Seasonal Report

2015 Ozone

MARYLAND
Department of the Environment

OVERVIEW

Similar to 2013 and 2014, 2015 was a very clean year for ozone pollution. Surface ozone is typically worst between May and September, as warm temperatures, more direct sunlight and weaker winds increase ozone concentrations. This summer period is also known as the "ozone season". Unlike upper atmospheric ozone, which protects us from harmful UV radiation emitted by the Sun, surface ozone can be detrimental to both humans and plant life. Surface ozone can lead to numerous adverse health effects including reduced lung function, inflammation of airways, chest tightness and shortness of breath. Ozone is one of six criteria pollutants under the National Ambient Air Quality [Health] Standards (NAAQS). In 2015, when the daily 8-hour average ozone concentration exceeds 75 ppb, or 100 on the Air Quality Index (AQI) (*see bottom of page),* it is deemed unhealthy for sensitive groups (USG). Days which fall into this category are known as "exceedance days" and can be a valuable indicator of the ozone season severity. In 2015 there were eight exceedance days; the second fewest number of days Maryland has experienced since ozone measurements began back in 1980 *(see Table 1).*

Maryland 2015 Ozone Exceedance Days

Date	No. of Monitors Exceeding 100 AQI	Highest AQI Monitor	8-Hr Average Ozone AQI
11-Jun	6	Fair Hill	161
7-Aug	1	Fair Hill	109
15-Aug	1	Padonia	101
2-Sept	2	Edgewood	132
4-Sept	3	Aldino	111
16-Sept	6	Furley	116
17-Sept	4	Padonia	119
18-Sept	2	Rockville	106

Table 1: 2015 Maryland ozone exceedance days. Highest monitor is noted along with its color coded 8-hr AQI value.

SEASONAL HIGHLIGHTS

2015 was an anomalous year for both the near-record low exceedance day count and when those days occurred. Typically, Maryland exceedance days occur when surface temperatures are warmest and sunlight is most direct during the months of June and July. In fact, over 50% of Maryland's total exceedance days typically occur within these two months alone. Of the eight exceedance days in 2015, only one fell within this time frame. A large factor in determining June's low number of exceedance days was the abundance of precipitation Maryland experienced. BWI reported 13.09'' of rain in the month of June. This was nearly 10'' higher than average! In total, there were eighteen days with measureable precipitation during the month. With more precipitation comes more cloud cover as well as more instability and mixing at the surface, which favor lower ozone concentrations and fewer exceedance days. July on the other hand, was right around average for both precipitation as well as temperature. BWI measured seven days in July where the daily high temperature hit 90°F or higher. On average, there is typically twelve days where this threshold is met. In addition to this, a large area just upwind in the Midwest region experienced temperatures which were below normal *(Figure 1)*. Typically, ozone and ozone precursors originate in states to Maryland's west and travel here by the prevailing westerly wind. Lower than normal temperatures in this area caused lower than normal total NO_x emissions. These emissions are the precursors to Maryland's ozone. As a consequence, air entering Maryland from this region was cleaner than normal for the month of July and therefore Maryland reported zero exceedance days during this time frame.

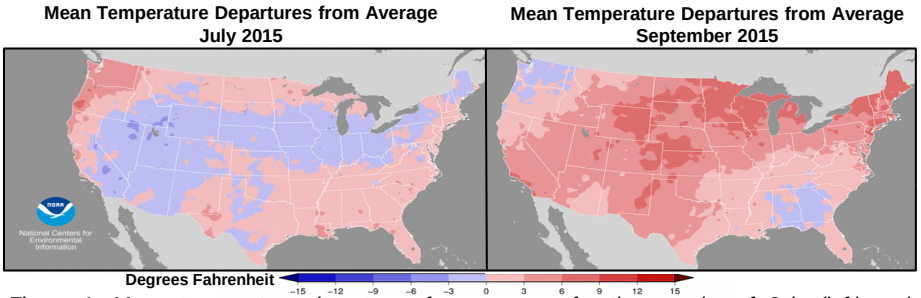

Figure 1: Mean temperature departures from average for the months of July (left) and September (right). Values are color coded in degrees Fahrenheit (see scale)

September on the other hand had an anomalously high amount of exceedance days. Five of the eight total days (62.5%) occurred in September *(refer to Table 1 as well as Figure 2)*. Typically, less than 10% of the total yearly exceedances fall within this month. The reason behind this is due to both the temperature and precipitation during this time period. September was drier than normal at BWI with 3.25'' of precipitation as compared to and average of 4.03''. Of that 3.25'', 2.69'' fell on one day alone! In total there were only four days with measurable precipitation during the month of September. With less precipitation there were fewer clouds and more direct sunlight, aiding ozone production. Temperatures in Maryland for the month of September were quite warm as well. BWI averaged 4.1°F warmer than normal. More importantly, not only was Maryland warm but the majority of the U.S was well above normal also *(as seen in Figure 1)*. Higher than normal temperatures in the Midwest caused higher than normal total NO_x emissions (ozone precursor). As a consequence, the air entering Maryland was dirtier and contributed to more ozone exceedance days in September.

