Seasonal Report

2024 Ozone

OVERVIEW

The 2024 Maryland ozone season was the 4th cleanest in recorded history despite record global heat. Surface ozone is a secondary air pollutant created through the interaction between nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Sources for these pollutants include but are not limited to vehicles, power plants and biomass burning. Ozone production is most prevalent between April and September where more direct sunlight, warm temperatures and generally weaker surface winds provide a suitable ozone formation environment. Unlike upper atmospheric ozone, which protects us from harmful UV radiation emitted by the Sun, surface ozone can be detrimental to human health. Exposure to elevated ozone levels can lead to adverse health effects such as respiratory issues, particularly for vulnerable groups like children, the elderly, and individuals with pre-existing lung conditions such as asthma. To mitigate health risks, it is essential to monitor local air quality conditions and limit outdoor activities when ozone concentrations are high. To more easily communicate air quality conditions to the public, the Environmental Protection Agency (EPA) developed the Air Quality Index (AQI) (*see bottom of page*). When the daily 8-hour average ozone concentration exceeds 70 parts per billion (ppb), or 100 on the AQI scale, it is deemed unhealthy for sensitive groups (USG). Days in which the 8-hour average meets this criteria are coined "exceedance days." A total count of exceedance days each year can be a key indicator of the ozone season's severity. Maryland recorded just 13 ozone exceedance days in 2024 (*see Figure 1*).

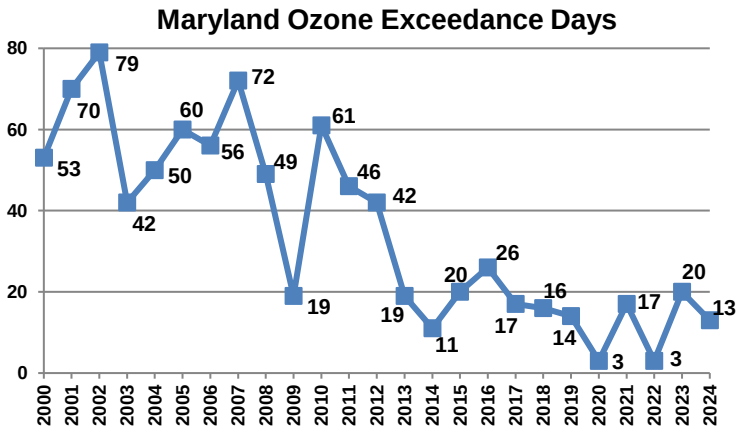

Figure 1: Total number of Maryland ozone exceedance days using the EPA 2015 70 ppb ozone standard, 2000 – 2024.

SEASONAL HIGHLIGHTS & STATISTICS

Temperatures across Maryland were well above normal during the 2024 ozone season (April – September). The April – September daily maximum temperatures in Maryland ranked in the top 95th percentile of recorded history (123rd of 130 years) (*see Figure 2*). Maryland's Baltimore/Washington International Thurgood Marshall Airport (BWI) recorded 45 days reaching or exceeding 90˚F in 2024. This is roughly 12 days above normal, ranking it the 14th most dating back to 1980. Several periods over the ozone season experienced extreme temperatures, with 6 record breaking or tying days recorded at BWI. A notable stretch occurred between July 14th and 17th, when temperatures soared above 100˚F for 4 consecutive days. The peak of this intense heatwave came on July 16th, with temperatures climbing to an astonishing 104˚F! Despite the extreme heat during this four-day window, there was just a single monitor ozone exceedance recorded on the final day (*see Table 1*). Furthermore, despite many surrounding states recording above average precipitation, conditions across Maryland were drier than normal, ranking in the 25th percentile (30th of 130 years) (*see Figure 2*). Dry weather during the ozone season is typically linked to more sunshine and in turn more favorable conditions for ozone formation. Despite the dry and unseasonably warm conditions across the state during the ozone season, Maryland experienced the 4th fewest ozone exceedance days (13) in recorded history. This is clear evidence of the tremendous strides that Maryland and surrounding states

