Seasonal Report

2020 Ozone

OVERVIEW

2020 was an extremely clean year for ozone pollution across the state of Maryland and continued the trend of cleaner air in recent years. Ground level ozone is a secondary air pollutant which is created through the interaction between NO_x and volatile organic compounds (VOCs). Meteorological factors such as warm temperatures, ample sunshine and weak surface winds help provide a very conducive ozone formation environment. Typically the "ozone season" begins in April, persisting through September. Unlike ozone in the upper atmosphere that shields the Earth from harmful solar radiation, ground level ozone adversely affects the human respiratory system. Some adverse health effects include reduced lung function, inflammation of airways, chest tightness, and shortness of breath to name a few. The Environmental Protection Agency (EPA) sets the National Ambient Air Quality Standards (NAAQS) for six criteria pollutants, including ozone. When the maximum daily 8-hour average ozone concentration exceeds 70 parts per billion (ppb), or 100 on the Air Quality Index (AQI) (see bottom of page), it is deemed unhealthy for sensitive groups (USG). A day that meets this criteria is referred to as an "exceedance day", and can be a key indicator of the ozone season's severity. The 2020 ozone season saw only three exceedance days (*see Figure 1*), by far the fewest total in Maryland's 40 years of measuring ground level ozone.

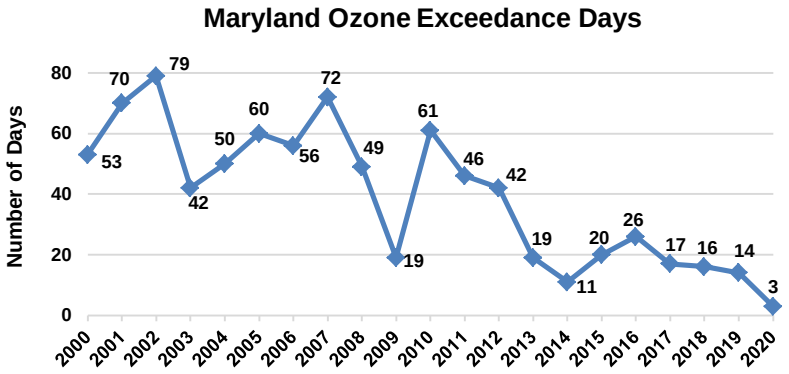

Figure 1: Total number of Maryland ozone exceedance days using the EPA 2015 70 ppb standard, 2000 – 2020.

Maryland 2020 Ozone Exceedance Days

Date	Day	No. of Monitors	Highest AQI Monitor	8-Hr Average Ozone AQI
9 Jun	Tue	1	Padonia	105
18 Jul	Sat	1	Glen Burnie	108
29 Jul	Wed	4	Edgewood	119

Table 1: Maryland 2020 ozone exceedance days. Day of week is noted along with highest reading monitor and its color coded 8-hr AQI value.

METEOROLOGY HIGHLIGHTS

The 2020 ozone season, similar to 2019, got off to a very slow start. Meteorologically, temperatures were well below normal to start the ozone season in April and May. May was in fact the 14th coolest on record for the state of Maryland. Although precipitation wasn't persistent and widespread over this timeframe, it was enough to keep any significant ozone buildup to a minimum. Over the first two months of the ozone season, Maryland only experienced eight days (13%) where the daily maximum 8-hour ozone concentration reached a Moderate AQI. Of these eight days the highest measured was only 59 ppb (May 13th), far from reaching the exceedance day level threshold of 70 ppb (*See Figure 3*).

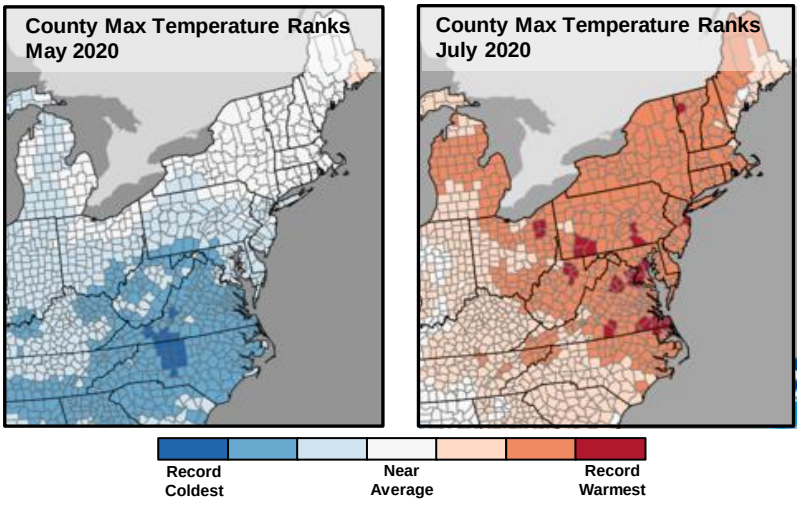

Figure 2: May 2020 county temperature ranks (left) and July 2020 county temperature ranks (right). Source: NOAA/NCDC Climate Division.