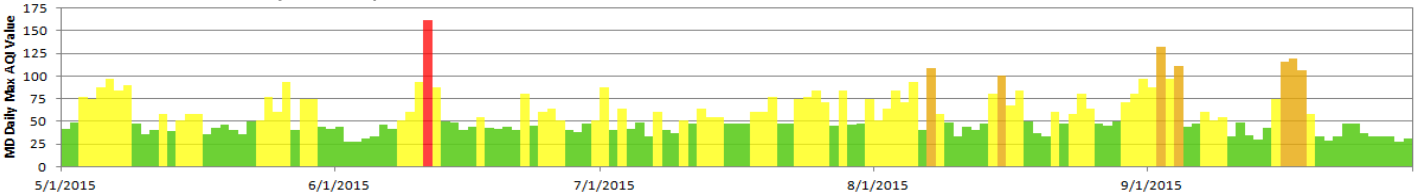

Figure 2: Maximum daily 8-hour ozone AQI in Maryland from May 1 – September 30, 2015. Bars are color coded by AQI.

AQI 0-50 Good	51-100 Moderate	101-150 USG*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

*Unhealthy for Sensitive Groups Based on 2008 8-hour ozone NAAQS

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Source: National Climate Data Center (NCDC)

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THE NEW STANDARD MOVING FORWARD

On October 1, 2015, the U.S. Environmental Protection Agency (EPA) lowered the NAAQS for ground-level ozone to 70 parts per billion (ppb). Previously, including the entire 2015 ozone season, the NAAQS was set at 75 ppb. This now means that in the future in order for a day to be classified as an exceedance day, the 8-hour average surface ozone concentrations will only need to be greater than 70 ppb. The big question is, how will the new standard impact Maryland's total number of exceedance days in the future? In all likelihood, given similar meteorological conditions, the total number of exceedance days will increase. When looking back at the 2015 ozone season for Maryland, while using the new standard of 70 ppb the total number of exceedance days jumped from eight to nineteen. Similarly in 2014, the number of exceedance days rises from five to eleven. This change of the standard was made based on extensive scientific evidence about ozone's effects on public health and welfare. The updated standard will help improve public health protection and awareness, particularly for at-risk groups. In addition, the lower standard will improve protection for trees, plants and ecosystems alike.

FEATURED EVENT – JUNE 11, 2015

New wildfires broke out between the 5th and 7th of June in the northern provinces of Saskatchewan and Alberta, Canada *(Figure 4)*. A fairly deep trough over the eastern half of the United States allowed for the large smoke plume to work its way south and east. By June 9th, the large smoke plume was making its way through the Midwest (*as seen in Figure 3)*. During this same time frame, a cold front passed through the Maryland region. This allowed for a general sinking of air before the onset of the smoke plume. By June 10th, the smoke reached Maryland and persisted through June 11th. What is interesting to note is that despite the smoke plume overhead on June 10th, Maryland did not experience and ozone exceedance day. The highest monitor was Padonia, with an AQI of 93. It wasn't until June 11th, where Maryland saw several monitors pushed into USG and even the Unhealthy category. So what was the reason behind the delayed spike in ozone concentrations? The answer can be tied to both meteorological and chemical interactions during this time frame.

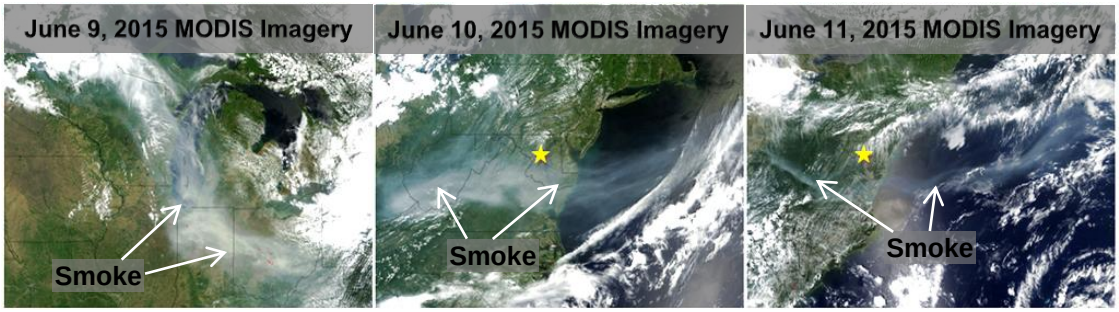

Figure 3 : MODIS imagery from June 9-11 showing smoke plume as it tracked across the Midwest into Maryland. Star on map is location of BWI.