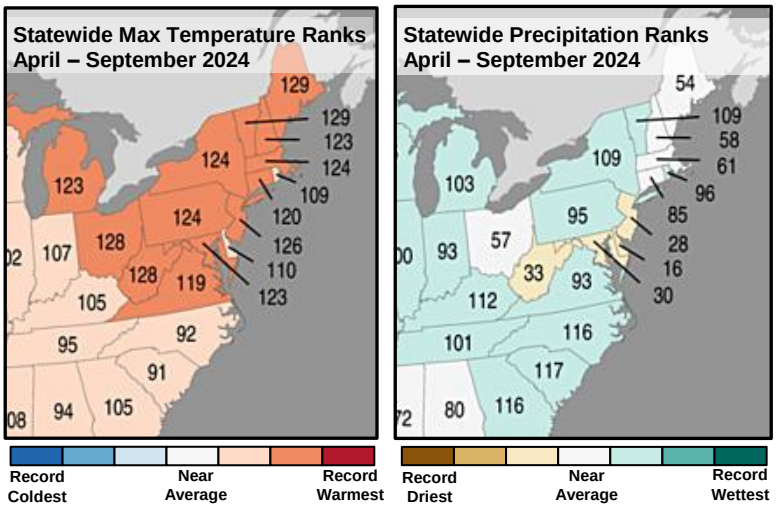

Figure 2: April – September 2024 statewide temperature ranks (left) and precipitation ranks (right). Numerical values represent the ranking warmest over the past 130 years of record. Source: NOAA/NCDC Climate Division.

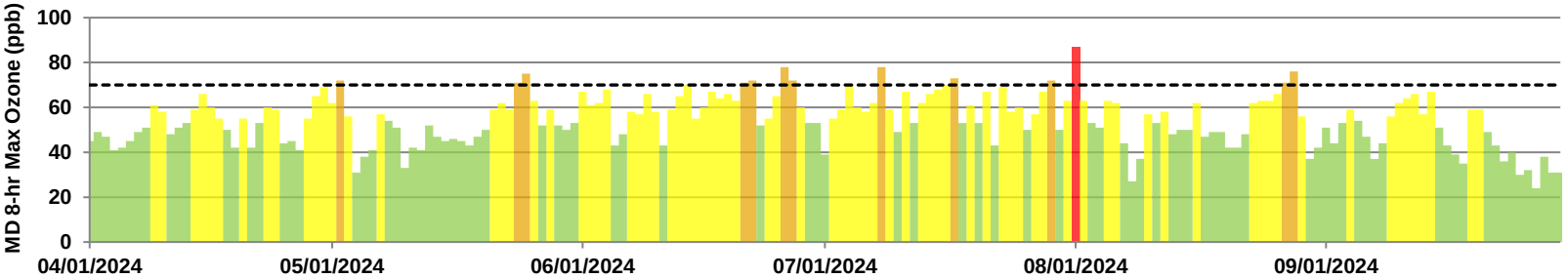

Figure 3: Maximum daily 8-hour ozone concentration (ppb) in Maryland from April 1 – September 30, 2024. Bars are color coded by AQI.

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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SEASONAL HIGHLIGHTS & STATISTICS (*cont.*)

have made towards improving air quality across the region.

Ozone exceedance events are often isolated to a few monitors in recent years. Widespread ozone exceedance day events have become few and far between. Of the 13 ozone exceedance days in Maryland in 2024, eight were triggered by just one or two monitors (~62%) with many of these events just squeaking over the 100 AQI standard (See Table 1). Local and regional NO_x emissions in recent years have reached a point where it is difficult to create widespread exceedance level ozone despite even the most favorable of meteorology. The reduction in NO_x emissions from vehicles and power plants has also shed light on the importance of wildfire smoke in ozone formation. Wildfires are emitters of both NO_x and VOCs, the two major components needed for the formation of ground level ozone. Major smoke events of 2023 showed the significance of wildfire smoke and its impact on air quality. Diffuse smoke from Canadian or Western Pacific fires used to be overshadowed by local NO_x and VOC emissions. These wildfire smoke events and their link to ozone formation can be picked out much easier now as regional emissions continue to decrease. 2024 saw several ozone exceedance days linked to long range diffuse smoke transport. August 1st, 2024, a day which saw the highest ozone of the year across Maryland with 10 ozone monitors exceeding (see *Table 1*), was linked to diffuse smoke from Canadian and Western U.S. fires.

