugaboo fire, the largest wildfire in the history of both Georgia and Florida, caused the spike seen in the 2007 data. Only three of the 46 exceedances during 2007 were not associated with the Bugaboo wildfire. The others were associated with the 4,630 wildfires supported by a significant drought. Except for wildfire impacts, the typical PM_{2.5} levels in Florida easily meet the standards. There were no exceedances of the 24-hour standard in 2017. Florida has never had a monitored violation of the annual standard.

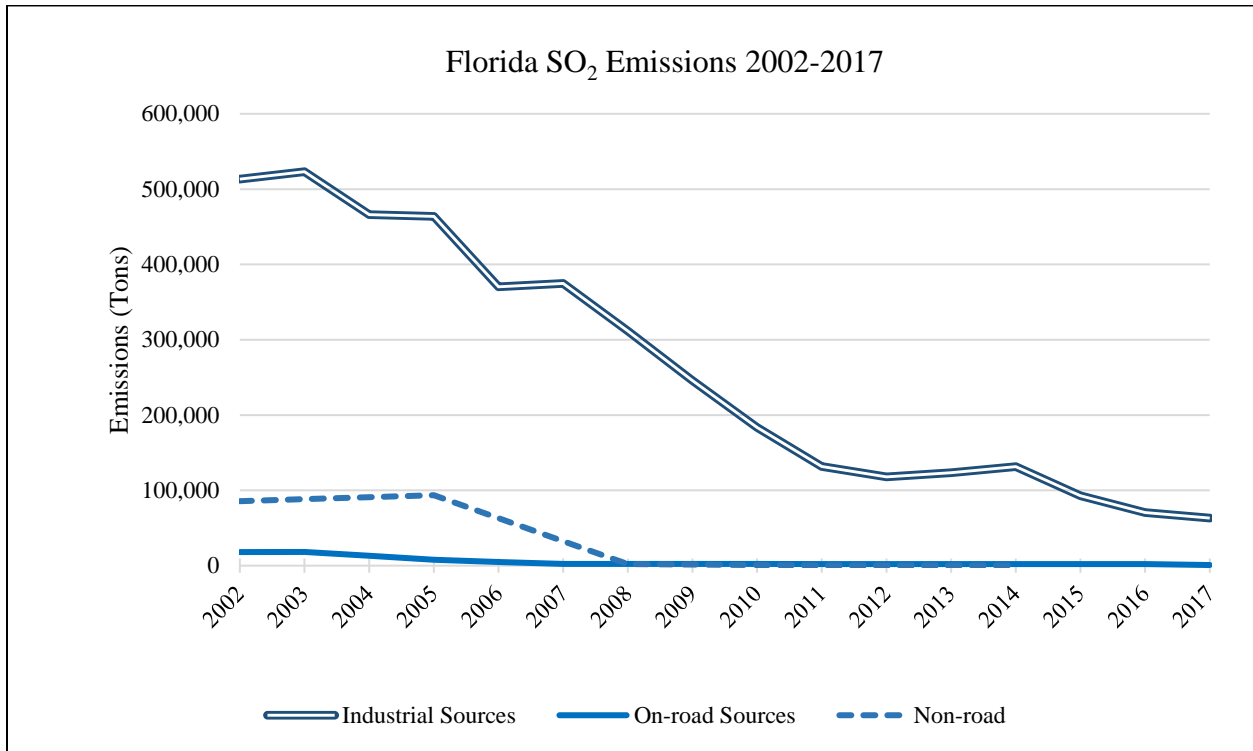
Figure 12: Annual number of monitored PM_{2.5} levels above the current PM_{2.5} standard.



What Are Florida's Particulate Matter Precursor Trends?

Most PM_{2.5} is formed in the atmosphere from chemical reactions involving the precursor pollutants. The most common reactions involve SO₂ and NO_x gases combining with sea salt or ammonia to form small particles called sulfates and nitrates. Sulfates and nitrates fall into the PM_{2.5} category and are responsible for most of the reduced visibility seen in rural areas across the country. Because NO_x is a precursor pollutant for both ozone and PM, the downward trends in NO_x emissions were discussed earlier and shown in **Figure 6**. SO₂ emissions have decreased even more than NO_x emissions. **Figure 13** shows that SO₂ emissions from sources other than industrial facilities have decreased to near zero. Emissions from industrial sources have decreased nearly 75% in the past decade. These precursor pollutant emissions have driven the significant reduction in PM_{2.5} design values seen across Florida.

Figure 13: Florida SO₂ emissions by source category.



Conclusions

The trends in ozone and particulate matter in Florida show less and less pollution over time. Florida's air quality is among the best in the nation and as the state's air quality continues to improve, it will remain so.