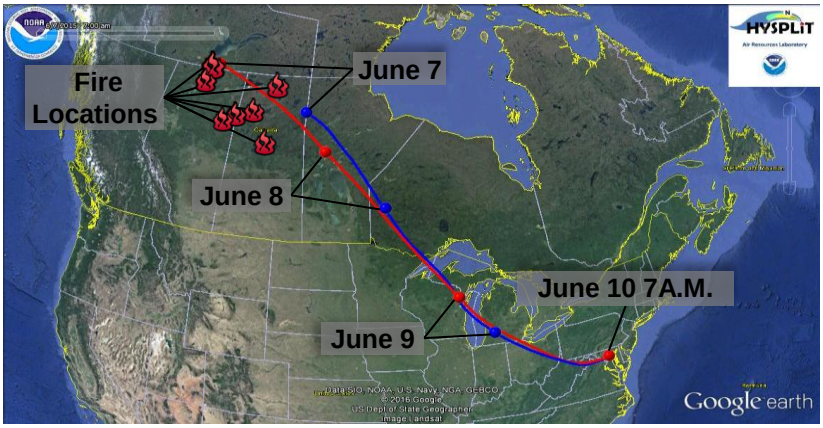

Figure 4: 72- hour backward trajectories starting June 10 at 7 A.M. Blue line is 2000 meters above ground level and red is 3000 m AGL. Points plotted at 24-hour intervals showing air mass location. Forest fires locations plotted accordingly.

Chemically, in order for ozone to be created there is an interaction between nitrogen oxides (NO_x) and volatile organic compounds (VOC's). VOC's, commonly found in smoke did not peak until June 11th. In fact, when looking at the numbers for individual VOC's, many doubled and even tripled from June 10th to June 11th. Meteorologically, a predominantly westerly flow on June 11th brought in NO_x rich air from the Ohio River Valley. In addition to the increased NO_x present (especially along the I-95 corridor), temperatures also rose between the 10th and 11th. BWI reported a high temperature of 93°F on June 11th versus only 84°F on June 10th. All of these ingredients came together to create a "perfect storm" leading to very high ozone concentrations on June 11th. High NO_x and VOC concentrations along with very warm surface temperatures set the stage for ozone to be created very quickly and efficiently.

In total, six monitors reached the code orange or higher level. The highest monitor (Fair Hill) reached an AQI value of 161. This was the worst air quality in Maryland since June 29th, 2012.

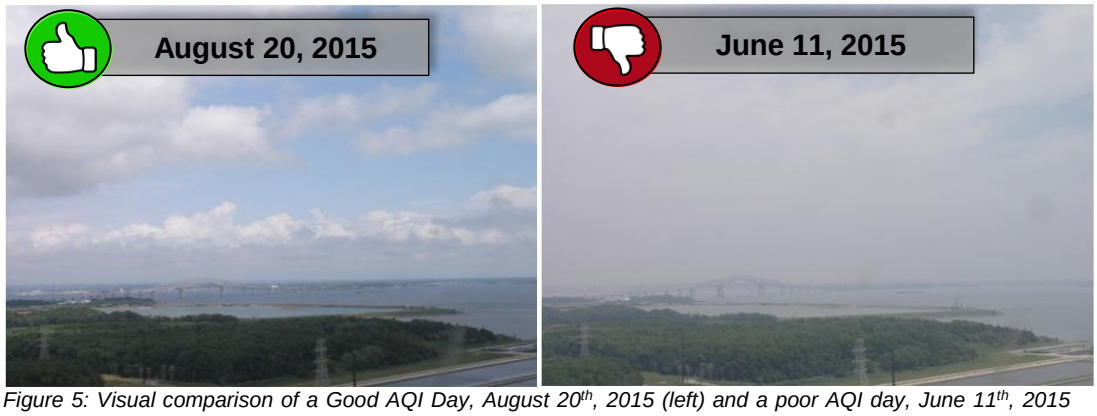

Figure 5: Visual comparison of a Good AQI Day, August 20th, 2015 (left) and a poor AQI day, June 11th, 2015 (right). Poor day is showing the visibility of the featured event date.

AQI	0-50 Good	51-100 Moderate	101-150 USG*	151-200 Unhealthy	201-300 Very Unhealthy	301-500 Hazardous

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