Temperatures began to warm up in June with July being the warmest in Maryland's recorded history. BWI Airport recorded a maximum temperature at or exceeding 90°F on 28 of July's 31 days. Ozone conducive patterns also became a bit more frequent. All three of Maryland's ozone exceedance days occurred during this two month window. Maryland's first ozone exceedance day of 2020 occurred on June 9th, the second latest in Maryland. Despite favorable meteorology, the high ozone over this time period was very isolated. Of the three ozone exceedance

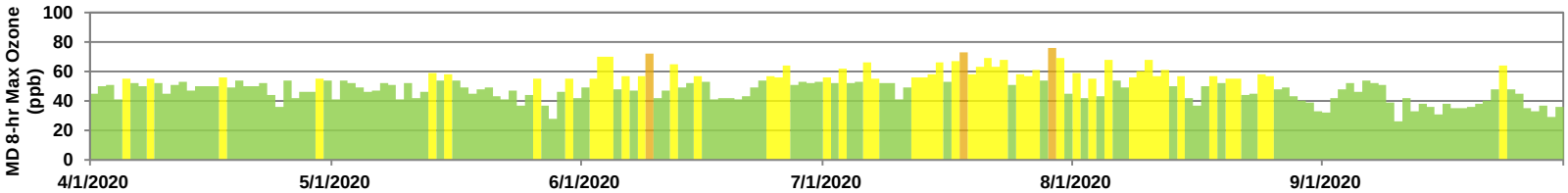

Figure 3: Maximum daily 8-hour ozone concentration (ppb) in Maryland from April 1 – September 30, 2020. Bars are color coded by AQI.

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 2015 8-hour ozone NAAQS

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METEOROLOGY HIGHLIGHTS (*cont.*)

days in Maryland, two of them were set by just one monitor (*See Table 1*). By August and September, ozone formation was limited as precipitation became much more frequent and temperatures returned to more seasonal norms. Of the 30 days in September, 29 (97%) had a maximum 8-hour ozone level in the Good AQI range.

OZONE AND COVID-19

In early March of 2020, Maryland declared a state of emergency to reduce the spread of COVID-19. Lockdowns were set in place as people were forced to curtail travel and stay at home. This disruption to the economy provided a unique opportunity to assess any impact to ozone. When measuring ozone, one critical pollutant to examine is NO_x, as it is a precursor to ozone formation. Vehicles are responsible for a large chunk of NO_x in our atmosphere. In fact, the transportation sector is responsible for over 55% of the total NO_x emissions in the United States.

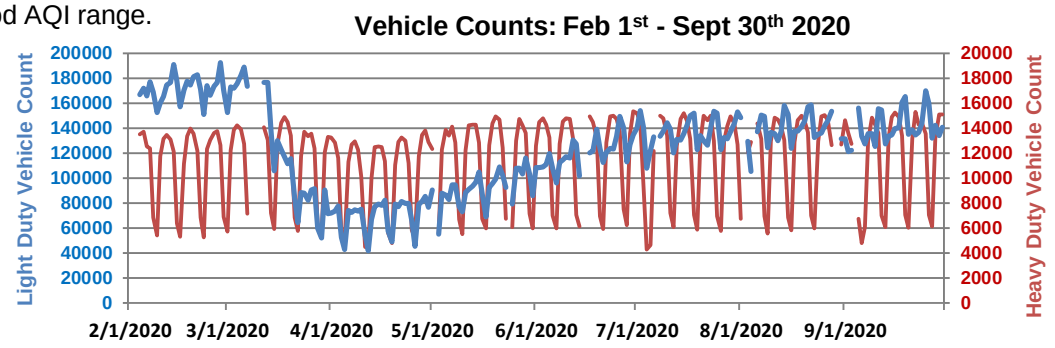

Figure 4: Vehicle counts along I-95 between D.C and Baltimore at the Howard County Near Road Station. Blue line indicates light duty vehicles (*passenger cars*), red indicates heavy duty vehicles (*tractor trailers*).

