Seasonal Report

2021 Fine Particles ($PM_{2.5}$)

OVERVIEW

Like recent years, 2021 was another very clean year for fine particulate ($PM_{2.5}$) pollution for the state of Maryland. $PM_{2.5}$ is one of six criteria pollutants which have a National Ambient Air Quality [Health] Standard (NAAQS) set by the Environmental Protection Agency (EPA). $PM_{2.5}$ can come from several different direct sources including vehicle exhaust, power plants, industrial processes, and wildfires. $PM_{2.5}$ can even be created by reactions between different types of pollution, water vapor and sunlight. Given their small size (<2.5µm in diameter), $PM_{2.5}$ can travel deep into the lungs and even pass to the bloodstream resulting in adverse health effects. When the midnight to midnight daily 24-hour average $PM_{2.5}$ concentration exceeds 35.4 µg/m³, or the equivalent of 100 on the Air Quality Index (AQI) (see bottom page) it is deemed unhealthy for sensitive groups (USG) and is otherwise known as an "exceedance day". Maryland has seen a significant decrease in the number of $PM_{2.5}$ exceedance days (See Figure 1) over the past 15+ years due in large part to the adoption of regulations to reduce emissions. Since 2014, $PM_{2.5}$ exceedance days have become few and far between. In fact, Maryland recorded just one day in 2021 where the AQI exceeded the USG threshold of 100.

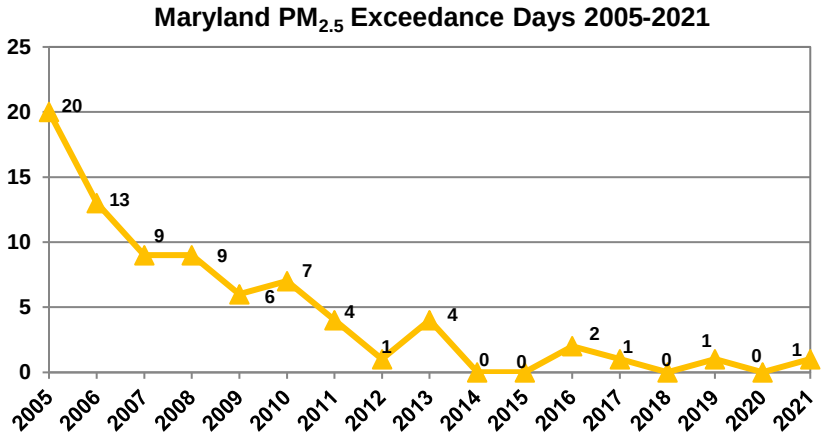

Figure 1: Annual number of days where the AQI surpassed 100 at any $PM_{2.5}$ monitor in Maryland, 2005-2021.

SEASONAL HIGHLIGHTS & STATS

When looking at the maximum daily $PM_{2.5}$ concentrations across the state, Maryland had 275 Good AQI days in 2021. This is roughly 75% of days. Although this is fewer Good AQI days versus 2019 and 2020, it still follows the steady upward trend over the past 15+ years (Figure 2). Since the number of $PM_{2.5}$ exceedance days in Maryland has been at all-time lows in recent years, a good alternative is to look at the number of "haze days". The term haze day is defined as when the daily maximum $PM_{2.5}$ concentration exceeds 25 µg/m³ (78 AQI). On these days, the air is perceptibly hazy. Maryland saw only three days which fit this criterion in 2021 (Figure 3). This annual number matches the fewest haze days in Maryland's recorded history.

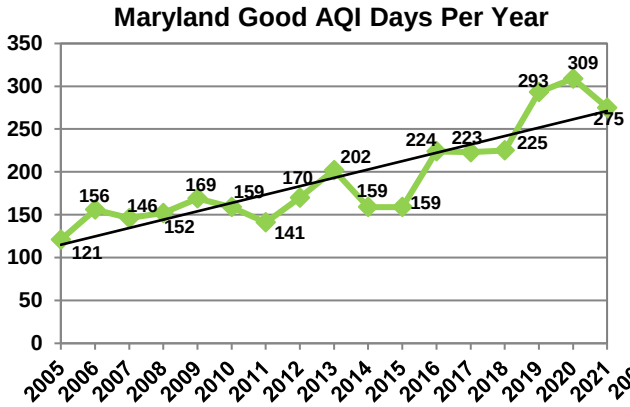

Figure 2: Number of days where the highest $PM_{2.5}$ monitor remained at or below and AQI of 50 (Good) in Maryland, 2005-2021. Black trend line is included.

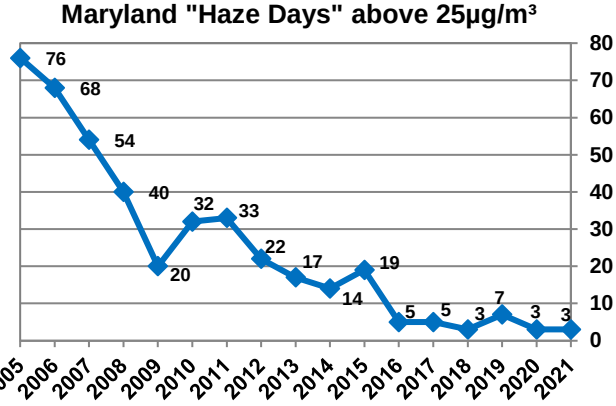

Figure 3: Number of days where $PM_{2.5}$ concentrations reached 25 µg/m³ or greater at any monitor in Maryland, 2005-2021.