Maryland 2024 Ozone Exceedance Days

Date	Day	No. of Monitors	Highest AQI Monitor	8-Hr Average Ozone AQI
2 May	Thur	1	Millington	105
24 May	Fri	1	Lake Montebello	101
25 May	Sat	4	Padonia	115
21 Jun	Fri	1	Lake Montebello	101
22 Jun	Sat	2	Beltsville	119
26 Jun	Wed	3	Fair Hill	126
27 Jun	Thur	1	Essex	105
8 Jul	Mon	4	Fair Hill	126
17 Jul	Wed	1	Edgewood	108
29 Jul	Mon	2	HU-Beltsville	105
1 Aug	Thur	10	Edgewood	154
27 Aug	Tue	1	Lake Montebello	101
28 Aug	Wed	5	So. Maryland	119

Table 1: Maryland 2024 ozone exceedance days. Day of week is noted along with highest reading monitor and its color coded 8-hr AQI value.

EXPOSURE HOUR: AN ALTERNATIVE LOOK AT OZONE

The EPA Design Value is the current metric for evaluating compliance with the Clean Air Act. Ozone Design Values are constructed as a three-year average of the annual fourth-highest daily maximum 8-hour average concentration. For instance, the 2024 ozone design value considers ozone from 2022, 2023, and 2024. While useful as an indicator, a site's design value and in turn its attainment status is defined by peak concentrations and/or peak days, however, both magnitude and duration of pollutant concentration determine exposure and the resultant human immune response. The form of the design value (i.e., top four days) does not track the frequency of ozone exposure. Furthermore, using exceedance days as a metric (e.g., Figure 1) can miss periods of high ozone on days that do not meet the 8-hour criteria for an official exceedance or be included in the design value calculation. For example, suppose one location experiences four days of 72 ppb for a maximum 8-hour average ozone (MD8AO) while another location experiences sixteen days of 72 ppb MD8AO each of the last 3 years. The two sites have an equal design value calculation though constituents at the latter site would be exposed to four times as many instances of "exceeding" ozone. An ability to quantify the difference in the ozone exposure between the two locations would be useful.

The following discussion presents a solution using a new methodology called the "Exposure Hour". Similar to heating or cooling degree days, the pollutant hour is a count of hours above a certain threshold. For example, using the 70 ppb threshold, a day with three hours above 70 ppb, such as 71, 78, and 76 ppb, would have a total of 15 ppb-hours (1 + 8 + 6). The total number of ppb-hours can be tallied at a given location over the ozone season. Figure 4 highlights cumulative ozone ppb-hours (using a 70 ppb threshold) for various years between 2010 and 2024 at the Essex monitor near downtown Baltimore. A nearly 90% reduction in ozone exposure is observed when comparing 2010 (2452 ppb-hrs) versus 2024 (278 ppb-hrs). In contrast, the design value at Essex went from 78 ppb to 71 ppb over the same period, indicating a muted 9% difference in exposure. 2020 saw the lowest number of ppb-hours (80) largely in part due to Covid-19 restrictions while 2023 (883 ppb-hrs) was significantly higher versus 2024 (278 ppb-hrs) due to significant impacts from Canadian wildfires on air quality. Using the ppb-hour, the magnitude of an ozone season can now also be quantified and compared both inter-seasonally, intra-seasonally, and spatially providing a means for measuring total exposure.

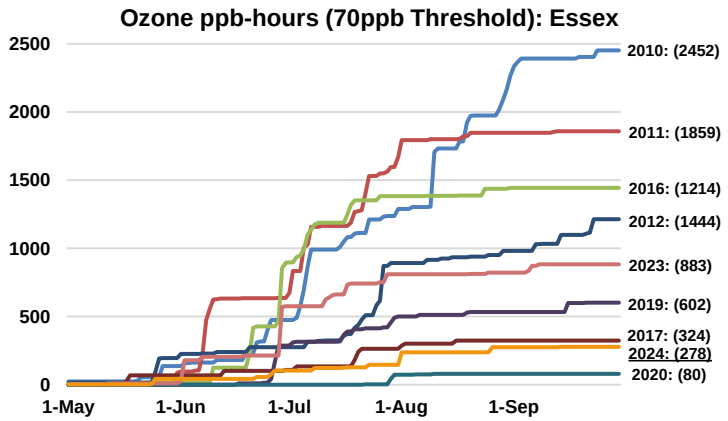

Figure 4: Ozone ppb-hours over the course of the season for various years highlighted between 2010 and 2024 at Essex. 2024 in orange is underlined.

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

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