Figure 4 shows the light duty and heavy duty vehicle counts along I-95 between February and September 2020. It is interesting to first note the wave-like variability on a week to week basis, with the fewest vehicle counts typically falling on Sundays (*and holidays*). Prior to COVID-19 lockdowns in February and early March, the average weekday light duty and heavy duty vehicle counts were roughly 175,000 and 13,000, respectively. As COVID-19 lockdowns began taking place in mid-March, there were significant drops in traffic and total vehicles on the road. By April, light duty vehicle counts along I-95 saw a reduction of over 50%! Tractor trailer trucks saw a drop as well, but not nearly to the extent as passenger vehicles as people still relied on essential goods to be delivered. May and June saw a gradual increase in light duty vehicle counts as folks starting going back to work and some COVID-19 restrictions were lifted. By July, both light and heavy duty vehicle counts flat lined as the "new norm" was established. Light duty vehicle counts were still down roughly 20% when compared to the "pre-COVID" time frame. On the other hand, heavy duty vehicles saw an increase of roughly 8% as people relied more on home delivery of goods and keeping store shelves stocked. It is worth noting however that this data reflects major interstate traffic where commuter traffic is high and may not be synonymous with localized roads.

It is difficult to quantify the total NO_x reduction that Maryland and upwind states experienced over the 2020 ozone season due to COVID-19 protocols. One way to give a best guess is by examining satellite measurements year over year. The TROPOsheric Monitoring Instrument (aka TROPOMI) is a sensor on the Copernicus Sentinel-5 Precursor satellite which has the ability to measure several pollutants, including nitrogen dioxide (NO_2). NO_2 is a key component of NO_x, which makes NO_2 a valuable part of the ozone formation puzzle. Daily satellite retrievals can be averaged together over an entire season and then compared over similar time frames. Figure 5 shows the percent change in TROPOMI measured NO_2 for the 2019 ozone season versus 2020. Blue values indicate that 2020 measurements were lower than in 2019 where as red values indicate that 2020 values were higher. As you can see across Maryland and much of the Mid-Atlantic, there were significant reductions in satellite measured NO_2 during the ozone season in 2020 versus 2019. These measurements don't take into account any variances in meteorology from year to year, although the temperatures and weather patterns in these two years were fairly comparable. Maryland saw a roughly 20-25% decrease in satellite measured NO_2 versus the 2019 ozone season. With significant NO_2 reductions over the 2020 ozone season noted from satellite measurements along with the reduction in interstate traffic, the question then becomes how much did these reductions play into the very limited number of ozone exceedance days in 2020? Although Maryland only experienced three exceedance days in 2020, there were several days where the maximum 8-hr ozone concentration was very close to exceeding the standard with eight days within just 3ppb of the 70ppb ozone standard.

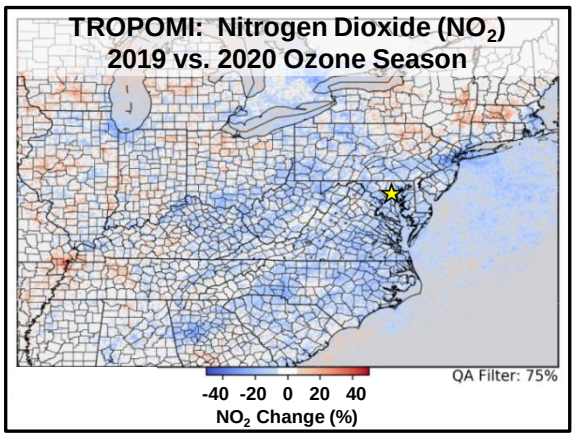

Figure 5: Percent Change in TROPOMI Tropospheric Column NO_2 across the Mid-Atlantic between the ozone seasons of 2019 and 2020. Baltimore is indicated by yellow star.

It is difficult to say whether these eight near-exceedance days would have been higher given a more "typical" ozone season as far as vehicle traffic is concerned. In all likelihood the total number of ozone exceedance days in 2020 would have been higher. It is interesting to note however that even if these eight additional days did exceed the ozone standard, 2020 still would have been one of the cleanest seasons on record. This is in large part due to the continued success of regulations to reduce emissions from NO_x both statewide and regionally along with reductions to vehicle emissions in recent years.

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 2015 8-hr ozone NAAQS. Denotes the USG