Summer months are beginning to be a growing concern for Maryland's $PM_{2.5}$ levels as large wildfires across the Western US and Canada occur perennially, enhanced by prolonged drought periods that exacerbate fire conditions. The Hazard Mapping System (HMS) has become a very important tool to track wildfire and associated smoke plumes. HMS uses existing air sensors and a suite of environmental satellites to create a daily fire and smoke analysis over the US and Canada *(See Figure 4)*. During the 2021 summer season (April – September), HMS analyzed smoke over Maryland on 19 days of which 17 days (~90%) had a 24-hour maximum $PM_{2.5}$ concentration greater than 15 µg/m³. In fact, the three "haze days" (July 19th-21st) and one exceedance day (July 20th) in Maryland were all tied to dense wildfire smoke across the state. This three-day wildfire smoke event will be discussed in the next section. For the latest HMS products and information, please visit here.

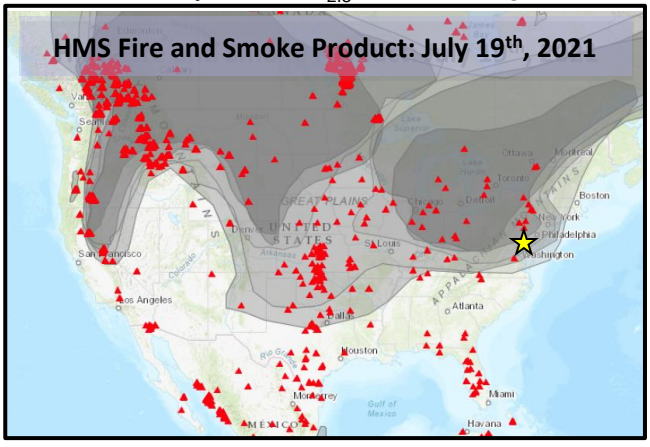

Figure 4 (Left): HMS Fire and Smoke Product for one of the three "Haze Days" in 2021, (July 19th). Red triangles indicate fire locations and shaded grey areas indicate areas of smoke. Darker greys signify denser smoke. Baltimore location is noted by a yellow star.

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

*Unhealthy for Sensitive Groups

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard | Baltimore, MD 21230
410-537-3000 | 1-800-633-6101
Larry Hogan, *Governor* | Boyd Rutherford, *Lt. Governor* | Ben Grumbles, *Secretary*

Seasonal Report

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FEATURED EPISODE: Wildfire Smoke Event: July 19th-21st

Hundreds of large fires burned across south central Canada and the Pacific Northwest during the month of July as excessive heat and limited moisture plagued the region. One of the more well-known blazes was the "Bootleg" fire, which burned over 400,000 acres across Oregon and was the third largest fire in Oregon's history since 1900. The smoke emitted by these fires was dense and voluminous, enabling it to travel thousands of miles from the initial source.

Beginning July 15th, while these wildfires were near peak strength, high pressure developed over the US Northern Plains and slowly tracked east towards the Great Lakes, pushing smoke eastward as a result. By July 18th, high pressure was positioned over the Great Lakes and remained nearly stationary for several days. Clockwise flow around it helped to bring the large smoke plume south towards Maryland *(See Figure 5)*. Meanwhile, a slow moving cold front began to approach from the north. This front consolidated and dropped the smoke plume towards the surface. Elevated $PM_{2.5}$ levels due to the smoke were first witnessed across Maryland during the morning and early afternoon hours of July 19th. Figure 6 below shows the heavily reduced visibility due to thick smoke $PM_{2.5}$ during the afternoon hours of July 19th across western Maryland. $PM_{2.5}$ concentrations were elevated across the state on the 19th, but remained in the Moderate AQI range for a midnight to midnight 24-hour average. The highest 24-hour $PM_{2.5}$ concentration was at the Padonia air monitor (*just north of Baltimore City*), reaching 25.38 µg/m³ (*78 AQI*).

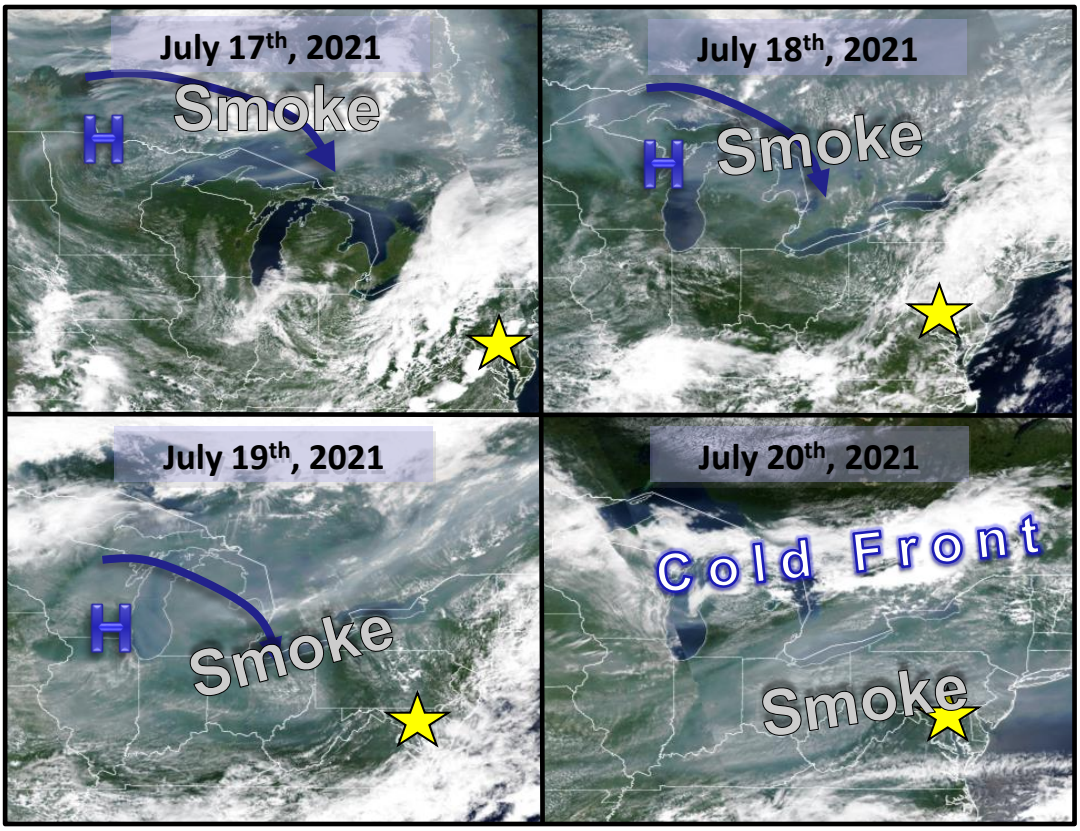

Figure 5: Visible MODIS satellite imagery on the afternoons of July 17th - 20th(top left to bottom right). High pressure location is noted each day along with circulation arrow. Smoke location is indicated and labeled. The cold front mentioned in the write-up is labeled on July 20th and is discernible by the thick white clouds along the Canadian/US border. Location of Baltimore is noted by yellow star.

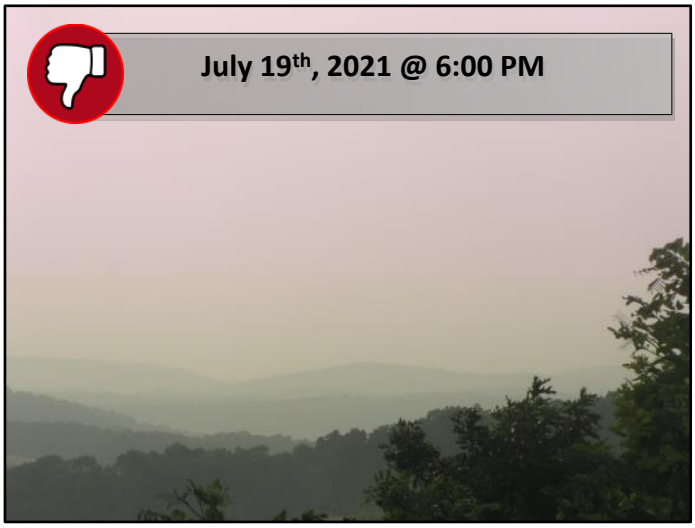

Figure 6: Haze cam imagery across western Maryland (Frostburg) highlighting the dense smoke and reduced visibly during the late afternoon hours on July 19th, 2021.

Dense smoke continued to push into the region from the north on the 20th. Skies were quite hazy as fine particulate levels remained elevated throughout the day, particularly across northeastern Maryland where hourly $PM_{2.5}$ concentrations pushed into the Unhealthy range. Smoke was also clearly visible on satellite over the region at this time as seen in the lower right panel of Figure 5 above.

Smoke continued to linger across the area for the first half of July 21st. However, during the afternoon hours, the previously mentioned cold front was finally able to push south through the state. This front acted like a bulldozer, pushing the dense smoke through the area and bringing in much cleaner air behind it. Despite high $PM_{2.5}$ readings in the morning, daily average $PM_{2.5}$ concentrations remained below USG, reaching 30.13 µg/m³ (*89 AQI*) in Maryland.

Despite widespread smoke across the state for a roughly 48-hour period, only two monitors exceeded (Fairhill & Padonia). Both of these exceedances occurred on July 20th in the northeast part of the state. Fairhill, in extreme northeastern Maryland, reached an impressive 42.42 µg/m³ for a 24-hour $PM_{2.5}$ concentration (*117 AQI*). This was the first $PM_{2.5}$ exceedance day in the state since December of 2019 and the first summer $PM_{2.5}$ exceedance day in Maryland since August 2011!

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